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UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No.	474139US01
First Named Inventor	Takeshi Okazaki
Title	Platform, Systems, and Methods for Identifying Property Characteristics and Property F
Express Mail Label No.	

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

1. ☐ **Fee Transmittal Form** (PTO/SB/17 or equivalent)
2. ☐ **Applicant asserts small entity status.** See 37 CFR 1.27
3. ☐ **Applicant certifies micro entity status.** See 37 CFR 1.29. Applicant must attach form PTO/SB/15A or B or equivalent.
4. ☑ **Specification** [*Total Pages* 51] Both the claims and abstract must start on a new page. *(See MPEP § 608.01(a) for information on the preferred arrangement)*
5. ☑ **Drawing(s)** (35 U.S.C. 113) [*Total Sheets* 15]
6. **Inventor's Oath or Declaration** [*Total Pages* 2] *(including substitute statements under 37 CFR 1.64 and assignments serving as an oath or declaration under 37 CFR 1.63(e))*
   a. ☑ Newly executed (original or copy)
   b. ☐ A copy from a prior application (37 CFR 1.63(d))
7. ☑ **Application Data Sheet** ** See note below.* See 37 CFR 1.76 (PTO/AIA/14 or equivalent)
8. **CD-ROM or CD-R** in duplicate, large table, or Computer Program (*Appendix*)
   ☐ Landscape Table on CD
9. **Nucleotide and/or Amino Acid Sequence Submission** (*if applicable, items a. – c. are required*)
   a. ☐ Computer Readable Form (CRF)
   b. ☐ Specification Sequence Listing on:
      i. ☐ CD-ROM or CD-R (2 copies); or
      ii. ☐ Paper
   c. ☐ Statements verifying identity of above copies

ADDRESS TO: **Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450**

ACCOMPANYING APPLICATION PAPERS

10. ☐ **Assignment Papers** (cover sheet & document(s)) Name of Assignee _____
11. ☐ **37 CFR 3.73(c) Statement** (*when there is an assignee*) ☐ **Power of Attorney**
12. ☐ **English Translation Document** (*if applicable*)
13. ☐ **Information Disclosure Statement** (PTO/SB/08 or PTO-1449)
    ☐ Copies of citations attached
14. ☐ **Preliminary Amendment**
15. ☐ **Return Receipt Postcard** (*MPEP § 503*) (*Should be specifically itemized*)
16. ☐ **Certified Copy of Priority Document(s)** (*if foreign priority is claimed*)
17. ☐ **Nonpublication Request** Under 35 U.S.C. 122(b)(2)(B)(i). Applicant must attach form PTO/SB/35 or equivalent.
18. ☐ **Other:** _____

Note*: (1) Benefit claims under 37 CFR 1.78 and foreign priority claims under 1.55 **must be included in an Application Data Sheet (ADS).
(2) For applications filed under 35 U.S.C. 111, the application must contain an ADS specifying the applicant if the applicant is an assignee, person to whom the inventor is under an obligation to assign, or person who otherwise shows sufficient proprietary interest in the matter. See 37 CFR 1.46(b).

19. CORRESPONDENCE ADDRESS

☑ The address associated with Customer Number: 146018 **OR** ☐ Correspondence address below

Name					
Address					
City		State		Zip Code	
Country		Telephone		Email	

Signature	/Natalie J. Grace/	Date	September 25, 2017
Name (Print/Type)	Natalie J. Grace	Registration No. (Attorney/Agent)	65,803

This collection of information is required by 37 CFR 1.53(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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ZESTY.AI EX1002 (Part 1 of 3)
U.S. Patent No. 10,529,029

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

PTO/AIA/01 (06-12)
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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	PLATFORM, SYSTEMS, AND METHODS FOR IDENTIFYING PROPERTY CHARACTERISTICS AND PROPERTY FEATURE MAINTENANCE THROUGH AERIAL IMAGERY ANALYSIS

As the below named inventor, I hereby declare that:

This declaration is directed to:

- [x] The attached application, or
- [ ] United States application or PCT international application number _____ filed on _____.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

WARNING:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

LEGAL NAME OF INVENTOR

Inventor: Takeshi Okazaki Date (Optional): 25 September 2017

Signature: Takeshi Okazaki

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 1 minute to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	Platform, Systems, and Methods for Identifying Property Characteristics and Property Feature Maintenance Through Aerial Imagery Analysis
First Named Inventor/Applicant Name:	Takeshi Okazaki
Filer:	Natalie J. Grace/Esther Carner
Attorney Docket Number:	474139US01

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
UTILITY APPLICATION FILING	1011	1	280	280
UTILITY SEARCH FEE	1111	1	600	600
UTILITY EXAMINATION FEE	1311	1	720	720
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**1600**

Electronic Acknowledgement Receipt

EFS ID:	30461603
Application Number:	15714376
International Application Number:	
Confirmation Number:	8275
Title of Invention:	Platform, Systems, and Methods for Identifying Property Characteristics and Property Feature Maintenance Through Aerial Imagery Analysis
First Named Inventor/Applicant Name:	Takeshi Okazaki
Customer Number:	146018
Filer:	Natalie J. Grace/Esther Carner
Filer Authorized By:	Natalie J. Grace
Attorney Docket Number:	474139US01
Receipt Date:	25-SEP-2017
Filing Date:	
Time Stamp:	15:47:59
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$1600
RAM confirmation Number	092617INTEFSW15484400
Deposit Account	601484
Authorized User	Esther Carner

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

37 CFR 1.16 (National application filing, search, and examination fees)

37 CFR 1.17 (Patent application and reexamination processing fees)

37 CFR 1.19 (Document supply fees)

37 CFR 1.20 (Post Issuance fees)

37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		474139US01_Specification.pdf	378423 3b69c2600ea4f93a3f4c4f28ec6cb5d2e9f59753	yes	51

Multipart Description/PDF files in .zip description

Document Description	Start	End
Specification	1	43
Claims	44	50
Abstract	51	51

Warnings:					
Information:					
2	Drawings-only black and white line drawings	474139US01_Drawings.pdf	2021628 85abb1da431a8353882c4f57561a594b6b9732ed	no	15
Warnings:					
Information:					
3	Application Data Sheet	474139US01_ADS.pdf	1822967 7e23fd274a6abe26f4dfd4b43cb39c17a6cef22b	no	8
Warnings:					
Information:					
4	Transmittal of New Application	474139US01_UtilityTransmittal.pdf	107646 186767b8e449dc3729dae6c2f8dd36263c26d13f	no	2
Warnings:					
Information:					
5	Oath or Declaration filed	474139US01_ExecutedDeclaration.pdf	324710 3ace94f2d829776c890e38c0e0814ac5f6f7dc22	no	2

Warnings:					
Information:					
6	Fee Worksheet (SB06)	fee-info.pdf	35262 c30f846ad2693d86bab7ece591bf72da9fc50296	no	2
Warnings:					
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			Total Files Size (in bytes):	4690636	

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

In the United States Patent and Trademark Office

Application for United States Patent

Title

Platform, Systems, and Methods for Identifying Property Characteristics and Property Feature Maintenance Through Aerial Imagery Analysis

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Inventor(s)

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Authorized Representative

Greg H. Gardella (Reg. No. 46,045)
Natalie J. Grace (Reg. No. 65,803)

Attorney Docket No.

474139US01

RELATED APPLICATIONS

[0001] This application claims priority to U.S. Provisional Patent Application Serial No. 62/398, 665, entitled "Platform, Systems, and Methods for Identifying Property Characteristics and Property Feature Maintenance Through Aerial Imagery Analysis," filed September 23, 2016, hereby incorporated by reference in its entirety.

BACKGROUND

[0002] A risk exposure database contains a compilation of as many building properties or characteristics relevant to insurance as possible. These properties can include characteristics like location coordinates, address, slope, and elevation, Other characteristics include construction type, occupancy type, year built and/or year of renovation, building height, soft stories, number of stories, and floor area. Further characteristics can include roof condition, roof shape, roof covering, roof anchors, roof equipment, cladding, and pounding (distance to closest building). Some of these characteristics can only be assessed by on-site inspections or by official documentation, but others can be measured using visual imagery.

[0003] Characteristics addressed in this disclosure include roof shape and roof condition. In one example, roof shapes can be broken into five categories: gambrel roof, gable roof, hipped roof, square roof, and flat roof. Each roof shape has a unique response and damage vulnerability to different natural perils like earthquake or wind.

[0004] Deep learning involves computational models composed of multiple processing layers to learn representations of data with multiple levels of abstractions. These models can be thought of as a way to automate predictive analytics. Representation learning is a set of methods that allows a machine to be fed with raw data and to automatically discover the representations needed for detection or classification. Use cases for deep learning include voice recognition, motion detection, translation, and medical diagnosis. By using deep

learning algorithms and sample datasets, computers can learn to distinguish and classify a wide range of characteristics to high levels of accuracy, often surpassing the recognition levels of human beings.

[0005] One model used for deep learning is the Network in Network model described in the paper "Network In Network" by M. Lin et al. and published in the International Conference on Learning Representations, 2014 (arXiv:1409.1556), the contents of which are hereby incorporated by reference in its entirety. Using the Network in Network model, a number of layers of artificial perception outcomes are generated using micro neural networks with complex structures. The artificial perception outcomes are then stacked and averaged to generate a single global average pooling layer for classification.

[0006] When applied to visual recognition, deep learning algorithms can break down an observation (e.g., an image) in a number of different ways to characterize features of the observation. In some examples, deep learning algorithms can be applied to review images as a set of intensity values per pixel, or in a more abstract way as a set of edges, regions of particular shape, etc. Some representations may demonstrate superior performance to others based upon the particular learning task. One of the promises of deep learning is replacing human identification of features with efficient algorithms for unsupervised or semi-supervised feature learning and hierarchical feature extraction.

[0007] The inventors recognized that deep learning methodology could be applied to risk exposure database population to analyze aerial imagery and automatically extract characteristics of individual properties, providing fast and efficient automated classification of building styles and repair conditions. In combining location-based vulnerabilities with individual property vulnerabilities identified in part through classification of repair conditions of one or more property features, risk of damage due to disaster can be more accurately estimated.

SUMMARY OF ILLUSTRATIVE EMBODIMENTS

[0008] The forgoing general description of the illustrative implementations and the following detailed description thereof are merely exemplary aspects of the teachings of this disclosure, and are not restrictive.

[0009] Systems, methods, and computing system platforms described herein support matching aerial image features of one or more properties to corresponding property conditions (e.g., maintenance levels of property features) through machine learning analysis. In a preferred application, the property condition analysis may be used in estimating damage risk in light of one or more disaster conditions, such as severe storms. The analysis may further aid in estimating costs of repair or replacement of each property, in one example, should a disaster cause the estimated damage. In another example, the analysis may be used to confirm that a property has been repaired.

[0010] In one aspect, the present disclosure relates to a method for automatically categorizing a repair condition of a property characteristic, including obtaining an aerial image of a geographic region including the property; identifying features of the aerial image corresponding to the property characteristic; analyzing the features to determine a property characteristic classification; analyzing a region of the aerial image including the property characteristic to determine a condition classification; and determining, using the property characteristic classification and the condition classification, a risk estimate of damage to the property due to one or more disasters. The property characteristic classification may be rooftop shape. Analyzing the features to determine a property characteristic may include applying a deep learning analysis model to the features. The deep learning analysis model may be NIN.

[0011] In some embodiments, analyzing the region of the aerial image including the property characteristic to determine the condition classification includes applying a machine learning

analysis model to image pixels within the region. The machine learning analysis model may include a color histogram analysis model. The condition classification may encompass classifications good and bad. Determining the risk estimate may include applying a disaster risk profile corresponding to a first disaster of the at least one disaster and the property characteristic.

[0012] In one aspect, the present disclosure relates to a system for automatically categorizing a repair condition of a property characteristic, the system including processing circuitry and a non-transitory computer-readable medium having instructions stored thereon. In some embodiments, the instructions, when executed by the processing circuitry, cause the processing circuitry to obtain an aerial image of a geographic region including the property; identify features of the aerial image corresponding to the property characteristic; analyze the features to determine a property characteristic classification; analyze a region of the aerial image including the property characteristic to determine a condition classification; and determine, using the property characteristic classification and the condition classification, a replacement cost for replacing the property characteristic. The aerial image may be a two-dimensional aerial image.

[0013] In some embodiments, the instructions, when executed by the processing circuitry, cause the processing circuitry to, prior to identifying the features, obtain a shape map image including the property; overlay the aerial image with the shape map image; and determine whether a boundary of the property as identified by the shape map matches a boundary of the property as illustrated in the aerial image. The instructions, when executed by the processing circuitry, may cause the processing circuitry to, upon determining that the shape map does not match the boundary of the corresponding property, obtain an alternate aerial image of the property. The instructions, when executed by the processing circuitry, may cause the

processing circuitry to, prior to identifying the features, assess orthogonality of the aerial imagery. The property may be a single family home.

[0014] In one aspect, the present disclosure relates to a non-transitory computer readable medium having instructions stored thereon, where the instructions, when executed by processing circuitry, cause the processing circuitry to receive identification of a property and at least one property characteristic; obtain an aerial image of a geographic region including the property; and identify respective features of the aerial image corresponding to each property characteristic of the at least one property characteristic. In some embodiments, the instructions, when executed by the processing circuitry, cause the processing circuitry to, for each property characteristic, analyze the corresponding features to determine a respective property characteristic classification, and analyze a region of the aerial image including the respective property characteristic to determine a respective condition classification. The instructions, when executed by the processing circuitry, may cause the processing circuitry to determine, using the property characteristic classification of each property characteristic and the condition classification of each property characteristic, at least one risk estimate representing risk of damage due to disaster.

[0015] In some embodiments, the instructions, when executed by the processing circuitry, cause the processing circuitry to, prior to obtaining the aerial image of the geographic region, determine, based upon the at least one property characteristic, a preferred image type corresponding to each property characteristic of the at least one property characteristic. The at least one property characteristic may include two or more property characteristics. The instructions, when executed by the processing circuitry, may cause the processing circuitry to, responsive to determining the preferred image type corresponding to a first property characteristic of the at least one property characteristic is a terrestrial image, obtain a terrestrial image of the geographic region including the property.

[0016] In some embodiments, the instructions, when executed by the processing circuitry, cause the processing circuitry to access one or more known property characteristics. Determining the at least one risk estimate may include determining the at least one risk estimate further based on the one or more known property characteristics. The one or more known property characteristics may include at least one of a property age, a property elevation, a property slope, a year built, a year renovated, and a building height.

[0017] In some embodiments, receiving identification of the property and the at least one property characteristic includes receiving, via a network from a remote computing device, the identification of the property. The instructions, when executed by the processing circuitry, may cause the processing circuitry to provide, via the network to the remote computing device in real-time responsive to receiving the at least one property characteristic, the at least one risk estimate.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate one or more embodiments and, together with the description, explain these embodiments. The accompanying drawings have not necessarily been drawn to scale. Any values dimensions illustrated in the accompanying graphs and figures are for illustration purposes only and may or may not represent actual or preferred values or dimensions. Where applicable, some or all features may not be illustrated to assist in the description of underlying features. In the drawings:

[0019] FIG. 1 is a flow diagram of an example system operational flow for matching aerial image features to corresponding property maintenance levels;

[0020] FIG. 2A illustrates example characteristic classifications and corresponding risk profile data;

[0021] FIG. 2B illustrates examples of condition characteristics and corresponding example histograms;

[0022] FIG. 2C illustrates an example condition profile corresponding to an example property characteristic type;

[0023] FIG. 2D is an example error rate graph comparing training data with test data in conducting matching aerial image features to corresponding rooftop shapes;

[0024] FIG. 3 is a block diagram of an example environment for matching aerial image topographical features to corresponding property maintenance levels;

[0025] FIG. 4 is a flow chart of an example method for classifying condition characteristics of a property based on aerial image analysis;

[0026] FIG. 5A illustrates an example structure shape map of a geographic area;

[0027] FIG. 5B illustrates an example two-dimensional aerial image of the geographic area of FIG. 5A;

[0028] FIG. 5C illustrates an example overlay map image of a section of the structure shape map of FIG. 5A overlaying a corresponding section of the aerial image of FIG. 5B;

[0029] FIG. 6 is a block diagram of an example computing system;

[0030] FIG. 7 is a block diagram of an example distributing computing environment including a cloud computing environment; and

[0031] FIGs. 8A through 8C illustrate a series of example user interface screen shots for reviewing property characteristic and maintenance level information.

DETAILED DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

[0032] The description set forth below in connection with the appended drawings is intended to be a description of various, illustrative embodiments of the disclosed subject matter. Specific features and functionalities are described in connection with each illustrative

embodiment; however, it will be apparent to those skilled in the art that the disclosed embodiments may be practiced without each of those specific features and functionalities.

[0033] Reference throughout the specification to "one embodiment" or "an embodiment" means that a particular feature, structure, or characteristic described in connection with an embodiment is included in at least one embodiment of the subject matter disclosed. Thus, the appearance of the phrases "in one embodiment" or "in an embodiment" in various places throughout the specification is not necessarily referring to the same embodiment. Further, the particular features, structures or characteristics may be combined in any suitable manner in one or more embodiments. Further, it is intended that embodiments of the disclosed subject matter cover modifications and variations thereof.

[0034] It must be noted that, as used in the specification and the appended claims, the singular forms "a," "an," and "the" include plural referents unless the context expressly dictates otherwise. That is, unless expressly specified otherwise, as used herein the words "a," "an," "the," and the like carry the meaning of "one or more." Additionally, it is to be understood that terms such as "left," "right," "top," "bottom," "front," "rear," "side," "height," "length," "width," "upper," "lower," "interior," "exterior," "inner," "outer," and the like that may be used herein merely describe points of reference and do not necessarily limit embodiments of the present disclosure to any particular orientation or configuration. Furthermore, terms such as "first," "second," "third," etc., merely identify one of a number of portions, components, steps, operations, functions, and/or points of reference as disclosed herein, and likewise do not necessarily limit embodiments of the present disclosure to any particular configuration or orientation.

[0035] Furthermore, the terms "approximately," "about," "proximate," "minor variation," and similar terms generally refer to ranges that include the identified value within a margin of 20%, 10% or preferably 5% in certain embodiments, and any values therebetween.

[0036] All of the functionalities described in connection with one embodiment are intended to be applicable to the additional embodiments described below except where expressly stated or where the feature or function is incompatible with the additional embodiments. For example, where a given feature or function is expressly described in connection with one embodiment but not expressly mentioned in connection with an alternative embodiment, it should be understood that the inventors intend that that feature or function may be deployed, utilized or implemented in connection with the alternative embodiment unless the feature or function is incompatible with the alternative embodiment.

[0037] Turning to FIG. 1, a flow diagram of an example system operational flow 100 for matching aerial image features to corresponding property maintenance levels obtains images (104) at property locations 102b is illustrated. In some implementations, commencement of at least a portion of the operational flow 100 by the system may be triggered by a property classification request submitted by a user, such as an insurance carrier or real estate investment broker at a dashboard interface screen on a computing device connected to the system via a network. For example, as illustrated in FIG. 8A, a particular property or, alternatively, a neighborhood of properties, may be selected within a map view user interface 800. The operational flow 100 may be used to analyze the condition of features of each property at each property location 102b based on aerial imagery 102c. In some implementations, the operational flow 100 may aid in estimating costs of repair or replacement of each property characteristic detected in the aerial images, for example. In another example, the operational flow 100 may be used to confirm that a property location 102b has been repaired.

[0038] The property locations 102b may represent, in some examples, locations of properties insured by a particular insurer, locations of properties recently affected by a disaster such as a tornado, hurricane, earthquake, storm surge, or explosion, locations of properties held in an

investment portfolio, or locations of properties considered for addition to an investment portfolio. The property locations 102b may be identified, in some examples, by a street address, global positioning system coordinates, or other geographic coordinates.

[0039] In some implementations, the operational flow 100 obtains images (104) at each property location 102b. The images can include aerial imagery 102c stored by the system or accessed by the system from a remote networked location. The aerial imagery 102c, for example, may include a three-dimensional or two-dimensional image of a geographic location including at least one of the property locations 102b. In one example, based upon street address or geographic coordinates, the system may query a remote database to obtain recent aerial imagery 102c including an image of at least one of the property locations 102b. The remote database, in some examples, can include private industry databases such as Google® Earth images by Google, Inc. of Mountain View, CA or NTT Geospace Corporation of Japan. In other examples, the remote database can include one or more databases of publicly owned organizations such as the Geospatial Information Authority (GSI) of Japan, the United States Geological Survey, or the Federal Agency for Cartography and Geodesy of Germany. Aerial imagery can be collected from one or more remote network locations, in some embodiments, using an Open Source Geographic Information System (GIS) such as QGIS by the Open Source Geospatial Foundation (OSGeo). The format for the images of the property locations 102b, in some embodiments, depends upon the format accepted by the various sources available for aerial imagery 102c. An example aerial image 510 of multiple property locations 102b is illustrated in FIG. 5B.

[0040] In some embodiments, the system may be configured to query multiple remote database systems to obtain at least two aerial images of a given property location 102b. The aerial images available at the various databases, for example, may differ in resolution and recency of capture. Through collecting two or more images of a particular property, for

example, the system may analyze each image to determine a best quality image for use in condition analysis. The condition analysis can include balancing of multiple factors such as, in some examples, clarity, completeness, and recency.

[0041] Further, in some embodiments, the system may be configured to query multiple remote database systems to obtain both a two-dimensional aerial image and a three-dimensional aerial image. Different property characteristics may be discerned based upon whether the aerial image is captured in two-dimensional or three-dimensional format. Two-dimensional aerial images, in some examples, can be used to determine location coordinates of the property, street name, occupancy type, floor area, existence of skylights, existence of chimneys, roof condition, roof shape, roof covering, roof anchors, roof equipment, and/or pounding. Three-dimensional aerial images, in comparison, can be used to determine location coordinates, street name, construction type, occupancy type, year built, building height, soft stories, number of stories, roof condition, roof shape, roof covering, roof anchors, roof equipment, cladding, and pounding. Where there is an overlap in characteristics identifiable using either a two-dimensional image or a three-dimensional image, in some embodiments, machine learning analysis of both images can be combined to provide increase confidence in identification of the individual characteristics.

[0042] In some implementations, the system obtains (104) shape map images 102a of each of the property locations 102b. The shape map images 102a, for example, include a block shape layout of existing properties in a municipality, such as urban planning maps used in urban planning and development. The shape map images 102a, in another example, can include block shape layout maps used in presenting information to a user of a computer-based navigation system. The shape map images 102a, in one example, can be obtained from Geospatial Information Authority of Japan or Zenrin Co. Ltd. of Japan. An example of an

urban planning map 500 is illustrated in FIG. 5A (image obtained from the Geospatial Information Authority of Japan, Digital Map 2500 (Spatial Data Framework)).

[0043] The shape map images 102a, in some embodiments, are used to confirm location of a particular property. The shape map image 102a of a geographical area, for example, can be overlaid with a corresponding aerial image 102c to match properties with images. An example overlaid image 520 of planning map image 500 of FIG. 5A with aerial image 510 of FIG. 5B is illustrated in FIG. 5C. In some embodiments, the shape map image 102a may not match in shape or location with the aerial image 102c. As illustrated in FIG. 5C, for example, a shape map outline (illustrated in a thickened line) for a location 522 may not be rectangular, while a rooftop shape beneath the outline may be rectangular in shape. In some embodiments, analyzing multiple aerial images 102c to determine the best quality image may include identifying one or more aerial images 102c that substantially align with the corresponding shape map image 102a. The overlay of the aerial image 102c with the shape map image 102a, further, can be used in aiding in cropping the aerial image 102c to focus analysis on a particular property location 102b. For example, turning to FIG. 5C, property location 524 is substantially aligning with the corresponding planning map image, and the general outline can be used in aiding in cropping of the property location 524. In some examples, the property location 524 may be identified within the overlaid image 520 when the property location 524 aligns with a property in the overlaid image 520 within a predetermined tolerance in order to account for renovations that may have been made to the property 524, such as property additions that may alter an overall shape of the property.

[0044] Returning to FIG. 1, in some embodiments, the shape map images 102a may be used to correct or compensate for alignment errors or inconsistencies of the corresponding two-dimensional aerial images 102c. For example, an aerial image representing a normal orthophoto angle may not be directly centered upon the planning map block. Using the

planning map block as a guide, for example, the aerial image can be geometrically corrected to obtain a true orthophoto version of the aerial image.

[0045] As illustrated in FIG. 1, in some implementations, the system identifies (106) features of each aerial image 102c to classify property characteristics. Using machine learning for analysis, for example, the system can extract features of the aerial image of a particular property location 102b. Groupings of extracted features, such as angles, outlines, substantially homogenous fields, etc. can be used to identify property features such as rooftop, swimming pool, chimney, and sky lights. Upon extracting image-related features identifiable as a property feature (e.g., rooftop), the extracted features may be analyzed to determine one or more property characteristics of that feature (e.g., type of rooftop). In one example, a swimming pool may be identified as the property feature of a pool (e.g., various shapes of outlines of a particular size or greater bordering a substantially homogenous field of blue), then characterized as a particular shape (e.g., rectangular, round, or kidney bean, etc.), type (e.g., above ground or in-ground), and/or size (e.g., approximate area). The machine learning classifier used in the machine learning analysis, in some embodiments, includes a convolutional neural network (CNN) to preprocess the aerial image 102c of the particular property location 102b and to classify the property features as property characteristics 110. Using CNN technology, for example, the biological process of visually reviewing and identifying an object or feature of an object is mimicked through a feed-forward artificial neural network where multilayer artificial perception minimizes preprocessing. CNN is a well-established and popular machine-learning methodology. An example of a CNN processing model is Alexnet. (See Krizhevksy et al. "ImageNet Classification with Deep Convolutional Neural Networks", Advances in neural information processing systems. 2012, the entire contents of which has been incorporated herein by reference). In other embodiments, the machine learning classifier may include a Network in Network (NIN)

where a number of layers of artificial perception outcomes are generated using micro neural networks with complex structures. The artificial perception outcomes are then stacked and averaged to generate a single global average pooling layer for classification. NIN has demonstrated superior performance outcome to conventional CNN processing. Additionally, NIN processing is less storage-intensive than CNN processing.

[0046] In some implementations, property characteristic profiles 108 are used in classifying property features. The property characteristic profiles 108, for example, may be developed through training the machine learning algorithms using aerial images (and, in some embodiments, terrestrial images 102d) of known property characteristics. Each property feature, for example, may be broken down into multiple classifications. In an illustrative example involving a classification of terrestrial images, cladding can include stone, brick, stucco, shingles, vertical boards, horizontal boards, or metal. The machine learning algorithms, for example, may generate a percentage confidence in a match between a new aerial image 102c including a gambrel rooftop and the characteristic profile 108 of gambrel rooftops.

[0047] In an illustrative example, turning to FIG. 2A, extracted angular and outline features of aerial images 204 may be used to classify a roof shape 202 of the particular property location 102b. In a first example, a gable roof 202b includes a central peak upon a generally rectangular outline, as depicted in corresponding aerial image 204b. A gambrel roof 202a includes these features of the gable roof 202b but, as illustrated in aerial image 204a, the gambrel roof additionally includes a "skirt" region surrounding the central gable-shaped portion. The "skirt" region can be identified, in part, based upon its corner edges extending from the four corners of the gable-shaped portion. A hipped roof 202c, as shown in aerial image 204c, includes a central peak and two opposing triangular ends extending from either end of the central peak. The central peak forms a top edge of two trapezoidal sections. A

square roof 202d, in contrast, has no central peak. Instead, as illustrated in aerial image 204d, the square roof includes four triangular portions meeting at a central point. Finally, a flat roof 202e, as shown in aerial image 204e, is represented by a substantially flat surface outlined by a rectangle.

[0048] Turning to FIG. 2D, an example error rate graph 240 compares training data 242 with accuracy of matching test data 244 in matching aerial image rooftop characteristics to corresponding rooftop type (e.g., shape). A test was conducted using NIN deep learning algorithms to classify rooftop shape in two-dimensional aerial images including a mix of gambrel, gable, hipped, square, and flat roof shapes of assorted colors. Further tests involved differing image sizes and mini-batch sizes. In particular, images were scaled using a formula of $y = w * (x\text{-}100) + z$, where x represents a property size (e.g., building with a small border surrounding the area of the rooftop), y represents pixel size, w ranged from 0.33 to 0.40 and z ranged from 90 to 110. The error rates ranged, among initial test cases involving mini batches from 5 to 20, from about 4.3% to about 10%. As shown by the error rate graph 240, in a test situation involving 2,250 sample images in a training dataset and 250 test images in a test dataset, the minimum error rate in determining rooftop condition was 6%, corresponding to an accuracy rate of 94%.

[0049] To improve accuracy rate, in some implementations, the image can be cropped and/or resized prior to analyzing. For example, the image may be cropped to include the property of interest, or the property of interest plus a portion of its surroundings (e.g., the lot containing the property and/or a portion of the proximate neighborhood in which the property resides). Resizing to a standard image size, in another example, can contribute to accuracy improvement.

[0050] Further to roof shape, in some embodiments, feature analysis can be used to discern additional roof features such as, in some examples, roof covering, roof anchors, roof

equipment, skylights, widow's walks, turrets, towers, dormers, and/or chimneys. Furthermore, upon identifying the outline of the roof, a footprint of the property location 102b (e.g., size of the roof) can be calculated based upon a scale of the aerial image 102c.

[0051] Returning to FIG. 1, rather than exclusively analyzing the particular property locations 102b individually, in some implementations, the particular property locations 102b are each classified based in part upon nearby structures. For example, based upon property location 102b dimensions, which may include lot dimensions, machine learning can be used to identify additional structures at the property location 102b such as, in some examples, a deck, swimming pool, shed, gazebo, detached garage, tennis court, fence, retaining wall, dock, playground equipment, or greenhouse. Further, the particular property locations 102b may be classified in part based upon distance from neighboring structures (pounding).

[0052] In some implementations, terrestrial images 102d may be used to classify features difficult to recognize using aerial imagery 102c. The terrestrial images 102d, in some examples, can include street view images obtained from a street view service or real estate listing. In some examples, street view images including a street-facing view of the property location 102b may be obtained from Google® Street View by Google, Inc., Bing® Maps Streetside by Microsoft Corp. of Redmond, WA, or Mapillary by Mapillary AB of Sweden. Using a terrestrial image, for example, the system can identify features such as construction type, cladding, building height, number of soft stories, number of floors, location coordinates, street name, slope, elevation, year built, and/or occupancy type. Where the characteristics identifiable via the terrestrial imagery 102d overlap with characteristics identifiable via two-dimensional or three-dimensional aerial imagery 102c, analysis of terrestrial imagery 102d can be combined with analysis of aerial imagery, in some embodiments, to increase confidence in identification of the particular characteristic(s). For example, house siding

features may be more easily detected in terrestrial imagery 102d and/or three-dimensional aerial imagery 120c than in two-dimensional aerial imagery 102c.

[0053] In some implementations, a condition of each property feature may be classified (112) as a corresponding condition characteristic 116. New properties are in good condition, but property feature conditions can deteriorate over time due to normal wear-and-tear on the property. Further, property features can suffer damage due to external forces such as storms and natural disasters. Eventually, conditions of housing features can deteriorate to the point where repair and/or replacement may be necessary. As with property characteristics described above at block 106, machine learning algorithms can be used to classify a present condition of individual detected property features. Using machine learning for analysis, for example, the system can extract pixel intensity distributions of previously identified property features of the aerial image of the particular property location 102b. In some examples, newly constructed property features generally have sharp contrast and well-defined features in machine learning image analysis. Conversely, weathered or damaged property features can have softened edges, blurred contrasts, and asymmetrical patches of wear. The machine learning classifier used in the machine learning condition analysis, in some embodiments, includes a machine learning analysis to process the aerial image 102c of the particular property location 102b and to classify the condition of previously identified property characteristics 110 as condition characteristics 116. The machine learning analysis, in some examples, can include two-dimensional color histogram analysis or three-dimensional color histogram analysis. In other embodiments, the machine learning analysis may be performed using pattern recognition algorithms (e.g., determining missing fence posts or missing/misaligned rooftop shingles). In other embodiments, the machine learning classifier includes deep learning analysis such as CNN or NIN.

[0054] In an illustrative example, turning to FIG. 2B, examples of condition characteristics of aerial images of hipped rooftops and corresponding example histograms generated through machine learning analysis of pixel intensity are presented. For example, a set of good condition aerial images 210a through 214a, are presented alongside corresponding good condition histograms 210b through 214b. The good condition histograms 210b through 214b, in an illustrative embodiment, illustrate probability metrics of grayscale color distribution, where a respective maximum value 210c through 214c demonstrates the peak probability of grayscale color distribution of a good condition roof. The values, for example, can range from 0 (total black) to 255 (total white).

[0055] Conversely, a set of poor condition aerial images 216a through 220a, are presented alongside corresponding poor condition histograms 216b through 220b. The poor condition histograms 216b through 220b, in an illustrative embodiment, illustrate probability metrics of grayscale color distribution, where a respective maximum value 216c through 220c demonstrates the peak probability of grayscale color distribution of a good condition roof. The maximum values 216c through 220c corresponding to the poor condition rooftops 216a through 220a are markedly lower than corresponding maximum values 210c through 214c of good condition rooftops 210a through 214a. In addition, a width of the distributions of the poor condition histograms 216b through 220b may be markedly wider than a width of the distributions of the good condition histograms 210b through 214b. As can be seen of the aerial images of the poor condition rooftops 216a through 220a, the color distribution is patchy and bleached out, while the edges of the rooftops have lost their crisp lines. Conversely, looking to the aerial images of the good condition rooftops 210a through 214a, the rooftops are more substantially uniform in color with crisp lines on the edges.

[0056] Turning to FIG. 2C, a condition profile 230 for a rooftop condition is illustrated. In some implementations, pixel value distribution histograms such as the histograms 210b

through 220b, in some implementations, can be combined to generate an example condition profile 230 corresponding to rooftop condition. The condition profile 230, for example, may be included as one of the condition profiles 114 of FIG. 1. Example reference bars 232a, 232b on the condition profile 230 illustrate values corresponding to a non-deteriorated hipped roof 214a and the deteriorated hipped roof 216a, respectively. In some examples, the closer the value of a reference bar 232 comes to 1 on the Y-axis, the better the condition of the roof, while values close to 0 represent poor condition rooftops. In one example, the reference bars 232 of the example condition profile 230 correspond to a test conditions sample data set including 2,500 images). The reference bars 232 can be combined, in some embodiments, in a logistic regression to generate a roof condition profile graph 236. The accuracy rate of the image histogram is 80% based on some validation.

[0057] Although illustrated as a single condition profile 230 corresponding to different types of rooftops (e.g., at least the hipped rooftop 216a and the gable rooftop 234), in other embodiments, individual condition profiles 114 can be generated for each property characteristic (e.g., profiles specific to gabled, gambrel, flat, hipped, square, etc.). In further refinements, in certain embodiments, individual condition profiles 114 can be generated for combinations of property characteristics (e.g., a gabled, shingled roof, a gabled, clay tiled roof, a gabled, metal roof, etc.) to increase accuracy rate based upon pixel densities corresponding to the combined characteristics. Many combinations of characteristics of property features may be used singly or in combination to generate a condition profile 114 designed to accurately identify the condition of the corresponding property feature.

[0058] Returning to FIG. 1, in some implementations, the property characteristics 110 and/or condition characteristics 116 may be analyzed to calculate (120) a risk estimate 122 corresponding to a risk of damage based upon one or more types of disasters. The types of disasters can include, in some examples, earthquake, hurricane, tornado, storm surge, straight

line winds, or explosion. The types and estimated severity of disasters, in some embodiments, may depend upon the particular property location 102b. For example, properties near active fault lines may be more susceptible to earthquakes, while coastal properties may be more susceptible to storm surge damage. The risk estimate 122, in some examples, can include an actuarial percentage indicating a likelihood of damage based upon the particular property characteristics. Different property characteristics, for example, may be more susceptible than others to certain types of damage. For example, flatter rooftops may be more susceptible to damage from excessive snow build-up, while peaked rooftops may be more vulnerable to strong winds.

[0059] In some embodiments, in calculating damage risk, one or more disaster risk profiles 118 can be applied based upon property characteristics. Vulnerability to damage due to disaster can vary, in some examples, by location, altitude, slope, rooftop shape, rooftop condition, cladding type, cladding condition, and/or pounding. In a particular example, as shown in FIG. 2A, a graphical risk profile 206 ranks types of rooftops by their vulnerability to strong winds. Vulnerability to wind damage increases from lowest vulnerability (flat rooftop 202e) to square roof 202d, to hipped roof 202c, to gable roof 202b, with the greatest wind damage vulnerability in gambrel roofs 202a.Vulnerability may be mathematically modeled based upon statistical information built from past damage results due to varying types and/or severity of disaster. In combining location-based vulnerabilities with individual property characteristic-based vulnerabilities, risk of damage due to disaster can be more accurately estimated.

[0060] Referring back to FIG. 1, the risk estimates 122, in some embodiments, can be used in insurance assessments. For example, the risk estimate 122 may be used in determining whether a property is adequately insured against potential damage. Further, when tracking an impending natural disaster, an insurance company may use the risk estimates 122 to estimate

claims based upon the forecast path and severity of the storm. Additionally, the risk estimates 122 may be applied by investors when selecting investment properties for an investment portfolio.

[0061] In some implementations, repair or replacement costs can be calculated (126) to determine a cost estimate 128 to place one or more property characteristics in good or "like new" condition. The cost estimates 128, in some embodiments, can be based in part on one or more replacement cost profiles 120. Replacement costs, in some examples, may vary based upon type of materials (e.g., rooftop materials, cladding materials, etc.), size of the job (e.g., estimated area of the roof, estimated length of fence, etc.), and/or additional property characteristics (e.g., contributing to the complexity of the work). The replacement profiles 120, in further examples, may be based in part on location (e.g., varying costs of material and labor regionally). In some implementations, the cost estimates 128 for repair or replacement of the property characteristics may be output to a dashboard interface screen at a remote computing device of a requester, such as an insurance carrier or real estate investment broker.

[0062] In some embodiments, cost estimates 128 can be used in automatically analyzing insurance claims. The cost estimate 128, further, may be combined with the risk estimate 122 in analyzing adequacy of insurance coverage for a particular property location 102b. Further, the cost estimates 128 may be used by investors in determining cost of maintaining/upgrading a particular investment property.

[0063] Although the operational flow is illustrated as a series of computational stages, in other implementations, more or fewer computational stages may be included. For example, aerial imagery 102c may be analyzed after an insurance claim has been paid to verify that the insured property has been repaired and/or to upgrade the estimated value of the property (e.g., in the circumstance where the owner upgraded the property rather than applying a straight repair/replacement of the damaged property characteristics.

[0064] Additionally, in other implementations, certain computational stages may be performed in a different order. For example, cost estimates 128 may be calculated prior to risk estimates 122. Other modifications of the operational flow 100 are possible.

[0065] FIG. 3 is a block diagram of an example environment 300 for matching aerial image topographical features to corresponding property maintenance levels. The example environment 300, for example, can be used to implement the operational flow 100 described in relation to FIG. 1. The example environment 300 includes a property characteristic classification and condition analysis system 302 in communication with client computing system(s) 306, a number of cost data and/or risk data source computing system(s) 308, and a number of shape map, aerial imagery, and/or terrestrial imagery source computing system(s) 304. The communication connection may be wired or wireless, over a variety of network types. In a general overview, the system 302 obtains property identifier(s) 340 from client computing system(s) 306, accesses images of a property identified by the property identifier 340 from the imagery source computing system(s) 304, and analyzes the images to determine property characteristic(s) 342 and condition characteristic(s) 344. Using cost and/or risk data obtained from cost and risk data source computing system(s) 308, the system 302 may determine replacement cost estimate data 350 and/or disaster risk estimate data 352 based upon the property characteristics and their condition.

[0066] In some implementations, a user of a particular client computing system 306 submits a request to the system 302 through a graphical user interface supplied by a graphical user interface engine 334. The request, for example, may include at least one property identifier 340 as well as one or more property characteristics 342 and/or identification of at least one of a replacement or repair cost estimate, a disaster risk estimate, and a confirmation of repair assessment. The property identifier 340, in some examples, may include location information (e.g., address, geolocation coordinates, lot boundaries, etc.). The location information, for

example, may conform with property location information 102b described in relation to FIG. 1. In other embodiments, the property identifier 340 may be a unique property identifier (e.g., number or string) used to look up property location information in a data store 310. In another embodiment, rather than submitting a property identifier, the user may submit a unique user identifier used to look up one or more properties associated with the user (e.g., properties insured by an insurance client, properties held by an investment client, etc.).

[0067] In one example, turning to FIG. 8A, a user may identify locations of one or more properties by selecting the properties within a graphical map interface 800. A number of properties are identified within the map view user interface 800 as indicated with an associated pin, such as pin 804. The pins, in some examples, may indicate properties insured by a particular insurance carrier, a type of property (e.g., commercial, industrial, residential, etc.), and/or properties of a value range (e.g., within a range, above a threshold, etc.). The pins, for example, may be displayed based upon filtering options supplied by the user or otherwise associated with a user profile (e.g., insurance carrier identification). In a particular example, a user may select three properties associated with three dialogue bubbles 802. As illustrated, each dialogue bubble identifies a replacement value associated with the property, and invites the user to review details regarding the selected property via a details control.

[0068] In some implementations, the user enters property characteristics associated with each selected property. In other implementations, the characteristics may be accessed upon identification of the property (e.g., selection of a pin identifying a property, as illustrated in FIG. 8A). For example, the property characteristics 342 may be obtained from the data store 310, as illustrated in FIG. 3. Turning to FIG. 8B, an example property characteristics user interface 820 presents building area characteristics 822 (e.g., building area 822a, stories 822b, and total building area 824c) and structure characteristics 824 (e.g., structure material 824a, construction class 824b). As described within, different or additional characteristics may

vary per implementation. In some embodiments, the user may be provided the ability via the user interface 820 to edit the building area characteristics 822 and/or the structure characteristics 824, for example via an edit control 828a or 828b. For example, in the circumstance of recent development or renovation (e.g., construction of an addition), the user may modify previously stored characteristics values. The property characteristics user interface 820, for example, may be presented to a user upon selection of a details control of one of the dialogue bubbles 802 illustrated in the user interface of FIG. 8A.

[0069] The user interface 820 further presents, in some implementations, premium characteristics 826 such as a replacement value. The premium information, for example, may relate to an insurance policy purchased for the property or parameters for insuring the property (e.g., based upon upgraded or new characteristics). The user, in some embodiments, may be provided to update the premium information via an edit control 828c.

[0070] In some implementations, upon identification of property location information, the system 302 accesses imagery of the property from the imagery source computing system(s) 304 using an image acquisition engine 336. The images can include, in some examples, a shape map (e.g., such as the shape maps 102a described in relation to FIG. 1), two-dimensional aerial imagery (e.g., such as the aerial imagery 102c described in relation to FIG. 1), three-dimensional aerial imagery (e.g., such as the aerial imagery 102c described in relation to FIG. 1), and/or terrestrial imagery (e.g., such as the terrestrial imagery 102d described in relation to FIG. 1). The images obtained by the image acquisition engine 336, in some embodiments, depend upon the property characteristic(s) identified by the user. For example, certain types of images are preferred for analyzing certain types of property characteristics. Housing siding, for example, is more easily perceived from a terrestrial image or three-dimensional aerial image than from a two-dimensional aerial image.

[0071] In some implementations, an image quality analysis and preparation engine 326 analyzes the acquired image(s) to confirm the acquired image(s) contains an adequately clear and detailed image of the property identified by the property identifier 340. In some embodiments, the image quality analysis and preparation engine 326 crops and/or resizes the acquired image(s). For example, the image quality analysis and preparation engine 326 may extract a portion of an acquired image based upon the property (e.g., building size). In some implementations, the image quality analysis and preparation engine 326 resizes each acquired image to a standard size. The standard size, in a particular example, may be 256 by 256 pixels per image. Resizing to a standard size, for example, may increase accuracy in later classification analysis. The image quality analysis and preparation engine 326, in some embodiments, may be configured to apply corrections to the acquired image(s). For example, the image quality analysis and preparation engine 326 may be configured to adjust an aerial image from a normal orthophoto angle, to a true orthophoto version as described above.

[0072] In some implementations, the image quality analysis and preparation engine 326 uses shape outlines as part of the analysis. For example, a composite image generation engine 318 may overlay an aerial image with a shape map image, as described in relation to FIG. 5C. Using the resultant composite image, the image quality analysis and preparation engine 326 may confirm the aerial image conforms with an urban planning map or other property placement guide (e.g., navigational map data, etc.). Further, the image quality analysis and preparation engine 326 may use the overlaid shape map as a guide in determining whether an aerial image requires correction to a true orthophoto angle and/or how closely to crop the image to capture the property (and, optionally, its immediate surroundings such as its lot or a portion of the proximate neighborhood).

[0073] In some implementations, if the image quality analysis and preparation engine 326 determines that the acquired image is insufficient, the image quality analysis and preparation

engine 326 may request a replacement image from the image acquisition engine 336. For example, the image acquisition engine 336 may obtain images based upon a variety of factors including, in some examples, recency of capture, resolution, cost, and/or applicability to a particular property characteristic analysis. Upon determination by the image quality analysis and preparation engine 326 that the first obtained image is insufficient, for example, the image acquisition engine 336 may determine a next best source for obtaining an image of the property.

[0074] In some implementations, once an image has been approved (and, optionally, prepared and/or corrected) by the image quality analysis and preparation engine 326, a feature identification engine 320 extracts features from the property image(s) related to the identified property characteristics 342. In the circumstance of a fence, for example, the feature identification engine 320 may identify a perimeter enclosure or partial perimeter enclosure abutting and extending from the property as indicative of a fence.

[0075] In some implementations, upon identification of features by the feature identification engine 320, a property characteristic classification engine 322 classifies the property characteristic. For example, the features may be classified using one or more machine learning techniques as described in relation to computational stage 106 (classify features of each image) of FIG. 1. The property characteristic classification engine 322, for example, may generate property characteristics 342 representing a grouping, type, or other characterization of a particular property feature. Continuing with the particular example of a fence, the extracted features may be analyzed and classified in relation to height and/or material. Upon classifying the property characteristics, the property characteristic classifications may be stored in the data store 310 as property characteristics 342 (e.g., similar to property characteristics 110 of FIG. 1).

[0076] In some implementations, the property characteristic classification engine 322 uses characteristic profile(s) 360 in classifying property characteristics. The property characteristic classification engine 322, for example, may obtain, for each property characteristic being analyzed, a particular characteristic profile 360 from a profile data store 314. The characteristic profiles, for example, may be similar to the characteristic profiles 108 described in relation to FIG. 1.

[0077] In some implementations, the property characteristic profiles 360 are generated by a characteristic classification learning engine 328. The characteristic classification learning engine 328, for example, may generate characteristic profiles 360 through a sample data set and learning process as described, generally, in relation to FIG. 2A. In a particular example, the characteristic classification learning engine 328 may analyze JPG (lossy compression digital image standard developed by the Joint Photographic Experts Group) to recognize varying rooftop shapes.

[0078] While certain property characteristic classifications are done by analysis, in some implementations, one or more feature classifications may be obtained from previously stored property characteristics 342. For example, based upon tax records, real estate records, etc. some basic materials and structure information regarding a property may be readily available through local and/or remote database system(s). In other examples, the previously stored property characteristics 342 may also be obtained from previous condition assessments performed for a property location by the system 302.

[0079] In some implementations, once the property characteristic classification engine 322 has classified the property characteristic(s), a characteristic condition classification engine 324 classifies the condition of each property characteristic. For example, the property characteristics may be classified as described in relation to computational stage 112 (classify condition of each feature) of FIG. 1. The characteristic condition classification engine 324,

for example, may generate condition characteristics 344 representing a rating, qualification, or ranking of the condition of the particular characteristic. In some examples, the characteristic condition classification engine 324 may qualify a characteristic as a) "good" or "bad", b) "like new", "acceptable", "needs repair", or "needs replacement", c) rated on a numeric scale such as a scale from 1 to 5 where 5 may correspond to "like new" and 1 may correspond to "needs replacement." In other implementations, particular problems may be identified by the characteristic condition classification engine 324 such as, in some examples, a fence feature is partially fallen, or a roof feature shows signs of structural damage.

[0080] In some implementations, the characteristic condition classification engine 324 uses condition profile(s) 362 in classifying property characteristic conditions. The characteristic condition classification engine 324, for example, may obtain, for each property characteristic being analyzed, a particular condition profile 362 from the profile data store 314. The condition profiles 362, for example, may be similar to the condition profiles 114 described in relation to FIG. 1.

[0081] In some implementations, the condition profiles 362 are generated by a condition classification learning engine 330. The condition classification learning engine 330, for example, may generate condition profiles 362 through a sample data set and learning process as described, generally, in relation to FIG. 2B. In a particular example, color histogram analysis may be used to identify peak pixel values of the images in gray scale. Using the group of calculated peak pixel values, the learning engine can classify property condition into certain categories.

[0082] In some implementations, based upon the output of the property characteristic classification engine 322 and/or the characteristic condition classification engine 324, a risk calculation engine 316 may estimate risk of damage based upon one or more types of disaster. For example, the disaster risk estimate data 352 may be calculated as described in

relation to computational stage 120 (calculate damage risk) of FIG. 1. The disaster risk estimate data 350, in one example, can include a percentage likelihood of damage due to each particular type of risk based upon the particular property characteristics and/or property conditions, as described in relation to the risk estimates 122 of FIG. 1. Further, in some embodiments, the disaster risk estimate data 350 may include a set of risk estimates based upon, in some examples, a number of severities of disaster, a particular path of disaster, and/or hazard intensity of disaster. The disaster severities, in some examples, may correspond to the Richter scale of seismic activity magnitude or the Saffir-Simpson Hurricane Wind Scale category. The path of the disaster, in some examples, can include geographical direction such as northeasterly, etc. or angle of impact with respect to the property characteristic(s). The hazard intensity of disaster, in some examples, can relate to wind speed or rainfall amount. Repair costs, for example, may be more accurately estimated when the roof condition is known. Due to poor condition of a rooftop in one particular example, the roof may be more vulnerable to damage requiring replacement. In another particular example, due to a poor condition rooftop, the likelihood for interior property damage (e.g., water damage due to breach of the roof) may increase at a set level of severity of disaster and above.

[0083] In some embodiments, the risk calculation engine 316 accesses one or more risk profiles 364 from the data store 314 based upon property characteristics and/or condition characteristics. The risk profiles, for example, may be similar to the disaster risk profiles 118 described in relation to FIG. 1. The risk profiles 364, for example, may be obtained from one or more risk data sources 306 by a cost and risk data acquisition engine 338. In other embodiments, the system 302 may generate risk profiles 364 (e.g., using risk data obtained from one or more cost and risk data sources 306 and a risk data analysis engine (not illustrated)).

[0084] The risk estimate data 352, in some embodiments, is shared with one or more clients 306. For example, an insurance carrier client 306 may use risk estimate data in making insurance assessments. In another example, a real estate investment broker or firm client 306 may apply risk estimate data 352 when selecting investment properties for an investment portfolio.

[0085] Turning to FIG. 8C, an example disaster risk user interface 840 presents risk assessment information based upon risk profiles 364 related to the selected property (e.g., one of the properties identified via the dialogue bubbles 802c of FIG. 8A). The user interface 840, for example, may be accessed by scrolling downward from the user interface 820. The user interface 840 illustrates a number of disaster risk factors 842 and associated risk estimate data 844 for the selected property. As illustrated, the disaster risk factors 842 include a fire factor 842a, a wind factor 842b, a flood factor 842c, an earthquake factor 842d, a tsunami factor 842e, and a landslide factor 842f. In some embodiments, only a subset of the risk estimate data is determined via risk assessment techniques described herein. For example, flood data 844c may be generated based upon governmental flood map evaluation rather than via aerial imaging assessment, while fire risk 844a may be determined at least in part based upon proximity to neighboring properties as derived via imaging analysis and/or construction properties derived via image analysis. Further, wind risk data 842b may be derived via rooftop analysis as described in greater detail herein.

[0086] In some implementations, based upon the output of the property characteristic classification engine 322 and/or the characteristic condition classification engine 324, a cost calculation engine 336 calculates repair or replacement costs for improving problems identified by the characteristic condition classification engine 324 and generates replacement cost estimate data 350. For example, the replacement cost estimate data 352 may be calculated as described in relation to computational stage 126 (calculate repair or replacement

costs) of FIG. 1. The replacement cost estimate data 350, for example, may be similar to the cost estimates 128 described in relation to FIG. 1.

[0087] In some implementations, the cost calculation engine 336 based calculations in part on one or more cost profiles 366 (e.g., similar to the cost profiles 120 of FIG. 1). In some embodiments, the cost calculation engine 336 accesses one or more cost profiles 366 from the data store 314 based upon property characteristics and/or condition characteristics. The cost profiles 366, in some embodiments, are obtained from one or more cost data sources 306 by the cost and risk data acquisition engine 338. In other embodiments, the system 302 may generate cost profiles 366 (e.g., by a cost data analysis engine (not illustrated) using cost data obtained from one or more cost and risk data sources 306).

[0088] The cost estimate data 350, in some embodiments, is shared with one or more clients 306. For example, an insurance carrier client 306 may use cost estimate data in determining adequacy of insurance coverage for a particular property. In another example, a real estate investment broker or real estate investment firm client 306 may apply cost estimate data 350 in determining cost of maintaining/upgrading a particular investment property.

[0089] In some implementations, the cost estimate data 350 and/or risk estimate data 352 is provided to a requesting client 306, responsive to receiving identification of one or more properties, in real-time or near real-time. For example, a client 306 accessing a dashboard interface, may format a request for a risk estimate or cost estimate related to an identified property within a dashboard interface and submit the request via a network to the system 302. Responsive to the request, the system 302 may conduct the analysis described generally above and respond, in real time or near-real time to the client 306 with a risk analysis or cost analysis. For example, risk analysis information is presented in user interface 840 of FIG. 8C.

[0090] In some implementations, the system may identify, through updated meteorological data, one or more properties within a client real estate portfolio affected by a disaster. The system, further to identification of the affected properties, may proactively prepare a repair estimate to provide to the client corresponding to the real estate portfolio shortly after the disaster took effect. In one example, the Japan Meteorological Agency may update observation data via a web site interface within an hour or so of observation. In this example, the system may provide repair cost estimates to clients between one and two hours after a disaster has taken place.

[0091] Rather than sharing cost estimate data 350 and/or risk estimate data 352 directly with the clients 306, in other embodiments, the system 302 may include a report generation engine (not illustrated) that prepares reports regarding condition, damage, and risk assessments of one or more properties. Further, in some embodiments, the system 302 may compare a current condition characteristic 344 to a historic condition characteristic 344 to confirm whether a property owner made repairs to a property (e.g., based upon payment of an insurance claim). Other modifications of the system 302 are possible.

[0092] FIG. 4 is a flow chart of an example method 400 for classifying condition characteristics of a property based on aerial image analysis. The flow chart, for example, may represent computational stages 104 through 112 as described in relation to FIG. 1. The method 400 may be performed, for example, by the system 302 of FIG. 3.

[0093] In some implementations, the method 400 begins with accessing a two-dimensional shape map including the shape of a property (402). The shape map, for example, may be accessed by the image acquisition engine 336 from a shape map imagery source 304, as described in relation to FIG. 3. The two-dimensional shape map, for example, may take a form of any of the shape maps 102a described in relation to FIG. 1. In a particular example,

the shape map may be in a form similar to the shape map 500 described in relation to FIG. 5A.

[0094] In some implementations, two-dimensional and/or three-dimensional aerial imagery including an image of the property is accessed (404). The two-dimensional and/or three-dimensional aerial imagery, for example, may be accessed by the image acquisition engine 336 from an aerial imagery source 304, as described in relation to FIG. 3. The two-dimensional and/or three-dimensional aerial imagery, for example, may take a form of any of the aerial imagery 102c described in relation to FIG. 1. In a particular example, the two-dimensional aerial imagery may be in a form similar to the aerial image 510 described in relation to FIG. 5B.

[0095] In some implementations, the aerial imagery is overlaid with the shape map (406). The composite image generation engine 318 of FIG. 3, for example, may overlay the aerial imagery with the shape map to generate a composite image. The composite image, for example, may be in a form similar to the composite image 520 described in relation to FIG. 5C.

[0096] If a shape match is not identified (408), in some implementations, the method 400 accesses alternate two-dimensional or three-dimensional aerial imagery (410). In some embodiments, the image quality analysis and preparation engine 326 of FIG. 3 determines whether the composite image presents an adequate shape match of the property(s) of interest. Upon determining the image does not match, the image acquisition engine 336 of FIG. 3, for example, may obtain an alternative two-dimensional or three-dimensional aerial image from the aerial imagery source(s) 304. As described in relation to FIG. 3, for example, For the image acquisition engine 336 may determine a next best source for obtaining an image of the property based upon one or more factors. Conversely, the method 400, in other

implementations (not illustrated), could proceed without matching the shape map to the aerial imagery.

[0097] If a shape match is identified (408), in some implementations, the formatting of the aerial imagery is prepared (411). In some embodiments, the image is cropped to include the property of interest or the property of interest plus a portion of its surroundings (e.g., the lot containing the property and/or a portion of the proximate neighborhood in which the property resides). Cropping may be based, for example, on the correlation of the shape map to the property. In illustration, the image may be cropped to include the shape map outline of the property plus a border region. In some embodiments, cropping may include cropping to a set shape (e.g., X by X pixels square, X by Y pixels rectangle, etc.). In some embodiments, in addition to cropping the image, the image may be resized. For example, depending upon the resolution of the aerial imagery, the image resolution may be reduced, for example, to fit within an X by X pixels square or an X by Y pixels rectangle. Resizing to a standard image size, for example, can contribute to analysis consistency and improvement in classification accuracy. In further embodiments, the color depth and/or color mapping of the aerial imagery may be adjusted. For consistent color histogram analysis of the imagery, for example, the color depth and color mapping may be made consistent across analyzed images. In a particular example, color images may be converted to grayscale for grayscale image analysis. Adjustments to the imagery, for example, may be effected by the image quality analysis and preparation engine 326, described in relation to FIG. 3.

[0098] In some implementations, orthogonality of the aerial imagery is assessed (412). For example, the image quality analysis and preparation engine 326 may assess orthogonality of the aerial imagery. The image quality analysis and preparation engine 326, in one example, may determine that orthogonality correction is desired. In another example, if the image represents a normal orthophoto rather than a true orthophoto, the image quality analysis and

preparation engine 326 may notify further modules which may compensate for the angle of capture of the aerial image. In other implementations (not illustrated), orthogonality may be assessed without use of an overlaid shape map.

[0099] Returning to FIG. 4, in some implementations, if the aerial imagery is not orthogonal (414), an orthogonal version of the aerial imagery is generated (416). The image quality analysis and preparation engine 326 of FIG. 3, for example, may correct a normal orthophoto form to generate a true orthophoto form. The true orthophoto form, for example, may better match the shape map overly.

[0100] In some implementations, one or more property characteristics of the property are classified (418). The property, in some embodiments, is analyzed based on the portion of the aerial image substantially bounded by the shape map of the property. In other embodiments, the property analysis encompasses a surrounding of the property (e.g., features proximate the property upon the property lot, nearby properties, etc.). The property characteristic(s), for example, may be classified by the property characteristic classification engine 322, as described in relation to FIG. 3. In a particular example, a rooftop property feature may be classified as one of a variety of rooftop shapes, as illustrated in FIG. 2A.

[0101] In some implementations, if a property characteristic classification is identified (420), a condition of each of the property characteristics can be classified (422). The property characteristic condition(s), for example, may be classified by the characteristic condition classification engine 324, as described in relation to FIG. 3. In a particular example, a hipped classification of the rooftop feature may be classified as one of a good condition and a poor condition, as illustrated in FIG. 2B. In some implementations, the classifications of the condition of each of the property characteristics may by output to a computing device of a requester (424) via a dashboard interface screen. In some examples, in addition to providing the condition classification for the property characteristics, the dashboard interface screen

may include replacement costs for replacing the property characteristics, risk cost estimates due to damage from natural disasters, or confirmation of whether or not repairs have been made to the property characteristics.

[0102] If, instead, a classification match was not identified (420), in some implementations, alternate two-dimensional or three-dimensional aerial imagery is accessed (410) and the method 400 restarts with overlaying the replacement aerial imagery with the shape map (406). Alternatively, in some embodiments, even if a classification match is not identified, condition may be assessed based upon a default profile associated with the property feature (not illustrated). For example, if the rooftop shape does not match one of the shapes trained into the system, the condition of the rooftop may still be assessed based upon a general condition profile trained with a variety of rooftop shapes. In some examples, the condition of the rooftop may be assessed by comparing the current rooftop conditions to stored historic condition characteristics for the property from a previous condition assessment.

[0103] Although the method 400 is illustrated as a series of steps, in other implementations, more or fewer steps may be included. For example, in some implementations, terrestrial images are obtained and used to classify the same and/or different property characteristics, as described in relation to the operational flow 100 of FIG. 1.

[0104] Additionally, in other implementations, certain steps may be performed in a different order. For example, in some implementations, property characteristics and condition characteristics may be classified (418, 422) in parallel. Other modifications of the operational flow 100 are possible.

[0105] Aspects of the present disclosure may be directed to computing systems for categorizing a repair condition of a property characteristic in order to provide dynamic, real-time property condition assessments in response to requests received from users such as insurance carriers or real estate investment brokers using aerial imagery. The

implementations described herein improve upon conventional methodologies by applying deep learning analysis models to detected property characteristics of the obtained imagery in order to assess whether a condition of the property characteristics is degraded to a point of needing repair or replacement and determine an amount of risk exposure of the property due to the detected condition of the property characteristics. The implementations described herein improve processing efficiency of the system to reduce an amount of time it takes to perform the condition assessments and automate a condition assessment process.

[0106] Next, a hardware description of the computing device, mobile computing device, or server according to exemplary embodiments is described with reference to Figure 6. In Figure 6, the computing device, mobile computing device, or server includes a CPU 600 which performs the processes described above. The process data and instructions may be stored in memory 602. These processes and instructions may also be stored on a storage medium disk 604 such as a hard drive (HDD) or portable storage medium or may be stored remotely. Further, the claimed advancements are not limited by the form of the computer-readable media on which the instructions of the inventive process are stored. For example, the instructions may be stored on CDs, DVDs, in FLASH memory, RAM, ROM, PROM, EPROM, EEPROM, hard disk or any other information processing device with which the computing device, mobile computing device, or server communicates, such as a server or computer.

[0107] Further, a portion of the claimed advancements may be provided as a utility application, background daemon, or component of an operating system, or combination thereof, executing in conjunction with CPU 600 and an operating system such as Microsoft Windows 6, UNIX, Solaris, LINUX, Apple MAC-OS and other systems known to those skilled in the art.

[0108] CPU 600 may be a Xenon or Core processor from Intel of America or an Opteron processor from AMD of America, or may be other processor types that would be recognized by one of ordinary skill in the art. Alternatively, the CPU 600 may be implemented on an FPGA, ASIC, PLD or using discrete logic circuits, as one of ordinary skill in the art would recognize. Further, CPU 600 may be implemented as multiple processors cooperatively working in parallel to perform the instructions of the inventive processes described above.

[0109] The computing device, mobile computing device, or server in FIG. 6 also includes a network controller 606, such as an Intel Ethernet PRO network interface card from Intel Corporation of America, for interfacing with network 6X. As can be appreciated, the network 628 can be a public network, such as the Internet, or a private network such as an LAN or WAN network, or any combination thereof and can also include PSTN or ISDN sub-networks. The network 628 can also be wired, such as an Ethernet network, or can be wireless such as a cellular network including EDGE, 3G and 4G wireless cellular systems. The wireless network can also be Wi-Fi, Bluetooth, or any other wireless form of communication that is known.

[0110] The computing device, mobile computing device, or server further includes a display controller 608, such as a NVIDIA GeForce GTX or Quadro graphics adaptor from NVIDIA Corporation of America for interfacing with display 610, such as a Hewlett Packard HPL2445w LCD monitor. A general purpose I/O interface 612 interfaces with a keyboard and/or mouse 614 as well as a touch screen panel 616 on or separate from display 610. General purpose I/O interface also connects to a variety of peripherals 618 including printers and scanners, such as an OfficeJet or DeskJet from Hewlett Packard.

[0111] A sound controller 620 is also provided in the computing device, mobile computing device, or server, such as Sound Blaster X-Fi Titanium from Creative, to interface with speakers/microphone 622 thereby providing sounds and/or music.

[0112] The general purpose storage controller 624 connects the storage medium disk 604 with communication bus 626, which may be an ISA, EISA, VESA, PCI, or similar, for interconnecting all of the components of the computing device, mobile computing device, or server. A description of the general features and functionality of the display 610, keyboard and/or mouse 614, as well as the display controller 608, storage controller 624, network controller 606, sound controller 620, and general purpose I/O interface 612 is omitted herein for brevity as these features are known.

[0113] One or more processors can be utilized to implement various functions and/or algorithms described herein, unless explicitly stated otherwise. Additionally, any functions and/or algorithms described herein, unless explicitly stated otherwise, can be performed upon one or more virtual processors, for example on one or more physical computing systems such as a computer farm or a cloud drive.

[0114] Reference has been made to flowchart illustrations and block diagrams of methods, systems and computer program products according to implementations of this disclosure. Aspects thereof are implemented by computer program instructions. These computer program instructions may be provided to a processor of a general purpose computer, special purpose computer, or other programmable data processing apparatus to produce a machine, such that the instructions, which execute via the processor of the computer or other programmable data processing apparatus, create means for implementing the functions/acts specified in the flowchart and/or block diagram block or blocks.

[0115] These computer program instructions may also be stored in a computer-readable medium that can direct a computer or other programmable data processing apparatus to function in a particular manner, such that the instructions stored in the computer-readable medium produce an article of manufacture including instruction means which implement the function/act specified in the flowchart and/or block diagram block or blocks.

[0116] The computer program instructions may also be loaded onto a computer or other programmable data processing apparatus to cause a series of operational steps to be performed on the computer or other programmable apparatus to produce a computer implemented process such that the instructions which execute on the computer or other programmable apparatus provide processes for implementing the functions/acts specified in the flowchart and/or block diagram block or blocks.

[0117] Moreover, the present disclosure is not limited to the specific circuit elements described herein, nor is the present disclosure limited to the specific sizing and classification of these elements. For example, the skilled artisan will appreciate that the circuitry described herein may be adapted based on changes on battery sizing and chemistry, or based on the requirements of the intended back-up load to be powered.

[0118] The functions and features described herein may also be executed by various distributed components of a system. For example, one or more processors may execute these system functions, where the processors are distributed across multiple components communicating in a network. The distributed components may include one or more client and server machines, which may share processing, as shown on Fig. 8, in addition to various human interface and communication devices (e.g., display monitors, smart phones, tablets, personal digital assistants (PDAs)). The network may be a private network, such as a LAN or WAN, or may be a public network, such as the Internet. Input to the system may be received via direct user input and received remotely either in real-time or as a batch process. Additionally, some implementations may be performed on modules or hardware not identical to those described. Accordingly, other implementations are within the scope that may be claimed.

[0119] In some implementations, as illustrated in FIG. 7, the innovations described herein may interface with a cloud computing environment 730, such as Google Cloud Platform™ to

perform at least portions of methods or algorithms detailed above. The processes associated with the methods described herein can be executed on a computation processor, such as the Google Compute Engine by data center 734. The data center 734, for example, can also include an application processor, such as the Google App Engine, that can be used as the interface with the systems described herein to receive data and output corresponding information. The cloud computing environment 730 may also include one or more databases 738 or other data storage, such as cloud storage and a query database. In some implementations, the cloud storage database 738, such as the Google Cloud Storage, may store processed and unprocessed data supplied by systems described herein.

[0120] The systems described herein may communicate with the cloud computing environment 730 through a secure gateway 732. In some implementations, the secure gateway 732 includes a database querying interface, such as the Google BigQuery platform.

[0121] The cloud computing environment 102 may include a provisioning tool 740 for resource management. The provisioning tool 740 may be connected to the computing devices of a data center 734 to facilitate the provision of computing resources of the data center 734. The provisioning tool 740 may receive a request for a computing resource via the secure gateway 732 or a cloud controller 736. The provisioning tool 740 may facilitate a connection to a particular computing device of the data center 734.

[0122] A network 702 represents one or more networks, such as the Internet, connecting the cloud environment 730 to a number of client devices such as, in some examples, a cellular telephone 710, a tablet computer 712, a mobile computing device 714, and a desktop computing device 716. The network 702 can also communicate via wireless networks using a variety of mobile network services 720 such as Wi-Fi, Bluetooth, cellular networks including EDGE, 3G and 4G wireless cellular systems, or any other wireless form of communication that is known. In some embodiments, the network 702 is agnostic to local interfaces and

networks associated with the client devices to allow for integration of the local interfaces and networks configured to perform the processes described herein.

[0123] While certain embodiments have been described, these embodiments have been presented by way of example only, and are not intended to limit the scope of the present disclosures. Indeed, the novel methods, apparatuses and systems described herein can be embodied in a variety of other forms; furthermore, various omissions, substitutions and changes in the form of the methods, apparatuses and systems described herein can be made without departing from the spirit of the present disclosures. The accompanying claims and their equivalents are intended to cover such forms or modifications as would fall within the scope and spirit of the present disclosures.

CLAIMS

What is claimed is:

1. A method for automatically categorizing a repair condition of a property characteristic, comprising:

receiving, from a user at a remote computing device, a request for a property condition classification, wherein the property classification request includes identification of a property and at least one property characteristic;

obtaining, by processing circuitry of a computing system responsive to receiving the request, an aerial image of a geographic region including the property;

identifying, by the processing circuitry, a plurality of features of the aerial image corresponding to the property characteristic;

analyzing, by the processing circuitry, the plurality of features to determine a property characteristic classification;

analyzing, by the processing circuitry, a region of the aerial image including the property characteristic to determine a condition classification;

determining, by the processing circuitry using the property characteristic classification and the condition classification, a risk estimate of damage to the property due to one or more disasters; and

returning, to the user at the remote computing device via a graphical user interface responsive to receiving the request, a condition assessment of the property characteristic including the condition classification and the risk estimate of damage to the property due to the one or more disasters.

2. The method of claim 1, wherein the property characteristic classification is rooftop shape.

3. The method of claim 1, wherein analyzing the plurality of features to determine a property characteristic comprises applying a deep learning analysis model to the plurality of features.

4. The method of claim 1, wherein the deep learning analysis model is NIN.

5. The method of claim 1, wherein analyzing the region of the aerial image including the property characteristic to determine the condition classification comprises applying a machine learning analysis model to a plurality of image pixels within the region.

6. The method of claim 5, wherein the machine learning analysis model comprises a color histogram analysis model.

7. The method of claim 1, wherein determining the risk estimate comprises applying a disaster risk profile corresponding to a) a first disaster of the at least one disaster and b) the property characteristic.

8. A system for automatically categorizing a repair condition of a property characteristic, comprising:

processing circuitry; and

a non-transitory computer-readable medium having instructions stored thereon;

wherein the instructions, when executed by the processing circuitry, cause the processing circuitry to

receive, from a user at a remote computing device, a property condition classification request, wherein the property classification request includes identification of a property and at least one property characteristic;

obtain, from a remote data source responsive to receiving the property classification request, an aerial image of a geographic region including the property;

identify a plurality of features of the aerial image corresponding to the property characteristic;

analyze the plurality of features to determine a property characteristic classification;

analyze a region of the aerial image including the property characteristic to determine a condition classification; and

determine, in real-time responsive to receiving the property classification request and using the property characteristic classification and the condition classification, a replacement cost for replacing the property characteristic.

9. The system of claim 8, wherein the instructions, when executed by the processing circuitry, cause the processing circuitry to, prior to identifying the plurality of features:

obtain a shape map image including the property;

overlay the aerial image with the shape map image; and

determine whether a boundary of the property as identified by the shape map matches a boundary of the property as illustrated in the aerial image.

10. The system of claim 9, wherein the instructions, when executed by the processing circuitry, cause the processing circuitry to, upon determining that the shape map

does not match the boundary of the corresponding property, obtain an alternate aerial image of the property.

11. The system of claim 8, wherein the instructions, when executed by the processing circuitry, cause the processing circuitry to compare a current condition classification of the property characteristic to a stored historic condition classification of the property characteristic.

12. The system of claim 11, wherein the instructions, when executed by the processing circuitry, cause the processing circuitry to, in real-time responsive to receiving the property condition classification request, determine whether repairs have been made to the property based on the comparison of the current condition classification to the historic condition classification of the property characteristic.

13. The system of claim 8, wherein the instructions, when executed by the processing circuitry, cause the processing circuitry to, prior to identifying the plurality of features, assess orthogonality of the aerial imagery.

14. The system of claim 13, wherein the instructions, when executed by the processing circuitry, cause the processing circuitry to, responsive to assessing that the orthogonality of the aerial imagery does not correspond to a true orthophoto form, cause correction of the aerial imagery to the true orthophoto form.

15. A non-transitory computer readable medium having instructions stored thereon, wherein the instructions, when executed by processing circuitry, cause the processing circuitry to:

receive, from a user at a remote computing device, a property condition classification request, wherein the property classification request includes identification of a property and at least one property characteristic;

obtain, from a remote data source responsive to receiving the property classification request, an aerial image of a geographic region including the property;

identify a respective plurality of features of the aerial image corresponding to each property characteristic of the at least one property characteristic;

for each of the at least one property characteristic,

analyze the corresponding plurality of features to determine a respective property characteristic classification, and

analyze a region of the aerial image including the respective property characteristic to determine a respective condition classification; and

determine, in real-time responsive to receiving the property classification request and using the property characteristic classification of each property characteristic and the condition classification of each property characteristic, at least one risk estimate representing risk of damage due to disaster.

16. The non-transitory computer readable medium of claim 15, wherein the instructions, when executed by the processing circuitry, cause the processing circuitry to, prior to obtaining the aerial image of the geographic region, determine, based upon the at least one property characteristic, a preferred image type

corresponding to each property characteristic of the at least one property characteristic.

17. The non-transitory computer readable medium of claim 16, wherein:

the at least one property characteristic comprises two or more property characteristics; and

the instructions, when executed by the processing circuitry, cause the processing circuitry to, responsive to determining the preferred image type corresponding to a first property characteristic of the at least one property characteristic is a terrestrial image, obtain a terrestrial image of the geographic region including the property.

18. The non-transitory computer readable medium of claim 15, wherein the instructions, when executed by the processing circuitry, cause the processing circuitry to access one or more known property characteristics, wherein determining the at least one risk estimate comprises determining the at least one risk estimate further based on the one or more known property characteristics.

19. The non-transitory computer readable medium of claim 18, wherein the one or more known property characteristics comprise at least one of a property age, a property elevation, a property slope, a year built, a year renovated, and a building height.

20. The non-transitory computer readable medium of claim 15, wherein:

receiving identification of the property and the at least one property characteristic comprises receiving, via a network from a remote computing device, the identification of the property; and

the instructions, when executed by the processing circuitry, cause the processing circuitry to provide, via the network to a graphical user interface at the remote computing device in real-time responsive to receiving the at least one property characteristic, the at least one risk estimate.

ABSTRACT

In an illustrative embodiment, methods and systems for automatically categorizing a repair condition of a property characteristic may include obtaining aerial imagery of a geographic region including the property, identifying features of the aerial imagery corresponding to the property characteristic, analyzing the features to determine a property characteristic classification, and analyzing a region of the aerial imagery including the property characteristic to determine a condition classification. The methods and systems may further include determining, using the property characteristic classification and the condition classification, a risk estimate of damage to the property due to one or more disasters and/or a cost estimate of repair or replacement of the property characteristic.

4824-9853-7804, v. 1

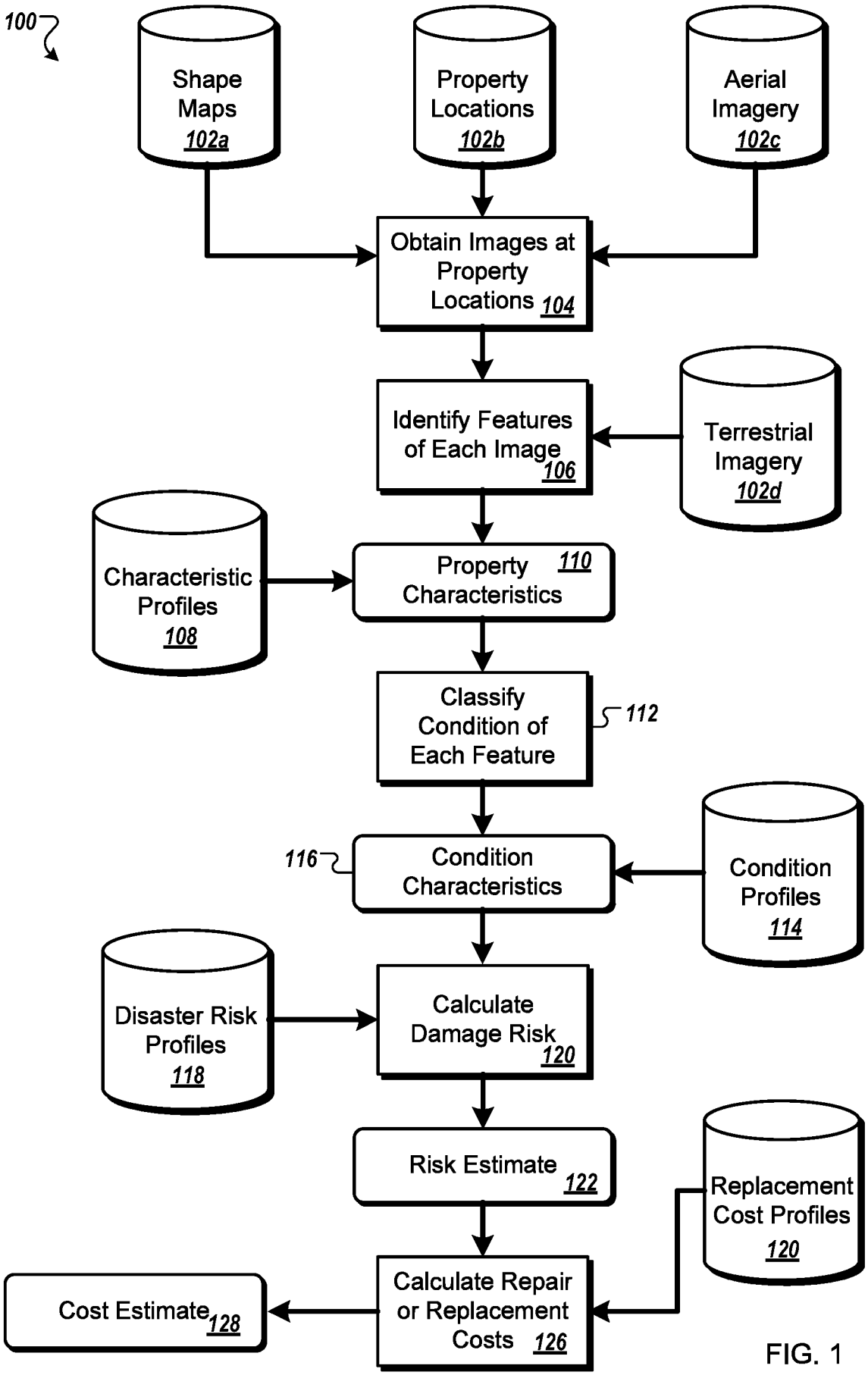

100
Shape Maps 102a
Property Locations 102b
Aerial Imagery 102c
Obtain Images at Property Locations 104
Identify Features of Each Image 106
Terrestrial Imagery 102d
Characteristic Profiles 108
Property Characteristics 110
Classify Condition of Each Feature 112
116
Condition Characteristics
Condition Profiles 114
Disaster Risk Profiles 118
Calculate Damage Risk 120
Risk Estimate 122
Replacement Cost Profiles 120
Cost Estimate 128
Calculate Repair or Replacement Costs 126

FIG. 1

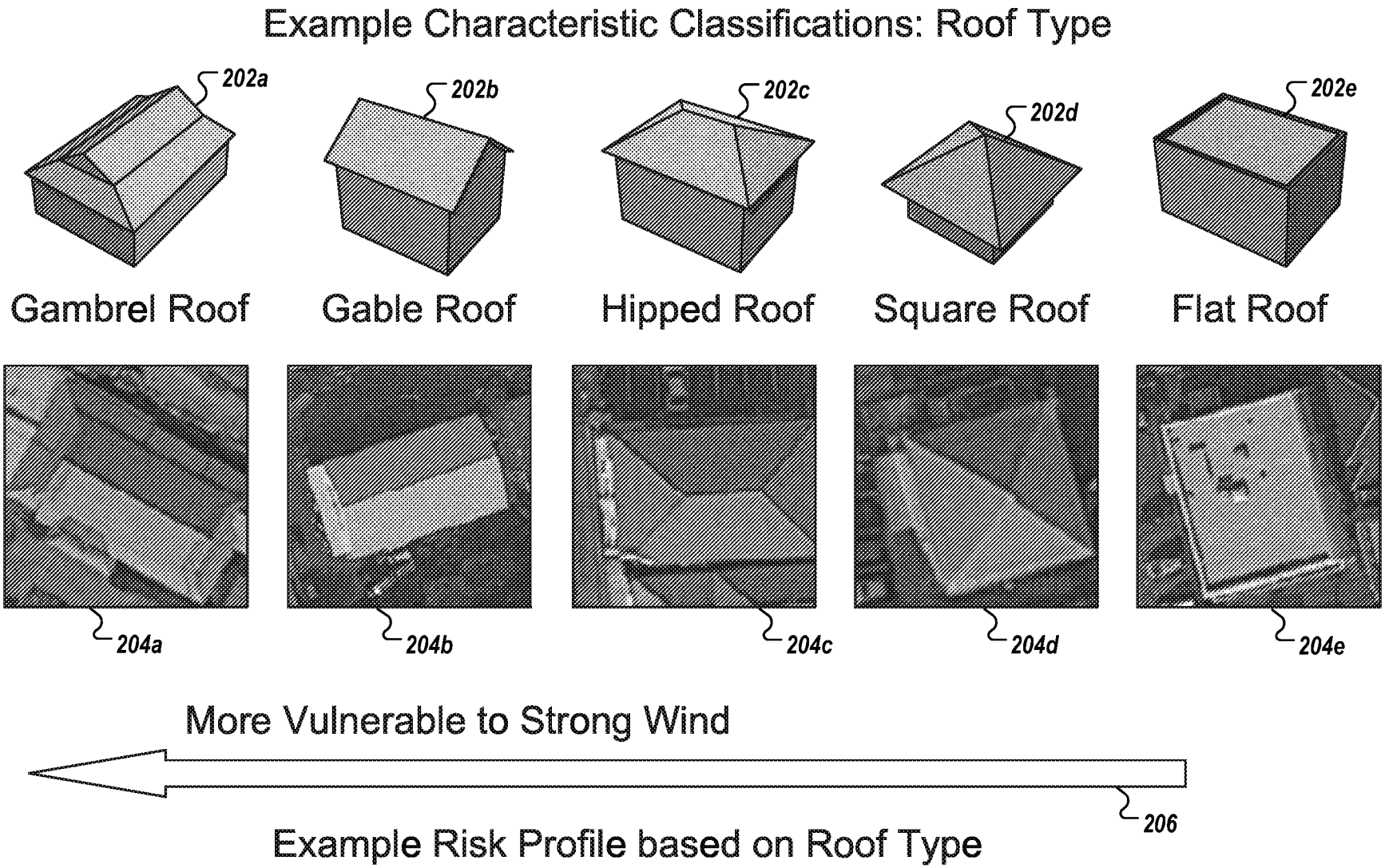

Example Characteristic Classifications: Roof Type
202a
202b
202c
202d
202e
Gambrel Roof
Gable Roof
Hipped Roof
Square Roof
Flat Roof
204a
204b
204c
204d
204e
More Vulnerable to Strong Wind
206
Example Risk Profile based on Roof Type

FIG. 2A

0062

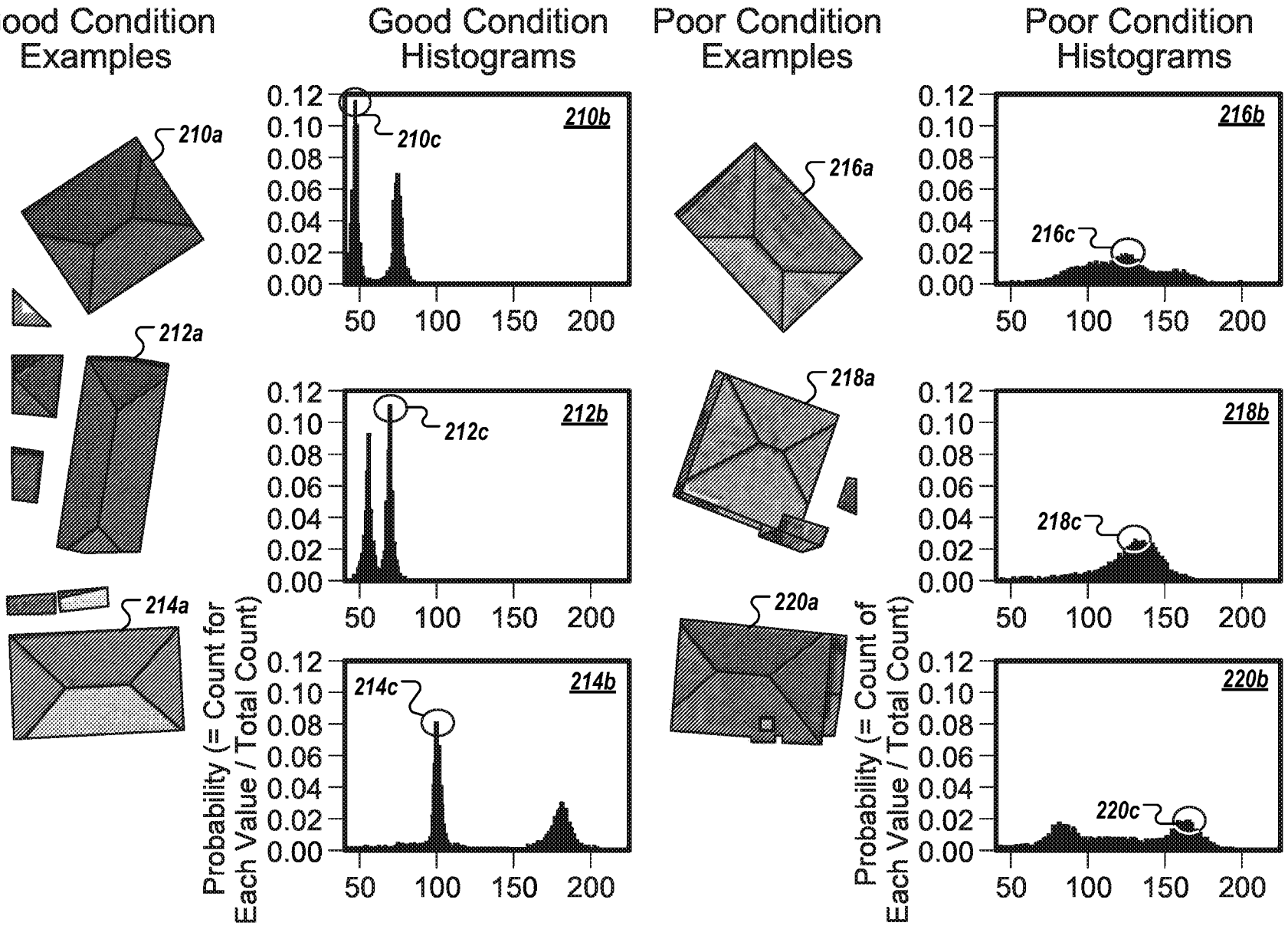
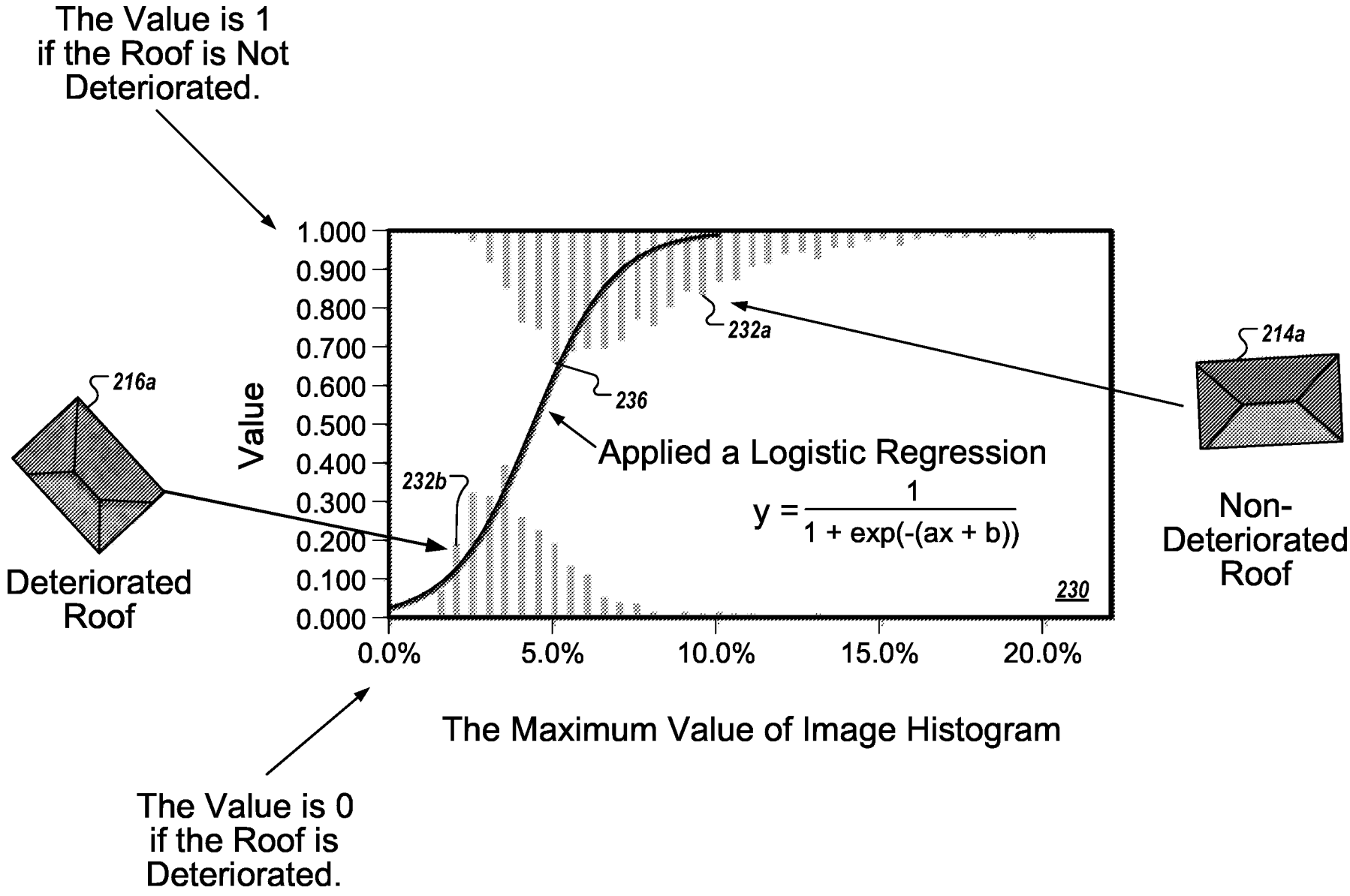

Good Condition Examples
Good Condition Histograms
Poor Condition Examples
Poor Condition Histograms
210a
212a
214a
216a
218a
220a
210b
210c
212b
212c
214b
214c
216b
216c
218b
218c
220b
220c
Probability (= Count for Each Value / Total Count)
Probability (= Count of Each Value / Total Count)
0.12
0.10
0.08
0.06
0.04
0.02
0.00
50
100
150
200

FIG. 2B

0063


The Value is 1 if the Roof is Not Deteriorated.
1.000
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
Value
232a
214a
216a
236
Applied a Logistic Regression
$y = \frac{1}{1 + \exp(-(ax + b))}$
232b
Non-Deteriorated Roof
Deteriorated Roof
230
0.0%
5.0%
10.0%
15.0%
20.0%
The Maximum Value of Image Histogram
The Value is 0 if the Roof is Deteriorated.

0064

FIG. 2C

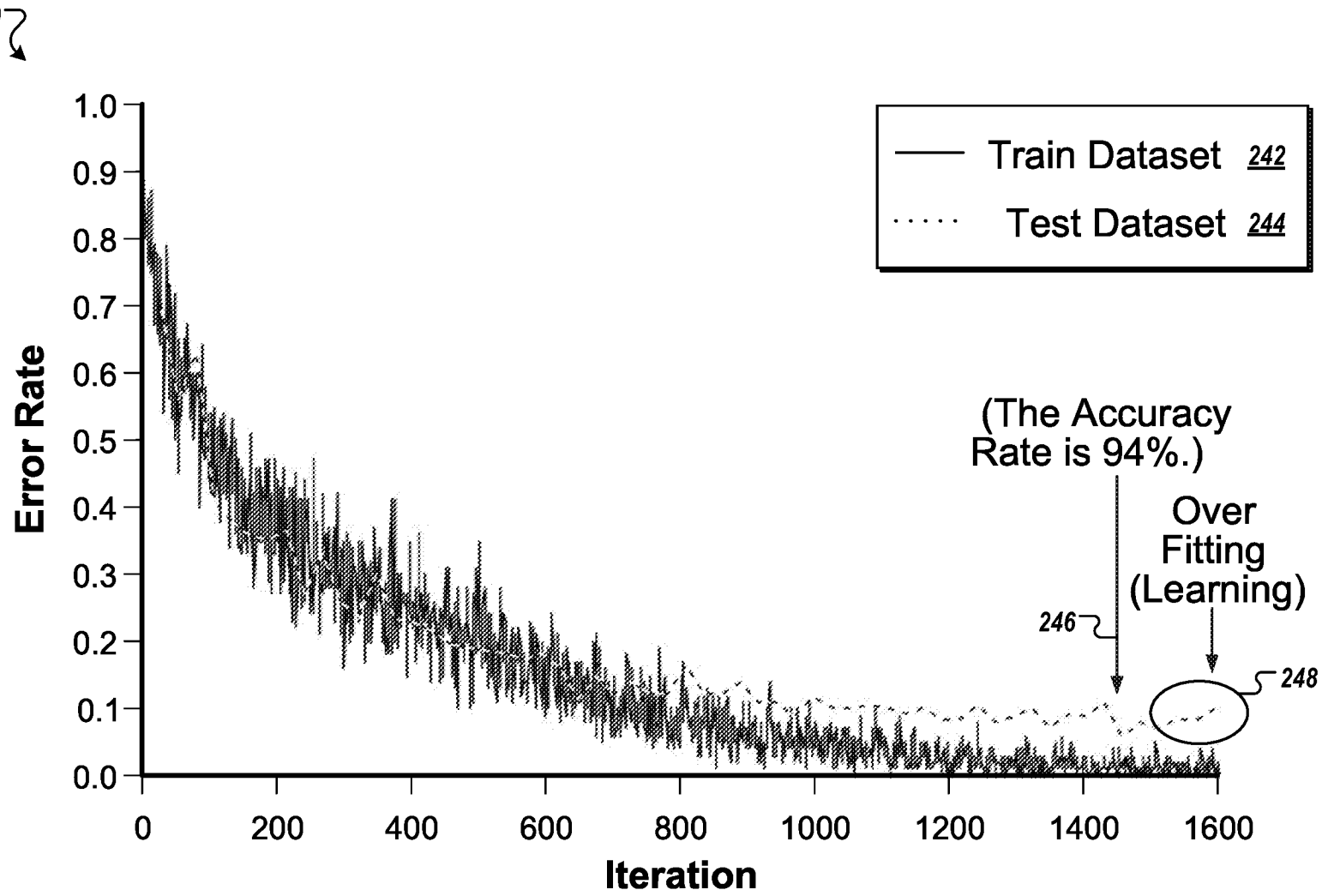

240
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Error Rate
0
200
400
600
800
1000
1200
1400
1600
Iteration
Train Dataset 242
Test Dataset 244
(The Accuracy Rate is 94%.)
Over Fitting (Learning)
246
248

FIG. 2D

0065

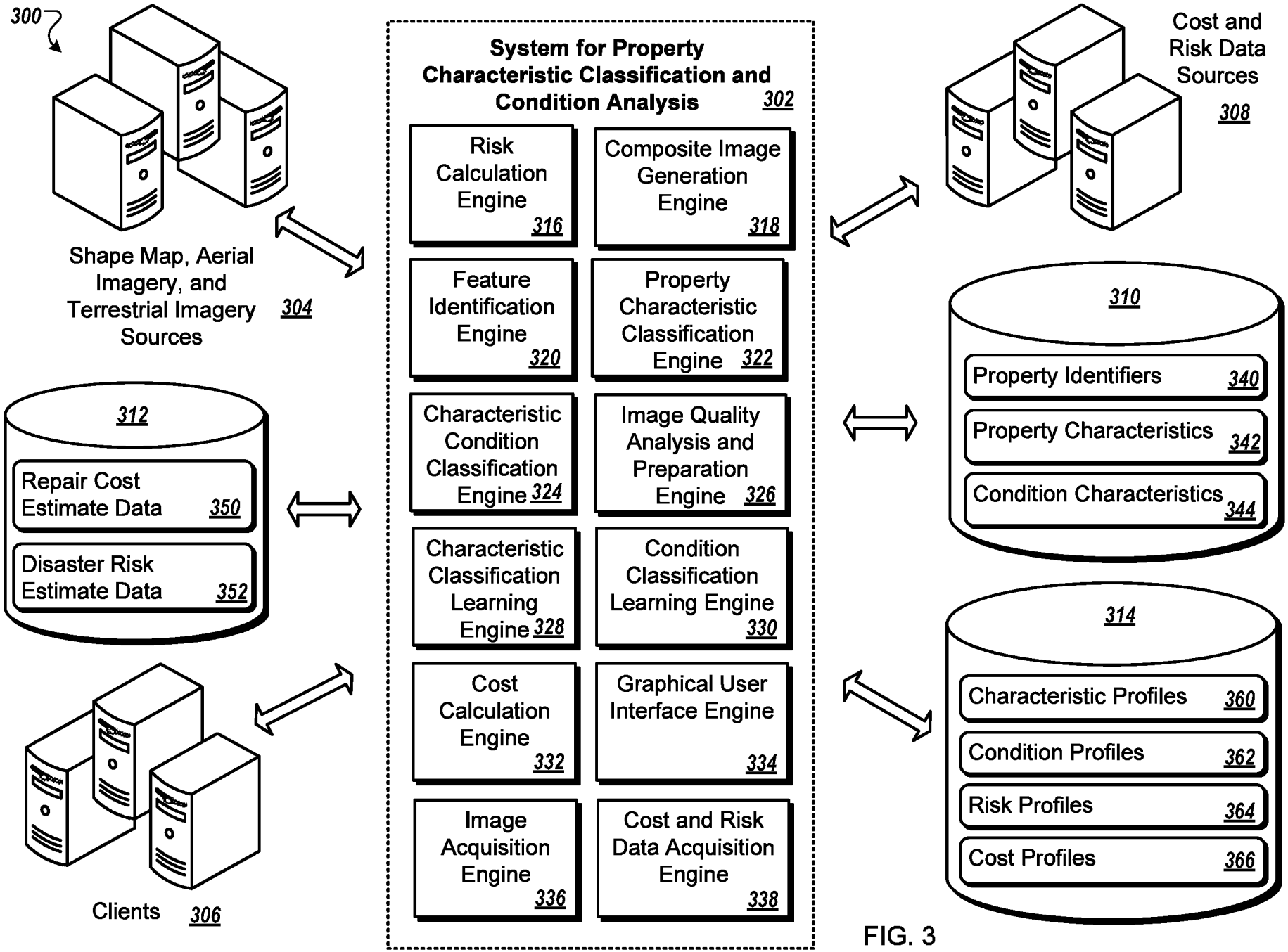

300
Shape Map, Aerial Imagery, and Terrestrial Imagery Sources 304
System for Property Characteristic Classification and Condition Analysis 302
Risk Calculation Engine 316
Composite Image Generation Engine 318
Feature Identification Engine 320
Property Characteristic Classification Engine 322
Characteristic Condition Classification Engine 324
Image Quality Analysis and Preparation Engine 326
Characteristic Classification Learning Engine 328
Condition Classification Learning Engine 330
Cost Calculation Engine 332
Graphical User Interface Engine 334
Image Acquisition Engine 336
Cost and Risk Data Acquisition Engine 338
Cost and Risk Data Sources 308
310
Property Identifiers 340
Property Characteristics 342
Condition Characteristics 344
312
Repair Cost Estimate Data 350
Disaster Risk Estimate Data 352
314
Characteristic Profiles 360
Condition Profiles 362
Risk Profiles 364
Cost Profiles 366
Clients 306
9600

FIG. 3

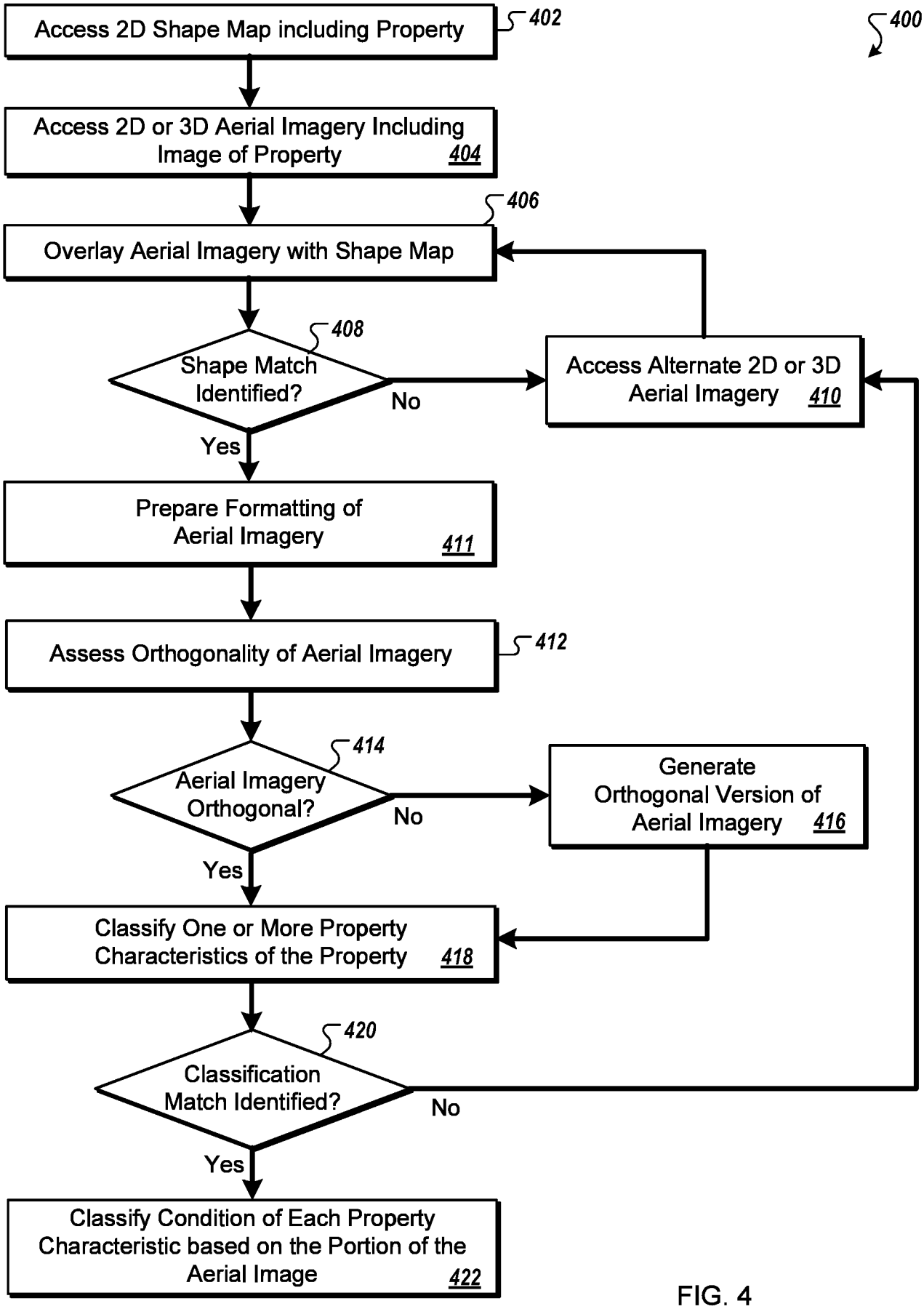

Access 2D Shape Map including Property
402
400
Access 2D or 3D Aerial Imagery Including Image of Property
404
406
Overlay Aerial Imagery with Shape Map
408
Shape Match Identified?
No
Access Alternate 2D or 3D Aerial Imagery
410
Yes
Prepare Formatting of Aerial Imagery
411
Assess Orthogonality of Aerial Imagery
412
414
Aerial Imagery Orthogonal?
No
Generate Orthogonal Version of Aerial Imagery
416
Yes
Classify One or More Property Characteristics of the Property
418
420
Classification Match Identified?
No
Yes
Classify Condition of Each Property Characteristic based on the Portion of the Aerial Image
422

FIG. 4

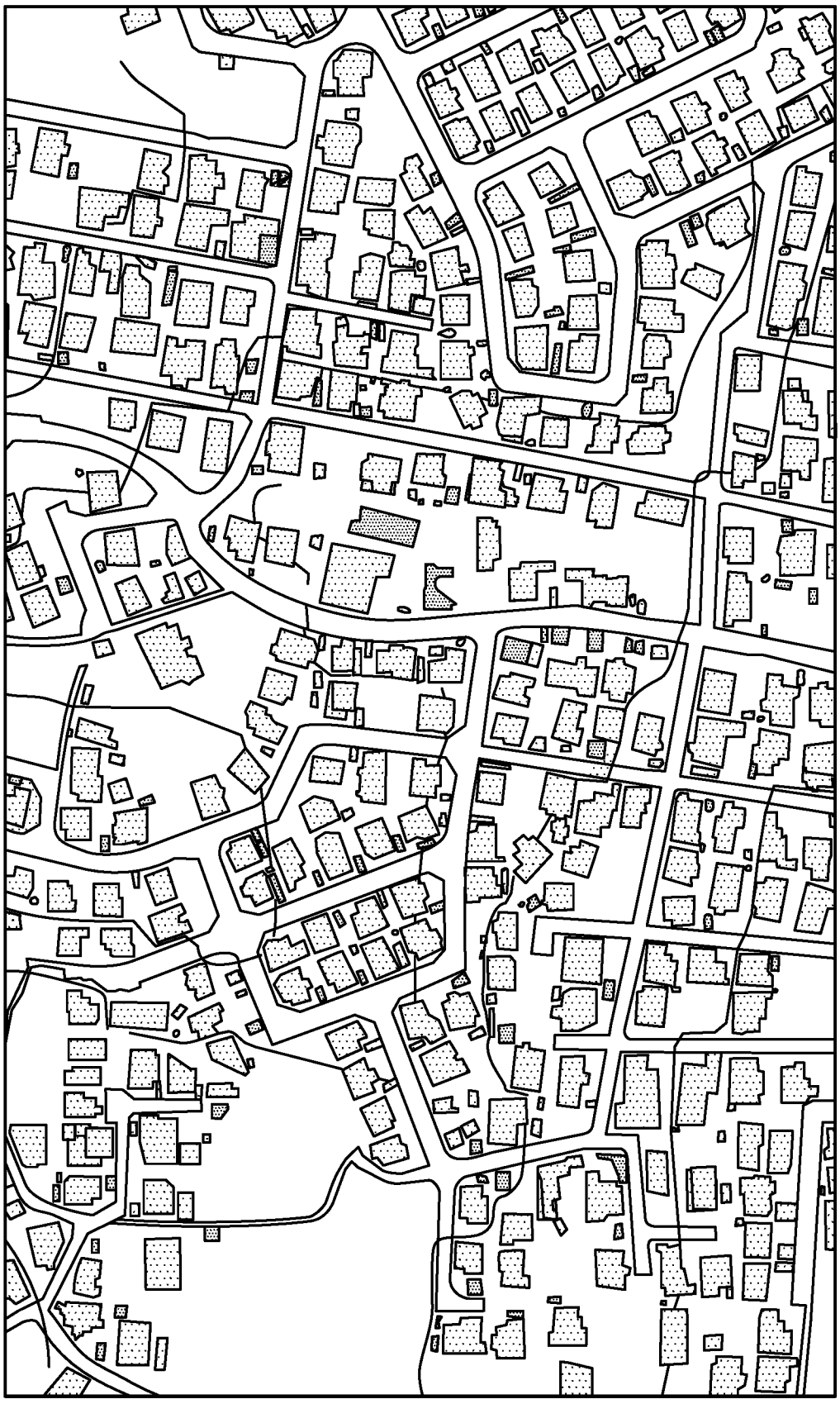


FIG. 5A

510



FIG. 5B

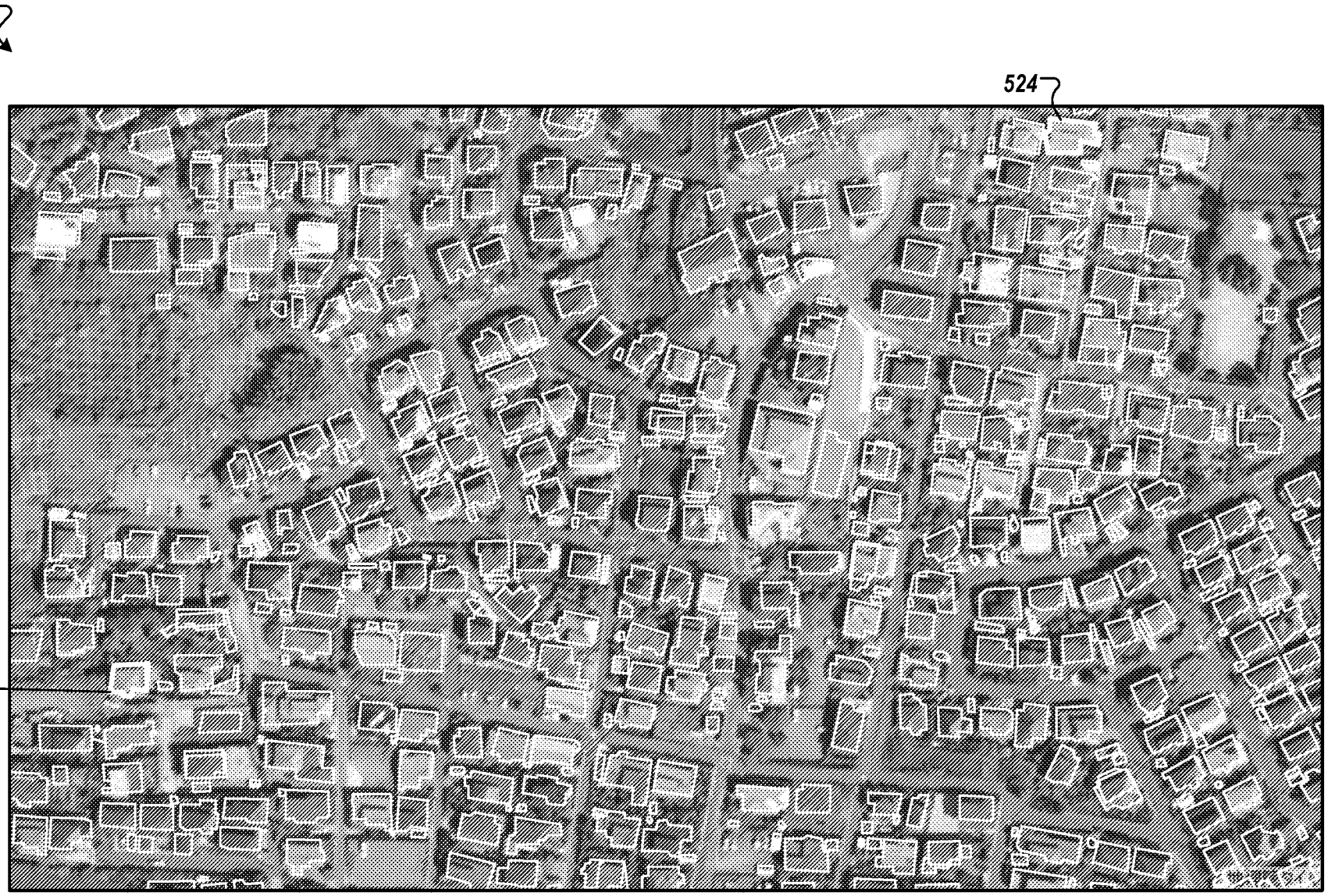


FIG. 5C

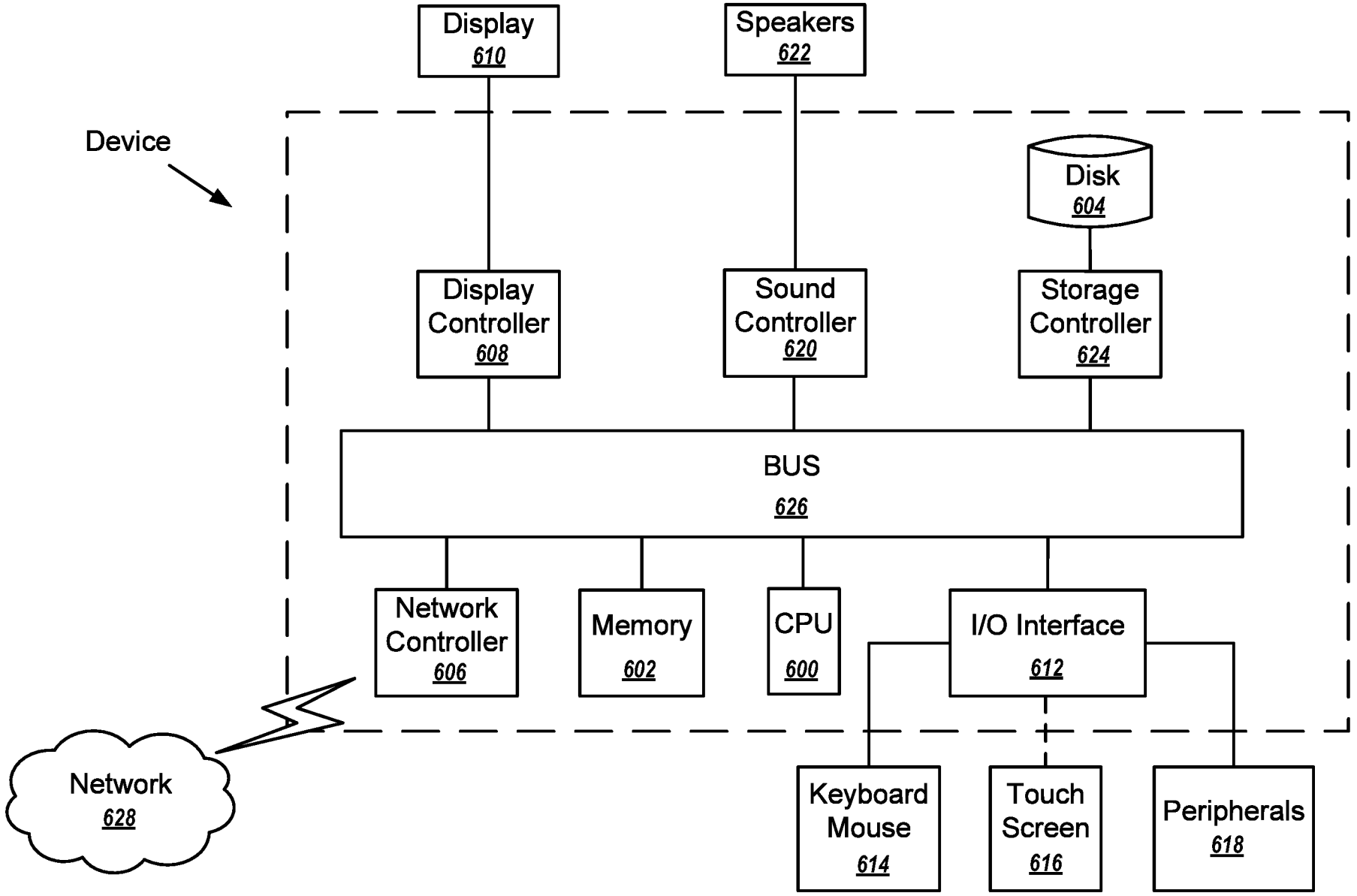

Display
610
Speakers
622
Device
Disk
604
Display
Controller
608
Sound
Controller
620
Storage
Controller
624
BUS
626
Network
Controller
606
Memory
602
CPU
600
I/O Interface
612
Network
628
Keyboard
Mouse
614
Touch
Screen
616
Peripherals
618

FIG. 6

0071

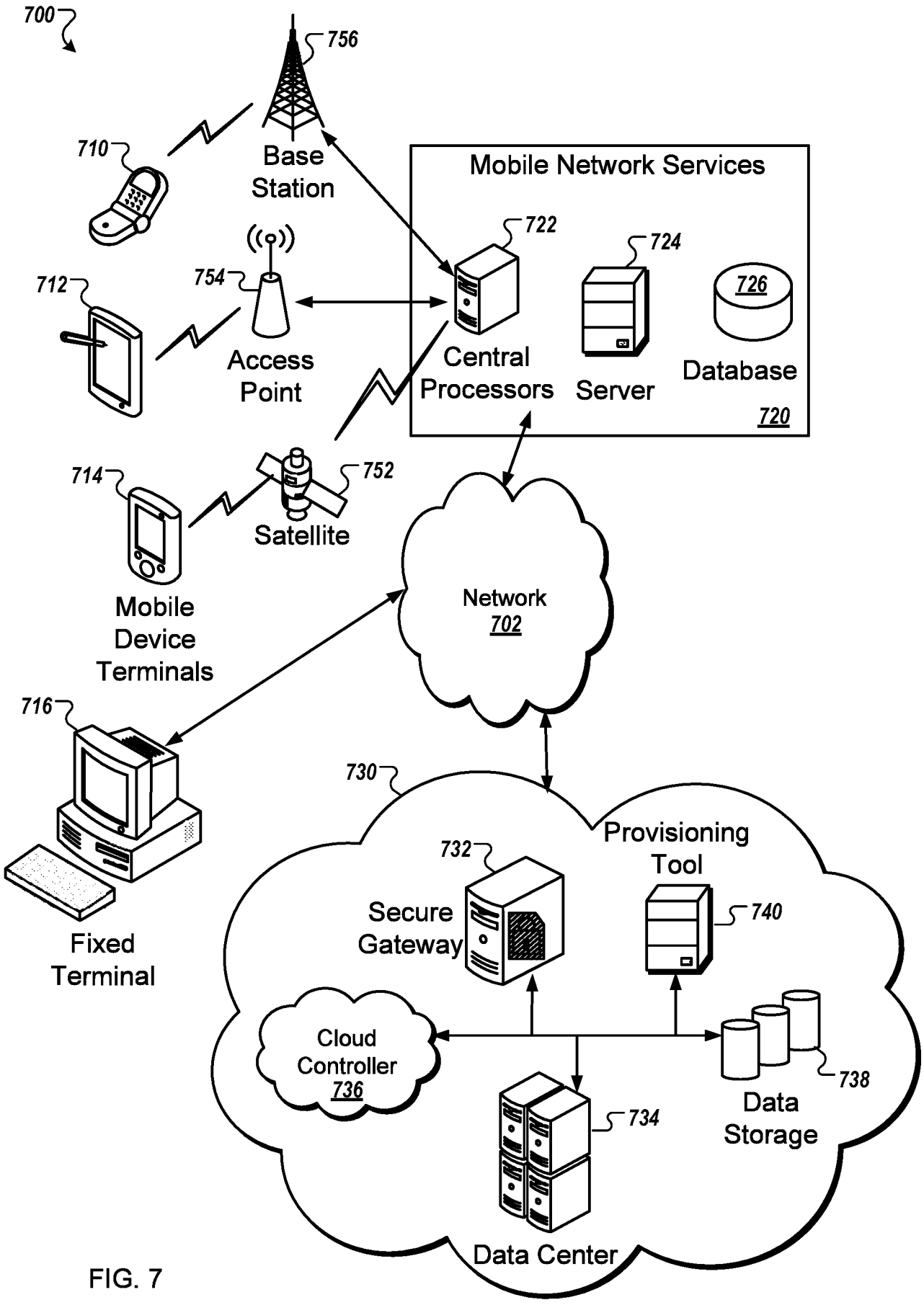
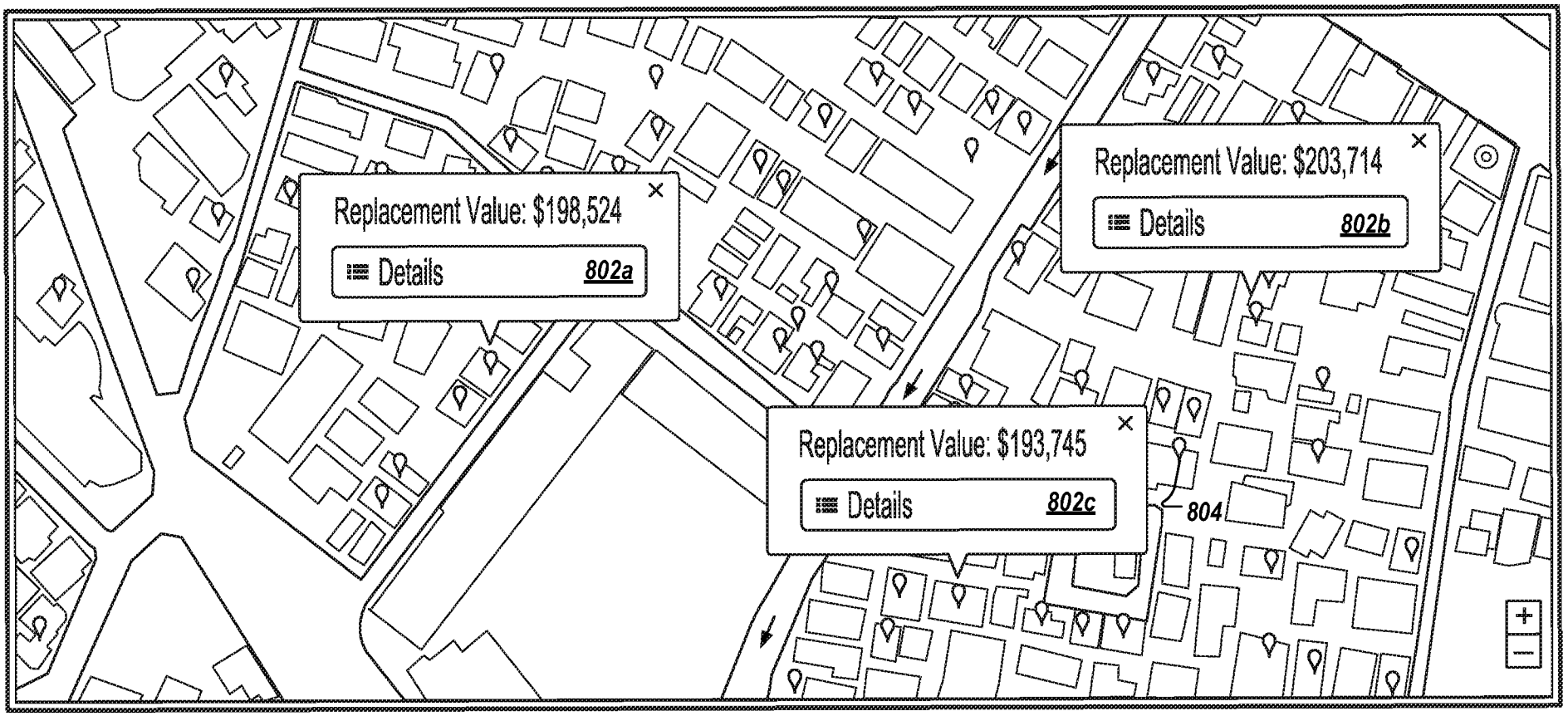
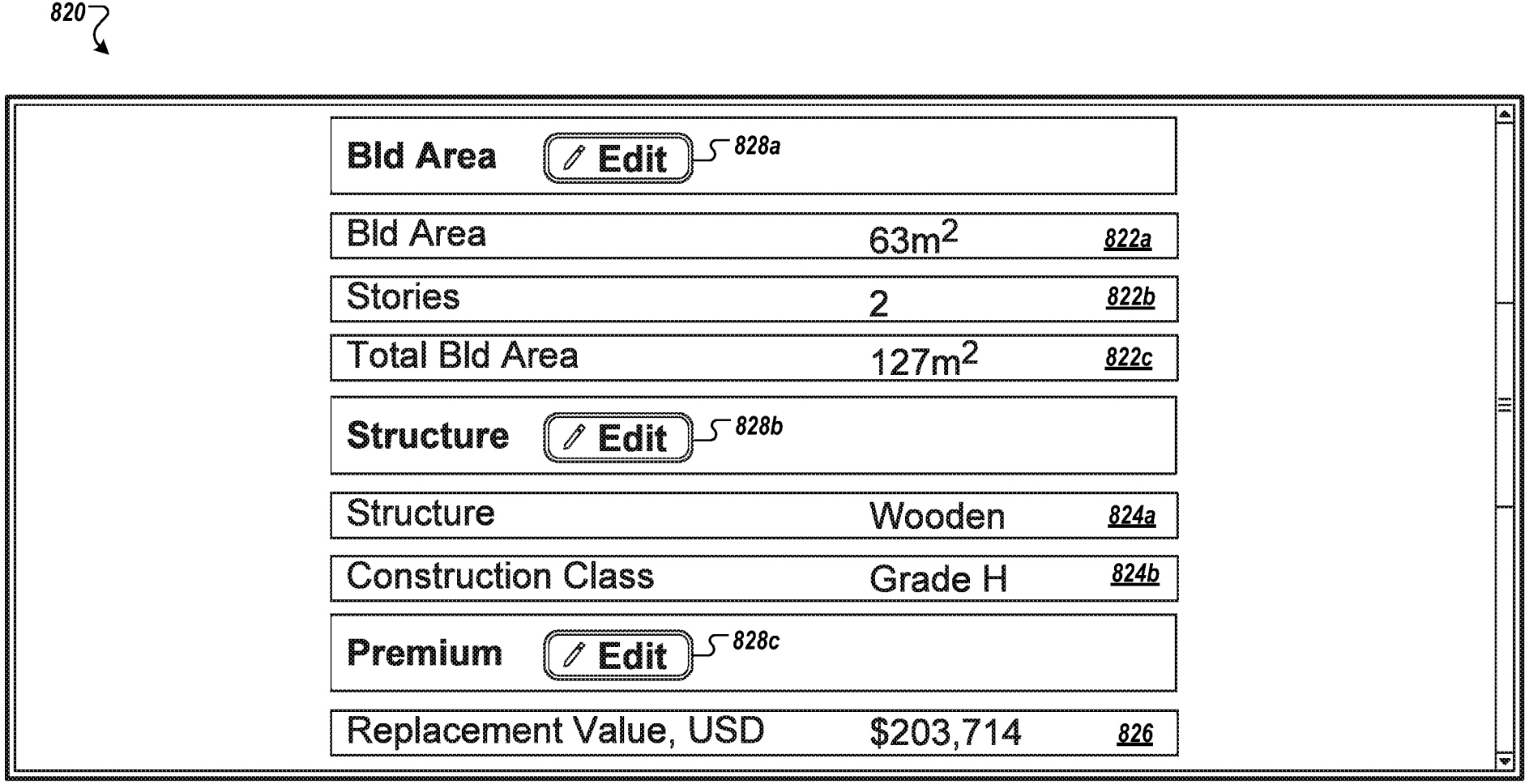

700
756
Base Station
710
Mobile Network Services
722
724
726
754
712
Access Point
Central Processors
Server
Database
720
714
752
Satellite
Network
702
Mobile Device Terminals
716
730
Provisioning Tool
732
740
Secure Gateway
Fixed Terminal
Cloud Controller
736
738
Data Storage
734
Data Center

FIG. 7


800
Replacement Value: $198,524
Details
802a
Replacement Value: $203,714
Details
802b
Replacement Value: $193,745
Details
802c
804

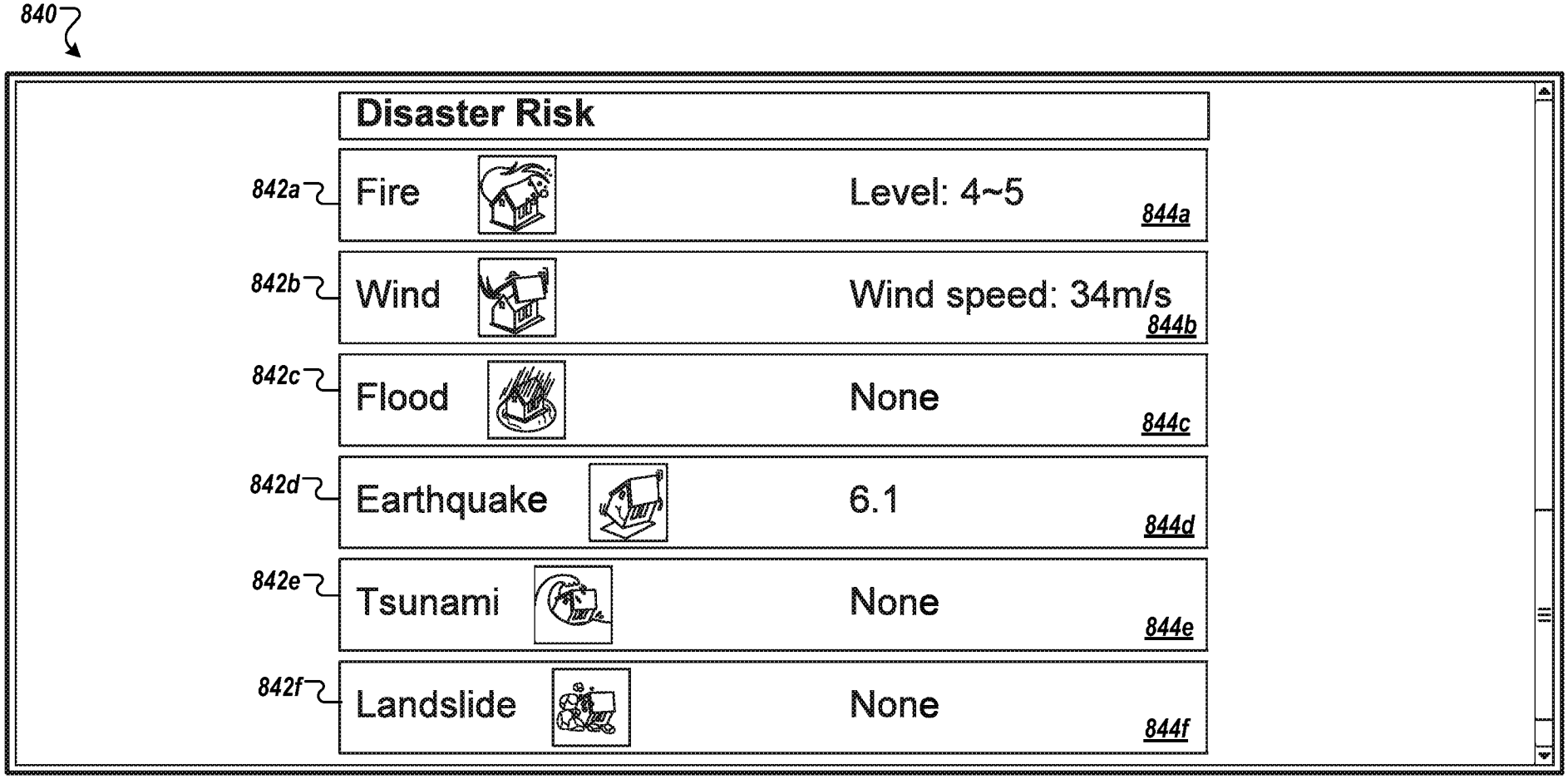
0073

FIG. 8A


820
Bld Area
Edit
828a
Bld Area
63m2
822a
Stories
2
822b
Total Bld Area
127m2
822c
Structure
Edit
828b
Structure
Wooden
824a
Construction Class
Grade H
824b
Premium
Edit
828c
Replacement Value, USD
$203,714
826

0074

FIG. 8B


840
Disaster Risk
842a
Fire
Level: 4~5
844a
842b
Wind
Wind speed: 34m/s
844b
842c
Flood
None
844c
842d
Earthquake
6.1
844d
842e
Tsunami
None
844e
842f
Landslide
None
844f

0075

FIG. 8C

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	474139US01
	Application Number	
Title of Invention	Platform, Systems, and Methods for Identifying Property Characteristics and Property Feature Maintenance Through Aerial Imagery Analysis	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2:

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor 1 — Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Takeshi		Okazaki	

Residence Information (Select One) US Residency ● Non US Residency Active US Military Service

City	Tokyo	Country of Residence i	JP

Mailing Address of Inventor:

Address 1	Capitol Tower 11F, 2-10-3
Address 2	Nagatacho, Chiyoda-ku
City	Tokyo — **State/Province**
Postal Code	100-0014 — **Country** i JP

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below.
For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	146018		
Email Address	info@gardellagrace.com	Add Email	Remove Email

Application Information:

Title of the Invention	Platform, Systems, and Methods for Identifying Property Characteristics and Property Feature Maintenance Through Aerial Imagery Analysis		
Attorney Docket Number	474139US01	**Small Entity Status Claimed**	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	15	**Suggested Figure for Publication (if any)**	

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	474139US01
	Application Number	
Title of Invention	Platform, Systems, and Methods for Identifying Property Characteristics and Property Feature Maintenance Through Aerial Imagery Analysis	

Filing By Reference:

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Please Select One:	● Customer Number	US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)
Customer Number	146018		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, 365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing benefit claim information in the Application Data Sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.
When referring to the current application, please leave the "Application Number" field blank.

Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
	Claims benefit of provisional	62398665	2016-09-23

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button. Add

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	474139US01
	Application Number	
Title of Invention	Platform, Systems, and Methods for Identifying Property Characteristics and Property Feature Maintenance Through Aerial Imagery Analysis	

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)[i] the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Remove

Application Number	Country[i]	Filing Date (YYYY-MM-DD)	Access Code[i] (if applicable)

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button. Add

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.
NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	474139US01
	Application Number	
Title of Invention	Platform, Systems, and Methods for Identifying Property Characteristics and Property Feature Maintenance Through Aerial Imagery Analysis	

Authorization or Opt-Out of Authorization to Permit Access:

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant **must opt-out** of the authorization by checking the corresponding box A or B or both in subsection 2 below.

NOTE: This section of the Application Data Sheet is **ONLY** reviewed and processed with the **INITIAL** filing of an application. After the initial filing of an application, an Application Data Sheet cannot be used to provide or rescind authorization for access by a foreign IP office(s). Instead, Form PTO/SB/39 or PTO/SB/69 must be used as appropriate.

1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

A. Priority Document Exchange (PDX) - Unless box A in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization (WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h)(1).

B. Search Results from U.S. Application to EPO - Unless box B in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the EPO access to the bibliographic data and search results from the instant patent application when a European patent application claiming priority to the instant patent application is filed. See 37 CFR 1.14(h)(2).

The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.

2. Opt-Out of Authorizations to Permit Access by a Foreign Intellectual Property Office(s)

☐ A. Applicant **DOES NOT** authorize the USPTO to permit a participating foreign IP office access to the instant application-as-filed. If this box is checked, the USPTO will not be providing a participating foreign IP office with any documents and information identified in subsection 1A above.

☐ B. Applicant **DOES NOT** authorize the USPTO to transmit to the EPO any search results from the instant patent application. If this box is checked, the USPTO will not be providing the EPO with search results from the instant application.

NOTE: Once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	474139US01
	Application Number	
Title of Invention	Platform, Systems, and Methods for Identifying Property Characteristics and Property Feature Maintenance Through Aerial Imagery Analysis	

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant 1 — Remove

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

Assignee	Legal Representative under 35 U.S.C. 117	Joint Inventor
● Person to whom the inventor is obligated to assign.	Person who shows sufficient proprietary interest	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor:

If the Applicant is an Organization check here. ☒

Organization Name	Aon Benfield Inc.		
Mailing Address Information For Applicant:			
Address 1	200 E. Randolph Street		
Address 2			
City	Chicago	**State/Province**	IL
Country	US	Postal Code	60601
Phone Number		Fax Number	
Email Address			

Additional Applicant Data may be generated within this form by selecting the Add button. Add

Assignee Information including Non-Applicant Assignee Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	474139US01
	Application Number	
Title of Invention	Platform, Systems, and Methods for Identifying Property Characteristics and Property Feature Maintenance Through Aerial Imagery Analysis	

Assignee 1

Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.

Remove

If the Assignee or Non-Applicant Assignee is an Organization check here. ☒

Organization Name	Aon Benfield Inc.

Mailing Address Information For Assignee including Non-Applicant Assignee:

Address 1	200 E. Randolph Street		
Address 2			
City	Chicago	**State/Province**	IL
Country i	US	Postal Code	60601
Phone Number		Fax Number	
Email Address			

Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button. Add

Signature:

Remove

NOTE: This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). **However, if this Application Data Sheet is submitted with the INITIAL filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).**

This Application Data Sheet **must** be signed by a patent practitioner if one or more of the applicants is a **juristic entity** (e.g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

Signature	/Natalie J. Grace/			Date (YYYY-MM-DD)	2017-09-25
First Name	Natalie	Last Name	Grace	Registration Number	65803

Additional Signature may be generated within this form by selecting the Add button. Add

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	474139US01
	Application Number	
Title of Invention	Platform, Systems, and Methods for Identifying Property Characteristics and Property Feature Maintenance Through Aerial Imagery Analysis	

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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The information provided by you in this form will be subject to the following routine uses:

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Application Number: 15714376 Document Date: 09/25/2017

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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
15/714,376	09/25/2017	2668	1600	474139US01	20	3

CONFIRMATION NO. 8275

FILING RECEIPT

146018
Gardella Grace P.A.
P.O. Box 51977
Washington, DC 20091

OC000000094569391

Date Mailed: 10/06/2017

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Inventor(s)

Takeshi Okazaki, Tokyo, JAPAN;

Applicant(s)

Aon Benfield Inc., Chicago, IL

Assignment For Published Patent Application

Aon Benfield Inc., Chicago, IL

Power of Attorney: None

Domestic Priority data as claimed by applicant

This appln claims benefit of 62/398,665 09/23/2016

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 10/05/2017

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 15/714,376**

Projected Publication Date: 03/29/2018

Non-Publication Request: No

Early Publication Request: No

Title

Platform, Systems, and Methods for Identifying Property Characteristics and Property Feature Maintenance Through Aerial Imagery Analysis

Preliminary Class

382

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

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Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

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PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 15/714,376

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	280
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	600
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	720
TOTAL CLAIMS (37 CFR 1.16(i))	20 minus 20 =	*			OR	x 80 =	0.00
INDEPENDENT CLAIMS (37 CFR 1.16(h))	3 minus 3 =	*				x 420 =	0.00
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	1600

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
15/714,376	09/25/2017	Takeshi Okazaki	474139US01

CONFIRMATION NO. 8275

146018
Gardella Grace P.A.
455 Massachusetts Ave, NW
Suite 507
Washington, DC 20001

PUBLICATION NOTICE

OC000000098410939

Title: Platform, Systems, and Methods for Identifying Property Characteristics and Property Feature Maintenance Through Aerial Imagery Analysis

Publication No.US-2018-0089763-A1
Publication Date:03/29/2018

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently http://www.uspto.gov/patft/.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Public Records Division. The Public Records Division can be reached by telephone at (571) 272-3150 or (800) 972-6382, by facsimile at (571) 273-3250, by mail addressed to the United States Patent and Trademark Office, Public Records Division, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently https://portal.uspto.gov/pair/PublicPair. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

Further assistance in electronically accessing the publication, or about PAIR, is available by calling the Patent Electronic Business Center at 1-866-217-9197.

Office of Data Managment, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/714,376	09/25/2017	Takeshi Okazaki	474139US01	8275

146018 7590 03/21/2019

Gardella Grace P.A.
80 M Street SE, 1st Floor
Washington, DC 20003

EXAMINER	
NGUYEN, TIEN C	

ART UNIT	PAPER NUMBER
3694	

NOTIFICATION DATE	DELIVERY MODE
03/21/2019	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

docketing@gardellagrace.com
ngrace@gardellagrace.com

Office Action Summary	Application No. 15/714,376	Applicant(s) Okazaki, Takeshi	
	Examiner TIEN C NGUYEN	Art Unit 3694	AIA (FITF) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☑ Responsive to communication(s) filed on 9/25/2017.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL.** 2b) ☑ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5) ☑ Claim(s) 1-20 is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6) ☐ Claim(s) _____ is/are allowed.

7) ☑ Claim(s) 1-20 is/are rejected.

8) ☐ Claim(s) _____ is/are objected to.

9) ☐ Claim(s) _____ are subject to restriction and/or election requirement

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to **PPHfeedback@uspto.gov.**

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☑ Notice of References Cited (PTO-892)

2) ☐ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date _____.

4) ☐ Other: _____.

Notice of Pre-AIA or AIA Status

The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

DETAILED ACTION

Status of the Claims

1. The following office action in response to the application filed on 9/25/2017.

2. Claims 1-20 are pending and addressed below.

Claim Rejections - 35 USC § 101

3. 35 U.S.C. 101 reads as follows:

> Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.

4. Claims 1-20 are rejected under 35 U.S.C. 101 because the claimed invention is directed to non-statutory subject matter.

Claims 1-20 are directed to a method, a system, a non-transitory computer readable medium which is a process, machine, manufacturer or composition of matter and thus a statutory category of invention (*Step 1: YES*).

Claim 1 is rejected under 35 U.S.C. 101 because the claimed invention recites an abstract idea without significantly more. The claim recites receiving from a user a request for a property condition classification, wherein the property classification request includes identification of a property and at least one property characteristic, obtaining responsive to receiving the request, an aerial image of a geographic region including the property, identifying a plurality of features of the aerial image corresponding to the property characteristic, analyzing the plurality of features to determine a property characteristic classification, analyzing a region of the aerial image including the property characteristic to determine a condition

classification, and determining, using the property characteristic classification and the condition classification, a risk estimate of damage to the property due to one or more disasters.

The limitations of receiving from a user a request for a property condition classification, wherein the property classification request includes identification of a property and at least one property characteristic, obtaining responsive to receiving the request, an aerial image of a geographic region including the property, identifying a plurality of features of the aerial image corresponding to the property characteristic, analyzing the plurality of features to determine a property characteristic classification, analyzing a region of the aerial image including the property characteristic to determine a condition classification, and determining, using the property characteristic classification and the condition classification, a risk estimate of damage to the property due to one or more disasters, as drafted, is a process that, under its broadest reasonable interpretation, covers performance of fundamental economic principles or practices but for the recitation of generic computer components. If a claim limitation, under its broadest reasonable interpretation, covers performance of fundamental economic principles or practices but for the recitation of generic computer components, then it falls within the "Certain Methods of Organizing Human Activity" grouping of abstract ideas. Accordingly, the claim recites an abstract idea.

This judicial exception is not integrated into a practical application because the claim only recites the additional element – using a remote computing device and a processing circuitry to perform all the steps of the claim. The remote computing device and the processing circuitry are recited at a high-level of generality to perform the functions of receiving information, obtaining information, identifying information, analyzing information, determining information of a risk estimate of damage to the property due to one or more disasters and returning to the user information of a condition assessment of the property characteristic including the condition classification and the risk estimate of damage to the property due to the one or more disasters, such that it amounts no more than mere instructions to apply the

exception using a generic computer component. Accordingly, these additional elements do not integrate the abstract idea into a particular application because it does not impose any meaningful limits on practicing the abstract idea. The claim is directed to an abstract idea.

The claim(s) does/do not include additional elements that are sufficient to amount to significantly more than the judicial exception. As discussed above with respect to integration of the abstract idea into a practical application, the additional elements of using the remote computing device and the processing circuitry to perform receiving information, obtaining information, identifying information, analyzing information, determining information of a risk estimate of damage to the property due to one or more disasters and returning to the user information of a condition assessment of the property characteristic including the condition classification and the risk estimate of damage to the property due to the one or more disasters, which amounts to mere instructions to apply the exception using the generic computer component. Mere instructions to apply an exception using the generic computer component cannot provide an inventive concept. The claim is not patent eligible.

The additional limitations of the claim, when viewed either individually or as an ordered combination, do not amount to a claim as a whole that is significantly more than the judicial exception because the claim do not include improvements to another technology or technical field, improvements to the function of the computer itself, and do not provide meaningful limitations beyond general linking the use of an abstract idea to a particular technological environment (MPEP 2106.05(a) and MPEP 2106.05(e)). They are just adding the words “apply it” (or an equivalent) with the judicial exception, or mere instructions to implement an abstract idea on a computer (see MPEP 2106.05(f)) and see discussion above)); generally linking the use of the judicial exception to a particular technological environment or field of use (see MPEP 2106.05(h)).

Independent claims 8 and 15 recite limitations substantially similar to claim 1. Thus, the claims are rejected based on the same reasoning as above in claim 1. Thus, the claims are not eligible.

Dependent Claims 2-7, 9-14 and 16-20 are dependent on claims 1, 8 and 15. Claims 2-7, 9-14 and 16-20 further recite the limitations that do not amount to "significantly more" than the abstract idea because the claims do not include improvements to the functioning of a computer or to any other technology or technical field, changing the functions of the computer itself or other meaningful limitations beyond generally linking the use of an abstract idea to a particular technological environment. Therefore, when viewed either individually, or as an ordered combination, the additional limitations of the claim do not amount to a claim as a whole that is significantly more than the abstract idea. The claims are not are not eligible.

For more information, please see The 2019 Revised Patent Subject Matter Eligibility Guidance (https://www.uspto.gov/patent/laws-and-regulations/examination-policy/subject-matter-eligibility).

Notes: the closest prior art of Swanson et al. (8,775,219) teaches a method and a system relates to using remote sensing capabilities like hyperspectral imaging to identify roof characteristics for insurance purposes. Downey et al. (2015/0325064) teaches methods, systems, and apparatus, including computer programs encoded on computer storage media, for unmanned aerial vehicle authorization and geofence envelope determination. Swanson and Downey fails to teach or render obvious a method and a system comprising: receiving from a user a request for a property condition classification, wherein the property classification request includes identification of a property and at least one property characteristic, obtaining responsive to receiving the request, an aerial image of a geographic region including the property, identifying a plurality of features of the aerial image corresponding to the property characteristic, analyzing the plurality of features to determine a property characteristic classification, analyzing a region of the aerial image including the property characteristic to

determine a condition classification, and determining, using the property characteristic classification and the condition classification, a risk estimate of damage to the property due to one or more disasters; and returning, to the user at the remote computing device via a graphical user interface responsive to receiving the request, a condition assessment of the property characteristic including the condition classification and the risk estimate of damage to the property due to the one or more disasters. Thus, claims 1-20 are defined over the prior art.

Conclusion

5. Any inquiry concerning this communication or earlier communications from the examiner should be directed to TIEN C. NGUYEN whose telephone number is 571-270-5108. The examiner can normally be reached on Monday-Thursday (6am-2pm EST).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Bennett Sigmond can be reached on 303-297-4411. The fax phone number for the organization where this application or proceeding is assigned is 571-270-6108.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

Any response to this action should be mailed to:

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or faxed to 571-273-8300.

Hand delivered responses should be brought to the United States Patent and Trademark Office Customer Service Window:

Randolph Building 401 Dulany Street Alexandria, VA 22314.

/TIEN C NGUYEN/
Primary Examiner, Art Unit 3694

Notice of References Cited	Application/Control No. 15/714,376	Applicant(s)/Patent Under Reexamination Okazaki, Takeshi	
	Examiner TIEN C NGUYEN	Art Unit 3694	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-6732120-B1	05-2004	Du; Mike	G01C21/20	715/764
*	B	US-8775219-B2	07-2014	Swanson; Aaron L.	G06Q50/16	705/4
*	C	US-20090265193-A1	10-2009	COLLINS; Dean	G06Q30/0185	705/4
*	D	US-20150325064-A1	11-2015	Downey; Jonathan	G08G5/006	701/29.3
	E					
	F					
	G					
	H					
	I					
	J					
	K					
	L					
	M					

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/714,376	Okazaki, Takeshi
	Examiner	Art Unit
	TIEN C NGUYEN	3694

CPC - Searched*		
Symbol	Date	Examiner
G06Q	03/18/2019	/tn/

CPC Combination Sets - Searched*		
Symbol	Date	Examiner
G 06Q 40/08, G 06Q 40/02, G 06Q 10/10, G 06F19/328, G 06Q 30/02.	03/18/2019	/tn/

US Classification - Searched*			
Class	Subclass	Date	Examiner
705	2	03/18/2019	/tn/
705	3	03/18/2019	/tn/
705	4	03/18/2019	/tn/
705	35	03/18/2019	/tn/
705	39	03/18/2019	/tn/
705	38	03/18/2019	/tn/
705	37	03/18/2019	/tn/
701	516	03/18/2019	/tn/
382	103	03/18/2019	/tn/
340	539.11	03/18/2019	/tn/
707	736	03/18/2019	/tn/
348	47	03/18/2019	/tn/

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

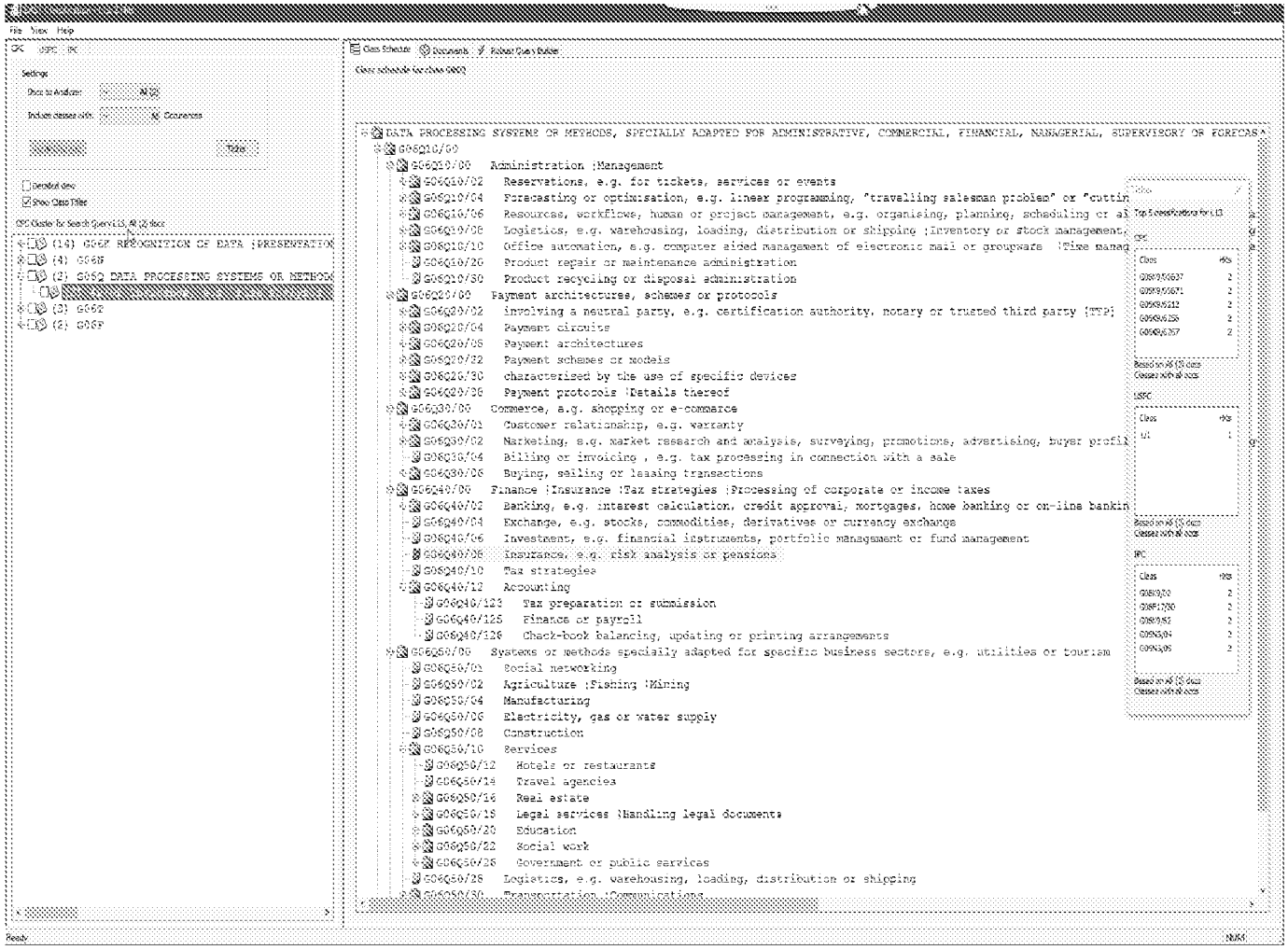
/TIEN C NGUYEN/ Primary Examiner, Art Unit 3694	

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/714,376	Okazaki, Takeshi
	Examiner	Art Unit
	TIEN C NGUYEN	3694

Search Notes		
Search Notes	**Date**	**Examiner**
Updated East and PALM.	03/18/2019	/tn/
Inventor search.	03/18/2019	/tn/
Google search.	03/18/2019	/tn/

Interference Search			
US Class/CPC Symbol	**US Subclass/CPC Group**	**Date**	**Examiner**

/TIEN C NGUYEN/
Primary Examiner, Art Unit 3694


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Class schedule for class G06Q
DATA PROCESSING SYSTEMS OR METHODS, SPECIALLY ADAPTED FOR ADMINISTRATIVE, COMMERCIAL, FINANCIAL, MANAGERIAL, SUPERVISORY OR FORECAS
G06Q10/00
G06Q10/00 Administration ;Management
G06Q10/02 Reservations, e.g. for tickets, services or events
G06Q10/04 Forecasting or optimisation, e.g. linear programming, "travelling salesman problem" or "cuttin
G06Q10/06 Resources, workflows, human or project management, e.g. organising, planning, scheduling or al
G06Q10/08 Logistics, e.g. warehousing, loading, distribution or shipping ;Inventory or stock management,
G06Q10/10 Office automation, e.g. computer aided management of electronic mail or groupware ;Time manag
G06Q10/20 Product repair or maintenance administration
G06Q10/30 Product recycling or disposal administration
G06Q20/00 Payment architectures, schemes or protocols
G06Q20/02 involving a neutral party, e.g. certification authority, notary or trusted third party (TTP)
G06Q20/04 Payment circuits
G06Q20/06 Payment architectures
G06Q20/32 Payment schemes or models
G06Q20/30 characterised by the use of specific devices
G06Q20/38 Payment protocols ;Details thereof
G06Q30/00 Commerce, e.g. shopping or e-commerce
G06Q30/01 Customer relationship, e.g. warranty
G06Q30/02 Marketing, e.g. market research and analysis, surveying, promotions, advertising, buyer profil
G06Q30/04 Billing or invoicing , e.g. tax processing in connection with a sale
G06Q30/06 Buying, selling or leasing transactions
G06Q40/00 Finance ;Insurance ;Tax strategies ;Processing of corporate or income taxes
G06Q40/02 Banking, e.g. interest calculation, credit approval, mortgages, home banking or on-line bankin
G06Q40/04 Exchange, e.g. stocks, commodities, derivatives or currency exchange
G06Q40/06 Investment, e.g. financial instruments, portfolio managment or fund management
G06Q40/08 Insurance, e.g. risk analysis or pensions
G06Q40/10 Tax strategies
G06Q40/12 Accounting
G06Q40/123 Tax preparation or submission
G06Q40/125 Finance or payroll
G06Q40/126 Check-book balancing, updating or printing arrangements
G06Q50/00 Systems or methods specially adapted for specific business sectors, e.g. utilities or tourism
G06Q50/01 Social networking
G06Q50/02 Agriculture ;Fishing ;Mining
G06Q50/04 Manufacturing
G06Q50/06 Electricity, gas or water supply
G06Q50/08 Construction
G06Q50/10 Services
G06Q50/12 Hotels or restaurants
G06Q50/14 Travel agencies
G06Q50/16 Real estate
G06Q50/18 Legal services ;Handling legal documents
G06Q50/20 Education
G06Q50/22 Social work
G06Q50/26 Government or public services
G06Q50/28 Logistics, e.g. warehousing, loading, distribution or shipping
Ready

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	399871	receiv$3 near7 request$3	USPAT	OR	ON	2019/03/18 05:27
L2	142259	(property or properties or house or houses or "real property" or resident$3) near7 (characteristic$3 or identification$3)	USPAT	OR	ON	2019/03/18 05:29
L3	7105	1 and 2	USPAT	OR	ON	2019/03/18 05:29
L4	8039	aerial$3 near7 imag$3	USPAT	OR	ON	2019/03/18 05:29
L5	46894	(geographic$3) near7 (region$3 or boundar$3)	USPAT	OR	ON	2019/03/18 05:30
L6	791	4 and 5	USPAT	OR	ON	2019/03/18 05:30
L7	30	3 and 6	USPAT	OR	ON	2019/03/18 05:30
L8	4	("5519809" | "5559707" | "5966135" | "6732120").PN. OR ("9760649").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2019/03/18 05:31
L9	134	("5193185" | "5214757" | "5418906" | "5426780" | "5751612" | "5953722" | "5963956" | "5968109" | "5974419" | "6047280" | "6282489").PN. OR ("6732120").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2019/03/18 05:32
L10	26181	(property or properties or house or houses or "real property" or resident$3) near7 (damag$3)	USPAT	OR	ON	2019/03/18 05:33
L11	106	(property or properties or house or houses or "real property" or resident$3) near7 (damag$3) with disaster$3	USPAT	OR	ON	2019/03/18 05:33
L12	4	11 and 3	USPAT	OR	ON	2019/03/18 05:33
L13	2	("20180089763").PN.	US-PGPUB; USPAT; USOCR; DERWENT	OR	ON	2019/03/18 05:34
L14	0	("2018/0089763").URPN.	USPAT	OR	ON	2019/03/18 05:35
L15	10	11 and 4	USPAT	OR	ON	2019/03/18 05:35
L16	13	("20080262789" | "20090265193" | "20090326383" | "7317416" | "7944559" | "8346578").PN. OR ("8775219").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2019/03/18 05:36
L17	174	("2009/0265193").URPN.	USPAT	OR	ON	2019/03/18 05:37
L18	80	("20080059068" | "20090265193" | "20100012776" | "20100215212" | "20100228418" | "20100286859" | "20110270470" | "20120197461" |	US-PGPUB; USPAT; USOCR	OR	ON	2019/03/18 05:37

		"20120250010" | "20120271461" | "20130206915" | "20130216089" | "20130238168" | "20140061376" | "20140259549" | "20140267627" | "20140277842" | "20140316614" | "20140316616" | "20140336928" | "20150325064" | "20150343644" | "20150344136" | "20150377405" | "20160004795" | "20160176542" | "4818990" | "5575438" | "7400384" | "7496226" | "7872794" | "7929125" | "8060270" | "8207484" | "8212995" | "8346578" | "8818572" | "8830485" | "8872818" | "8874283" | "8896819" | "8997362" | "9009000" | "9129355" | "9152863" | "9162753" | "9256225" | "9256994" | "9273981").PN. OR ("9513635").URPN.				
L19	16	("2015/0325064").URPN.	USPAT	OR	ON	2019/03/18 05:39
L20	49	("20020109829" | "20030137645" | "5345304" | "6865034").PN. OR ("7400384").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2019/03/18 05:40
L21	80	("20080059068" | "20090265193" | "20100012776" | "20100215212" | "20100228418" | "20100268409" | "20100286859" | "20110270470" | "20120170797" | "20120197461" | "20120250010" | "20120271461" | "20130206915" | "20130216089" | "20130238168" | "20140061376" | "20140259549" | "20140267627" | "20140277842" | "20140316614" | "20140316616" | "20140324405" | "20140336928" | "20150325064" | "20150343644" | "20150344136" | "20150377405" | "20160004795" | "20160176542" | "4818990" | "5575438" | "7400384" | "7496226" | "7872794" | "7929125" | "8060270" | "8207484" | "8212995" | "8346578" | "8818572" | "8830485" | "8872818" | "8874283" | "8896819" | "8997362" | "9009000" | "9129355" | "9152863" | "9162753" | "9256225" | "9256994" | "9273981" | "9310221" | "9329599" | "9340283" | "9403593" | "9406237").PN. OR ("9609288").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2019/03/18 05:40

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BIB DATA SHEET

CONFIRMATION NO. 8275

SERIAL NUMBER	FILING or 371(c) DATE RULE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
15/714,376	09/25/2017	705	3694	474139US01

APPLICANTS
Aon Benfield Inc., Chicago, IL

INVENTORS
Takeshi Okazaki, Tokyo, JAPAN;

**** CONTINUING DATA ***************************
This appln claims benefit of 62/398,665 09/23/2016

**** FOREIGN APPLICATIONS ***************************

**** IF REQUIRED, FOREIGN FILING LICENSE GRANTED ****
10/05/2017

Foreign Priority claimed ❑ Yes ☑ No 35 USC 119(a-d) conditions met ❑ Yes ☑ No Verified and Acknowledged /TIEN C NGUYEN/ Examiner's Signature	❑ Met after Allowance Initials	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
		JAPAN	15	20	3

ADDRESS

Gardella Grace P.A.
80 M Street SE, 1st Floor
Washington, DC 20003
UNITED STATES

TITLE

Platform, Systems, and Methods for Identifying Property Characteristics and Property Feature Maintenance Through Aerial Imagery Analysis

FILING FEE RECEIVED		
1600	FEES: Authority has been given in Paper No._____ to charge/credit DEPOSIT ACCOUNT No._____ for following:	❑ All Fees ❑ 1.16 Fees (Filing) ❑ 1.17 Fees (Processing Ext. of time) ❑ 1.18 Fees (Issue) ❑ Other _____ ❑ Credit

UNITED STATES PATENT AND TRADEMARK OFFICE

USPTO Automated Interview Request (AIR)

Jun 12 2019

This paper requesting to schedule and/or conduct an interview is appropriate because:

This submission is requested to be accepted as an authorization for this interview to communicate via the internet. Recognizing that Internet communications are not secure, I hereby authorize the USPTO to communicate with the undersigned concerning scheduling of the interview via video conference, instant messaging, or electronic mail, and to conduct the interview in accordance with office practice including video conferencing.

Name(s):
Ruth Davila

S-signature:
/Ruth Davila/

Registration Number:
73956

U.S. Application Number:
15714376

Confirmation Number:
8275

E-mail Address:
rdavila@gardellagrace.com

Phone Number:
+1 7037405611

Proposed Time of Interview:
6-20-2019 11:00 AM ET

Alternative Proposed Time(s) of Interview:
6-21-2019 1:00 PM ET

Prefered Interview Type:
Telephonic

I am the applicant or applicant's representative for this application.

Topic for Discussion:
Discuss proposed amendments to overcome non-final office action rejections

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 15/714,376	Filing Date 09/25/2017	☐ To be Mailed

ENTITY: ☑ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA		RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A		N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A		N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*		x $80 =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*		x $420 =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).				
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))					
* If the difference in column 1 is less than zero, enter "0" in column 2.				TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT	06/21/2019	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 20	Minus	** 20	= 0		x $100 =	0
	Independent (37 CFR 1.16(h))	* 3	Minus	*** 3	= 0		x $460 =	0
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	0

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=		x $0 =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=		x $0 =	
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.	OPAC
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".	/BRIDGET C. MONROE/
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".	
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.	

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

IN RE APPLICATION OF	|
AON BENFIELD INC.	| EXAMINER: NGUYEN, TIEN C.
APPLICATION NO.: 15/714,376	| GROUP ART UNIT: 3694
FILED: SEPTEMBER 25, 2017	| DOCKET NO.: 474139US01
FOR: PLATFORM, SYSTEMS, AND METHODS FOR IDENTIFYING PROPERTY CHARACTERISTICS AND PROPERTY FEATURE MAINTENANCE THROUGH AERIAL IMAGERY ANALYSIS	|

AMENDMENT UNDER 37 C.F.R. § 1.111

MAIL STOP AMENDMENTS
COMMISSIONER FOR PATENTS
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ALEXANDRIA, VIRGINIA 22313

Commissioner:

In response to the Non-Final Office Action dated March 21, 2019, please amend the above-identified application as follows.

Applicant does not believe that any fees, other than those provided in the accompanying fee worksheet, are due at this time. If, however, any additional fees are required, including fees for extensions of time, then the Commissioner is authorized to charge such fees to Gardella Grace P.A. deposit account number 601484, referencing docket number 474139US01.

Amendments to the Claims begin on page **2** of this paper.

Remarks begin on page **11** of this paper.

AMENDMENTS TO THE CLAIMS

Please amend the claims as follows:

1. (Currently Amended) A method for automatically categorizing a repair condition of a property characteristic, comprising:

receiving, from a user at a remote computing device, a request for a property condition classification, wherein the property classification request includes identification of a property and at least one property characteristic;

obtaining, by processing circuitry of a computing system responsive to receiving the request, an aerial image of a geographic region including the property;

~~identifying~~ extracting, by the processing circuitry, one or more of a plurality of features [[of]] from the aerial image corresponding to the property characteristic, wherein the extracted features include pixel groupings representing the property characteristic;

~~analyzing~~ determining, by the processing circuitry from the extracted features, ~~the plurality of features to determine~~ a property characteristic classification for the property characteristic, wherein determining the property characteristic classification includes applying the pixel groupings for the property characteristic to a first machine learning classifier trained to identify property characteristics from a set of pixel groupings;

~~analyzing~~ determining, by the processing circuitry based on the identified property characteristic and the extracted features, ~~a region of the aerial image including the property characteristic to determine~~ a condition classification for the property characteristic, wherein identifying the condition classification includes applying the

pixel groupings for the property characteristic to a second machine learning classifier trained to identify property characteristic conditions from a set of pixel groupings;

determining, by the processing circuitry [[using]] based in part on the property characteristic classification and the condition classification, a risk estimate of damage to the property due to one or more disasters; and

returning, to the user at the remote computing device via a graphical user interface responsive to receiving the request, a condition assessment of the property characteristic including the condition classification and the risk estimate of damage to the property due to the one or more disasters.

2. (Original) The method of claim 1, wherein the property characteristic classification is rooftop shape.

3. (Canceled)

4. (Currently Amended) The method of claim 1, wherein ~~the deep learning analysis model is NIN~~ at least one of the first machine learning classifier and the second machine learning classifier is a Network in Network (NIN) classifier.

5. – 6. (Canceled)

7. (Original) The method of claim 1, wherein determining the risk estimate comprises applying a disaster risk profile corresponding to a) a first disaster of the at least one disaster and b) the property characteristic.

8. (Currently Amended) A system for automatically categorizing a repair condition of a property characteristic, comprising:

processing circuitry; and

a non-transitory computer-readable medium having instructions stored thereon;

wherein the instructions, when executed by the processing circuitry, cause the processing circuitry to

receive, from a user at a remote computing device, a property condition classification request, wherein the property classification request includes identification of a property and at least one property characteristic;

obtain, from a remote data source responsive to receiving the property classification request, an aerial image of a geographic region including the property;

~~identify~~ extract one or more of a plurality of features [[of]] from the aerial image corresponding to the property characteristic, wherein the extracted features include pixel groupings representing the property characteristic;

~~analyze the plurality of features to~~ determine, from the extracted features, a property characteristic classification, wherein determining the property characteristic classification includes applying the pixel groupings for the property characteristic to a first machine learning classifier trained to identify property characteristics from a set of pixel groupings;

~~analyze a region of the aerial image including the property characteristic to~~ determine, based on the identified property characteristic and the extracted features, a condition classification for the property characteristic, wherein identifying the condition classification includes applying the pixel groupings for the property characteristic to a second machine learning classifier trained to identify property characteristic conditions from a set of pixel groupings; and

determine, in real-time responsive to receiving the property classification request and using the property characteristic classification and the condition classification, a replacement cost for replacing the property characteristic.

9. (Currently Amended) The system of claim 8, wherein the instructions, when executed by the processing circuitry, cause the processing circuitry to, prior to identifying the one or more of the plurality of features:

obtain a shape map image including the property;

overlay the aerial image with the shape map image; and

determine whether a boundary of the property as identified by the shape map matches a boundary of the property as illustrated in the aerial image.

10. (Original) The system of claim 9, wherein the instructions, when executed by the processing circuitry, cause the processing circuitry to, upon determining that the shape map does not match the boundary of the corresponding property, obtain an alternate aerial image of the property.

11. (Original) The system of claim 8, wherein the instructions, when executed by the processing circuitry, cause the processing circuitry to compare a current condition classification of the property characteristic to a stored historic condition classification of the property characteristic.

12. (Original) The system of claim 11, wherein the instructions, when executed by the processing circuitry, cause the processing circuitry to, in real-time responsive to receiving the property condition classification request, determine whether repairs have been made to the property based on the comparison of the current condition classification to the historic condition classification of the property characteristic.

13. (Currently Amended) The system of claim 8, wherein the instructions, when executed by the processing circuitry, cause the processing circuitry to, prior to identifying the one or more of the plurality of features, assess orthogonality of the aerial imagery.

14. (Original) The system of claim 13, wherein the instructions, when executed by the processing circuitry, cause the processing circuitry to, responsive to assessing that the orthogonality of the aerial imagery does not correspond to a true orthophoto form, cause correction of the aerial imagery to the true orthophoto form.

15. (Currently Amended) A non-transitory computer readable medium having instructions stored thereon, wherein the instructions, when executed by processing circuitry, cause the processing circuitry to:

receive, from a user at a remote computing device, a property condition classification request, wherein the property classification request includes identification of a property and at least one property characteristic;

obtain, from a remote data source responsive to receiving the property classification request, an aerial image of a geographic region including the property;

~~identify a respective~~ extract from one or more of a plurality of features [[of]] from the aerial image corresponding to each property characteristic of the at least one property characteristic, wherein the extracted features include pixel groupings representing the respective property characteristic;

for each of the at least one property characteristic,

~~analyze the corresponding plurality of features to~~ determine, from the extracted features for the respective property characteristic, a respective property characteristic classification, wherein determining the respective property characteristic classification includes applying the pixel groupings for the respective property characteristic to a first machine learning classifier trained to identify property characteristics from a set of pixel groupings, and

~~analyze a region of the aerial image including the respective property characteristic to~~ determine, based on the respective identified property characteristic and the respective extracted features, a respective condition classification for the respective property characteristic, wherein identifying the respective condition classification includes applying the respective pixel groupings for the respective property characteristic to a second machine learning classifier trained to identify property characteristic conditions from a set of pixel groupings; and

determine, in real-time responsive to receiving the property classification request and using the property characteristic classification of each property characteristic and the condition classification of each property characteristic, at least one risk estimate representing risk of damage due to disaster.

16. (Original) The non-transitory computer readable medium of claim 15, wherein the instructions, when executed by the processing circuitry, cause the processing circuitry to, prior to obtaining the aerial image of the geographic region, determine, based upon the at least one property characteristic, a preferred image type corresponding to each property characteristic of the at least one property characteristic.

17. (Original) The non-transitory computer readable medium of claim 16, wherein:

the at least one property characteristic comprises two or more property characteristics; and

the instructions, when executed by the processing circuitry, cause the processing circuitry to, responsive to determining the preferred image type corresponding to a first property characteristic of the at least one property characteristic is a terrestrial image, obtain a terrestrial image of the geographic region including the property.

18. (Original) The non-transitory computer readable medium of claim 15, wherein the instructions, when executed by the processing circuitry, cause the processing circuitry to access one or more known property characteristics, wherein determining the at least

one risk estimate comprises determining the at least one risk estimate further based on the one or more known property characteristics.

19. (Original) The non-transitory computer readable medium of claim 18, wherein the one or more known property characteristics comprise at least one of a property age, a property elevation, a property slope, a year built, a year renovated, and a building height.

20. (Original) The non-transitory computer readable medium of claim 15, wherein:

receiving identification of the property and the at least one property characteristic comprises receiving, via a network from a remote computing device, the identification of the property; and

the instructions, when executed by the processing circuitry, cause the processing circuitry to provide, via the network to a graphical user interface at the remote computing device in real-time responsive to receiving the at least one property characteristic, the at least one risk estimate.

21. (New) The method of claim 1, wherein the pixel groupings comprise at least one of angles, outlines, and substantially homogenous pixel fields defining the property characteristic.

22. (New) The method of claim 1, wherein identifying the condition classification for the property characteristic comprises:

generating, from the pixel groupings, a pixel intensity distribution of the property characteristic; and

determining, by applying the second machine learning classifier, the condition classification based on the pixel intensity distribution of the property characteristic.

23. (New) The method of claim 2, wherein the first machine learning classifier is trained with a set of aerial training images having known rooftop shapes such that the machine learning classifier is configured to determine the rooftop shape from a plurality of rooftop shapes.

REMARKS

Status of the Claims

Claims 1-2, 4, and 7-23 are currently pending. Claims 1, 4, 8, 9, 13, and 15 are currently amended. Claims 3, 5, and 6 are hereby cancelled without prejudice or disclaimer. Claims 21-23 are new. The present amendments introduce no new matter. Support for the present amendments can be found at least at ¶¶ 45-47 and 53-55 of the as-filed Specification, which discuss property characteristic and condition classifications. Applicant reserves the right to pursue the cancelled claims in one or more divisional applications.

§101 Rejections

In the Office Action dated March 21, 2019 ("Office Action"), Claims 1-20 were rejected under 35 U.S.C. §101 as allegedly being directed to non-statutory subject matter. *Office Action* at 2. Applicant respectfully disagrees; however, to advance prosecution, independent claims 1, 8, and 15 have been amended to include additional features that recite patentable subject matter in view of the USPTO 2019 Revised Guidance as discussed in detail below.

Summary of 2019 Revised Guidance

The 2019 Revised Guidance "revises the procedures for determining whether a patent claim or patent application claim is directed to a judicial exception (laws of nature, natural phenomena, and abstract ideas) under Step 2A of the USPTO's Subject Matter Eligibility Guidance in two ways." 84 Fed. Reg. at 50. First, the Revised Guidance explains that abstract ideas can be "grouped as, e.g., mathematical concepts, certain methods of organizing human activity, and mental processes." *Id.* Second, the 2019 Revised Guidance explains that a recited

judicial exception "is not 'directed to' the judicial exception if the judicial exception is integrated into a practical application of the judicial exception." *Id.* Practically speaking, "Revised Step 2A" is a two-pronged approach to assessing whether the recited claims are "directed to" a judicial exception by focusing on "(1) whether the claim recites a judicial exception; and (2) whether a recited judicial exception is integrated into a practical application." *Id.* at 51. If the claim does not recite a judicial exception, then the claim qualifies are eligible subject matter. *Id.* If the claim does recite a judicial exception, only when the claim fails to integrate the recited exception into a practical application is the claim directed to a judicial exception, thus triggering further analysis under Step 2B. *Id.*

Application of the 2019 Revised Guidance by the PTAB

In *ex parte Williamson* (Appeal 2018-004131; Application Ser. No. 12/955,768 ("the '768 Application")), Appellant filed a patent application directed to systems and methods for generating interpolated input data sets using reduced input objects on November 29, 2010. Claim 1 of the '768 application is presented below:

1. A method, comprising:

receiving a multi-dimensional input data object;

receiving output data;

presenting a selection dialog via a user interface, the selection dialog comprising a first interface element and a second interface element;

receiving a selection of the first interface element, the selection comprising an adjustment to the input data object;

generating, by a processor and in view of the adjustment, reduced input data from the input data object by removing, from along an axis of the input data object, a plane of data that distorts an interpolation function with respect to the input data object, wherein generating the reduced input data reduces computational overhead on the processor with respect to computing the interpolation function;

generating first interpolated input data in view of the input data object and the output data;

generating, by the processor, second interpolated input data in view of the reduced input data and the output data, the second interpolated input data being generated to conformally map a combination of the reduced input data and the first interpolated input data to the output data, wherein by generating the reduced input data the processor generates the second interpolated input data more efficiently than generating the second interpolated input data in view of the input data object; and

in response to receipt of a selection of the second interface element, accepting the reduced input data in view of a determination that the second interpolated input data is within a series output margin of the first interpolated input data.

The office action in the '768 application rejected the claims under 35 U.S.C. § 101 as being directed to patent-ineligible subject matter because the claimed invention is directed to a judicial exception in part because "removal of data from the set is an abstract idea, and therefore the benefits provided by the abstract idea itself do not provide anything beyond implementing it on a computer." Decision on Appeal at 9. The Board found this argument unpersuasive because "the removal of data from the set facilitates greater efficiency in the (subsequent) performance of the interpolation function." *Id.* at 9-10.

In its analysis of the claims under Prong 1 of Revised Step 2A, the Board found that "Appellant's invention is directed to multiple mathematical concepts, similar to those found to be patent-ineligible by the courts." Decision on Appeal at 7. However, upon application of Prong 2 of Revised Step 2A, the Board found that "the judicial application identified in the claims (the plural mathematical concepts mentioned supra) is integrated into a practical application," rendering the claims directed to patent-eligible subject matter. *Id.* at 8. Further, the Board agreed with Appellant that the "claimed removal of a plane of data that distorts an interpolation function to constitute an improvement to the functioning of a computer, because the disclosed and claimed reduction in computational overhead in computing the interpolation function, and because of the disclosed and claimed greater efficiency in generating the second interpolated input data." *Id.* Therefore, the Board concluded that the claimed invention of the '768 Application was patent-eligible. *Id.* at 10-11.

Similar to *ex parte Williamson*, the currently amended claims reduce computational overhead and allow greater efficiency in generating automated building condition assessments useful to the end user in evaluating damage risk due to disaster. For example, at least the claimed features of "extracting…one or more of a plurality of features from the aerial image corresponding to the property characteristic, wherein the extracted features include pixel groupings representing the property characteristic;" "determining…a property characteristic classification for the property characteristic, wherein determining the property characteristic classification includes applying the pixel groupings for the property characteristic to a first machine learning classifier trained to identify property characteristics from a set of pixel groupings;" and "determining…based on the identified property characteristic and the extracted features, a condition classification for the property characteristic, wherein identifying the

condition classification includes applying the pixel groupings for the property characteristic to a second machine learning classifier trained to identify property characteristic conditions from a set of pixel groupings;" illustrate that the system "automatically extract[s] characteristics of individual properties, providing fast and efficient automated classification of building styles and repair conditions" so that "damage due to disaster can be more accurately estimated." *Specification* at ¶¶ 7, 45-47, 53-55.

Analysis Under Prong One of Revised Step 2A of *Alice*

The 2019 Revised Guidance directs that "revised Step 2A" is a two-prong inquiry. 84 Fed. Reg. 50 at 53-54. At Prong One, examiners "evaluate whether the claim recites a judicial exception." *Id.* If the claim recites a judicial exception (i.e., an abstract idea) the claim requires further analysis at Prong Two. *Id.* If the claim does not recite a judicial exception, then the claim is eligible at Prong One. *Id.* Applicant respectfully submits that independent claims 1, 8, and 15 do not recite any of the judicially recognized exceptions above (i.e., the answer to Prong One of Step 2A is "no"), and therefore the claims qualify as eligible subject matter under revised Step 2A.

Examiners are instructed at Prong One of Revised Step 2A to (a) identify the specific limitation(s) in the claim under examination (individually or in combination) that the examiner believes recites an abstract idea; and (b) determine whether the identified limitation(s) falls within the subject matter groupings of abstract ideas enumerated in Section I of the 2019 Revised Guidance (i.e., mathematical concepts, certain methods of organizing human activity, and mental processes). 84 Fed. Reg. 50 at 54. Although the Office Action states that the claimed invention allegedly "covers performance of fundamental economic principles or practices but for the

recitation of generic computer components," the claims embody implementations for "provid[ing] dynamic, real-time property condition assessments" that "improve upon conventional methodologies by applying deep learning analysis models to detected property characteristics…to assess whether a condition of the property characteristics is degraded to a point of needing repair or replacement and determine an amount of risk exposure of the property due to the detected condition of the property characteristics." *Office Action* at 3; *Specification* at ¶ 105. The core of the inventive solution is automating building condition assessments that improve upon the way manual condition assessments are performed by automatically detecting and extracting property features based on pixel groupings in aerial images and identifying property characteristics and conditions through application of trained machine learning algorithms. *See Specification* at ¶¶ 7, 45-47, 53-55, 105. Thus, the claimed features provide a particular "solution [that] is necessarily rooted in computer technology in order to overcome a problem," similar to the claims held patent-eligible in *DDR Holdings, LLC v Hotels.com*. *See DDR Holdings, LLC v Hotels.com*, L.P. 773 F.3d 1245, 1259 (Fed. Cir. 2014).

The pending claims are directed to an improvement in feature detection and image processing techniques that improve the accuracy and processing efficiency of automated building condition assessments which is patent-eligible despite the Office Action's identification that the claims "cover[] performance of fundamental economic principles or practices but for the recitation of generic computer components." *Office Action* at 3. As with the claimed invention in *Enfish* that "functions differently than conventional [systems]" by providing "faster search times, and smaller memory requirements," the amended claims "also function differently from conventional systems by "reduc[ing] an amount of time it takes to perform the condition assessments and automate a condition assessment process" through "applying deep learning

analysis models to [extracted pixel groupings of] detected property characteristics…to assess whether a condition of the property characteristics is degraded." *Enfish*, 822 F.3d at 1337; *Specification* at ¶ 105. For example, Applicant's independent claim 1 (and similarly claims 8 and 15) recites "extracting…one or more of a plurality of features from the aerial image corresponding to the property characteristic, wherein the extracted features include pixel groupings representing the property characteristic;" "determining…a property characteristic classification for the property characteristic, wherein determining the property characteristic classification includes applying the pixel groupings for the property characteristic to a first machine learning classifier trained to identify property characteristics from a set of pixel groupings;" and "determining…based on the identified property characteristic and the extracted features, a condition classification for the property characteristic, wherein identifying the condition classification includes applying the pixel groupings for the property characteristic to a second machine learning classifier trained to identify property characteristic conditions from a set of pixel groupings." *Specification* at ¶¶ 7, 45-47- 53-55, 105. Thus, as described in Applicant's specification, the claimed system provides "fast and efficient automated classification of building styles and repair conditions" so that "risk of damage due to disaster can be more accurately estimated." *Id.* at ¶ 7.

Additionally, in response to recent decisions related to subject matter eligibility that included *Finjan, Inc. v. Blue Coat Systems, Inc.*, 879 F.3d 1299 (Fed. Cir. 2018), the USPTO released a memorandum of April 2, 2018 ("Finjan Memo") identifying software eligibility case law developments supportive of the subject matter eligibility of the pending claims. Finjan Memo at 1. Specifically, the Finjan Memo confirmed that "software-based innovations can make 'non-abstract improvements to computer technology' and be deemed patent-eligible subject

matter at the first step of the Alice/Mayo analysis (Step 2A in the Office's subject matter eligibility guidance, see MPEP § 2106.04 et seq.)." *Id.* Further, the *Finjan* decision demonstrates "that a claim reciting a software-related invention focused on improving computer technology may not be directed to an abstract idea." *Id.* at 2.

In *Finjan*, the court found the claims of U.S. Patent No. 6,154,844 ("the '844 patent") to be subject matter eligible under step 1 of Alice (Step 2A of the USPTO's subject matter eligibility guidance) because *Finjan's* solution "employs a new kind of file that enables a computer security system to do things it could not do before. The security profile approach allows access to be tailored for different users and ensures that threats are identified before a file reaches a user's computer. The fact that the security profile 'identifies suspicious code' allows the system to accumulate and utilize newly available, behavior-based information about potential threats." *Finjan*, 879 F.3d at 1305. Claim 1 of the '844 patent is reproduced below:

> 1. A method comprising:
>
> receiving by an inspector a Downloadable;
>
> generating by the inspector a first Downloadable security profile that identifies suspicious code in the received Downloadable; and
>
> linking by the inspector the first Downloadable security profile to the Downloadable before a web server makes the Downloadable available to web clients.

The *Finjan* court found it particularly compelling that the claims of the '844 patent "recite specific steps—generating a security profile that identifies suspicious code and linking it to a downloadable—that accomplish the desired result. Moreover, there is no contention that the only thing disclosed is the result and not an inventive arrangement for accomplishing the result." *Id.* at 1305-06.

Similarly, the currently pending claims present specific steps for automating property characteristic feature detection and condition assessments of the detected property characteristics based on patterns of pixel groupings within aerial images. As explained in the specification, property condition assessment includes "applying deep learning analysis models to [extracted pixel groupings of] detected property characteristics…to assess whether a condition of the property characteristics is degraded." *Specification* at ¶ 105. As recited in the pending claims, the system is configured to "extracting…one or more of a plurality of features from the aerial image corresponding to the property characteristic, wherein the extracted features include pixel groupings representing the property characteristic;" "determining…a property characteristic classification for the property characteristic, wherein determining the property characteristic classification includes applying the pixel groupings for the property characteristic to a first machine learning classifier trained to identify property characteristics from a set of pixel groupings;" and "determining…based on the identified property characteristic and the extracted features, a condition classification for the property characteristic, wherein identifying the condition classification includes applying the pixel groupings for the property characteristic to a second machine learning classifier trained to identify property characteristic conditions from a set of pixel groupings." The pending claims describe generation of a particular data storage structure (extracted pixel groupings of a property characteristic) and method for classifying the property characteristic and associated condition, i.e. "an inventive arrangement for accomplishing the result" beyond, as the *Finjan* court noted, mere disclosure of a desired result. *Finjan*, 879 F.3d at 1305-06. Accordingly, Applicant respectfully submits that independent claims 1, 8, and 15 do not recite any of the judicially recognized exceptions under Prong One of revised step 2A.

Analysis Under Prong Two of Revised Step 2A of *Alice*

Further, assuming *arguendo* that the claims recite one of the judicially recognized exceptions (i.e., the answer to Prong One of Step 2A is "yes"), at Prong Two of revised Step 2A, examiners "evaluate whether the claim recites additional elements that integrate the exception into a practical application of that exception." 84 Fed. Reg. 50 at 53-54. If the recited exception is integrated into a practical application of that exception, then the claim is patent eligible, and the eligibility analysis is concluded. *Id.* The 2019 Revised Guidance provides example considerations in determining whether an additional element (or combination of elements) integrates the exception into a practical application including (1) an additional element reflecting an improvement in the functioning of a computer, or an improvement to other technology or technical field; and (2) an additional element applying or using the judicial exception in some other meaningful way beyond generally linking the use of the judicial exception to a particular technological environment, such that the claim as a whole represents more than a drafting effort designed to monopolize the exception. Applicant respectfully submits that independent claims 1, 8, and 15 recite additional elements that integrate the alleged exception into a practical application of the alleged exception in accordance with the listed considerations.

First, the features recited in independent claim 1 (and similarly claims 8 and 15) integrate the alleged exception into a practical application that reflects an improvement in the functioning of a computer, or an improvement to other technology or technical field. As discussed above for Prong One of Step 2A, Applicant's independent claim 1 recites a specific system for automatically performing building condition assessments involving "extracting…one or more of a plurality of features from the aerial image corresponding to the property characteristic, wherein

the extracted features include pixel groupings representing the property characteristic;" "determining…a property characteristic classification for the property characteristic, wherein determining the property characteristic classification includes applying the pixel groupings for the property characteristic to a first machine learning classifier trained to identify property characteristics from a set of pixel groupings;" "determining…based on the identified property characteristic and the extracted features, a condition classification for the property characteristic, wherein identifying the condition classification includes applying the pixel groupings for the property characteristic to a second machine learning classifier trained to identify property characteristic conditions from a set of pixel groupings;" and "determining, by the processing circuitry based in part on the property characteristic classification and the condition classification, a risk estimate of damage to the property due to one or more disasters." *Specification* at ¶¶ 7, 43-45, 53-55, 105. Thus, as described in Applicant's specification, the claimed implementations "improve processing efficiency of the system to reduce an amount of time it takes to perform the condition assessments and automate a condition assessment process" by "applying deep learning analysis models to detected property characteristics of the obtained imagery in order to assess whether a condition of the property characteristics is degraded to a point of needing repair or replacement and determine an amount of risk exposure of the property due to the detected condition of the property characteristics." *Id.* at ¶ 105. As discussed above, like the claimed invention in *Enfish* that "functions differently than conventional [systems]" by providing "faster search times, and smaller memory requirements," the amended claims "also function differently from conventional systems by "reduc[ing] an amount of time it takes to perform the condition assessments and automate a condition assessment process" through "applying deep learning analysis models to [extracted pixel groupings of] detected property

characteristics…to assess whether a condition of the property characteristics is degraded." *Enfish*, 822 F.3d at 1337; *Specification* at ¶ 105.

Second, the features recited in amended independent claim 1 (and similarly claims 8 and 15) integrate the alleged exception into a practical application by applying or using the alleged exception in a meaningful way beyond generally linking the use of the alleged judicial exception to a particular technical environment. In independent claim 1 (and, similarly, independent claims 8 and 15) at least the features of "extracting…one or more of a plurality of features from the aerial image corresponding to the property characteristic, wherein the extracted features include pixel groupings representing the property characteristic;" "determining…a property characteristic classification for the property characteristic, wherein determining the property characteristic classification includes applying the pixel groupings for the property characteristic to a first machine learning classifier trained to identify property characteristics from a set of pixel groupings;" "determining…based on the identified property characteristic and the extracted features, a condition classification for the property characteristic, wherein identifying the condition classification includes applying the pixel groupings for the property characteristic to a second machine learning classifier trained to identify property characteristic conditions from a set of pixel groupings" and "determining, by the processing circuitry based in part on the property characteristic classification and the condition classification, a risk estimate of damage to the property due to one or more disasters" are directed to the practical application of providing "fast and efficient automated classification of building styles and repair conditions" and in turn more accurately estimating risk of damage due to disaster. *Specification* at ¶¶ 7, 45-57, 53-55, 105. Further, because the property characteristic classification and condition assessment include pattern analysis of pixel groupings that are extracted from aerial images, the steps performed by

the system are inherently tied to the technical environment in which they are performed because the human mind would be incapable of assessing building conditions in the same way and on the same scale as recited in the claims.

As an example, the currently amended claims are unlike the claims in *Electric Power Group* that the court found to be patent-ineligible under § 101 because (1) the claims were entirely directed to collecting, analyzing, and displaying information without any recited technical improvement thereto; and (2) the claims were directed to the result of a problem and not a specific solution to the problem. *See Electric Power Group, LLC v. Alstom S.A.* 830 F.3d 1350, 1356 (Fed. Cir. 2016). The court stated that "there is a critical difference between patenting a particular concrete solution to a problem and attempting to patent the abstract idea of a solution to the problem in general." *Id.* The court went on to state that rather than claiming "'some specific way of enabling a computer to monitor data from multiple sources across an electric power grid,' some 'particular implementation,' they 'purport to monopolize every potential solution to the problem'—any way of effectively monitoring multiple sources on a power grid. Whereas patenting a particular solution 'would incentivize further innovation in the form of alternative methods for achieving the same result,' the court concluded, allowing claims like Electric Power Group's claims here would 'inhibit innovation by prohibiting other inventors from developing their own solutions to the problem without first licensing the abstract idea.'" *Id.*

McRO, Inc. v. Bandai Namco Games America, Inc., 837 F.3d 1299 (Fed. Cir. 2016), another Federal Circuit decision released just weeks after *Electric Power Group*, sheds light on this distinction between claiming a particular concrete solution to a problem and claiming the abstract idea of a solution to the problem in general. The invention in *McRO* was directed to generating animations of facial expressions that match a given sequence of phonemes by

applying morph weights to points on an animated face based on the timing of the phoneme sub-sequences. *McRO*, 837 F.3d at 1306-08. Further, the invention of *McRO* was carried out entirely in software operating on a general-purpose computer. *See id.* at 1306-08, 1314. Example claim 1 of *McRO* patent 6,307,576 is reproduced below:

> 1. A method for automatically animating lip synchronization and facial expression of three-dimensional characters comprising:
>
> obtaining a first set of rules that define output morph weight set stream as a function of phoneme sequence and time of said phoneme sequence;
>
> obtaining a timed data file of phonemes having a plurality of sub-sequences;
>
> generating an intermediate stream of output morph weight sets and a plurality of transition parameters between two adjacent morph weight sets by evaluating said plurality of sub-sequences against said first set of rules;
>
> generating a final stream of output morph weight sets at a desired frame rate from said intermediate stream of output morph weight sets and said plurality of transition parameters; and
>
> applying said final stream of output morph weight sets to a sequence of animated characters to produce lip synchronization and facial expression control of said animated characters.

Like the claimed invention in *Electric Power Group*, the invention of *McRO* consisted of receiving, processing, and displaying data. *Id.* However, unlike the claims in *Electric Power Group*, the claims in *McRO* were not abstract because they represented a technical improvement and there was "no evidence that the process previously used by animators is the same as the process required by the claims." *Id.* Further, the court acknowledged that the rule-based claims

of *McRO* could be carried out manually and yet were not directed to an abstract idea because they recited an unconventional procedure that had not previously been carried out manually. *Id.* Thus, *McRO* makes it clear that claims involving software operating on a general-purpose computer can be patent-eligible where a particular concrete technical solution to a problem is claimed, rather than an idea of a solution.

While the claims in *Electric Power Group* were merely limited to a particular technological environment without anything more, the claims in *McRO* contained an "inventive concept" that transformed the steps of receiving, analyzing, and displaying into "a patent-eligible application." *See Electric Power Group*, 830 F.3d at 1354; see also McRO, 837 F.3d at 1312. Applicant respectfully asserts that, like *McRO*, at least the features of "extracting…one or more of a plurality of features from the aerial image corresponding to the property characteristic, wherein the extracted features include pixel groupings representing the property characteristic;" "determining…a property characteristic classification for the property characteristic, wherein determining the property characteristic classification includes applying the pixel groupings for the property characteristic to a first machine learning classifier trained to identify property characteristics from a set of pixel groupings;" "determining…based on the identified property characteristic and the extracted features, a condition classification for the property characteristic, wherein identifying the condition classification includes applying the pixel groupings for the property characteristic to a second machine learning classifier trained to identify property characteristic conditions from a set of pixel groupings;" and "determining, by the processing circuitry based in part on the property characteristic classification and the condition classification, a risk estimate of damage to the property due to one or more disasters" in independent claim 1 (and similarly claims 8 and 15) contain a concrete, inventive solution to the

problems of applying deep learning methodologies a "risk exposure database population to analyze aerial imagery and automatically extract characteristics of individual properties, providing fast and efficient automated classification of building styles and repair conditions." *Specification* at ¶ 7.

Accordingly, Applicant respectfully submits that independent claims 1, 8, and 15 are not "directed to" any of the judicially recognized exceptions under revised Step 2A of Alice.

Analysis Under Step 2B of *Alice*

Examples of claim features qualifying as "significantly more" than abstract concepts include improvements to another technology or technical field, improvements to the functioning of the computer itself, adding a specific feature other than what is well-understood, routine and conventional in the field, or adding unconventional steps that confine the claim to a particular useful application. MPEP § 2106.05. Even if, *arguendo*, Applicant's claims are directed to an abstract idea under step 2A of Alice, the claims of the present application recite features qualifying as "significantly more" for incorporating features that go beyond that which is well-understood, routine and conventional in the field to improve the functioning of the computer itself in determining geographically linked venue recommendations.

As discussed in *Berkheimer*, the elements of a claim should be considered both individually and as an ordered combination, and "whether a claim element or combination of elements is well-understood, routine and conventional to a skilled artisan in the relevant field is a question of fact." *Berkheimer v. HP, Inc.*, 881 F.3d 1360, 1367-68 (Fed. Cir. 2018). According to *Berkheimer*, "[w]hether a particular technology is well-understood, routine, and conventional goes beyond what was simply known in the prior art. The mere fact that something is disclosed

in a piece of prior art, for example, does not mean it was well-understood, routine, and conventional." *Id.* at 1369. Thus, the *Berkheimer* court determined that a genuine question of fact existed regarding certain dependent claims because, according to the specification, the features recited within those claims were characterized as differing from conventional systems and providing a significant benefit. *Id.* at 1370.

In illustration, the *Berkheimer* court determined that claim 1 of the '713 patent recites abstract subject matter:

> 1. A method of archiving an item in a computer processing system comprising:
>
> presenting the item to a parser;
>
> parsing the item into a plurality of multi-part object structures wherein portions of the structures have searchable information tags associated therewith;
>
> evaluating the object structures in accordance with object structures previously stored in an archive;
>
> presenting an evaluated object structure for manual reconciliation at least where there is a predetermined variance between the object and at least one of a predetermined standard and a user defined rule.

Id. at 1370.

Conversely, the *Berkheimer* court determined that a genuine question of fact existed in whether the following recitations in dependent claims 4-7 added "something more" under step B of Alice:

> 4. The method as in claim 1 which includes storing a reconciled object structure in the archive without substantial redundancy.

5. The method as in claim 4 which includes selectively editing an object structure, linked to other structures to thereby effect a one-to-many change in a plurality of archived items.

6. The method as in clam 5 which includes compiling an item to be output from the archive, wherein at least one object-type structure of the item has been edited during the one-to-many change and wherein the compiled item includes a plurality of linked object-type structures converted into a predetermined output file formal.

7. The method as in claim 6 which includes compiling a plurality of items wherein the at least one object-type structure had been linked in the archive to members of the plurality.

Id.

Regarding the *Berkheimer* decision, the USPTO released a memorandum of April 19, 2018 identifying steps for reviewing claims under step 2B of Alice in view of *Berkheimer*. According to the Memo,

> In a step 2B analysis, an additional element (or combination of elements) is not well-understood, routine or conventional unless the examiner finds, and expressly supports a rejection in writing with, one or more of the following:
>
> 1. A citation to an express statement in the specification or to a statement made by an applicant during prosecution that demonstrates the well-understood, routine, conventional nature of the additional element(s).
>
> . . .

> 2. A citation to one or more of the court decisions discussed in MPEP § 2106.05(d)(II) as noting the well-understood, routine, conventional nature of the additional element(s). . . .
>
> 3. A citation to a publication that demonstrates the well-understood, routine, conventional nature of the additional element(s). . . .
>
> 4. A statement that the examiner is taking official notice of the well-understood, routine, conventional nature of the additional element(s).

Memorandum of April 19, 2018 "Changes in Examination Procedure Pertaining to Subject Matter Eligibility, Recent Subject Matter Eligibility Decision (Berkheimer v. HP, Inc.) ("Berkheimer Memo") at pp. 3-4.

The Office Action states that "[t]he claim(s) does/do not include additional elements that are sufficient to amount to significantly more than the judicial exception. As discussed above with respect to integration of the abstract idea into a practical application, the additional elements of using the remote computing device and the processing circuitry to perform receiving information, obtaining information, identifying information, analyzing information, determining information of a risk estimate of damage to the property due to one or more disasters and returning to the user information of a condition assessment of the property characteristic including the condition classification and the risk estimate of damage to the property due to the one or more disasters, which amounts to mere instructions to apply the exception using the generic computer component." *Office Action* at 4. However, the Office Action does not provide support for this assessment according to the criteria put forth in the *Berkheimer Memo* and described above. *Berkheimer Memo* at 3-4. Further, as explained in the specification, the claimed features embody a series of steps which "improve upon conventional methodologies by

applying deep learning analysis models to detected property characteristics…to assess whether a condition of the property characteristics is degraded to a point of needing repair or replacement and determine an amount of risk exposure of the property due to the detected condition of the property characteristics." *Specification* at ¶ 105. According to the Berkheimer Memo, to be a "well-understood, routine, conventional activity, the additional elements must be widely prevalent or in common use in the relevant field, comparable to the types of activity or elements that are so well-known that they do not need to be described in detail in a patent application to satisfy 35 U.S.C. § 112(a). Berkheimer Memo at p. 5. But, the pending claims represent specific steps for data manipulation and organization, painstakingly detailed within the specification and characterized in the specification as being clearly different than conventional systems, thus raising a genuine dispute of fact regarding these features. *Berkheimer*, 881 F.3d at 1370.

For all of the reasons described above, the currently pending claims are not directed to patent ineligible subject matter. Instead, each claim recites novel and patent-eligible features capturing techniques for "automatically extract[ing] characteristics of individual properties, providing fast and efficient automated classification of building styles and repair conditions" so that "damage due to disaster can be more accurately estimated." *Specification* at ¶¶ 7, 45-47, 53-55.

Namely, these features include both the combination of the elements of "extracting…one or more of a plurality of features from the aerial image corresponding to the property characteristic, wherein the extracted features include pixel groupings representing the property characteristic;" "determining…a property characteristic classification for the property characteristic, wherein determining the property characteristic classification includes applying the pixel groupings for the property characteristic to a first machine learning classifier trained to

identify property characteristics from a set of pixel groupings;" "determining…based on the identified property characteristic and the extracted features, a condition classification for the property characteristic, wherein identifying the condition classification includes applying the pixel groupings for the property characteristic to a second machine learning classifier trained to identify property characteristic conditions from a set of pixel groupings;" and "determining, by the processing circuitry based in part on the property characteristic classification and the condition classification, a risk estimate of damage to the property due to one or more disasters." As such, Applicant respectfully submits that even if Applicant's independent claims 1, 8, and 15 are directed to an abstract idea under Step 2A of Alice, Applicant's independent claims still recite "something more" under Step 2B of Alice. Applicant respectfully requests withdrawal of the pending §101 claim rejections.

No Disclaimers or Disavowals

Although this paper may amend the specification or claims, identify claimed features not taught or suggested in the prior art, or otherwise distinguish the claimed subject matter from the prior art, Applicant(s) are not conceding that the subject matter of any previously pending claim is not patentable over the prior art. Applicant(s) reserve the right to later pursue claims covering any of the subject matter embraced by the previously pending claims or supported by the specification and drawings as filed. Accordingly, the Office should not infer from this paper any disclaimer or disavowal of any subject matter.

CONCLUSION

In view of the above, it is believed that the claims, as amended, are in condition for allowance. Favorable reconsideration of this application is respectfully requested. Examiner Nguyen is encouraged to contact Representative Ruth Davila at 703-740-5611 or Representative Natalie Grace at 703-740-4538 should any additional information be necessary to advance prosecution and accelerate allowance.

Respectfully submitted,

/Natalie J. Grace/

Natalie J. Grace
Attorney of Record
Registration No. 65,803

Ruth G. Davila
Agent of Record
Registration No. 73,956

Date: June 21, 2019

GARDELLA GRACE P.A.
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Electronic Acknowledgement Receipt

EFS ID:	36374507
Application Number:	15714376
International Application Number:	
Confirmation Number:	8275
Title of Invention:	Platform, Systems, and Methods for Identifying Property Characteristics and Property Feature Maintenance Through Aerial Imagery Analysis
First Named Inventor/Applicant Name:	Takeshi Okazaki
Customer Number:	146018
Filer:	Natalie J. Grace/Jon Bhatty
Filer Authorized By:	Natalie J. Grace
Attorney Docket Number:	474139US01
Receipt Date:	21-JUN-2019
Filing Date:	25-SEP-2017
Time Stamp:	15:11:57
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		2019-06-21_Aon_474139US01_Response_to_NFOA.pdf	264242 7b550d84aeeb3b520ac1b88febaeaa783d9609c6	yes	32

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Amendment/Req. Reconsideration-After Non-Final Reject	1	1
	Claims	2	10
	Applicant Arguments/Remarks Made in an Amendment	11	32
Warnings:			
Information:			
	Total Files Size (in bytes):	264242	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/714,376	09/25/2017	Takeshi Okazaki	474139US01	8275

146018 7590 06/27/2019

Gardella Grace P.A.
80 M Street SE, 1st Floor
Washington, DC 20003

EXAMINER	
NGUYEN, TIEN C	

ART UNIT	PAPER NUMBER
3694	

NOTIFICATION DATE	DELIVERY MODE
06/27/2019	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

docketing@gardellagrace.com
ngrace@gardellagrace.com

Applicant-Initiated Interview Summary	**Application No.** 15/714,376	**Applicant(s)** Okazaki, Takeshi	
	Examiner TIEN C NGUYEN	**Art Unit** 3694	**AIA (FITF) Status** Yes

All participants (applicant, applicants representative, PTO personnel):

(1) Ruth G. Davila (Reg. No. 73,956). (3) _____.

(2) PE Tien Nguyen. (4) _____.

Date of Interview: 18 June 2019.

Type: ☑ Telephonic ☐ Video Conference
☐ Personal [copy given to: ☐ applicant ☐ applicant's representative]

Exhibit shown or demonstration conducted: ☐ Yes ☐ No.
If Yes, brief description: _____.

Issues Discussed ☐101 ☐112 ☐102 ☐103 ☐Others
(For each of the checked box(es) above, please describe below the issue and detailed description of the discussion)

Claim(s) discussed: _____.

Identification of prior art discussed: _____.

Substance of Interview
(For each issue discussed, provide a detailed description and indicate if agreement was reached. Some topics may include: identification or clarification of a reference or a portion thereof, claim interpretation, proposed amendments, arguments of any applied references etc...)

Mrs. Davila canceled the interview via an email on 6/18/2019 because Applicant have decided to file the response by the 3 month date of June 21.

Applicant recordation instructions: The formal written reply to the last Office action must include the substance of the interview. (See MPEP section 713.04). If a reply to the last Office action has already been filed, applicant is given a non-extendable period of the longer of one month or thirty days from this interview date, or the mailing date of this interview summary form, whichever is later, to file a statement of the substance of the interview.

Examiner recordation instructions: Examiners must summarize the substance of any interview of record. A complete and proper recordation of the substance of an interview should include the items listed in MPEP 713.04 for complete and proper recordation including the identification of the general thrust of each argument or issue discussed, a general indication of any other pertinent matters discussed regarding patentability and the general results or outcome of the interview, to include an indication as to whether or not agreement was reached on the issues raised.

☐ Attachment

/TIEN C NGUYEN/ Primary Examiner, Art Unit 3694	

Summary of Record of Interview Requirements

Manual of Patent Examining Procedure (MPEP), Section 713.04, Substance of Interview Must be Made of Record
A complete written statement as to the substance of any face-to-face, video conference, or telephone interview with regard to an application must be made of record in the application whether or not an agreement with the examiner was reached at the interview.

Title 37 Code of Federal Regulations (CFR) 1.133 Interviews
Paragraph (b)

In every instance where reconsideration is requested in view of an interview with an examiner, a complete written statement of the reasons presented at the interview as warranting favorable action must be filed by the applicant. An interview does not remove the necessity for reply to Office action as specified in §§ 1.111, 1.135. (35 U.S.C. 132)

37 CFR §1.2 Business to be transacted in writing.
All business with the Patent or Trademark Office should be transacted in writing. The personal attendance of applicants or their attorneys or agents at the Patent and Trademark Office is unnecessary. The action of the Patent and Trademark Office will be based exclusively on the written record in the Office. No attention will be paid to any alleged oral promise, stipulation, or understanding in relation to which there is disagreement or doubt.

The action of the Patent and Trademark Office cannot be based exclusively on the written record in the Office if that record is itself incomplete through the failure to record the substance of interviews.

It is the responsibility of the applicant or the attorney or agent to make the substance of an interview of record in the application file, unless the examiner indicates he or she will do so. It is the examiners responsibility to see that such a record is made and to correct material inaccuracies which bear directly on the question of patentability.

Examiners must complete an Interview Summary Form for each interview held where a matter of substance has been discussed during the interview by checking the appropriate boxes and filling in the blanks. Discussions regarding only procedural matters, directed solely to restriction requirements for which interview recordation is otherwise provided for in Section 812.01 of the Manual of Patent Examining Procedure, or pointing out typographical errors or unreadable script in Office actions or the like, are excluded from the interview recordation procedures below. Where the substance of an interview is completely recorded in an Examiners Amendment, no separate Interview Summary Record is required.

The Interview Summary Form shall be given an appropriate Paper No., placed in the right hand portion of the file, and listed on the "Contents" section of the file wrapper. In a personal interview, a duplicate of the Form is given to the applicant (or attorney or agent) at the conclusion of the interview. In the case of a telephone or video-conference interview, the copy is mailed to the applicants correspondence address either with or prior to the next official communication. If additional correspondence from the examiner is not likely before an allowance or if other circumstances dictate, the Form should be mailed promptly after the interview rather than with the next official communication.

The Form provides for recordation of the following information:
- Application Number (Series Code and Serial Number)
- Name of applicant
- Name of examiner
- Date of interview
- Type of interview (telephonic, video-conference, or personal)
- Name of participant(s) (applicant, attorney or agent, examiner, other PTO personnel, etc.)
- An indication whether or not an exhibit was shown or a demonstration conducted
- An identification of the specific prior art discussed
- An indication whether an agreement was reached and if so, a description of the general nature of the agreement (may be by attachment of a copy of amendments or claims agreed as being allowable). Note: Agreement as to allowability is tentative and does not restrict further action by the examiner to the contrary.
- The signature of the examiner who conducted the interview (if Form is not an attachment to a signed Office action)

It is desirable that the examiner orally remind the applicant of his or her obligation to record the substance of the interview of each case. It should be noted, however, that the Interview Summary Form will not normally be considered a complete and proper recordation of the interview unless it includes, or is supplemented by the applicant or the examiner to include, all of the applicable items required below concerning the substance of the interview.

A complete and proper recordation of the substance of any interview should include at least the following applicable items:
1) A brief description of the nature of any exhibit shown or any demonstration conducted,-
2) an identification of the claims discussed,
3) an identification of the specific prior art discussed,
4) an identification of the principal proposed amendments of a substantive nature discussed, unless these are already described on the Interview Summary Form completed by the Examiner,
5) a brief identification of the general thrust of the principal arguments presented to the examiner,
(The identification of arguments need not be lengthy or elaborate. A verbatim or highly detailed description of the arguments is not required. The identification of the arguments is sufficient if the general nature or thrust of the principal arguments made to the examiner can be understood in the context of the application file. Of course, the applicant may desire to emphasize and fully describe those arguments which he or she feels were or might be persuasive to the examiner.)
6) a general indication of any other pertinent matters discussed, and
7) if appropriate, the general results or outcome of the interview unless already described in the Interview Summary Form completed by the examiner.

Examiners are expected to carefully review the applicants record of the substance of an interview. If the record is not complete and accurate, the examiner will give the applicant an extendable one month time period to correct the record.

Examiner to Check for Accuracy

If the claims are allowable for other reasons of record, the examiner should send a letter setting forth the examiners version of the statement attributed to him or her. If the record is complete and accurate, the examiner should place the indication, Interview Record OK on the paper recording the substance of the interview along with the date and the examiners initials.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
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NOTICE OF ALLOWANCE AND FEE(S) DUE

146018 7590 08/07/2019

Gardella Grace P.A.
80 M Street SE, 1st Floor
Washington, DC 20003

EXAMINER	
NGUYEN, TIEN C	
ART UNIT	PAPER NUMBER
3694	

DATE MAILED: 08/07/2019

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/714,376	09/25/2017	Takeshi Okazaki	474139US01	8275

TITLE OF INVENTION: Platform, Systems, and Methods for Identifying Property Characteristics and Property Feature Maintenance Through Aerial Imagery Analysis

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1000	$0.00	$0.00	$1000	11/07/2019

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Maintenance fees are due in utility patents issuing on applications filed on or after Dec. 12, 1980. It is patentee's responsibility to ensure timely payment of maintenance fees when due. More information is available at www.uspto.gov/PatentMaintenanceFees.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

146018 7590 08/07/2019

Gardella Grace P.A.
80 M Street SE, 1st Floor
Washington, DC 20003

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/714,376	09/25/2017	Takeshi Okazaki	474139US01	8275

TITLE OF INVENTION: Platform, Systems, and Methods for Identifying Property Characteristics and Property Feature Maintenance Through Aerial Imagery Analysis

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1000	$0.00	$0.00	$1000	11/07/2019

EXAMINER	ART UNIT	CLASS-SUBCLASS
NGUYEN, TIEN C	3694	705-004000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

❑ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

❑ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-09 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 _____
2 _____
3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. Fees submitted: ❑ Issue Fee ❑ Publication Fee (if required) ❑ Advance Order - # of Copies _____

4b. Method of Payment: *(Please first reapply any previously paid fee shown above)*

❑ Electronic Payment via EFS-Web ❑ Enclosed check ❑ Non-electronic payment by credit card (Attach form PTO-2038)

❑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. _____

5. **Change in Entity Status** (from status indicated above)

❑ Applicant certifying micro entity status. See 37 CFR 1.29

❑ Applicant asserting small entity status. See 37 CFR 1.27

❑ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

UNITED STATES PATENT AND TRADEMARK OFFICE

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/714,376	09/25/2017	Takeshi Okazaki	474139US01	8275

146018 7590 08/07/2019

Gardella Grace P.A.
80 M Street SE, 1st Floor
Washington, DC 20003

EXAMINER	
NGUYEN, TIEN C	
ART UNIT	PAPER NUMBER
3694	

DATE MAILED: 08/07/2019

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 30 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	Application No. 15/714,376	Applicant(s) Okazaki, Takeshi	
	Examiner TIEN C NGUYEN	Art Unit 3694	AIA (FITF) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☑ This communication is responsive to 6/21/2019.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

3. ☑ The allowed claim(s) is/are 1-2,4 and 7-23 . As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information , please see **http://www.uspto.gov/patents/init_events/pph/index.jsp** or send an inquiry to **PPHfeedback@uspto.gov.**

4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☐ All b) ☐ Some *c) ☐ None of the:

   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____ .

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file areply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____ .

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☑ Notice of References Cited (PTO-892)
2. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____.
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material _____.
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date. _____.
5. ☐ Examiner's Amendment/Comment
6. ☑ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/TIEN C NGUYEN/
Primary Examiner, Art Unit 3694

Notice of Pre-AIA or AIA Status

The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Examiner's Statement of Reasons for Allowance

1. The following is an Allowance in response filed on 6/21/2019.

2. Claims 1, 4, 8, 9, 13 and 15 are currently amended.

3. Claims 7, 10-12, 14 and 16-20 were previously presented.

4. Claims 21-23 are newly added.

5. Claims 3 and 5-6 are canceled.

6. Therefore, claims 1-2, 4 and 7-23 are pending and allowed below.

Reasons for Allowance

7. The following is an examiner's statement of reasons for allowance:

Regarding the 35 USC 101 in view of Alice rejections, Applicant's arguments have been fully considered and they are persuasive (please see the remark on pages 16-22). Applicant's claims recite the additional limitations of "obtaining, by processing circuitry of a computing system responsive to receiving the request, an aerial image of a geographic region including the property; extracting, by the processing circuitry, one or more of a plurality of features from the aerial image corresponding to the property characteristic, wherein the extracted features include pixel groupings representing the property characteristic: determining, by the processing circuitry from the extracted features, the a property characteristic classification for the property characteristic, wherein determining the property characteristic classification includes applying the pixel groupings for the property characteristic to a first machine learning classifier trained to identify property characteristics from a set of pixel groupings; determining, by the processing circuitry based on the identified property characteristic and the extracted features, a condition classification for the property characteristic, wherein identifying the condition classification includes applying the pixel groupings for the property characteristic to a second machine

learning classifier trained to identify property characteristic conditions from a set of pixel groupings; determining, by the processing circuitry based in part on the property characteristic classification and the condition classification, a risk estimate of damage to the property due to one or more disasters; and returning, to the user at the remote computing device via a graphical user interface responsive to receiving the request, a condition assessment of the property characteristic including the condition classification and the risk estimate of damage to the property due to the one or more disasters", when viewed as an ordered combination, these additional limitations of the claims are applying or using the judicial exception in some other meaningful way beyond generally linking the use of the judicial exception to a particular technological environment. Thus, the claims are patent eligible.

Regarding the 35 USC 103 rejections, Swanson et al. (8,775,219) teaches a method and a system relates to using remote sensing capabilities like hyperspectral imaging to identify roof characteristics for insurance purposes. Downey et al. (2015/0325064) teaches methods, systems, and apparatus, including computer programs encoded on computer storage media, for unmanned aerial vehicle authorization and geofence envelope determination. Swanson and Downey does not teach a method and a system for automatically categorizing a repair condition of a property characteristic, comprising: receiving, from a user at a remote computing device, a request for a property condition classification, wherein the property classification request includes identification of a property and at least one property characteristic; obtaining, by processing circuitry of a computing system responsive to receiving the request, an aerial image of a geographic region including the property; extracting, by the processing circuitry, one or more of a plurality of features from the aerial image corresponding to the property characteristic, wherein the extracted features include pixel groupings representing the property characteristic: determining, by the processing circuitry from the extracted features, the a property characteristic classification for the property characteristic, wherein determining the property characteristic classification includes applying the pixel groupings for the property

characteristic to a first machine learning classifier trained to identify property characteristics from a set of pixel groupings; determining, by the processing circuitry based on the identified property characteristic and the extracted features, a condition classification for the property characteristic, wherein identifying the condition classification includes applying the pixel groupings for the property characteristic to a second machine learning classifier trained to identify property characteristic conditions from a set of pixel groupings; determining, by the processing circuitry based in part on the property characteristic classification and the condition classification, a risk estimate of damage to the property due to one or more disasters; and returning, to the user at the remote computing device via a graphical user interface responsive to receiving the request, a condition assessment of the property characteristic including the condition classification and the risk estimate of damage to the property due to the one or more disasters".

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Conclusion

8. Any inquiry concerning this communication or earlier communications from the examiner should be directed to TIEN C. NGUYEN whose telephone number is 571-270-5108. The examiner can normally be reached on Monday-Friday (6am-2pm EST).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Ben Sigmond can be reached on 303-297-4411. The fax phone number for the organization where this application or proceeding is assigned is 571-270-6108.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished

applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

Any response to this action should be mailed to:

Commissioner of Patents and Trademarks

P.O. Box 1450 Alexandria, VA 22313-1450

or faxed to 571-273-8300.

Hand delivered responses should be brought to the United States Patent and Trademark Office Customer Service Window:

Randolph Building 401 Dulany Street Alexandria, VA 22314.

/TIEN C NGUYEN/
Primary Examiner, Art Unit 3694

Notice of References Cited	Application/Control No. 15/714,376	Applicant(s)/Patent Under Reexamination Okazaki, Takeshi	
	Examiner TIEN C NGUYEN	Art Unit 3694	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-6732120-B1	05-2004	Du; Mike	G01C21/20	715/764
*	B	US-8775219-B2	07-2014	Swanson; Aaron L.	G06Q50/16	705/4
*	C	US-20090265193-A1	10-2009	COLLINS; Dean	G06Q30/0185	705/4
*	D	US-20150325064-A1	11-2015	Downey; Jonathan	H04W4/029	701/29.3
*	E	US-9846915-B2	12-2017	Howe; Richard L.	G06Q40/08	1/1
*	F	US-20160086285-A1	03-2016	Jordan Peters; Julie A.	G06Q40/08	705/4
*	G	US-20130226667-A1	08-2013	Terrazas; Alex	G06Q30/0205	705/7.34
*	H	US-20050063563-A1	03-2005	Soliman, Samir S.	H04N1/00204	382/104
*	I	US-8731234-B1	05-2014	Ciarcia; Christopher Albert	G06K9/00637	382/100
*	J	US-20140032433-A1	01-2014	Eick; Stephen G.	G06Q50/163	705/314
*	K	US-20100215212-A1	08-2010	Flakes, JR.; Malcolm S.	G01M5/0025	382/100
*	L	US-8346578-B1	01-2013	Hopkins, III; John Chandler	G06Q40/00	382/100
*	M	US-20100179787-A2	07-2010	Pershing; Chris	G06Q10/00	702/156

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/714,376	Okazaki, Takeshi
	Examiner	**Art Unit**
	TIEN C NGUYEN	3694

CPC						
Symbol					**Type**	**Version**
G06Q	/	40	/	08	F	2013-01-01
G06N	/	3	/	04	I	2013-01-01
G06N	/	3	/	08	I	2013-01-01
G06K	/	9	/	6267	I	2013-01-01
G06K	/	9	/	00637	I	2013-01-01
G06K	/	9	/	6256	I	2013-01-01
G06K	/	9	/	6212	I	2013-01-01
G06T	/	11	/	60	I	2013-01-01
G06K	/	9	/	00671	I	2013-01-01
G06F	/	16	/	51	I	2019-01-01
G06K	/	9	/	6273	I	2013-01-01
G06N	/	3	/	0454	I	2013-01-01
G06K	/	9	/	4604	A	2013-01-01
G06T	/	2210	/	04	A	2013-01-01
G06K	/	9	/	4642	A	2013-01-01
G06K	/	9	/	4652	A	2013-01-01

CPC Combination Sets							
Symbol					**Type**	**Set**	**Ranking**	**Version**
	/		/					

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	20	
/TIEN C NGUYEN/ Primary Examiner, Art Unit 3694	21 July 2019	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

U.S. Patent and Trademark Office — Part of Paper No.: 20190627a

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/714,376	Okazaki, Takeshi
	Examiner	**Art Unit**
	TIEN C NGUYEN	3694

INTERNATIONAL CLASSIFICATION				
CLAIMED				
G06Q	/	40	/	00

NON-CLAIMED				
	/		/	

US ORIGINAL CLASSIFICATION	
CLASS	**SUBCLASS**
705	4

CROSS REFERENCES(S)						
CLASS	**SUBCLASS (ONE SUBCLASS PER BLOCK)**					
705	2	5	3	40	38	39
382	100	155				
713	176					
705	314					
709	224					

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	20	
/TIEN C NGUYEN/ Primary Examiner, Art Unit 3694	21 July 2019	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

U.S. Patent and Trademark Office — Part of Paper No.: 20190627a

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/714,376	Okazaki, Takeshi
	Examiner	**Art Unit**
	TIEN C NGUYEN	3694

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIMS

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
1	1	10	10	19	19										
2	2	11	11	20	20										
	3	12	12	6	21										
4	4	13	13	7	22										
	5	14	14	3	23										
	6	15	15												
5	7	16	16												
8	8	17	17												
9	9	18	18												

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	20	
/TIEN C NGUYEN/ Primary Examiner, Art Unit 3694	21 July 2019	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

U.S. Patent and Trademark Office Part of Paper No.: 20190627a

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/714,376	Okazaki, Takeshi
	Examiner	**Art Unit**
	TIEN C NGUYEN	3694

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

CLAIMS

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	07/21/2019								
1	1	=								
2	2	=								
	3	-								
4	4	=								
	5	-								
	6	-								
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19	19	=								
20	20	=								
6	21	=								
7	22	=								
3	23	=								

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/714,376	Okazaki, Takeshi
	Examiner	Art Unit
	TIEN C NGUYEN	3694

CPC - Searched*		
Symbol	Date	Examiner
G06Q	07/22/2019	/tn/

CPC Combination Sets - Searched*		
Symbol	Date	Examiner
G 06Q 40/08, G 06Q 40/02, G 06Q 10/10, G 06F19/328, G 06Q 30/02.	07/22/2019	/tn/

US Classification - Searched*			
Class	Subclass	Date	Examiner
705	2	07/22/2019	/tn/
705	3	07/22/2019	/tn/
705	4	07/22/2019	/tn/
705	35	07/22/2019	/tn/
705	39	07/22/2019	/tn/
705	38	07/22/2019	/tn/
705	37	07/22/2019	/tn/
701	516	07/22/2019	/tn/
382	103	07/22/2019	/tn/
340	539.11	07/22/2019	/tn/
707	736	07/22/2019	/tn/
348	47	07/22/2019	/tn/

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

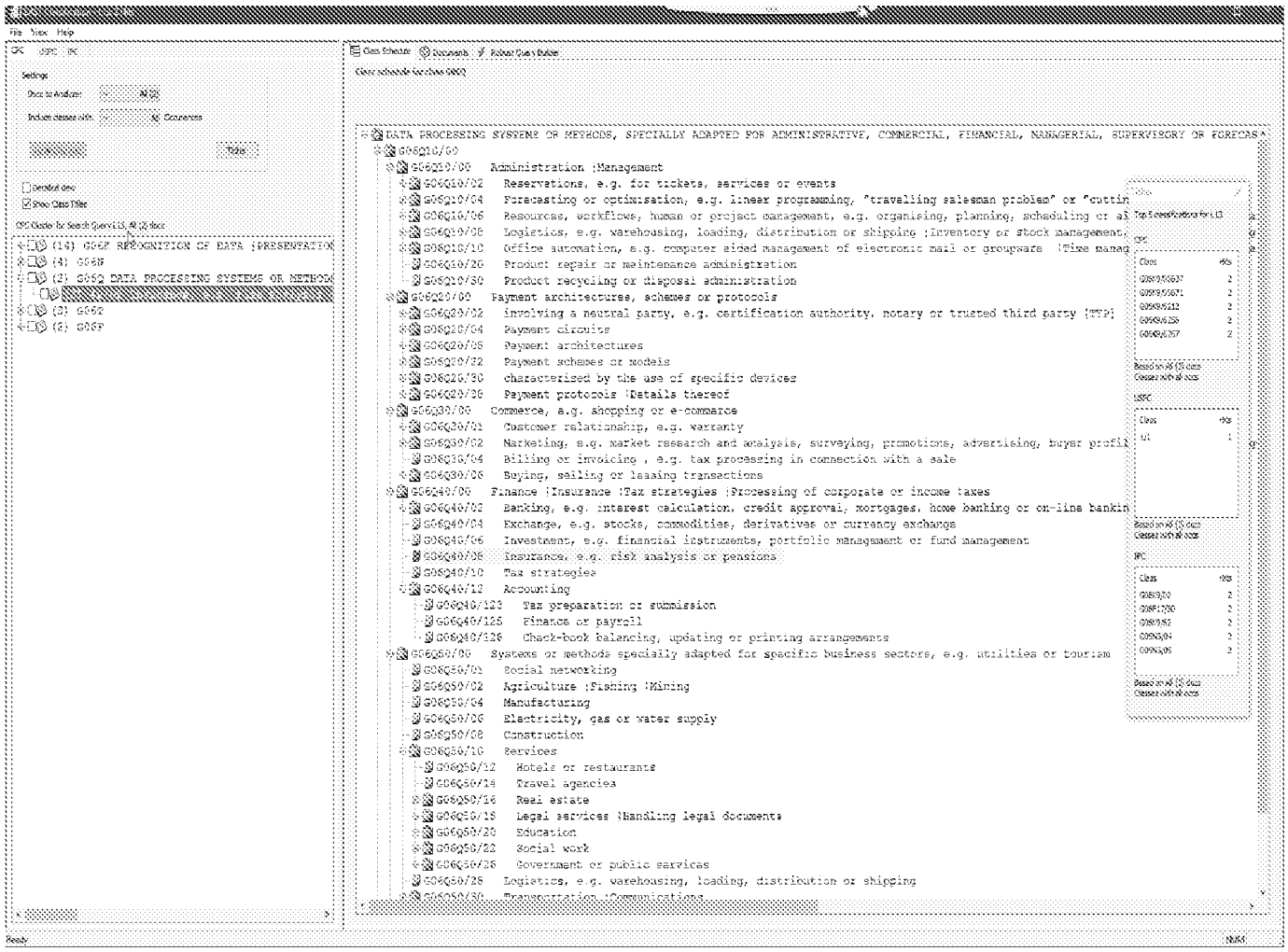
/TIEN C NGUYEN/ Primary Examiner, Art Unit 3694	

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/714,376	Okazaki, Takeshi
	Examiner	**Art Unit**
	TIEN C NGUYEN	3694

Search Notes		
Search Notes	**Date**	**Examiner**
Updated East and PALM.	07/22/2019	/tn/
Inventor search.	07/22/2019	/tn/
Google search.	07/22/2019	/tn/

Interference Search			
US Class/CPC Symbol	**US Subclass/CPC Group**	**Date**	**Examiner**
705/ G06K	4/ 9/00		
705/ G06F	4/ 17/30		
705/ G06F	4/ 9/62		

/TIEN C NGUYEN/ Primary Examiner, Art Unit 3694	


File View Help
Settings
Class schedule for class G06Q
G06Q10/00 Administration ;Management
G06Q10/02 Reservations, e.g. for tickets, services or events
G06Q10/04 Forecasting or optimisation, e.g. linear programming, "travelling salesman problem" or "cuttin
G06Q10/06 Resources, workflows, human or project management, e.g. organising, planning, scheduling or al
G06Q10/08 Logistics, e.g. warehousing, loading, distribution or shipping ;Inventory or stock management,
G06Q10/10 Office automation, e.g. computer aided management of electronic mail or groupware ;Time manag
G06Q10/20 Product repair or maintenance administration
G06Q10/30 Product recycling or disposal administration
G06Q20/00 Payment architectures, schemes or protocols
G06Q20/02 involving a neutral party, e.g. certification authority, notary or trusted third party {TTP}
G06Q20/04 Payment circuits
G06Q20/06 Payment architectures
G06Q20/32 Payment schemes or models
G06Q20/30 characterised by the use of specific devices
G06Q20/38 Payment protocols ;Details thereof
G06Q30/00 Commerce, e.g. shopping or e-commerce
G06Q30/01 Customer relationship, e.g. warranty
G06Q30/02 Marketing, e.g. market research and analysis, surveying, promotions, advertising, buyer profil
G06Q30/04 Billing or invoicing , e.g. tax processing in connection with a sale
G06Q30/06 Buying, selling or leasing transactions
G06Q40/00 Finance ;Insurance ;Tax strategies ;Processing of corporate or income taxes
G06Q40/02 Banking, e.g. interest calculation, credit approval, mortgages, home banking or on-line bankin
G06Q40/04 Exchange, e.g. stocks, commodities, derivatives or currency exchange
G06Q40/06 Investment, e.g. financial instruments, portfolio management or fund management
G06Q40/08 Insurance, e.g. risk analysis or pensions
G06Q40/10 Tax strategies
G06Q40/12 Accounting
G06Q40/123 Tax preparation or submission
G06Q40/125 Finance or payroll
G06Q40/126 Check-book balancing, updating or printing arrangements
G06Q50/00 Systems or methods specially adapted for specific business sectors, e.g. utilities or tourism
G06Q50/01 Social networking
G06Q50/02 Agriculture ;Fishing ;Mining
G06Q50/04 Manufacturing
G06Q50/06 Electricity, gas or water supply
G06Q50/08 Construction
G06Q50/10 Services
G06Q50/12 Hotels or restaurants
G06Q50/14 Travel agencies
G06Q50/16 Real estate
G06Q50/18 Legal services ;Handling legal documents
G06Q50/20 Education
G06Q50/22 Social work
G06Q50/26 Government or public services
G06Q50/28 Logistics, e.g. warehousing, loading, distribution or shipping
Ready

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United States Patent and Trademark Office
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BIB DATA SHEET

CONFIRMATION NO. 8275

SERIAL NUMBER	FILING or 371(c) DATE RULE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
15/714,376	09/25/2017	705	3694	474139US01

APPLICANTS
Aon Benfield Inc., Chicago, IL

INVENTORS
Takeshi Okazaki, Tokyo, JAPAN;

**** CONTINUING DATA ***************************
This appln claims benefit of 62/398,665 09/23/2016

**** FOREIGN APPLICATIONS ***************************

**** IF REQUIRED, FOREIGN FILING LICENSE GRANTED ****
10/05/2017

Foreign Priority claimed ☐ Yes ☑ No 35 USC 119(a-d) conditions met ☐ Yes ☑ No Verified and Acknowledged /TIEN C NGUYEN/ Examiner's Signature	☐ Met after Allowance Initials	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
		JAPAN	15	20	3

ADDRESS

Gardella Grace P.A.
80 M Street SE, 1st Floor
Washington, DC 20003
UNITED STATES

TITLE

Platform, Systems, and Methods for Identifying Property Characteristics and Property Feature Maintenance Through Aerial Imagery Analysis

FILING FEE RECEIVED		
1600	FEES: Authority has been given in Paper No._____ to charge/credit DEPOSIT ACCOUNT No._____ for following:	☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other _____ ☐ Credit

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	399871	receiv$3 near7 request$3	USPAT	OR	ON	2019/07/21 05:27
L2	142259	(property or properties or house or houses or "real property" or resident$3) near7 (characteristic$3 or identification$3)	USPAT	OR	ON	2019/07/21 05:29
L3	7105	1 and 2	USPAT	OR	ON	2019/07/21 05:29
L4	8039	aerial$3 near7 imag$3	USPAT	OR	ON	2019/07/21 05:29
L5	46894	(geographic$3) near7 (region$3 or boundar$3)	USPAT	OR	ON	2019/07/21 05:30
L6	791	4 and 5	USPAT	OR	ON	2019/07/21 05:30
L7	30	3 and 6	USPAT	OR	ON	2019/07/21 05:30
L8	4	("5519809" | "5559707" | "5966135" | "6732120").PN. OR ("9760649").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2019/07/21 05:31
L9	134	("5193185" | "5214757" | "5418906" | "5426780" | "5751612" | "5953722" | "5963956" | "5968109" | "5974419" | "6047280" | "6282489").PN. OR ("6732120").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2019/07/21 05:32
L10	26181	(property or properties or house or houses or "real property" or resident$3) near7 (damag$3)	USPAT	OR	ON	2019/07/21 05:33
L11	106	(property or properties or house or houses or "real property" or resident$3) near7 (damag$3) with disaster$3	USPAT	OR	ON	2019/07/21 05:33
L12	4	11 and 3	USPAT	OR	ON	2019/07/21 05:33
L13	2	("20180089763").PN.	US-PGPUB; USPAT; USOCR; DERWENT	OR	ON	2019/07/21 05:34
L14	0	("2018/0089763").URPN.	USPAT	OR	ON	2019/07/21 05:35
L15	10	11 and 4	USPAT	OR	ON	2019/07/21 05:35
L16	13	("20080262789" | "20090265193" | "20090326383" | "7317416" | "7944559" | "8346578").PN. OR ("8775219").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2019/07/21 05:36
L17	174	("2009/0265193").URPN.	USPAT	OR	ON	2019/07/21 05:37
L18	80	("20080059068" | "20090265193" | "20100012776" | "20100215212" | "20100228418" | "20100286859" | "20110270470" | "20120197461" |	US-PGPUB; USPAT; USOCR	OR	ON	2019/07/21 05:37

07/21/2019 11:41:22 AM
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EAST Search History

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L1	449	(extract$3) with ((aerial$3) near7 (imag$3))	USPAT	OR	ON	2019/07/21 10:32
L2	41745	pixel$3 near7 (group$3 or grouping$3)	USPAT	OR	ON	2019/07/21 10:33
L3	54	1 and 2	USPAT	OR	ON	2019/07/21 10:33

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EAST Search History

L4	6016	(property or properties or house or houses or "real property" or resident$3) near7 (classif$3)	USPAT	OR	ON	2019/07/21 10:34
L5	1	3 and 4	USPAT	OR	ON	2019/07/21 10:34
L6	47173	(risk$3 or damag$3) near7 (estimat$3 or determin$3)	USPAT	OR	ON	2019/07/21 10:35
L7	1	5 and 6	USPAT	OR	ON	2019/07/21 10:35
L8	40	("20050251427" | "20060095304" | "20080103841" | "20090063234" | "20090265193" | "20090276708" | "20100179787" | "20100215212" | "20100257477" | "20130117078" | "20130297353" | "20140032433" | "20140039935" | "20140149144" | "20150332355" | "20160086285" | "6098070" | "6219930" | "7676061" | "8078875" | "8170840" | "8209152" | "8346578" | "8401222" | "8401877" | "8515125" | "8670961" | "8731234" | "8756085" | "8774525" | "8775219" | "8818572" | "8818770" | "8825454" | "8874454" | "8929586" | "8977520" | "8995757" | "9002719").PN. OR ("9846915").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2019/07/21 10:38
L9	51	("2623291" | "2623292" | "3029522" | "3890715" | "4131998" | "4353988" | "4389782" | "4435769" | "4507872" | "4517748" | "4896428" | "5128859" | "5293309" | "5317503" | "5377098" | "5491902").PN. OR ("6219930").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2019/07/21 10:39
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L15	622	("5032979" | "5517519" | "5579222" | "5590245" | "5614940" | "5619656" | "5627886" | "5678041" | "5696965" | "5706507" | "5727159" | "5796952").PN. OR ("6018619").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2019/07/21 10:41
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L17	8348	aerial$3 near7 imag$3	USPAT	OR	ON	2019/07/21 10:42
L18	49314	(geographic$3) near7 (region$3 or boundar$3)	USPAT	OR	ON	2019/07/21 10:42
L19	849	L17 and L18	USPAT	OR	ON	2019/07/21 10:42
L20	6	("20060122776" | "20070025595" | "20130226667" | "20190050625" | "20190130641" | "9389084").PN. OR ("10339646").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2019/07/21 10:57
L21	7	("20060239537" | "20130141540" | "20150169723").PN. OR ("9389084").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2019/07/21 10:57
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L23	10	("2013/0226667").URPN.	USPAT	OR	ON	2019/07/21 10:57
L24	849	L17 and L18	USPAT	OR	ON	2019/07/21 10:58
L25	12	("20040239688" | "20050063563" | "20060267803" | "20120038633" | "20150317597" | "20160300375" |	US-PGPUB; USPAT; USOCR	OR	ON	2019/07/21 10:58

EAST Search History

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S1	399871	receiv$3 near7 request$3	USPAT	OR	ON	2019/07/21 05:27
S2	142259	(property or properties or house or houses or "real property" or resident$3) near7 (characteristic$3 or identification$3)	USPAT	OR	ON	2019/07/21 05:29
S3	7105	S1 and S2	USPAT	OR	ON	2019/07/21 05:29
S4	8039	aerial$3 near7 imag$3	USPAT	OR	ON	2019/07/21 05:29
S5	46894	(geographic$3) near7 (region$3 or boundar$3)	USPAT	OR	ON	2019/07/21 05:30
S6	791	S4 and S5	USPAT	OR	ON	2019/07/21 05:30
S7	30	S3 and S6	USPAT	OR	ON	2019/07/21 05:30
S8	4	("5519809" | "5559707" | "5966135" | "6732120").PN. OR ("9760649").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2019/07/21 05:31
S9	134	("5193185" | "5214757" | "5418906" | "5426780" | "5751612" | "5953722" | "5963956" | "5968109" | "5974419" | "6047280" | "6282489").PN. OR ("6732120").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2019/07/21 05:32
S10	26181	(property or properties or house or houses or "real property" or resident$3) near7 (damag$3)	USPAT	OR	ON	2019/07/21 05:33
S11	106	(property or properties or house or houses or "real property" or resident$3) near7 (damag$3) with disaster$3	USPAT	OR	ON	2019/07/21 05:33
S12	4	S11 and S3	USPAT	OR	ON	2019/07/21 05:33
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S14	0	("2018/0089763").URPN.	USPAT	OR	ON	2019/07/21 05:35
S15	10	S11 and S4	USPAT	OR	ON	2019/07/21 05:35

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L19	849	L17 and L18	USPAT	OR	ON	2019/07/21 10:42
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EAST Search History

EAST Search History (Interference)

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L3	7105	1 and 2	USPAT	OR	ON	2019/07/21 05:29
L4	8039	aerial$3 near7 imag$3	USPAT	OR	ON	2019/07/21 05:29
L5	46894	(geographic$3) near7 (region$3 or boundar$3)	USPAT	OR	ON	2019/07/21 05:30
L6	791	4 and 5	USPAT	OR	ON	2019/07/21 05:30
L7	30	3 and 6	USPAT	OR	ON	2019/07/21 05:30
L8	4	("5519809" | "5559707" | "5966135" | "6732120").PN. OR ("9760649").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2019/07/21 05:31
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L10	26181	(property or properties or house or houses or "real property" or resident$3) near7 (damag$3)	USPAT	OR	ON	2019/07/21 05:33
L11	106	(property or properties or house or houses or "real property" or resident$3) near7 (damag$3) with disaster$3	USPAT	OR	ON	2019/07/21 05:33
L12	4	11 and 3	USPAT	OR	ON	2019/07/21 05:33
L13	2	("20180089763").PN.	US-PGPUB; USPAT; USOCR; DERWENT	OR	ON	2019/07/21 05:34
L14	0	("2018/0089763").URPN.	USPAT	OR	ON	2019/07/21 05:35
L15	10	11 and 4	USPAT	OR	ON	2019/07/21 05:35
L16	13	("20080262789" | "20090265193" | "20090326383" | "7317416" | "7944559" | "8346578").PN. OR ("8775219").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2019/07/21 05:36
L17	174	("2009/0265193").URPN.	USPAT	OR	ON	2019/07/21 05:37
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07/21/2019 11:41:22 AM
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L19	16	("2015/0325064").URPN.	USPAT	OR	ON	2019/07/21 05:39
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L1	449	(extract$3) with ((aerial$3) near7 (imag$3))	USPAT	OR	ON	2019/07/21 10:32
L2	41745	pixel$3 near7 (group$3 or grouping$3)	USPAT	OR	ON	2019/07/21 10:33
L3	54	1 and 2	USPAT	OR	ON	2019/07/21 10:33
L4	6016	(property or properties or house or houses or	USPAT	OR	ON	2019/07/21

EAST Search History

		"real property" or resident$3) near7 (classif$3)				10:34
L5	1	3 and 4	USPAT	OR	ON	2019/07/21 10:34
L6	47173	(risk$3 or damag$3) near7 (estimat$3 or determin$3)	USPAT	OR	ON	2019/07/21 10:35
L7	1	5 and 6	USPAT	OR	ON	2019/07/21 10:35
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L16	8	("20140316614" | "20150371543" | "20160012730" | "20160224932" | "20160292696" | "20170011340" | "20170011343" | "20170148467").PN. OR ("10102758").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2019/07/21 10:42
L17	8348	aerial$3 near7 imag$3	USPAT	OR	ON	2019/07/21 10:42
L18	49314	(geographic$3) near7 (region$3 or boundar$3)	USPAT	OR	ON	2019/07/21 10:42
L19	849	L17 and L18	USPAT	OR	ON	2019/07/21 10:42
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L21	7	("20060239537" | "20130141540" | "20150169723").PN. OR ("9389084").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2019/07/21 10:57
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L23	10	("2013/0226667").URPN.	USPAT	OR	ON	2019/07/21 10:57

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POWER OF ATTORNEY TO PROSECUTE APPLICATIONS BEFORE THE USPTO

I hereby revoke all previous powers of attorney given in the application identified in the attached statement under 37 CFR 3.73(c).

I hereby appoint:

☒ Practitioners associated with Customer Number: 146018

OR

☐ Practitioner(s) named below (if more than ten patent practitioners are to be named, then a customer number must be used):

Name	Registration Number

Name	Registration Number

As attorney(s) or agent(s) to represent the undersigned before the United States Patent and Trademark Office (USPTO) in connection with any and all patent applications assigned only to the undersigned according to the USPTO assignment records or assignments documents attached to this form in accordance with 37 CFR 3.73(c).

Please change the correspondence address for the application identified in the attached statement under 37 CFR 3.73(c) to:

☒ The address associated with Customer Number: 146018

OR

☐	Firm or Individual Name			
	Address			
	City		State	Zip
	Country			
	Telephone		Email	

Assignee Name and Address: AON BENFIELD INC.
200 EAST RANDOLPH STREET
CHICAGO, ILLINOIS 60601

A copy of this form, together with a statement under 37 CFR 3.73(c) (Form PTO/AIA/96 or equivalent) is required to be filed in each application in which this form is used. The statement under 37 CFR 3.73(c) may be completed by one of the practitioners appointed in this form, and must identify the application in which this Power of Attorney is to be filed.

SIGNATURE of Assignee of Record

The individual whose signature and title is supplied below is authorized to act on behalf of the assignee

Signature	George W. deMenocal	Date	July 13, 2017
Name	George W. deMenocal	Telephone	203.326.4379
Title	President and Chief Executive Officer - U.S.		

This collection of information is required by 37 CFR 1.31, 1.32 and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

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STATEMENT UNDER 37 CFR 3.73(c)

Applicant/Patent Owner: Aon Benfield Inc.

Application No./Patent No.: 15/714,376 Filed/Issue Date: September 25, 2017

Titled: Platform, Systems, and Methods for Identifying Property Characteristics and Property Feature Maintenance Through Aerial Imagery Analysis

Aon Benfield Inc., a corporation

(Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

states that, for the patent application/patent identified above, it is (choose **one** of options 1, 2, 3 or 4 below):

1. ☑ The assignee of the entire right, title, and interest.

2. ☐ An assignee of less than the entire right, title, and interest (check applicable box):

   ☐ The extent (by percentage) of its ownership interest is _____%. Additional Statement(s) by the owners holding the balance of the interest must be submitted to account for 100% of the ownership interest.

   ☐ There are unspecified percentages of ownership. The other parties, including inventors, who together own the entire right, title and interest are:

   Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

3. ☐ The assignee of an undivided interest in the entirety (a complete assignment from one of the joint inventors was made). The other parties, including inventors, who together own the entire right, title, and interest are:

   Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

4. ☐ The recipient, via a court proceeding or the like (*e.g.*, bankruptcy, probate), of an undivided interest in the entirety (a complete transfer of ownership interest was made). The certified document(s) showing the transfer is attached.

The interest identified in option 1, 2 or 3 above (not option 4) is evidenced by either (choose **one** of options A or B below):

A. ☑ An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel _____, Frame _____, or for which a copy thereof is attached.

B. ☐ A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: _____ To: _____

   The document was recorded in the United States Patent and Trademark Office at

   Reel _____, Frame _____, or for which a copy thereof is attached.

2. From: _____ To: _____

   The document was recorded in the United States Patent and Trademark Office at

   Reel _____, Frame _____, or for which a copy thereof is attached.

This collection of information is required by 37 CFR 3.73(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450**.

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STATEMENT UNDER 37 CFR 3.73(c)

3. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

4. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

5. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

6. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

☐ Additional documents in the chain of title are listed on a supplemental sheet(s).

☑ As required by 37 CFR 3.73(c)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (i.e., a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

/Natalie J. Grace/	2019-10-04
Signature	Date
Natalie J. Grace	65,803
Printed or Typed Name	Title or Registration Number

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

ASSIGNMENT

WHEREAS, I (WE) Takeshi OKAZAKI of Tokyo, Japan
have invented certain new and useful improvements in: PLATFORM, SYSTEMS, AND METHODS FOR IDENTIFYING PROPERTY CHARACTERISTICS AND PROPERTY FEATURE MAINTENANCE THROUGH AERIAL IMAGERY ANALYSIS
for which a non-provisional application was filed as U.S. Application No. 15/714,376 on September 25, 2017 and claims priority to a provisional application filed on September 23, 2016 as U.S. Application No. 62/398,665, and WHEREAS, AON BENFIELD INC. (hereinafter referred to as "ASSIGNEE") having a place of business at: 200 E. Randolph Street, Chicago, IL 60601 is desirous of acquiring the entire right, title and interest in and to said invention and in and to any Letters Patent that may be granted therefore in the United States and its territorial possessions and in any and all foreign countries;

NOW, THEREFORE, for good and valuable consideration, the receipt whereof is hereby acknowledged, and for other good and valuable consideration, I, by these presents do sell, assign and transfer unto said ASSIGNEE, the full and exclusive right to the said invention in the United States and its territorial possessions and in all foreign countries (including the right to claim priority under the terms of the International Convention and other relevant International Treaties and Arrangements from the aforesaid application) and the entire right, title and interest in and to any and all Letters Patent which may be granted therefor in the United States and its territorial possessions and in any and all foreign countries and in and to any and all divisions, reissues, continuations, substitutions and renewals thereof.

I (WE) hereby authorize and request the Patent Office Officials in the United States and its territorial possessions and any and all foreign countries to issue any and all of said Letters Patent, when granted, to said ASSIGNEE as the assignee of my (our) entire right, title and interest in and to the same, for the sole use and behoof of said ASSIGNEE, its (his) successors and assigns, to the full end of the term for which said Letters Patent may be granted, as fully and entirely as the same would have been held by me (us) had this Assignment and sale not been made.

The undersigned hereby grant(s) the firm Gardella Grace P.A. of 80 M Street SE, 1st Floor, Washington, D.C. 20003 the power to insert on this assignment any further identification, including the application number and filing date, which may be necessary or desirable in order to comply with the rules of the United States Patent and Trademark Office for recordation of this document.

Date: 25 September 2017

Takeshi Okazaki

(Signature of Inventor) Takeshi OKAZAKI

Electronic Acknowledgement Receipt

EFS ID:	37364391
Application Number:	15714376
International Application Number:	
Confirmation Number:	8275
Title of Invention:	Platform, Systems, and Methods for Identifying Property Characteristics and Property Feature Maintenance Through Aerial Imagery Analysis
First Named Inventor/Applicant Name:	Takeshi Okazaki
Customer Number:	146018
Filer:	Natalie J. Grace/Kristin Sims
Filer Authorized By:	Natalie J. Grace
Attorney Docket Number:	474139US01
Receipt Date:	04-OCT-2019
Filing Date:	25-SEP-2017
Time Stamp:	08:07:02
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		474139US01_POA373Assignment.pdf	1411607 f61caeba49639367b0b11b449c24bb1b8d93159c	yes	7

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Power of Attorney	1	2
	Assignee showing of ownership per 37 CFR 3.73	3	7
Warnings:			
Information:			
	Total Files Size (in bytes):	1411607	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.
National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.
New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
15/714,376	09/25/2017	Takeshi Okazaki	474139US01

CONFIRMATION NO. 8275

POA ACCEPTANCE LETTER

146018
Gardella Grace P.A.
80 M Street SE, 1st Floor
Washington, DC 20003

OC000000111706823

Date Mailed: 10/08/2019

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 10/04/2019.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/vnguyen/

Doc code: RCEX
Doc description: Request for Continued Examination (RCE)

PTO/SB/30EFS (02-18)
Approved for use through 11/30/2020. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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REQUEST FOR CONTINUED EXAMINATION(RCE)TRANSMITTAL
(Submitted Only via EFS-Web)

Application Number	15714376	Filing Date	2017-09-25	Docket Number (if applicable)	474139US01	Art Unit	3694
First Named Inventor	Takeshi Okazaki			Examiner Name	TIEN C. NGUYEN		

This is a Request for Continued Examination (RCE) under 37 CFR 1.114 of the above-identified application.
Request for Continued Examination (RCE) practice under 37 CFR 1.114 does not apply to any utility or plant application filed prior to June 8, 1995, or to any design application. The Instruction Sheet for this form is located at WWW.USPTO.GOV

SUBMISSION REQUIRED UNDER 37 CFR 1.114

Note: If the RCE is proper, any previously filed unentered amendments and amendments enclosed with the RCE will be entered in the order in which they were filed unless applicant instructs otherwise. If applicant does not wish to have any previously filed unentered amendment(s) entered, applicant must request non-entry of such amendment(s).

☐ Previously submitted. If a final Office action is outstanding, any amendments filed after the final Office action may be considered as a submission even if this box is not checked.

- ☐ Consider the arguments in the Appeal Brief or Reply Brief previously filed on _____
- ☐ Other _____

☒ Enclosed

- ☐ Amendment/Reply
- ☒ Information Disclosure Statement (IDS)
- ☐ Affidavit(s)/ Declaration(s)
- ☐ Other _____

MISCELLANEOUS

☐ Suspension of action on the above-identified application is requested under 37 CFR 1.103(c) for a period of months _____ (Period of suspension shall not exceed 3 months; Fee under 37 CFR 1.17(i) required)

☐ Other _____

FEES

☒ **The RCE fee under 37 CFR 1.17(e) is required by 37 CFR 1.114 when the RCE is filed.**
The Director is hereby authorized to charge any underpayment of fees, or credit any overpayments, to Deposit Account No 601484

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED

☒ Patent Practitioner Signature

Applicant Signature

PTO/SB/30EFS (02-18)
Approved for use through 11/30/2020. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Signature of Registered U.S. Patent Practitioner			
Signature	/Natalie J. Grace/	Date (YYYY-MM-DD)	2019-11-05
Name	Natalie J. Grace	Registration Number	65803

This collection of information is required by 37 CFR 1.114. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

IN RE APPLICATION OF:	|
AON BENFIELD INC.	| EXAMINER: TIEN C. NGUYEN
APPLICATION NO.: 15/714,376	| GROUP ART UNIT: 3694
FILED: SEPTEMBER 25, 2017	| DOCKET NO. 474139US01
FOR: PLATFORM, SYSTEMS, AND METHODS FOR IDENTIFYING PROPERTY CHARACTERISTICS AND PROPERTY FEATURE MAINTENANCE THROUGH AERIAL IMAGERY ANALYSIS	|

INFORMATION DISCLOSURE STATEMENT

COMMISSIONER FOR PATENTS
P.O. BOX 1450
ALEXANDRIA, VIRGINIA 22313

Commissioner:

Applicant wishes to make of record the reference(s) listed on the attached PTO/SB/08a forms. This Information Disclosure Statement is being submitted concurrently with a Request for Continued Examination. Consequently, no certification or fee is required.

If any fees are required, then the Commissioner is authorized to charge such fees or credit any overpayment to Gardella Grace P.A. deposit account number 601484, referencing docket number 474139US01.

Respectfully submitted,

Date: November 5, 2019

/Natalie J. Grace/
Natalie J. Grace
Attorney of Record
Registration No. 65,803

GARDELLA GRACE P.A.
80 M Street SE, 1st Floor
Washington, DC 20003
Telephone: (703) 556-9600
Facsimile: (703) 740-4541

PTO/SB/08a (02-18)
Approved for use through 11/30/2020. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	15714376
Filing Date	2017-09-25
First Named Inventor	Takeshi Okazaki
Art Unit	3694
Examiner Name	TIEN C. NGUYEN
Attorney Docket Number	474139US01

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	10311302		2019-06-04	Kottenstette et al.	
	2	9141872		2015-09-22	Marchisio et al.	
	3	9569690		2017-02-14	Marchisio et al.	
	4	9858645		2018-01-02	Malitz	
	5	9031325		2015-05-12	Ouzounis	
	6	8682079		2014-03-25	Ouzounis	
	7	9589210		2017-03-07	Estrada et al.	
	8	10013774		2019-07-03	Estrada et al.	

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	Art Unit	3694
	Examiner Name	TIEN C. NGUYEN
	Attorney Docket Number	474139US01

	9	9147132		2015-09-29	Marchisio et al.	
	10	9619734		2017-04-11	Marchisio et al.	
	11	9495618		2016-11-15	Tabb	
	12	9767565		2017-09-19	Estrada et al.	
	13	10157479		2018-12-18	Estrada et al.	
	14	9904849		2018-02-27	Estrada et al.	
	15	9230168		2016-01-05	Gueguen	
	16	8145578		2012-03-27	Pershing et al.	
	17	8670961		2014-03-11	Pershing et al.	
	18	9514568		2016-12-06	Pershing et al.	
	19	8731234		2014-05-20	Ciarcia et al.	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
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	Attorney Docket Number	474139US01

	20	9070018		2015-06-30	Ciarcia et al.	
	21	8995757		2015-03-31	Ciarcia et al.	
	22	8825454		2014-09-02	Pershing	
	23	9135737		2015-09-15	Pershing	
	24	8818770		2014-08-26	Pershing	
	25	9129376		2015-09-08	Pershing	
	26	8078436		2011-12-13	Pershing et al.	
	27	8170840		2012-05-01	Pershing	
	28	8209152		2012-06-26	Pershing	
	29	10217207		2019-02-26	Marra et al.	
	30	10178303		2019-01-08	Castillo et al.	

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	Attorney Docket Number	474139US01

	31	9639960		2017-05-02	Loveland et al.	
	32	8775219		2014-07-08	Swanson et al.	
	33	10402676		2019-09-03	Wang et al.	
	34	8977520		2015-03-10	Stephens et al.	
	35	10346935		2019-07-09	Thornberry et al.	
	36	9183538		2015-11-10	Thornberry et al.	
	37	9330494		2016-05-03	Schultz	
	38	9959667		2018-05-01	Schultz	
	39	10198857		2019-02-05	Schultz	
	40	8401222		2013-03-19	Thornberry et al.	
	41	8515125		2013-08-20	Thornberry et al.	

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	Art Unit	3694
	Examiner Name	TIEN C. NGUYEN
	Attorney Docket Number	474139US01

	42	8542880		2013-09-24	Thornberry et al.	
	43	9329749		2016-05-03	Thornberry et al.	
	44	9244589		2016-01-26	Thornberry et al.	
	45	9933254		2018-04-03	Thornberry et al.	
	46	8873842		2014-10-28	Robinson et al.	
	47	10410289		2019-09-10	Tofte et al.	
	48	10102589		2018-10-16	Tofte et al.	
	49	10134092		2018-11-20	Harvey et al.	
	50	9875509		2018-01-23	Harvey et al.	

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U.S.PATENT APPLICATION PUBLICATIONS Remove

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
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	Art Unit	3694
	Examiner Name	TIEN C. NGUYEN
	Attorney Docket Number	474139US01

	1	20150317740		2015-11-05	Emison et al.	
	2	20170161559		2017-06-08	Du et al.	
	3	20170330032		2017-11-16	Du et al.	
	4	20140245165		2014-08-28	Battcher et al.	
	5	20140245210		2014-08-28	Battcher et al.	
	6	20150370928		2015-12-24	Fershing	
	7	20130311240		2013-11-21	Fershing et al.	
	8	20170053436		2017-02-23	Fershing et al.	
	9	20120209782		2012-08-16	Fershing et al.	
	10	20160155097		2016-06-02	Venkatesha	
	11	20150025914		2015-01-22	Lekas	

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	Examiner Name	TIEN C. NGUYEN
	Attorney Docket Number	474139US01

	12	20160350907		2016-12-01	Simula et al.	
	13	20150363717		2015-12-17	Lim	
	14	20160063642		2016-03-03	Luciani et al.	
	15	20140278697		2014-09-18	Thornberry et al.	
	16	20150178416		2015-06-25	Stephens et al.	
	17	20140237430		2014-08-21	Thornberry et al.	
	18	20150310557		2015-10-29	Engelhorn	
	19	20150310558		2015-10-29	Cuttell et al.	
	20	20170154131		2017-06-01	Loveland et al.	
	21	20170277980		2017-09-28	Taylor et al.	
	22	20150302529		2015-10-22	Jagannathan	

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	First Named Inventor	Takeshi Okazaki
	Art Unit	3694
	Examiner Name	TIEN C. NGUYEN
	Attorney Docket Number	474139US01

	23	20140019166		2014-01-16	Swanson et al.	
	24	20160259994		2016-09-08	Ravindran et al.	

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FOREIGN PATENT DOCUMENTS Remove

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	2017040691	WO	A1	2017-03-09	CAPE ANALYTICS, INC.		
	2	2017151673	WO	A1	2017-09-08	DIGITALGLOBE, INC.		
	3	2015009798	WO	A1	2015-01-22	DIGITALGLOBE, INC.		
	4	2015017366	WO	A1	2015-02-05	DIGITALGLOBE, INC.		
	5	2015038358	WO	A1	2015-03-19	DIGITALGLOBE, INC.		
	6	2016053791	WO	A1	2016-04-07	DIGITALGLOBE, INC.		
	7	2014151122	WO	A1	2014-09-25	EAGLE VIEW TECHNOLOGIES, INC.		

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15714376
	Filing Date	2017-09-25
	First Named Inventor	Takeshi Okazaki
	Art Unit	3694
	Examiner Name	TIEN C. NGUYEN
	Attorney Docket Number	474139US01

	8	2017142788	WO	A1	2017-08-24	PICTOMETRY INTERNATIONAL CORP.		
	9	2012054239	WO	A2	2012-04-26	PICTOMETRY INTERNATIONAL CORP.		
	10	2012054239	WO	A3	2012-04-26	PICTOMETRY INTERNATIONAL CORP.		
	11	2013142406	WO	A1	2013-09-26	PICTOMETRY INTERNATIONAL CORP.		
	12	2017186515	WO	A1	2017-11-02	SIEMENS AKTIENGESELLSCHAFT		
	13	2013123354	WO	A1	2013-08-22	XACTWARE SOLUTIONS, INC.		
	14	2015017855	WO	A1	2015-02-05	XACTWARE SOLUTIONS, INC.		
	15	2018058044	WO	A1	2018-03-29	AON BENFIELD INC.		

If you wish to add additional Foreign Patent Document citation information please click the Add button Add

NON-PATENT LITERATURE DOCUMENTS Remove

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1	International Search Report and Written Opinion issued in International Application No. PCT/US2017/053265 on December 11, 2017.	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
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	Art Unit	3694
	Examiner Name	TIEN C. NGUYEN
	Attorney Docket Number	474139US01

	2	International Patent Report on Patentability issued in International Application No. PCT/US2017/053265 on March 26, 2019.
	3	LIN, et al., Network in Network, International Conference on Learning Representations, 2014, pp. 10.
	4	KRIZHEVSKY, et al., ImageNet Classification with Deep Convolutional Neural Networks, Advances in neural information processing systems, 2012, pp. 9.

If you wish to add additional non-patent literature document citation information please click the Add button Add

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	15714376
Filing Date	2017-09-25
First Named Inventor	Takeshi Okazaki
Art Unit	3694
Examiner Name	TIEN C. NGUYEN
Attorney Docket Number	474139US01

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Natalie J. Grace/	Date (YYYY-MM-DD)	2019-11-05
Name/Print	Natalie J. Grace	Registration Number	65803

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

PTO/SB/08a (02-18)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	15714376
Filing Date	2017-09-25
First Named Inventor	Takeshi Okazaki
Art Unit	3694
Examiner Name	TIEN C. NGUYEN
Attorney Docket Number	474139US01

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	9928553		2018-03-27	Harvey et al.	
	2	10173773		2019-01-08	Flick	
	3	10137984		2018-11-27	Flick	
	4	10163164		2018-12-25	Tofte et al.	
	5	9501700		2016-11-22	Loveland et al.	
	6	9679227		2017-06-13	Taylor et al.	
	7	10453147		2019-10-22	Davis	

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

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Application Number	15714376
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EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15714376
	Filing Date	2017-09-25
	First Named Inventor	Takeshi Okazaki
	Art Unit	3694
	Examiner Name	TIEN C. NGUYEN
	Attorney Docket Number	474139US01

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

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☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

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Signature	/Natalie J. Grace/	Date (YYYY-MM-DD)	2019-11-05
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PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter I of the Patent Cooperation Treaty)

(PCT Rule 44*bis*)

Applicant's or agent's file reference 474139WO00	**FOR FURTHER ACTION**	See item 4 below
International application No. PCT/US2017/053285	International filing date *(day/month/year)* 25 September 2017 (25.09.2017)	Priority date *(day/month/year)* 23 September 2016 (23.09.2016)
International Patent Classification (8th edition unless older edition indicated) See relevant information in Form PCT/ISA/237		
Applicant AON BENFIELD INC.		

1. This international preliminary report on patentability (Chapter I) is issued by the International Bureau on behalf of the International Searching Authority under Rule 44 *bis*.1(a).

2. This REPORT consists of a total of 8 sheets, including this cover sheet.

   In the attached sheets, any reference to the written opinion of the International Searching Authority should be read as a reference to the international preliminary report on patentability (Chapter I) instead.

3. This report contains indications relating to the following items:

☒	Box No. I	Basis of the report
☐	Box No. II	Priority
☐	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
☐	Box No. IV	Lack of unity of invention
☒	Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
☐	Box No. VI	Certain documents cited
☐	Box No. VII	Certain defects in the international application
☐	Box No. VIII	Certain observations on the international application

4. The International Bureau will communicate this report to designated Offices in accordance with Rules 44*bis*.3(c) and 93*bis*.1 but not, except where the applicant makes an express request under Article 23(2), before the expiration of 30 months from the priority date (Rule 44*bis* .2).

	Date of issuance of this report 26 March 2019 (26.03.2019)
The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No. +41 22 338 82 70	Authorized officer Simin Baharlou e-mail: pct.ieoma@wipo.int

Form PCT/IB/373 (January 2004)

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To: GREG H. GARDELLA
GARDELLA GRACE P.A.
P.O. BOX 51977
WASHINGTON, DC 20091

PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Date of mailing *(day/month/year)*	11DEC 2017
Applicant's or agent's file reference 474139WO00	FOR FURTHER ACTION See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US 17/53265	25 September 2017 (25.09.2017)	23 September 2016 (23.09.2016)

International Patent Classification (IPC) or both national classification and IPC
IPC(8) - G06K 9/00 (2017.01)
CPC - G06T 2201/0051, H04N 2201/327, G06T 2201/0052, H04N 2201/3233, G06T 1/0028

Applicant AON BENFIELD INC.

1. This opinion contains indications relating to the following items:

- [X] Box No. I Basis of the opinion
- [ ] Box No. II Priority
- [ ] Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- [ ] Box No. IV Lack of unity of invention
- [X] Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement
- [ ] Box No. VI Certain documents cited
- [ ] Box No. VII Certain defects in the international application
- [ ] Box No. VIII Certain observations on the international application

2. FURTHER ACTION

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA/US	Date of completion of this opinion	Authorized officer
Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300	14 November 2017 (14.11.2017)	Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/237 (cover sheet) (January 2015)

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US 17/53265

Box No. I Basis of this opinion

1. With regard to the language, this opinion has been established on the basis of:

☒ the international application in the language in which it was filed.

☐ a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

2. ☐ This opinion has been established taking into account the rectification of an obvious mistake authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a)).

3. ☐ With regard to any nucleotide and/or amino acid sequence disclosed in the international application, this opinion has been established on the basis of a sequence listing:

a. ☐ forming part of the international application as filed:

☐ in the form of an Annex C/ST.25 text file.

☐ on paper or in the form of an image file.

b. ☐ furnished together with the international application under PCT Rule 13*ter*.1(a) for the purposes of international search only in the form of an Annex C/ST.25 text file.

c. ☐ furnished subsequent to the international filing date for the purposes of international search only:

☐ in the form of an Annex C/ST.25 text file (Rule 13*ter*.1(a)).

☐ on paper or in the form of an image file (Rule 13*ter*.1(b) and Administrative Instructions, Section 713).

4. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that forming part of the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US 17/53265

Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-20	YES
	Claims	None	NO
Inventive step (IS)	Claims	None	YES
	Claims	1-20	NO
Industrial applicability (IA)	Claims	1-20	YES
	Claims	None	NO

2. Citations and explanations:

Claims 1-5, 7-20 lack an inventive step under PCT Article 33(3) as being obvious over US 2014/0019186 A1 to Swanson et al. (hereinafter Swanson) in view of US 2016/0259994 A1 to Accenture Global Service Limited (hereinafter Accenture).

As per claim 1, Swanson teaches a method for automatically categorizing a repair condition of a property characteristic (e.g. a method for aerially assessing roof type and conditions in a geographic area to determine property liability, para [0009]), comprising:
obtaining, by processing circuitry of a computing system responsive to receiving the request, an aerial image of a geographic region including the property (e.g. analyze hyperspectral images to determine roof condition to determine property liability....said computer program logic having a receiving procedure for receiving spectral images and aerial photography of a geographic area, para [0012]);
identifying, by the processing circuitry, a plurality of features of the aerial image corresponding to the property characteristic (e.g. an analyzing procedure for comparing spectral images of an identified roof object with spectral information stored in a database, para [0012]);
analyzing, by the processing circuitry, the plurality of features to determine a property characteristic classification (e.g. Classification of rooftop spectra demonstrate unique changes with age and exposure to environmental impacts, along with inadequate ventilation, that allow the quantification of roof condition to be determined. Classification of the spectral reflectance confirms the unique signatures of significant hail strikes, wet shingles, and vegetation on roofs, allowing the determination of the events having impacted on rooftops, para [0025]; e.g. extracted variables including, but not limited to, the roof type and condition, para [0033]);
analyzing, by the processing circuitry, a region of the aerial image including the property characteristic to determine a condition classification (e.g. At step 12, the platform is flown over a geographic area of interest to collect data on environmental attributes. Next, at step 14, the data is rectified by a series of processes that correct for radiometric, atmospheric, and geospatial attributes tied to the aerial data. At step 16, algorithms are run that extract regions of interest and characterize them with geospatial and spectral references to identify specific targets of interest like rooftops, para [0026].e.g. dry trees and brush very close to a home pose a greater fire risk than moist healthy trees located 150 ft from a home, para [0034]);
determining, by the processing circuitry using the property characteristic classification and the condition classification, a risk estimate of damage to the property due to one or more disasters (e.g. Mapping urban environments with HSI (or other high spectral resolution imager) further allows the classification of all materials in the area, providing a means of characterizing vegetation types, the condition of water reservoirs, and other targets of interest for risk and property insurance assessment, para [0025]; para [0034], [0044]).
Swanson fails to teach receiving, from a user at a remote computing device, a request for a property condition classification, wherein the property classification request includes identification of a property and at least one property characteristic and returning, to the user at the remote computing device via a graphical user interface responsive to receiving the request, a condition assessment of the property characteristic including the condition classification and the risk estimate of damage to the property due to the one or more disasters.
However, in related art, Accenture teaches receiving, from a user at a remote computing device, a request for a property condition classification, wherein the property classification request includes identification of a property and at laast one property characteristic (e.g. In block 505, the training circuit 412, for instance, may create a training set from images of damaged property or objects, para [0031]; After the training set has been created, the method 500 may iteratively select candidate architectures and candidate parameters to optimize the CNN's ability to, for example, accurately classify an extent of damage for an object in an image, para [0032]-[0035]; The image capture device 110 may communicate with the image processing server 130 via the communications network 120. The image capture device 110 may be any computing device that includes a camera such as, but not limited to, a smartphone, a computing tablet, a laptop computer, a desktop computer, or any wearable computing device, para [0017]);
returning, to the user at the remote computing device via a graphical user interface responsive to receiving the request, a condition assessment of the property characteristic including the condition classification and the risk estimate of damage to the property due to the one or more disasters (e.g. In block 555, the classifier 418, for instance, may classify the extent of damage for the object in each image in the validation set. According to an example, the classifying includes aggregating predictions from the ensemble of flagged intermediate CNNs to achieve greater accuracy in the classification of the extent of damage for the object in each image in the validation set, para [0043]; The processor 402, which may comprise a microprocessor, a micro-controller, an application specific integrated circuit (ASIC), Graphical Processing Unit (GPU) or the like, is to perform various processing functions in the computing device, para [0024]; para [0032]-[0035]).
It would have been obvious to one of ordinary skill in the art to have modified the system of Swanson by including the system of Accenture because the modification would provide building and training an ensemble of deep learning models to accurately and automatically perform image processing to detect particular attributes of objects in a digital image, and to classify the objects according to the detected attributes.

-Continuation in supplemental box-

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US 17/53265

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of:
Box V. 2. Citations and Explanations

As per claim 2, Swanson and Accenture teaches the method of claim 1. Swanson further teaches wherein the property characteristic classification is rooftop shape (e.g. The new advancement in this invention is the application of high resolution spectral imaging (hyperspectral or multispectral) to property characterization, specifically rooftop classification, para [0008]; para [0031]-[0032]).

As per claim 3, Swanson and Accenture teaches the method of claim 1. Accenture further teaches wherein analyzing the plurality of features to determine a property characteristic comprises applying a deep learning analysis model to the plurality of features (e.g. The technical benefits and advantages of the disclosed examples include providing an advanced deep learning architecture that exhibits superior classification accuracy to assess property damage and an iterative image processing system that determines that advanced deep learning architecture, para [0012]).

As per claim 4, Swanson and Accenture teaches the method of claim 1. Accenture further teaches wherein the deep learning analysis model is NIN (e.g. An image processing system, according to an example, builds and trains an ensemble of deep learning models, such as convolutional neural networks (CNNs), to accurately and automatically perform image processing to detect particular attributes of objects in a digital image, and to classify the objects according to the detected attributes, para [0010]).

As per claim 5, Swanson and Accenture teaches the method of claim 1. Accenture further teaches wherein analyzing the region of the aerial image including the property characteristic to determine the condition classification comprises applying a machine learning analysis model to a plurality of image pixels within the region (e.g. The image processing system may automatically classify the damaged property based on amount of damage determined from the image processing of the received digital images. In this example, the image processing system provides a machine vision method and apparatus to automatically detect the extent of damage to the property as captured in digital images, para [0013]; In block 510, the model builder 414, for instance, may select a candidate architecture from a plurality of candidate architectures. According to an example, the plurality of candidate architectures may include different combinations of a number of convolution layers and subsampling layers and a classifier type. The classifier type may include a multilayer perceptron (MLP), a support vector machine (SVM), and the like, para [0033]; para [0036]-[0037]).

As per claim 7, Swanson and Accenture teaches the method of claim 1. Swanson further teaches wherein determining the risk estimate comprises applying a disaster risk profile corresponding to a) a first disaster of the at least one disaster and b) the property characteristic (e.g. the invention is a system for assessing roof conditions to determine property liability having one or more databases for storing spectral information for roof materials, said spectral information including at least one of aging impacts on roof material, weathering impacts on roof material, vegetation impacts on roof material, storm impacts on roof material, para [0010]).

As per claim 8, Swanson teaches a system for automatically categorizing a repair condition of a property characteristic (para [0009], [0023]; abstract), comprising:
obtain, from a remote data source responsive to receiving the property classification request, an aerial image of a geographic region including the property (e.g. said computer program logic having a receiving procedure for receiving spectral images and aerial photography of a geographic area, para [0012]);
identify a plurality of features of the aerial image corresponding to the property characteristic (e.g. an analyzing procedure for comparing spectral images of an identified roof object with spectral information stored in a database, para [0012]);
analyze the plurality of features to determine a property characteristic classification (e.g. Classification of rooftop spectra demonstrate unique changes with age and exposure to environmental impacts, along with inadequate ventilation, that allow the quantification of roof condition to be determined. Classification of the spectral reflectance confirms the unique signatures of significant hail strikes, wet shingles, and vegetation on roofs, allowing the determination of the events having impacted on rooftops, para [0025]; e.g. extracted variables including, but not limited to, the roof type and condition, para [0033]);
analyze a region of the aerial image including the property characteristic to determine a condition classification (e.g. At step 12, the platform is flown over a geographic area of interest to collect data on environmental attributes. Next, at step 14, the data is rectified by a series of processes that correct for radiometric, atmospheric, and geospatial attributes tied to the aerial data. At step 16, algorithms are run that extract regions of interest and characterize them with geospatial and spectral references to identify specific targets of interest like rooftops, para [0026]; e.g. dry trees and brush very close to a home pose a greater fire risk than moist healthy trees located 150 ft from a home, para [0034]); and
determine, in real-time responsive to receiving the property classification request and using the property characteristic classification and the condition classification, a replacement cost for replacing the property characteristic (e.g. Mapping urban environments with HSI (or other high spectral resolution imager) further allows the classification of all materials in the area, providing a means of characterizing vegetation types, the condition of water reservoirs, and other targets of interest for risk and property insurance assessment, para [0026]; para [0034]; para [0044]).
Swanson fails to teach processing circuitry, a non-transitory computer-readable medium having instructions stored thereon, and wherein the instructions, when executed by the processing circuitry, cause the processing circuitry to receive, from a user at a remote computing device, a property condition classification request, wherein the property classification request includes identification of a property and at least one property characteristic.
However, in related art, Accenture teaches processing circuitry (e.g. the image processing platform 410 includes a hardware device, such as a circuit or multiple circuits arranged on a board, para [0026]); and
a non-transitory computer-readable medium having instructions stored thereon (e.g. the image processing platform 410 includes machine readable instructions stored on a non-transitory computer readable medium 413 and executed by the processor, para [0026]);
-Continuation in supplemental box-

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US 17/53265

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of:
Box V. 2: Citations and Explanations

wherein the instructions, when executed by the processing circuitry, cause the processing circuitry to receive, from a user at a remote computing device, a property condition classification request, wherein the property classification request includes identification of a property and at least one property characteristic (e.g. In block 505, the training circuit 412, for instance, may create a training set from images of damaged property or objects, para [0031]; After the training set has been created, the method 500 may iteratively select candidate architectures and candidate parameters to optimize the CNN's ability to, for example, accurately classify an extent of damage for an object in an image, para [0032]-[0035]; The image capture device 110 may communicate with the image processing server 130 via the communications network 120. The image capture device 110 may be any computing device that includes a camera such as, but not limited to, a smartphone, a computing tablet, a laptop computer, a desktop computer, or any wearable computing device, para [0017]).
It would have been obvious to one of ordinary skill in the art to have modified the system of Swanson by including the system of Accenture because the modification would provide building and training an ensemble of deep learning models to accurately and automatically perform image processing to detect particular attributes of objects in a digital image, and to classify the objects according to the detected attributes.

As per claim 9, Swanson and Accenture teaches the system of claim 8. Swanson further teaches wherein the instructions, when executed by the processing circuitry, cause the processing circuitry to, prior to identifying the plurality of features:
obtain a shape map image including the property (e.g. In step 62, the roof polygons are associated with public data, for example, addresses and parcel info, to provide a georeferenced data set, para [0032]);
overlay the aerial image with the shape map image (e.g. An embodiment of the process in step 62 can also load the final imagery into a geospatial database and web server that can overlay the public datasets with the analyzed aerial imagery and property Analysis, para [0033]); and
determine whether a boundary of the property as identified by the shape map matches a boundary of the property as illustrated in the aerial image (e.g. This creates a convenient web based access point for utilization and exploitation of imagery and extracted variables including, but not limited to, the roof type and condition, para [0033]; para [0031]-[0032]).

As per claim 10, Swanson and Accenture teaches the system of claim 9. Swanson further teaches wherein the instructions, when executed by the processing circuitry, cause the processing circuitry to, upon determining that the shape map does not match the boundary of the corresponding property, obtain an alternate aerial image of the property (e.g. building a model of the geographic area to identify roof objects using aerial photos, mapping the geographic area using an airborne hyperspectral or multi-spectral imager to collect high resolution aerial spectral images, measuring requisite geopositional data to accurately locate aerial imagery to geographic aree of interest, para [0009]).

As per claim 11, Swanson and Accenture teaches the system of claim 8. Swanson further teaches wherein the instructions, when executed by the processing circuitry, cause the processing circuitry to compare a current condition classification of the property characteristic to a stored historic condition classification of the property characteristic (e.g. analyzing the high resolution aerial spectral images to characterize the condition of roof objects according to the geographic property model by comparing the images with the reference spectral information from the database, associating the roof objects with geographic identifications of specific properties and developing property liability assessments for the specific properties based on the comparisons, para [0009]).

As per claim 12, Swanson and Accenture teaches the system of claim 11. Swanson further teaches wherein the instructions, when executed by the processing circuitry, cause the processing circuitry to, in real-time responsive to receiving the property condition classification request, determine whether repairs have been made to the property based on the comparison of the current condition classification to the historic condition classification of the property characteristic (e.g. Using an airborne spectral imager, visible to shortwave infrared reflected radiation from rooftop material can be collected and compared with reference data on reflectance changes with time and exposure. This allows for the distinction of new versus aged and worn roof conditions, para [0025]; para [0041], [0044]).

As per claim 13, Swanson and Accenture teaches the system of claim 8. Swanson further teaches wherein the instructions, when executed by the processing circuitry, cause the processing circuitry to, prior to identifying the plurality of features, assess orthogonality of the aerial imagery (e.g. The geospatial polygon maps isolate the locations of the geometrically corrected (.orthorectified.) images to focus the spectral image analysis on individual target locations which are uniquely numerically identified, para [0031]-[0032]).

As per claim 14, Swanson and Accenture teaches the system of claim 13. Swanson further teaches wherein the instructions, when executed by the processing circuitry, cause the processing circuitry to, responsive to assessing that the orthogonality of the aerial imagery does not correspond to a true orthophoto form, cause correction of the aerial imagery to the true orthophoto form (e.g. The segmented targets are derived from orthophotos collected along with the HSI data often at higher GSD than the HSI, or polygons derived from the HSI data itself, para [0031]-[0032]).

-Continuation in supplemental box-

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US 17/53265

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.
Continuation of:
Box V. 2. Citations and Explanations

As per claim 15, Swanson teaches obtain, from a remote data source responsive to receiving the property classification request, an aerial image of a geographic region including the property (e.g. said computer program logic having a receiving procedure for receiving spectral images and aerial photography of a geographic area, para [0012]; para [0033]-[0034]);
identify a respective plurality of features of the aerial image corresponding to each property characteristic of the at least one property characteristic (e.g. an analyzing procedure for comparing spectral images of an identified roof object with spectral information stored in a database, para [0012]; para [0033]-[0034]);
for each of the at least one property characteristic, analyze the corresponding plurality of features to determine a respective property characteristic classification, and analyze a region of the aerial image including the respective property characteristic to determine a respective condition classification (e.g. Classification of rooftop spectra demonstrate unique changes with age and exposure to environmental impacts, along with inadequate ventilation, that allow the quantification of roof condition to be determined. Classification of the spectral reflectance confirms the unique signatures of significant hail strikes, wet shingles, and vegetation on roofs, allowing the determination of the events having impacted on rooftops, para [0025]; para [0033]); and
determine, in real-time responsive to receiving the property classification request and using the property characteristic classification of each property characteristic and the condition classification of each property characteristic, at least one risk estimate representing risk of damage due to disaster (e.g. Mapping urban environments with HSI (or other high spectral resolution imager) further allows the classification of all materials in the area, providing a means of characterizing vegetation types, the condition of water reservoirs, and other targets of interest for risk and property insurance assessment, para [0025]; para [0034], [0044]).
Swanson fails to teach a non-transitory computer readable medium having instructions stored thereon, wherein the instructions, when executed by processing circuitry, cause the processing circuitry to receive, from a user at a remote computing device, a property condition classification request, wherein the property classification request includes identification of a property and at least one property characteristic.
However, in related art, Accenture teaches a non-transitory computer readable medium having instructions stored thereon, wherein the instructions, when executed by processing circuitry, cause the processing circuitry to (e.g. the image processing platform 410 includes machine readable instructions stored on a non-transitory computer readable medium 413 and executed by the processor, para [0026]):
receive, from a user at a remote computing device, a property condition classification request, wherein the property classification request includes identification of a property and at least one property characteristic (e.g. In block 505, the training circuit 412, for instance, may create a training set from images of damaged property or objects, para [0031]; After the training set has been created, the method 500 may iteratively select candidate architectures and candidate parameters to optimize the CNN's ability to, for example, accurately classify an extent of damage for an object in an image, para [0032]; The image capture device 110 may communicate with the image processing server 130 via the communications network 120. The image capture device 110 may be any computing device that includes a camera such as, but not limited to, a smartphone, a computing tablet, a laptop computer, a desktop computer, or any wearable computing device, para [0017]).
It would have been obvious to one of ordinary skill in the art to have modified the system of Swanson by including the system of Accenture because the modification would provide building and training an ensemble of deep learning models to accurately and automatically perform image processing to detect particular attributes of objects in a digital image, and to classify the objects according to the detected attributes.

As per claim 16, Swanson and Accenture teaches the non-transitory computer readable medium of claim 15. Swanson further teaches wherein the instructions, when executed by the processing circuitry, cause the processing circuitry to, prior to obtaining the aerial image of the geographic region, determine, based upon the at least one property characteristic, a preferred image type corresponding to each property characteristic of the at least one property characteristic (e.g. At step 12, the platform is flown over a geographic area of interest to collect data on environmental attributes. Next, at step 14, the data is rectified by a series of processes that correct for radiometric, atmospheric, and geospatial attributes tied to the aerial data. At step 16, algorithms are run that extract regions of interest and characterize them with geospatial and spectral references to identify specific targets of interest like rooftops, para [0026]; para [0033]-[0034]).

As per claim 17, Swanson and Accenture teaches the non-transitory computer readable medium of claim 16. Swanson further teaches wherein:
the at least one property characteristic comprises two or more property characteristics (e.g. an analyzing procedure for comparing spectral images of an identified roof object with spectral information stored in a database, para [0012]); and
the instructions, when executed by the processing circuitry, cause the processing circuitry to, responsive to determining the preferred image type corresponding to a first property characteristic of the at least one property characteristic is a terrestrial image, obtain a terrestrial image of the geographic region including the property (e.g. At step 12, the platform is flown over a geographic area of interest to collect data on environmental attributes. Next, at step 14, the data is rectified by a series of processes that correct for radiometric, atmospheric, and geospatial attributes tied to the aerial data. At step 16, algorithms are run that extract regions of interest and characterize them with geospatial and spectral references to identify specific targets of interest like rooftops, para [0026]; para [0033]-[0034]).

As per claim 18, Swanson and Accenture teaches the non-transitory computer readable medium of claim 15. Swanson further teaches wherein the instructions, when executed by the processing circuitry, cause the processing circuitry to access one or more known property characteristics, wherein determining the at least one risk estimate comprises determining the at least one risk estimate further based on the one or more known property characteristics (e.g. Mapping urban environments with HSI (or other high spectral resolution imager) further allows the classification of all materials in the area, providing a means of characterizing vegetation types, the condition of water reservoirs, and other targets of interest for risk and property insurance assessment, para [0025]; para [0034], [0044])

-Continuation in supplemental box-

Form PCT/ISA/237 (Supplemental Box) (January 2015)

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US 17/53265

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of:
Box V. 2: Citations and Explanations

As per claim 19, Swanson and Accenture teaches the non-transitory computer readable medium of claim 18. Swanson further teaches wherein the one or more known property characteristics comprise at least one of a property age, a property elevation, a property slope, a year built, a year renovated, and a building height (e.g. Roofs that were damaged and aged 10-30 years, often in the process of being replaced, when compared with the corresponding new roof material obtained from the leading roof contractors allowed for classification of spectral change as a unique marker for roof condition. Examples of the spectral response curves of new and aged/weathered roofs are shown in FIGS. 4-6. From this dataset it is possible to show the aging process for the dominant roof types used in residential homes, para [0041]).

As per claim 20, Swanson and Accenture teaches the non-transitory computer readable medium of claim 15. Swanson further teaches wherein:
receiving identification of the property and the at least one property characteristic comprises receiving, via a network from a remote computing device, the identification of the property (e.g. In step 46, the HSI data undergoes a process of geo-rectification using the tagged IMU geo coordinates and attitudinal data, para [0027]); and
Accenture further teaches the instructions, when executed by the processing circuitry, cause the processing circuitry to provide, via the network to a graphical user interface at the remote computing device in real-time responsive to receiving the at least one property characteristic, the at least one risk estimate (e.g. In block 555, the classifier 418, for instance, may classify the extent of damage for the object in each image in the validation set. According to an example, the classifying includes aggregating predictions from the ensemble of flagged intermediate CNNs to achieve greater accuracy in the classification of the extent of damage for the object in each image in the validation set, para [0043]; The processor 402, which may comprise a microprocessor, a micro-controller, an application specific integrated circuit (ASIC), Graphical Processing Unit (GPU) or the like, is to perform various processing functions in the computing device, para [0024]).

Claim 6 lacks an inventive step under PCT Article 33(3) as being obvious over Swanson in view of Accenture and in further view of US 9,070,018 B1 to Eagle View Technologies, Inc. (hereinafter Eagle).

As per claim 6, Swanson and Accenture teaches the method of claim 5, but fails to teach wherein the machine learning analysis model comprises a color histogram analysis model.
However, Eagle, in an analogous art, teaches wherein the machine learning analysis model comprises a color histogram analysis model (multiple target images are automatically grouped based on image characteristics (e.g., average contrast, brightness, color-histogram, or the like)....the AI system is trained on the region of interest from the exemplar image. Then, for each of the images in the group, a roof is detected based on the trained AI system, col. 11, ln 5-15; col. 7, ln 55-62). It would have been obvious to one of ordinary skill in the art to have modified the system of Swanson and Accenture by including the machine learning analysis model comprises a color histogram analysis model as taught by Eagle because the modification would automatically identify and classify the objects in the image based on the pixel colors.

Claims 1-20 have industrial applicability as defined by PCT Article 33(4) because the subject matter can be made or used in industry.

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 474139WO00	FOR FURTHER ACTION	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
International application No. PCT/US 17/53265	International filing date *(day/month/year)* 25 September 2017 (25.09.2017)	(Earliest) Priority Date *(day/month/year)* 23 September 2016 (23.09.2016)
Applicant AON BENFIELD INC.		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 2 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

a. With regard to the **language**, the international search was carried out on the basis of:

☒ the international application in the language in which it was filed.

☐ a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

b. ☐ This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.6*bis*(a)).

c. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.

2. ☐ **Certain claims were found unsearchable** (see Box No. II).

3. ☐ **Unity of invention is lacking** (see Box No. III).

4. With regard to the title,

☒ the text is approved as submitted by the applicant.

☐ the text has been established by this Authority to read as follows.

5. With regard to the abstract,

☒ the text is approved as submitted by the applicant.

☐ the text has been established, according to Rule 38.2, by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. With regard to the **drawings**,

a. the figure of the **drawings** to be published with the abstract is Figure No. 1

☒ as suggested by the applicant.

☐ as selected by this Authority, because the applicant failed to suggest a figure.

☐ as selected by this Authority, because this figure better characterizes the invention.

b. ☐ none of the figures is to be published with the abstract.

Form PCT/ISA/210 (first sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 17/53265

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - G06K 9/00 (2017.01)
CPC - G06T 2201/0051, H04N 2201/327, G06T 2201/0052, H04N 2201/3233, G06T 1/0028

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
See Search History Document

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
See Search History Document

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
See Search History Document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2014/0019166 A1 (Swanson et al.) 16 January 2014 (16.01.2014) entire document (especially para [0008]-[0010], para [0012], para [0025]-[0026])	1-20
Y	US 2016/0259994 A1 (Accenture Global Service Limited) 08 September 2016 (08.09.2016) entire document (especially para [0010]-[0013], para [0017], para [0024], para [0034], para [0043])	1-20
Y	US 9,070,018 B1 (Eagle View Technologies, Inc.) 30 June 2015 (30.06.2015) (col. 7, ln 55-62;col. 11, ln 5-15)	6

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
14 November 2017 (14.11.2017)	11 DEC 2017
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (January 2015)

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To: GREG H. GARDELLA
GARDELLA GRACE P.A.
P.O. BOX 51977
WASHINGTON, DC 20091

PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Date of mailing *(day/month/year)*	11DEC 2017
Applicant's or agent's file reference 474139WO00	FOR FURTHER ACTION See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US 17/53265	25 September 2017 (25.09.2017)	23 September 2016 (23.09.2016)

International Patent Classification (IPC) or both national classification and IPC
IPC(8) - G06K 9/00 (2017.01)
CPC - G06T 2201/0051, H04N 2201/327, G06T 2201/0052, H04N 2201/3233, G06T 1/0028

Applicant AON BENFIELD INC.

1. This opinion contains indications relating to the following items:

- [X] Box No. I Basis of the opinion
- [ ] Box No. II Priority
- [ ] Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- [ ] Box No. IV Lack of unity of invention
- [X] Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement
- [ ] Box No. VI Certain documents cited
- [ ] Box No. VII Certain defects in the international application
- [ ] Box No. VIII Certain observations on the international application

2. FURTHER ACTION

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA/US	Date of completion of this opinion	Authorized officer
Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300	14 November 2017 (14.11.2017)	Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/237 (cover sheet) (January 2015)

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US 17/53265

Box No. I Basis of this opinion

1. With regard to the language, this opinion has been established on the basis of:

☒ the international application in the language in which it was filed.

☐ a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

2. ☐ This opinion has been established taking into account the rectification of an obvious mistake authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a)).

3. ☐ With regard to any nucleotide and/or amino acid sequence disclosed in the international application, this opinion has been established on the basis of a sequence listing:

a. ☐ forming part of the international application as filed:

☐ in the form of an Annex C/ST.25 text file.

☐ on paper or in the form of an image file.

b. ☐ furnished together with the international application under PCT Rule 13*ter*.1(a) for the purposes of international search only in the form of an Annex C/ST.25 text file.

c. ☐ furnished subsequent to the international filing date for the purposes of international search only:

☐ in the form of an Annex C/ST.25 text file (Rule 13*ter*.1(a)).

☐ on paper or in the form of an image file (Rule 13*ter*.1(b) and Administrative Instructions, Section 713).

4. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that forming part of the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US 17/53265

Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-20	YES
	Claims	None	NO
Inventive step (IS)	Claims	None	YES
	Claims	1-20	NO
Industrial applicability (IA)	Claims	1-20	YES
	Claims	None	NO

2. Citations and explanations:

Claims 1-5, 7-20 lack an inventive step under PCT Article 33(3) as being obvious over US 2014/0019186 A1 to Swanson et al. (hereinafter Swanson) in view of US 2016/0259994 A1 to Accenture Global Service Limited (hereinafter Accenture).

As per claim 1, Swanson teaches a method for automatically categorizing a repair condition of a property characteristic (e.g. a method for aerially assessing roof type and conditions in a geographic area to determine property liability, para [0009]), comprising:
obtaining, by processing circuitry of a computing system responsive to receiving the request, an aerial image of a geographic region including the property (e.g. analyze hyperspectral images to determine roof condition to determine property liability....said computer program logic having a receiving procedure for receiving spectral images and aerial photography of a geographic area, para [0012]);
identifying, by the processing circuitry, a plurality of features of the aerial image corresponding to the property characteristic (e.g. an analyzing procedure for comparing spectral images of an identified roof object with spectral information stored in a database, para [0012]);
analyzing, by the processing circuitry, the plurality of features to determine a property characteristic classification (e.g. Classification of rooftop spectra demonstrate unique changes with age and exposure to environmental impacts, along with inadequate ventilation, that allow the quantification of roof condition to be determined. Classification of the spectral reflectance confirms the unique signatures of significant hail strikes, wet shingles, and vegetation on roofs, allowing the determination of the events having impacted on rooftops, para [0025]; e.g. extracted variables including, but not limited to, the roof type and condition, para [0033]);
analyzing, by the processing circuitry, a region of the aerial image including the property characteristic to determine a condition classification (e.g. At step 12, the platform is flown over a geographic area of interest to collect data on environmental attributes. Next, at step 14, the data is rectified by a series of processes that correct for radiometric, atmospheric, and geospatial attributes tied to the aerial data. At step 16, algorithms are run that extract regions of interest and characterize them with geospatial and spectral references to identify specific targets of interest like rooftops, para [0026].e.g. dry trees and brush very close to a home pose a greater fire risk than moist healthy trees located 150 ft from a home, para [0034]);
determining, by the processing circuitry using the property characteristic classification and the condition classification, a risk estimate of damage to the property due to one or more disasters (e.g. Mapping urban environments with HSI (or other high spectral resolution imager) further allows the classification of all materials in the area, providing a means of characterizing vegetation types, the condition of water reservoirs, and other targets of interest for risk and property insurance assessment, para [0025]; para [0034], [0044]).
Swanson fails to teach receiving, from a user at a remote computing device, a request for a property condition classification, wherein the property classification request includes identification of a property and at least one property characteristic and returning, to the user at the remote computing device via a graphical user interface responsive to receiving the request, a condition assessment of the property characteristic including the condition classification and the risk estimate of damage to the property due to the one or more disasters.
However, in related art, Accenture teaches receiving, from a user at a remote computing device, a request for a property condition classification, wherein the property classification request includes identification of a property and at laast one property characteristic (e.g. In block 505, the training circuit 412, for instance, may create a training set from images of damaged property or objects, para [0031]; After the training set has been created, the method 500 may iteratively select candidate architectures and candidate parameters to optimize the CNN's ability to, for example, accurately classify an extent of damage for an object in an image, para [0032]-[0035]; The image capture device 110 may communicate with the image processing server 130 via the communications network 120. The image capture device 110 may be any computing device that includes a camera such as, but not limited to, a smartphone, a computing tablet, a laptop computer, a desktop computer, or any wearable computing device, para [0017]);
returning, to the user at the remote computing device via a graphical user interface responsive to receiving the request, a condition assessment of the property characteristic including the condition classification and the risk estimate of damage to the property due to the one or more disasters (e.g. In block 555, the classifier 418, for instance, may classify the extent of damage for the object in each image in the validation set. According to an example, the classifying includes aggregating predictions from the ensemble of flagged intermediate CNNs to achieve greater accuracy in the classification of the extent of damage for the object in each image in the validation set, para [0043]; The processor 402, which may comprise a microprocessor, a micro-controller, an application specific integrated circuit (ASIC), Graphical Processing Unit (GPU) or the like, is to perform various processing functions in the computing device, para [0024]; para [0032]-[0035]).
It would have been obvious to one of ordinary skill in the art to have modified the system of Swanson by including the system of Accenture because the modification would provide building and training an ensemble of deep learning models to accurately and automatically perform image processing to detect particular attributes of objects in a digital image, and to classify the objects according to the detected attributes.

-Continuation in supplemental box-

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

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Box V. 2. Citations and Explanations

As per claim 2, Swanson and Accenture teaches the method of claim 1. Swanson further teaches wherein the property characteristic classification is rooftop shape (e.g. The new advancement in this invention is the application of high resolution spectral imaging (hyperspectral or multispectral) to property characterization, specifically rooftop classification, para [0008]; para [0031]-[0032]).

As per claim 3, Swanson and Accenture teaches the method of claim 1. Accenture further teaches wherein analyzing the plurality of features to determine a property characteristic comprises applying a deep learning analysis model to the plurality of features (e.g. The technical benefits and advantages of the disclosed examples include providing an advanced deep learning architecture that exhibits superior classification accuracy to assess property damage and an iterative image processing system that determines that advanced deep learning architecture, para [0012]).

As per claim 4, Swanson and Accenture teaches the method of claim 1. Accenture further teaches wherein the deep learning analysis model is NIN (e.g. An image processing system, according to an example, builds and trains an ensemble of deep learning models, such as convolutional neural networks (CNNs), to accurately and automatically perform image processing to detect particular attributes of objects in a digital image, and to classify the objects according to the detected attributes, para [0010]).

As per claim 5, Swanson and Accenture teaches the method of claim 1. Accenture further teaches wherein analyzing the region of the aerial image including the property characteristic to determine the condition classification comprises applying a machine learning analysis model to a plurality of image pixels within the region (e.g. The image processing system may automatically classify the damaged property based on amount of damage determined from the image processing of the received digital images. In this example, the image processing system provides a machine vision method and apparatus to automatically detect the extent of damage to the property as captured in digital images, para [0013]; In block 510, the model builder 414, for instance, may select a candidate architecture from a plurality of candidate architectures. According to an example, the plurality of candidate architectures may include different combinations of a number of convolution layers and subsampling layers and a classifier type. The classifier type may include a multilayer perceptron (MLP), a support vector machine (SVM), and the like, para [0033]; para [0036]-[0037]).

As per claim 7, Swanson and Accenture teaches the method of claim 1. Swanson further teaches wherein determining the risk estimate comprises applying a disaster risk profile corresponding to a) a first disaster of the at least one disaster and b) the property characteristic (e.g. the invention is a system for assessing roof conditions to determine property liability having one or more databases for storing spectral information for roof materials, said spectral information including at least one of aging impacts on roof material, weathering impacts on roof material, vegetation impacts on roof material, storm impacts on roof material, para [0010]).

As per claim 8, Swanson teaches a system for automatically categorizing a repair condition of a property characteristic (para [0009], [0023]; abstract), comprising:
obtain, from a remote data source responsive to receiving the property classification request, an aerial image of a geographic region including the property (e.g. said computer program logic having a receiving procedure for receiving spectral images and aerial photography of a geographic area, para [0012]);
identify a plurality of features of the aerial image corresponding to the property characteristic (e.g. an analyzing procedure for comparing spectral images of an identified roof object with spectral information stored in a database, para [0012]);
analyze the plurality of features to determine a property characteristic classification (e.g. Classification of rooftop spectra demonstrate unique changes with age and exposure to environmental impacts, along with inadequate ventilation, that allow the quantification of roof condition to be determined. Classification of the spectral reflectance confirms the unique signatures of significant hail strikes, wet shingles, and vegetation on roofs, allowing the determination of the events having impacted on rooftops, para [0025]; e.g. extracted variables including, but not limited to, the roof type and condition, para [0033]);
analyze a region of the aerial image including the property characteristic to determine a condition classification (e.g. At step 12, the platform is flown over a geographic area of interest to collect data on environmental attributes. Next, at step 14, the data is rectified by a series of processes that correct for radiometric, atmospheric, and geospatial attributes tied to the aerial data. At step 16, algorithms are run that extract regions of interest and characterize them with geospatial and spectral references to identify specific targets of interest like rooftops, para [0026]; e.g. dry trees and brush very close to a home pose a greater fire risk than moist healthy trees located 150 ft from a home, para [0034]); and
determine, in real-time responsive to receiving the property classification request and using the property characteristic classification and the condition classification, a replacement cost for replacing the property characteristic (e.g. Mapping urban environments with HSI (or other high spectral resolution imager) further allows the classification of all materials in the area, providing a means of characterizing vegetation types, the condition of water reservoirs, and other targets of interest for risk and property insurance assessment, para [0026]; para [0034]; para [0044]).
Swanson fails to teach processing circuitry, a non-transitory computer-readable medium having instructions stored thereon, and wherein the instructions, when executed by the processing circuitry, cause the processing circuitry to receive, from a user at a remote computing device, a property condition classification request, wherein the property classification request includes identification of a property and at least one property characteristic.
However, in related art, Accenture teaches processing circuitry (e.g. the image processing platform 410 includes a hardware device, such as a circuit or multiple circuits arranged on a board, para [0026]); and
a non-transitory computer-readable medium having instructions stored thereon (e.g. the image processing platform 410 includes machine readable instructions stored on a non-transitory computer readable medium 413 and executed by the processor, para [0026]);
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wherein the instructions, when executed by the processing circuitry, cause the processing circuitry to receive, from a user at a remote computing device, a property condition classification request, wherein the property classification request includes identification of a property and at least one property characteristic (e.g. In block 505, the training circuit 412, for instance, may create a training set from images of damaged property or objects, para [0031]; After the training set has been created, the method 500 may iteratively select candidate architectures and candidate parameters to optimize the CNN's ability to, for example, accurately classify an extent of damage for an object in an image, para [0032]-[0035]; The image capture device 110 may communicate with the image processing server 130 via the communications network 120. The image capture device 110 may be any computing device that includes a camera such as, but not limited to, a smartphone, a computing tablet, a laptop computer, a desktop computer, or any wearable computing device, para [0017]).
It would have been obvious to one of ordinary skill in the art to have modified the system of Swanson by including the system of Accenture because the modification would provide building and training an ensemble of deep learning models to accurately and automatically perform image processing to detect particular attributes of objects in a digital image, and to classify the objects according to the detected attributes.

As per claim 9, Swanson and Accenture teaches the system of claim 8. Swanson further teaches wherein the instructions, when executed by the processing circuitry, cause the processing circuitry to, prior to identifying the plurality of features:
obtain a shape map image including the property (e.g. In step 62, the roof polygons are associated with public data, for example, addresses and parcel info, to provide a georeferenced data set, para [0032]);
overlay the aerial image with the shape map image (e.g. An embodiment of the process in step 62 can also load the final imagery into a geospatial database and web server that can overlay the public datasets with the analyzed aerial imagery and property Analysis, para [0033]); and
determine whether a boundary of the property as identified by the shape map matches a boundary of the property as illustrated in the aerial image (e.g. This creates a convenient web based access point for utilization and exploitation of imagery and extracted variables including, but not limited to, the roof type and condition, para [0033]; para [0031]-[0032]).

As per claim 10, Swanson and Accenture teaches the system of claim 9. Swanson further teaches wherein the instructions, when executed by the processing circuitry, cause the processing circuitry to, upon determining that the shape map does not match the boundary of the corresponding property, obtain an alternate aerial image of the property (e.g. building a model of the geographic area to identify roof objects using aerial photos, mapping the geographic area using an airborne hyperspectral or multi-spectral imager to collect high resolution aerial spectral images, measuring requisite geopositional data to accurately locate aerial imagery to geographic aree of interest, para [0009]).

As per claim 11, Swanson and Accenture teaches the system of claim 8. Swanson further teaches wherein the instructions, when executed by the processing circuitry, cause the processing circuitry to compare a current condition classification of the property characteristic to a stored historic condition classification of the property characteristic (e.g. analyzing the high resolution aerial spectral images to characterize the condition of roof objects according to the geographic property model by comparing the images with the reference spectral information from the database, associating the roof objects with geographic identifications of specific properties and developing property liability assessments for the specific properties based on the comparisons, para [0009]).

As per claim 12, Swanson and Accenture teaches the system of claim 11. Swanson further teaches wherein the instructions, when executed by the processing circuitry, cause the processing circuitry to, in real-time responsive to receiving the property condition classification request, determine whether repairs have been made to the property based on the comparison of the current condition classification to the historic condition classification of the property characteristic (e.g. Using an airborne spectral imager, visible to shortwave infrared reflected radiation from rooftop material can be collected and compared with reference data on reflectance changes with time and exposure. This allows for the distinction of new versus aged and worn roof conditions, para [0025]; para [0041], [0044]).

As per claim 13, Swanson and Accenture teaches the system of claim 8. Swanson further teaches wherein the instructions, when executed by the processing circuitry, cause the processing circuitry to, prior to identifying the plurality of features, assess orthogonality of the aerial imagery (e.g. The geospatial polygon maps isolate the locations of the geometrically corrected (.orthorectified.) images to focus the spectral image analysis on individual target locations which are uniquely numerically identified, para [0031]-[0032]).

As per claim 14, Swanson and Accenture teaches the system of claim 13. Swanson further teaches wherein the instructions, when executed by the processing circuitry, cause the processing circuitry to, responsive to assessing that the orthogonality of the aerial imagery does not correspond to a true orthophoto form, cause correction of the aerial imagery to the true orthophoto form (e.g. The segmented targets are derived from orthophotos collected along with the HSI data often at higher GSD than the HSI, or polygons derived from the HSI data itself, para [0031]-[0032]).

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As per claim 15, Swanson teaches obtain, from a remote data source responsive to receiving the property classification request, an aerial image of a geographic region including the property (e.g. said computer program logic having a receiving procedure for receiving spectral images and aerial photography of a geographic area, para [0012]; para [0033]-[0034]);
identify a respective plurality of features of the aerial image corresponding to each property characteristic of the at least one property characteristic (e.g. an analyzing procedure for comparing spectral images of an identified roof object with spectral information stored in a database, para [0012]; para [0033]-[0034]);
for each of the at least one property characteristic, analyze the corresponding plurality of features to determine a respective property characteristic classification, and analyze a region of the aerial image including the respective property characteristic to determine a respective condition classification (e.g. Classification of rooftop spectra demonstrate unique changes with age and exposure to environmental impacts, along with inadequate ventilation, that allow the quantification of roof condition to be determined. Classification of the spectral reflectance confirms the unique signatures of significant hail strikes, wet shingles, and vegetation on roofs, allowing the determination of the events having impacted on rooftops, para [0025]; para [0033]); and
determine, in real-time responsive to receiving the property classification request and using the property characteristic classification of each property characteristic and the condition classification of each property characteristic, at least one risk estimate representing risk of damage due to disaster (e.g. Mapping urban environments with HSI (or other high spectral resolution imager) further allows the classification of all materials in the area, providing a means of characterizing vegetation types, the condition of water reservoirs, and other targets of interest for risk and property insurance assessment, para [0025]; para [0034], [0044]).
Swanson fails to teach a non-transitory computer readable medium having instructions stored thereon, wherein the instructions, when executed by processing circuitry, cause the processing circuitry to receive, from a user at a remote computing device, a property condition classification request, wherein the property classification request includes identification of a property and at least one property characteristic.
However, in related art, Accenture teaches a non-transitory computer readable medium having instructions stored thereon, wherein the instructions, when executed by processing circuitry, cause the processing circuitry to (e.g. the image processing platform 410 includes machine readable instructions stored on a non-transitory computer readable medium 413 and executed by the processor, para [0026]):
receive, from a user at a remote computing device, a property condition classification request, wherein the property classification request includes identification of a property and at least one property characteristic (e.g. In block 505, the training circuit 412, for instance, may create a training set from images of damaged property or objects, para [0031]; After the training set has been created, the method 500 may iteratively select candidate architectures and candidate parameters to optimize the CNN's ability to, for example, accurately classify an extent of damage for an object in an image, para [0032]; The image capture device 110 may communicate with the image processing server 130 via the communications network 120. The image capture device 110 may be any computing device that includes a camera such as, but not limited to, a smartphone, a computing tablet, a laptop computer, a desktop computer, or any wearable computing device, para [0017]).
It would have been obvious to one of ordinary skill in the art to have modified the system of Swanson by including the system of Accenture because the modification would provide building and training an ensemble of deep learning models to accurately and automatically perform image processing to detect particular attributes of objects in a digital image, and to classify the objects according to the detected attributes.

As per claim 16, Swanson and Accenture teaches the non-transitory computer readable medium of claim 15. Swanson further teaches wherein the instructions, when executed by the processing circuitry, cause the processing circuitry to, prior to obtaining the aerial image of the geographic region, determine, based upon the at least one property characteristic, a preferred image type corresponding to each property characteristic of the at least one property characteristic (e.g. At step 12, the platform is flown over a geographic area of interest to collect data on environmental attributes. Next, at step 14, the data is rectified by a series of processes that correct for radiometric, atmospheric, and geospatial attributes tied to the aerial data. At step 16, algorithms are run that extract regions of interest and characterize them with geospatial and spectral references to identify specific targets of interest like rooftops, para [0026]; para [0033]-[0034]).

As per claim 17, Swanson and Accenture teaches the non-transitory computer readable medium of claim 16. Swanson further teaches wherein:
the at least one property characteristic comprises two or more property characteristics (e.g. an analyzing procedure for comparing spectral images of an identified roof object with spectral information stored in a database, para [0012]); and
the instructions, when executed by the processing circuitry, cause the processing circuitry to, responsive to determining the preferred image type corresponding to a first property characteristic of the at least one property characteristic is a terrestrial image, obtain a terrestrial image of the geographic region including the property (e.g. At step 12, the platform is flown over a geographic area of interest to collect data on environmental attributes. Next, at step 14, the data is rectified by a series of processes that correct for radiometric, atmospheric, and geospatial attributes tied to the aerial data. At step 16, algorithms are run that extract regions of interest and characterize them with geospatial and spectral references to identify specific targets of interest like rooftops, para [0026]; para [0033]-[0034]).

As per claim 18, Swanson and Accenture teaches the non-transitory computer readable medium of claim 15. Swanson further teaches wherein the instructions, when executed by the processing circuitry, cause the processing circuitry to access one or more known property characteristics, wherein determining the at least one risk estimate comprises determining the at least one risk estimate further based on the one or more known property characteristics (e.g. Mapping urban environments with HSI (or other high spectral resolution imager) further allows the classification of all materials in the area, providing a means of characterizing vegetation types, the condition of water reservoirs, and other targets of interest for risk and property insurance assessment, para [0025]; para [0034], [0044])

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As per claim 19, Swanson and Accenture teaches the non-transitory computer readable medium of claim 18. Swanson further teaches wherein the one or more known property characteristics comprise at least one of a property age, a property elevation, a property slope, a year built, a year renovated, and a building height (e.g. Roofs that were damaged and aged 10-30 years, often in the process of being replaced, when compared with the corresponding new roof material obtained from the leading roof contractors allowed for classification of spectral change as a unique marker for roof condition. Examples of the spectral response curves of new and aged/weathered roofs are shown in FIGS. 4-6. From this dataset it is possible to show the aging process for the dominant roof types used in residential homes, para [0041]).

As per claim 20, Swanson and Accenture teaches the non-transitory computer readable medium of claim 15. Swanson further teaches wherein:
receiving identification of the property and the at least one property characteristic comprises receiving, via a network from a remote computing device, the identification of the property (e.g. In step 46, the HSI data undergoes a process of geo-rectification using the tagged IMU geo coordinates and attitudinal data, para [0027]); and
Accenture further teaches the instructions, when executed by the processing circuitry, cause the processing circuitry to provide, via the network to a graphical user interface at the remote computing device in real-time responsive to receiving the at least one property characteristic, the at least one risk estimate (e.g. In block 555, the classifier 418, for instance, may classify the extent of damage for the object in each image in the validation set. According to an example, the classifying includes aggregating predictions from the ensemble of flagged intermediate CNNs to achieve greater accuracy in the classification of the extent of damage for the object in each image in the validation set, para [0043]; The processor 402, which may comprise a microprocessor, a micro-controller, an application specific integrated circuit (ASIC), Graphical Processing Unit (GPU) or the like, is to perform various processing functions in the computing device, para [0024]).

Claim 6 lacks an inventive step under PCT Article 33(3) as being obvious over Swanson in view of Accenture and in further view of US 9,070,018 B1 to Eagle View Technologies, Inc. (hereinafter Eagle).

As per claim 6, Swanson and Accenture teaches the method of claim 5, but fails to teach wherein the machine learning analysis model comprises a color histogram analysis model.
However, Eagle, in an analogous art, teaches wherein the machine learning analysis model comprises a color histogram analysis model (multiple target images are automatically grouped based on image characteristics (e.g., average contrast, brightness, color-histogram, or the like)....the AI system is trained on the region of interest from the exemplar image. Then, for each of the images in the group, a roof is detected based on the trained AI system, col. 11, ln 5-15; col. 7, ln 55-62). It would have been obvious to one of ordinary skill in the art to have modified the system of Swanson and Accenture by including the machine learning analysis model comprises a color histogram analysis model as taught by Eagle because the modification would automatically identify and classify the objects in the image based on the pixel colors.

Claims 1-20 have industrial applicability as defined by PCT Article 33(4) because the subject matter can be made or used in industry.

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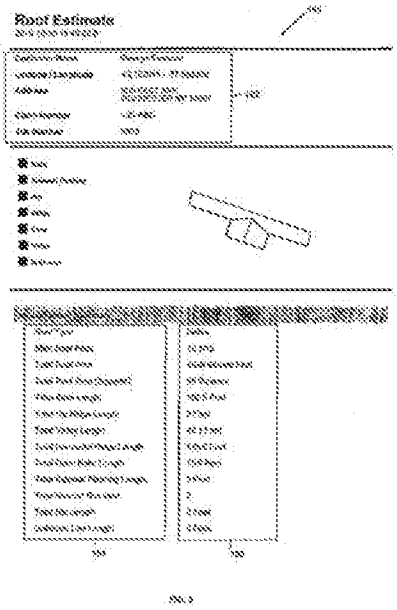
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(54) Title: COMPUTER SYSTEM FOR AUTOMATICALLY CLASSIFYING ROOF ELEMENTS



(57) Abstract: A set of instructions stored on at least one computer readable medium for running on a computer system. The set of instructions includes instructions for identifying line segments of a roof that is preferably displayed within a geo-referenced image, instructions for determining three-dimensional information of the line segments including position, orientation and length of the line segments preferably utilizing the geo-referenced image, and instructions for classifying, automatically, at least one of the line segments as one of a plurality of predefined roof elements utilizing at least one of the relative position and orientation of the line segments.

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Computer System for Automatically Classifying Roof Elements

Cross Reference to Related Applications

[0001] Not Applicable.

Field of Invention

[0002] The presently claimed and disclosed invention(s) relate to methods and computer systems for generating information indicative of roofs of buildings using geo-referenced images. More particularly, the presently claimed and disclosed invention(s) use a methodology for automatically classifying line segments as one of a plurality of predefined roof elements utilizing at least one of a relative position and orientation of the line segments.

Background of the Art

[0003] In the remote sensing/aerial imaging industry, imagery is used to capture views of a geographic area and to be able to measure objects and structures within the images as well as to be able to determine geographic locations of points within the image. These are generally referred to as "geo-referenced images" and come in two basic categories:

[0004] Vertical Imagery – these images are captured with the camera pointed vertically downward and thus generally only capture the tops of structures.

[0005] Oblique Imagery – these images are captured with the camera aimed at an angle so as to capture the sides of structures as well as the tops.

[0006] Most vertical imagery is processed in order to fit a mathematically rectangular projection or map. This process is known as ortho-rectification and attempts to create an appearance as if the sensor were directly above each pixel in the image. The resulting image is known as an ortho-photo. Since the images are mathematically projected, they can be

combined into a seamless mosaic. The resulting composite image is called an ortho-mosaic. The term "ortho image" is used to denote an image that is either an ortho-photo image or an ortho-mosaic image.

[0007] Because they are captured looking straight down, an ortho-photo or ortho-mosaic contains a view of the world to which we are not accustomed. As a result, many people have difficulty determining what it is they are looking at in the image. For instance, they might have difficulty distinguishing between two commercial properties since the only thing they can see of the properties in the ortho-mosaic is their roof tops, where as most of the distinguishing properties are on the sides of the buildings. An entire profession, the photo interpreter, has arisen to address these difficulties as these individuals have years of training and experience specifically in interpreting what they are seeing in ortho imagery.

[0008] Since an oblique image, by definition, is captured at an angle, it presents a more natural appearance because it shows the sides of objects and structures – what we are most accustomed to seeing. In addition, because oblique images are not generally ortho-rectified, they are still in the natural appearance that the camera captures as opposed to the mathematical construction of the ortho image. This combination makes it very easy for people to look at something in an oblique image and realize what that object is. Photo interpretation skills are not required when working with oblique images.

[0009] In the past, people have used geo-referenced oblique images to measure objects and structures within the images as well as to be able to determine geographic locations of points within the image when preparing estimates for a variety of construction projects, such as roadwork, concrete work, and roofing. Estimating construction projects using software is desirable in that it increases the speed at which an estimate can be prepared, and reduces labor and fuel costs associated with on-site visits. For roofing, this is even more important since measuring an actual roof can be a costly and potentially hazardous job – especially with steeply pitched roofs.

[0010] With respect to estimating roofing projects, software for measuring the pitch of a roof of a building using a geo-referenced oblique

image has been developed. This software causes a computer system to display an oblique image, and provides a "pitch tool" to measure the area and pitch of a roof in an oblique image. To measure pitch, the software permits the user to (1) click a pitch tool, (2) measure a height from the ground to the roof's eave by clicking at the ground, dragging to the eave, and then releasing the mouse button, (3) measure the height from the ground to the roof's peak, by clicking at the ground, dragging to the peak, and then releasing the mouse button, and (4) measure a distance of a ridge-line by clicking where the user last released the mouse, dragging along the ridge-line to the opposite end of the roof, and then releasing the mouse button.

[0011] The prior software displayed an area outline and a measurement on the image, and the following measurements appeared on a status bar: area, eave height, peak height, roof angle, roof, and roof pitch (rise over run).

[0012] Software for measuring the slope of a roof without using elevation data has also been developed. The software allows a user to measure slope (change in elevation between two points) without using elevation data by clicking a point in a first image at which to start the slope measurement. A small red crosshair marked the starting point. A corresponding point was clicked in a second image, and then a point in the first image at which to end the slope measurement was clicked. A line connected the starting and ending points and a dialog box showed a slope, a distance, a height difference and a pitch.

[0013] However, the prior software did not include any manner of automatically classifying roof elements, such as ridge lines, drip edges or eaves and the like so that reports including cumulative lengths of such roof elements could be automatically or semi-automatically prepared. It is to such an improvement that the present disclosure is directed.

Summary of Disclosure

[0014] In one version, the present disclosure describes a set of instructions stored on at least one computer readable medium for running on a computer system. The set of instructions may be a sequence of instructions

that are ordered or linked to work together. The set of instructions includes instructions for identifying line segments of a roof, instructions for determining three-dimensional information of the line segments including position, orientation and length of the line segments, and instructions for classifying, automatically, at least one of the line segments as one of a plurality of predefined roof elements utilizing at least one of the relative position and orientation of the line segments. Exemplary roof elements include an eave (which may be referred to as a drip edge line), a hip, a sidewall flashing, a valley, a rake, and a ridge.

[0015] In another version, the present disclosure describes a method for configuring a computer system for displaying one or more geo-referenced image on a display. In this method, a set of instructions on a computer readable medium is made accessible to a processor of a computer system, the set of instructions including instructions for: identifying line segments of a roof, determining three-dimensional information of the line segments including position, orientation and length of the line segments, and classifying, automatically, at least one of the line segments as one of a plurality of predefined roof elements utilizing at least one of the relative position and orientation of the line segments.

[0016] In another version, the present disclosure describes a method in which a set of instructions stored on at least one computer readable medium is sold and distributed. The set of instructions includes instructions for identifying line segments of a roof; determining three-dimensional information of the line segments including position, orientation and length of the line segments; and classifying, automatically, at least one of the line segments as one of a plurality of predefined roof elements utilizing at least one of the relative position and orientation of the line segments.

[0017] In yet another version, the present disclosure describes a method in which access to a set of instructions stored on a first computer readable medium is provided for installation on a second computer readable medium associated with a user device. For example, the first computer readable medium can be portable, such as a CD-ROM, and the second computer readable medium can be one or more physical hard drives or

memories which may be partitioned into one or more logical drives. The set of instructions includes instructions for: identifying line segments of a roof; determining three-dimensional information of the line segments including position, orientation and length of the line segments; and classifying, automatically, at least one of the line segments as one of a plurality of predefined roof elements utilizing at least one of the relative position and orientation of the line segments.

[0018] In yet another version, the present disclosure describes a computer system including at least one processor; and one or more computer readable medium. The one or more computer readable medium stores a set of instructions that when executed by the at least one processor cause the at least one processor to: identify line segments of a roof displayed within one or more geo-referenced images; determine three-dimensional information of the line segments including position, orientation and length of the line segments utilizing the one or more geo-referenced images; and classify, automatically, at least one of the line segments as one of a plurality of predefined roof elements utilizing at least one of the relative position and orientation of the line segments.

[0019] In various aspects, the set of instructions may include instructions for generating a three-dimensional model of the roof utilizing the line segments, as well as at least one instruction for storing classification information indicative of a classification of the at least one line segment as the plurality of predefined roof elements. The line segments preferably have lengths, and the set of instructions may include instructions for generating a report including a cumulative length of the line segments for one or more predefined roof element. The line segments may also include end points, and wherein the set of instructions further comprising instructions for grouping the end points of the line segments by elevation. The instructions for grouping the end points of the line segments by elevation may also include instructions for receiving user input to group the end points of the line segments by elevation. In another aspect, the set of instructions may also include instructions for calculating an elevation of each end point of the line segments and then averaging the elevation within each group of end points. In yet

another aspect, the set of instructions includes instructions for determining whether at least two points on the line segments (such as the end points) are at a same elevation in classifying the line segments as predefined roof elements.

[0020] In further aspects, the set of instructions includes instructions for determining an angle between adjacent line segments in classifying one of the line segments as at least one of a rake and a valley; and instructions for determined a relative elevation between line segments within a roof section in classifying one of the line segments as at least one of a ridge and an eave.

Brief Description of the Several Views of the Drawings

[0021] To assist those of ordinary skill in the relevant art in making and using the subject matter hereof, reference is made to the appended drawings, which are not intended to be drawn to scale, and in which like reference numerals are intended to refer to similar elements for consistency. For purposes of clarity, not every component may be labeled in every drawing.

[0022] Fig. 1 is a schematic diagram of the hardware forming an exemplary embodiment of a computer system constructed in accordance with the present disclosure.

[0023] Fig. 2 is a pictorial representation of a display of the computer system having a first image showing a building having a roof in accordance with the present disclosure.

[0024] Fig. 3 is a pictorial representation of a roof report prepared in accordance with the present disclosure.

[0025] Fig. 4 is a logic flow diagram summarizing a classification process in accordance with the present disclosure for automatically classifying line segments as one of a plurality of predefined roof elements utilizing at least one of a relative position and orientation of the line segments.

[0026] Fig. 5 is a pictorial representation of the display of the computer system showing an exemplary process for defining roof sections in accordance with the presently disclosed inventive concepts.

[0027] Fig. 6 is a pictorial representation of the display of the computer system showing an exemplary process for grouping line segment end points by elevation in accordance with the presently disclosed inventive concepts.

[0028] Figs. 7A and 7B are pictorial representations of the display of the computer system having a second image utilized for calibrating line segment end points of a first set of elevation grouped rooflines in accordance with the presently disclosed inventive concepts.

[0029] Figs. 8A and 8B are pictorial representations of the display of the computer system having the second image utilized for calibrating line segment end points of a second set of elevation grouped rooflines in accordance with the presently disclosed inventive concepts.

[0030] Figs. 9A and 9B are pictorial representations of the display of the computer system having the second image utilized for calibrating line segment end points of a third set of elevation grouped rooflines in accordance with the presently disclosed inventive concepts.

[0031] Fig. 10 is a pictorial representation of the display of the computer system having the second image utilized for reviewing and reclassifying automatically classified rooflines/line segments in accordance with the presently disclosed inventive concepts.

[0032] Figures 11a-k cooperate to form a more detailed exemplary logic flow diagram of the classification process in accordance with the present disclosure for automatically classifying line segments as one of a plurality of predefined roof elements utilizing at least one of a relative position and orientation of the line segments.

Detailed Description

[0033] Before explaining at least one embodiment of the disclosure in detail, it is to be understood that the disclosure is not limited in its application to the details of construction, experiments, exemplary data, and/or the arrangement of the components set forth in the following description or illustrated in the drawings.

[0034] The disclosure is capable of other embodiments or of being practiced or carried out in various ways. Also, it is to be understood that the phraseology and terminology employed herein is for purpose of description and should not be regarded as limiting.

[0035] Referring now to the drawings, and in particular to FIG. 1, shown therein and designated by a reference numeral 10 is an exemplary computer system constructed in accordance with the present disclosure. The computer system 10 can be a system or systems that are able to embody and/or execute the logic of the processes described herein. The logic embodied in the form of software instructions, or firmware may be executed on any appropriate hardware which may be a dedicated system or systems, or a personal computer system, or distributed processing computer system. In particular, the logic can be implemented in a stand-alone environment operating on a single computer system, or the logic can be implemented in a networked environment such as a distributed system using multiple computers and/or processors.

[0036] Preferably, the computer system 10 is distributed, and includes a host system 12, communicating with one or more user devices 14 via a network 16. The network 16 can be the Internet or other network. In either case, the host system 12 typically includes one or more servers 18 configured to communicate with the network 16 via one or more gateways 20.When the network 16 is the Internet, the primary user interface of the computer system 10 is delivered through a series of web pages, but the primary user interface can be replaced by another type of interface, such as a Windows-based application. This method is also used when deploying the computer system 10 in a stand-alone environment such as a kiosk.

[0037] The network 16 can be almost any type of network although Internet and Internet 2 networks are preferred because of the wide support of their underlying technologies. The preferred embodiment of the network 16 exists in an Internet environment, which means a TCP/IP-based network. It is conceivable that in the near future, the preferred or other embodiments, may wish to use more advanced networking topologies.

[0038] The servers 18 can be networked with a LAN 30. The gateway 20 is an entity responsible for providing access between the LAN 30 and the network 16. The gateway 20 can also be used as a security means to protect the LAN 30 from attack from external networks such as the network 16.

[0039] The LAN 30 network can be based on a TCP/IP network such as the Internet, or it can be based on another underlying network transport technology. The preferred embodiment uses an Ethernet network with TCP/IP because of the availability and acceptance of underlying technologies, but other embodiments may use other types of networks such as Fibre Channel, SCSI, Gigabit Ethernet, etc.

[0040] As discussed above, in one preferred embodiment, the host system 12 includes the servers 18. The configuration of the server hardware will depend greatly upon the requirements and needs of the particular embodiment of the computer system 10. Typical embodiments, including the preferred embodiment, will include multiple servers 18 with load balancing to increase stability and availability. It is envisioned that the servers 18 will include database servers and application/web servers. The database servers are preferably separated from the application/web servers to improve availability and also to provide the database servers with improved hardware and storage.

[0041] The user devices 14 can be any number and type of devices. The most typical scenario of the user device 14 involves a user 32, using a computer 34 with a display 36, keyboard 38, and mouse 40. The display 36 can be a single monitor or multiple adjacent monitors. Typically, the user device 14 uses a type of software called a "browser" as indicated by a reference numeral 42 to render HTML/XHTML content that is generated when requesting resources from a source, such as the host system 12. In the preferred embodiment, the computer system 10 is designed to be compatible with major Web Browser vendors (e.g., Microsoft Internet Explorer, Google Chrome, Mozilla Firefox, and Opera). Other embodiments may wish to focus on one particular browser depending upon the common user base using the computer system 10.

[0042] The user devices 14 can also be implemented as a portable device such as a laptop computer 50 (or handheld computer); a cellular telephone 52 with a micro or embedded Web Browser; a Portable Digital Assistant 54 (PDA) capable of wireless network access; a pen-based or tablet computer 56. In another embodiment, the user device 14 can be a cable box

60 or other similar device for viewing through a display 62 or television. Current embodiments of computer system 10 can also be modified to use any of these or future developed devices.

[0043] The computer system 10 is designed in this way as to provide flexibility in its deployment. Depending upon the requirements of the particular embodiment, the instructions could be designed to work in almost any environment such as a desktop application, a web application, or even simply as a series of web services designed to communicate with an external application.

[0044] The hardware and system software are designed with two key concerns; flexibility and scalability. Although some specifics for software and hardware components may be mentioned herein, it will be understood that a wide array of different components could be substituted, such as using different database vendors or even replacing the databases with XML-based document stores.

[0045] When the computer system 10 is used to execute the logic of the processes described herein, such computer(s) and/or execution can be conducted at a same geographic location or multiple different geographic locations. Furthermore, the execution of the logic can be conducted continuously or at multiple discrete times.

[0046] In general, the computer system 10 is capable of displaying and navigating geo-referenced imagery, such as aerial imagery. The geo-referenced imagery can be represented by a single pixel map, or by a series of tiled pixel maps that when aggregated recreate the image pixel map.

[0047] The computer system 10 will be described by way of example utilizing aerial images shown on the display 36 of the computer 34. However, it should be understood that the computer system 10 can use other types of images, such as architectural images.

[0048] Shown in Fig. 2 is a screen 100 displayed on the display 36 of the computer 34. The screen 100 shows a first image 101 of a portion of a building 102 having a roof 103 with three separate roof sections identified by reference numerals 104, 106, and 108. The roof 103 can be of various shapes, types and/or sizes. For example, the roof 103 can be of a type

identified as a gable roof, a flat roof, a hip roof, an intersecting roof, a gambrel roof, a mansard roof, a butterfly roof or a shed roof. The first image 101 is preferably an orthogonal image, but can be an oblique image. The roof section 104 includes a perimeter 110 defined by line segments 112, 114, 116, 118, 120, 122, and 124. The roof section 106 includes a perimeter 130 defined by line segments 118, 132, 134, and 136. The roof section 108 includes a perimeter 138 defined by line segments 120, 136, 140, and 142. The various line segments 112, 114, 116, 118, 120, 122, 124, 132, 134, 136, 140 and 142 may or may not be interconnected.

[0049] In accordance with the presently disclosed inventive concepts, the computer system 10 includes one or more computer readable medium storing instructions that when implemented by one or more processors of the computer system 10 causes the one or more processors to display the screen 100, as well as for identifying the line segments 112, 114, 116, 118, 120, 122, 124, 132, 134, 136, 140 and 142; determining 3-dimensional information of the line segments 112, 114, 116, 118, 120, 122, 124, 132, 134, 136, 140 and 142 including position, orientation and length of the line segments 112, 114, 116, 118, 120, 122, 124, 132, 134, 136, 140 and 142; and classifying, automatically, at least one of the line segments 112, 114, 116, 118, 120, 122, 124, 132, 134, 136, 140 and 142 as one of a plurality of predefined roof elements utilizing at least one of a relative position and orientation of the line segments 112, 114, 116, 118, 120, 122, 124, 132, 134, 136, 140 and 142. Preferably, the computer system 10 automatically classifies all of the line segments 112, 114, 116, 118, 120, 122, 124, 132, 134, 136, 140 and 142. The three-dimensional information of the line segments 112, 114, 116, 118, 120, 122, 124, 132, 134, 136, 140 and 142 can be determined in any suitable manner, such as by calculating the information utilizing a single image in a manner disclosed by U.S. Patent No. 7,424,133; calculating the information with two images utilizing stereoscopic photogrammetry techniques, and/or loading the information from one or more table(s).

[0050] The three-dimensional information can be implemented using any suitable methodology and preferably includes a position, length and orientation of each of the line segments 112, 114, 116, 118, 120, 122, 124,

132, 134, 136, 140 and 142. For example, the three dimensional coordinates, for each of the line segments 112, 114, 116, 118, 120, 122, 124, 132, 134, 136, 140 and 142 could be identified as a point, a direction and a length, and/or could include x, y, z coordinates of two end points on the line segment such that the length can be determined.

[0051] The screen 100 is also provided with a legend 150 showing a variety of predefined roof elements that can be automatically determined by the instructions discussed herein. The predefined roof elements are shown by way of example as a rake, a hip, a valley, an eave, a ridge, and unknown. The roof element identified in Figure 2 as a "rake" can also be referred to herein as a "gable"; the roof element identified in Figure 2 as a "eave" can also be referred to herein as a "drip edge" or a "drip edge line". In addition, other types of roof elements may also be determined by the instructions, such as sidewall flashing (which may also be referred to herein as an "intersecting rake") as well as a headwall flashing. For example, the line segments 114, 124, 134, and 140 have been automatically classified as a rake; the line segments 118 and 120 have been automatically classified as a valley; the line segments 116, 132, 122 and 142 have been automatically classified as eaves; and the line segment 112 has been automatically classified as a ridge.

[0052] Referring now to Figure 3, in accordance with the presently disclosed inventive concepts, a report 160 can be automatically and/or manually prepared which includes a summary of the cumulative lengths of the line segments 112, 114, 116, 118, 120, 122, 124, 132, 134, 136, 140 and 142 for each predefined roof element. In general, the report 160 is provided with multiple zones including, for example, a job information zone 162, a predefined roof element zone 164, and a measurement zone 166.

[0053] The job information zone 162 includes information identifying the building 102 for which the report 160 has been prepared. Various identifying information such as address, latitude/longitude, customer name and/or owner name can be provided within the job information zone 162. The identifying information can be provided in a plurality of fields provided within a merge document, for preparing the report 160.

[0054] The predefined roof element zone 164 includes a listing of the predefined roof elements, and the measurement zone 166 includes cumulative totals for the measurements of the various line segments 112, 114, 116, 118, 120, 122, 124, 132, 134, 136, 140 and 142 which are automatically classified according to the predefined roof elements. For example, the cumulative roof area of the roof sections 104, 106 and 108 is 2593.32 square feet; and the total eave length of the line segments 116, 122, 132 and 142 is equal to 100.21 feet. The information within the predefined roof element zone 164 and the measurement zone 166 can be provided in a plurality of fields provided within a merge document for automating and/or preparing the report 160.

[0055] The computer readable medium is a device that can be read either directly or indirectly by one or more processor of the computer system 10. The computer readable medium can be a part of the host system 12, the user devices 14 or combinations thereof. Examples of the computer readable medium include an optical storage device such as a CD-ROM, a magnetic storage device such as a disk, an electronic storage device such as a memory or the like.

[0056] Referring now to Figure 4, shown therein is a flow chart illustrating a classification process 200 developed in accordance with the presently disclosed inventive concepts implemented in the form of instructions being run by one or more processors of the computer system 10, preferably with the aid of one or more users utilizing the user devices 14. In particular, the classification process 200 starts as indicated by a step 202, and then branches to a step 204 in which the roof sections 104, 106 and 108, for example, are defined. Typically, this occurs by providing the screen 100 on the display 36 via the computer 34, and/or the host system 12 and the user 32 selecting various end points within the first image 101 to define the line segments surrounding the roof sections 104, 106 and 108, such as the line segments 112, 114, 116, 118, 120, 122, 124, 132, 134, 136, 140, and 142 surrounding the roof sections 104, 106 and 108. This is described in more detail below with reference to Figure 5.

[0057] Once all of the roof sections (e.g., roof sections 104, 106 and 108) have been defined within the first image 101, the classification process 200 branches to a step 206 where end points of the line segments 112, 114, 116, 118, 120, 122, 124, 132, 134, 136, 140, and 142 are grouped by elevation. This is described in more detail below with reference to Figure 6 and increases the accuracy of the classification process 200 by permitting an average elevation value to be utilized in the classification process 200.

[0058] Thereafter, the classification process 200 branches to a step 208 where a second image 210 (shown in Figures 7a, 7b, 8a, 8b, 9a and 9b) of the building 102 is shown. The second image 210 can be an orthogonal image, or an oblique image. In any event, each group of the line segments 112, 114, 116, 118, 120, 122, 124, 132, 134, 136, 140, and 142 is preferably calibrated to the second image 210, and then the classification process 200 branches to a step 212 where an elevation for each of the end points of the line segments 112, 114, 116, 118, 120, 122, 124, 132, 134, 136, 140, and 142 is calculated utilizing the first image 101 and the second image 210 preferably using stereo photogrammetry techniques. An average elevation value is calculated for each group prior to or during a step 214. In the step 214, the classification process 200 automatically classifies at least one, and preferably all of the line segments 112, 114, 116, 118, 120, 122, 124, 132, 134, 136, 140, and 142 as one of the plurality of predefined roof elements utilizing at least one of a relative position and orientation of the line segments 112, 114, 116, 118, 120, 122, 124, 132, 134, 136, 140, and 142. The relative position and/or orientation of the line segments 112, 114, 116, 118, 120, 122, 124, 132, 134, 136, 140, and 142 can be calculated utilizing the average elevation value.

[0059] Once the line segments 112, 114, 116, 118, 120, 122, 124, 132, 134, 136, 140, and 142 are classified, the classification process branches to a step 216 to permit user review of the classifications and make any changes if necessary or desirable, and then the classification process 200 branches to a step 218 to generate the report 160. As shown in Figure 10, the screen 100 may include an input block 219, such as a text box or field, for changing the

classification of the line segments 112, 114, 116, 118, 120, 122, 124, 132, 134, 136, 140, and 142.

[0060] The first image 101, and the second image 210 can be any type of image that has location coordinates or a measuring system stored with or associated with the image. The computer system 10 uses one or more databases or servers 18 (see FIG. 1) to store the first image 101, and the second image 210 in an organized format. The first image 101, second image 210 can use any color space, and be stored in any industry supported file format, such as TIFF, JPEG, TARGA, GIF, BMP, ECW or the like.

[0061] In practice, the methodology disclosed and claimed herein, includes multiple steps and data transformations that can be accomplished by one of ordinary skill in the art given the present specification. Either instructions running on the host system 12 or the instructions running on the user devices 14 can be used for automatically classifying the line segments 112, 114, 116, 118, 120, 122, 124, 132, 134, 136, 140, and 142 as one of the plurality of predefined roof elements.

[0062] Referring to Fig. 5 and 11A, examples of the step 204 for defining the roof sections will be described in more detail. In particular, a first step 250 in defining the roof sections is to obtain a relevant geographic location which can be identified by an address, county identifier or the like of the building 102. Once the geographic location is obtained, a set of images representing the geographic location is then obtained and then the first image 101 can be selected and displayed on the display 36, for example. The first image 101 can be obtained from the database servers 18 discussed above. The relevant geographic location can be obtained internally, through calculating a position based upon a mathematical formula, or through an external entity, such as a database or user input. In the preferred embodiment, the user device 14 receives an address of the building 102 or a region identifier (i.e., subdivision, township or the like) encompassing multiple addresses and/or multiple buildings 102 from the user via the keyboard 38, mouse 40 or other input device. When the region identifier is received, the computer system 10 may execute the instructions of the classification process

200 for each of the addresses and/or buildings within a region identified by the region identifier.

[0063] The classification process 200 branches to a step 252 where the computer system 10 receives a selection of the first image 101, and then the classification process 200 branches to a step 254 where the computer system 10 receives selection of a point 256a on a roof line to define a boundary of a roof section. The line segments 112, 114, 116, 118, 120, 122, 124, 132, 134, 136, 140, and 142 may be referred to herein as "rooflines". The classification process 200 then branches to a step 258 where the computer system 10 determines if the user has selected all points to define the roof section, and if not, the classification process 200 branches to the step 254 for the user to select another point, such as point 256b. Once the user has selected all points 256a-g to define the roof section 104, for example, the classification process 200 branches to a step 262 where the user inputs all points 256a-g selected to define the roof section 104, such as by clicking an "Add Roof Section" button 266.

[0064] The classification process 200 then branches to a step 268 to determine whether the user has defined all of the roof sections, and if not, the classification process 200 branches to the step 254 to permit the user to define another roof section, such as the roof section 106. The computer system 10 can determine that the user is done defining all roof sections, by any suitable methodology, such as receiving input from the user. For example, the user could use the mouse 40 to click on a "Next Step" button 270.

[0065] Shown in Fig. 11B is the step 206 in which the computer system 10 groups points by elevation, preferably using input by the user. In particular, the computer system 10 branches to a step 300 where the computer system 10 waits for the user to group all roofline points at the same fixed elevation. Then, the computer system 10 branches to a step 302 where the user selects points on the rooflines points that are at the same fixed elevation. In the example of Figure 6, the user has selected points 256a, 256d, 256e, 256g, 256h and 256i that are selected as being on the same elevation, typically by manual evaluation of the screen 100. Then, the

classification process 200 branches to a step 304 in which the user indicates that all roofline points of the same fixed elevation have been selected, such as by utilizing the mouse 40 to click on the "Next Step" button 270. Thereafter, the classification process 200 branches to a step 306 to inquire whether the user has grouped all roofline points at the same fixed elevation, and if not the classification process branches to the step 302 to permit the user to select and thereby group additional roofline points at the same elevation, such as the points 256b and 256c.

[0066] Once the classification process 200 has determined that the user has grouped all roofline points at the same fixed elevation in the step 306, the classification process 200 branches to a step 308 to see if the user has indicated that all fixed elevation rooflines points have been grouped together within their respective elevations, such as by the user utilizing the mouse 40 to click on the "Next Step" button 270.

[0067] The classification process 200 then branches to a step 320 where the computer system 10 displays the second image 210, which is preferably an oblique image and then branches to a step 322 where the computer system 10 pre-draws a first set of elevation grouped rooflines 323a and 323b onto the second image 210, e.g., an oblique geo-referenced image, and produces a wireframe image 324 of the roof sections 104, 106 and 108 as shown in Figure 7a. The first set of elevation grouped rooflines 323a and 323b are formed by the set of points 256a, 256g, 256h, 256i, 256e and 256d discussed above with respect to Figure 6. In a preferred embodiment, the elevation grouped rooflines 323a and 323b are drawn onto the second image 210 utilizing a process known in the art as manual correlation in which the estimated position of the elevation grouped rooflines 323a and 323b is calculated utilizing positional information associated with the first image 101 and the second image 210.

[0068] Then, the classification process 200 branches to a step 325 in which the user aligns the elevation grouped rooflines 323a and 323b onto actual rooflines 326a and 326b displayed within the second image 210. Once the user has aligned the elevation grouped rooflines 323a and 323b onto the actual rooflines 326a and 326b, as shown in Figure 7b, the classification

process 200 branches to a step 330 in which the computer system 10 calculates the average elevation of all points within the elevation grouped rooflines 323a and 323b. The classification process 200 then branches to a step 332 to determine whether the user has aligned all elevation grouped rooflines onto actual rooflines of the second image 210. If not, the user selects a "Next Roof Level" button 328, (or other suitable mechanism) and then the classification process 200 branches to the step 325 to repeat the process for each set of elevation grouped rooflines. In this example, the user has prepared 3 sets of elevation grouped rooflines; and the process repeats with the user utilizing the computer system 10 to align a second set of elevation grouped rooflines 334 with an actual roofline 336 as shown in Figures 8a and 8b; and with the user utilizing the computer system 10 to align a third set of elevation grouped rooflines 340 with an actual roofline 342 as shown in Figures 9a and 9b.

[0069] The classification process 200 then branches to the step 212 discussed above where the elevation for each of the end points of the line segments 112, 114, 116, 118, 120, 122, 124, 132, 134, 136, 140, and 142 can be calculated utilizing the first image 101 and the second image 210 preferably using stereo photogrammetry techniques. Then, an average elevation value is calculated for each set of elevation grouped rooflines 323a, 323b, 334, and 340.

[0070] The classification process branches to a first step 350 of the step 214 (discussed above with reference to Figure 4) where the computer system 10 selects one of the roof sections 104, 106 or 108 (such as the roof section 104), and then branches to a step 352 to determine a lowest elevation point of the roof section 104, such as the elevation associated with points 256a, 256g, 256e, and 256d (as shown in Figure 5). The classification process 200 then branches to a step 354 where the computer system 10 stores the lowest elevation point of the roof section 104, and then branches to a step 356 where the computer system 10 determines a highest elevation point of the roof section 104 and then branches to a step 358 to store the highest elevation point(s). In this example, the highest elevation point(s) of the roof section 104 is associated with points 256b and 256c (as shown in

Figure 5). Then, the computer system 10 branches to a step 362 to select two points on a line segment associated with roofline such as the line segment 112 (shown in Figure 2) and then branches to a step 364 to determine whether the line segment, for example, is level by comparing the elevation of the two endpoints of the line segment. As indicated by a step 366, if the elevation of the two endpoints is the same, the classification process 200 branches to a step 368 where the computer system 10 compares the elevation of the two endpoints of the line segment against the lowest and highest elevations of rooflines/line segments within the roof section 104. The classification process 200 then branches to a step 370 where the computer system determines whether the two points are at the lowest stored elevation and if so the roofline/line segment is classified as an eave or drip edge line in a step 372. The classification process then branches to a step 374 where the system determines if all roofline/line segments have been classified within the roof section 104. If not, the classification process 200 branches to a step 376 (shown in Figure 11h) where the computer system 10 selects a next unidentified roofline/line segment in the roof section 104 and then branches back to the step 360 (shown in Figure 11d).

[0071] Referring back to step 370 (shown in Figure 11e), if the computer system 10 determines that the two points are not at the lowest stored elevation, the computer system 10 branches to a step 380 to determine if the two points are at the highest stored elevation. If so, the classification process 200 branches to a step 382 (shown in Figure 11g) and classifies and stores information indicative of the roofline/line segment being a ridgeline. The classification process 200 then branches to the step 374 as shown in Figure 11h. However, if the computer system 10 determines that the two points are not at the highest stored elevation at the step 380, then the classification process 200 branches to a step 384 where the roofline/line segment is classified as unknown, and then the classification process 200 then branches to the step 374 shown in Figure 11h.

[0072] Referring back to step 366, if the computer system 10 determines that the two points are not at the same elevation (i.e. the line segment extending between the two points is not level), then the classification

process 200 branches to a step 400 where the computer system 10 analyzes adjacent level lines on a same elevation as one of the two points, and then branches to a step 402 (shown in Figure 11f). At the step 402, the computer system 10 determines whether there is an adjacent level line segment on a same elevation as one of the two roofline endpoints. If not, the classification process 200 branches to a step 404 where the roofline/line segment is classified as unknown, and then to the step 374 as discussed above.

[0073] However, if the computer system 10 determines that there is an adjacent level line segment on the same elevation as one of the two roofline endpoints, the classification process 200 branches from the step 402 to a step 406 where the computer system 10 loads the appropriate adjacent roofline/line segment and then branches to a step 408 (shown in Figure 11g) where the computer system 10 computes an angle between the adjacent roofline/line segments utilizing trigonometric techniques. The classification process 200 then branches to a step 410 to determine whether the adjacent roofline/line segment is connected to an upper elevation point, such as points 256b, or 256c and if so the classification process 200 branches to a step 412 to subtract the angle computed in step 408 from 180° and then branches to a step 414 to determine whether the angle between the adjacent rooflines is approximately 90°, e.g., from 85° to 95°. If so, the roofline/line segment is classified as a rake line at a step 416 and then the classification process 200 branches to the step 374 as discussed above.

[0074] However, if the adjacent roofline/line segment is not connected to an upper elevation point, then the classification process 200 branches from the step 410 to the step 414 and bypasses the step 412. If at the step 414, the computer system 10 determines that the angle between adjacent rooflines is not approximately 90°, the classification process branches to a step 420 (shown in Figure 11h) to determine whether the angle between the adjacent roofline/line segment is less than 90°. If so, the roof line/line segment is classified as a hip line at a step 422, and if not, the roofline/line segment is classified as a valley line at a step 424.

[0075] Once all of the rooflines have been classified within the roof section 104 as determined by the step 374, the classification process 200

then branches to a step 430 to determine whether any roofline/line segment classified as an eave or drip edge line has also been classified in another roof section as a ridgeline. If so, then the classification process 200 re-classifies the roofline/line segment as a ridgeline at a step 432, and if not, the classification process 200 branches to a step 434 to determine whether all roof sections have been analyzed. If not, the classification process branches back to the step 350 (shown in Figure 11d) to repeat the process for another one of the roof sections 104, 106 and 108. Once all of the roof sections 104, 106 and 108 have had all of their roofline/line segments classified, then the classification process 200 branches to a step 436 to determine whether any have the roofline/line segments have been classified as unknown. If not, then all of the roofline/line segments have been classified as one of the predefined roof elements, and then the classification process 200 branches to a step 440 where the computer system 10 preferably color codes all rooflines/line segments.

[0076] However, if at the step 436, any of the roofline/line segments are classified as unknown, the classification process 200 tries to reclassify the unknown line segments utilizing roofline/line segments within an adjacent roof section. In particular, the classification process 200 branches to a step 442 to determine whether any roofline/line segments classified as unknown are shared between adjacent roof sections 104, 106 and 108 of the roof. If not, the roofline/line segments are classified as unknown at a step 444, and if so the classification process 200 branches to a step 446 to determine whether roofline/line segment can be classified based upon the geometry of the adjacent roof section utilizing the techniques discussed above. If so, the classification process 200 branches to a step 448 where a classification for the roofline/line segment is determined and labeled. However, if at the step 446 the classification for the roofline/line segment cannot be determined by the adjacent roofline/line segment geometry, the classification process 200 branches to the step 444 where the roofline/line segment is classified as unknown.

[0077] The classification process 200, then branches to the step 216 to permit user review of the classifications and make any changes if necessary

or desirable, and then the classification process 200 branches to a step 218 to generate the report 160. The step 216 is shown in more detail in Figure 11k. In particular, the classification process 200 branches to a step 460 where the user reviews rooflines/line segments, and can manually select and change known and unknown classifications. Once the user selects and/or changes known and unknown classifications, the classification process 200 branches to a step 462 in which the user indicates acceptance of all roofline/line segment classifications.

[0078] In various aspects, the set of instructions discussed above can be distributed or used in a variety of manners. For example, one or more computer readable medium storing the set of instructions could be sold and/or distributed through retail locations as a set of one or more CD-ROMs or downloaded from an server. The term "sold" as used herein includes a sale where ownership is transferred, as well as an exchange of funds where a license or rights are granted but ownership has not changed. As another example, the set of instructions could be made available to the processor for execution in a variety of manners, such as by installing the set of instructions onto a local hard drive or memory, or by having the processor access a remote server or memory providing the set of instructions.

[0079] Although the foregoing has been described in some detail by way of illustration and example for purposes of clarity of understanding, it will be obvious to those skilled in the art that certain changes and modifications may be practiced without departing from the spirit and scope thereof, as described in this specification and as defined in the appended claims below.

What is claimed is:

1. A set of instructions stored on at least one computer readable medium for running on a computer system, comprising:

instructions for identifying line segments of a roof;

instructions for determining three-dimensional information of the line segments including position, orientation and length of the line segments; and

instructions for classifying, automatically, at least one of the line segments as one of a plurality of predefined roof elements utilizing at least one of the relative position and orientation of the line segments.

2. The set of instructions stored on the at least one computer readable medium of claim 1 further comprising instructions for generating a three-dimensional model of the roof utilizing the line segments.

3. The set of instructions stored on the at least one computer readable medium of claims 1 or 2, further comprising at least one instruction for storing classification information indicative of a classification of the at least one line segment as the plurality of predefined roof elements.

4. The set of instructions stored on the at least one computer readable medium of claim 3, wherein the line segments have lengths, and further comprising instructions for generating a report including a cumulative length of the line segments for one or more predefined roof element.

5. The set of instructions stored on the at least one computer readable medium of claims 1-4, wherein the line segments have end points, and wherein the set of instructions further comprise instructions for grouping the end points of the line segments by elevation.

6. The set of instructions stored on the at least one computer readable medium of claim 5, wherein the instructions for grouping the end points of the

line segments by elevation include instructions for receiving user input to group the end points of the line segments by elevation.

7. The set of instructions stored on the at least one computer readable medium of claim 5, further comprising instructions for calculating an elevation of each end point of the line segments and then averaging the elevation within each group of end points.

8. The set of instructions stored on the at least one computer readable medium of claims 1-7, wherein the set of instructions includes instructions for determining whether at least two points on the line segments are at a same elevation in classifying the line segments as predefined roof elements.

9. The set of instructions stored on the at least one computer readable medium of claims 1-8, wherein the predefined roof elements are selected from a group consisting of a rake and a valley, and wherein the set of instructions includes instructions for determining an angle between adjacent line segments in classifying one of the line segments as at least one of a rake and a valley.

10. The set of instructions stored on the at least one computer readable medium of claims 1-9, wherein the predefined roof elements are selected from a group consisting of a ridge and an eave, and wherein the set of instructions includes instructions for determining a relative elevation between line segments within a roof section in classifying one of the line segments as at least one of a ridge and an eave.

11. A method, comprising the step of:

making a set of instructions on a computer readable medium accessible to a processor of a computer system, the set of instructions including instructions for:

identifying line segments of a roof;

determining three-dimensional information of the line segments including position, orientation and length of the line segments; and

classifying, automatically, at least one of the line segments as one of a plurality of predefined roof elements utilizing at least one of the relative position and orientation of the line segments.

12. A method, comprising the step of:

selling and distributing a set of instructions stored on at least one computer readable medium for:

identifying line segments of a roof;

determining three-dimensional information of the line segments including position, orientation and length of the line segments; and

classifying, automatically, at least one of the line segments as one of a plurality of predefined roof elements utilizing at least one of the relative position and orientation of the line segments.

13. A method comprising the step of:

providing access to a set of instructions stored on a first computer readable medium for installation on a second computer readable medium associated with a user device, the set of instructions including instructions for:

identifying line segments of a roof;

determining three-dimensional information of the line segments including position, orientation and length of the line segments; and

classifying, automatically, at least one of the line segments as one of a plurality of predefined roof elements utilizing at least one of the relative position and orientation of the line segments.

14. The method of claims 11, 12 or 13, wherein the set of instructions on the computer readable medium is constructed according to any one of claims 2-10.

15. A computer system, comprising:

at least one processor;

one or more computer readable medium storing a set of instructions that when executed by the at least one processor cause the at least one processor to:

identify line segments of a roof displayed within one or more geo-referenced images;

determine three-dimensional information of the line segments including position, orientation and length of the line segments utilizing the one or more geo-referenced images; and

instructions for classifying, automatically, at least one of the line segments as one of a plurality of predefined roof elements utilizing at least one of the relative position and orientation of the line segments.

16. The computer system of claim 15, wherein the set of instructions on the computer readable medium is constructed according to any one of claims 2-10.

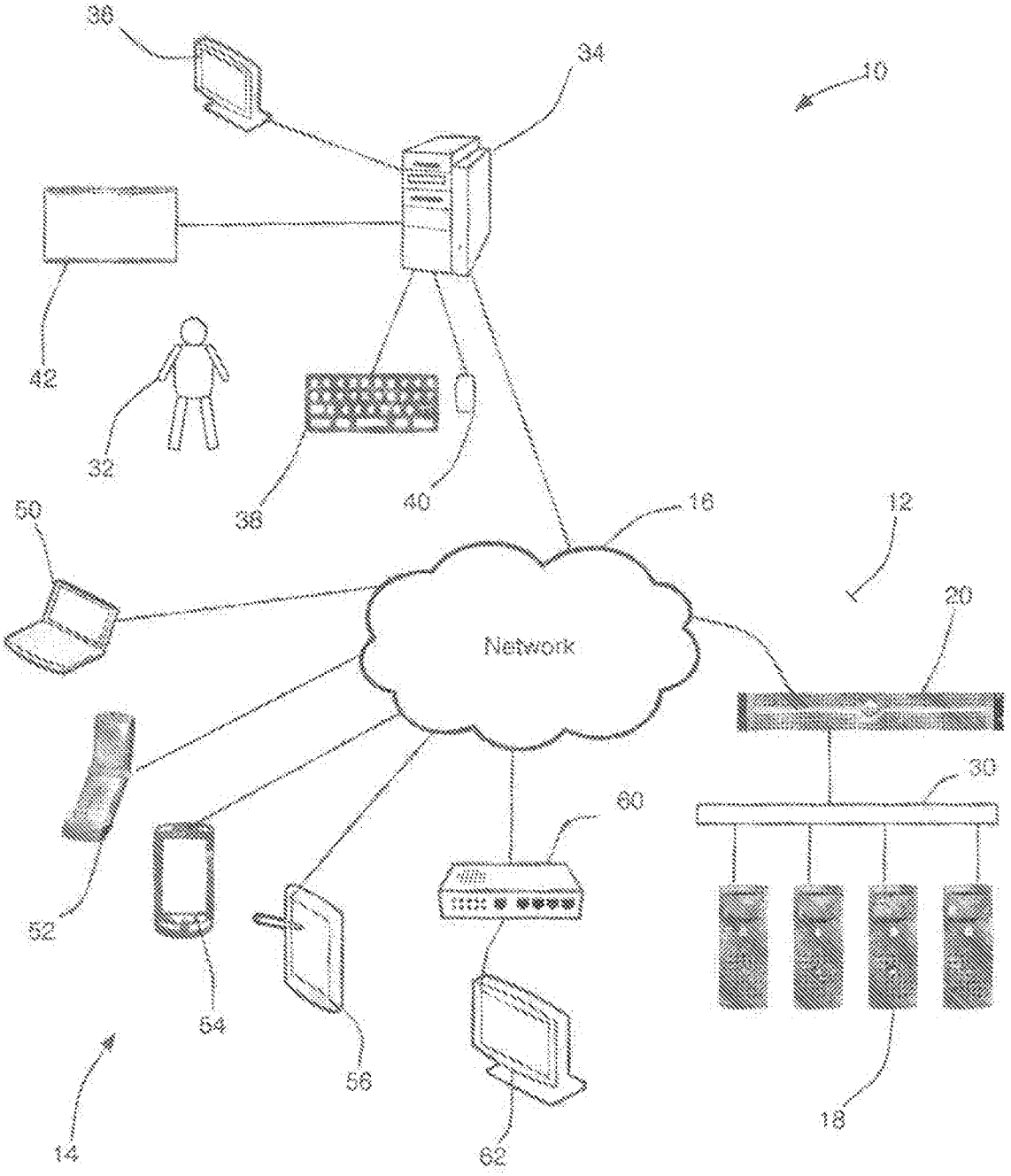


Fig. 1

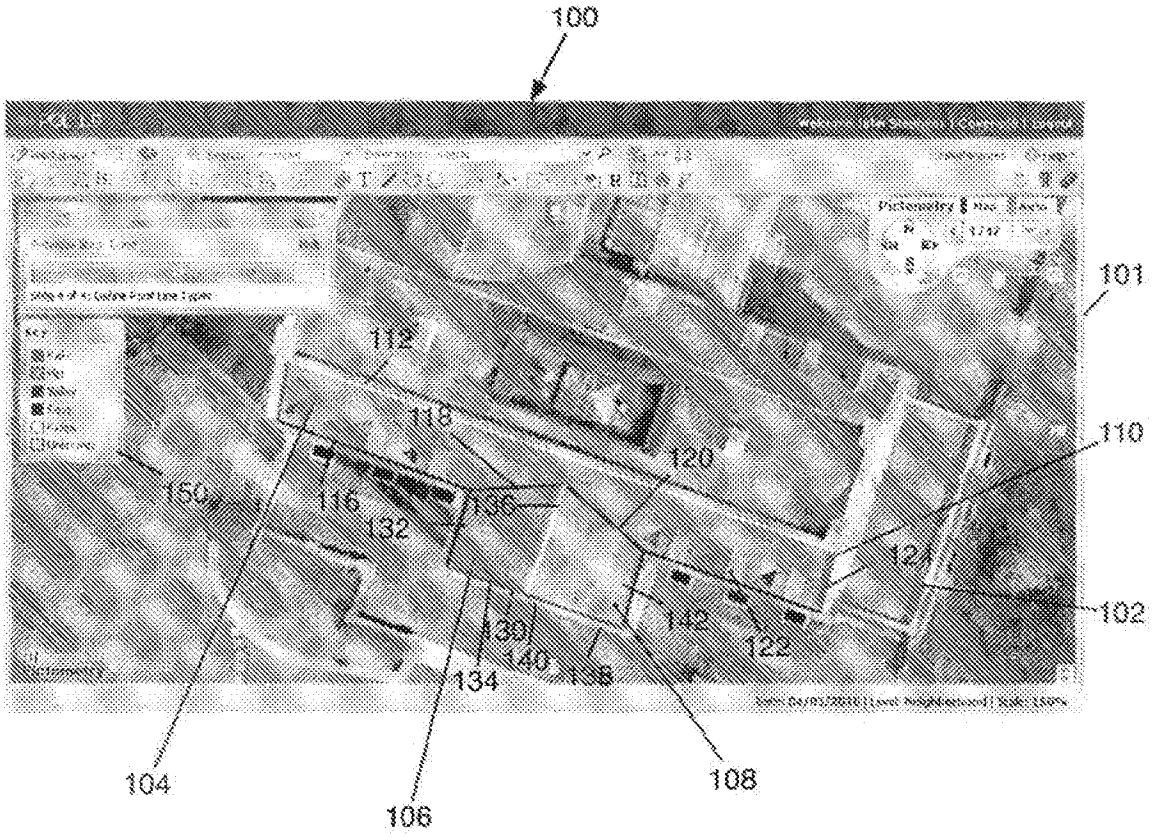

100
101
112
118
120
110
150
116
132
136
122
102
130
140
138
142
134
104
106
108

FIG. 2

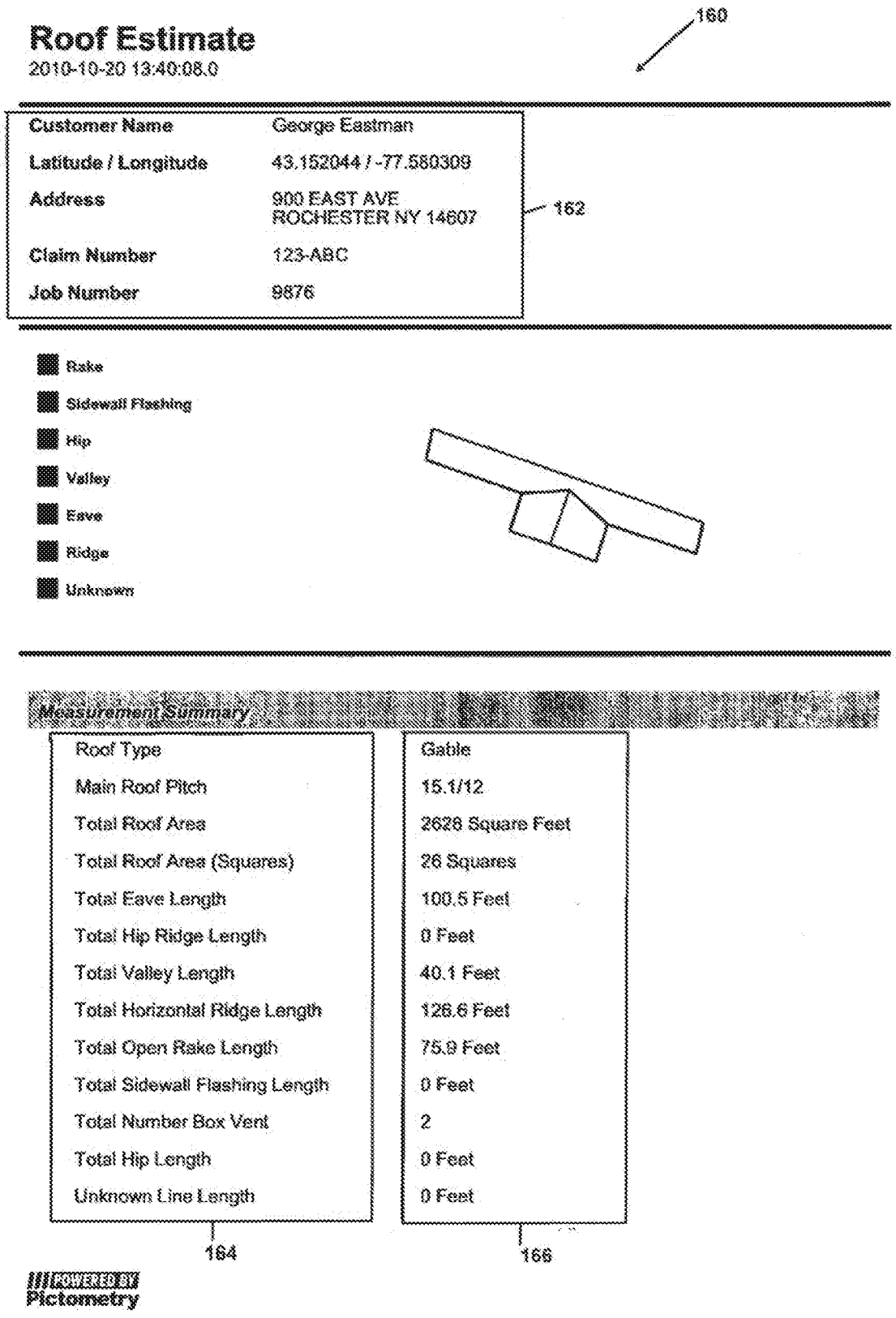

Roof Estimate
2010-10-20 13:40:08.0
160
Customer Name
George Eastman
Latitude / Longitude
43.152044 / -77.580309
Address
900 EAST AVE
ROCHESTER NY 14607
Claim Number
123-ABC
Job Number
9876
162
Rake
Sidewall Flashing
Hip
Valley
Eave
Ridge
Unknown
Measurement Summary
Roof Type
Gable
Main Roof Pitch
15.1/12
Total Roof Area
2626 Square Feet
Total Roof Area (Squares)
26 Squares
Total Eave Length
100.5 Feet
Total Hip Ridge Length
0 Feet
Total Valley Length
40.1 Feet
Total Horizontal Ridge Length
126.6 Feet
Total Open Rake Length
75.9 Feet
Total Sidewall Flashing Length
0 Feet
Total Number Box Vent
2
Total Hip Length
0 Feet
Unknown Line Length
0 Feet
164
166
POWERED BY
Pictometry

FIG. 3

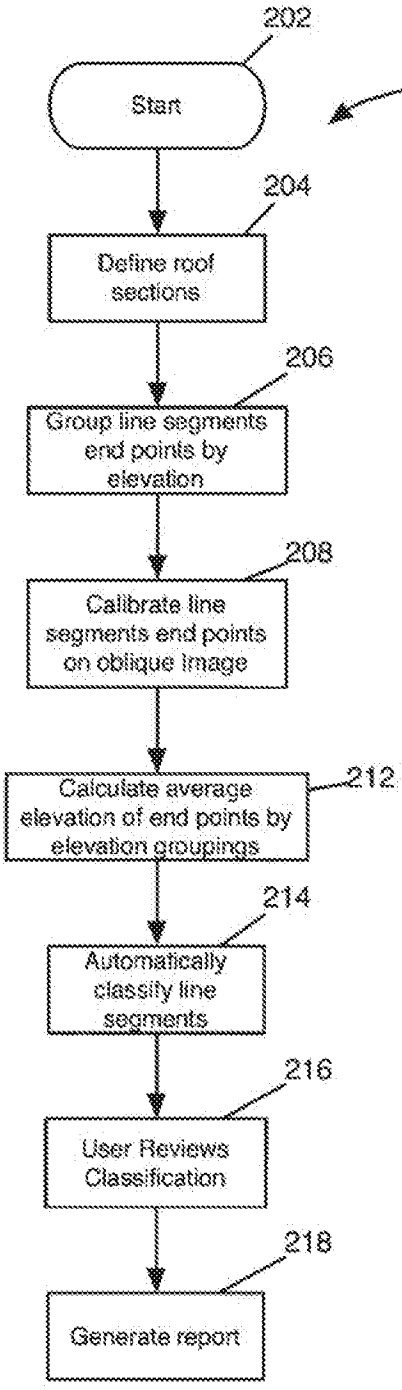

202
Start
200
204
Define roof sections
206
Group line segments end points by elevation
208
Calibrate line segments end points on oblique image
212
Calculate average elevation of end points by elevation groupings
214
Automatically classify line segments
216
User Reviews Classification
218
Generate report

Fig. 4

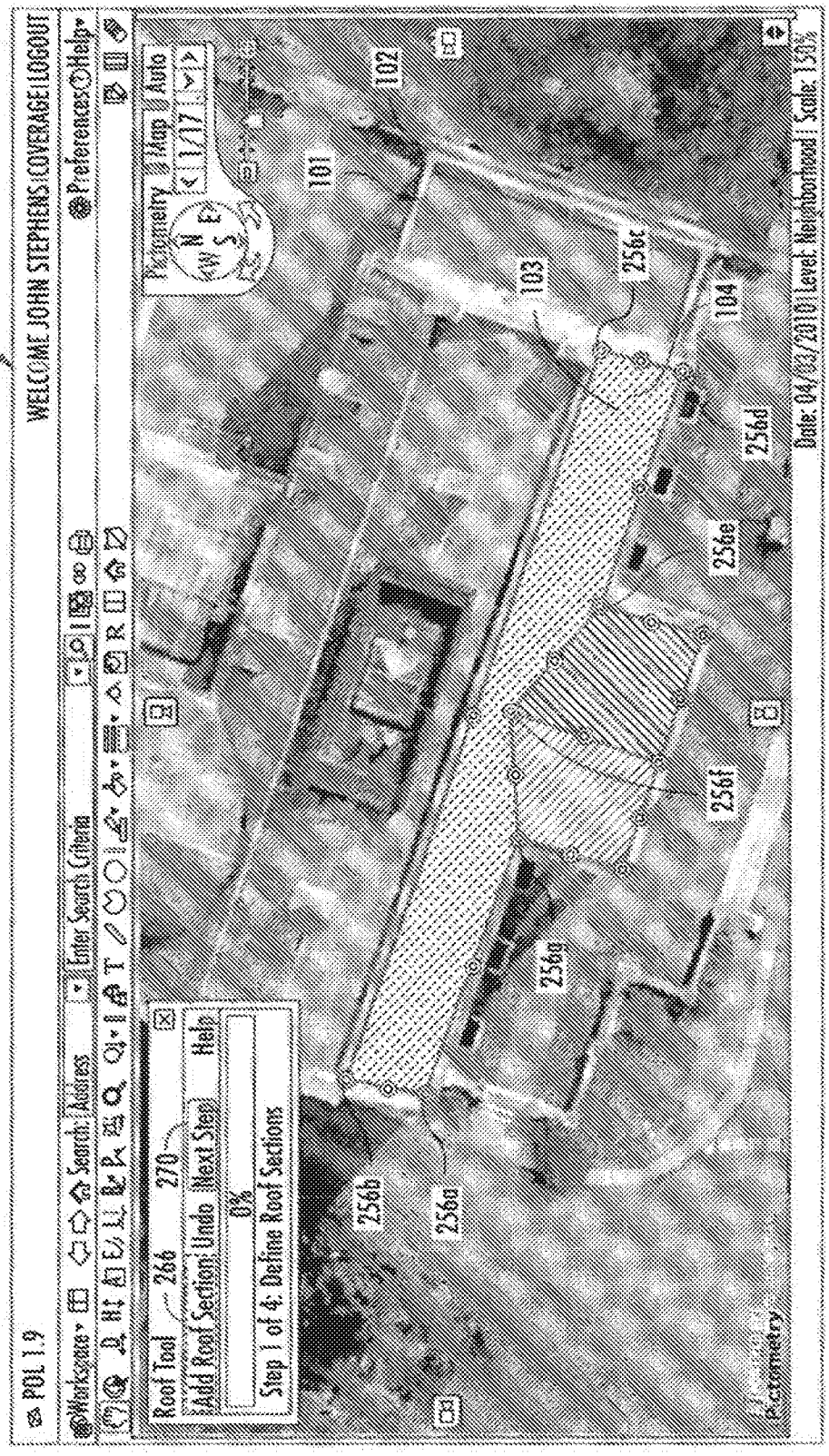

100
WELCOME JOHN STEPHENS | COVERAGE | LOGOUT
POL 1.9
Workspace
Search Address
Enter Search Criteria
Preferences
Help
Roof Tool
266
270
Add Roof Section
Undo
Next Step
Help
0%
Step 1 of 4: Define Roof Sections
Pictometry
Map
Auto
101
102
103
104
256a
256b
256c
256d
256e
256f
256g
Date: 04/03/2011 Level: Neighborhood Scale: 1:30

FIG. 5

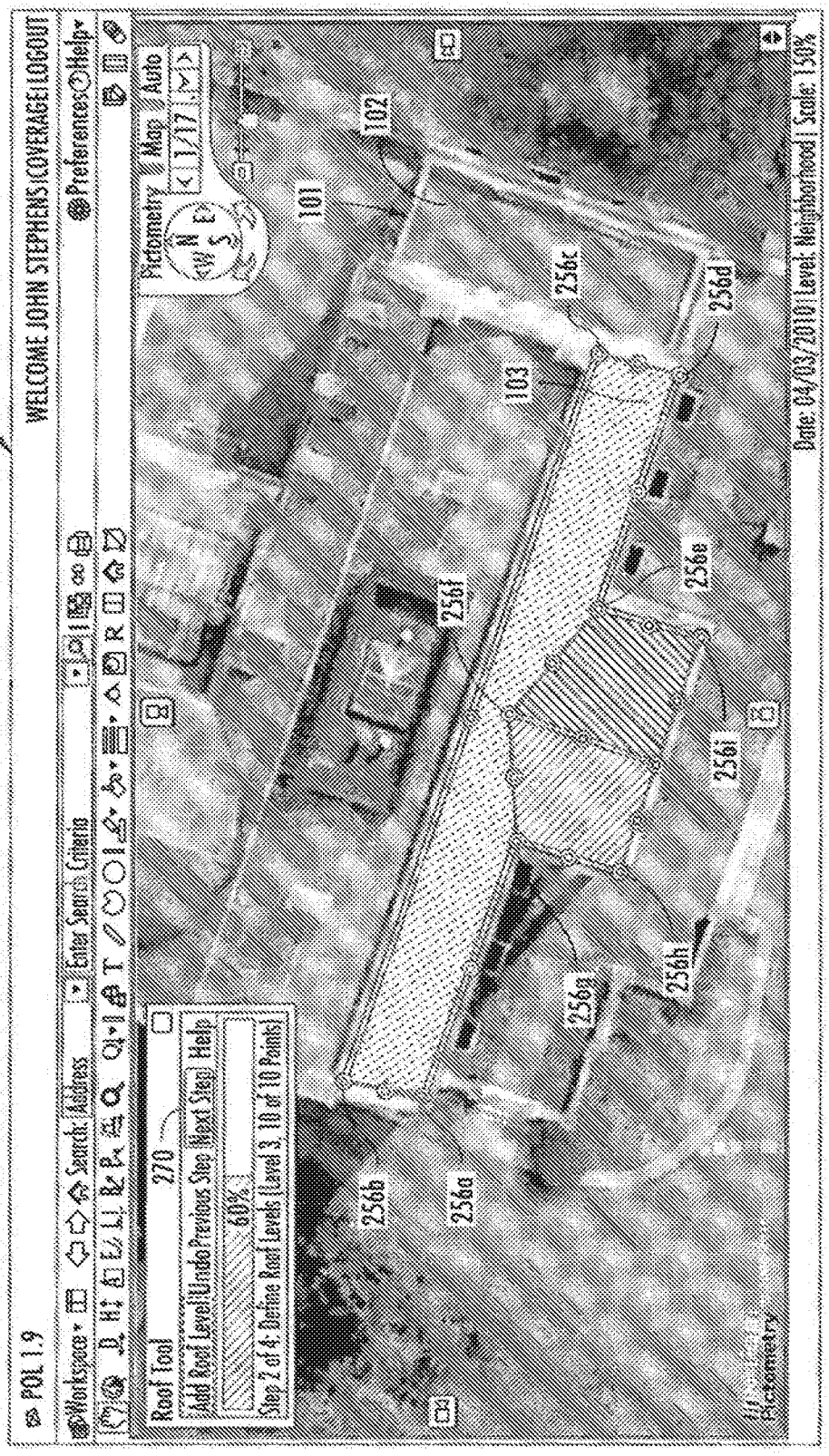

100
POL 1.9
WELCOME JOHN STEPHENS | COVERAGE | LOGOUT
Workspace
Search: Address
Enter Search Criteria
Preferences
Help
Roof Tool
270
Add Roof Level | Undo Previous Step | Next Step | Help
60%
Step 2 of 4: Define Roof Levels (Level 3, 10 of 10 Points)
Pictometry
Map
Auto
101
102
103
256a
256b
256c
256d
256e
256f
256g
256h
256i
Date: 04/03/2010 | Level: Neighborhood | Scale: 150%

FIG. 6

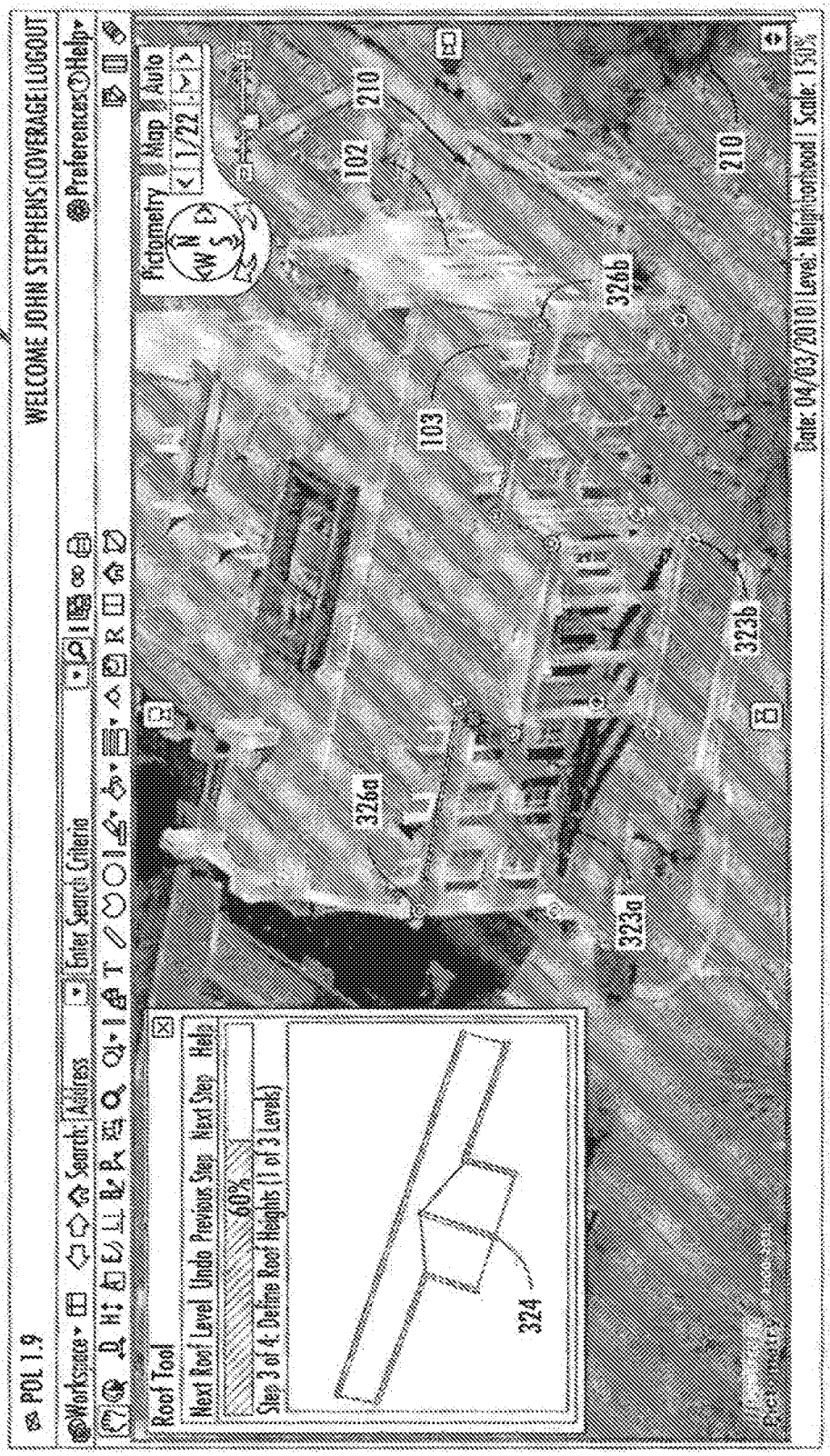

100
WELCOME JOHN STEPHENS | COVERAGE | LOGOUT
PDL 1.9
Workspace
Search Address
Enter Search Criteria
Preferences
Help
Roof Tool
Next Roof Level Undo Previous Step Next Step Help
60%
Step 3 of 4: Define Roof Heights (1 of 3 Levels)
324
Pictometry | Map | Auto
1/22
102
210
103
326a
326b
323a
323b
210
Date: 04/03/2010 | Level: Neighborhood | Scale: 150%

FIG. 7A

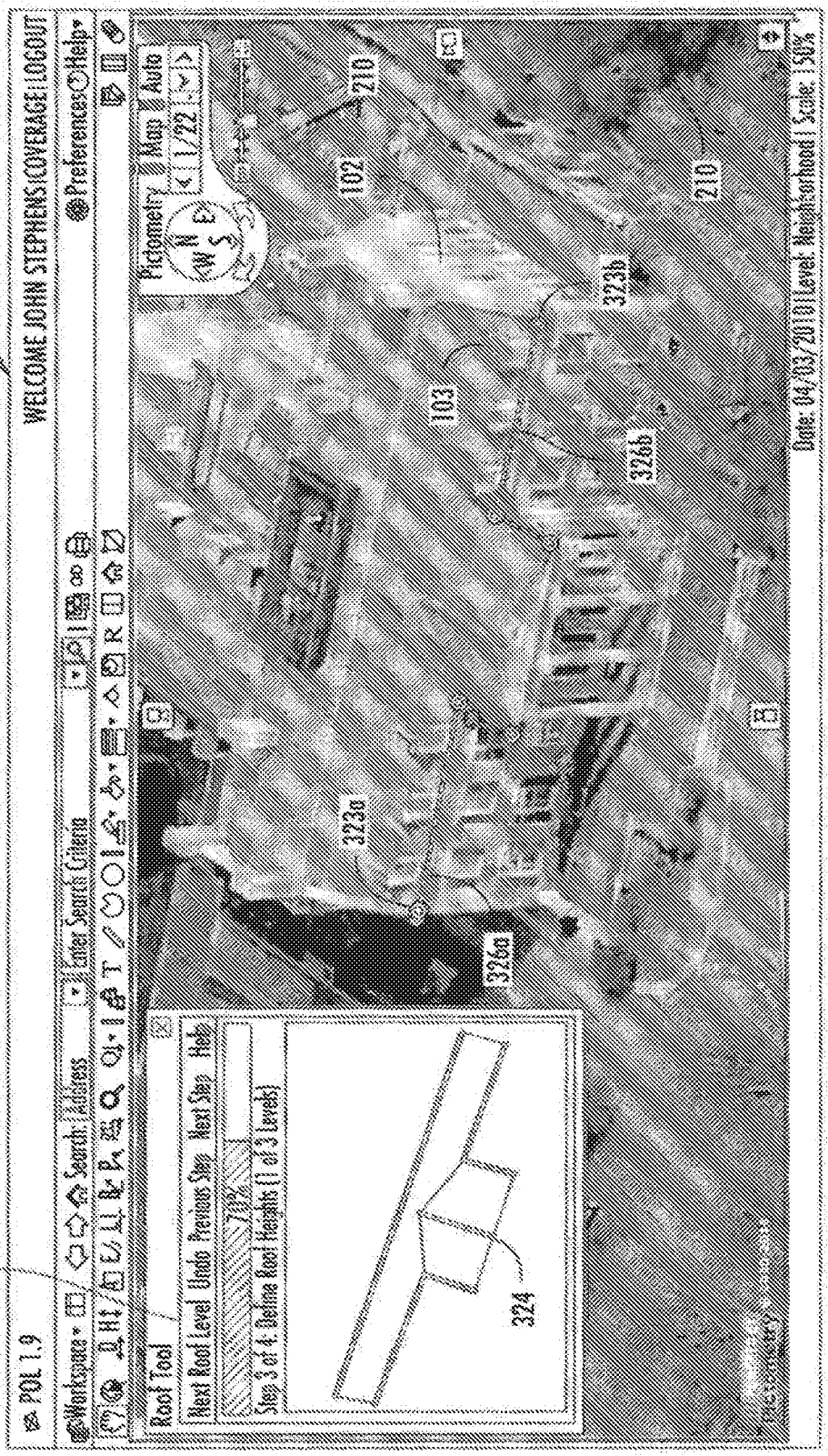

100
323
WELCOME JOHN STEPHENS|COVERAGE|LOGOUT
POL 1.9
Workspace
Search Address
Enter Search Criteria
Preferences
Help
Roof Tool
Next Roof Level
Undo Previous Step
Next Step
Help
Step 3 of 4: Define Roof Heights (1 of 3 Levels)
324
326a
323a
103
102
210
326b
323b
Pictometry
Map
Auto
Date: 04/03/2010 | Level: Neighborhood | Scale: 150%

FIG. 7B

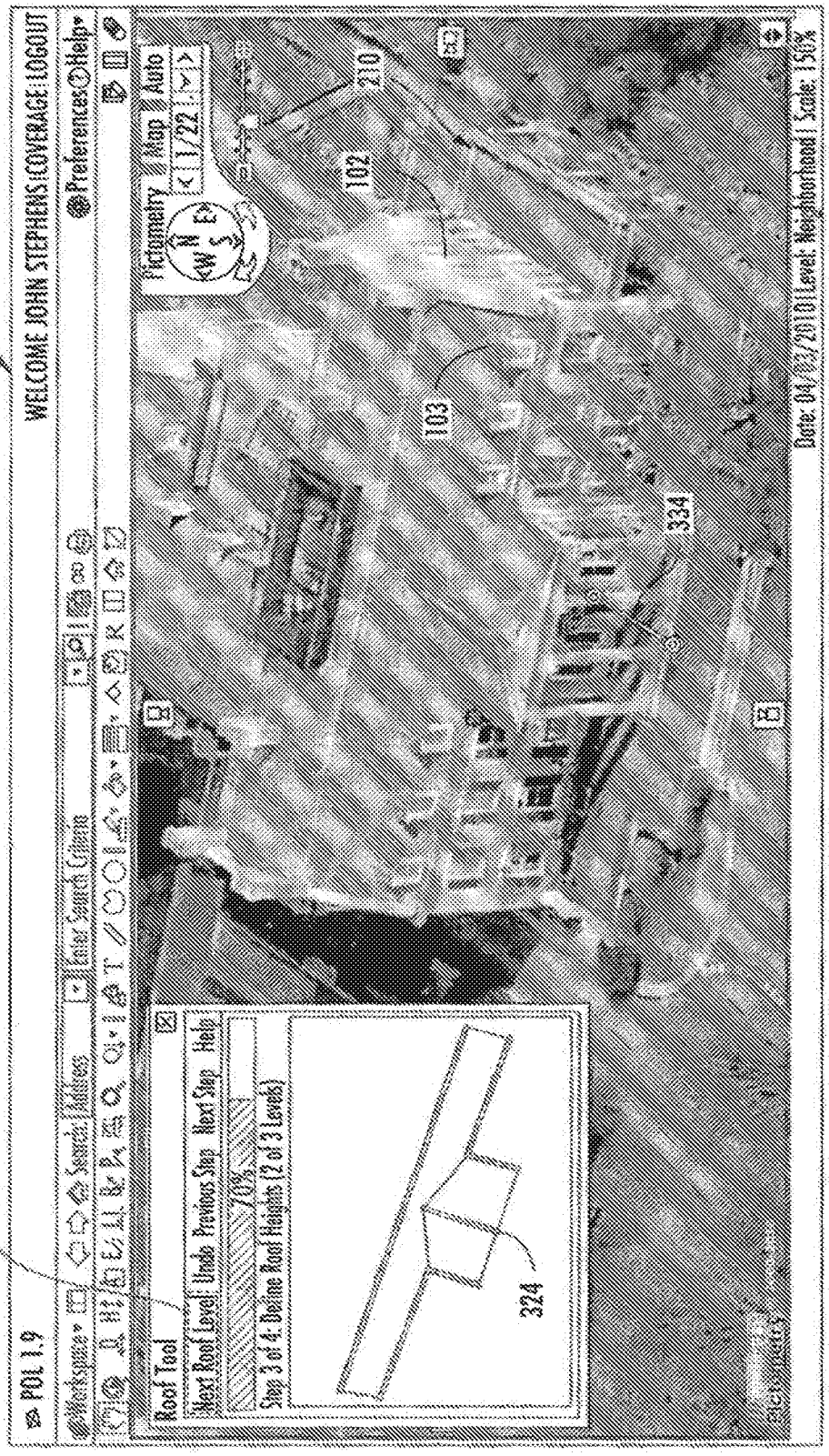

100
333
WELCOME JOHN STEPHENS | COVERAGE | LOGOUT
POL 1.9
Preferences
Help
Search Address
Enter Search Criteria
Roof Tool
Next Roof Level
Undo Previous Step
Next Step
Help
Step 3 of 4: Define Roof Heights (2 of 3 Levels)
324
102
103
210
334
Pictometry
Map
Auto
Date: 04/03/2011 | Level: Neighborhood | Scale: 156'

FIG. 8A

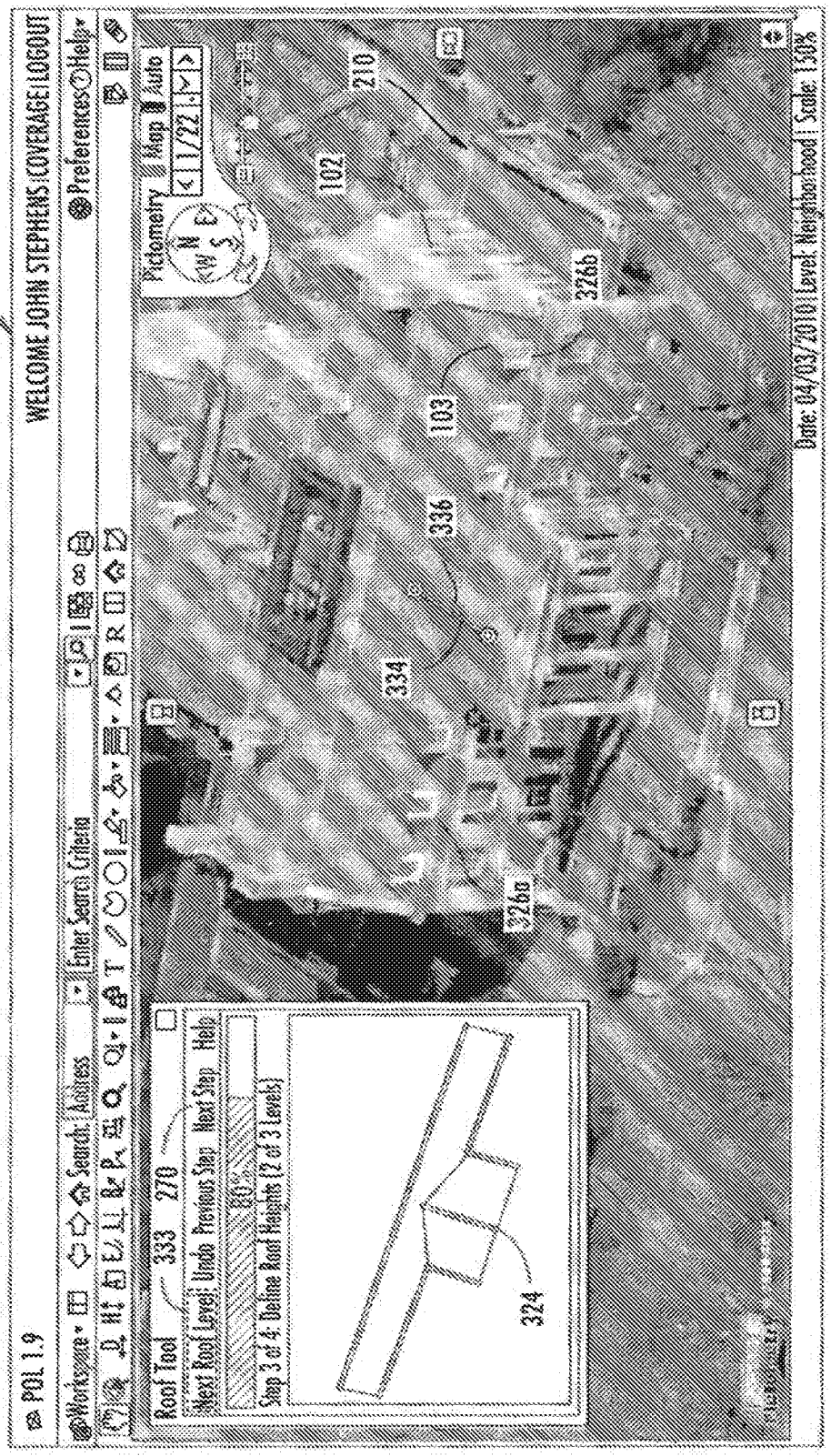

100
POL 1.9
WELCOME JOHN STEPHENS | COVERAGE | LOGOUT
Workspace
Search
Address
Enter Search Criteria
Preferences
Help
Roof Tool
333
270
Next Roof Level | Undo | Previous Step | Next Step | Help
Step 3 of 4: Define Roof Heights (2 of 3 Levels)
324
102
210
103
336
334
326a
326b
Pictometry
Map
Auto
Date: 04/03/2010 | Level: Neighborhood | Scale: 130ft

FIG. 8B

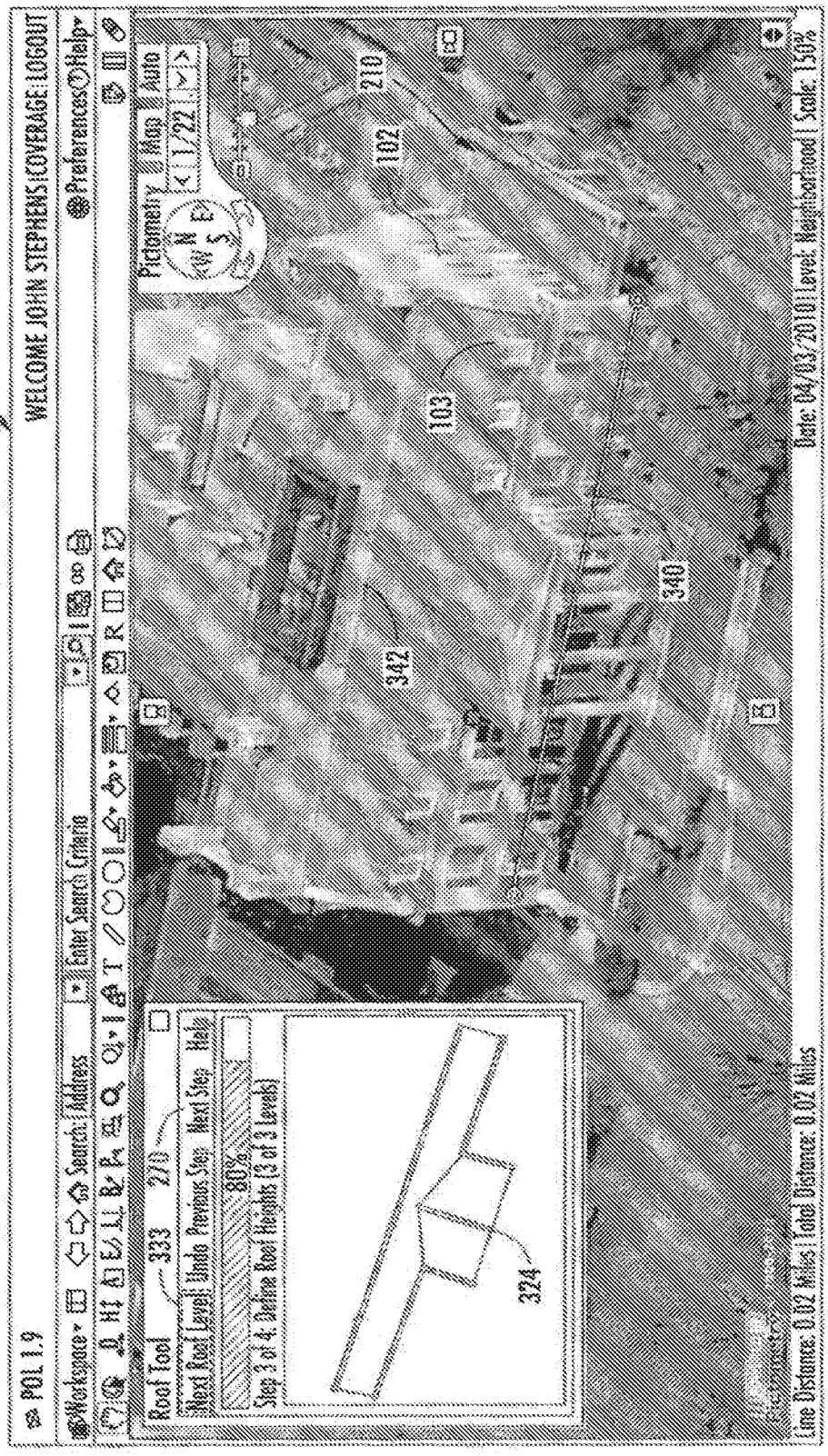

100
WELCOME JOHN STEPHENS | COVERAGE | LOGOUT
POL 1.9
Workspace
Search Address
Enter Search Criteria
Preferences
Help
Roof Tool
333
210
Next Roof Level | Undo Previous Step | Next Step | Help
80%
Step 3 of 4: Define Roof Heights (3 of 3 Levels)
324
342
340
103
102
210
Pictometry
Map
Auto
1/22
Line Distance: 0.02 Miles | Total Distance: 0.02 Miles
Date: 04/03/2010 | Level: Neighborhood | Scale: 150%

FIG 9A

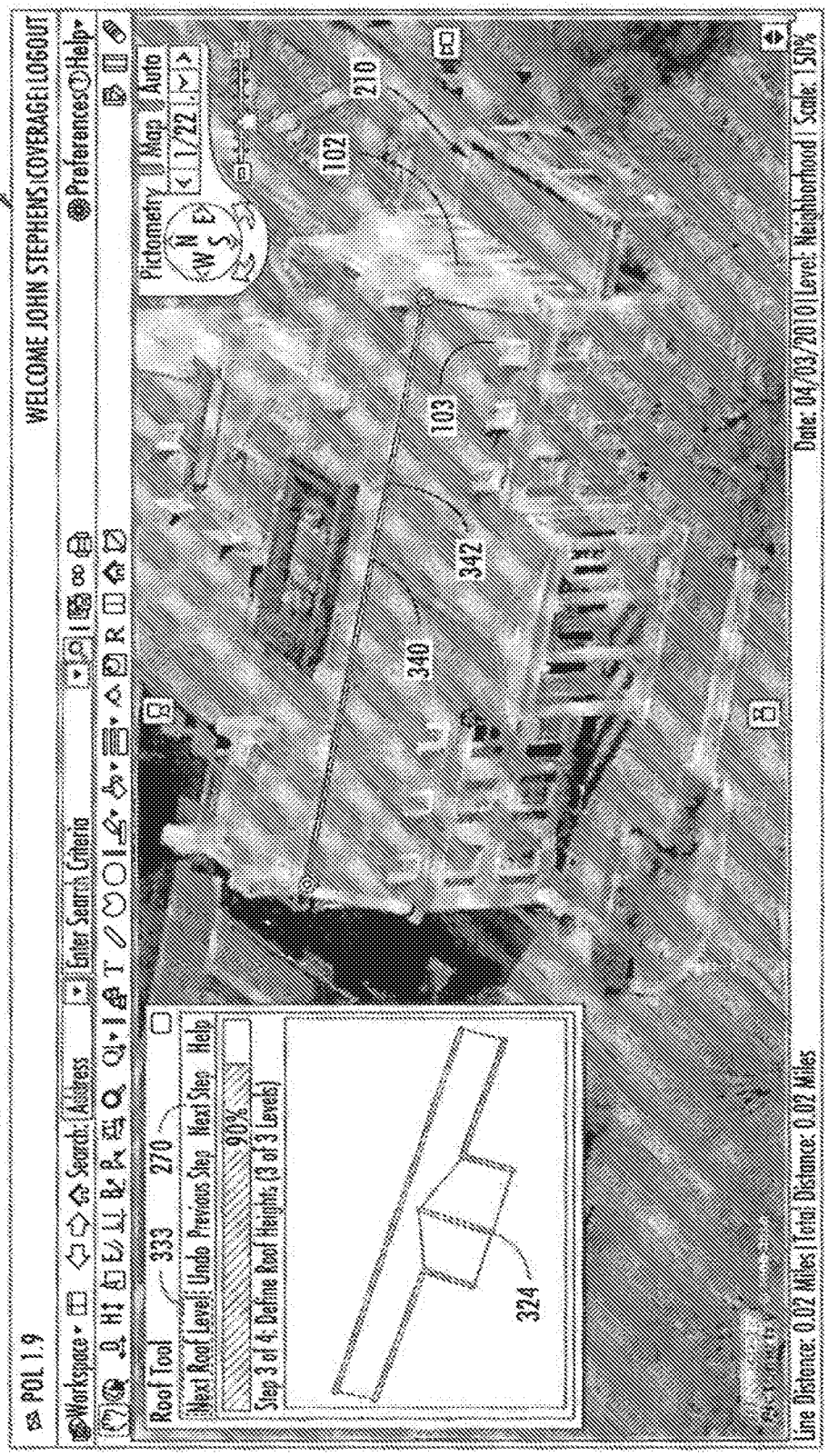

100
WELCOME JOHN STEPHENS | COVERAGE | LOGOUT
POL 1.9
Workspace
Search Address
Enter Search Criteria
Preferences | Help
Roof Tool
333
270
Next Roof Level | Undo Previous Step | Next Step | Help
90%
Step 3 of 4: Define Roof Heights (3 of 3 Levels)
324
340
342
102
103
210
Pictometry | Map | Auto
1/22
Line Distance: 0.02 Miles | Total Distance: 0.02 Miles
Date: 04/03/2010 | Level: Neighborhood | Scale: 150%

FIG. 9B

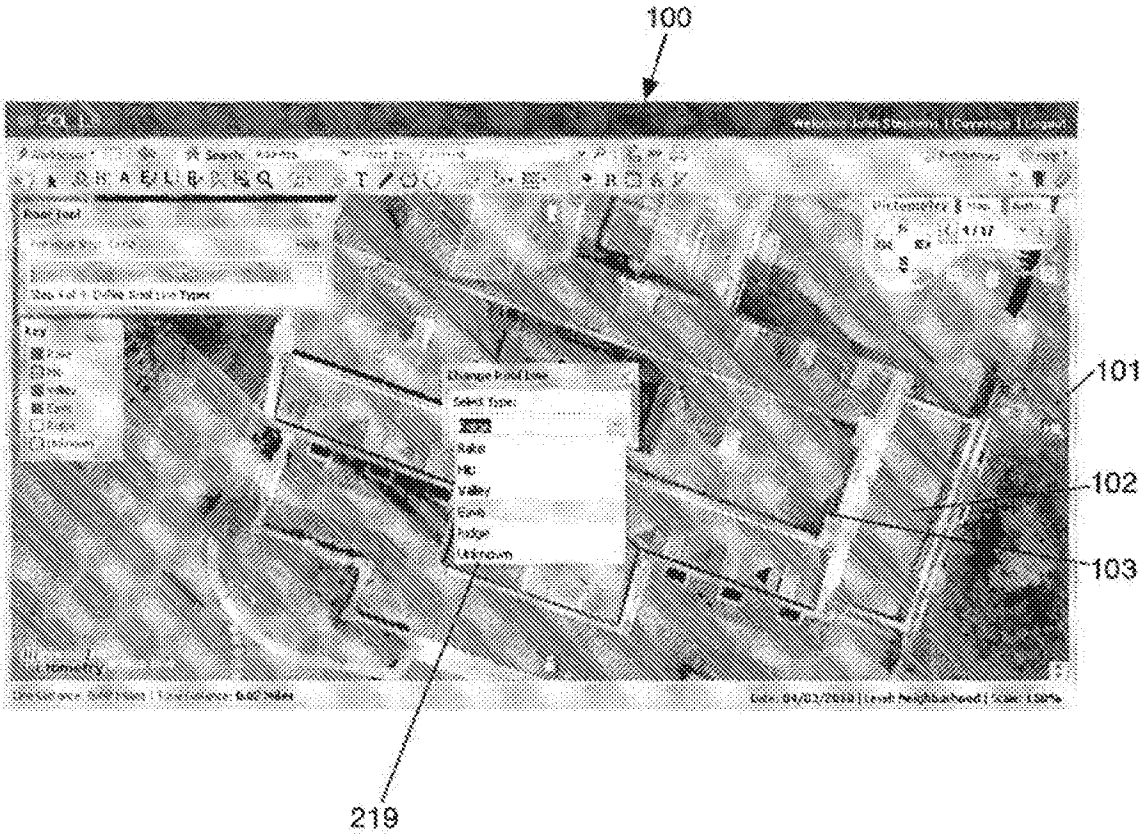


FIG. 10

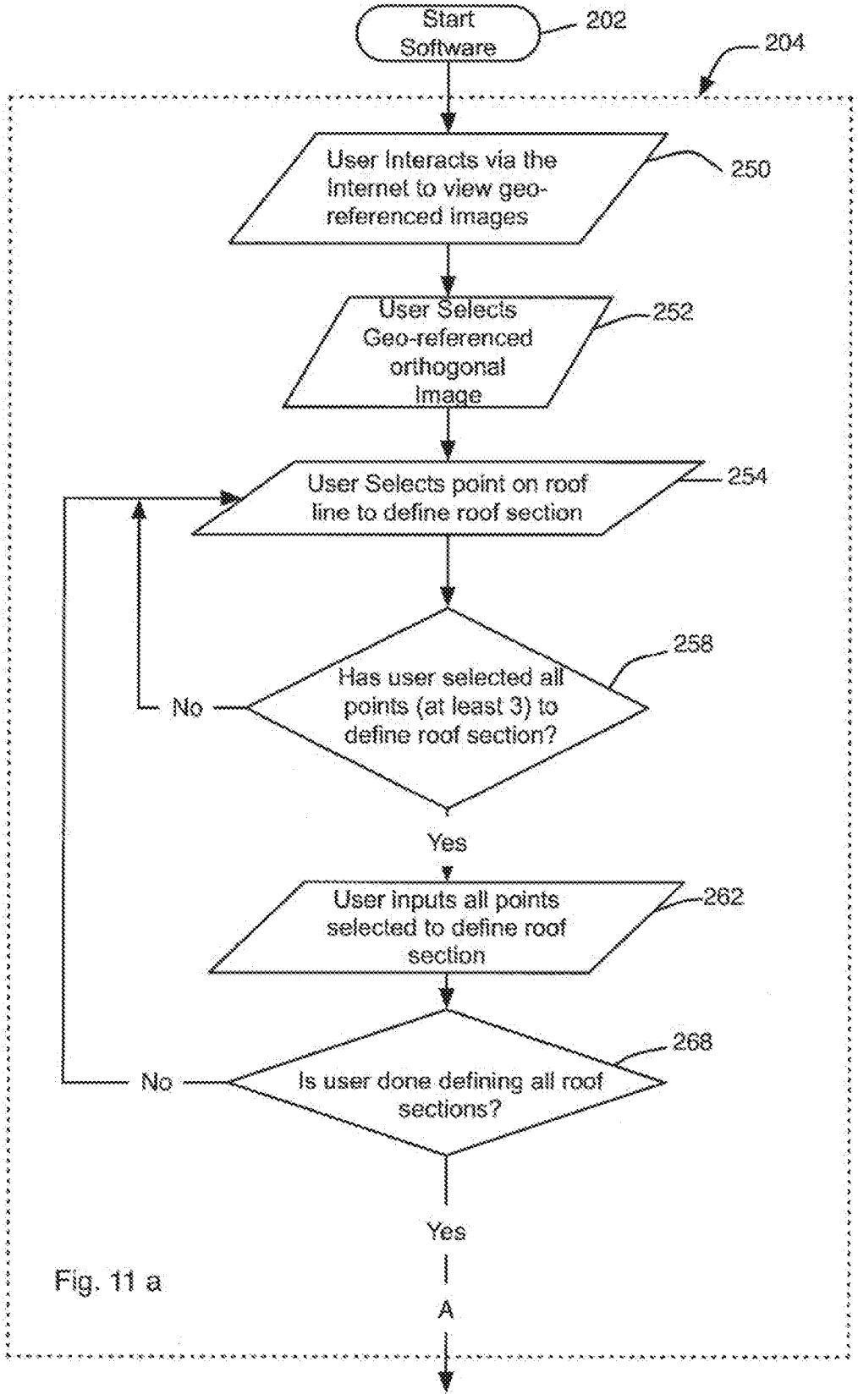

Start Software
202
204
User Interacts via the Internet to view geo-referenced images
250
User Selects Geo-referenced orthogonal Image
252
User Selects point on roof line to define roof section
254
Has user selected all points (at least 3) to define roof section?
258
No
Yes
User inputs all points selected to define roof section
262
Is user done defining all roof sections?
268
No
Yes
A

Fig. 11 a

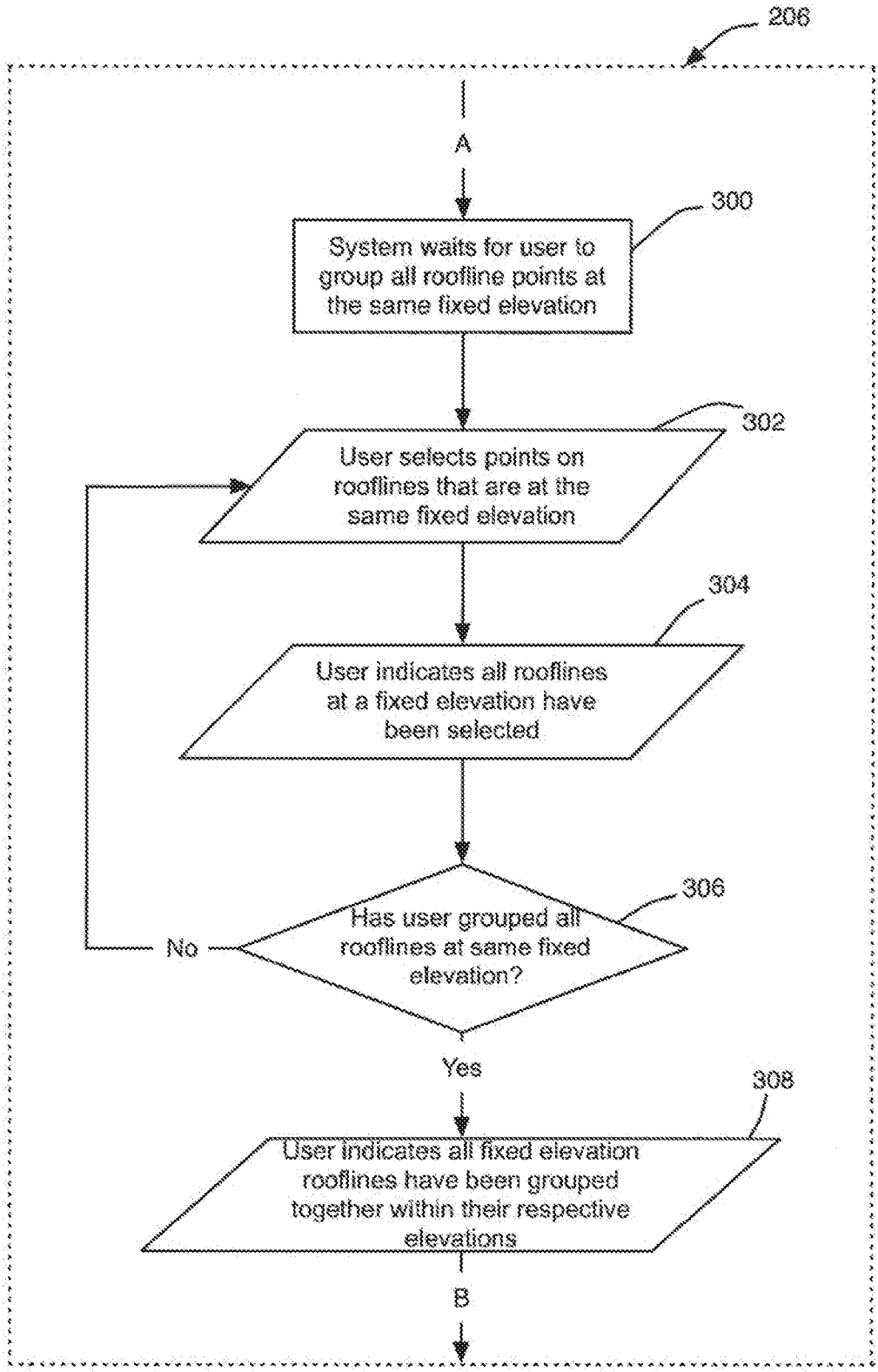

206
A
300
System waits for user to group all roofline points at the same fixed elevation
302
User selects points on rooflines that are at the same fixed elevation
304
User indicates all rooflines at a fixed elevation have been selected
306
Has user grouped all rooflines at same fixed elevation?
No
Yes
308
User indicates all fixed elevation rooflines have been grouped together within their respective elevations
B

Fig. 11 b

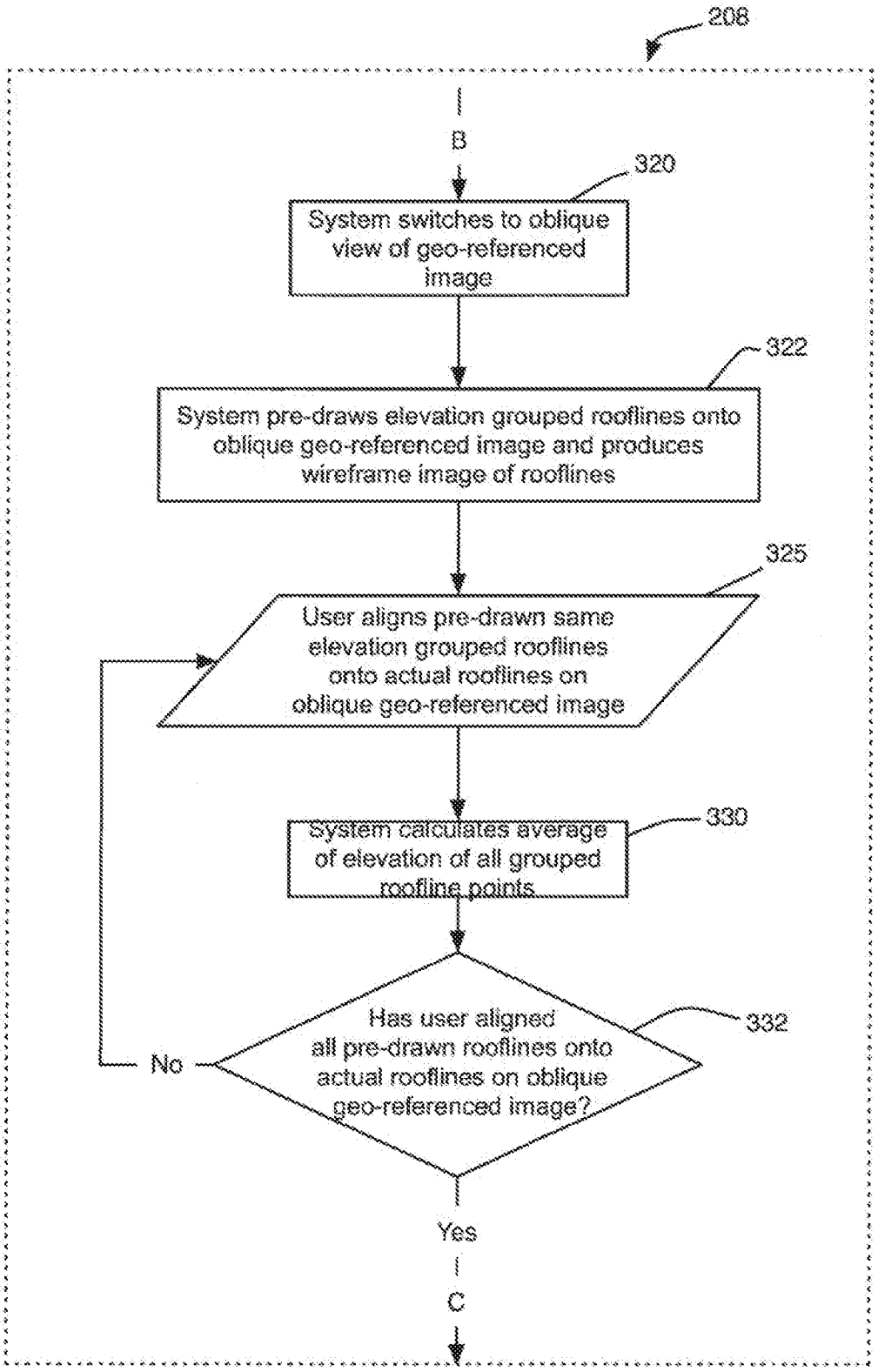

208
B
320
System switches to oblique view of geo-referenced image
322
System pre-draws elevation grouped rooflines onto oblique geo-referenced image and produces wireframe image of rooflines
325
User aligns pre-drawn same elevation grouped rooflines onto actual rooflines on oblique geo-referenced image
330
System calculates average of elevation of all grouped roofline points
332
Has user aligned all pre-drawn rooflines onto actual rooflines on oblique geo-referenced image?
No
Yes
C

Fig. 11 c

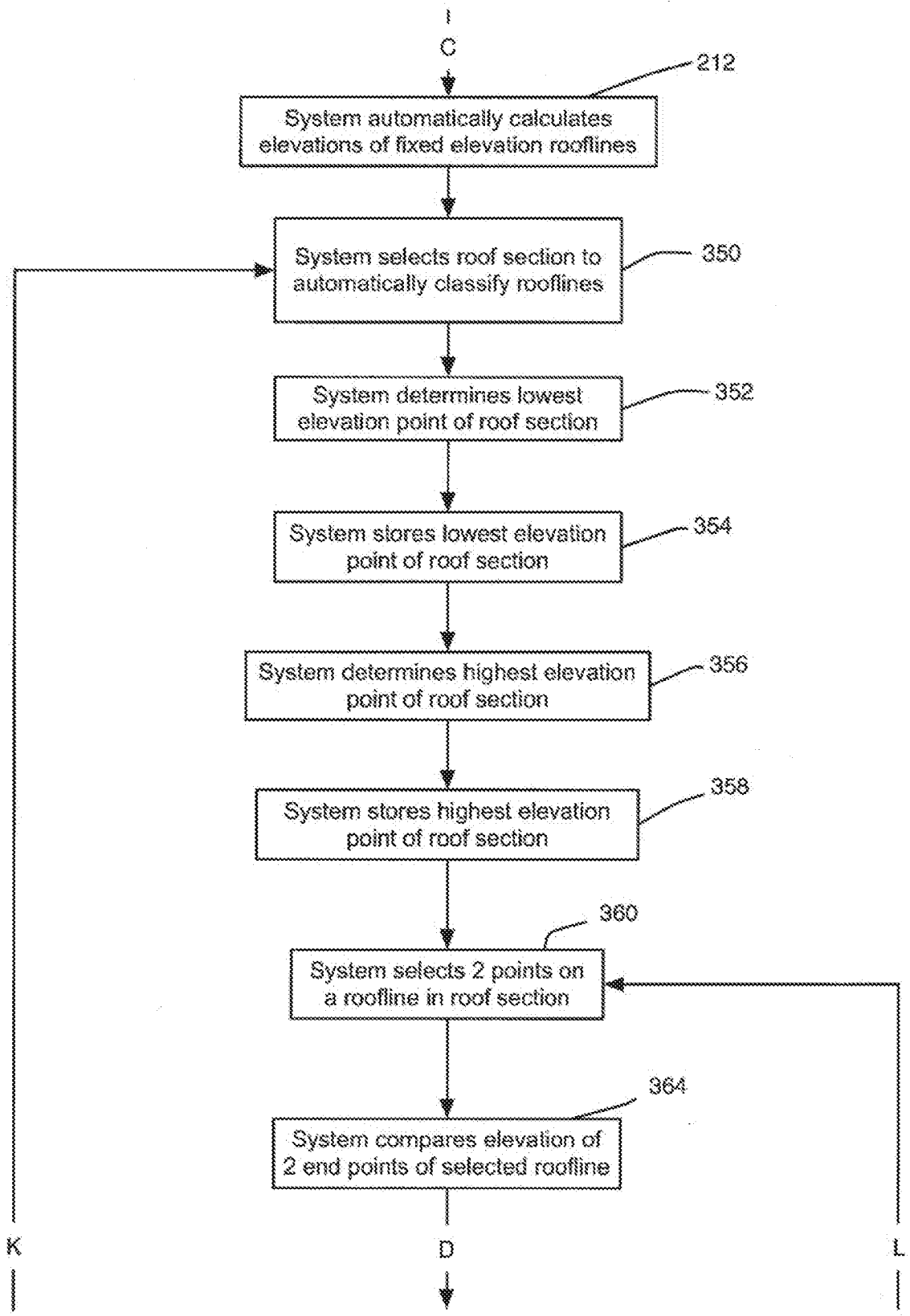

I
C
212
System automatically calculates elevations of fixed elevation rooflines
System selects roof section to automatically classify rooflines
350
System determines lowest elevation point of roof section
352
System stores lowest elevation point of roof section
354
System determines highest elevation point of roof section
356
System stores highest elevation point of roof section
358
360
System selects 2 points on a roofline in roof section
364
System compares elevation of 2 end points of selected roofline
K
D
L

Fig. 11 d

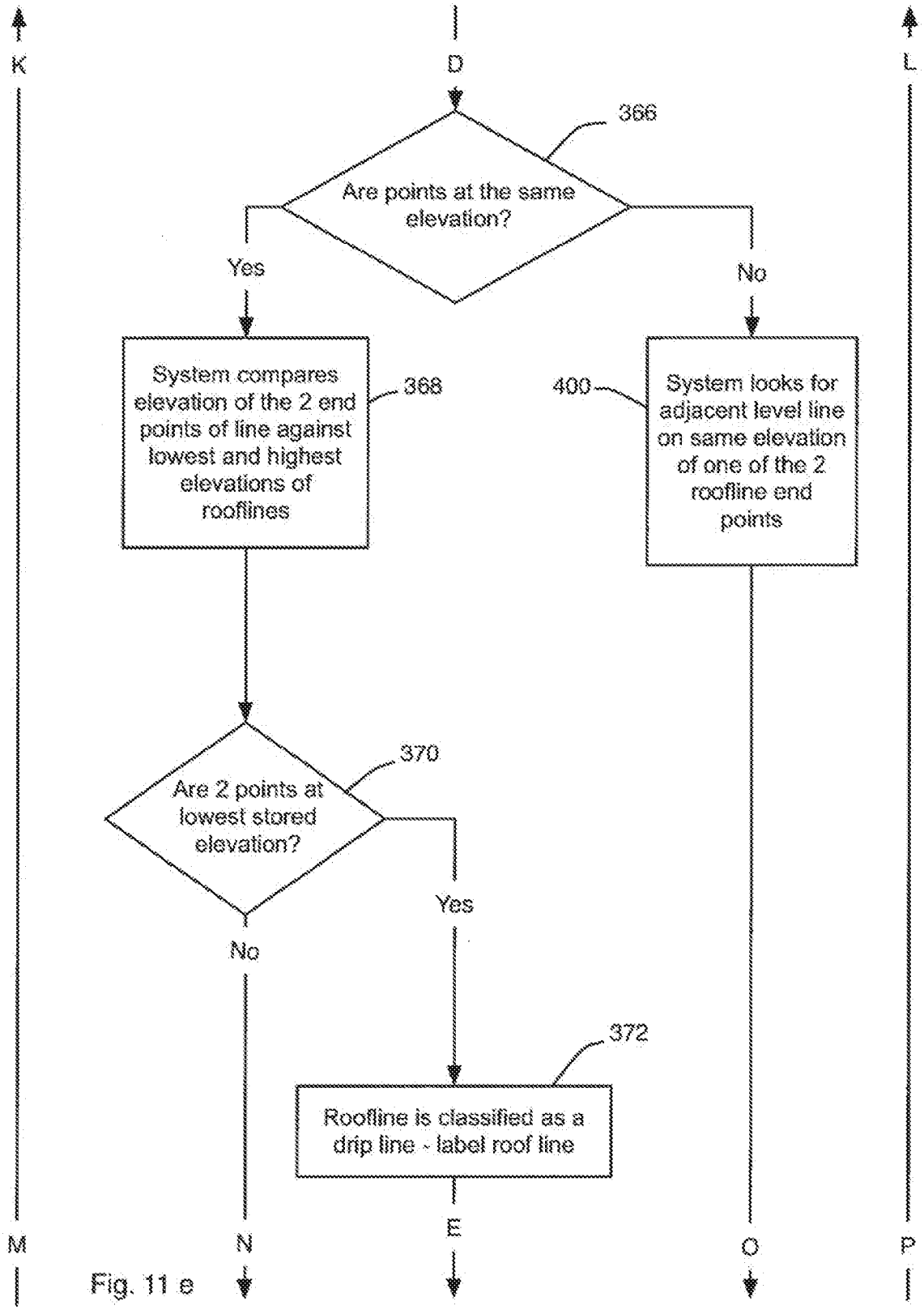

K
D
L
366
Are points at the same elevation?
Yes
No
System compares elevation of the 2 end points of line against lowest and highest elevations of rooflines
368
400
System looks for adjacent level line on same elevation of one of the 2 roofline end points
370
Are 2 points at lowest stored elevation?
Yes
No
372
Roofline is classified as a drip line - label roof line
M
N
E
O
P

Fig. 11 e

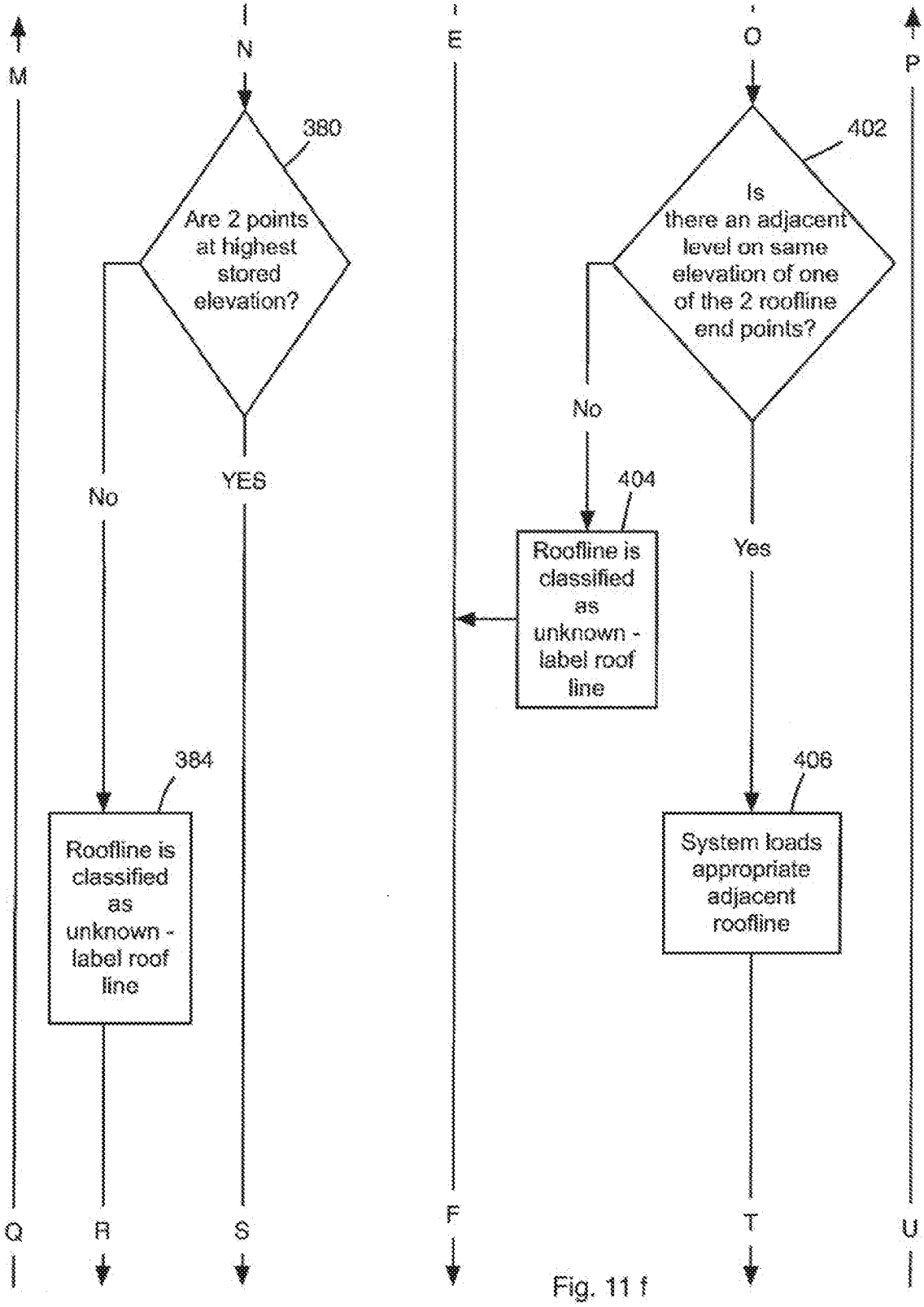

M
N
380
Are 2 points at highest stored elevation?
No
YES
384
Roofline is classified as unknown - label roof line
Q
R
S
E
O
P
402
Is there an adjacent level on same elevation of one of the 2 roofline end points?
No
Yes
404
Roofline is classified as unknown - label roof line
406
System loads appropriate adjacent roofline
F
T
U

Fig. 11 f

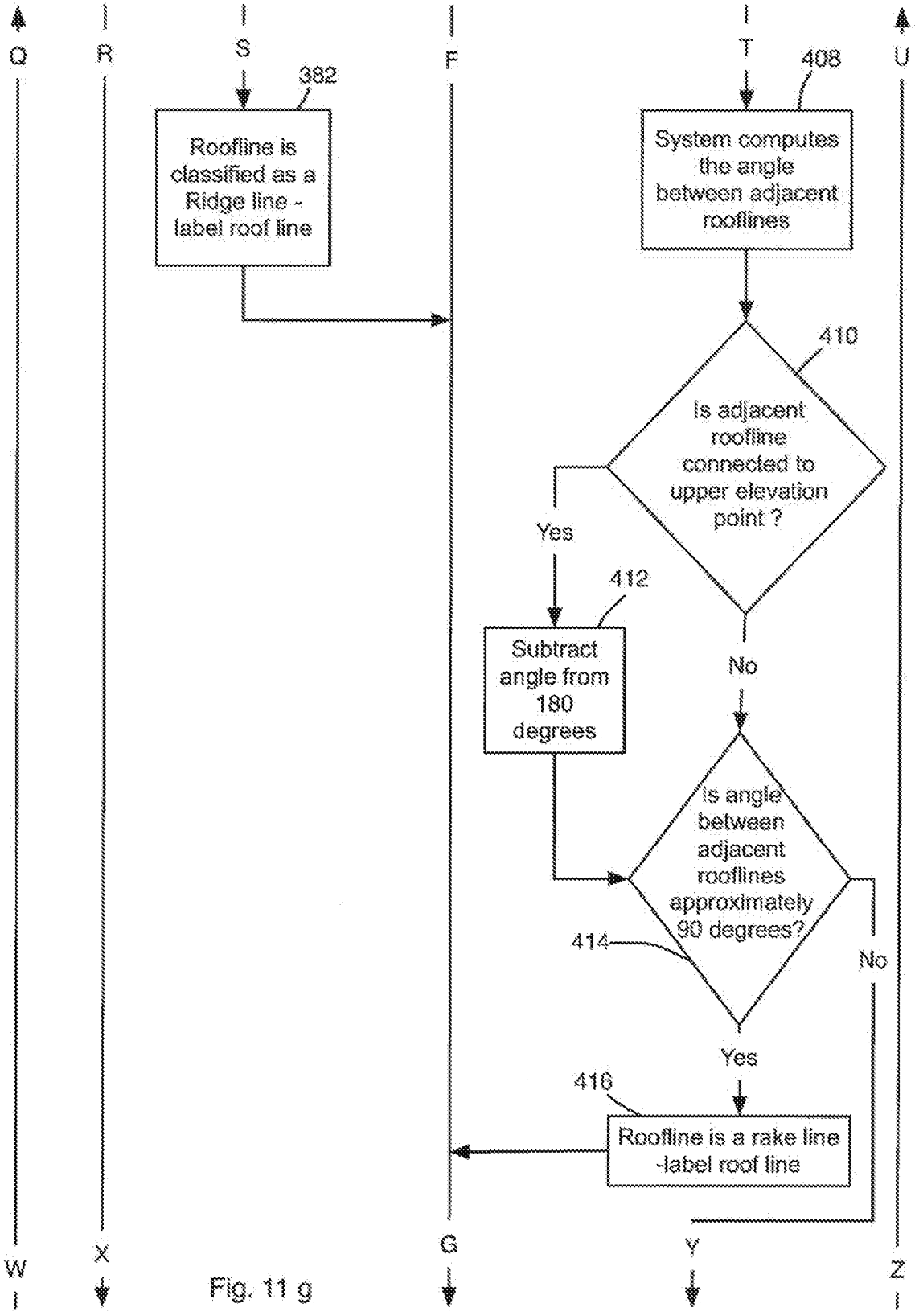

Q
R
S
F
T
U
382
Roofline is classified as a Ridge line - label roof line
408
System computes the angle between adjacent rooflines
410
Is adjacent roofline connected to upper elevation point ?
Yes
412
Subtract angle from 180 degrees
No
Is angle between adjacent rooflines approximately 90 degrees?
414
No
Yes
416
Roofline is a rake line -label roof line
W
X
G
Y
Z

Fig. 11 g

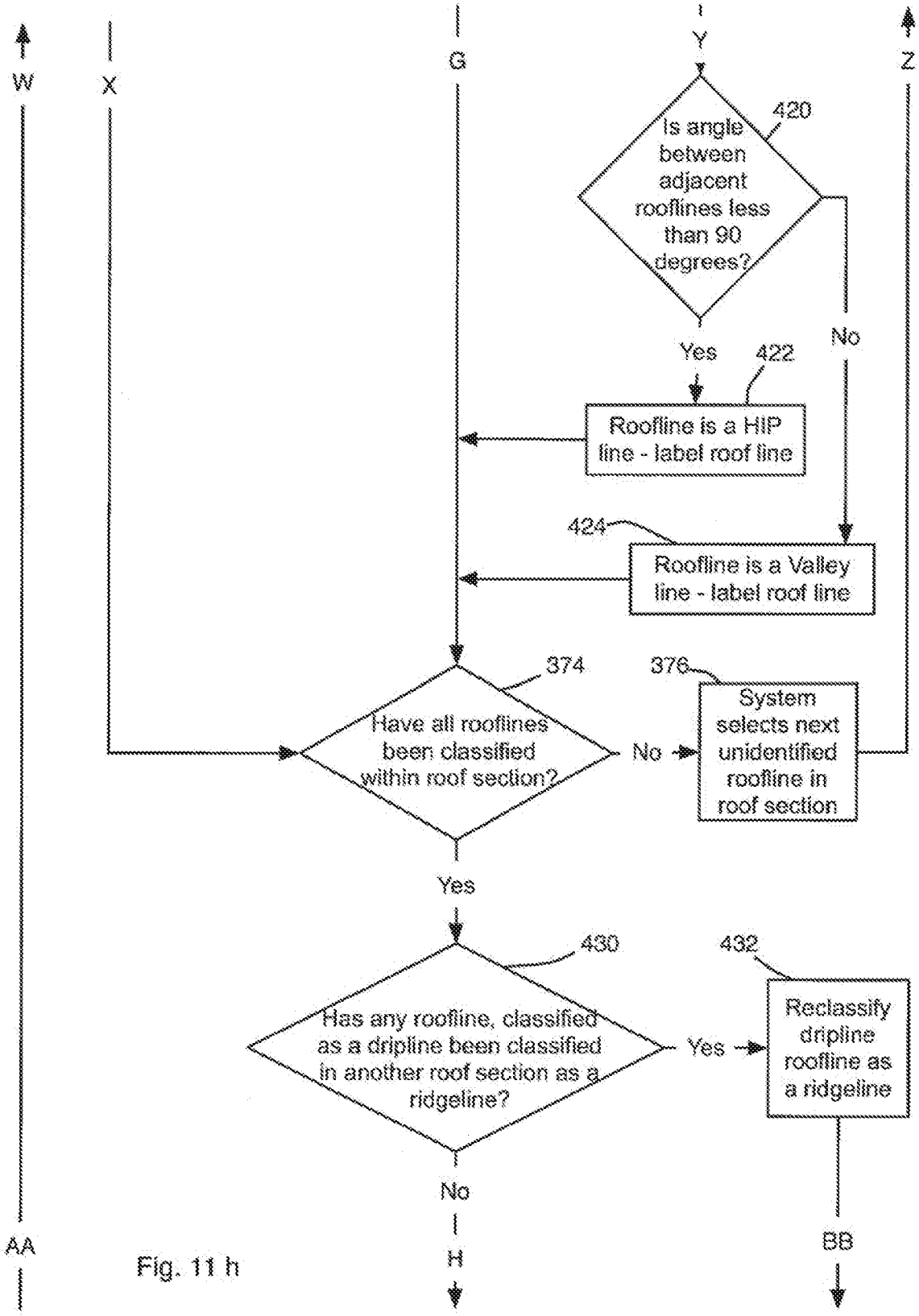

W
X
G
Y
Z
Is angle between adjacent rooflines less than 90 degrees?
420
Yes
No
422
Roofline is a HIP line - label roof line
424
Roofline is a Valley line - label roof line
374
Have all rooflines been classified within roof section?
No
376
System selects next unidentified roofline in roof section
Yes
430
Has any roofline, classified as a dripline been classified in another roof section as a ridgeline?
Yes
432
Reclassify dripline roofline as a ridgeline
No
AA
H
BB

Fig. 11 h

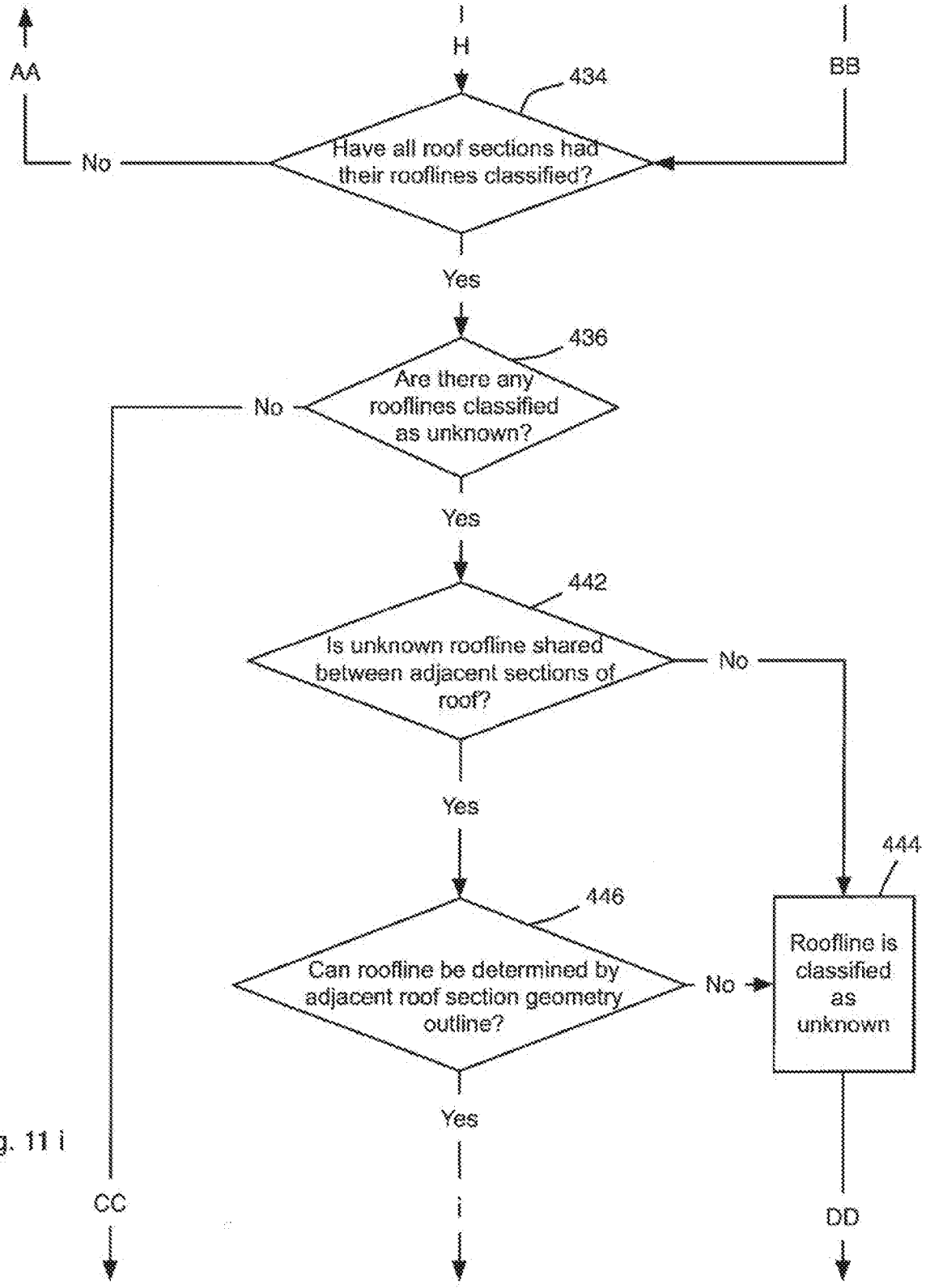

AA
H
BB
434
Have all roof sections had their rooflines classified?
No
Yes
436
Are there any rooflines classified as unknown?
No
Yes
442
Is unknown roofline shared between adjacent sections of roof?
No
Yes
444
446
Can roofline be determined by adjacent roof section geometry outline?
No
Roofline is classified as unknown
Yes
CC
i
DD

Fig. 11 i

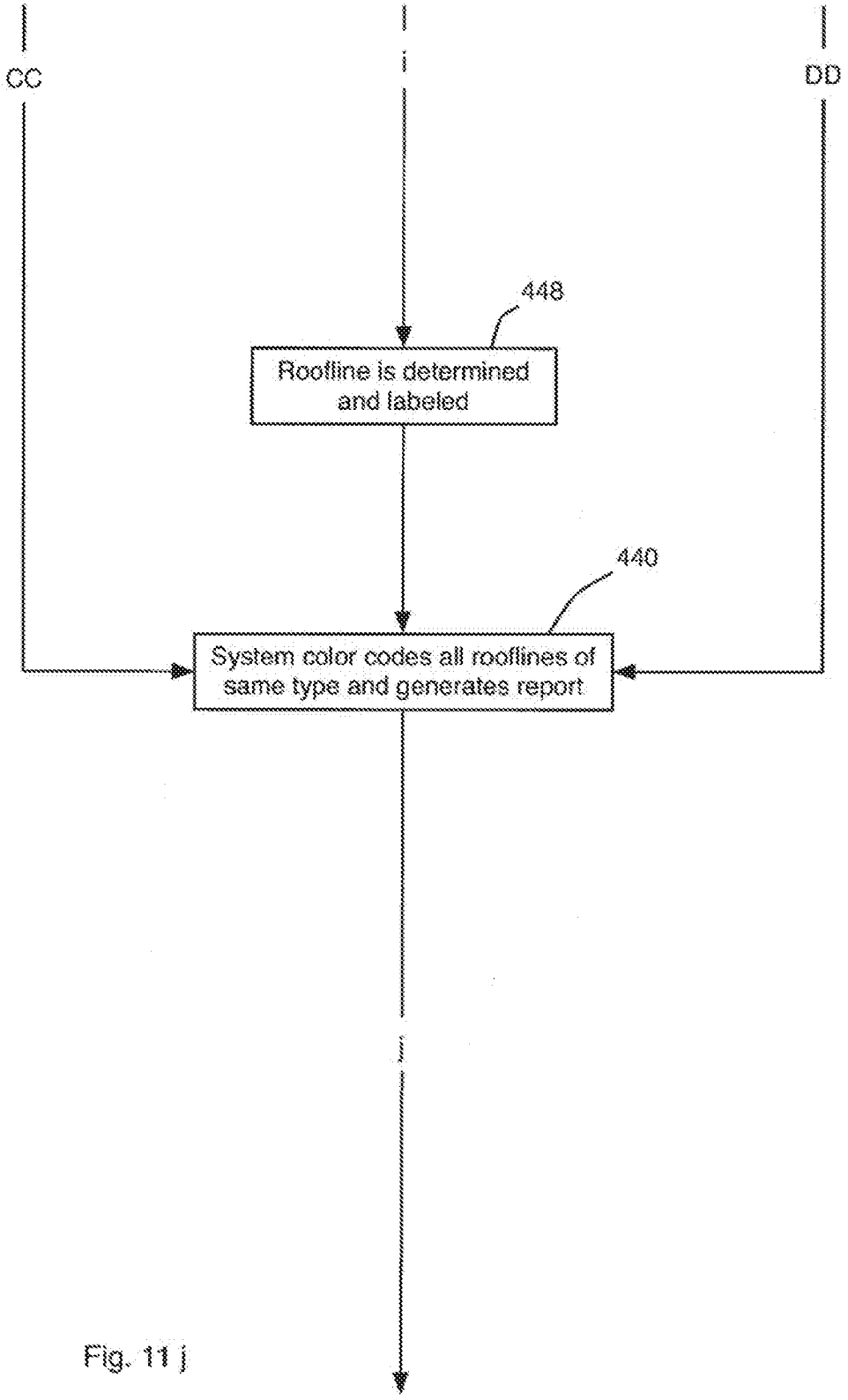

CC
i
DD
448
Roofline is determined and labeled
440
System color codes all rooflines of same type and generates report
j

Fig. 11 j

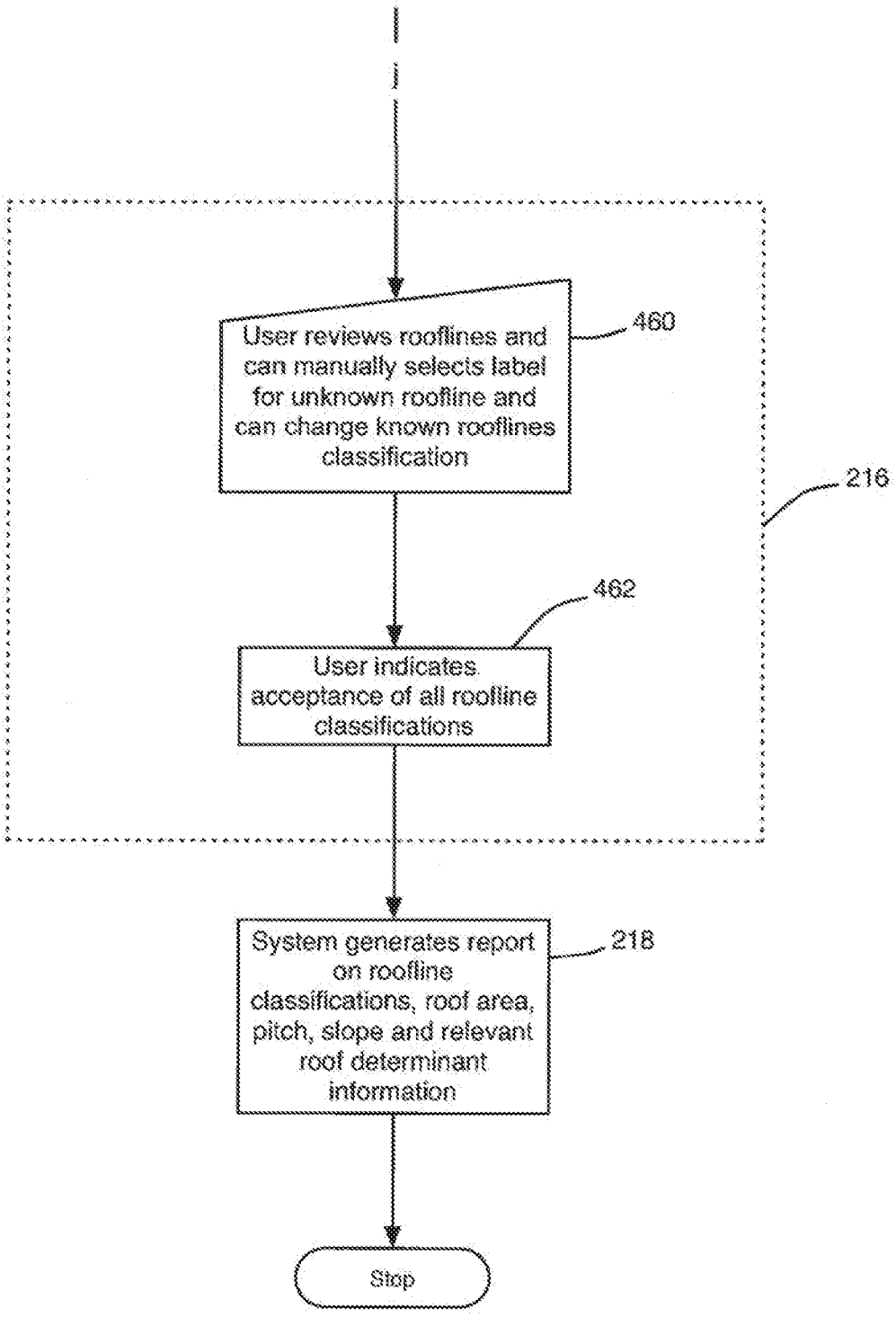

User reviews rooflines and can manually selects label for unknown roofline and can change known rooflines classification
460
216
462
User indicates acceptance of all roofline classifications
System generates report on roofline classifications, roof area, pitch, slope and relevant roof determinant information
218
Stop

Fig. 11 k

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International Bureau

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WIPO | PCT

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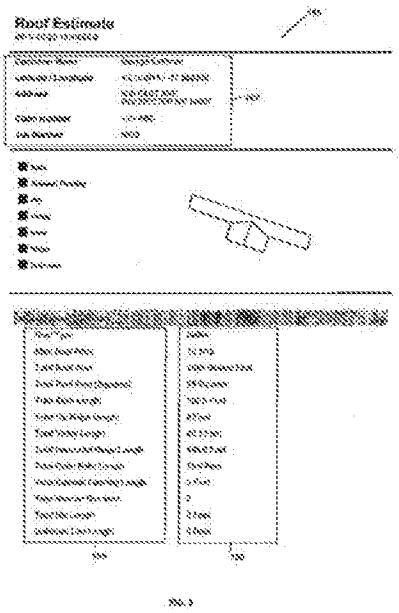
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[Continued on next page]

(54) Title: COMPUTER SYSTEM FOR AUTOMATICALLY CLASSIFYING ROOF ELEMENTS



(57) Abstract: A set of instructions stored on at least one computer readable medium for running on a computer system. The set of instructions includes instructions for identifying line segments of a roof that is preferably displayed within a geo-referenced image, instructions for determining three-dimensional information of the line segments including position, orientation and length of the line segments preferably utilizing the geo-referenced image, and instructions for classifying, automatically, at least one of the line segments as one of a plurality of predefined roof elements utilizing at least one of the relative position and orientation of the line segments.

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— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

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28 June 2012

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2011/055107

A. CLASSIFICATION OF SUBJECT MATTER

G06F 9/44(2006.01)i, G06F 17/50(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

G06F 9/44; G06G 7/48; G06T 15/00; G06K 9/62; G06K 9/00; G06Q 10/00; G09G 5/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & Keywords: roof estimate, line segments, three-dimensional model, classifying roof elements

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2009-0122436 A1 (PERSHING CHRIS et al.) 21 May 2009 See the abstract, paras.[0023],[0038],[0052],[0054],[0057],[0060],[0082] and figs.5C,6,8.	1-4,15
A	US 2003-0147553 A1 (LIANG-CHIEN CHEN et al.) 07 August 2003 See the abstract, paras.[0017],[0069] and fig.10.	1-4,15
A	US 2006-0061566 A1 (VIVEK VERMA et al.) 23 March 2006 See the abstract, paras.[0032],[0034]-[0039] and figs.1,2,10.	1-4,15
A	US 2008-0021683 A1 (RAMPS, MARK et al.) 24 January 2008 See the abstract, paras.[0026],[0027],[0033]-[0034], claim 14 and fig.6.	1-4,15

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
07 MAY 2012 (07.05.2012)	**08 MAY 2012 (08.05.2012)**

Name and mailing address of the ISA/KR	Authorized officer
Korean Intellectual Property Office Government Complex-Daejeon, 189 Cheongsa-ro, Seo-gu, Daejeon 302-701, Republic of Korea	Park Ji Eun
Facsimile No. 82-42-472-7140	Telephone No. 82-42-481-5696

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2011/055107

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☒ Claims Nos.: 11, 12, 13
because they relate to subject matter not required to be searched by this Authority, namely.

Claims 11-13 directed to methods of human acts (making, selling, distributing and providing) are considered to be methods of doing business and relate to subject matter which the International Searching Authority is not required to search under PCT Article 17(2)(a)(i) and PCT Rule 39.1(iii).

2. ☒ Claims Nos.: 6, 7, 14, 16
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

Claims 6, 7, 14, and 16 are unclear because they refer to multiple dependent claims 5, 8, 9, or 10] which do not comply with PCT Rule 6.4(a).

3. ☒ Claims Nos.: 5, 8-10
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

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(54) Title: SYSTEM AND METHOD FOR CONSTRUCTION ESTIMATION USING AERIAL IMAGES

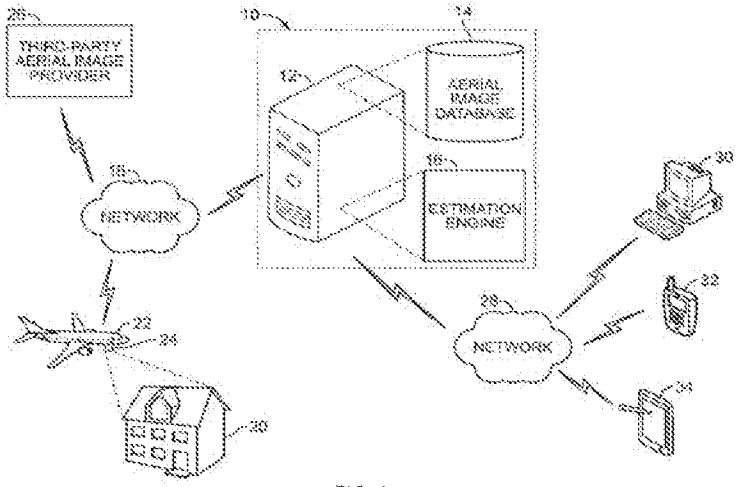


FIG. 1

(57) Abstract: A system and method for construction estimation using aerial images is provided. The system receives at least one aerial image of a building. An estimation engine processes the aerial image at a plurality of angles to automatically identify a plurality (e.g., perimeter and interior) lines in the image corresponding to a plurality of features of a roof the building. The estimation engine allows users to generate two-dimensional and three- dimensional models of the roof by automatically delineating various roof features, and generates a report including information about the roof of the building.

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SYSTEM AND METHOD FOR CONSTRUCTION ESTIMATION USING AERIAL IMAGES

SPECIFICATION

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

The present invention relates generally to the field of construction estimation. More specifically, the present invention relates to a system and method for construction estimation using aerial images.

RELATED ART

In the construction and insurance industries, accurate and rapid estimation of construction materials and costs is important. For example, such information is often used by construction professionals to specify materials and associated costs for both newly-constructed buildings, as well as for replacing and upgrading existing structures. Further, in the insurance industry, accurate information about construction materials and costs is critical to determining the proper costs for insuring buildings/structures.

It is of particular importance in the construction and insurance industries to quickly and accurately estimate various parameters regarding roof structures, such as roof dimensions, pitches, surfaces, areas, and associated material costs. To this end, various software systems have been implemented to estimate roofing materials and roofing costs. Such systems process aerial images (e.g., using digital photographs taken from airplanes flying over buildings) and allow users to estimate construction materials and costs by delineating the bounds of a roof, and by calculating dimensions based upon the delineated bounds. However, such systems are time-consuming and difficult to use. Indeed, such systems often require a large amount of manual input by the user (e.g., by manually delineating roof boundaries using a mouse and graphical user interface) before a roof model or estimation report can be generated.

In view of existing technology in this field, what would be desirable is a system that processes aerial images of a building structure and automatically performs steps to quickly and efficiently assist a user in the roof estimation process. Specifically, what would be desirable is a system that automatically delineates roof boundaries in an image of a building or a structure with minimal user intervention, automatically creates a model of

the roof structure, and automatically generates a roof estimation report which includes useful information about the roof including material costs and dimensions of the roof. Accordingly, what would be desirable, but has not yet been provided, is a system and method for construction estimation using aerial images which addresses the foregoing needs.

SUMMARY OF THE INVENTION

The present invention relates to a system and method for construction estimation using aerial images. The system includes a computer system for receiving at least one aerial image of a building, and an estimation engine for processing the aerial image to estimate one or more features relating to a roof of the building, the estimation engine histogram processing the aerial image at a plurality of angles to automatically identify a plurality of lines in the image corresponding to features of a roof the building.

A method for building estimation is also provided. The method comprises the steps of receiving at a computer system at least one aerial image of a building, histogram processing the aerial image at a plurality of angles using an estimation engine in the computer system to automatically identify a plurality of lines in the image corresponding to a plurality of feature of a roof of the building, constructing a three-dimensional wireframe model of the roof using the plurality of lines, and processing the three-dimensional model of the roof using the estimation engine to generate a report including information about the roof of the building.

A non-transitory, computer-readable medium is also provided. The computer readable medium includes computer-readable instructions stored thereon which, when executed by a computer system, cause the computer system to perform the steps comprising receiving at a computer system at least one aerial image of a building, histogram processing the aerial image at a plurality of angles using an estimation engine in the computer system to automatically identify a plurality of lines in the image corresponding to a plurality of feature of a roof of the building, constructing a three-dimensional wireframe model of the roof using the plurality of lines, and processing the three-dimensional model of the roof using the estimation engine to generate a report including information about the roof of the building.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing features of the invention will be apparent from the following Detailed Description of the Invention, taken in connection with the accompanying drawings, in which:

FIG. 1 is a diagram showing the system of the present invention for construction estimation using aerial images;

FIG. 2 is a flowchart showing overall processing steps carried out by the system of the present invention;

FIGS. 3A-3L are screenshots showing operation of the system of the present invention in detail;

FIGS. 4A-4B are views of a sample estimation report generated by the present invention;

FIG. 5 is a flowchart showing processing steps carried out by the present invention for processing an aerial image to automatically identify roof lines; and

FIGS. 6A-6K are views illustrating the steps of **FIG. 5** for processing an aerial image to automatically identify roof lines.

DETAILED DESCRIPTION OF THE INVENTION

The present invention relates to a system and method for construction estimation using aerial images, as discussed in detail below in connection with **FIGS. 1-6K**.

FIG. 1 is a diagram showing the system of the present invention, indicated generally at **10**. The system **10** comprises a computer system **12** (e.g., a server) having an aerial image database **14** stored therein and an estimation software engine (module) **16**. The database **14** could be stored on the computer system **12**, or located externally (e.g., in a separate database server in communication with the system **10**). As will be discussed in greater detail below, the estimation engine **16** allows users to generate three-dimensional models of roofs and buildings/structures to estimate dimensions of such structures as well as material costs and other parameters. Importantly, the estimation engine **16** allows users to easily generate such models by automatically delineating various roof structures such as eaves, hips, ridges, valleys, etc.

The system **10** can communicate through a network **18** with one or more of a variety of image providers to obtain aerial images or photographs of a building structure **20** and can store them in the aerial image database **14** in any suitable format, such as JPEG, TIFF, GIF, etc. Network communication could be over the Internet using standard TCP/IP communications protocols (e.g., hypertext transfer protocol (HTTP), secure HTTP (HTTPS), file transfer protocol (FTP), electronic data interchange (EDI), etc.), through a private network connection (e.g., wide-area network (WAN) connection, e-mails, electronic data interchange (EDI) messages, extensible markup language (XML) messages, file transfer protocol (FTP) file transfers, etc.), or any other suitable wired or wireless electronic communications format.

Image providers that the computer system **12** could communicate with include, but are not limited to, an airplane **22** having a camera **24** capable of capturing images of the structure **20**, and/or a third-party aerial image provider **26**, such as Pictometry, Google, or Bing. Although images of any quality can be used, high-quality images free from obstructions (e.g., trees, shadows, snow, etc.) are preferred.

The computer system **12** could be any suitable computer server (e.g., a server with an INTEL microprocessor, multiple processors, multiple processing cores) running any suitable operating system (e.g., Windows by Microsoft, Linux, etc.). The computer system **12** includes non-volatile storage, which could include disk (e.g., hard disk), flash memory, read-only memory (ROM), erasable, programmable ROM (EPROM), electrically-erasable,

programmable ROM (EEPROM), or any other type of non-volatile memory. The estimation engine **16**, discussed in greater detail below, could be embodied as computer-readable instructions stored in computer-readable media (e.g., the non-volatile memory mentioned above), and programmed in any suitable programming language (e.g., C, C++, Java, etc.).

The system **10** could be web-based and could allow for remote access to the system **10** over a network **28** (e.g., Internet, WAN, LAN, etc.) by one or more devices, such as a personal computer system **30**, a smart cellular telephone **32**, a tablet computer **34**, or other devices. It is also contemplated that at least some of the functionality of the system **10** could run locally on devices (e.g., personal computer **30**, smart cellular telephone **32**, tablet computer **34**, etc.) programmed with software in accordance with the present invention. It is conceivable that, in such circumstances, the device could communicate with a remote aerial image database over a network **28**.

FIG. 2 is a flowchart showing overall processing steps **40** carried out by the estimation engine **16** of the system **10**. Reference is also made herein to **FIGS. 3A-4B**, which are views showing operation of the estimation engine **16**. Beginning in step **42**, as shown in **FIG. 3A**, a graphical user interface **80** is generated by the estimation engine **16** and presented to a user to allow the user to select an aerial image **82** of a building or structure, preferably from the aerial image database **14**. Then, in step **44**, the user can crop the image **82** by selecting a roof **86** from the image **82** using a selection tool **84** of the graphical user interface **80**, e.g., by creating a box around the desired area. In step **46**, as shown in **FIG. 3B**, the estimation engine **16** automatically rotates the roof **86** of the cropped image **82** so that the image **82** is aligned vertically and horizontally using roof lines **88**, **90**.

The process for aligning the image **82** is described as follows. First, the processing steps discussed in detail below in connection with **FIG. 5** are carried out to automatically identify perimeter and interior roof lines in the image. Using this information, a sequence of points are identified in each direction (e.g., 360 degrees) and are defined as rays in the set {raycast}, and include top ray {top}, bottom ray {bottom}, left ray {left}, and right ray {right}. Then, for each ray in the set {raycast}, the sequence of points are divided into |raycast| – 2 subsets of two sequences made up of points {{0…1}, {2…|raycast| – 1}}, {{0…2}, {3…|raycast| - 1}} to {{0 – |raycast|…3}, {|raycast| – 2…|raycast| – 1}} where |raycast| is the length of the sequence and 0…1 is the indices of the first and second point

and 2…|raycast| - 1 is the remaining points in the sequence. For each of these subsequences {{0…n}, {n + 1…|raycast| – 1}}, the two point sets are treated as plots and their linear slope is found using linear regression. The difference between slopes is found, and only the maximum difference is retained. After iterating through every subsequence in the set {raycast}, if the maximum difference is greater than a specified threshold, the sequence is split at that point and the process is recursively repeated for each of the subsequences. Once all subsequences can no longer be divided, the length and slope of each subsequence is cached for further use. Finally, slopes are identified which are similar, and their lengths are combined. The slopes are then used to identify the roof lines **88, 90**, which are then used to align the image **82** vertically and horizontally.

Then in step **48**, as shown in **FIG. 3C**, the estimation engine **16** uses image processing algorithms to automatically identify and delineate perimeter lines **92** of the roof **86** to form a closed polygon or a bounded area. In step **50**, a user decides whether the estimation engine **16** has correctly identified the perimeter lines **92** or whether adjustments or alterations must be made. If alterations are required, step **52** occurs where, as shown in **FIG. 3D**, the user manually adjusts the perimeter lines **92** to create corrected perimeter lines **94**, such as by clicking on the corners of the roof **86** that were not correctly identified automatically. As the user clicks on or moves the cursor toward a roof feature (e.g., a corner), the estimation engine **16** could automatically suggest potential changes to the outline of the perimeter, by way of dashed lines **94** as shown in **FIG. 3D**. The user can confirm changes by clicking on the dashed lines **94**, which converts the dashed lines to solid lines.

After perimeter line alterations have been made, or if no alterations are determined to be needed in step **50**, the process proceeds to step **54** where, as shown in **FIG. 3E**, the estimation engine **16** automatically identifies and delineates interior lines **96** (e.g., ridges and valleys) and interior intersections **98** of the roof **86**. Different roof features can be identified and distinguished using lines of different colors (e.g., ridges as red lines, valleys as blue lines, etc.). The user can move the mouse cursor over certain sections of the roof, such as intersection **98**, and the system evaluates that section (e.g., by evaluating the proximity and configuration of existing adjacent points and other detected and identified lines) and automatically delineates colored dashed lines **96** as suggestions for lines to be included in the model. The user can then confirm the line, change the type of line, or reject the line. Once confirmed by the user, the dashed lines **96** are converted to solid lines **100**,

as shown in **FIG. 3F**. In step **56**, a determination is made as to whether all lines have been found. If a negative determination is made, step **54** is repeated. Otherwise, if all lines have been identified (e.g., including the lines **102**, **104**, **106** in **FIG. 3F**, as well as any other lines corresponding to roof structures), a two-dimensional wireframe of the roof is created based on the perimeter lines and interior lines discussed above.

The two-dimensional model **110** is shown in **FIG. 3G**. The model **110** can be processed, either automatically by the engine **16** or through manual user manipulation, into a three-dimensional model. Thus, in step **59**, a decision is made as to whether to automatically or manually create the three-dimensional model. If automatic creation is to be performed, a three-dimensional wireframe of the roof is created in step **61**, based on the perimeter lines and interior lines. In this regard, the estimation engine **16** creates closed polygon surfaces, as shown in **FIG. 3G**, that represent the roof faces, and then calculates and assigns an orientation (e.g., direction of slope) based on roof constraints for each face. Using a center of mass calculation, the engine **16** selects a prominent face and assigns it a default slope. The slopes of the other faces are then iteratively calculated by the engine **16** based on constraints imposed by the relationship of lines between adjacent faces and orientations of the faces. Also, the user can manually enter a slope for a specific face and the engine **16** will recalculate the slope of the adjacent faces based on the manual slope entry. A three dimensional wireframe model is then created based on the slopes, as shown in **FIG. 3H**. The process then proceeds to step **70** discussed below.

If manual creation of the three-dimensional model is to be performed, the process proceeds to step **60**, as shown in **FIG. 3I**, where an oblique image **112** is selected, preferably from the aerial database **14**. Then, in step **62**, the wireframe **110** is superimposed over the oblique image **112** either by the user or automatically by the estimation engine **16**. Then in step **64**, as shown in **FIGS. 3J-3K**, a plurality of points on the wireframe **110** are matched with a plurality of corresponding points on the roof **86** of the oblique image **112**, and the wireframe **110** is deformed as a result. The plurality of points could be on eave edges and/or at the same eave height. For example, a user could match three corners **104, 116, 118** of the wireframe **110** with three corresponding points of the roof **86** in the oblique image **112**, causing the wireframe **110** to deform accordingly. Then, the user clicks and drags the interior points of the wireframe **110** to corresponding locations on the roof **86** of the oblique image **112** (e.g., the ridge lines of the roof **86**), until the wireframe **110** outlines all of the perimeter lines and interior lines of the roof **86** in the

oblique image **112**. It is noted that this process could also be carried out automatically by the estimation engine **16**. The final, deformed wireframe is shown in **FIG. 3L**. In step **66**, the estimation engine **16** calculates roof pitches **120** based on the deformations of the superimposed wireframe **110**, as shown in **FIG. 3L**.

In step **68**, a user could optionally set eave heights to fine-tune the wireframe **110**, and the estimation engine **16** would recalculate pitches based thereon. For example, the user could use an eave edit handle **122** on the midpoint of each eave line of the wireframe **110** to adjust the slope of one or more faces of the wireframe **110** by clicking and dragging. Alternatively, the user could click and drag the entire wireframe **110** until the eave line of the wireframe **110** overlays the eave line of the roof **86** of the oblique image **112**.

Proceeding to step **70**, as shown in **FIGS. 4A-4B**, the system **10** generates a report. The report could comprise a two-dimensional wireframe model **130**, a three-dimensional model, and/or one or more charts **132** containing construction information (e.g., roof dimensions, pitches, surfaces, and areas, and associated material costs). Other types of information, such as waste calculations, could also be included in the report. The report could have an XML flag as a way to verify that a roof model was created by the system **10**. The system **10** could also require that a model have an XML flag before including the model in the report or before automatically generating the report.

FIGS. 5 is a flowchart showing more detailed processing steps **140** carried out by the estimation engine **16** for processing an aerial image to automatically identify roof lines. Reference is also made herein to **FIGS. 6A-6K**, which are views illustrating the steps carried out in **FIG. 5**. Beginning with step **142**, as shown in **FIG. 6A**, an aerial image is selected. A portion of the image containing the roof is selected in step **144**, as shown in **FIG. 6B**, and the image is then cropped in step **146**, as shown in **FIG. 6C**. The image is then converted to grayscale in step **148**, as shown in **FIG. 6D**. In step **150**, as shown in **FIG. 6E**, a filter is applied to the grayscale image, such as a Sobel filter, although it is noted that a filter could be applied without first converting the image to grayscale. The Sobel filter calculates the gradient of image intensity at each point in the image, giving a direction and rate of change to the largest increases from light to dark. The estimation engine **16** computes the likelihood that a point in the image represents a perimeter or interior line of a roof based on the direction and magnitude of the greatest intensity

increase. In step **152**, as shown in **FIG. 6F**, a Gaussian filter or blur could be applied to the image to decrease blur and/or sharpen the image.

In step **154**, as shown in **FIG. 6G**, the image is rotated by a first angle θ (e.g., 48 degrees), as shown in **FIG. 6G**, and then histogram processing is performed on the rotated image in step **156**. The horizontal lines shown in **FIGS. 6G-6I** correspond to the direction of scan for image intensity. In step **158**, a determination is made as to whether further histogram processing is required. If so, the process repeats until the image has been processed at a sufficient number of angles. It has been found that histograms taken at one degree increments (e.g., from 0 through 360 degrees) have provided excellent results, but other increments and/or number of histograms used are possible. Indeed, as shown in **FIG. 6H**, the image could be rotated to align vertically and then histogram processed, and/or the image could be rotated to align horizontally and then histogram processed, as shown in **FIG. 6I**. Of course any other angles could be used.

In step **160**, as shown in **FIG. 6J**, grid lines could be superimposed on the image, such as at perimeter lines, interior lines, and/or points of intersection. The grid lines can be used to segment/divide the image into sub-images, each of which are processed in accordance with the present invention. The grid lines need not be shown to the user, and indeed, can be used solely for purposes of image processing.

The histograms generated at the plurality of angles indicate the probability that a given feature in the image corresponds to a line (e.g., to a perimeter line or to an interior line corresponding a roof feature). In step **162**, the histogram data (e.g., all of the histograms generated in steps **156-158**) is processed to identify lines (e.g., perimeter and interior lines) corresponding to roof features. For example, in step **162**, cluster analysis could be performed on the histograms to identify the lines (e.g., perimeter or interior lines). Thus, by application of the foregoing image processing techniques, the estimation engine **16** can scan the entire image and detect and identify all perimeter and interior lines. Finally, in step **164**, as shown in **FIG. 6K**, a filtered image is generated and used by the estimation engine **16** to automatically delineate perimeter lines and interior lines in the GUI **80** shown in **FIGS. 3A-3F**.

As noted above, the estimation engine **16** can automatically identify the type of roof feature to which a given line in the model corresponds. This is accomplished by rules-based pattern recognition performed by the estimation engine **16**, which could vary according to the type of roof feature to be automatically identified. For example, a set of

rules could be programmed into the estimation engine **16** such that a ridge or a valley is automatically identified for a given point on the image if specific lines are detected in proximity to a given point in the image and/or if a pre-defined angle (or, range of angles) is detected between such lines. If the estimation engine **16** is unable to identify the type of line, the line could be temporarily marked as unknown and automatically altered by the estimation engine **16** as more information becomes available. Subsequently, the user could then manually correct the lines and line types if required.

Having thus described the invention in detail, it is to be understood that the foregoing description is not intended to limit the spirit or scope thereof. What is desired to be protected is set forth in the following claims.

CLAIMS

What is claimed is:

1. A system for construction estimation, comprising:

a computer system for receiving at least one aerial image of a building; and

an estimation engine in said computer system for processing the aerial image to estimate one or more features relating to a roof of the building, the estimation engine histogram processing the aerial image at a plurality of angles to automatically identify a plurality of lines in the aerial image corresponding to one or more features of the roof.

2. The system of Claim 1, further comprising a graphical user interface for displaying the aerial image of the building, the estimation engine automatically delineating the plurality of lines in the aerial image.

3. The system of Claim 2, further comprising a two-dimensional wireframe model of the roof, the two-dimensional wireframe model including the plurality of lines delineated by the estimation engine.

4. The system of Claim 3, wherein the estimation engine obtains an oblique image of the building and superimposes the two-dimensional wireframe model of the roof on the oblique image.

5. The system of Claim 4, wherein the two-dimensional wireframe model is deformed into a three-dimensional model of the roof by dragging points on the wireframe model to corresponding points on the oblique image.

6. The system of Claim 5, wherein the estimation engine processes the three-dimensional wireframe model to calculate roof dimensions and pitches, and generates a report including the calculated roof dimensions and pitches.

7. The system of Claim 5, wherein the estimation engine processes the three-dimensional wireframe model to calculate material costs associated with the roof, and generates a report including the calculated material costs.

8. The system of Claim 1, wherein the estimation engine crops the aerial image around the building.

9. The system of Claim 8, wherein the estimation engine automatically aligns the aerial image.

10. The system of Claim 9, wherein the estimation engine applies at least one filter to the image.

11. The system of Claim 1, wherein the estimation engine allows a user to adjust one or more of the plurality of lines automatically identified by the estimation engine.

12. The system of Claim 1, wherein the estimation engine automatically identifies perimeter and interior lines in the aerial image corresponding to one or more features of the roof.

13. A method for construction estimation, comprising the steps of:

receiving at a computer system at least one aerial image of a building;

histogram processing the aerial image at a plurality of angles using an estimation engine in the computer system to automatically identify a plurality of lines in the aerial image corresponding to a plurality of features of a roof;

constructing a three-dimensional wireframe model of the roof using the plurality of lines; and

processing the three-dimensional model of the roof using the estimation engine to generate a report including information about the roof of the building.

14. The method of Claim 13, further comprising generating and displaying a graphical user interface including the aerial image of the building, the estimation engine automatically delineating the plurality of lines in the graphical user interface.

15. The method of Claim 13, further comprising generating a two-dimensional wireframe model of the roof, the wireframe model including the plurality of lines.

16. The method of Claim 15, further comprising obtaining an oblique image of the building and superimposing the two-dimensional wireframe model of the roof on the oblique image.

17. The method of Claim 16, further comprising deforming the two-dimensional wireframe model into the three-dimensional wireframe model of the roof by dragging points on the two-dimensional wireframe model to corresponding points on the oblique image.

18. The method of Claim 11, further comprising processing the three-dimensional wireframe model to calculate roof dimensions and pitches, and including the calculated roof dimensions and pitches in the report.

19. The method of Claim 11, further comprising processing the three-dimensional wireframe model to calculate material costs associated with the roof, and including the calculated material costs in the report.

20. The method of Claim 11, further comprising cropping the aerial image around the building.

21. The method of Claim 20, further comprising automatically aligning the aerial image.

22. The method of Claim 21, further comprising applying at least one filter to the image.

23. The method of Claim 11, further comprising allowing a user to adjust one or more of the plurality of lines automatically identified by the estimation engine.

24. The method of Claim 11, further comprising automatically identifying perimeter and interior lines in the aerial image corresponding to one or more features of the roof.

25. A non-transitory, computer-readable medium having computer-readable instructions stored thereon which, when executed by a computer system, cause the computer system to perform the steps comprising:

receiving at the computer system at least one aerial image of a building;

histogram processing the aerial image using an estimation engine in the computer system to automatically identify a plurality of lines in the image corresponding to a plurality of features of a roof of the building;

constructing a three-dimensional wireframe model of the roof using the plurality of lines; and

processing the three-dimensional model of the roof using the estimation engine to generate a report including information about the roof of the building.

26. The computer-readable medium of Claim 25, further comprising computer-readable instructions for causing the computer system to perform the steps of generating and displaying a graphical user interface including the aerial image of the building, the estimation engine automatically delineating the plurality of lines in the graphical user interface.

27. The computer-readable medium of Claim 25, further comprising computer-readable instructions for causing the computer system to perform the step of generating a two-dimensional wireframe model of the roof, the wireframe model including the plurality of lines.

28. The computer-readable medium of Claim 27, further comprising computer-readable instructions for causing the computer system to perform the step of obtaining an oblique

image of the building and superimposing the two-dimensional wireframe model of the roof on the oblique image.

29. The computer-readable medium of Claim 28, further comprising computer-readable instructions for causing the computer system to perform the step of deforming the two-dimensional wireframe model into the three-dimensional wireframe model of the roof by dragging points on the two-dimensional wireframe model to corresponding points on the oblique image.

30. The computer-readable medium of Claim 25, further comprising computer-readable instructions for causing the computer system to perform the steps of processing the three-dimensional wireframe model to calculate roof dimensions and pitches, and including the calculated roof dimensions and pitches in the report.

31. The computer-readable medium of Claim 25, further comprising computer-readable instructions for causing the computer system to perform the steps of processing the three-dimensional wireframe model to calculate material costs associated with the roof, and including the calculated material costs in the report.

32. The computer-readable medium of Claim 25, further comprising computer-readable instructions for causing the computer system to perform the step of cropping the aerial image around the building.

33. The computer-readable medium of Claim 32, further comprising computer-readable instructions for causing the computer system to perform the step of automatically aligning the aerial image.

34. The computer-readable medium of Claim 33, further comprising computer-readable instructions for causing the computer system to perform the step of applying at least one filter to the image.

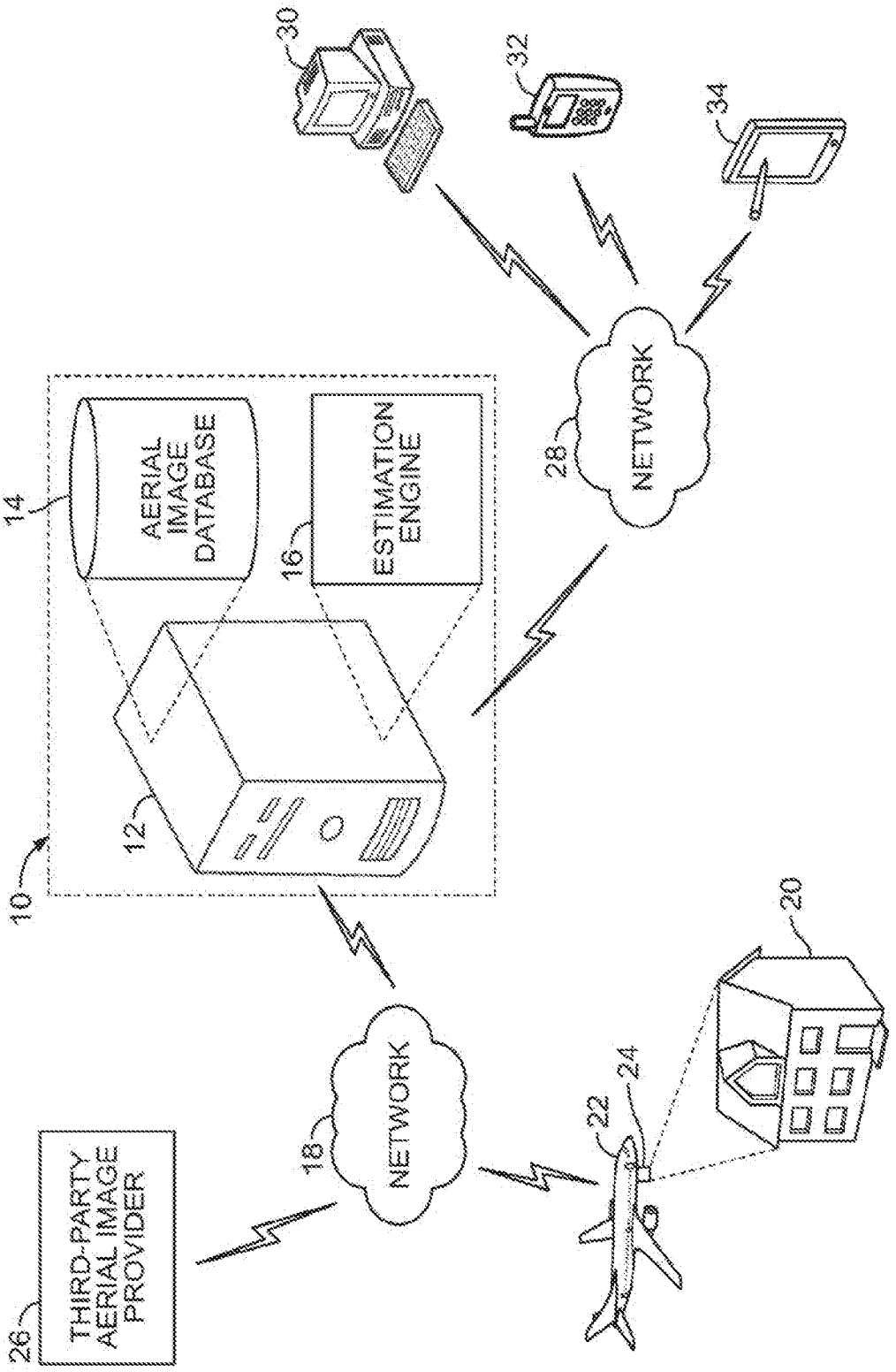

30
32
34
NETWORK
28
AERIAL IMAGE DATABASE
14
ESTIMATION ENGINE
16
12
10
20
NETWORK
18
22
24
THIRD-PARTY AERIAL IMAGE PROVIDER
26

FIG. 1

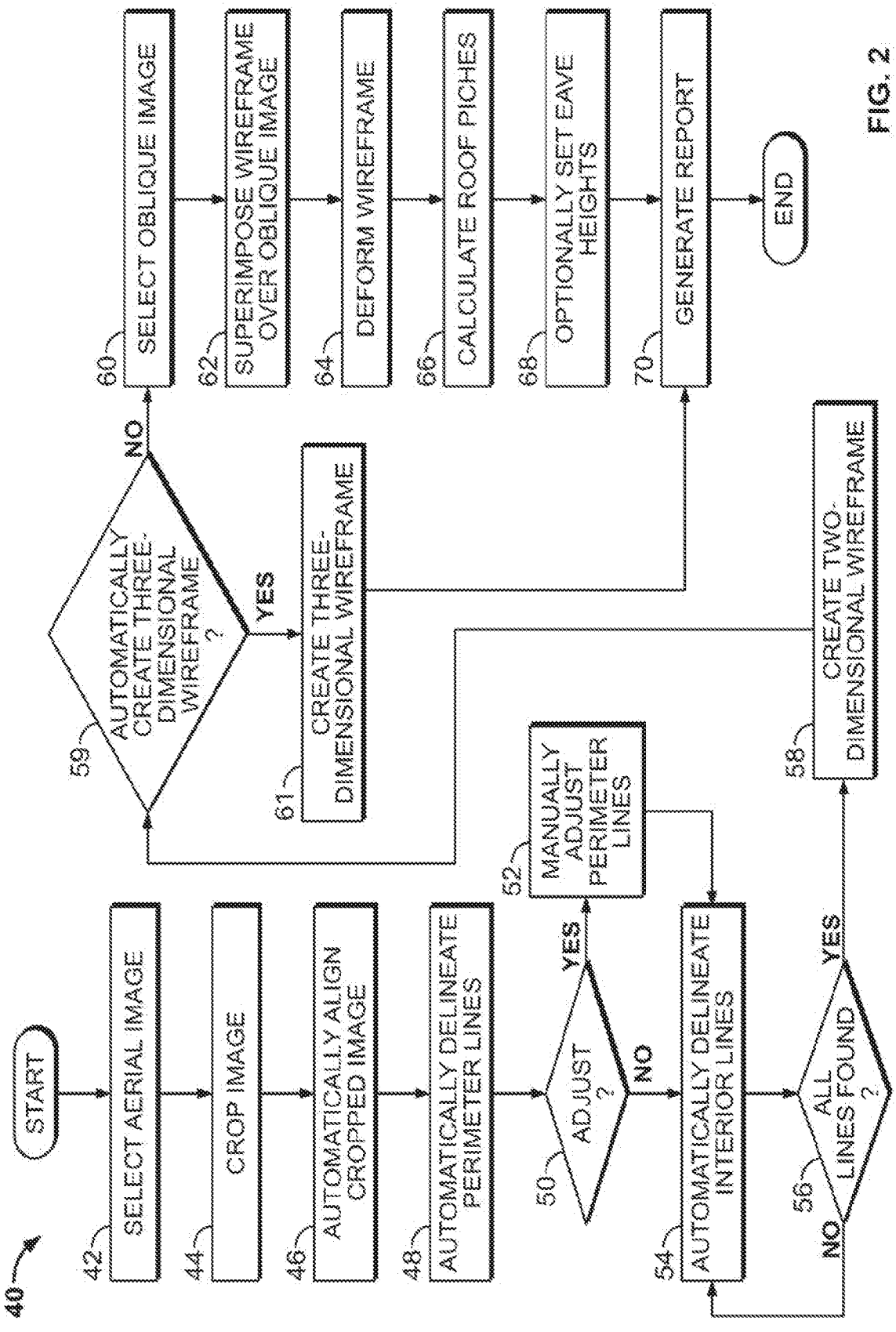

40
START
42
SELECT AERIAL IMAGE
44
CROP IMAGE
46
AUTOMATICALLY ALIGN CROPPED IMAGE
48
AUTOMATICALLY DELINEATE PERIMETER LINES
50
ADJUST ?
YES
NO
52
MANUALLY ADJUST PERIMETER LINES
54
AUTOMATICALLY DELINEATE INTERIOR LINES
56
ALL LINES FOUND ?
YES
NO
58
CREATE TWO-DIMENSIONAL WIREFRAME
59
AUTOMATICALLY CREATE THREE-DIMENSIONAL WIREFRAME ?
YES
NO
61
CREATE THREE-DIMENSIONAL WIREFRAME
60
SELECT OBLIQUE IMAGE
62
SUPERIMPOSE WIREFRAME OVER OBLIQUE IMAGE
64
DEFORM WIREFRAME
66
CALCULATE ROOF PICHES
68
OPTIONALLY SET EAVE HEIGHTS
70
GENERATE REPORT
END

FIG. 2

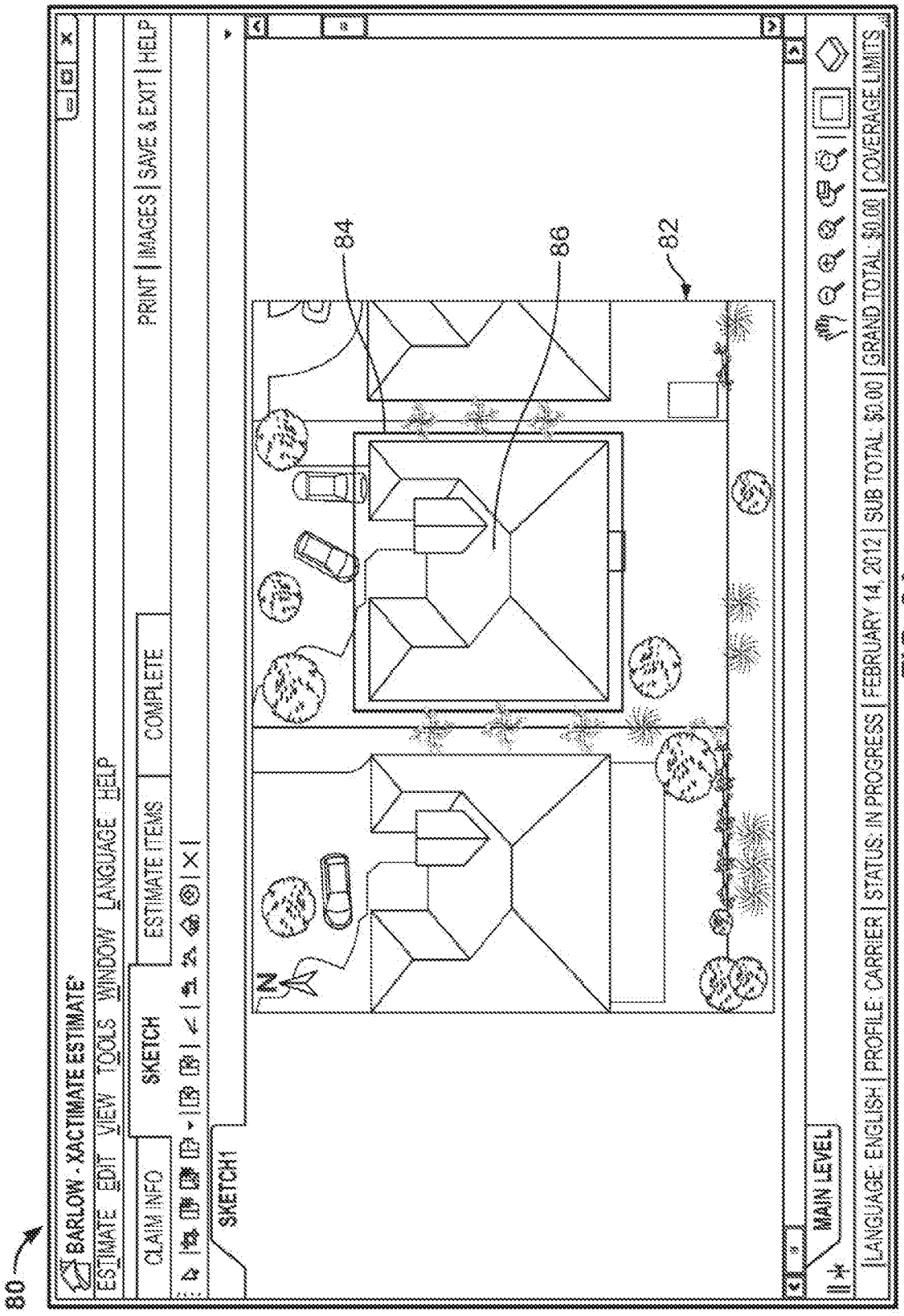

80
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CLAIM INFO
SKETCH
ESTIMATE ITEMS
COMPLETE
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SKETCH1
84
86
82
N
MAIN LEVEL
LANGUAGE: ENGLISH | PROFILE: CARRIER | STATUS: IN PROGRESS | FEBRUARY 14, 2012 | SUB TOTAL: $0.00 | GRAND TOTAL: $0.00 | COVERAGE LIMITS

FIG. 3A

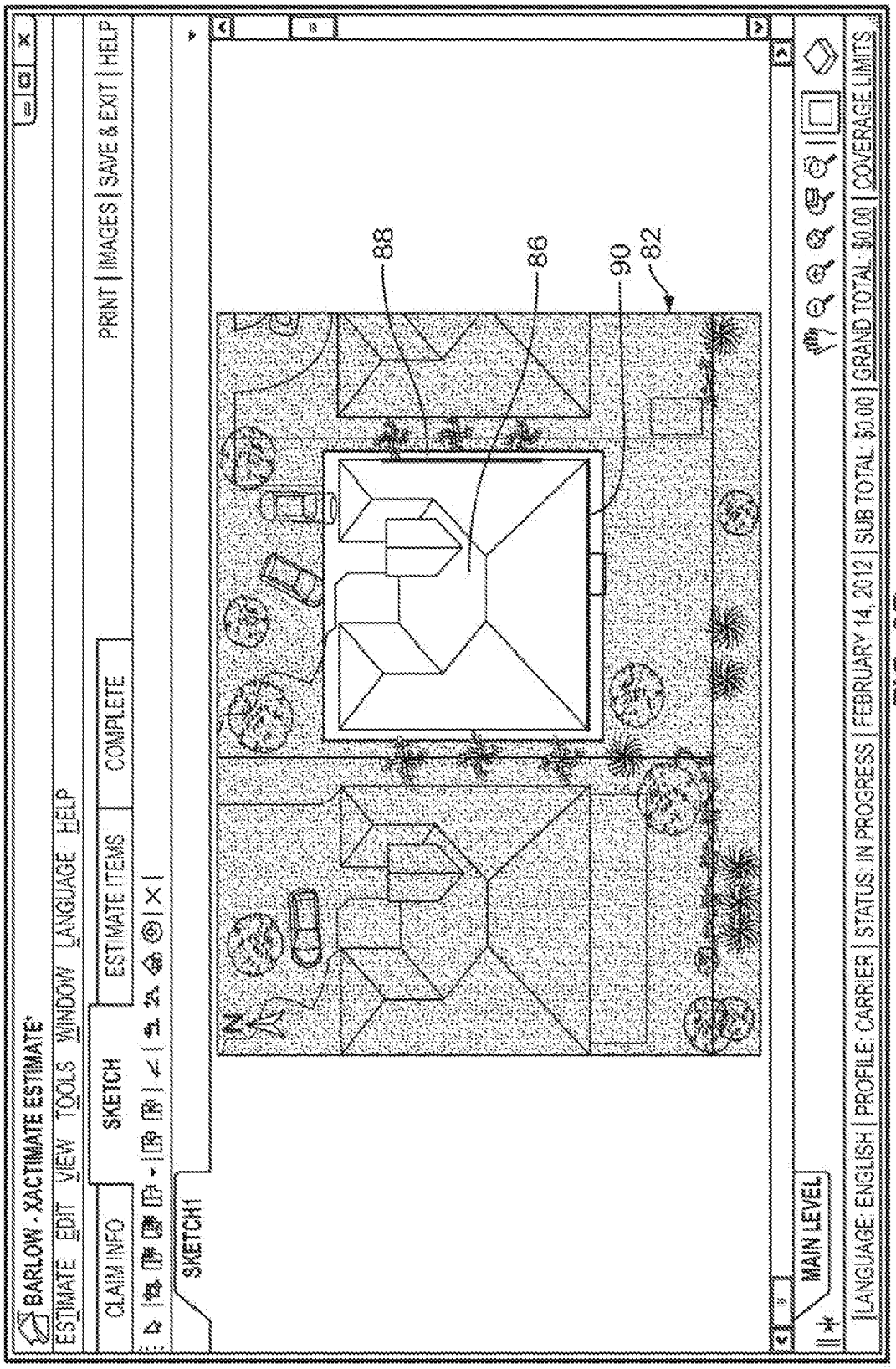

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CLAIM INFO
SKETCH
ESTIMATE ITEMS
COMPLETE
PRINT IMAGES SAVE & EXIT HELP
SKETCH1
88
86
90
82
MAIN LEVEL
LANGUAGE: ENGLISH PROFILE: CARRIER STATUS: IN PROGRESS FEBRUARY 14, 2012 SUB TOTAL: $0.00 GRAND TOTAL: $0.00 COVERAGE LIMITS

FIG. 3B

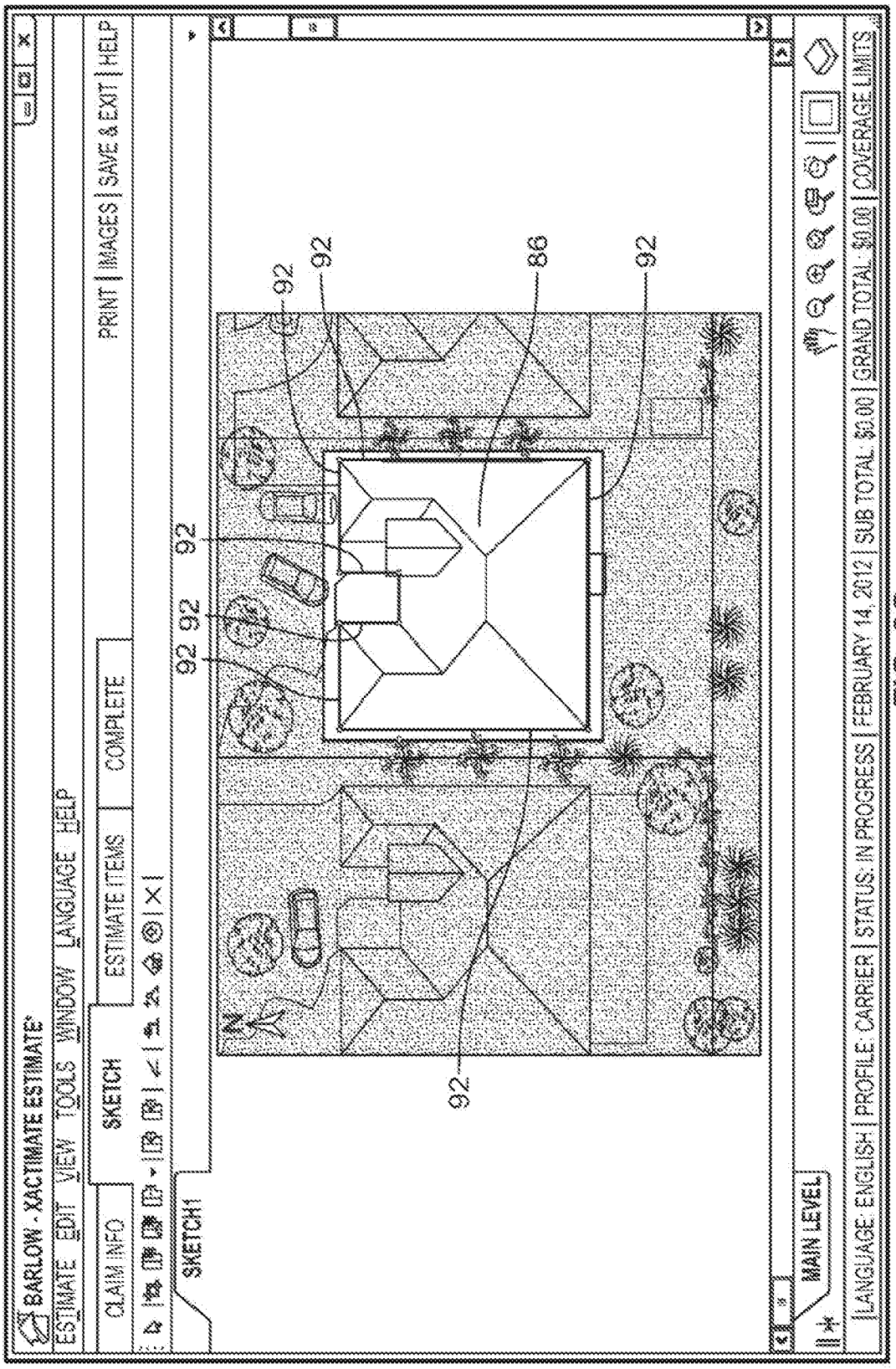

BARLOW - XACTIMATE ESTIMATE
ESTIMATE EDIT VIEW TOOLS WINDOW LANGUAGE HELP
CLAIM INFO
SKETCH
ESTIMATE ITEMS
COMPLETE
PRINT IMAGES SAVE & EXIT HELP
SKETCH1
92
86
MAIN LEVEL
LANGUAGE: ENGLISH PROFILE: CARRIER STATUS: IN PROGRESS FEBRUARY 14, 2012 SUB TOTAL: $0.00 GRAND TOTAL: $0.00 COVERAGE LIMITS

FIG. 3C

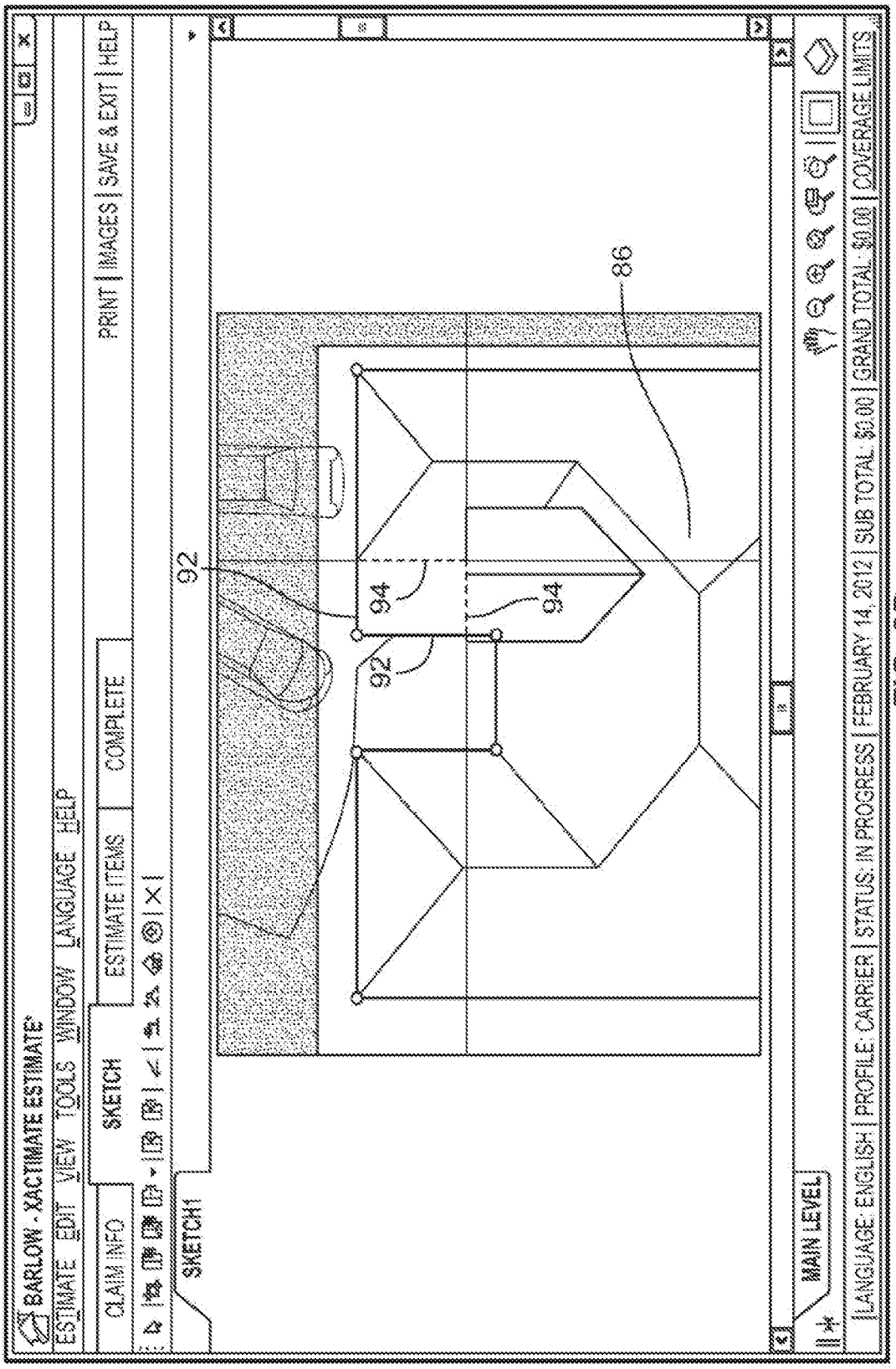

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ESTIMATE EDIT VIEW TOOLS WINDOW LANGUAGE HELP
CLAIM INFO
SKETCH
ESTIMATE ITEMS
COMPLETE
PRINT | IMAGES | SAVE & EXIT | HELP
SKETCH1
92
94
94
92
86
MAIN LEVEL
LANGUAGE: ENGLISH | PROFILE: CARRIER | STATUS: IN PROGRESS | FEBRUARY 14, 2012 | SUB TOTAL: $0.00 | GRAND TOTAL: $0.00 | COVERAGE LIMITS

FIG. 3D

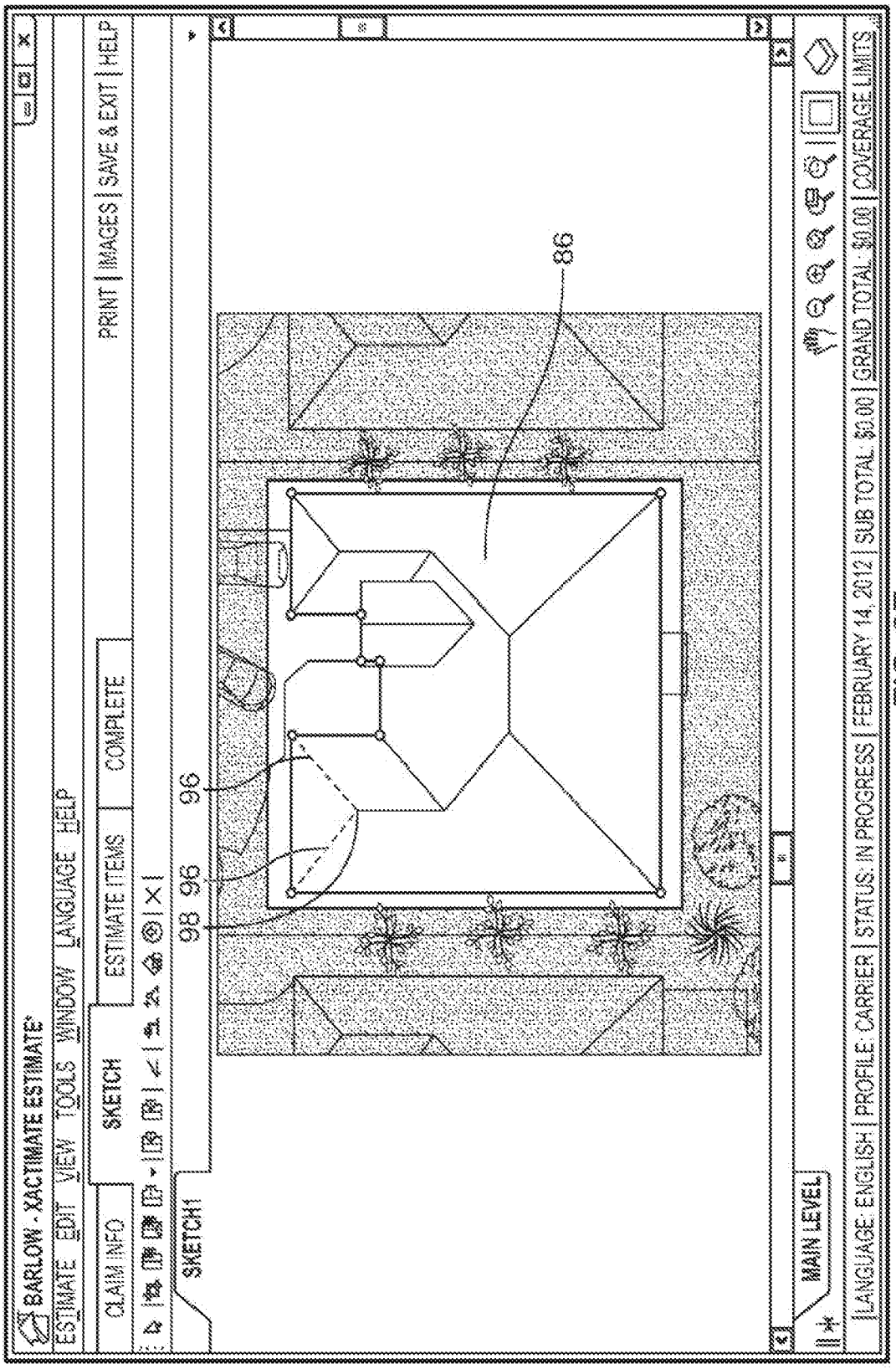

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ESTIMATE EDIT VIEW TOOLS WINDOW LANGUAGE HELP
CLAIM INFO
SKETCH
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COMPLETE
PRINT | IMAGES | SAVE & EXIT | HELP
SKETCH1
98 96 96
86
MAIN LEVEL
LANGUAGE: ENGLISH | PROFILE: CARRIER | STATUS: IN PROGRESS | FEBRUARY 14, 2012 | SUB TOTAL: $0.00 | GRAND TOTAL: $0.00 | COVERAGE LIMITS

FIG. 3E

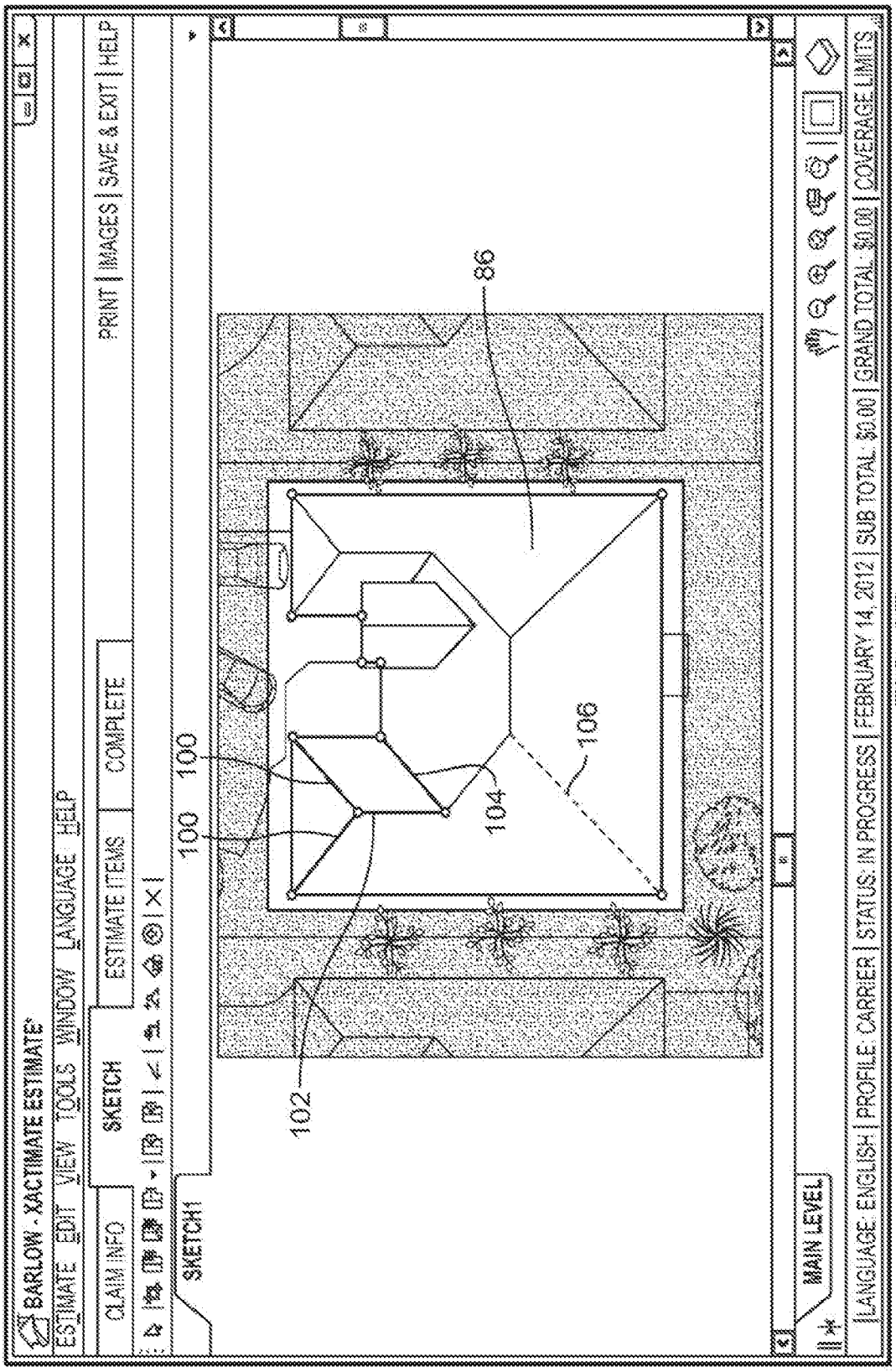

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ESTIMATE ITEMS
COMPLETE
PRINT | IMAGES | SAVE & EXIT | HELP
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FIG. 3F

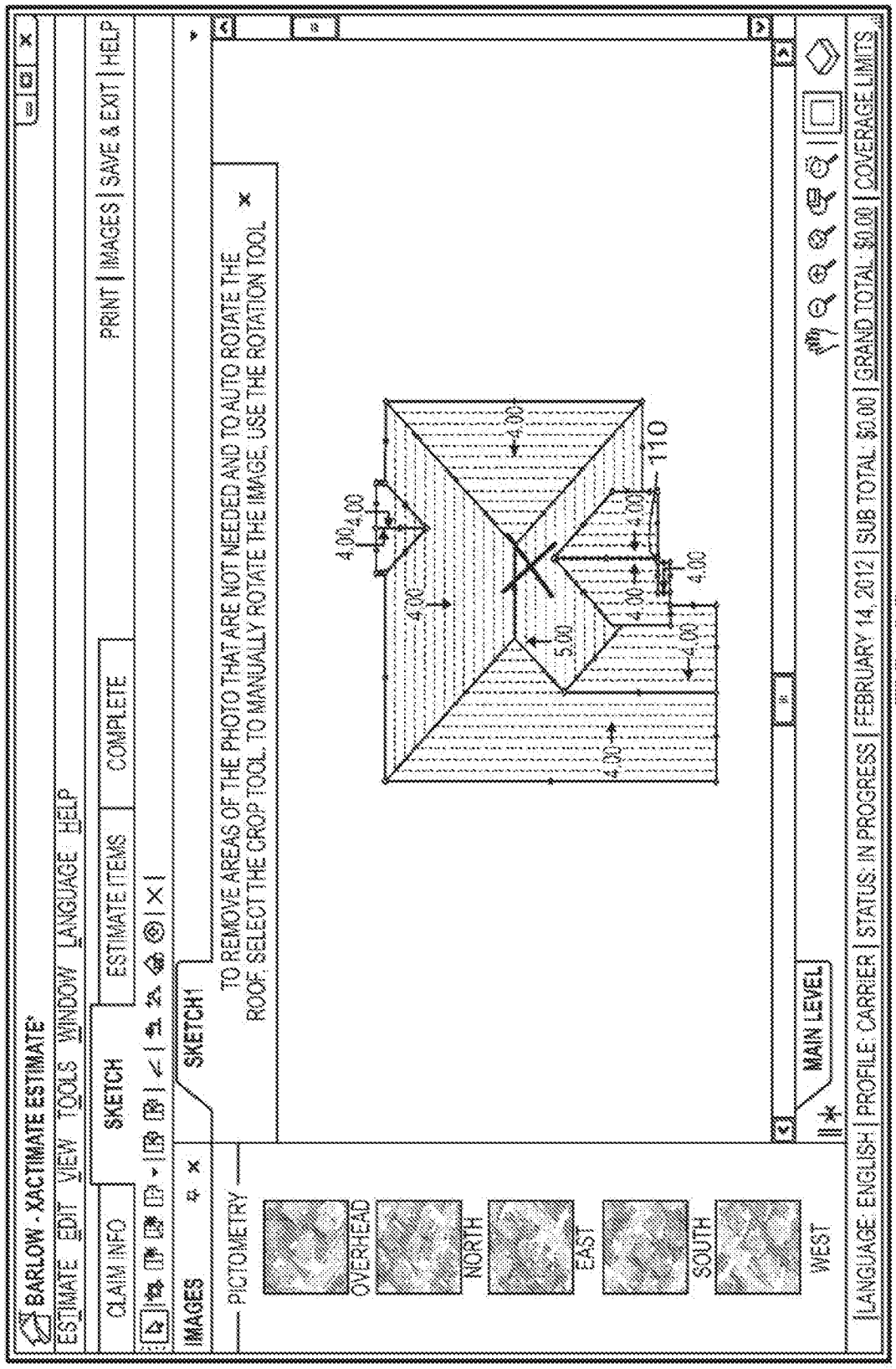

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CLAIM INFO
SKETCH
ESTIMATE ITEMS
COMPLETE
PRINT | IMAGES | SAVE & EXIT | HELP
IMAGES
SKETCH1
TO REMOVE AREAS OF THE PHOTO THAT ARE NOT NEEDED AND TO AUTO ROTATE THE ROOF, SELECT THE CROP TOOL. TO MANUALLY ROTATE THE IMAGE, USE THE ROTATION TOOL
PICTOMETRY
OVERHEAD
NORTH
EAST
SOUTH
WEST
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4.00
5.00
MAIN LEVEL
LANGUAGE: ENGLISH | PROFILE: CARRIER | STATUS: IN PROGRESS | FEBRUARY 14, 2012 | SUB TOTAL: $0.00 | GRAND TOTAL: $0.00 | COVERAGE LIMITS

FIG. 3G

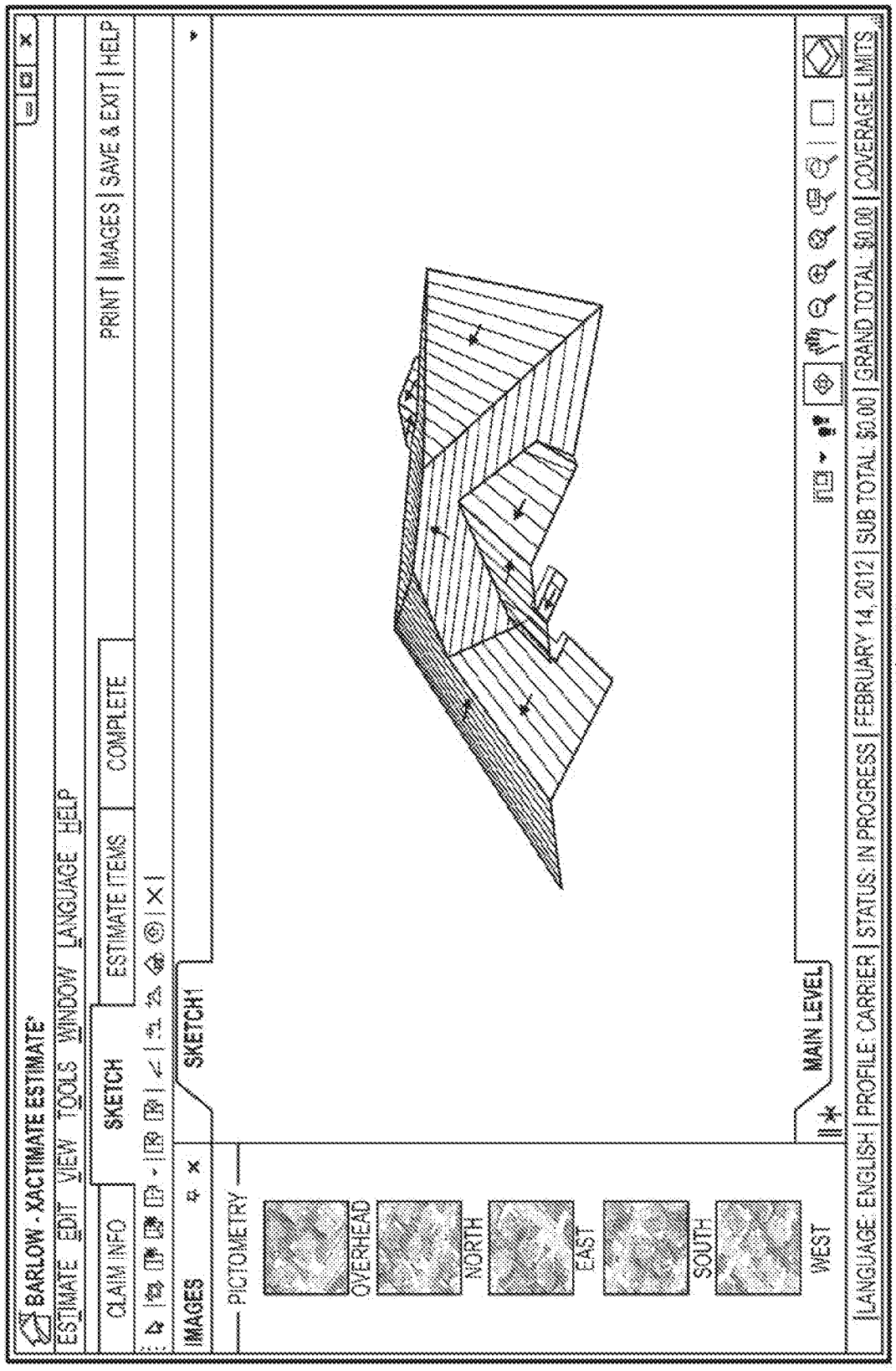

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SKETCH1
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EAST
SOUTH
WEST
MAIN LEVEL
LANGUAGE: ENGLISH | PROFILE: CARRIER | STATUS: IN PROGRESS | FEBRUARY 14, 2012 | SUB TOTAL: $0.00 | GRAND TOTAL: $0.00 | COVERAGE LIMITS

FIG. 3H

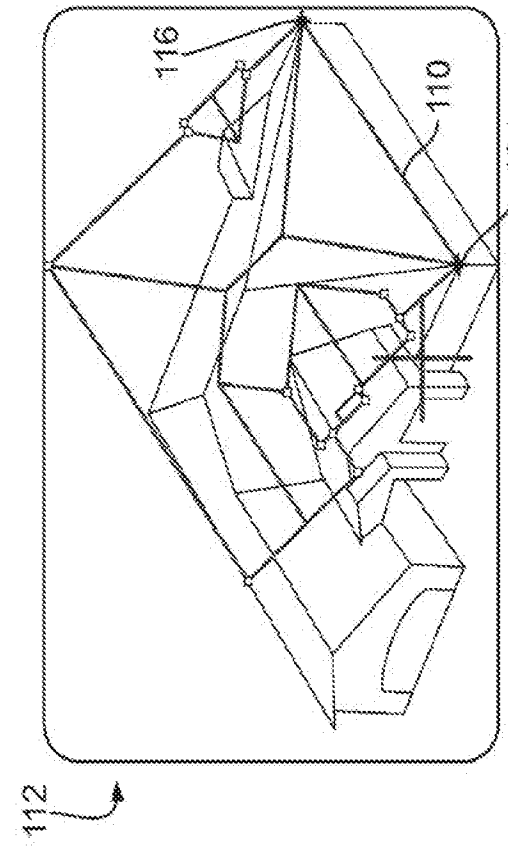


FIG. 3J

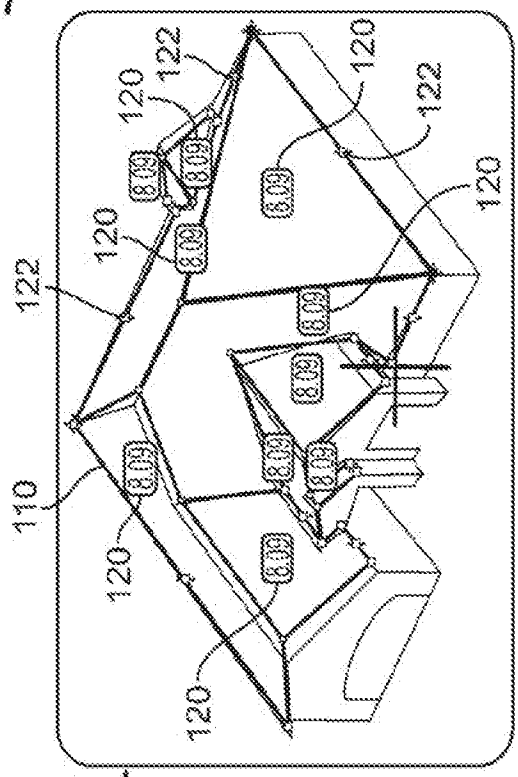


FIG. 3L

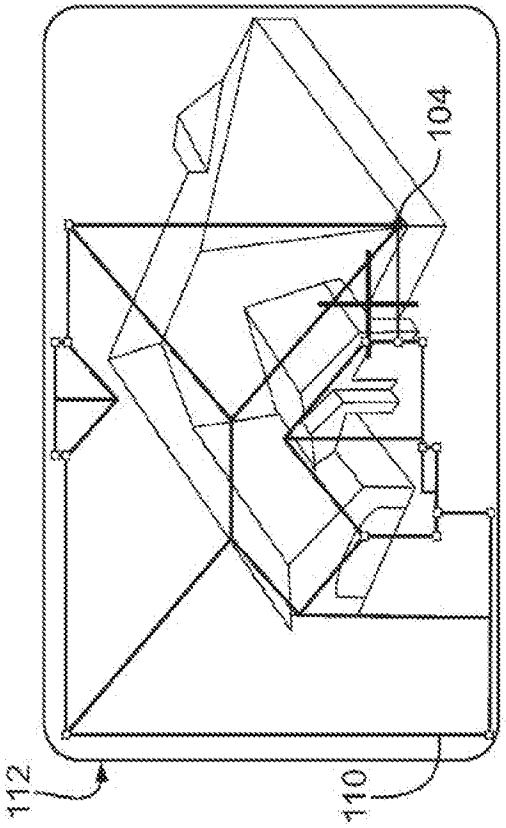


FIG. 3I

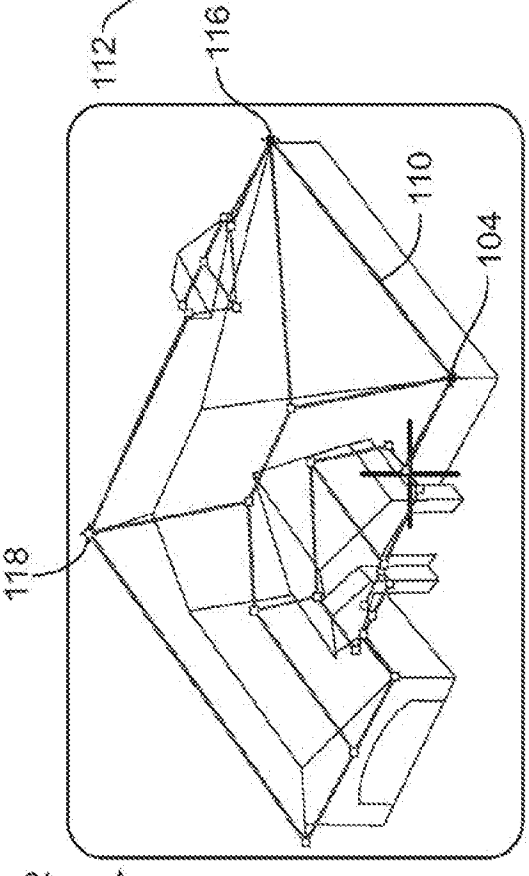
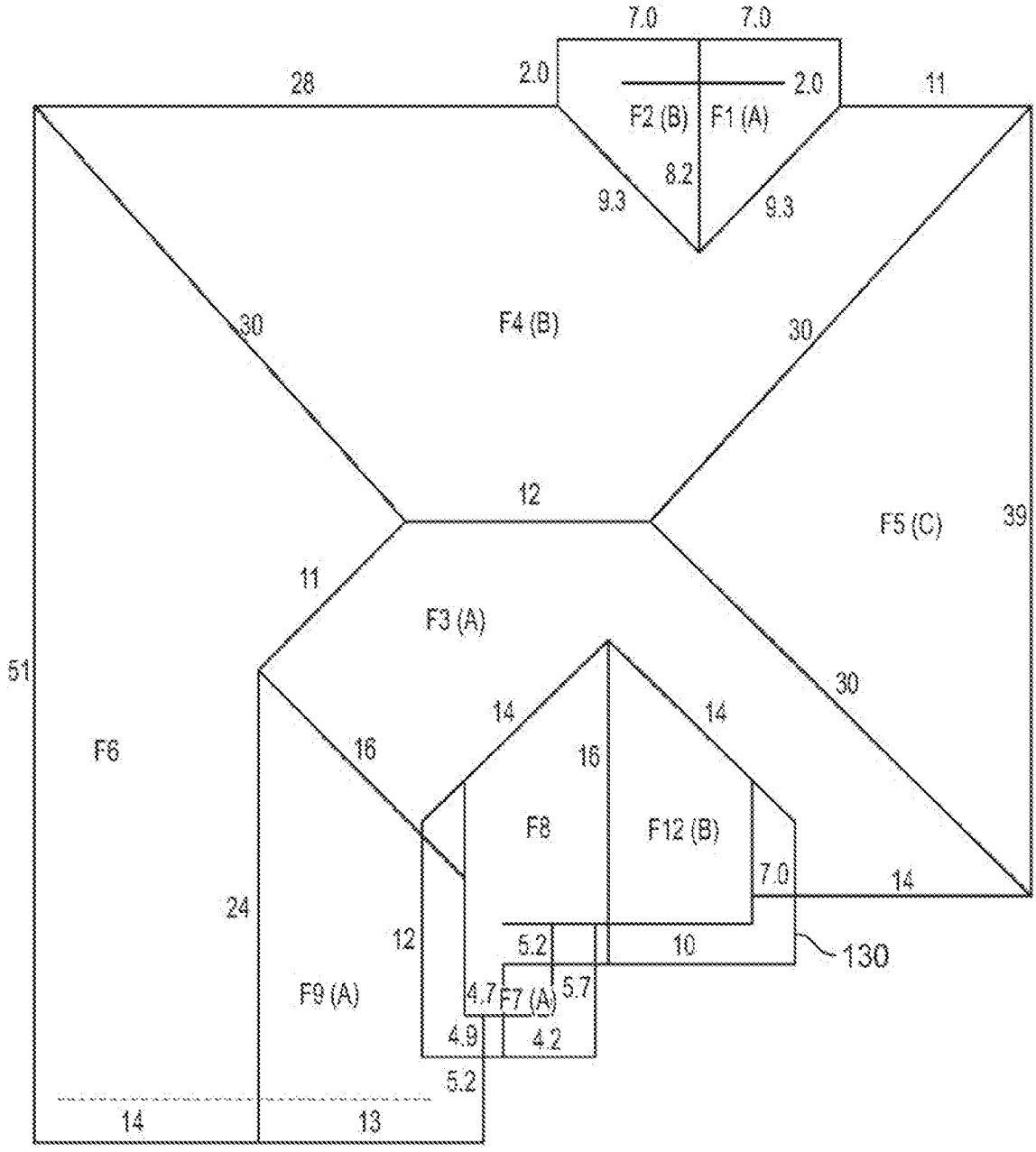


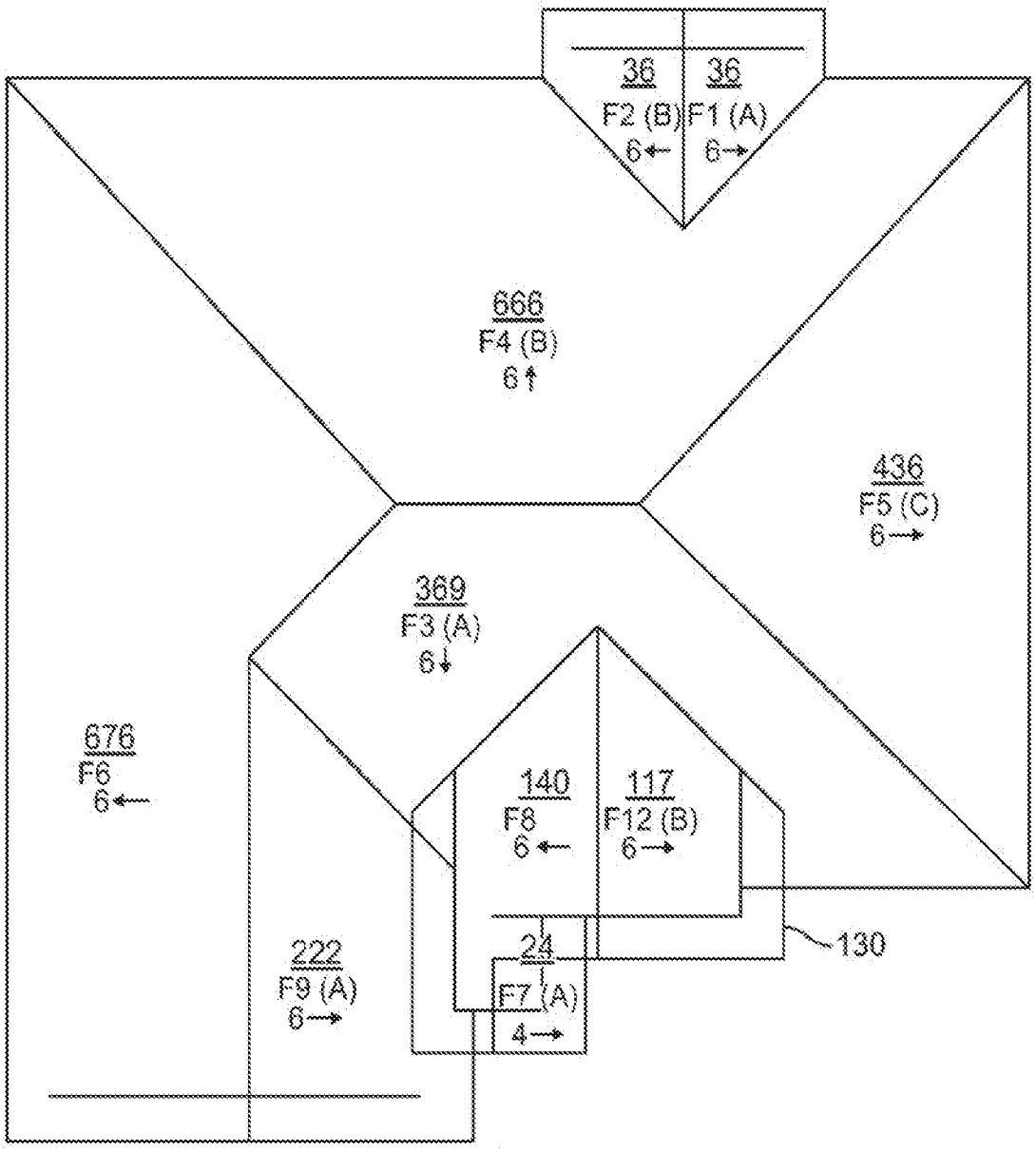
FIG. 3K



TOTALS FOR PERIMETER, RIDGES AND VALLEYS:			
PERIMETER	FLAT RIDGES	HIP RIDGES	VALLEYS
242.56 (FT)	64.96 (FT)	99.98 (FT)	61.36 (FT)

132

FIG. 4A



TOTALS FOR AREA AND SLOPE:	
AREA	AVERAGE SLOPE
2,721.97 (SQ FT)	6

132

132

WASTE CALCULATIONS: 2,721.97 (SQ FT)					
10%	15%	17%	20%	22%	25%
272.20	408.30	462.73	544.39	598.83	680.49

FIG. 4B

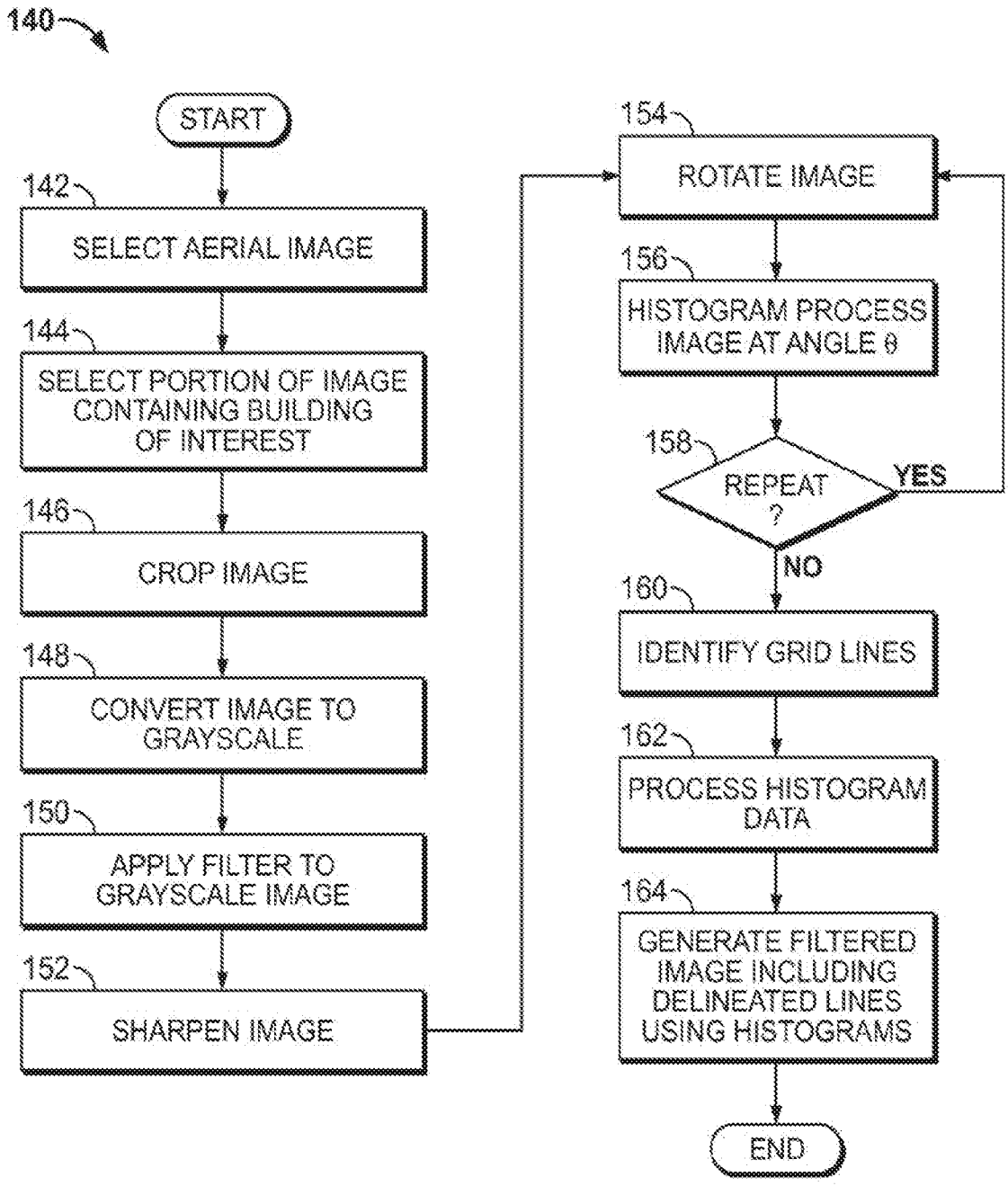

140
START
142
SELECT AERIAL IMAGE
144
SELECT PORTION OF IMAGE CONTAINING BUILDING OF INTEREST
146
CROP IMAGE
148
CONVERT IMAGE TO GRAYSCALE
150
APPLY FILTER TO GRAYSCALE IMAGE
152
SHARPEN IMAGE
154
ROTATE IMAGE
156
HISTOGRAM PROCESS IMAGE AT ANGLE θ
158
REPEAT ?
YES
NO
160
IDENTIFY GRID LINES
162
PROCESS HISTOGRAM DATA
164
GENERATE FILTERED IMAGE INCLUDING DELINEATED LINES USING HISTOGRAMS
END

FIG. 5

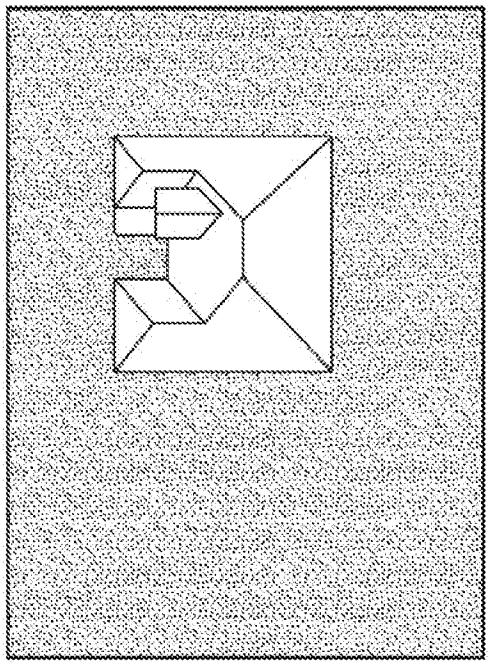


FIG. 6B

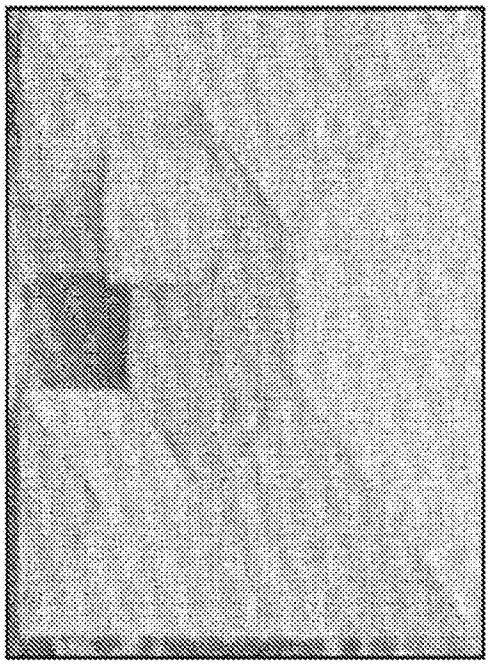


FIG. 6D

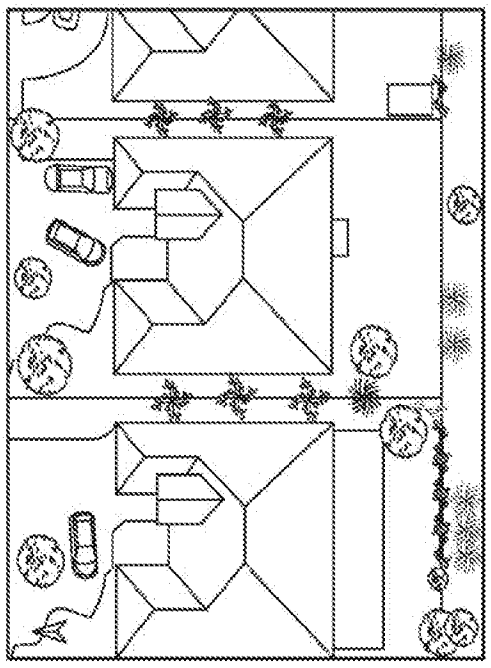


FIG. 6A

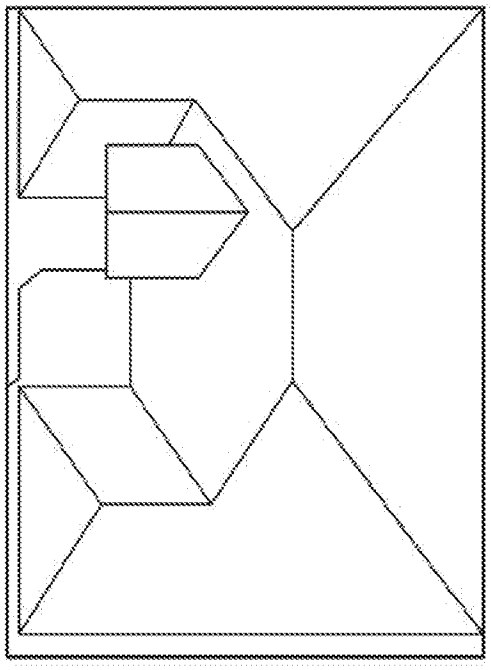


FIG. 6C

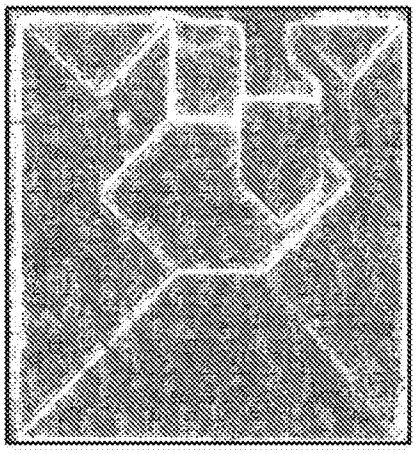


FIG. 6E

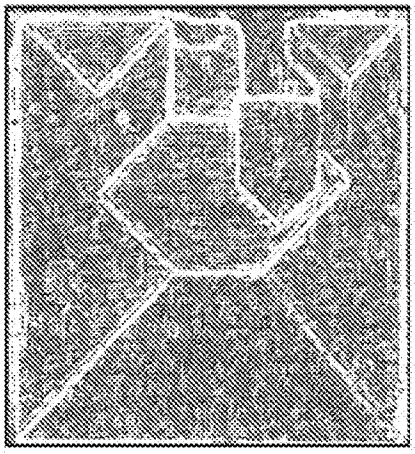


FIG. 6F

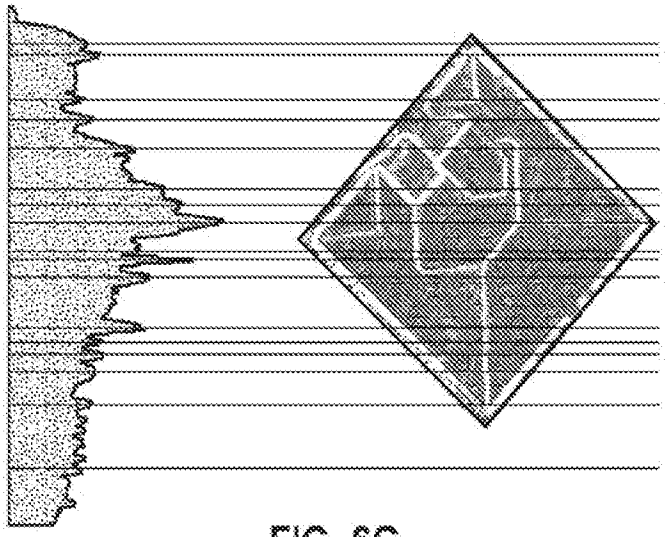


FIG. 6G

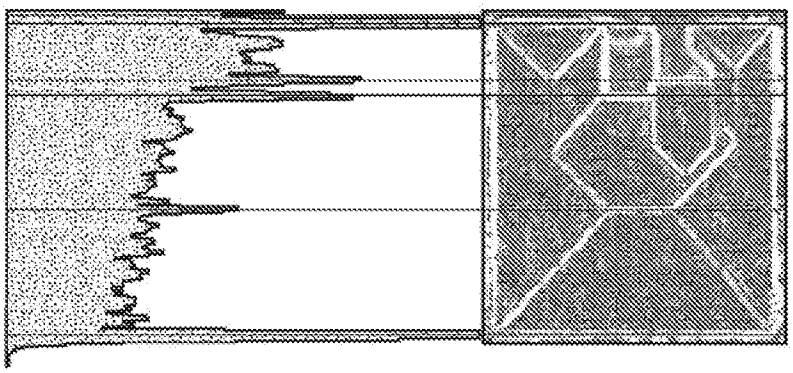


FIG. 6H

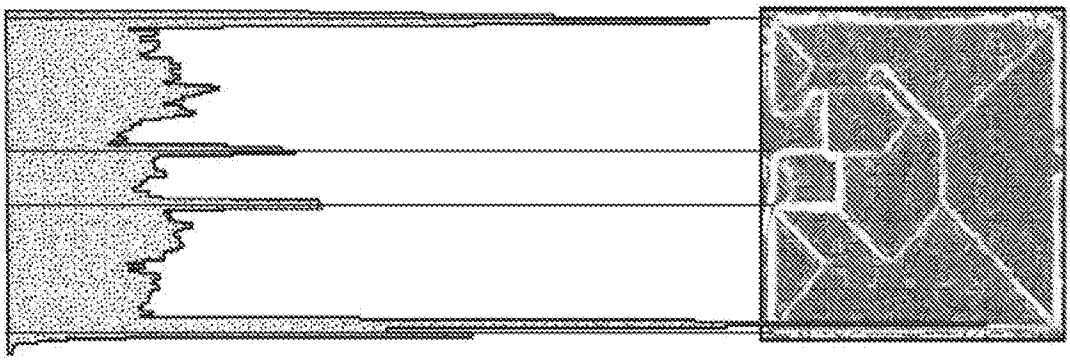


FIG. 6I

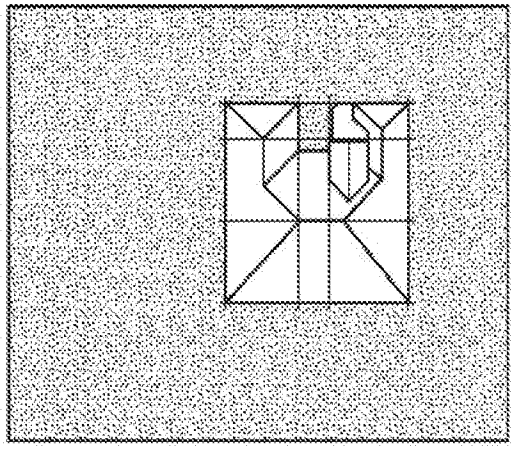


FIG. 6J

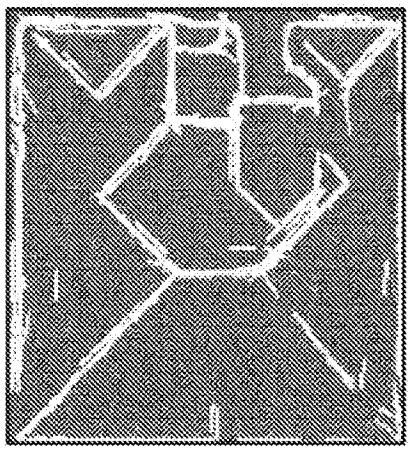


FIG. 6K

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 13/26385

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - G06Q 50/00 (2013.01)
USPC - 705/313
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC(8): G06Q 50/00 (2013.01)
USPC: 705/313

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
IPC(8): G06Q 50/00 (2013.01)
USPC: 705/313; 705/1.1, 7.11, 7.12, 7.23; 345/630 (keyword limited; terms below)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PatBase; Google(Web); Search terms used: aerial image roof construction material cost report estimation wire frame model drag aligned mouse marker corresponding sections points features building angle pitches oblique perspective

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2010/0114537 A1 (Pershing) 06 May 2010 (06.05.2010), entire document especially abstract; para [0003], [0038]-[0047], [0082]-[0091], [0116], [0117], [0132]	1-34
Y	US 2010/0241406 A1 (Rahmes et al.) 23 September 2010 (23.09.2010), para [0027], [0030], [0036]	1-34
A	US 2011/0047048 A1 (Yahiro et al.) 24 February 2011 (24.02.2011), entire document	1-34
Y	US 2008/0262789 A1 (Pershing et al.) 23 October 2008 (23.10.2008) entire document	1-34

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
22 March 2013 (22.03.2013)	26 APR 2013
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

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(74) Agent: **BROCKHAUS, Marc, A.**; Dunlap Codding, P.C., P.O. Box 16370, Oklahoma City, OK 73113 (US).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

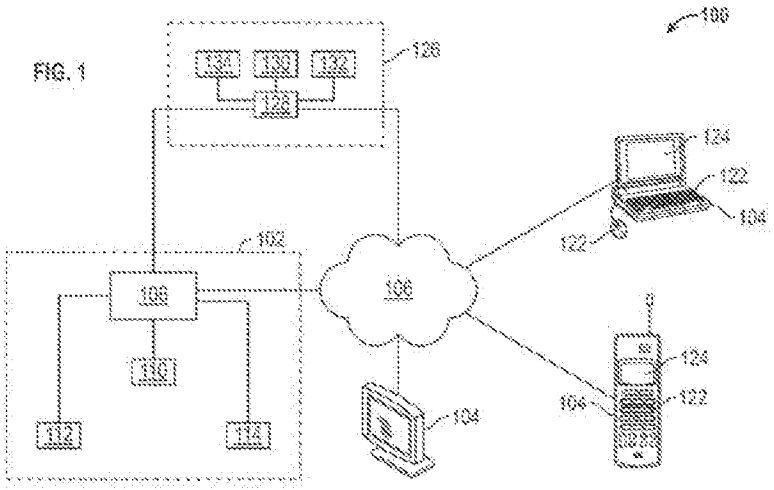
(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

(54) Title: METHOD AND SYSTEM FOR QUICK SQUARE ROOF REPORTING

FIG. 1



(57) Abstract: A set of instructions stored on one or more computer readable medium for running on one or more computer systems is described herein. The set of instructions generally may include instructions for identifying a geographic location of a roof, instructions for determining contact information of one or more contractors within a region of interest of the geographic location of the roof, instructions for determining a footprint of the roof, instructions for determining predominant pitch of the roof, and/or instructions for determining an estimated roofing area based on the predominant pitch and the footprint of the roof.

WO 2013/142406 A1

Electronically Transmitted: 2013 March 18

A Method and System for Quick Square Roof Reporting

Cross-Reference to Related Applications

[0001] Not Applicable.

Background

[0002] Residential and/or commercial property owners approaching a major roofing project may be unsure of the amount of material needed and/or the next step in completing the project. Generally, such owners contact one or more contractors for a site visit. Each contractor must physically be present at the site of the structure in order to make a determination on material needs and/or time. The time and energy for providing such an estimate becomes laborious and may be affected by contractor timing, weather, contractor education, and the like. Estimates may be varied even between contractors in determination of estimated square footage causing variance in supply ordering as well. Additionally, measuring an actual roof may be costly and potentially hazardous – especially with steeply pitched roofs. Completion of a proposed roofing project may depend on ease in obtaining a simplified roofing estimate and/or obtaining reputable contractors for the roofing project.

[0003] Images are currently being used to measure objects and structures within the images, as well as to be able to determine geographic locations of points within the image when preparing estimates for a variety of construction projects, such as roadwork, concrete work, and roofing. Estimating construction projects using software may increase speed at which an estimate can be prepared, and may reduce labor and fuel costs associated with on-site visits.

Brief Description of the Several Views of the Drawings

[0004] Like reference numerals in the figures represent and refer to the same or similar element or function. Implementations of the disclosure may be better understood when consideration is given to the following detailed description thereof. Such description makes reference to the annexed pictorial illustrations, schematics, graphs, drawings, and appendices. In the drawings:

[0005] FIG. 1 is a schematic diagram of an embodiment of a roof estimator reporting system according to the instant disclosure.

[0006] FIG. 2 is a block diagram of an embodiment of one or more memory according to the instant disclosure.

[0007] FIG. 3 is an exemplary embodiment of a program logic according to the instant disclosure.

[0008] FIG. 4 is another exemplary embodiment of a program logic according to the instant disclosure.

[0009] FIG. 5 is yet another exemplary embodiment of a program logic according to the instant disclosure.

[0010] FIG. 6 is a further exemplary embodiment of a program logic according to the instant disclosure.

[0011] FIG. 7 is an exemplary slope factor chart for determining pitch factors according to the instant disclosure.

[0012] FIG. 8 is an exemplary embodiment of a roofing report presentation page according to the instant disclosure.

Detailed Description of Inventive Concept

[0013] Before explaining at least one embodiment of the inventive concept disclosed herein in detail, it is to be understood that the inventive concept is not limited in its application to the details of construction and the arrangement of the components or steps or methodologies set forth in the following description or illustrated in the drawings. The inventive concept disclosed herein is capable of other embodiments or of being practiced or carried out in various ways. Also, it is to be understood that the phraseology and terminology employed herein is for the purpose of description and should not be regarded as limiting in any way.

[0014] In the following detailed description of embodiments of the inventive concept, numerous specific details are set forth in order to provide a more thorough understanding of the inventive concept. It will be apparent to one of ordinary skill in the art, however, that the inventive concept within the disclosure may be practiced without these specific details. In other instances, well-known features have not been described in detail to avoid unnecessarily complicating the instant disclosure.

[0015] Referring now to the drawings, and in particular to FIG. 1, shown therein and designated by a reference numeral 100 is an exemplary computer system 100 constructed in accordance with the present disclosure. The system 100 can be a system or systems that are able to embody and/or execute the logic of the

processes described herein. The logic embodied in the form of software instructions, or firmware may be executed on any appropriate hardware which may be a dedicated system or systems.

[0016] As used herein, the terms "network-based", "cloud-based" and any variations thereof, are intended to include the provision of configurable computational resources on demand via interfacing with a computer and/or computer network, with software and/or data at least partially located on the computer and/or computer network, by pooling processing power of two or more networked processors.

[0017] As used herein, the terms "comprises", "comprising", "includes", "including", "has", "having", or any other variation thereof, are intended to be non-exclusive inclusions. For example, a process, method, article, or apparatus that comprises a set of elements is not limited to only those elements but may include other elements not expressly listed or even inherent to such process, method, article, or apparatus.

[0018] As used in the instant disclosure, the terms "provide", "providing", and variations thereof comprise displaying or providing for display a webpage (e.g., roofing webpage) to one or more user terminals interfacing with a computer and/or computer network(s) and/or allowing the one or more user terminal(s) to participate, such as by interacting with one or more mechanisms on a webpage (e.g., roofing webpage) by sending and/or receiving signals (e.g., digital, optical, and/or the like) via a computer network interface (e.g., Ethernet port, TCP/IP port, optical port, cable modem, and combinations thereof). A user may be provided with a web page in a web browser, or in a software application, for example.

[0019] As used herein, the term "roof request", "roofing request", "roofing order", and any variations thereof may comprise a feature of the graphical user interface or a feature of a software application, allowing a user to indicate to a host system that the user wishes to place an order, such as by interfacing with the host system over a computer network and exchanging signals (e.g., digital, optical, and/or the like), with the host system using a network protocol, for example. Such mechanism may be implemented with computer executable code executed by one or more processors, for example, with a button, a hyperlink, an icon, a clickable symbol, and/or combinations thereof, that may be activated by a user terminal interfacing with the at least one processor over a computer network, for example.

[0020] Further, unless expressly stated to the contrary, "or" refers to an inclusive or and not to an exclusive or. For example, a condition A or B is satisfied by anyone of the following: A is true (or present) and B is false (or not present), A is false (or not present) and B is true (or present), and both A and B are true (or present).

[0021] In addition, the use of the "a" or "an" are employed to describe elements and components of the embodiments herein. This is done merely for convenience and to give a general sense of the inventive concept. This description should be read to include one or more, and the singular also includes the plural unless it is obvious that it is meant otherwise.

[0022] Finally, as used herein any reference to "one embodiment" or "an embodiment" means that a particular element, feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment. The appearance of the phrase "in one embodiment" in various places in the specification are not necessarily all referring to the same embodiment.

[0023] Referring now to FIG. 1, shown therein is an exemplary embodiment of a roof estimator reporting system 100 according to the instant disclosure. The system 100 comprises two or more host systems 102 and 126 interfacing and/or communicating with one or more user terminals 104 via a network 106.

[0024] The one or more user terminals 104 may be implemented as a personal computer, a smart phone, network-capable TV set, TV set-top box, a tablet, an e-book reader, a laptop computer, a desktop computer, a network-capable handheld device, a video game console, a server, a digital video recorder, a DVD-player, a Blu-Ray player and combinations thereof, for example. In an exemplary embodiment, the user terminal 104 may comprise an input device 122, an output device 124, a processor (not shown) capable of interfacing with the network 106, processor executable code (not shown), and a web browser capable of accessing a website and/or communicating information and/or data over a network, such as the network 106. As will be understood by persons of ordinary skill in the art, the one or more user terminals 104 may comprise one or more non-transient memories comprising processor executable code and/or software applications, for example.

[0025] The input device 122 may be capable of receiving information input from a user and/or other processor(s), and transmitting such information to the user terminal 104 and/or to the host system 102. The input device 122 may be

implemented as a keyboard, a touchscreen, a mouse, a trackball, a microphone, a fingerprint reader, an infrared port, a slide-out keyboard, a flip-out keyboard, a cell phone, a PDA, a video game controller, a remote control, a fax machine, a network interface, and combinations thereof, for example.

[0026] The output device 124 may output information in a form perceivable by a user and/or other processor(s). For example, the output device 124 may be a server, a computer monitor, a screen, a touchscreen, a speaker, a website, a TV set, a smart phone, a PDA, a cell phone, a fax machine, a printer, a laptop computer, and combinations thereof. It is to be understood that in some exemplary embodiments, the input device 122 and the output device 124 may be implemented as a single device, such as, for example, a touchscreen or a tablet. It is to be further understood that as used herein the term user is not limited to a human being, and may comprise a computer, a server, a website, a processor, a network interface, a human, a user terminal, a virtual computer, and combinations thereof, for example.

[0027] The system 100 may include one or more host systems. For example, FIG. 1 illustrates system 100 having two host systems 102 and 126. The host systems 102 and 126 may be partially or completely network-based or cloud based, and not necessarily located in a single physical location. Each of the host systems 102 and 126 may further be capable of interfacing and/or communicating with the one or more user terminals 104 via the network 106, such as by exchanging signals (e.g., digital, optical, and/or the like) via one or more ports (e.g., physical or virtual) using a network protocol, for example. Additionally, each host system 102 and 126 may be capable of interfacing and/or communicating with other host systems directly and/or via the network 106, such as by exchanging signals (e.g., digital, optical, and/or the like) via one or more ports.

[0028] In some embodiments, host systems 102 and 126 may be independently controlled by separate entities. Host system 102 may be controlled by a first company and host system 126 may be controlled by a second company distinct from the first company. For example, host system 102 may be controlled by a roofing material supplier and host system 126 may be controlled by a roofing report company. The roofing material supplier may be a separate entity from the roofing report company.

[0029] The host system 102 may be referred to hereinafter as the "first host system" and the host system 126 may be referred to hereinafter as the "second host

system". The first host system 102 may comprise one or more processors 108 working together, or independently to, execute processor executable code, one or more memories 110 capable of storing processor executable code, one or more input devices 112, and one or more output devices 114. Each element of the first host system 102 may be partially or completely network-based or cloud-based, and not necessarily located in a single physical location.

[0030] The one or more processors 108 may be implemented as a single or plurality of processors 108 working together, or independently to execute the logic as described herein. Exemplary embodiments of the one or more processors 108 include a digital signal processor (DSP), a central processing unit (CPU), a field programmable gate array (FPGA), a microprocessor, a multi-core processor, and/or combinations thereof. The one or more processors 108 may be capable of communicating with the one or more memories 110 via a path (e.g., data bus). The one or more processors 108 may be capable of communicating with the input devices 112 and the output devices 114.

[0031] The one or more processors 108 may be further capable of interfacing and/or communicating with the one or more user terminals 104 via the network 106. For example, the one or more processors 108 may be capable of communicating via the network 106 by exchanging signals (e.g., digital, optical, and/or the like) via one or more physical or virtual ports using a network protocol. It is to be understood that in certain embodiments using more than one processor 108, the one or more processors 108 may be located remotely from one another, located in the same location, or comprising a unitary multi-core processor (not shown). The one or more processors 108 may be capable of reading and/or executing processor executable code and/or of creating, manipulating, altering, and/or storing computer data structures into one or more memories 110.

[0032] The one or more memories 110 may be capable of storing processor executable code. Additionally, the one or more memories 110 may be implemented as a conventional non-transient memory 110, such as, for example, random access memory (RAM), a CD-ROM, a hard drive, a solid state drive, a flash drive, a memory card, a DVD-ROM, a floppy disk, an optical drive, and/or combinations thereof. It is to be understood that while one or more memories 110 may be located in the same physical location as the first host system 102, the one or more memories 110 may be located remotely from the first host system 102, and may communicate with the one

or more processor 108 via the network 106. Additionally, when more than one memory 110 is used, a first memory 110 may be located in the same physical location as the first host system 102, and additional memories 110 may be located in a remote physical location from the first host system 102. The physical location(s) of the one or more memories 110 may be varied. Additionally, one or more memories 110 may be implemented as a "cloud memory" (i.e., one or more memory 110 may be partially or completely based on or accessed using the network 106).

[0033] The one or more input devices 112 may transmit data to the processors 108, and may be implemented as a keyboard, a mouse, a touchscreen, a camera, a cellular phone, a tablet, a smart phone, a PDA, a microphone, a network adapter, and/or combinations thereof. The input devices 112 may be located in the same physical location as the first host system 102, or may be remotely located and/or partially or completely network-based.

[0034] The one or more output devices 114 may transmit information from the processor 108 to a user, such that the information may be perceived by the user. For example, the output devices 114 may be implemented as a server, a computer monitor, a cell phone, a tablet, a speaker, a website, a PDA, a fax, a printer, a projector, a laptop monitor, and/or combinations thereof. The output device 114 may be physically co-located with the first host system 102, or may be located remotely from the first host system 102, and may be partially or completely network based (e.g., website). As used herein, the term "user" is not limited to a human, and may comprise a human, a computer, a host system, a smart phone, a tablet, and/or combinations thereof, for example.

[0035] The first host system 102 may directly communicate with the second host system 126 and/or communicate via network 106. Generally, the first host system 102 may include one or more processors 108 capable of executing a first set of processor executable code and the second host system 126 may include one or more processors 128 capable of executing a second set of processor executable code.

[0036] The second host system 126 may further comprise one or more memories 130 capable of storing processor executable code, one or more input devices 132, and one or more output devices 134. Each element of the second host system 126 may be partially or completely network-based or cloud based, and not necessarily located in a single physical location.

[0037] The one or more processors 128 may be implemented as a single or a plurality of processors 128 working together to execute the logic described herein. Exemplary embodiments of the one or more processors 128 include a digital signal processor (DSP), a central processing unit (CPU), a field programmable gate array (FPGA), a microprocessor, a multi-core processor, and/or combinations thereof. The one or more processors 128 may be capable of communicating with the one or more memories 130 via a path (e.g., data bus). The one or more processors 128 may be capable of communicating with the input devices 132 and the output devices 134.

[0038] The one or more processors 128 may be further capable of interfacing and/or communicating with the one or more user terminals 104 via the network 106. For example, the one or more processors 128 may be capable of communicating via the network 106 by exchanging signals (e.g., digital, optical, and/or the like) via one or more physical or virtual ports using a network protocol. It is to be understood that in certain embodiments using more than one processor 128, the one or more processors 128 may be located remotely from one another, located in the same location, or comprising a unitary multi-core processor (not shown). The one or more processors 128 may be capable of reading and/or executing processor executable code and/or of creating, manipulating, altering, and/or storing computer data structures into one or more memories 130.

[0039] The one or more memories 130 may be capable of storing processor executable code. Additionally, the one or more memories 130 may be implemented as a conventional non-transient memory 130, such as, for example, random access memory (RAM), a CD-ROM, a hard drive, a solid state drive, a flash drive, a memory card, a DVD-ROM, a floppy disk, an optical drive, and/or combinations thereof. It is to be understood that while one or more memories 130 may be located in the same physical location as the second host system 126, the one or more memories 130 may be located remotely from the second host system 126, and may communicate with the one or more processor 128 via the network 106. Additionally, when more than one memory 130 is used, a first memory 130 may be located in the same physical location as the second host system 126, and additional memories 130 may be located in a remote physical location from the second host system 126. The physical location(s) of the one or more memories 130 may be varied. Additionally, one or more memories 130 may be implemented as a "cloud memory" (i.e., one or

more memory 130 may be partially or completely based on or accessed using the network 106).

[0040] The input devices 132 may transmit data to the processors 128, and may be implemented as a keyboard, a mouse, a touchscreen, a camera, a cellular phone, a tablet, a smart phone, a PDA, a microphone, a network adapter, and/or combinations thereof. The input devices 132 may be located in the same physical location as the second host system 126, or may be remotely located and/or partially or completely network-based.

[0041] The output devices 134 may transmit information from the processors 128 to a user, such that the information may be perceived by the user. For example, the output devices 134 may be implemented as a server, a computer monitor, a cell phone, a tablet, a speaker, a website, a PDA, a fax, a printer, a projector, a laptop monitor, and/or combinations thereof. The output devices 134 may be physically co-located with the second host system 126, or may be located remotely from the second host system 126, and may be partially or completely network based (e.g., website).

[0042] The network 106 may permit bi-directional communication of information and/or data between the first host system 102, the second host system 126 and/or user terminals 104. The network 106 may interface with the first host system 102, the second host system 126, and the user terminals 104 in a variety of ways. For example, the network 106 may interface by optical and/or electronic interfaces, and/or may use a plurality of network topographies and/or protocols including, but not limited to, Ethernet, TCP/IP, circuit switched paths, and/or combinations thereof. For example, the network 106 may be implemented as the World Wide Web (or Internet), a local area network (LAN), a wide area network (WAN), a metropolitan network, a wireless network, a cellular network, a GSM-network, a CDMA network, a 3G network, a 4G network, a satellite network, a radio network, an optical network, a cable network, a public switched telephone network, an Ethernet network, and/or combinations thereof. Additionally, the network 106 may use a variety of network protocols to permit bi-directional interface and/or communication of data and/or information between the first host system 102, the second host system 126, and/or one or more user terminals 104.

[0043] Referring to FIGS. 1 and 2, the one or more memories 110 may store processor executable code and/or information comprising a user database 136, a

contractor database 137, a first image database 138 and program logic 139. The processor executable code may be stored as a data structure, such as a database and/or a data table, for example.

[0044] The user database 136 may include information about customers engaging with the first host system 102. For example, one or more customers may access the first host system 102 through the one or more user terminals 104. The first host system 102 may provide a roof request website to the user terminal 104. The roof request website may be directed by the one or more processors 108. The processor 108 may also direct the one or more customers to a login/registration portion of the website.

[0045] In some embodiments, customers may register a user profile with the first host system 102. The user profile may be created and/or stored in the user database 136 by the processor 108. For example, the customer may be prompted by the processor 108 to provide login credentials (e.g., username and/or password). Login credentials may allow the processor 108 to authenticate the customer against the user database 136. In this manner, the first host system 102 may access the user profile in the user database 136. The user profile may include information including, but not limited to, demographic information including, but not limited to, name, age, address, billing account information, username, password, behavioral information, experience, gender, and/or the like.

[0046] If user authentication is successful, the user profile may be accessed by the processor 108. If the user authentication fails, the customer may be returned to the login/registration page, where the customer may be prompted for a username and password again. Optionally, the processor 108 may block a customer from entering a username and/or password after a preset number of failed authentication attempts.

[0047] In some embodiments, customers may be prompted by the processor 108 to provide information for a user profile without registration and/or authentication using a username and/or password. The user profile may be created and/or stored in the user database 136 by the processor 108. For example, the processor 108 may prompt the customer to provide demographic information (e.g., name, address, billing account information, and the like), and store the information in a user profile for the customer using a unique customer identification.

[0048] The contractor database 137 may comprise information about roofing contractors within a given geographic location. Each roofing contractor may be associated with a contractor profile having information including, but not limited to, roofing contractor business name, roofing contractor owner name, address, experience level, age of contractor business, review information, and the like. In some embodiments, the contractor profile may include a geographical category assignment identification (ID). For example, the contractor profile may be assigned a numerical or alphabetical identification based on geographic location of the business.

[0049] In some embodiments, the contractor profile may include review information. The review information may include positive and/or negative feedback relating to each contractor. For example, the review information may be based on prior customer feedback of customers using the system 100. Review information may also be obtained from one or more outside databases (e.g., Yelp, Google review, and/or the like).

[0050] One or more contractors may provide a contractor profile via the first host system 102. For example, one or more contractors may access the roof review website of the first host system 102 via the user terminal 104. The processor 108 may direct the contractor via the roof review website to a login/registration portion of the website. If the contractor has previously registered with the first host system 102, the contractor may be prompted by the processor 108 to provide login credentials (e.g., username and/or password), which may allow the processor 108 to authenticate the contractor against the contractor database 137.

[0051] If the contractor is not registered with the first host system 102, the first host system 102 may prompt the contractor to provide information via the one or more user terminals 104 to create a contractor profile. Alternatively, the contractor profiles may be provided in the contractor database 137 without information provided by each contractor. For example, a user of the first host system 102 may provide information via the input device 112, the network 106, and/or the like, setting up a contractor profile without direct knowledge of the contractor.

[0052] The one or more memories 110 may include the image database 138. The image database 138 may store geo-referenced imagery. Such imagery may be represented by a single pixel map, and/or by a series of tiled pixel maps that when aggregated recreate the image pixel map. Imagery may include nadir, ortho-rectified

and/or oblique geo-referenced images. The one or more processors 108 may provide the images via the image database 138 to customers at the one or more user terminals 104. Customers, using the user terminals 104, may provide geographic location information associated with a roof request using the geo-referenced images provided by the one or more processors 108. For example, a customer may be provided a geo-referenced image to validate the location of a structure (e.g., roof). In some embodiments, the customer may be able to select the structure (e.g., via a drag-and-drop user interface) to pinpoint a location of the structure within the image. Selection of the structure may provide location information (e.g., latitude/longitude coordinate, or and the like) of the structure to the first host system 102. For simplicity, the description will provide for a roof as the structure of interest. However, is should be apparent that other structures of buildings and/or landscapes may be used in accordance with the present disclosure.

[0053] The one or more memories 110 may further store processor executable code and/or instructions, which may comprise the program logic 139. The program logic 139 may comprise processor executable instructions and/or code, which when executed by the processor 108, may cause the processor 108 to generate, maintain, provide, and/or host a website providing one or more roofing requests, for example. The program logic 139 may further cause the processor 108 to collect user information and/or contractor information, create user profiles and/or contractor profiles, provide users one or more geo-referenced images, and allow one or more users to validate a location of the roof as described herein.

[0054] The one or more processors 108 may generate, maintain, or provide one or more roofing orders to the second host system 126. For example, the one or more processors 108 may provide the one or more roofing orders to the second host system 126 by copying information obtained and/or stored in one or more memories 110. The roofing orders may include contractor profile, user profile, user validated images, a unique ordering ID, and/or the like.

[0055] The one or more memories 130 of the second host system 126 may store processor executable code and/or information comprising an order database 140, a second image database 141 and the program logic 142. The processor executable code may be stored as a data structure, such as a database and/or a data table, for example.

[0056] The order database 140 may include information about a roofing order placed by a customer and copied by the first host system 102. For example, a roofing order may include contractor profile, user profile, user validated images, a unique ordering ID, and/or the like. The second host system 126 may access the order database 140 to provide a roofing report as described in detail herein.

[0057] The one or more memories 130 of the second host system 126 may also include a second image database 141. The second image database 141 may provide additional nadir, ortho-rectified, and/or oblique geo-referenced and/or non-geo-referenced images for use in providing a roofing report as described in detail herein. Alternatively, the image database 138 and the image database 141 may be the same database.

[0058] The one or more memories 130 of the second host system 126 may further store processor executable code and/or instructions, which may comprise program logic 142. The program logic 142 may comprise processor executable instructions and/or code, which when executed by the one or more processors 128, may cause the one or more processors 128 to generate, maintain, and/or provide a website or series of websites for providing roofing reports. The program logic 142 may further cause the one or more processors 128 to allow one or more users to participate in executing a roofing report via the input devices 132.

[0059] Referring to FIG. 3, shown therein is an exemplary flow chart 144 of program logic 139 for creating a roof report order which may be used with the first host system 102 according to the instant disclosure. Program logic 139 may comprise executable code, which when executed by the one or more processors 108 may cause the one or more processors 108 to execute one or more of the following:

[0060] The program logic 139 may provide for one or more user terminals 104 interfacing with the processor 108 over the network 106 to provide one or more roofing request website pages allowing customers to place a roofing request order. Each order is generally a request of the customer to provide estimated square footage of a specific roof. Additionally, each order may also include a request for contractor information and/or a bid request for estimate costs and associated features of materials, supplies, physical labor, and the like.

[0061] Generally, in a step 145, customers using one or more user terminals 104 may provide user information to the first host system 102. The user information may then be used to prepare one or more user profiles for use in preparing the

roofing report. Additionally, program logic 139 may generate a unique identification number and/or alpha numeric character to associate with the user profile.

[0062] The user information may include a location of the roof provided by the customer. For example, the customer may provide a residential and/or commercial address of the roof. One or more processors 108 may direct customers to validate the location of the roof using user terminals 104, in step 146. For example, processors 108 may provide one or more images via the image database 138. The images may be geo-referenced images illustrating portions or all of the roof. The program logic 139 may cause the processor 108 to provide users the one or more geo-referenced images, and allow the customer to validate the location of the roof. For example, the customer may be able to use a drag-and-drop element provided by the program logic 139 via user terminal 104 to select the roof within the one or more geo-referenced images. Selection of the roof within the one or more geo-referenced images may provide one or more validated images and a validated location of the roof. In some embodiments, the geographic location may include coordinates, and validation of the geographic location may be provided by a customer by altering one or more coordinates of the geographic location. Customers may alter the one or more coordinates by methods including, but not limited to, manual manipulation, drag-and-drop elements, and the like.

[0063] It should be understood that validation of the geo-referenced images may be provided by the second host system 126 via the one or more processors 128 in lieu of, or in combination with host system 102. For example, the first host system 102 may direct customers to the second host system 126 wherein the one or more processors 128 of the second host system 126 provide geo-referenced images from image database 141 to the customer for validation of one or more roof and/or roofing structures. As such, in some embodiments, only the second host system 126 provides geo-referenced images in the image database 141.

[0064] The first host system 102 may determine contractor availability within a region of interest about the validated location of the roof as shown in step 147. For example, program logic 139 may extract the validated location and compare the validated location against location of contractors in a region of interest. The region of interest may be determined by the customer via user terminal and/or the region of interest may be a pre-programmed determination. For example, the region of interest may be a five mile radius about the validated location. Contractor availability

may include contractors having a contractor profile within the contractor database 137. Contractors within the contractor database 137 may be provided with a copy of the roofing report as described herein.

[0065] The program logic 139 may direct the one or more processors 108 to create and/or store a roofing order for the customer as shown in step 148. Additionally, the program logic 139 may direct one or more processors to transfer the roofing order to the second host system 126.

[0066] FIG. 4 illustrates a flow chart 149 of an exemplary embodiment of the program logic 139 and/or 142 for processing a roof report order which may be used with the system 100 according to the instant disclosure. The program logic 139 comprises processor executable code, that when executed by the processor 108, may cause the processor 108 to execute one or more of the following:

[0067] The program logic 139 may include a step 150 wherein one or more user terminals 104 interfacing with the processor 108 over the network 106 may be provided with one or more websites having a mechanism allowing a customer to request a roof report. The customer may provide the request to the first host system 102 using the one or more websites, in a step 152. Prior to providing customer information, the customer may be notified that the first host system 102 may distribute any contact information provided by the customer to contractors provided within the first host system 102. The one or more processors 108 may provide the customer an option for agreeing to terms of service (e.g., distribution of their contact information), in a step 154.

[0068] In a step 156, the roof report request website may include queries regarding customer information including, but not limited to, customer name, address, address of the roof, billing information, and the like. The customer information may be provided by the one or more processors 108 and stored in the one or more memories 110. For example, the customer information may be provided by processors 108 as a user profile and stored in the user database 136 of the one or more memories 110.

[0069] Customers may be able to select the desired roof, location, and/or the like on the one or more websites provided by the processor 108 over the network 106, in step 158. For example, the customer may use the one or more user terminals 104 to provide a geographical location (e.g., address, latitude/longitude coordinates, or the like), a geo-referenced image, and/or an element within a geo-

referenced image. Once the geographical location of the roof is selected, the processor 108 may provide a verification web page or similar mechanism for customer review and/or approval of a proposed order, in a step 160. The first host system 102 may receive the proposed order via the processor 108, store the order and/or transfer the order to the second host system 126 for processing, in a step 162. The processor 108 may provide a confirmation webpage or similar mechanism informing the customer of a successful order placement, in a step 164.

[0070] FIG. 5 illustrates a flow chart 169 of an exemplary embodiment of the program logic 139 and/or 142 for providing a roof report which may be used with the system 100 according to the instant disclosure. Generally, processing of the proposed order may be provided using the second host system 126. The program logic 142 comprises processor executable code, that when executed by the processor 128, may cause the processor 128 to execute one or more of the following:

[0071] The second host system 126 may receive the proposed order via the one or more processors 108 of the first host system 102. Generally, the validity of the location of the roof provided by the customer may be determined, in a step 170. In a step 172, the second host system 126 may determine if the location of the roof provided by the customer exists. If the location is not found, the customer may be further contacted by the second host system 126 and/or the first host system 102 requesting resubmission or additional information for the proposed order, in a step 174. Additionally, in a step 176, the second host system 126 may determine if corresponding imagery within image database 141 exists for the location provided by the customer. If there is no corresponding imagery, the customer may be further contacted by the second host system 126 and/or the first host system 102 with a status message indicating no suitable imagery of the roof currently exists, in a step 178.

[0072] The second host system 126 may further process and review the order, in a step 180. An exemplary series of steps for implementing step 180 is shown in a flow chart 188 illustrated in FIG. 6. For example, the one or more processors 128 of the second host system 126 may receive the proposed order, in a step 190. The one or more processors 128 may extract order related information and images. Generally, a user may access a roof report website provided by the one or more processors 128 to review and/or process the proposed order. For example, the user

may access the roof report website using the input devices 132 and the output devices 134 to review and/or process the proposed order.

[0073] In some embodiments, using the input devices 132 and/or the output devices 134, the user may provide additional details to the proposed order regarding the roof including, but not limited to, identification of areas of the roof (e.g., eaves, drip edges, ridges, and the like), pitch, distance, angle, and/or the like.

[0074] The footprint of the roof may be determined, in step 192. For example, the footprint of the roof may be determined using systems and methods including, but not limited to, those described in U.S. Patent Publication No. 2010/0179787, U.S. Patent Publication No. 2010/0110074, U.S. Patent Publication No. 2010/0114537, U.S. Patent Publication No. 2011/0187713, U.S. Patent No. 8,078,436, and U.S. Serial No. 12/090,692, all of which are incorporated by reference herein in their entirety.

[0075] In some embodiments, the one or more processors 128 may provide one or more websites to the user for evaluation of multiple oblique images to provide the footprint of the roof. For example, the user and/or the processors 128 may identify edges of the roof. Two-dimensional and/or three-dimensional information regarding the edges (e.g., position, orientation, and/or length) may be obtained from the images. Using the two-dimensional and/or three-dimensional information (e.g., position orientation, and/or length), line segments may be determined with multiple line segments forming at least a portion of the footprint of the roof.

[0076] The footprint may provide a two-dimensional boundary and/or outline of the roof. In a step 194, a predominant pitch value for the roof may be determined. In some embodiments, a predominant pitch value may be determined using the footprint as a boundary of the roof. The predominant pitch may be a weighted average of individual pitch factors for two or more portions of the roof. FIG. 7 illustrates an exemplary slope factor chart for determining pitch factors. For example, a first portion of the roof (e.g., 60% of the roof) may be at a 6:12 pitch. The 6:12 pitch corresponds to 1.1180 as the pitch factor). A second portion of the roof (e.g. 40% of the roof) may be at a 4:12 pitch. The 4:12 pitch corresponds to 1.0541 as the pitch factor. Thus, the weighted value of the first portion of the roof having 6:12 pitch is:

(Pitch Factor) * (Percentage of roof) = First Weighted Value **EQ. 1**

1.1180 * 0.6 = 0.6708

The weighted value of the second portion of the roof having 4:12 pitch is:

(Pitch Factor) * (Percentage of roof) = Second Weighted Value **EQ. 2**

1.0541 * 0.4 = 0.42164

The sum of 0.6708 and 0.42164 is 1.09244 as the total weighted pitch value. A total weighted pitch value of 1.09244 is closest to a pitch factor of 1.0833 in the table in FIG. 7. This pitch factor corresponds to a 5:12 pitch. As such, the predominant pitch in this scenario would be 5:12. Using the predominant pitch and outer dimensions provided by the footprint, an estimated area of the roof may be determined, in a step 196.

[0077] In some embodiments, the user may review and reevaluate the estimated area of the roof obtained. For example, using the system and methods described herein, the user may review the steps for obtaining the footprint, the predominant pitch value, and/or estimated area. Additionally, the user may provide for a review report. The review report may comprise feedback to the one or more processors 128 regarding errors, concerns, and/or the like.

[0078] Referring to FIGS. 1, 6 and 8, in a step 184 and 186, a customer and/or contractor may receive a roof report 200. FIG. 8 illustrates an exemplary embodiment of a roof report 200 provided in accordance with the present disclosure. The program logic 139 may provide for one or more user terminals 104 interfacing with the processor 108 over the network 106 to provide one or more roofing report website pages allowing customers and/or contractors to view the roof report 200.

[0079] Generally, roofing reports within the industry are detailed with data sets regarding pitch, total area, eave length, hip ridge length, valley length, number of box vents, and the like. The roof report 200 may be streamlined to generally include data sets such as customer information 202, roofing 204, estimated area detail 206, and contractor(s) 208. The customer information data set 202 may include the customer name, customer contact information, and the like. The roofing data set 204 may include one or more nadir images of the roof and one or more oblique images of the

roof. The estimated area detail 206 may provide the total estimated roof area as determined using the second host system 126 described herein. The contractor data set 208 may include one or more contractor names and associated contractor contact information for the one or more contractor names.

[0080] The roof report 200 may be distributed using the first host system 102 and/or the second host system 126 to the one or more user terminals 104. For example, the roof report 200 may be distributed using the first host system 102 to a contractor at a first user terminal 104 and the roof report 200 may be distributed using the first host system 102 to the customer at a second user terminal 104.

[0081] In some embodiments, the first host system 102 and/or the second host system 126 may distribute the roof report 200 to one or more recipients in addition to, or in lieu of, the customer. For example, the roof report 200 may be distributed to recipients including, but not limited to, roof material suppliers (e.g., small roofing companies, Lowes, Home Depot, and the like), insurance companies, real estate agencies, home services and/or cleaning companies, insulation companies, auditing companies, and/or contractors. Contractors and/or suppliers may be associated with residential and/or commercial building elements and/or services including, but not limited to, fireplaces, pool sales, fencing, lawn maintenance, gardening, pavement resurfacing, decking, sunrooms, roofing, guttering, custom Christmas light designs, siding, windows, doors, garage doors, and the like.

[0082] In some embodiments, additional data sets may be included within the roof report 200. For example, data sets may include, but are not limited to, weather data, insurance/valuation data, census data, school district data, real estate data, and the like.

[0083] Weather data sets may be provided by one or more databases storing information associated with weather (e.g., inclement weather). A weather data set within the roof report 200 may include, but is not limited to, hail history information and/or location, wind data, severe thunderstorm data, hurricane data, tornado data, and/or the like. In some embodiments, the one or more databases providing weather information may be hosted by a separate system (e.g., LiveHailMap.com) and provide information to the first host system 102 and/or the second host system 126. The weather data set may be included within the roof report 200 and provided to the customer and/or other parties. In some embodiments, weather data sets may

be provided within a report as described herein without the addition of roof related information (e.g., roofing data set 204).

[0084] Insurance and/or valuation data sets may be provided by one or more databases storing information associated with housing insurance and/or valuation. An insurance and/or valuation data set may include, but is not limited to, insured value of the home, insurance premium amount, type of residence (e.g., multi-family, single family), number of floors (e.g., multi-floor, single-floor), building type, and/or the like. In some embodiments, the one or more databases may be hosted by a separate system (e.g., Bluebook, MSB, 360Value) and provide information to the first host system 102 and/or the second host system 126.

[0085] The insurance and/or valuation data set may be included within the roof report 200 and provided to the customer and/or other parties. For example, during underwriting of a home, an insurance company may be able to request the roof report 200 on a home that is recently purchased. The information within the roof report 200 may be integrated with insurance information provided by an insurance database and used to form a quote report. The quote report may be sent to the customer and/or insurance company. Alternatively, the roof report 200 may be solely sent to the insurance company with the insurance company using the information to formulate a quote.

[0086] In another example, the roof report 200 may be used in an insurance claim. In the case of a catastrophe of a customer, one or more databases may be used to provide an insurance dataset with claim information in the roof report 200. For example, an insurance database having a policy in force (PIF) and a weather database may be used to correlate information regarding an insurance claim for a particular roof. This information may be provided within the roof report 200.

[0087] Real estate and/or census data sets may also be including within the roof report. The real estate and/or census data sets may be provided by one or more databases having detailed information of a home. For example, a real estate data set may include, but is not limited to, the homeowner's name, the purchase price of the home, number of times the home has been on the market, the number of days the home has been on the market, the lot size, and/or the like. The census data set may include information concerning the number of residents within the home. In some embodiments, the one or more databases may be hosted by a separate system (e.g., Core Logic) and provide information to the first host system

102 and/or the second host system 126 to provide data sets as described herein. The real estate data set may be included within the roof report 200 and provided to the customer and/or other parties.

[0088] The roof reports 200 may include roofing data as described herein; however, system 100 may be used to provide other information to a customer and/or other party without roof related information (e.g., roofing data set 204). For example, in a real estate transaction, one or more databases in host system 102 and/or host system 126 may include recent home sales over time in one or more geographic areas. The footprint of each home and home valuation may be provided in one or more databases within host system 102 and/or host system 126. Using the systems and methods described herein, a customer (e.g., homeowner) may request a report determining approximate sales price of a home using the footprint and/or valuation versus comparables within the geographic area. The report may provide an approximate sale price of the home. In some embodiments, demographics of the homeowners may be used and stored in one or more databases. The demographic information may be used for potential advertising and/or comparables within the geographic area.In another example, using systems and methods as described herein, a report may be provided for housecleaning and/or home services area (e.g., fireplace cleaning, pool sales, fencing, lawn maintenance/gardening, pavement resurfacing, decking, sunrooms, roofing, guttering, custom Christmas light designs, siding, windows, doors, garage doors, and the like). For example, using a footprint of a home, number of stories within a home, and the like, a determination of average square footage within a home may be determined. This information may be used to formulate a price quote for cleaning services.

[0089] Other services related to roofing may be provided within the roof report 200. For example, using the square footage of the roofing footprint, a price quote may be generated on the cost of insulation for the roof (e.g., energy efficiency, insulation replacement, and the like). Additionally, audits may be performed using information within one or more databases. For example, using the roofing area of a home, historically paid insurance claims for comparables, and validation of payment for a specific claim for the home, a comparison may be made to determine whether the service payment for the specific claim was within a certain threshold. Auditing, it should be understood, may be applied to other areas as described herein as well.

[0090] Although the terms "home" and "house" are used herein, it should be noted that the systems and methods in the present disclosure may be applied to any residential and/or commercial building or structure.

[0091] From the above description, it is clear that the inventive concept(s) disclosed herein is well adapted to carry out the objects and to attain the advantages mentioned herein as well as those inherent in the inventive concept(s) disclosed herein. While presently preferred embodiments of the inventive concept(s) disclosed herein have been described for purposed of this disclosure, it will be understood that numerous changes may be made which will readily suggest themselves to those skilled in the art and which are accomplished within the scope and spirit of the inventive concept(s) disclosed herein and defined by the appended claims.

What is claimed is:

1. A set of instructions stored on one or more computer readable medium for running on one or more computer systems, comprising:

instructions for identifying a geographic location of a roof;

instructions for determining contact information of one or more contractors within a region of interest of the geographic location of the roof; and,

instructions for determining a footprint of the roof;

instructions for determining predominant pitch of the roof;

instructions for determining an estimated roofing area based on the predominant pitch and the footprint of the roof.

2. The set of instructions of claim 1, further comprising instructions for providing a roof report, wherein the roof report includes one or more ortho images of the roof, one or more oblique images of the roof, the estimated roofing area and contact information of one or more contractor within the region of interest of the geographic location of the roof.

3. The set of instructions of claim 2, wherein the roof report includes contact information of the customer.

4. The set of instructions of claim 1, wherein the one or more computer readable medium comprises a first computer readable medium of a first host system and a second computer readable medium of a second host system.

5. The set of instructions of claim 1, wherein instructions for identifying the geographic location of the roof further comprises instructions for obtaining contact information of a customer.

6. The set of instructions of claim 1, wherein the one or more computer readable medium further comprises instructions for receiving customer input to validate geographic location of the roof.

7. The set of instructions of claim 6, wherein the geographic location includes coordinates and validation of the geographic location includes instructions for receiving customer input to alter one or more coordinates of the geographic location.

8. The set of instructions of claim 1, wherein instructions for identifying a geographic location of the roof includes identifying one or more edges of the roof in an image.

9. The set of instructions of claim 1, wherein instructions for determining a footprint of the roof further comprises:

instructions for identifying edges of the roof;

instructions for determining three-dimensional information of the edges including position, orientation and length using multiple oblique images from multiple cardinal directions; and,

instructions for determining, automatically, one or more line segments forming a portion of a footprint of the roof utilizing position and orientation of the edges.

10. The set of instructions of claim 1, wherein determining the predominant pitch includes determining a plurality of pitch values, the predominant pitch based on the plurality of pitch values.

11. The set of instructions of claim 10, wherein each pitch value is associated with an estimated percentage of roof area to provide an average pitch value.

12. The set of instructions of claim 1, further comprising:

instructions for providing the roof report to one or more contractors, the contractor located within the region of interest of the geographic location of the roof.

13. A system, comprising:

two or more host systems, each host system having one or more computer readable medium; the first host system storing a set of instructions that when executed by one or more processors causes the one or more processors to:

identify a geographic location of a roof;

determine contact information of at least one contractor within a region of interest about the geographic location of the roof;

the second host system storing a set of instructions that when executed by one or more processors causes the one or more processors to:

determine a footprint of the roof;

determine a predominant pitch;

determine an estimated roofing area based on the predominant pitch and the footprint of the roof; and,

provide a roof report, wherein the roof report includes one or more ortho images of the roof, one or more oblique images of the roof, the estimated roofing area and contact information of one or more contractors within the region of interest.

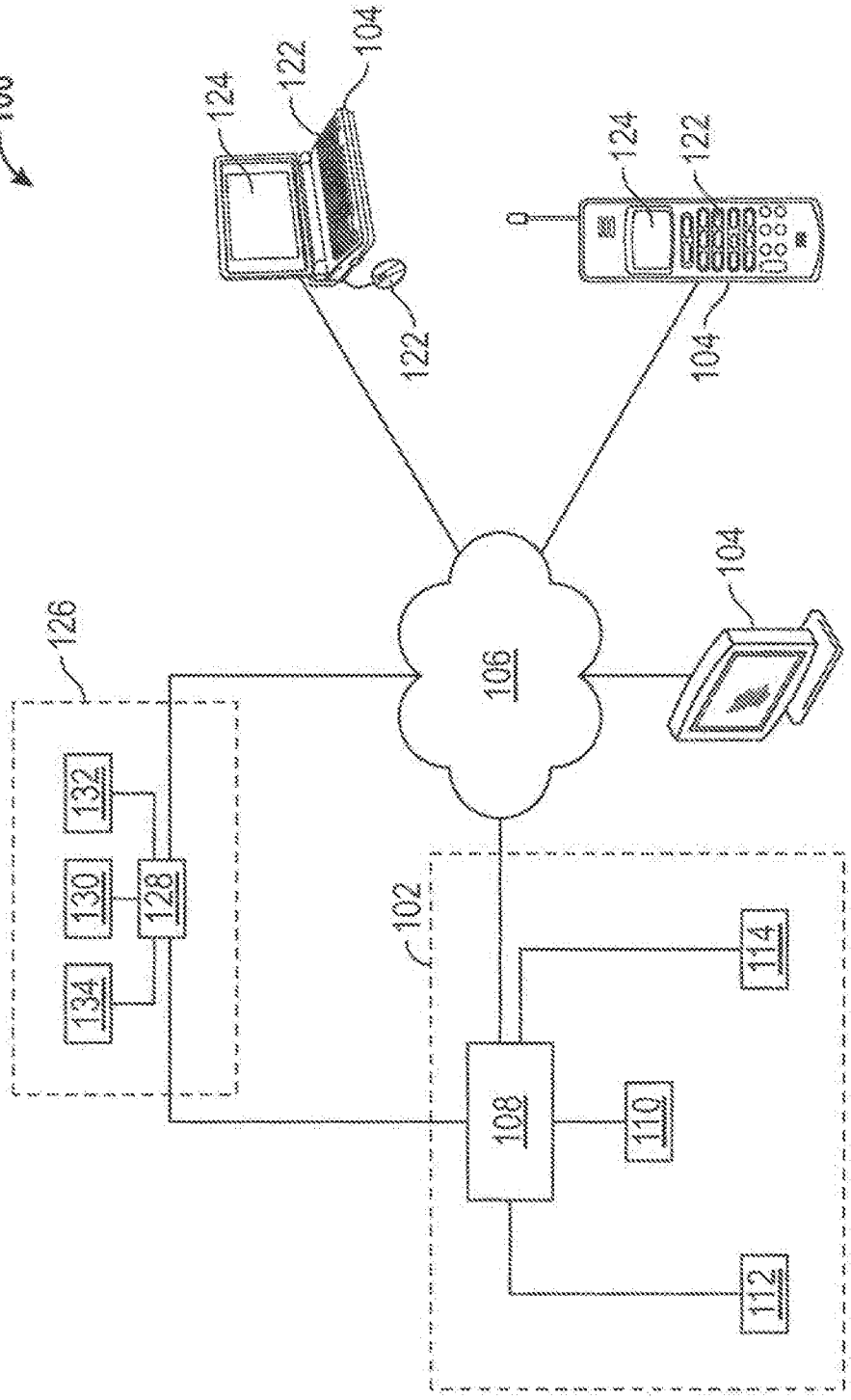

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112

FIG. 1

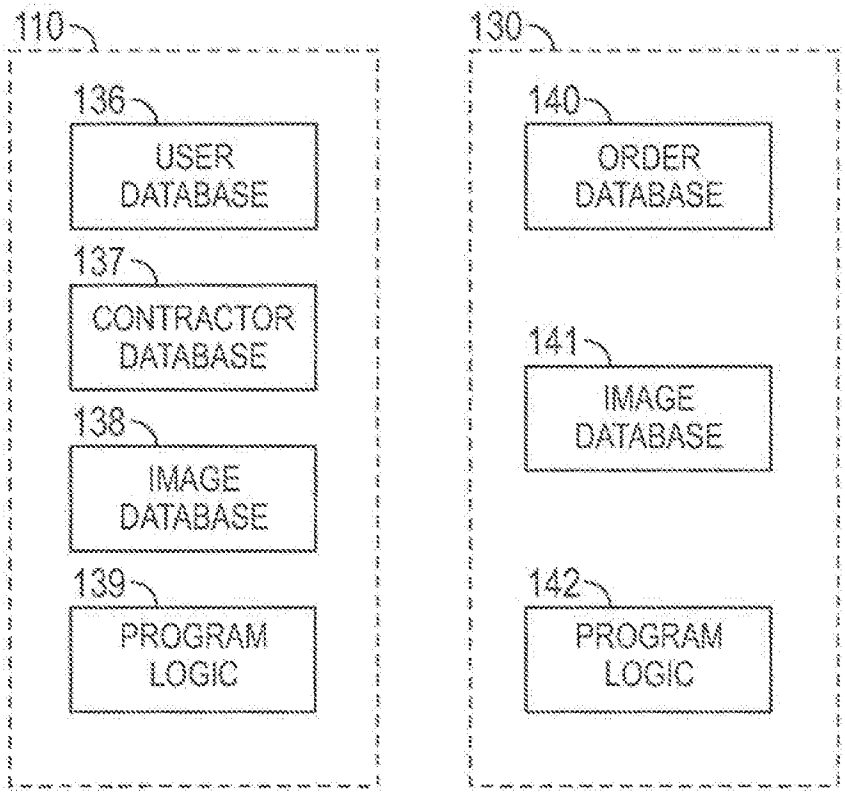

110
136
USER DATABASE
137
CONTRACTOR DATABASE
138
IMAGE DATABASE
139
PROGRAM LOGIC
130
140
ORDER DATABASE
141
IMAGE DATABASE
142
PROGRAM LOGIC

FIG. 2

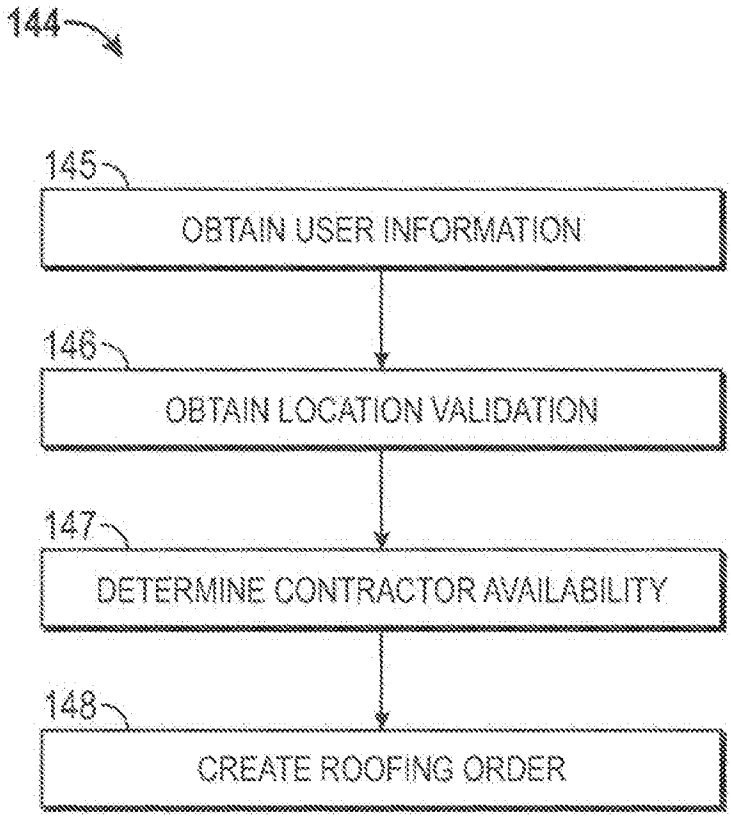

144
145
OBTAIN USER INFORMATION
146
OBTAIN LOCATION VALIDATION
147
DETERMINE CONTRACTOR AVAILABILITY
148
CREATE ROOFING ORDER

FIG. 3

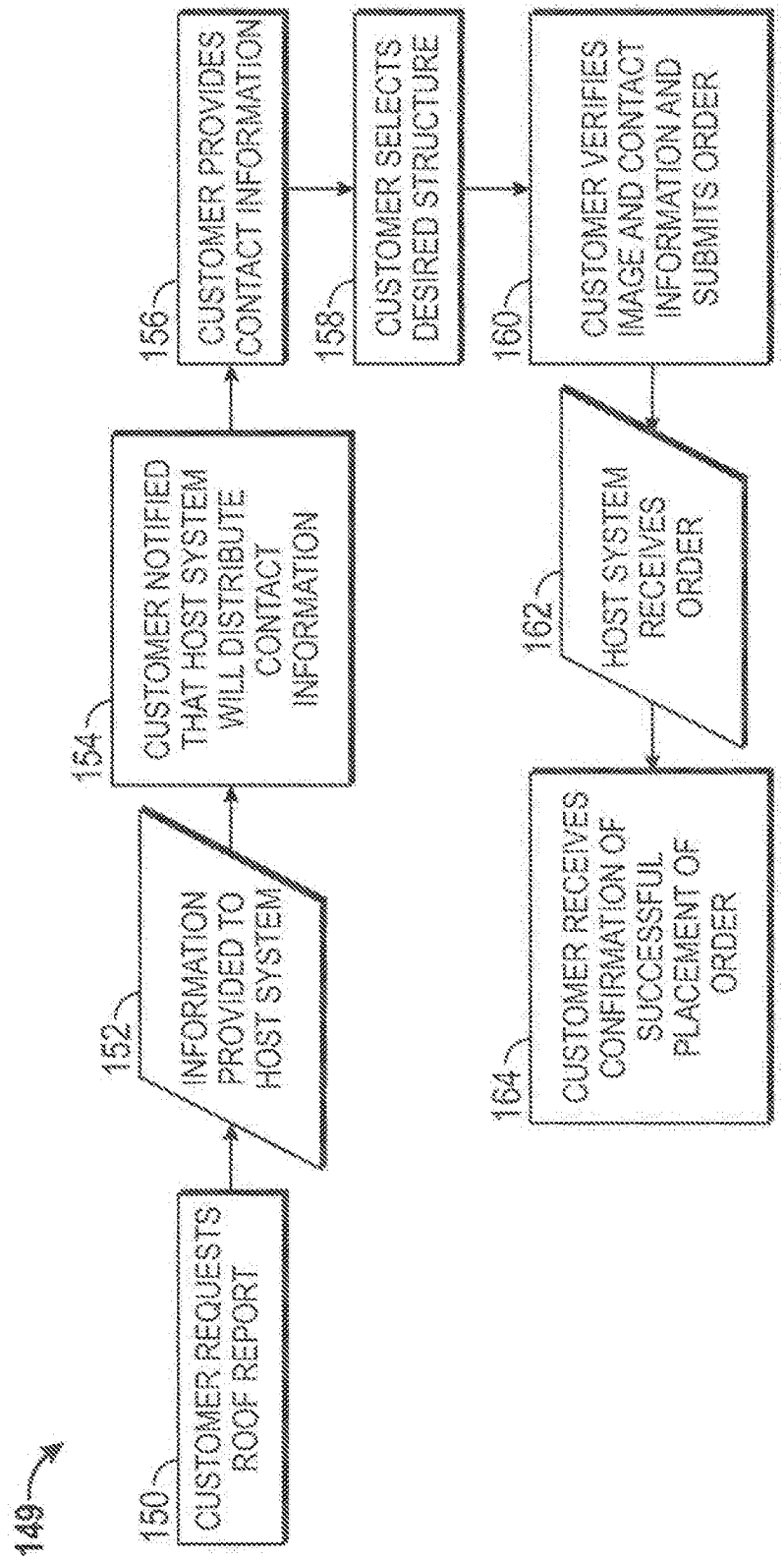

149
150
CUSTOMER REQUESTS ROOF REPORT
152
INFORMATION PROVIDED TO HOST SYSTEM
154
CUSTOMER NOTIFIED THAT HOST SYSTEM WILL DISTRIBUTE CONTACT INFORMATION
156
CUSTOMER PROVIDES CONTACT INFORMATION
158
CUSTOMER SELECTS DESIRED STRUCTURE
160
CUSTOMER VERIFIES IMAGE AND CONTACT INFORMATION AND SUBMITS ORDER
162
HOST SYSTEM RECEIVES ORDER
164
CUSTOMER RECEIVES CONFIRMATION OF SUCCESSFUL PLACEMENT OF ORDER

FIG. 4

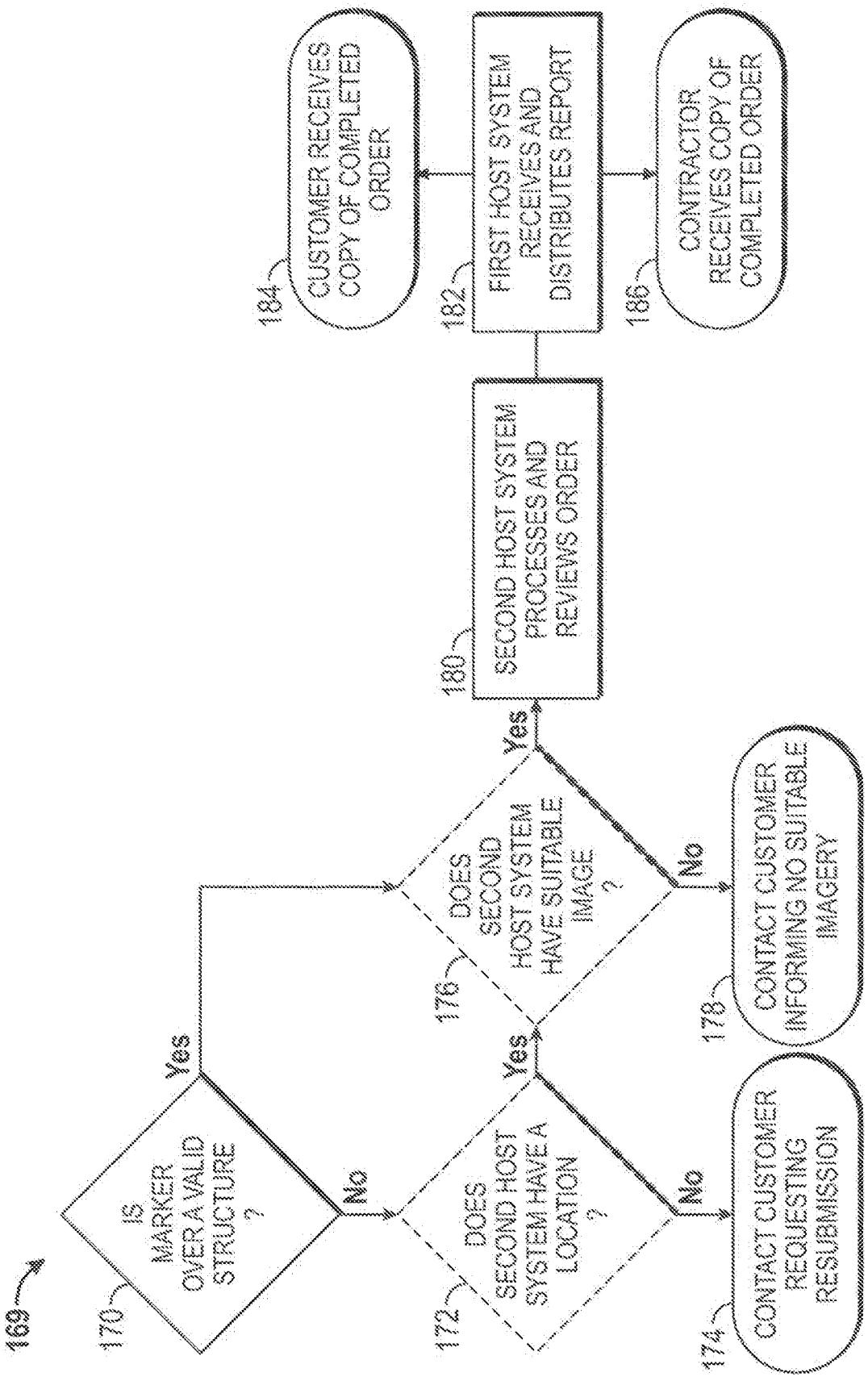

169
170
IS MARKER OVER A VALID STRUCTURE ?
Yes
No
172
DOES SECOND HOST SYSTEM HAVE A LOCATION ?
Yes
No
174
CONTACT CUSTOMER REQUESTING RESUBMISSION
176
DOES SECOND HOST SYSTEM HAVE SUITABLE IMAGE ?
Yes
No
178
CONTACT CUSTOMER INFORMING NO SUITABLE IMAGERY
180
SECOND HOST SYSTEM PROCESSES AND REVIEWS ORDER
182
FIRST HOST SYSTEM RECEIVES AND DISTRIBUTES REPORT
184
CUSTOMER RECEIVES COPY OF COMPLETED ORDER
186
CONTRACTOR RECEIVES COPY OF COMPLETED ORDER

FIG. 5

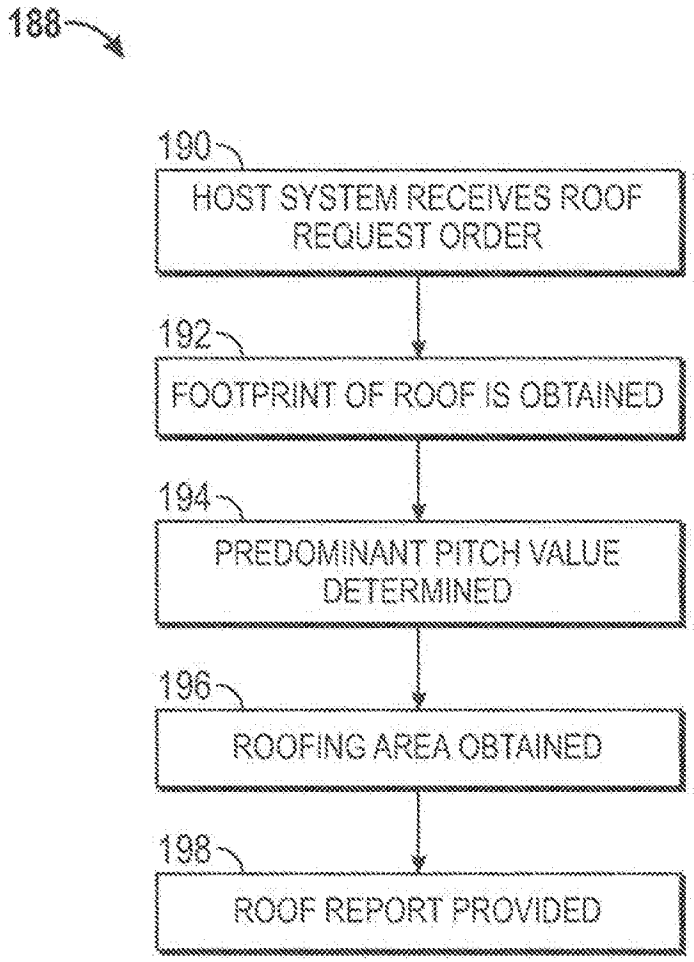

188
190
HOST SYSTEM RECEIVES ROOF REQUEST ORDER
192
FOOTPRINT OF ROOF IS OBTAINED
194
PREDOMINANT PITCH VALUE DETERMINED
196
ROOFING AREA OBTAINED
198
ROOF REPORT PROVIDED

FIG. 6

Slope Factor Chart

Pitch of Roof	1:12	2:12	3:12	4:12	5:12	6:12	7:12	8:12	9:12	10:12	11:12	12:12
Slope Factor	1.0035	1.0138	1.0308	1.0541	1.0833	1.1180	1.1577	1.2019	1.2500	1.3017	1.3566	1.4142

(A) x (Slope Factor) = (B)

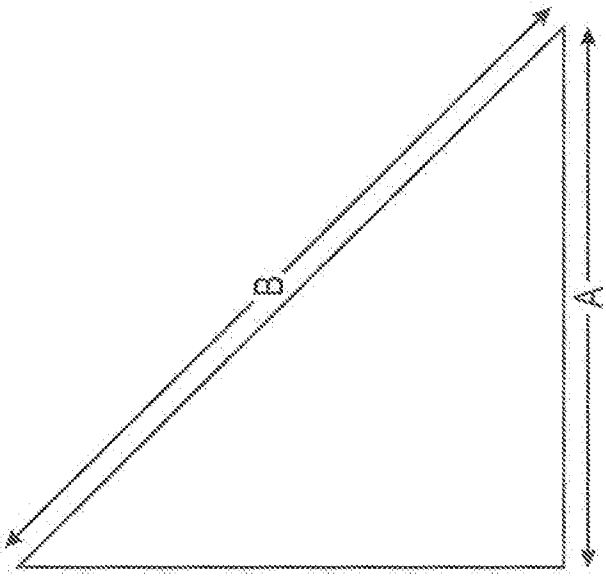


FIG. 7

200
202
John Homeowner
1440 Monroe Ave
Rochester NY, 14618
123-456-7890
homeowner@gaf.com
Congratulations!
You have received a Pictometry Roof Squares Report compliments of GAF. This report provides an estimate of the number of squares on your roof.
204
REPORT DETAILS : INTRODUCTION
HOMEOWNER
John Homeowner
1440 Monroe Ave
Rochester NY, 14618
Order # : PIC-000012840
Phone : 123-456-7890
Email : homeowner@gaf.com
REPORT BY
GAF
Pictometry
Find out more: GeoEstimator.com
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For example, do not make or distribute copies for collecting bids or estimates.
Page 1
202

FIG. 8

FIG. 8
(Continued)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2013/032760

A. CLASSIFICATION OF SUBJECT MATTER

G06Q 50/10(2012.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G06Q 50/10; G06F 3/048; G06F 17/60; G06Q 30/00; G06Q 50/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & Keywords:location, roof, property, report, image

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2002-123889 A (DAINIPPON PRINTING CO., LTD.) 26 April 2002 See paragraphs [0006]-[0009], [0018]-[0026], [0031]-[0032], [0047]-[0053], [0067]-[0072], claims 1-2, 8-9 and figures 4-10.	1-13
Y	US 2006-0026513 A1 (JERRY WHATLEY et al.) 16 February 2006 See abstract, paragraphs [0024], [0022]-[0036], claims 1-2, 8 and figures 2-4b.	1-13
A	JP 2001-306687 A (OSHIMA KENJI) 02 November 2001 See paragraphs [0014]-[0017], [0029]-[0030], claims 1-3 and figures 7-14, 20.	1-13
A	US 2009-0258668 A1 (LEE CHUN KYOUNG) 15 October 2009 See abstract, claims 1-4 and figures 1-4, 7-9.	1-13
A	JP 2006-031087 A (NEC CORP.) 02 February 2006 See abstract, claims 1-3, 7-8 and figures 3-4.	1-13

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
09 July 2013 (09.07.2013)	**10 July 2013 (10.07.2013)**

Name and mailing address of the ISA/KR	Authorized officer
Korean Intellectual Property Office 189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 302-701, Republic of Korea Facsimile No. +82-42-472-7140	OH Bung Gie Telephone No. +82-42-481-8744

Form PCT/ISA/210 (second sheet) (July 2009)

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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		WO 2007-142494 A1	13/12/2007
JP 2006-031087 A	02/02/2006	None	

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G06F 7/60 (2006.01)

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(30) Priority Data:
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14/204,142 11 March 2014 (11.03.2014) US

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(74) Agents: **BLAIR, Steven, R.** et al.; Seed Intellectual Property Law Group PLLC, Suite 5400, 701 Fifth Avenue, Seattle, Washington 98104-7064 (US).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,

[Continued on next page]

(54) Title: METHODS FOR RISK MANAGEMENT ASSESSMENT OF PROPERTY

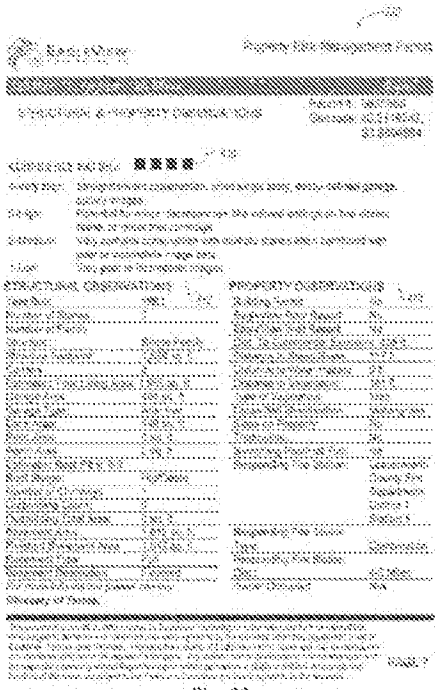


Fig. 29

(57) Abstract: System and methods for performing a risk management assessment of a property using at least aerial imagery of the property and additional data about the property that is evaluated against risk management criteria. Data acquired through aerial imagery includes identifying buildings and floor area of the buildings, condition of the buildings including roof and exterior walls, and identifying other property hazards. Additional data may include property information coming from multiple sources including city and County governments, contractors and insurance companies. The resulting risk management assessment may be used to settle insurance claims and to determine insurance products and premium rates offered on the property.

WO 2014/151122 A1

TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

Published:

— *with international search report (Art. 21(3))*

SYSTEMS AND METHODS FOR PERFORMING A RISK MANAGEMENT ASSESSMENT OF A PROPERTY

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit under 35 U.S.C. § 119(e) of U.S. Non Provisional Patent Application No. 14/204,142, filed March 11, 2014 and U.S. Non Provisional Patent Application No. 13/844,467 filed March 15, 2013, the contents of which are incorporated herein by reference in their entireties.

BACKGROUND

Technical Field

This invention is in the field of building size estimation, and in particular, building floor area estimation.

Description of the Related Art

Building floor area is used throughout the construction, real estate, insurance and finance industries. For example, the square footage measurement of a building is used as a main factor in quickly determining the market value of real estate, estimating costs of materials to repair or replace flooring and make other improvements or modifications to the entire building. Thus, accurate floor area measurements are instrumental in these calculations. Current methods of measuring floor area often involve a person having to visit the building and manually measure particular dimensions within the building, or by referring to original plans or blueprints of the building. Manually measuring the dimensions for verification of building floor area is costly and original plans for the building may be unavailable or out of date. Therefore, accurate methods for estimating and verifying floor area, and for using such floor area estimation

and verification in the construction, real estate, insurance and finance industries, which avoid these drawbacks are desirable.

SUMMARY OF THE INVENTION

A subset of building floor area, referred to as total living area (TLA) is used by insurance underwriters (Underwriters) as one component of assessing whether to insure a property, what kind of insurance to provide and at what premium rate. Underwriters also factor in overall condition of the property to be insured which includes, among other things, a visual assessment of the number of buildings such as detached garages and barns on the property; building features such as roofs, chimneys, siding, skylights, windows and doors; items on the property such as recreational vehicles, abandoned cars, and animal pens; and distances from the property to features such as steep ground slopes, water hazards, greenbelt areas, and fire hydrants. In addition, Underwriters may also factor in data from government records pertaining to the property and buildings on it. Current methods of acquiring this information often involve a person having to visit the property and manually measure and inspect the property, or having to visit a location to view original plans or blueprints of the building. Manually measuring total living area (TLA) and manually evaluating property condition is costly, particularly given the high demand for underwriting new policies or reassessing old policies. Therefore accurate methods for estimating TLA and evaluating property conditions that avoid these drawbacks are desirable.

In one embodiment, a floor area measurement system receives a first and a second aerial image of the building, each of the aerial images providing a different view of the roof of the building. The system correlates the first aerial image with the second aerial image to generate a three-dimensional model of the roof that includes a plurality of planar roof sections that each have a corresponding slope, area, and edges. An adjusted roof model is generated by adjusting a slope of the planar roof sections in the three dimensional model

of the roof to substantially zero. This may be performed in a variety of manners, including, in one embodiment, removing particular roof features from the model that would not be present in a flat roof, namely a roof with zero slope. For example, one step is to remove ridge lines or other features distinguishing individual planar roof sections resulting in a virtual fusing of the individual roof sections in the model into one flat roof. This may be performed instead of or in addition to adjusting a slope parameter or variable of each roof section within the roof model to zero. In other embodiments, this step may be performed with just one initial aerial image of the building showing a substantially orthogonal view of the building since roof pitch need not be determined and can be assumed to be zero.

The system generates the estimated floor area measurement of the building based on the calculated estimated total roof area of the roof after the roof model has been adjusted. This is based on a correlation between the size of the building roof and the size of the building. Typically, the floor area of a single full floor of the building is roughly the size of the roof of the building if the roof were assumed to be flat, namely a slope of zero. This will turn the roof into another floor in the virtual space. With additional adjustments to the roof area measurements to account for multiple floors, roof overhang, wall width, internal building features such as walls and staircases, and/or obstructed views of the building in the aerial image(s), etc., an even more accurate floor area estimation is generated.

In one embodiment, a floor area measurement estimation system may be a system integrated with a roof estimation system or other system that provides roof measurements. In other embodiments, the roof area measurements may be provided by an external source, system or entity, or may be input manually by an operator of the floor area measurement estimation system. Various received roof measurements may often correspond closely to external dimensions of the building such as the width and length of the building and/or lengths of exterior walls or sections of exterior walls of the building. In

another embodiment, the output of the floor area measurement may take the form of an electronic or printed report that includes, but is not limited to geocoding information of the property, images of the property from one or more views, diagrams showing the area and dimensions of living area on different floors.

One embodiment is a computing system for generating an estimated floor area measurement, the computing system comprising: a memory; a floor area measurement estimation module that is stored on the memory and that is configured, when executed, to: receive one or more aerial images of a roof of a building including a substantially top-down image of the roof; and generate, based at least in part on the received aerial images, an estimated floor area measurement of the building.

One embodiment is a computer-implemented method for generating an estimated floor area measurement, the method comprising: receiving one or more aerial images of a roof of a building including a substantially top-down image of the roof; using the substantially top-down image of the roof to calculate an estimated total roof area of the roof assuming each section of the roof has no slope; and generating the estimated floor area measurement of the building based on the calculated estimate total roof area of the roof.

One embodiment is a computer-readable medium whose contents enable a computing system to generate an estimated floor area measurement, by performing a method comprising: receiving one or more aerial images of a roof of a building including a substantially top-down image; using the substantially top-down image to calculate an estimated total roof area of the roof assuming each section of the roof has no slope; using the one or more aerial images of the roof to determine the number of floors of the building that are under the roof; and generating, based at least in part on the estimated total roof area measurement and the number of floors that are under the roof, an estimated floor area measurement of the building.

One embodiment is a computing system for generating a risk management report, the computer system comprising: a memory; a risk management report module that is stored on the memory and that is configured, when executed, to: receive features and conditions data about a property; receive risk management criteria for the property; and generate, based at least in part on the received features and conditions data and risk management criteria, a risk management report for the property.

One embodiment is a computer-implemented method for generating a risk management report, the method comprising: receiving features and conditions data about a property; receiving risk management criteria for the property; and generating, based at least in part on the received features and conditions data and risk management criteria, a risk management report for the property.

One embodiment is a computer-readable medium whose contents enable a computing system to generate an estimated floor area measurement, by performing a method comprising: receiving features and conditions data about a property; receiving risk management criteria for the property; and generating, based at least in part on the received features and conditions data and risk management criteria, a risk management report for the property.

One embodiment is a computing system for generating a risk management report, the computing system comprising: a memory; a risk management report module that is stored on the memory and that is configured, when executed, to: receive features and conditions data about a property; receive risk management criteria for the property; receive one or more aerial images of a roof of a building on the property including a substantially top-down image of the roof; generate, based at least in part on the received aerial images, an estimated floor area measurement of the building; and generate, based at least in part on the received features and conditions data, estimated floor area measurement of the building and risk management criteria, a risk management report for the property.

One embodiment is a computer-implemented method for generating a risk management report, the method comprising: receiving features and conditions data about a property; receiving risk management criteria for the property; receiving one or more aerial images of a roof of a building on the property including a substantially top-down image; using the substantially top-down image of the roof to calculate an estimated total roof area of the roof assuming each section of the roof has no slope; using the one or more aerial images of the roof to determine the number of floors of the building that are under the roof; generating, based at least in part on the estimated total roof area measurement and the number of floors that are under the roof, an estimated floor area measurement of the building; and generating, based at least in part on the received features and conditions data, estimated floor area measurement of the building and risk management criteria, a risk management report for the property.

A computer-readable medium whose contents enable a computing system to generate an estimated floor area measurement, by performing a method comprising: receiving features and conditions data about a property; receiving risk management criteria for the property; receiving one or more aerial images of a roof of a building on the property including a substantially top-down image; using the substantially top-down image of the roof to calculate an estimated total roof area of the roof assuming each section of the roof has no slope; using the one or more aerial images of the roof to determine the number of floors of the building that are under the roof; and generating, based at least in part on the received features and conditions data, estimated floor area measurement of the building and risk management criteria, a risk management report for the property.

In another embodiment, the output of the floor area measurement may take the form of an electronic or printed report that includes, but is not limited to geocoding information of the property, images of the property from

one or more views, diagrams showing the area and dimensions of living area on different floors, number of stories.

The output of the overall property condition evaluation includes structural observations such as type of structure, corners, estimated roof pitch, roof shape, structure footprint, basement area and basement type; and property observations, such as whether there is building permit, roof or wall report available, distances to commercial exposures or natural hazards, and/or other property observations.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

The patent or application file contains at least one drawing executed in color. Copies of this patent or patent application publication with color drawing(s) will be provided by the Office upon request and payment of the necessary fee.

Figure 1A is a flow diagram showing an example method of generating an estimated floor area measurement, according to one non-limiting illustrated embodiment.

Figure 1B is a flow diagram showing a method that may be included as part of the generating floor area measurement step of the method shown in Figure 1A, according to one non-limiting illustrated embodiment.

Figure 1C is a flow diagram showing a method that may be included as part of the generating total roof area step of the method shown in Figure 1B, according to one non-limiting illustrated embodiment.

Figure 1D is a flow diagram showing an example method of generating a risk management report and determining insurance product offers, which in some instances may use the floor area measurements or methods for generating the floor area measurements described herein, according to one non-limiting illustrated embodiment.

Figure 1E is a flow diagram showing a method that may be included as a part of the receive risk management criteria step of the method shown in Figure 1D, according to one non-limiting illustrated embodiment.

Figure 1F is a flow diagram showing a method that may be included as a part of the receive additional data from one or more sources step of the method shown in Figure 1D, according to one non-limiting illustrated embodiment.

Figure 1G is a flow diagram showing a method that may be included as a part of the evaluate the aerial views and received additional data in light of the risk management criteria step of the method shown in Figure 1D, according to one non-limiting illustrated embodiment.

Figure 1H is a flow diagram showing a method that may be included as a part of the provide additions, updates, and/or corrections to the data step of the method shown in Figure 1D, according to one non-limiting illustrated embodiment.

Figure 1I is a flow diagram showing a method that may be included as a part of the receive underwriting criteria step of the method shown in Figure 1D, according to one non-limiting illustrated embodiment.

Figure 2 is an example screenshot of a user interface of a system for generating floor area measurements, which may be used independently of, as part of, or integrated with the systems and methods for generating a risk management report described herein, showing roof sections annotated on an aerial image of the roof, according to one non-limiting illustrated embodiment.

Figure 3 is an example screenshot of a user interface of the system of Figure 2 for generating floor area measurements with area measurements of roof sections annotated on an aerial image of the roof, according to one non-limiting illustrated embodiment.

Figure 4 is an example screenshot of a user interface of the system of Figure 2 for generating floor area measurements showing the roof annotated with an estimated total roof area on which to base an estimated floor

area measurement, such as that estimated in the method of Figures 1A-1C, according to one non-limiting illustrated embodiment.

Figure 5 is an example screenshot of a user interface of the system of Figure 2 for generating floor area measurements showing the building annotated with an adjusted estimated floor area measurement, such as that estimated in the method of Figures 1A-1C, according to one non-limiting illustrated embodiment.

Figure 6 is an example screenshot of a user interface of the system of Figure 2 for generating floor area measurements showing the building annotated with adjusted estimated first and second floor area measurements, such as that estimated in the method of Figures 1A-1C, according to one non-limiting illustrated embodiment.

Figure 7 is an example screenshot of a user interface of the system of Figure 2 for generating floor area measurements showing a line drawing of a top plan view of each the first and second floor of the building annotated with corresponding floor area measurements, such as that estimated in the method of Figures 1A-1C, according to one non-limiting illustrated embodiment.

Figure 8 is an example screenshot of a user interface of the system of Figure 2 for generating floor area measurements showing a line drawing of a top perspective view of the first and second floor of the building annotated with corresponding floor area measurements, such as that estimated in the method of Figures 1A-1C, according to one non-limiting illustrated embodiment.

Figure 9 is a schematic diagram of a computing environment in which systems and methods for estimation of building floor area and generating a risk management report may be implemented or of which they may be a part.

Figure 10 is an example screenshot of a user interface of a system for generating floor area measurements which may be used independently of, as part of, or integrated with the systems and methods for

generating a risk management report described herein, showing roof sections annotated on an aerial image of the roof, according to one non-limiting illustrated embodiment.

Figure 11 is an example screenshot of a user interface of the system of Figure 10 for generating floor area measurements showing an aerial view used to identify floors and the roof section areas, dimensions, and levels annotated on which to base an estimated floor area measurement or a risk management report, such as that estimated in the method of Figures 1A-1I, according to one non-limiting illustrated embodiment.

Figure 12 is an example screenshot of a user interface of the system of Figure 10 for generating floor area measurements showing an aerial view used to identify floors and the roof section areas, dimensions, and levels annotated on which to base an estimated floor area measurement or a risk management report, such as that estimated in the methods of Figures 1A-1I, according to one non-limiting illustrated embodiment.

Figure 13 is an example screenshot of a user interface of the system of Figure 10 for generating floor area measurements showing an aerial view used to identify floors and the roof section areas, dimensions, and levels annotated on which to base an estimated floor area measurement or a risk management report, such as that estimated in the methods of Figures 1A-1I, according to one non-limiting illustrated embodiment.

Figure 14 is an example screenshot of a user interface of the system of Figure 10 for generating floor area measurements showing an aerial view used to identify floors and the roof section areas, dimensions, and levels annotated on which to base an estimated floor area measurement or a risk management report, such as that estimated in the methods of Figures 1A-1I, according to one non-limiting illustrated embodiment.

Figure 15 is an example screenshot of a user interface of the system of Figure 10 for generating floor area measurements showing an aerial view used to identify floors and the roof section areas, dimensions, and levels

annotated on which to base an estimated floor area measurement or a risk management report, such as that estimated in the method of Figures 1A-1I, according to one non-limiting illustrated embodiment.

Figure 16 is an example screenshot of a user interface of a system for gathering property risk assessment data using one or more aerial images of the property, which may be used independently of, as part of, or integrated with the systems and methods for generating a risk management report described herein, according to one non-limiting illustrated embodiment.

Figure 17 is an example screenshot of a user interface of the system of Figure 16 for gathering property risk assessment data, such as that described in the method of Figures 1A-1I, according to one non-limiting illustrated embodiment.

Figure 18 is an example screenshot of a user interface of the system of Figure 16 for gathering property assessment data, using measurement tools to estimate distance, such as that described in the method of Figures 1A-1I, according to one non-limiting illustrated embodiment.

Figure 19 is an example screenshot of a user interface of the system of Figure 16 for gathering property risk assessment data, showing data entered from other sources, such as that described in the method of Figures 1A-1I, according to one non-limiting illustrated embodiment.

Figure 20 is an example screenshot of a user interface of the system of Figure 16 for gathering property risk assessment data, including roof characteristics, such as that estimated in the method of Figures 1A-1I, according to one non-limiting illustrated embodiment.

Figure 21 is an example screenshot of a user interface of the system of Figure 16 for gathering property risk assessment data including property ground characteristics, such as that described in the method of Figures 1A-1I, according to one non-limiting illustrated embodiment.

Figure 22 is an example page of a report that provides floor area and property assessment data, such as that estimated in the method of Figures 1A-1I, according to one non-limiting illustrated embodiment.

Figure 23 is an example page of a report to provide floor area and property risk assessment data, including report details and building summary, such as that estimated in the method of Figures 1A-1I, according to one non-limiting illustrated embodiment.

Figure 24 is an example page of a report to provide floor area and property risk assessment data, including report images, such as that described in the method of Figures 1A-1I, according to one non-limiting illustrated embodiment.

Figure 25 is an example page of a report to provide floor area and property risk assessment data, including multiple aerial angles of the property, such as that described in the method of Figures 1A-1I, according to one non-limiting illustrated embodiment.

Figure 26 is an example page of a report to provide floor area and property risk assessment data, including multiple aerial angle images, such as that described in the method of Figures 1A-1I, according to one non-limiting illustrated embodiment.

Figure 27 is an example page of a report to provide floor area and property risk assessment data, including the dimensions and the area for different sections of a floor of a building, such as that estimated in the method of Figures 1A-1I, according to one non-limiting illustrated embodiment.

Figure 28 is an example page of a report to provide floor area and property risk assessment data, including dimensions and area by sections for a particular floor of a building, such as that estimated in the method of Figures 1A-1F, according to one non-limiting illustrated embodiment.

Figure 29 is an example page of a report to provide floor area and property assessment data, including structural observations, property observations, and confidence rating of the floor area and property assessment

data, such as that described in the method of Figures 1A-1I, according to one non-limiting illustrated embodiment.

DETAILED DESCRIPTION

Figure 1A is a flow diagram showing an example method 100 of generating an estimated floor area measurement, according to one non-limiting illustrated embodiment.

While each of the steps shown in Figure 1A contributes to the overall solution, each can be used independently or in various combinations to yield improvements in estimating floor area measurements as discussed below. Below is an overview of each step in the process, which will be followed by a more detailed discussion of each step.

At 102, the process receives roof measurements of a building having a roof. These measurements may be estimated or actual dimensional and/or area measurements of the roof such as one or more of: roof edge lengths, ridge lengths, gable lengths, hip lengths, valley lengths, roof section pitch, roof area measurements, planar roof section area measurements, planar roof section dimension measurements, etc. These roof measurements may be generated internally by a component of a system that estimates floor area measurements (i.e., a floor area measurement estimation system) and received from such an internal component, or may be generated and received from an external component or entity separate from the floor area measurement estimation system. In some embodiments, the external component is located remotely from the floor area measurement estimation system.

For example, in some embodiments, the floor area measurement estimation system may be a system integrated with a roof estimation system or other system that provides roof measurements. In other embodiments, the roof area measurements may be provided by an external source, system or entity, or may be input manually by an operator of the floor area measurement estimation system. Various received roof measurements may often correspond

closely to external dimensions of the building such as the width and length of the building and/or lengths of exterior walls or sections of exterior walls of the building.

At 104, the process generates, based at least in part on the received roof measurements, an estimated floor area measurement of the building. For example, the received roof measurements may include roof edge measurements of the roof. In such an embodiment, a floor area measurement estimation module of the floor area measurement estimation system is configured to generate, based at least in part on the received roof measurements, an estimated floor area measurement. In some embodiments, the received roof measurements may include roof area measurements. In some embodiments, the floor area measurement estimation module of the floor area measurement estimation system is configured to generate, based at least in part on the received roof area measurements, an estimated floor area measurement. For example, the roof measurements may be generated by the roof estimation system described in U.S. Patent No. 8,078,436 issued December 13, 2011, and entitled AERIAL ROOF ESTIMATION SYSTEMS AND METHODS, U.S. Patent No. 8,209,152 issued June 26, 2012, and entitled CONCURRENT DISPLAY SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION, which are each incorporated herein by reference in their entireties and such a roof estimation system may be integrated with the floor area measurement estimation system, or various components of the floor area measurement estimation system described herein. Also, features of embodiments described herein may be combined with one or more other features of estimating measurements of structures, including those systems and methods described in U.S. Patent Application No. 13/757,694, filed February 1, 2013 entitled SYSTEMS AND METHODS FOR ESTIMATION OF BUILDING WALL AREA which is incorporated herein by reference in its entirety.

In many such embodiments, one or more of the roof measurements are based on aerial photographs of the building via manual or automated analysis of roof features, such as by using the roof estimation system or modules described in one or more of U.S. Patent Application Serial No. 12/148,439 filed on April 17, 2008 and entitled AERIAL ROOF ESTIMATION SYSTEM AND METHOD, U.S. Patent No. 8,078,436 issued December 13, 2011, and entitled AERIAL ROOF ESTIMATION SYSTEMS AND METHODS, U.S. Patent Application Serial No. 12/467,244 filed May 15, 2009 and entitled PITCH DETERMINATION SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION, U.S. Patent Application Serial No. 12/467,250 filed May 15, 2009 and entitled CONCURRENT DISPLAY SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION, U.S. Patent Application Serial No. 13/019,228 filed February 1, 2011 and entitled GEOMETRIC CORRECTION OF ROUGH WIREFRAME MODELS DERIVED FROM PHOTOGRAPHS and U.S. Provisional Patent Application Serial No. 61/594,956 filed February 3, 2012 and entitled SYSTEMS AND METHODS FOR ESTIMATION OF BUILDING WALL AREA. In some alternative embodiments, such measurements may be made by an operator or an automated system actually or virtually outlining, drawing and/or otherwise detecting the perimeter of the roof on, or based on, an aerial image of the roof to indicate an initial estimated floor shape or foot print, and providing such data as input used by the system for estimating floor area described herein which would otherwise use the roof edge measurements from a two or three dimensional model of the roof. For example, such outlining or drawing the perimeter on the roof may be performed within a graphical user interface displaying the image of the roof such as that shown in Figures 10-15 below. Thus, utilizing some embodiments described herein, one may estimate floor area measurements of a building merely using one or more aerial photographs of the building, with little or no additional information initially needed.

Figure 1B is a flow diagram showing a method 110 that may be included as part of the generating floor area measurement step of the method shown in Figure 1A, according to one non-limiting illustrated embodiment.

While each of the steps shown in Figure 1B contributes to the overall solution, each can be used independently or in various combinations to yield improvements in estimating floor area measurements as discussed below.

At 112, the process generates roof edge measurements based on initial roof edge measurements included in the received roof measurements, assuming each section of the roof has no slope regardless of an actual slope of each section of the roof. For example, if the two edges of the gable of a pitched roof are 20 feet and the gable has a pitch angle of 90 degrees, then instead of two edges of 20 feet, the process generates a single roof edge of sqrt(800) ~ 28.3 feet. The process generates roof edge measurements as if the entire roof was flat.

At 114, the process uses the roof edge measurements to calculate an estimated total roof area of the roof assuming each section of the roof has no slope. Thus, the process generates roof area measurements as if the entire roof was flat.

In embodiments in which a roof estimation system is integrated with the floor area measurement system, the floor area measurement system first receives a first and a second aerial image of the building, each of the aerial images providing a different view of the roof of the building. The system correlates the first aerial image with the second aerial image to generate a three-dimensional model of the roof that includes a plurality of planar roof sections that each have a corresponding slope, area, and edges. In this embodiment, an adjusted roof model is generated by adjusting a slope of the planar roof sections in the three dimensional model of the roof to substantially zero. This may be performed in a variety of manners, including, for example, removing particular roof features from the model that would not be present in a roof with a slope of zero. The planar roof sections in the model become one

large flat roof section. For example, the system will remove ridge lines, valleys or other features distinguishing individual planar roof sections. This creates the effect of having fused all roof sections together which can be termed as fusing them in a virtual software computer sense. This may be also performed instead of or in addition to by just adjusting a slope parameter or variable of each roof section within the roof model to zero. In other embodiments, this step may be performed with just one initial aerial image of the building showing a substantially orthogonal view of the building since roof pitch need not be determined and can be assumed to be zero.

At 116, the process generates the estimated floor area measurement based on the calculated estimated total roof area of the roof. This is based on a correlation between the size of the building roof and the size of the building. Typically, the floor area of a single full floor of the building is roughly the size of the roof of the building if the roof were flat with no slope (i.e., virtually turning the roof into another floor). With additional adjustments to the roof area measurements described below (e.g., with respect to Figure 1C) to account for multiple floors, roof overhang, wall width, internal building features such as walls and staircases, and/or obstructed views of the building in the aerial image(s), etc., an even more accurate floor area estimation is generated.

In other embodiments, the received roof measurements may instead or additionally include at least one of: a plurality of dimensional measurements of a two-dimensional outline of the roof from a top plan view of the roof and an area of the two-dimensional outline of the roof from the top plan view of the roof. In such instances, the dimensions of the two-dimensional outline of the roof from a top plan view of the roof may be used as the roof edge measurements on which to base the estimated floor area. However, these dimensional measurements of a two-dimensional outline of the roof need not be referred to as "roof edge measurements" or "roof measurements" to fall within the scope of the embodiments described herein.

Figure 1C is a flow diagram showing a method 120 that may be included as part of the generating total roof area step of the method shown in Figure 1B, according to one non-limiting illustrated embodiment. While each of the steps shown in Figure 1C contributes to the overall solution, each can be used independently or in various combinations to yield improvements in estimating floor area measurements as discussed herein.

At 122, the process subtracts an amount from one or more of the roof edge measurements corresponding to an estimated roof overhang over one or more walls of the building to obtain adjusted roof edge measurements. For example, each roof edge measurement may be reduced by 6 inches to 18 inches corresponding to an estimated roof overhang, which is selectable by a user of the floor area measurement estimation system. This can be considered to be eroding the length in a virtual sense by some amount. However, any variety of other lengths or ranges of lengths may be used including, for example a zero length or those of standard or typical roof overhang lengths.

At 124 the process subtracts an amount from one or more of the adjusted roof edge measurements corresponding to an estimated wall width to obtain adjusted roof edge measurements. For example, each roof edge measurement may be reduced by 6 inches to 18 inches corresponding to an estimated wall width, which is selectable by a user of the floor area measurement estimation system. However, other lengths or ranges of lengths may be used (e.g., those of standard or typical wall widths).

At 126 the process receives information regarding floor area spaces of the building that are not to be included in the estimated floor area measurement of the building. For example, these areas may be areas of the building that are not used for living inside the building or areas outside the building including, but not limited to: garages; attics; unfinished rooms above the garage or other locations; covered balconies; patios, decks or porches, unfinished basements; crawl spaces; etc. This information may be received from an external system, source or entity; input by a user (e.g., identified or

marked by a user on an image or drawing of the building displayed within a graphical user interface of the system); and/or identified by the system via analysis of an image of the building. In some embodiments, adjustments to exclude areas not to be included in the living area calculation may be made by reducing the total area of the building by a certain percentage factor. This reduction would estimate non--living area taken up by interior walls, stairs, and other similar features. This percentage factor reduction may be based on statistical analysis of buildings with similar design, historical measurements of the building, or partial measurements of the building. The percentage factor reduction may also be estimated by the building owner, occupier, or contractor.

At 128 the process generates an initial estimated floor area measurement based on an area corresponding to an extent to which the spaces that are not to be included in the estimated floor area measurement extend under the roof and based on the adjusted roof edge measurements. For example, the roof edge measurements may be used to calculate an estimated roof area with assumed slope of zero. Then, areas corresponding to an extent to which such spaces extend under the roof may be subtracted from the estimated roof area. This also may be performed in response to a user marking or otherwise identifying such areas on an image or drawing of the building displayed within a graphical user interface of the system. In some embodiments, the entire process of generating an initial estimated floor area is automated by the system recognizing these particular features in one or more images of the building through image analysis that utilizes typical characteristics of such features as viewed from the various angles of those in the one or more images of the building.

At 130, the process generates the estimated floor area measurement based on information received regarding a number of stories or floors of the building. For example, the floor area measurement estimation system may receive information regarding how many stories the building has and regarding one or more sections of the roof below which one or more of the

stories extends. The system may then generate the estimated floor area measurement based on a total area of the one or more sections of the roof under which each of the stories extends and based on the generated estimated total roof area of the roof. This total area of the one or more sections of the roof under which each of the stories extends may be calculated using the adjusted roof edge measurements and then adjusted according to various other features of the building indentified in the an image of the building or otherwise received by the system. These various other features of the building indicate one or more sections of the roof below which one or more of the stories extends. Such features identify split level homes, homes with lofts, vaulted ceilings, etc.

In some embodiments, the system may be used to identify the footprint area based on identifying points at the level of the ground around the base of the building. This may be done by using one or more aerial images to select the points at various intervals where the ground meets the structure of the building, for example where the ground comes into contact with the foundation of the building. This method may be used to produce a polygon that is determined by the base of the building. In other embodiments, the points identified at the base of the building may be used to create a three-dimensional model of the building at the ground level, and use this model to estimate the buildings footprint area at ground level. Once this is done, a user may then use different oblique aerial images to determine the number of floors in the building, and therefore determine an accurate area estimate of the building. In some embodiments, this process of creating a three-dimensional building model at ground level, and/or determining the footprint area of the building may be automated using visual analysis or graphics analysis techniques applied to the aerial images.

The system may determine how many stories the building has using a second aerial image of the building representing a view from a different angle than the substantially orthogonal view of the top of the building such that the building height and other features related to how many stories the building

has may at least be partially seen. This determination may be performed in response to a user inputting a value representing the number of stories or by the user marking or otherwise identifying such areas corresponding to the different stories on an image or drawing of the building displayed within the graphical user interface of the system. A number of different techniques may be used to identify the stories in a building. For example, a user may looking for eave lines to identify a ceiling of a story, or identifying features such as windows, decks, toward dormers that indicate a floor. In addition, the user may assume a standard room height for each story, for example 8 feet, and working either from the top of the building down, or starting at the base of the building and working up estimate the number of stories. Using multiple techniques may result in a more accurate story estimate.

The shape and perimeter of each building story may be annotated on a drawing or image of the building displayed in the graphical user interface and manipulated by a user of the system collectively and/or individually to make the adjustments described herein. The adjustments will indicate one or more sections of the roof below which one or more of the stories laterally extends. The estimated total floor area of the building is then calculated by adding the areas of each identified floor together to get the total area. The resulting changes in estimated total floor area are generated by the floor area estimation system and displayed on the drawing or image of the building displayed in the graphical user interface.

In some embodiments, the entire process of generating an initial estimated floor area is automated by the system recognizing these particular building features (e.g., building stories, floors, etc.) in one or more images of the building through image analysis that utilizes typical characteristics of such features as viewed from the various angles of those in the one or more images.

Examples of using the estimated floor area of a structure (e.g., a building) and/or the processes and systems to generate estimated floor area described herein include using such estimated floor area, processes and/or

systems as part of generating estimates for and/or data for generating estimates or assessments regarding insurance coverage for the structure or real estate including the structure, property risk assessment, and/or construction and repair of the structure. For example these estimates and/or assessments include, but not limited to, estimates and/or assessments regarding: the overall value of a structure; the overall value of real estate including the structure; cost of replacing or repairing the structure; insurance rates or premiums for insuring the structure; determining, predicting and/or calculating costs of replacing or repairing the structure pursuant to processing or paying insurance claims regarding the structure; processing insurance claims regarding the structure; managing risk with respect to the structure becoming or being damaged and/or risk with respect to insuring and/or paying existing or potential insurance claims on the structure; etc.

For example, Figure 1D is a flow diagram showing method 135 of generating a risk management report, which in some instances may use the floor area measurements or methods for generating the floor area measurements described herein, according to one non-limiting illustrated embodiment.

While each of the steps shown in figure 1D contributes to the overall solution, each can be used independently or in various combinations to also yield improvements in producing a risk management report as discussed below. Below is an overview of each step in the process, which will be followed by a more detailed discussion of each step.

At 135a, the process receives risk management criteria from an entity, wherein the risk management criteria are used to create a risk management profile of a particular property. For example, an insurance company may have risk management criteria that it uses to evaluate a property to create a risk management profile of the property. This permits an insurance company to manage the risk with respect to the structure on the property or other features of the property becoming or being damaged and/or risk with

respect to insuring and/or paying existing or potential insurance claims on the property. This profile can be used, for example, to determine which insurance products and at what premiums it will offer the owner. The risk management criteria may include but is not limited to conditions of aspects of buildings on the property, density and size of vegetation on the property, property terrain features such as steepness of slope or water features, and nearness to commercial areas or fire stations.

At 135c, the process receives one or more aerial views of the property and surrounding area. In some embodiments, these aerial views may include top-down, substantially orthogonal views, or oblique views showing the property and buildings at an angle. In some embodiments these aerial views may be used to evaluate the features and conditions of the property.

In some instances, the resolution of these aerial views, or other images taken of the property, is detailed enough to allow visual analysis of specific features such that a user viewing the image, or a computer based process of analyzing the image, can determine conditions that previously could only be discovered through an on-site visit to the property. For example, differences in shading on a roof may indicate excessive or uneven weathering of the roof that may require earlier repair. Another example is to view the cupping of shingles or evidence of missing shingles that indicate a repair is needed. Differences in the texture roof may also indicate a recent repair or patch that has been done, or that loss or other debris is collecting on the roof. This information will allow a user, for example, to determine whether a roof has not been properly maintained, or is near the end of its life more accurately from these images, resulting in fewer on-site property visits.

These higher resolution images may be acquired from a number of sources, including enhanced satellite images, enhanced images acquired from airplane over-flights, or images acquired from drones.

In addition, multiple images of the property captured at multiple times may also be used to assess condition. For example, a 2002 picture of a

garage roof that shows damage may be compared with a 2007 picture of the same roof that shows a tree landed on the same spot as the previous damage. This information would be useful in determining the amount of loss attributable only to the tree damage.

At 135e, the process receives additional data from one or more sources. These sources may include, but are not limited to, insurance companies, government entities, contractors, and the like. The sources may also include systems that have generated roof estimations, wall estimations, or floor estimations.

At 135g, the process evaluates the received aerial views and received additional data using the risk management criteria to determine the risk management profile of the property. In some embodiments, this evaluation involves a human operator viewing the aerial images and the additional data to answer questions about the property that correspond to risk management criteria used to assess the risk management profile of the property. In this instance, the human operator is in the role of an evaluator who is providing additional information about the property value and the risks involved by viewing one or more aerial images of the property. In other embodiments, these questions may also be asked to property owners, property occupants, and to owners or occupants of surrounding properties. These questions may also be asked to related or concerned parties with respect to the property, for example police, public utility workers, maintenance workers, lenders, previous owners, and the like.

There may be commonly used questions associated with certain risk management criteria that all insurance companies will want answered. For example, these questions may include age of the property, total living area, distance to a fire hydrant, and the like. There will also be questions unique to an individual insurance company that may, for example, use enhanced actuarial models for the property it ensures. In addition, there will be questions asked that are based on the geographic region or location of the property. For

example, these questions may include detailed information on the construction and securing of a building roof in areas known for tornadoes, or detailed questions on drainage systems for buildings in areas known for heavy rain or flooding.

In other embodiments, this evaluation involves graphical image processing, data management, and/or statistical methods to answer the questions. For example, where high-resolution imagery described above may not be available for a property, statistical methods applied lower-resolution imagery may be preferable to incurring the cost to send a person on-site. One example of this method includes analyzing multiple lower-resolution images of the same facet of the building taken at the same time but at different angles for texturing differences that may reveal more information than either image would alone.

Statistical methods may be used on images captured outside the visible spectrum. For example, using ultraviolet images of a building may reveal how worn a roof is depending on the roof's ultraviolet reflective properties. Similarly, statistical analysis on infrared images may be used to detect water damage, or areas of a roof with higher water content in the materials based on different rates of absorption of infrared by water. Also, infrared images may be used to create heat-loss profiles for a neighborhood, allowing comparisons among the buildings that may indicate the beginning of a roof failure.

Other statistical methods may be used to understand the condition of a property include the age of the home, the age of the neighborhood, whether the home is used as a rental, and other factors to estimate property condition.At 135i, the process generates a risk management profile report for the property based on the evaluation completed in the previous step.

At 135k, the process stores the risk management profile information. In some embodiments, this information is stored along with profiles

of other properties to be used for various purposes such as property risk history.

At 135m, the process distributes the risk management profile report. In some embodiments, the report is sent to the insurance company, the insurance agent, the property owner, or other entity that uses the risk profile to make decisions concerning the property.

At 135o, the process provides additions, updates, and/or corrections to the data received. In some embodiments, the evaluation process which uses property data from many sources may uncover errors or other problems which the source of the data may wish to know about and correct. For example, a building's total living area as determined by an operator using current aerial views may not match the total living area documented in county tax records. In one embodiment, the process will allow data that is collected and verified for a risk management profile to be shared with a government agency. In this way the government agency, for example the county in which the property resides, can maintain current records for the property data it uses for its operations. For example, whether the current building area is correct, whether there is a change in the use of land which may be indicated by clearing a forest, erecting outbuildings, paving the lot, and the like. The county may wish to update their records in order to determine a fair tax valuation for the property, or adjust services to the property such as waste disposal. In some embodiments, discrepancies discovered in data that exceed a tolerance threshold may generate an automatic notification to the government. In another embodiment, the data may be directly updated by the process by sending the data directly to government databases, either county or state.

In other embodiments, this data may be shared directly with one or more insurance companies, either by notifying the company that their data is out of date, or by directly updating the insurance company's database. The insurance company will use changes in the data to determine whether changes

in features and conditions of the property are significant enough to require reevaluation of other insurance products associated with the property,

At 135q, the process receives underwriting criteria from insurance companies that describes the insurance products and premium amounts the company offers based on the features and risk management profile of a property. In one embodiment, the criteria determines the features or combination of features on the property that will cause it to the insurable, and provides the formulas that use the conditions of features on the property to determine insurance premium cost.

The risk management profile of the property is determined by combining the results of the questions asked, the data analyzed and the statistical methods used. If the risk management profile can be determined remotely with a high degree of accuracy, it may not be necessary to incur the cost of sending an agent or inspector for an on-site property visit.

The principle determiner for the premium amount charged for an insurance policy on a structure is the structure's replacement cost. If the estimate of replacement cost is based on inaccurate data, the customer may not be offered sufficient coverage for the structure. In result of a total loss, the insurance payments will not be sufficient to rebuild the structure, which will result in a highly dissatisfied customer. On the other hand, the customer will be dissatisfied if replacement cost is overestimated, resulting in higher premiums than the customer could have paid.At 135r, the process determines the insurance products to offer and the pricing of the products for the property. In one embodiment, certain features and conditions of the property will be associated with certain insurance products. For example, if a residential property also has one or more commercial buildings on it, than a commercial insurance product may be appropriate. In another example, if the residential property has an RV parked in the yard, offering an auto insurance product that covers the RV may be appropriate. In another embodiment, criteria involving conditions of features on the property may determine the premium amounts

offered for a particular policy. For example, if the condition of the roof of a residential building appears excessively worn or damaged, the premiums for ensuring that building will be higher than if the roof was not damaged.

Figure 1E is a flow diagram showing an example method 140 of receiving risk management criteria used to create a risk management profile of a property step of the method shown in Figure 1D, according to one non-limiting illustrated embodiment. While each of the steps shown in Figure 1E contributes to the overall solution, each can be used independently or in various combinations to yield improvements in receiving risk management criteria from an entity as discussed below.

At 140a, the process receives risk management criteria from an entity used to create a risk management profile of a property. In one embodiment, the criteria are used to evaluate features of the property to create a risk management profile of the property. Features of the property may include but are not limited to buildings, vegetation, terrain, distance to water, distance to commercial areas, and distance to a fire station. Features of a building may include but are not limited to year built, number of stories, style of roof, floor area, and number of windows. In addition, the criteria may also describe various conditions of the features of a property. In one or more embodiments, the criteria may be received as a data file that may be imported into an evaluation system.

At 140c, the process stores the risk management criteria received from each company. In one embodiment, the criteria from each company are stored in a database and used during the evaluation process, described below, when the property risk assessment profile is being created.

At 140e, the process determines the criteria elements that are common among companies. In one embodiment, elements are reviewed by an operator to determine the common elements. In another embodiment elements are compared electronically.

At 140g, the process uses the common criteria elements to allow risk management profile evaluation comparison among companies. In one embodiment, this allows the evaluation process, described below, to efficiently produce risk management profile reports for a number of insurance companies.

Figure 1F is a flow diagram showing an example method 150 of receiving additional data from one or more sources to used to determine a risk management profile step of the method shown in figure 1D, according to one non-limiting illustrated embodiment. While each of the steps shown in Figure 1F contributes to the overall solution, each can be used independently or in various combinations to yield improvements in receiving additional data from one or more sources as discussed below.

At 150a, the process receives one or more aerial views of the property. In one or more embodiments, these aerial views may include a top-down, or substantially orthogonal view of the property, and/or oblique views of the property taken at angles from different directions. For example, an oblique aerial view of the property may be taken at a 45° angle from the north, and another taken at a 50° angle from the west. In one embodiment, these aerial views are provided in a digital format.

At 150c, the process receives floorplan estimates and total living area estimates for buildings on the property. In one embodiment, these estimates are received from the roof estimation system or a floor area measurement system described herein. In another embodiment the estimates may come from county records.

At 150e, the process receives data generated from modeling or estimation software for buildings. In one or more embodiments, this data may be generated by a roof estimation systems, wall estimation systems, 3D modeling systems, CAD systems, or the like.

At 150g, the process receives data on file for similar houses in the community. In one or more embodiments, this data may include the date the

neighborhood was developed, the average age of houses, typical improvements done to property, and the like.

At 150i, the process receives government records on the property. In one or more embodiments, these records may include but are not limited to information received from county or city building departments, which include building plans, building permit information, as-built information and the like. The records may also include government tax records that include estimated total living area of buildings on the property. One embodiment therefore provides for the aggregating of city and county property records, deeds, tax assessments, with insurance company information, together with a series of photographic images of the home taken at distinct times from a plane or satellite.

At 150K, the process receives data from contractor or construction firms. In one or more embodiments, this may include but is not limited to blueprints, as-built information, landscape elevations, and repair information.

At 150m, the process receives data from scans of the property. In one or more embodiments, these scans may include but are not limited to infrared scans, thermal imaging scans, and the like.

At 150o, the process receives property data collected on-site. In one or more embodiments, this data includes but is not limited to visual information on property features, for example external and internal property features of buildings. Examples of external features are the condition of walls, roofs, chimneys, skylights, porches, patio, decks, garages, and other exterior features. Example of internal features are the conditions of walls, ceilings, floors, carpeting, windows, fixtures, skylights, and other interior features.

Conditions of other property features may include but are not limited to terrain, vegetation, water hazards, trampolines, hot tubs, swimming pools, outbuildings, automobiles, or other outside features relevant to determine a risk management profile. Of particular interest will be above ground

swimming pools. In some instances, these may hold a great deal of water, for example a pool of about 4'-5' high and 12'-15' in diameter holds many thousands of gallons. Such a pool not only increases the risk of personal injury to those who live on and visit a property, but also increase the risk of flood damage to the home owner and close neighbors. The photographic images will show, for example, if a home owner has placed a large above ground pool very close to his home or immediately adjacent his property line and close to a neighbor's home. If, at some later time, the pool were to leak or burst, such a placement may cause significant property damage to the owner's home by flooding basement, washing out a foundation or the like. It may also present a risk to a neighbor's home for the same reason. This is just one example of risk management factors that could be taken into account by an insurance carrier in setting a premium or deciding whether to agree to insure the property.

In some embodiments, this visual information may be captured using an image or video recording device by the property owner or one or more other individuals evaluating the property. In some embodiments, the data collected may include but is not limited to interviews with property owners, tenants, or one or more neighbors.

In other embodiments, data collected may include data from chemical samples, odor detectors, radiation detectors, radon detectors, moisture detectors, RFI detectors and the like.

In one or more embodiments, additional data required during the evaluation process, described below, may be requested from one or more individuals who are evaluating the property.

At 150q, the process receives data collected from insurance companies. In one or more embodiments, this data may include but is not limited to existing photographs of the property, descriptions and measurements of features on the property, insurance claims history of the property and the like. In addition this data may include insurance data available for buildings or property near the property being evaluated. A preferred source of data are

aerial images taken by planes and satellites at distinct time intervals over a period of time.

Figure 1G is a flow diagram showing a method 155 that may be included as a part of the evaluate the aerial views and received data in light of risk management criteria step of the method shown in figure 1D, according to one non-limiting illustrated embodiment. While each of the steps shown in Figure 1G contributes to the overall solution, each can be used independently or in various combinations to yield improvements in evaluating the aerial views and received data as discussed below.

At 155a, the process generates questions for assessing the individual elements of the risk management criteria for the property. In one embodiment, a question is created for each criteria element. For example, if an element is the age of a building, a generated question may be "what year was the building built?" If an element is an above ground pool, this could be asked, if the answer is yes, then more questions can be generated about its location, size and other issues.

At 155c, the process uses the aerial views and received data to provide answers to the generated questions. In one or more embodiments, the answers to the questions may be but are not limited to being provided by an operator at a workstation viewing the images and the data, an automated system analyzing the aerial views and received data, and one or more individuals viewing the aerial views and receive data according to a crowd sourcing model.

At 155e, the process receives questions to answer. In one non-limiting embodiment, an individual at a workstation is viewing the aerial images and the received data. However, in some embodiments, this process may be automated.

At 155g, the process evaluates data and aerial images to answer the received questions. In this embodiment, an operator at a workstation is viewing the aerial images, the received data and the received questions, and is

answering the questions based on the operator's evaluation of the images and data.

At 155i, the process provides a confidence rating for answers to the questions. In one embodiment, the operator enters a confidence rating for each individual question answered. In another embodiment, the operator enters an overall confidence rating once all questions are answered.

At 155k, the process receives questions to answer. In one non-limiting embodiment, the aerial images and received data are analyzed by an automated system to determine the answers.

At 155m, the process uses graphical processing to analyze received aerial views to identify features of the property. In one non-limiting embodiment, a feature of the property may be a building, terrain, water feature, vegetation, or other characteristic of the property relevant to a risk management assessment.

At 155n, the process uses visual recognition, graphical analysis, and the like to identify features and conditions of the property to determine answers to the questions. For example, to identify roof wear or prior patch made to the roof by analyzing the pattern or color differences identified on the roof or to identify the condition of the skylight or window by using optical density analysis. In another example, to use visual analysis to determine the distance to the nearest water feature or to determine the style of a building, or to identify if a trampoline or swimming pool is located on the property.

At 155o, the process uses graphical processing to compare similar aerial views of the property taken at different times to determine answers to the questions. Examples include but are not limited to identifying the rate of deterioration of an outbuilding roof, the rate of growth of vegetation, whether any structures have been newly built or modified, whether damage to a structure has been sustained but unrepaired over time such as hailstorm damage, and the like.

At 155p, the process uses data processing to analyze data about neighboring properties to estimate answers to the questions. Examples include but are not limited to the age of surrounding buildings, the age of the neighborhood, the condition of surrounding property, and the like.

At 155q, the process uses statistical techniques to determine the confidence rating for answers to the questions. These techniques include but are not limited to analyzing the resolution of aerial views, any obstruction by trees of views to the buildings, age of data received indicating it may be out of date, and the like.

At 155r, the process receives questions to answer. In one non-limiting embodiment, the evaluation is performed using a crowd sourcing model, in which, for example a number of individuals view the aerial views and additional data, and answer the questions. The questions the evaluators would be asked will give significant information that affect the valuation of the property, the risk of loss and cost to replace certain structures. The evaluator may be asked to consider such as issues as the upkeep of the yard, whether they are one or more abandoned vehicles on the property, the presence of any pets, such as dogs or cats and other issues that may drastically affect the property value. In one embodiment, the evaluators would be provided access to images of the property over a range of time.

In one embodiment, the evaluator they would able to view current pictures of the property, pictures from 2-3 years prior, then 4-5 years prior, then 6-8 years prior, etc. The evaluators who are part of the crowd sourcing would be able to view the property modifications over time to inform them of the quality of their evaluations. For example, the evaluator would be able to obtain data regarding when the current owner bought the property, which would be supplied from the system that obtained the data from county and state property ownership records. The evaluator would then request images having dates from prior to the current owner and then after the current owner. The evaluator would review whether the condition of the property had improved significantly

under the current owner or deteriorated under the current owner. For example, the evaluator might notice that a new fence has been built and that the yard is being well maintained. He may also notice a number of other features which indicate that the owner has kept the property in good condition and improved it significantly. He might also notice that a new tool shed has been built and other improvements made that are not reported on the county or state property records. He may notice that new siding was recently added and new storm proof, double pane windows installed. These would be significant factors to increase the quality of the property and its value, many of which would not be reported, or even obtainable by other methods.

The evaluator may be asked to look for such factors as the installation of burglar alarms, security lights, a sidewalk installed by the city, the addition of city lights near the home, and other factors will affect the risk of a claim on the property which would not show up on normal property report.

Similarly, the reviewer may notice that shortly after the current owner bought the property that a dog house was added in the back yard. He may also notice that the yard is being torn up, with because it is not maintained or a pet is destroying some of the landscape. In addition, the evaluator may be asked to look for the addition of a swimming pool. Recently, above ground pools have become quite popular and are often added, but these are not reported on property records of building permits, yet they present a significant increase in the risk of death or serious injury to a child. The evaluator will be able to look at pictures spaced every few years to compare the changes in the state of the property. This will give the evaluator addition data and information to make an informed evaluation about the current state of the home and whether it is improving or decreasing.

One series of questions the evaluator might be asked will directed to determining the honesty of the property owner regarding reports about his own property, which will be significant benefit to the insurance company that is doing the risk assessment. For example, the evaluator may obtain property

specific data that has been supplied by the property owner that states whether a pool is present on the property, if a new fence has been built, if there is a security system that has been recently installed, if there are abandoned vehicles on the property and the like. The evaluator will then be asked the same questions about the property for which the owner has provided information. If the owner reported that there was no pool on the property and pictures show that shortly after he bought the property, he installed a pool and it has been there for few years, this will provide information about the integrity of the owner. Similar data can be checked to determine whether the photographs of the property match statements the owner has made about the property, which can used to evaluate the risk to the insurance company.

By the technique of viewing images of the property that span multiple years, the evaluator will be given questions to answer that will provide insights as to the risk to an insurance company to insure the property and also the true value of the property. Some factors, such as installing new windows, a new fence, new siding and maintaining the yard will indicate that the risk of certain types of claims is low and therefore the insurance company can better evaluate the premium to be charged and the value of the home. Other factors will indicate that the current occupant is a high risk or that the property is not well maintained and thus the insurance company may increase the premium. At 155s, the process identifies the evaluators that will receive the questions, the additional data, and aerial images, referred to an evaluator information packet. In one or more embodiments the evaluators may be but are not limited to the general public, volunteers, paid contractors, the property owner, property tenants, neighbors of the property, and the like.

At 155t, the process sends the questions, data, and aerial images to the evaluators. In one or more non-limiting embodiments, this may be done electronically via email, a Smartphone application, on paper, or the like.

At 155u, the process evaluates the data and aerial images to answer the questions. In one or more non-limiting embodiments, this may be

done by an individual operator at a workstation, by an automated process, using crowd sourcing, or by a combination of each.

In a preferred embodiment for crowd sourcing, the process sends the evaluator information packet to the evaluators along with a deadline date for completing the property evaluation. Other people, master reviewers would review and evaluate the evaluators work, and make comments on the original evaluation, along with comments on the evaluators. These comments would be made public, which in one or more embodiments may refer to the pool of evaluators, a group of people interested in the result of the evaluation, the public at large, or some other group. The original evaluation and the assessment of the evaluation by the master reviewers would then be reviewed to determine whether the evaluation should be accepted as is or if the original evaluation should be modified. The master reviewer would be able to edit the evaluation by the evaluators. He would also have data to be able to determine whether the evaluator has an unacceptable bias and thus his comments should be edited or eliminated. Some of the basis by which the master reviewer would be able to evaluate the quality of the evaluators report are described below.

Once completed, after the master reviewer has completed his review and modification of the work of the evaluators and the crowd sourcing, the evaluation could be made public or provided on a private basis to insurance companies. In some embodiments, a master reviewer does not modify or even view the report and this step is omitted, but it is preferred in most embodiments.

In one embodiment, the property information provided to the evaluators should not contain any geographically identifiable information or other information that may be used to identify the individuals living in the building being evaluated. Thus, the evaluation is done unbiased since the evaluator can view details about the property, but does not know its physical location.

In one alternative, evaluators would be in the same geographic area as the property they are evaluating. According to one embodiment, the

third party might, in some cases be selected based on living close to the same address as the property to be evaluated. The evaluation therefore might be done by a neighbor who lives across the street, on the same block or in the same general area. While such evaluations have data to be more accurate, there is significant risk of bias, either favorable or unfavorable to the property owner. Whether the evaluator had personal knowledge of the property on the owner being evaluated will be data that is given to the master reviewer. He will therefore take this into account whether to weight the evaluators report with a high confidence rating or a low confidence rating or ignore it completely.

At 155v, the process provides a confidence rating for answers to the questions. In one or more embodiments, the operator may enter either a confidence rating for each individual question answered, or an overall confidence rating once all questions are answered. Or, if using an automated process, statistical techniques may be used to determine the confidence rating.

At 155w, the process receives the answers from the evaluators. In one or more non-limiting embodiments, this may be done electronically, via email, a Smartphone application, on paper, or the like.

At 155x, the process assesses the accuracy of each evaluator for use in selecting future evaluators. In one or more embodiments, the assessment may take the form of, but not limited to, several techniques. In one non-limiting example, statistical techniques may be used to generate the most likely correct answer for each question answered by the evaluator and compare that answer to the evaluator's answer. In another non-limiting example, individuals may review the evaluations done by each evaluator and vote on the accuracy of the each evaluation.

Figure 1H is a flow diagram showing a method 160 that may be included as part of providing additions, updates, and/or corrections to the data received step of the method shown in Figure 1D, according to one non-limiting illustrated embodiment. While each of the steps shown in figure 1H contributes to the overall solution, each can be used independently or in various

combinations to yield improvements in providing additions, updates, and/or corrections to the data received as discussed below.

At 160c, the process identifies data that has been found during the evaluation process to be incorrect. In one or more embodiments, examples of this data include but are not limited to images that are out of date, area estimates of buildings that are incorrect, number of listed outbuildings that is not correct, and the like. In one or more embodiments, the term "correct" may include a deviation within a certain tolerance level.

At 160e, the process reports to the source of the data that the data is not correct. In one or more embodiments, this may include but is not limited to notifying the source of the data (e.g. an insurance company) that the data is not correct, sending the source the correct data, updating the source with the correct data, and the like.

Figure 1I is a flow diagram showing a method 165 that may be included as part of the receiving underwriting criteria for insurance product offers and pricing for the property step of the method shown in figure 1D, according to one non-limiting illustrated embodiment. While each of the steps shown in Figure 1I contributes to the overall solution, each can be used independently or in various combinations to yield improvements in estimating floor area measurements as discussed below.

At 165a, the process receives underwriting criteria to determine the insurance products and premiums available based on a property's risk assessment profile. Examples of this underwriting criteria include but are not limited to a list of the features of a property that corresponds to a particular insurance products offered by the company and the various conditions of the features of the property that affect premium cost of each insurance product.

At 165c, the process receives the property risk management profile. In one non-limiting embodiment, the property risk management profile is retrieved from a database containing property risk management profiles.

At 165e, the process determines the insurance products and pricing for the property. In one non-limiting embodiment, the process compares the features and conditions of the property found in the property risk management profile to the received underwriting criteria to determine what insurance products are available for the property and the premium cost of each insurance product.

At 165g, the process determines if the confidence rating for the property risk management profile is high enough to not send a person to the property for an on-site inspection. In one non-limiting embodiment, the confidence rating that is part of the properties risk management profile is compared with other factors including but not limited to the features of the property, the condition of the features of the property, the dollar cost of the insurance products being quoted, cost to send someone for an on-site inspection, and the like. A company may, based on the comparison, either choose to not send a person on-site and instead make the decision to issue the policy based solely on the analysis of remotely-gathered information in a process known as "desk underwriting" insurance products.

Figure 2 is an example screenshot of a user interface of a system for generating floor area measurements with roof sections annotated on an aerial image of the roof, according to one non-limiting illustrated embodiment. For example, the screenshots of Figures 2-8 are screenshots of the graphical user interface of the floor area measurement system which performs the processes described in Figures 1A-1C above.

Shown is a graphical user interface including two panels, one with an image of a building showing a top substantially orthogonal view 202 of the building and the other with an image of the building showing a top oblique view 204 of the same building. Also shown is an annotation 212, which is a line drawing of a three dimensional model of the roof. The annotation 212 is an adjustable graphical user interface element overlaid on the roof of the building in each image corresponding to the angle of view 202 and view 204 of the roof

in each image. The annotation 212 also shows various planar sections of the roof as delineated by the roof features and roof lines, such as the ridge line, valley lines and roof eaves, etc. This annotation 212 is an interactive graphical user interface feature and may be manipulated by a user of the system to make various adjustments to roof features and characteristics for the purpose of generating roof measurements, such as those used in the processes shown in Figures 1A-1C and other embodiment described herein. These may be performed by user interaction with the annotation itself and/or various selectable controls 206.

Also shown are image selection bars 208 and 210 which display thumbnail or reduced-size images of various other images showing the building from other perspectives and view angles. Selection bar 208 is located above view 202. When a particular thumbnail image in selection bar 208 is selected, the image showing the current view 202 is replaced with that of the selected image. Similarly, selection bar 210 is located above view 204. When a particular thumbnail image in selection bar 210 is selected, the image showing the current view 204 is replaced with that of the selected image.

Figure 3 is an example screenshot 300 of a user interface of the system of Figure 2 for generating floor area measurements with area measurements 302, 304 and 306 of roof sections annotated on an aerial image of the roof, according to one non-limiting illustrated embodiment. For example, when the user selects the "next button" 214 shown in Figure 2, the floor area measurement estimation system calculates the areas 302, 304 and 306 of each roof section according to the roof annotation 212, as adjusted by the user, and displays these area values 302, 304 and 306 on the corresponding sections of the roof in the displayed image. Also shown is a "Fuse" button 308, the selection of which causes results to be displayed as shown in Figure 4.

Figure 4 is an example screenshot 400 of a user interface of the system of Figure 2 for generating floor area measurements showing the roof annotated with an estimated total roof area 402 on which to base an estimated

floor area measurement, such as that estimated in the method of Figures 1A-1C, according to one non-limiting illustrated embodiment. For example, when the user selects the "Fuse" button 308 shown in Figure 3, the floor area measurement estimation system may perform the acts 112 and 114 of the process shown in Figure 1B to calculate an estimated total roof area of the roof by setting each section of the roof to a zero slope.

In this embodiment, the floor area measurement estimation system generates an adjusted roof model by adjusting the slope to substantially zero of the planar roof sections having areas 302, 304 and 306 shown in Figure 3 in the three dimensional model of the roof represented by annotation 212. This may be performed in a variety of manners, including, for example, by removing particular roof features from the model represented by annotation 212 in Figure 3 that would not be present in a flat roof with no slope. This could be considered "fusing" individual planar roof sections in the model into one flat roof section, such as by removing ridge lines or other features distinguishing individual planar roof sections instead of, or in addition to, adjusting a slope parameter or variable within the model to zero. This process results in the adjusted annotation 212 displayed by the system as shown in Figure 4 without lines indicating roof features such as ridge lines associated the pitched roof. Thus, the system generates and provides roof edge measurements using the roof model as if the entire roof was flat with no slope, as shown by the annotation 212 representing the roof model in Figure 4.

Although the screenshot of the graphical user interface 300 shows both the orthogonal view 202 and oblique view 204, in other embodiments, this action may be performed with just one initial aerial image of the building using and/or showing only the substantially orthogonal view 202 of the building since roof pitch need not be determined and can be assumed to be zero.

Also shown is an "Erode" button 402, the selection of which causes results to be displayed as shown in Figure 5, as will be explained in conjunction with Figure 5 below.

Figure 5 is an example screenshot 500 of a user interface of the system of Figure 2 for generating floor area measurements showing the building annotated with an adjusted estimated floor area measurement, such as that estimated in the method of Figures 1A-1C, according to one non-limiting illustrated embodiment. For example, when the user selects the "Erode" button 402 shown in Figure 4, the floor area measurement estimation system will perform the acts 122 and 124 of the process shown in Figure 1C to calculate an adjusted estimated total roof area of the roof by subtracting an amount from each section of the roof to account for an eave overhang distance.

In this embodiment, the floor area measurement estimation system subtracts an amount from one or more of the roof edge measurements in the roof model represented by annotation 212 corresponding to an estimated roof overhang over one or more walls of the building to obtain adjusted roof edge measurements. For example, each roof edge measurement may be reduced (i.e., "eroded") by 6 inches to 18 inches corresponding to an estimated roof overhang, which is selectable by a user of the floor area measurement estimation system. However, other lengths or ranges of lengths may be used.

The floor area measurement estimation system may also subtract an amount from one or more of the adjusted roof edge measurements in the roof model represented by annotation 212 corresponding to an estimated wall width to obtain adjusted roof edge measurements. For example, each roof edge measurement may be reduced (i.e., "eroded") by 6 inches to 18 inches corresponding to an estimated wall width, which is selectable by a user of the floor area measurement estimation system. However, other lengths or ranges of lengths may be used.

The amount of length subtracted from a line to obtain a more accurate measure of the internal footprint of the home will vary depending on the factor being subtracted for. If the factor being subtracted for is an eave, the value may be 2 feet, 3 feet, or another selected amount which may be a default value, such as 2 feet, or a value selected by an operator from seeing a second

image of the home, which provides an oblique view of the overhang difference, which in some homes might be 4 feet. On the other hand, if the subtraction is for a wall thickness, the amount will usually be 6 inches or at most 10 inches. For a porch or deck, the amount might be 10 feet, 12 feet or some other value, based on an estimate of the true distance from an operator viewing one or more oblique images.

In some embodiments, each time a user selects the "erode" button 402, an additional adjustment shortening the lengths of the roof edges will be performed by the system. Note that the annotation 212 in Figure 5 is now adjusted corresponding to the adjusted roof edge lengths such that the actual edges of the roof in the image shown in both the orthogonal view 202 and oblique view 204 extend beyond the borders of the annotation 212. The corresponding roof area measurement 502 is also therefore adjusted accordingly by the floor area measurement estimation system (e.g., from 2144 square feet down to 1855 square feet as shown in Figures 4 and 5, respectively).

Figure 6 is an example screenshot 600 of a user interface of the system of Figure 2 for generating floor area measurements showing the building annotated with adjusted estimated first floor and second floor area measurements, such as that estimated in the method of Figures 1A-1C, according to one non-limiting illustrated embodiment. For example, the user may manipulate or otherwise adjust the annotation 212, or add additional annotations to represent multiple floors of the building as identified in the oblique view 204 of the building. Based on these adjustments, the floor area measurement estimation system may perform act 130 of the process shown in Figure 1C to generate the estimated floor area measurement based on information received regarding a number of stories of the building. For example, the floor area measurement estimation system may receive information regarding how many stories the building has and regarding one or more sections of the roof below which one or more of the stories laterally

extends. The system may then generate the estimated floor area measurement based on a total area of the one or more sections of the roof under which each of the stories extends and based on the generated estimated total roof area of the roof.

In the example embodiment shown in Figure 6, shown is a first floor annotation 602 and a second floor annotation 604 that combined form annotation 212. The relationship between the first floor, second floor and roof can be seen form a different perspective in the oblique view 204 as the second floor annotation 604 shows that the second floor laterally extends substantially the entire length of the roof. However, the first floor annotation 602 shows that the first floor laterally extends about half way the length of the roof and the second floor due to the garage. The first floor annotation 602 and a second floor annotation 604 may be directly or indirectly manipulated and adjusted resulting in different area measurements of the floor represented by these annotations.

Also, first floor annotation 602 and second floor annotation 604 may be directly or indirectly manipulated and adjusted to account for spaces that are not to be included in the estimated floor area measurement. For example, these areas may be areas of the building that are not used for living inside the building or areas outside the building, including but not limited to: garages; attics; unfinished rooms above the garage or other unfinished spaces; covered balconies; patios, decks or porches, basements; crawl spaces; etc. This also may be performed in response to a user marking or otherwise identifying such areas on the first floor annotation 602 and second floor annotation 604, or otherwise adjusting the dimensions of the sides of the first floor annotation 602 and second floor annotation 604 to "notch" out or "cut" out such areas. In some embodiments, selectable graphical user interface items are provided representing such spaces. When selected an placed on the first floor annotation 602 and second floor annotation 604, a an area corresponding to a standard size and/or shape of such a space will be removed from the first

floor annotation 602 and second floor annotation 604, and the floor area measurements will be adjusted accordingly.

For example, a selectable graphical user interface item representing a standard two-car garage may be selected by a user and placed in a position on the first floor annotation 604 overlaid on the image of the building corresponding to where a garage of the building is located. The floor area measurement estimation system will then subtract an area corresponding to the area of the standard two-car garage from the area of the first floor according to the position of the graphical user interface item representing the standard two-car garage on the first floor annotation 604.

Figure 7 is an example screenshot 700 of a user interface of the system of Figure 2 for generating floor area measurements showing a line drawing of a top plan view of each the first and second floor of the building annotated with corresponding floor area measurements of the building shown in Figure 6, such as that estimated in the method of Figures 1A-1C, according to one non-limiting illustrated embodiment. The line drawing represents the first floor annotation 602 and the second floor annotation 604 shown in Figure 6. Note that the corresponding estimated floor areas are displayed on each annotation. These are adjusted by the floor area measurement estimation system upon manipulation of the corresponding first floor annotation 602 or second floor annotation 604 by the user.

Figure 8 is an example screenshot 800 of a user interface of the system of Figure 2 for generating floor area measurements showing a line drawing of a top perspective view of the first and second floor of the building shown in Figure 6 annotated with corresponding floor area measurements, such as that estimated in the method of Figures 1A-1C, according to one non-limiting illustrated embodiment. Shown in this manner in the graphical user interface of the floor area measurement estimation system, a user may manipulate the corresponding first floor annotation 602 and/or second floor annotation 604 and see the visual effects of the changes according to the

positional relationships between the first and second floors corresponding to the oblique view 204 shown in Figure 6.

Provided the example in Figure 8, the total estimated floor area of the building is 2866 square feet (1076 square feet as noted on the first floor annotation 602 plus 1790 square feet as noted on the second floor annotation 604). Various reports may be generated showing the estimated areas of the various floors and/or the estimated total floor area of the building. For example, a report may be generated by the building floor area measurement estimation system or by using the data provided by the building floor area measurement estimation system that includes diagrams similar to the screenshots 700 and 800 shown in Figure 7 and 8, respectively either alone or overlaid on the corresponding images of the building shown in Figure 6.

Figure 9 is a schematic diagram of a computing environment in which systems and methods for estimation of building floor area may be implemented or of which they may be a part. For example, processes 100, 110 and 120 described above in conjunction with Figures 1A-1C may be performed or implemented by, for example, one or more software modules or components or any combination of suitable hardware, firmware or software components or devices including those that are a part of, stored in, or configure the computing environment of Figure 9. Also, the graphical user interface functions and features may be performed or implemented by, for example, one or more software modules or components or any combination of suitable hardware, firmware or software components or devices including those that are a part of, stored in, or configure the computing environment of Figure 9.

The computing environment 900 will at times be referred to in the singular herein, but this is not intended to limit the embodiments to a single device since in typical embodiments there may be more than one computer system or device involved. Unless described otherwise, the construction and operation of the various blocks shown in Figure 9 are of conventional design.

As a result, such blocks need not be described in further detail herein, as they will be understood by those skilled in the relevant art.

The computing environment 900 may include one or more processing units 912a, 912b (collectively 912), a system memory 914 and a system bus 916 that couples various system components including the system memory 914 to the processing units 912. The processing units 912 may be any logic processing unit, such as one or more central processing units (CPUs) 912a, digital signal processors (DSPs) 912b, digital video or audio processing units such as coder-decoders (codecs) or compression-decompression units, application-specific integrated circuits (ASICs), field programmable gate arrays (FPGAs), etc. The system bus 916 can employ any known bus structures or architectures, including a memory bus with memory controller, a peripheral bus, and a local bus. The system memory 914 includes read-only memory ("ROM") 918 and random access memory ("RAM") 920. A basic input/output system ("BIOS") 922, which can form part of the ROM 918, contains basic routines that help transfer information between elements within the computing environment 900, such as during start-up.

The computing environment 900 may include a hard disk drive 924 for reading from and writing to a hard disk 926 (including a solid state memory device), an optical disk drive 928 for reading from and writing to removable optical disks 932, and/or a magnetic disk drive 930 for reading from and writing to magnetic disks 934. The optical disk 932 can be a CD-ROM, while the magnetic disk 934 can be a magnetic floppy disk or diskette. The hard disk drive 924, optical disk drive 928 and magnetic disk drive 930 may communicate with the processing unit 912 via the system bus 916. The hard disk drive 924, optical disk drive 928 and magnetic disk drive 930 may include interfaces or controllers (not shown) coupled between such drives and the system bus 916, as is known by those skilled in the relevant art. The drives 924, 928 and 930, and their associated computer-readable storage media 926, 932, 934, may provide nonvolatile and non-transitory storage of computer

readable instructions, data structures, program modules and other data for the computing environment 900. Although the depicted computing environment 900 is illustrated employing a hard disk 924, optical disk 928 and magnetic disk 930, those skilled in the relevant art will appreciate that other types of computer-readable storage media that can store data accessible by a computer may be employed, such as magnetic cassettes, flash memory, solid state drives, digital video disks ("DVD"), Bernoulli cartridges, RAMs, ROMs, smart cards, etc. For example, computer-readable storage media may include, but is not limited to, random access memory (RAM), read-only memory (ROM), electrically erasable programmable read-only memory (EEPROM), flash memory, compact disc ROM (CD-ROM), digital versatile disks (DVD) or other optical disk storage, magnetic cassettes, magnetic tape, magnetic disk storage or other magnetic storage devices, solid state memory or any other medium which can be used to store the desired information and which may be accessed by processing unit 912a.

Program modules can be stored in the system memory 914, such as an operating system 936, one or more application programs 938, other programs or modules 940 and program data 942. Application programs 938 may include instructions that cause the processor(s) 912 to perform generating digital roof models, generating roof and floor area measurements, and store and display input images or images generated by generating digital roof models and generating roof and floor area measurements, including the processes described herein. Other program modules 940 may include instructions for handling security such as password or other access protection and communications encryption. The system memory 914 may also include communications programs, for example, a Web client or browser 944 for permitting the computing environment 900 to access and exchange data including digital images, roof measurements and other building data with sources such as Web sites of the Internet, corporate intranets, extranets, or other networks and devices, as well as other server applications on server

computing systems. The browser 944 in the depicted embodiment is markup language based, such as Hypertext Markup Language (HTML), Extensible Markup Language (XML) or Wireless Markup Language (WML), and operates with markup languages that use syntactically delimited characters added to the data of a document to represent the structure of the document. A number of Web clients or browsers are commercially available such as those from Mozilla, Google, and Microsoft of Redmond, Washington.

While shown in Figure 9 as being stored in the system memory 914, the operating system 936, application programs 938, other programs/modules 940, program data 942 and browser 944 can be stored on the hard disk 926 of the hard disk drive 924, the optical disk 932 of the optical disk drive 928 and/or the magnetic disk 934 of the magnetic disk drive 930.

An operator can enter commands and information into the computing environment 900 through input devices such as a touch screen or keyboard 946 and/or a pointing device such as a mouse 948, and/or via a graphical user interface in order to receive, process, store and send data on which floor area measurement estimation has been or will be performed as described herein. Other input devices can include a microphone, joystick, game pad, tablet, scanner, etc. These and other input devices are connected to one or more of the processing units 912 through an interface 950 such as a serial port interface that couples to the system bus 916, although other interfaces such as a parallel port, a game port or a wireless interface or a universal serial bus ("USB") can be used. A monitor 952 or other display device is coupled to the system bus 916 via a video interface 954, such as a video adapter which may be configured to display images used by or generated by floor area measurement estimation as described herein. The computing environment 900 can include other output devices, such as speakers, printers, etc.

The computing environment 900 can operate in a networked environment using logical connections to one or more remote computers and/or

devices. For example, the computing environment 900 can operate in a networked environment using logical connections to one or more other computing systems, mobile devices and other service providers or information servers that provide the digital images in various formats or by other electronic delivery methods. Communications may be via a wired and/or wireless network architecture, for instance wired and wireless enterprise-wide computer networks, intranets, extranets, telecommunications networks, cellular networks, paging networks, and other mobile networks.

Figure 10 is an example screenshot 702 of a user interface of a floor plan editor tool for generating floor area measurements, which may be used independently of, as part of, or integrated with the systems and methods for generating a risk management report described herein. In one embodiment, the tool consists of a floor plan editor 300, a facet label editor 302, and control buttons 304. The floor plan editor 300 consists of an approximately orthogonal view of the property 306 over which the software operator can draw shapes, such as rectangles, to outline the dimensions and area of different approximate floor areas of different sections of the house or building 308. The facet label editor 302 is a window that displays multiple aerial views of the property. In this example, the operator is looking at a West view which is indicated in area 310. Below this area there are a series of thumbnail images 314, with the current image being viewed highlighted 312. The highlighted image 312 indicates the expanded view of the image shown below 320. The operator, when drawing the floor areas 308, uses the multiple views of the property that are referenced by the thumbnail images 314 to determine the various features and facet types of the building for which the operator wants to estimate a floor area. An example of these facet types and features are listed in the facet label editor as facet type buttons 316. These facet types include, but are not limited to, footprint 316a, outbuilding 316b, garage 316c, first floor 316d, second floor 316e, third floor 316f, deck 316g, patio 316h, and porch 316i. The operator

may select one of these buttons to associate one floor plan shape drawn on the building 308.

Control buttons 304 allow the operator to adjust floor plan shapes and choose different views of the property to show on the facet label editor 302. The operator can select the image 320 to display by using either the left arrow 318a or the right arrow 318b to move the selected thumbnail image, in this case image 312, to the desired image to be shown. Selecting different aerial images of the property taken at different angles allows the operator to better understand the structure of the building to determine the number of floors, the levels, garages, decks, patios, porches, or other features of the building. The erode button 330 allows a floor plan shape that is selected from among the number of floor plan shapes 308 to have its edges slightly reduced, for example, by 16 inches to 18 inches. Conversely, the dilate button 332 will enlarge the size of the selected shape by a small amount. The erode and dilate features are used as fine-tune adjustments by the operator to adjust the rectangle shape to the approximate floor plan of the building section that is being estimated. The checklist button 322 will take the user to the gathering property assessment screens described starting in Figure 16. When the operator has finished drawing all the shapes and is satisfied with the drawings of the floor plan, the operator selects the finish button 326. To reject the changes and start over, the operator selects the reject button 324.

Figure 11 is an example screenshot 704 of the user interface of the system described in Figure 10. Here, the operator has zoomed in, using the floor plan editor, on the image showing the top of the building being measured 306. In one embodiment, the operator uses a mouse to move cursor 336 to different locations over the house to draw rectangles that represents floor areas the operator wishes to measure. For example, if the operator wished to estimate the measurement of the deck 338, the operator would first select the deck facet types button 316g, then on the floor plan editor image 306 select the four corners that appear to the operator to be the corners of deck

338. Once the operator has completed this for all of the floor plan areas desired to be captured, the operator can go to the facet label editor thumbnail images 314 and select the top view, in this example by selecting thumbnail 340, which shows the top view of the building in the facet label editor overlaid with the different facet types as identified by the operator. In this example, the facet types are differentiated by different names, such as garage, footprint, first floor, second floor, deck, etc. and are also distinguished by color: magenta, beige, blue, dark blue, gray, etc. In addition, the dimensions and the areas associated with each facet type footprint also appear in the same color in the floor plan editor overlaid on the top-down image 306.

Figure 12 is an example screenshot 706 of the user interface of the system from Figure 10. In this example, the user has selected thumbnail 342, which is an oblique aerial view of the property facing east. The operator may use this view to verify the operator's choices of the different facet types for the floor areas.

Figure 13 is an example screenshot 708 of the user interface of the system of Figure 10. Here, the operator has selected thumbnail 344, which is a oblique aerial view of the property facing north, again to check whether the facet type selections for the floor area need any adjustment.

Figure 14 is an example screenshot 710 of a user interface of the system of Figure 10. Here, the operator has zoomed in further on the north oblique-facing image 348 to better check and review the operator's assessment of the features of the building.

Figure 15 is an example screenshot 712 of a user interface of the system of Figure 10. Here, the operator has selected the top thumbnail 340 to review the final floor plan selections and facet type selections for any final changes. If the operator is satisfied with the floor plan, the operator selects the finish button 326.

Figure 16 is an example screenshot 714 of a user interface of a system for gathering property assessment data for a property and the buildings

on the property, which may be used independently of, as part of, or integrated with the systems and methods for generating a risk management report described herein, according to one non-limiting illustrated embodiment. For example, the screenshots of Figures 16-21 are screenshots of the graphical user interface of the gathering property assessment data, which performs the processes described in Figures 1A-1I above.

Shown is a graphical user interface including two panels, one with an image of the property 346, and one with a series of questions pertaining to the property to be answered 348. In some embodiments, the answers may be provided by other data sources, or by the operator in viewing the pictures of the property in panel 346.

In some embodiments the panel 346 may display various images of the property which can be viewed by selecting a tab 342. The available images may come from different sources, may be of different perspectives (e.g. top-down versus oblique), and may have different image manipulation methods, for example viewing an image in Bing vs. Google. The operator can select a view of 342 and use the image displayed to answer questions 348 about the property. In screen 714, the questions 348 have to do with a house on the property. In this example, the operator is asked a series of questions to be answered based on the operator's visual assessment of the property from the given aerial images. For example, the number of stories in the house, the type of structure, the number of corners, and total living area information of the structure, which can be either estimated or taken from the floor plan editor tool.

Figure 17 is an example screenshot 716 of a user interface of the system for Figure 16 for gathering property assessment data, according to one non-limiting illustrated embodiment. In this example, additional questions 350 regarding the house on the property have been answered by the operator.

Figure 18 is an example screenshot 718 of a user interface of the system of Figure 16 for gathering property assessment data according to one non-limiting embodiment. Here, the operator is asked for data regarding

exposures to the property and to the house 352, for example, the nearest nonresidential exposures, nearest steep slope, nearest water hazard, nearest natural vegetation exposure. In this example, the operator may either estimate and type the number directly into the answer area 354, or the operator can use the get distance tool by clicking 356. When the operator uses the get distance tool, in one embodiment the system presents the operator an image of the property and surrounding area 346 as well as a marker indicating the location of the property that is being evaluated 358. The system displays a marker 360 which can be moved within the image to indicate the location that the distance should be measured to. Line 362 connects the marker showing the location of the property 358 to the floating marker that the user is able to place at the location of the exposure to which the distance needs to be determined.

Figure 19 is an example screenshot 720 of a user interface of the system of Figure 16 for gathering property assessment data according to one non-limiting illustrated embodiment. Screen 720 shows the results of using the get distance tool which was selected by pressing button 356 in screen 718. In this example, the tool estimated the distance based on the top-down image scale 346, and put the result in answer box 358. In addition to measuring the distance, the operator is asked to identify the type of vegetation present around the property and also if there are any recreational vehicles, boats or motorcycles on the property.

Figure 20 is an example screenshot 722 of a user interface for of the system of Figure 16 for gathering property assessment data according to one non-limiting illustrated embodiment. In this example, the operator is asked about roof characteristics including how steep the roof is, the pitch of the roof (estimate), the type or style of the roof, for example, a hip or gabled roof versus a flat roof, the number of chimneys in the house, and the number of outbuildings on the property 360.

Figure 21 is an example screenshot 724 of a user interface of the system of Figure 16 for gathering property assessment data according to one

non-limiting illustrated embodiment. In this example, the operator is asked for additional information on the property 362. For example, ground slope beneath the main structure on the property, whether there is a trampoline on the property, and whether there is a pool or hot-tub on the property. In this example, the operator is able to go back to previous screens by selecting previous button 364. Otherwise, if the operator is finished with the property assessment data, the operator selects the finish button 366.

Figure 22 is an example page of a report 726 of a property risk management report according to one non-limiting illustrated embodiment. Figures 22-29 are examples of the presentation of data which is received from the processes described in Figures 1A-1F. This example shows a top-down view of the property 368, a title of the report 370, the type of report 372, in this case a custom residential report, a report date, property address, and insurance policy number related to the property, if available. Finally, the example includes the name and address of the individual or company for which the report was prepared 374.

Figure 23 is an example page 728 of a property risk management report example of Figure 22, according to one non-limiting illustrated embodiment. This example page shows, the date of the report, report details including a report number, an insurance policy number that is related, if any, the renewal date of the insurance policy related, if any, the date of the photo, and the geocoded location, for example, in latitude and longitude, of where the property exists. In addition, a building summary is presented which includes the year built, the number of stories, and the estimated living area, whether or not there is a garage, and whether the garage is attached.

Figure 24 is an example page 730 of a property risk management report of Figure 22, according to one non-limiting illustrated embodiment. This example page contains a top view or orthogonal view 380 of the property.

Figure 25, is an example page 732 of a property risk management report of Figure 22, according to one non-limiting illustrated embodiment. This

example page shows two orthogonal views of the property: a north view 382, and a south view 384.

Figure 26 is an example page 734 of a property risk management report of Figure 22, according to one non-limiting illustrated embodiment. This example page shows two additional aerial oblique views of the property: an east view 386, and a west view of the property 388.

Figure 27 is an example page 736 of a property risk management report, according to one non-limiting illustrated embodiment. The example page includes total estimated living area 390, number of stories 392, and an indicator of the floor level 393 and the area and dimension diagram of the features for that floor in diagram form 404. A color-coded key 394 is used to identify the different features of the floor diagram 404 being shown. The example of this report has a color key 394 for each feature area, which corresponds to colors of the features shown in diagram 404, namely the living area 398 in light blue, the garage area 396 in peach, the deck area 400 in maroon, etc. In addition, there is a compass rose 402 to orient the position of the buildings on the property.

Figure 28 is an example page 738 of a property risk management report of Figure 22, according to one non-limiting illustrated embodiment. This example page describes the second floor and shows the dimensions and area for the living area in light blue 406 and the footprint in grey 408.

Figure 29 is an example page 740 of a property risk management report of Figure 22, according to one non-limiting illustrated embodiment. This examples page includes a confidence rating 410 that allows the operator in the gathering property assessment data tool discussed above to indicate the operator's level of confidence in the ratings and estimations given for the property. Structural observations 412 include year built, number of stories, type of family structure, footprint, number of corners, estimated total living area, garage area, garage type, deck area, patio area, porch area, estimated roof pitch, roof shape, number of chimneys, outbuilding count, outbuilding total area,

basement area, finished basement area, basement type, basement description. Property observations 413 include whether there is a building permit, whether an EagleView roof report was completed, whether an EagleView wall report was completed, property distance to a commercial exposure, property distance to a steep slope, property distance to a water hazard, property distance to vegetation, type of vegetation, cross-sell identification, slope on property, existence of a trampoline, swimming pool/hot tub, the location of the nearest responding fire station, the type of responding fire station, property distance of the responding fire station, and whether the structure is owner occupied.

The various embodiments described above can be combined to provide further embodiments. All of the U.S. patents, U.S. patent application publications, U.S. patent applications, foreign patents, foreign patent applications and non-patent publications referred to in this specification and/or listed in the Application Data Sheet are incorporated herein by reference, in their entirety. Aspects of the embodiments can be modified, if necessary to employ concepts of the various patents, applications and publications to provide yet further embodiments.

These and other changes can be made to the embodiments in light of the above-detailed description. In general, in the following claims, the terms used should not be construed to limit the claims to the specific embodiments disclosed in the specification and the claims, but should be construed to include all possible embodiments along with the full scope of equivalents to which such claims are entitled. Accordingly, the claims are not limited by the disclosure.

CLAIMS

1. A method, comprising:

obtaining one or more aerial views of a first property from a first source;

obtaining additional data from a second source, the additional data relating to the first property;

evaluating the obtained one or more aerial views against risk management criteria;

evaluating the obtained additional data against the risk management criteria;

determining a risk management profile of the first property based on both evaluations;

storing the determined risk management profile of the first property;

generating a risk management report for the first property based on the risk management profile of the first property;

determining a confidence rating of the risk management profile of the first property based on the both evaluations;

storing the determined confidence rating of the risk management profile of the first property;

outputting the risk management report for the first property based on the stored risk management profile of the first property; and

outputting the confidence rating for the risk management report of the first property based on the stored confidence rating.

2. The method of claim 1 wherein risk management criteria further comprises at least one or more of:

number of buildings, building roof area, building roof condition, building floor area, density and size of vegetation on property, slope of the

terrain of the first property, water features on first property, proximity to commercial areas, and proximity to a fire station.

3. The method of claim 1 wherein a second source for obtaining additional data relating to the first property further comprises:

government agencies, county tax records, construction companies, insurance companies, and sources of property description data describing conditions on a second property adjacent to the first property.

4. The method of claim 1 wherein evaluating the obtained one or more aerial views against the risk management data further comprises:

applying computer-based graphical analysis to the one or more aerial views.

5. The method of claim 1, further comprising:

receiving an insurance claim for damage on the first property;

comparing the insurance claim to the stored risk management profile of the first property; and

determining, based on the comparison, whether to pay the insurance claim.

6. The method of claim 1 wherein evaluating the obtained one or more aerial views against risk management criteria further comprises:

identifying a plurality of individuals, the individuals being part of a crowd source network;

creating a questionnaire, the questionnaire including a plurality of questions based at least in part on the risk management criteria;

sending to the identified plurality of individuals the questionnaire and at least one of the one or more obtained aerial views; and

receiving from each of the plurality of individuals a questionnaire reply having answers to one or more of the plurality of questions of the sent questionnaire, the answers based on the individual's evaluation of the first property using the at least one of the one or more obtained aerial views.

7. The method of claim 1 wherein evaluating the obtained additional data against risk management criteria further comprises:

identifying a plurality of individuals, the individuals being part of a crowd source network;

creating a questionnaire, the questionnaire including a plurality of questions based at least in part on the risk management criteria;

sending to the identified plurality of individuals the questionnaire and at least a subset of the obtained additional data; and

receiving from each of the plurality of individuals a questionnaire reply having answers to one or more of the plurality of questions of the sent questionnaire, the answers based on the individual's evaluation of the first property using the at least a subset of the obtained additional data.

8. The method of claim 1, further comprising:

if the confidence rating for the risk management profile of the first property is less than a threshold level, sending a person to the location of the first property to acquire additional data.

9. The method of claim 1, further comprising:

comparing the risk management report for the first property to underwriting criteria, the underwriting criteria including at least a plurality of insurance products each including a plurality of premium amounts;

storing the comparison result;

identifying, from the stored comparison result, the insurance products and premium amounts available for the first property that satisfy the underwriting criteria;

storing the insurance products and premium amounts available for the first property that meet the underwriting criteria; and

outputting the stored insurance products and premium amounts available for the first property that meet the underwriting criteria.

10. The method of claim 9, further comprising:

if the confidence level for the risk management report is above a threshold level, sending the stored insurance products and premium amounts to an owner of the first property.

11. A method, comprising:

obtaining one or more aerial views of a first property from a first source;

obtaining additional data from a second source, the additional data including data items and associated data item values relating to the first property;

evaluating both the obtained one or more aerial views and the obtained additional data;

identifying, based on the evaluation, a data item from the obtained additional data that has a data item value that is not correct;

determining, based on the evaluation, the correct data item value to be associated with the identified data item; and

outputting to the second source an indication of the identified data item and the correct data item value.

12. The method according to claim 11, wherein the second source includes at one of: county records agency, insurance company, and tax authority.

13. The method according to claim 11, wherein the data item from the obtained additional data that has a data item value that is not correct includes one of: square footage of the property, number of buildings on the property, and total living area in a building on the property.

14. The method according to claim 13, wherein the second source is county tax records.

15. The method according to claim 11, wherein the second source includes an insurance company, the additional data includes attributes of the first property, and the identified data item is the number of outbuildings on the first property.

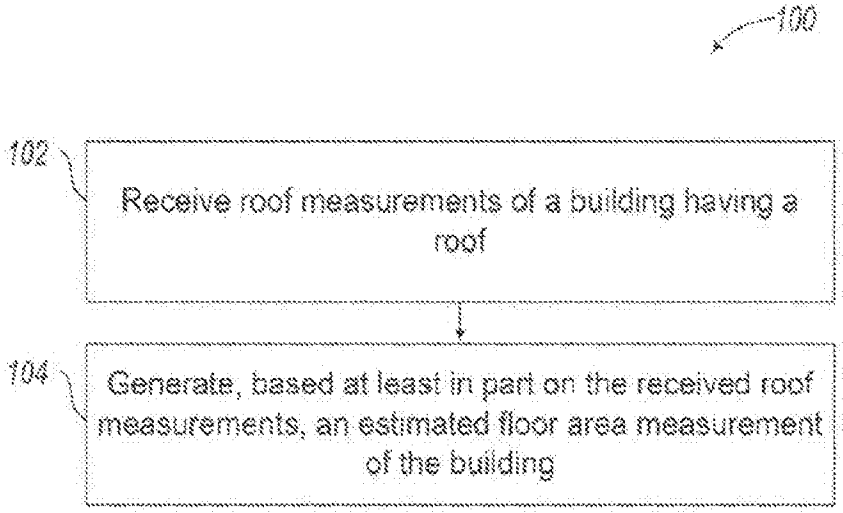

100
102
Receive roof measurements of a building having a roof
104
Generate, based at least in part on the received roof measurements, an estimated floor area measurement of the building

Fig. 1A

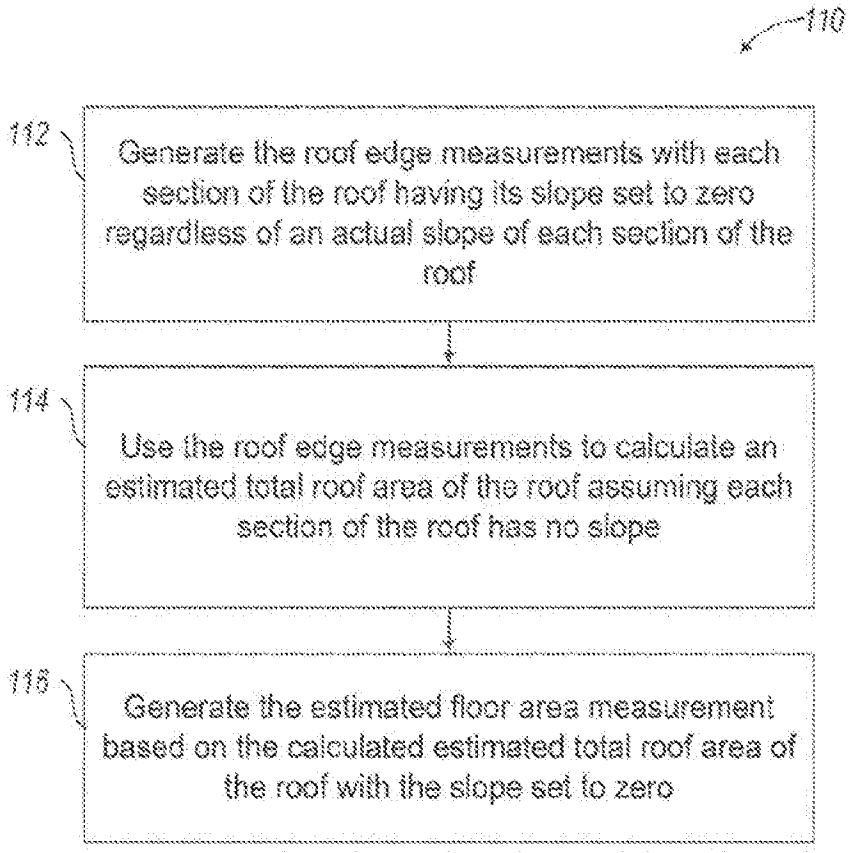

110
112
Generate the roof edge measurements with each section of the roof having its slope set to zero regardless of an actual slope of each section of the roof
114
Use the roof edge measurements to calculate an estimated total roof area of the roof assuming each section of the roof has no slope
116
Generate the estimated floor area measurement based on the calculated estimated total roof area of the roof with the slope set to zero

Fig. 1B

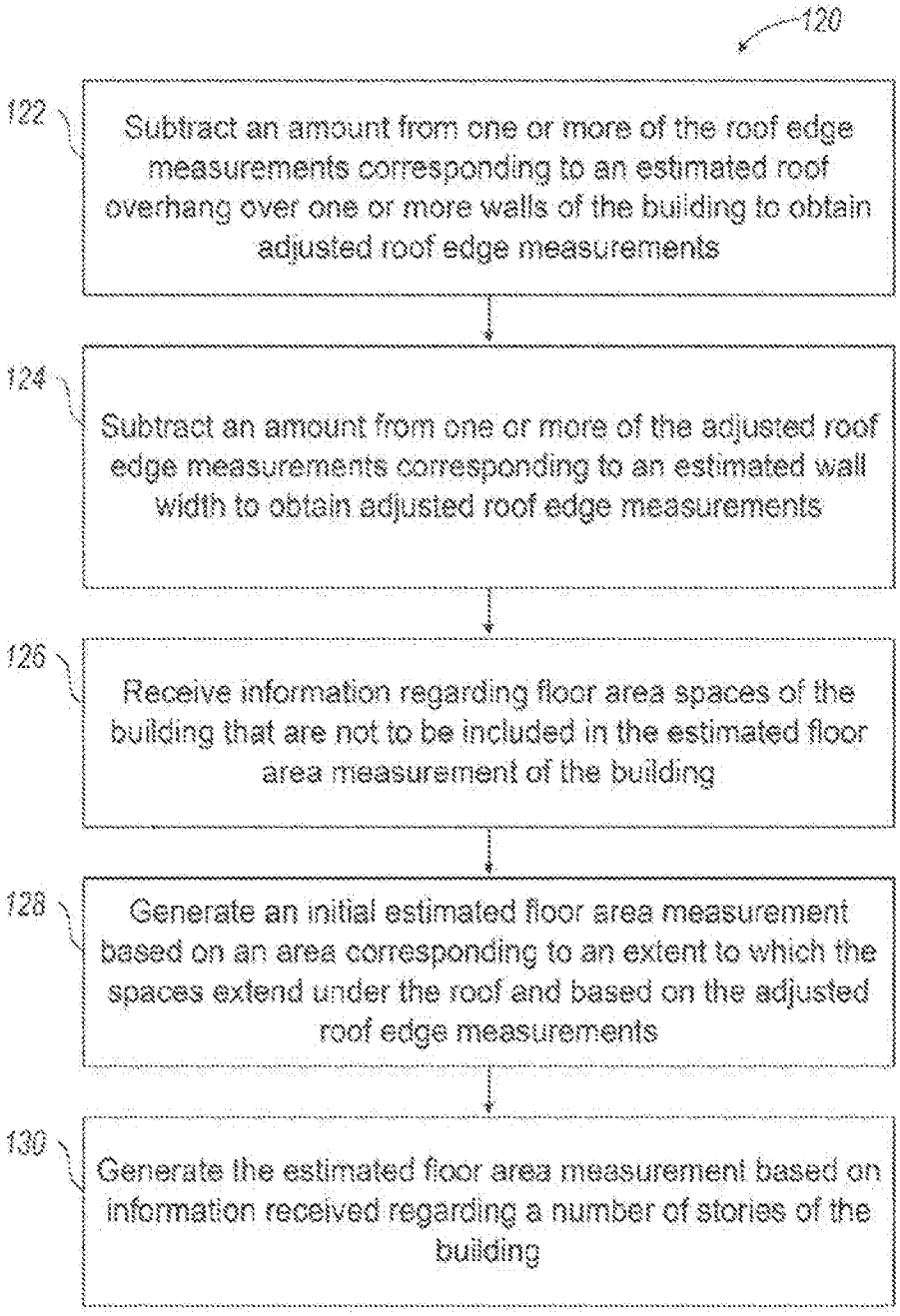

120
122
Subtract an amount from one or more of the roof edge measurements corresponding to an estimated roof overhang over one or more walls of the building to obtain adjusted roof edge measurements
124
Subtract an amount from one or more of the adjusted roof edge measurements corresponding to an estimated wall width to obtain adjusted roof edge measurements
126
Receive information regarding floor area spaces of the building that are not to be included in the estimated floor area measurement of the building
128
Generate an initial estimated floor area measurement based on an area corresponding to an extent to which the spaces extend under the roof and based on the adjusted roof edge measurements
130
Generate the estimated floor area measurement based on information received regarding a number of stories of the building

Fig. 1C

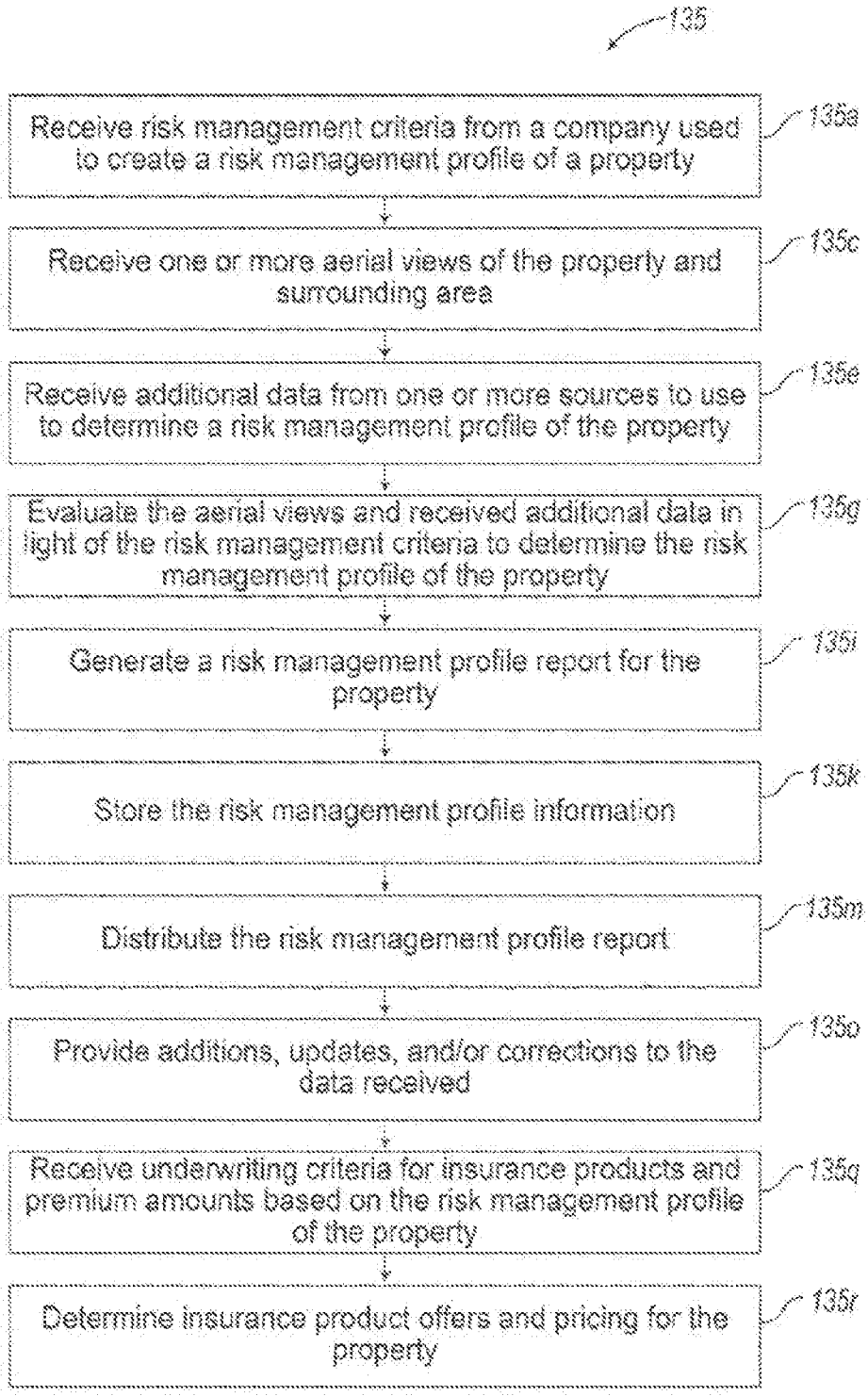

135
Receive risk management criteria from a company used to create a risk management profile of a property
135a
Receive one or more aerial views of the property and surrounding area
135c
Receive additional data from one or more sources to use to determine a risk management profile of the property
135e
Evaluate the aerial views and received additional data in light of the risk management criteria to determine the risk management profile of the property
135g
Generate a risk management profile report for the property
135i
Store the risk management profile information
135k
Distribute the risk management profile report
135m
Provide additions, updates, and/or corrections to the data received
135o
Receive underwriting criteria for insurance products and premium amounts based on the risk management profile of the property
135q
Determine insurance product offers and pricing for the property
135r

Fig. 1D

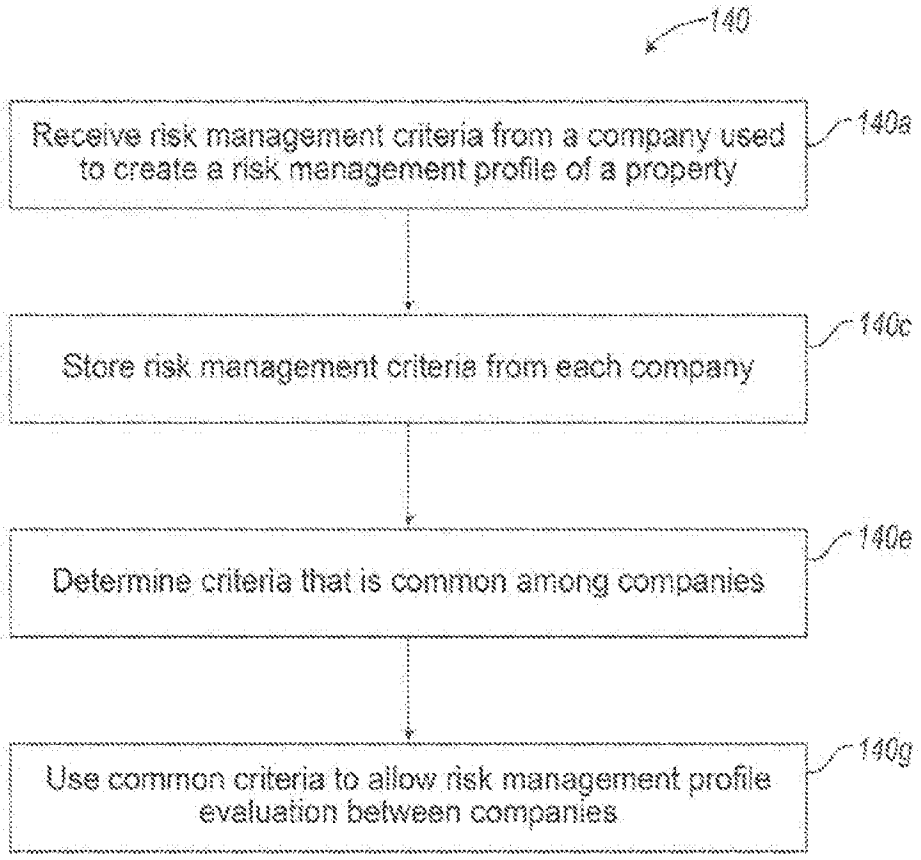

140
Receive risk management criteria from a company used to create a risk management profile of a property
140a
Store risk management criteria from each company
140c
Determine criteria that is common among companies
140e
Use common criteria to allow risk management profile evaluation between companies
140g

Fig. 1E

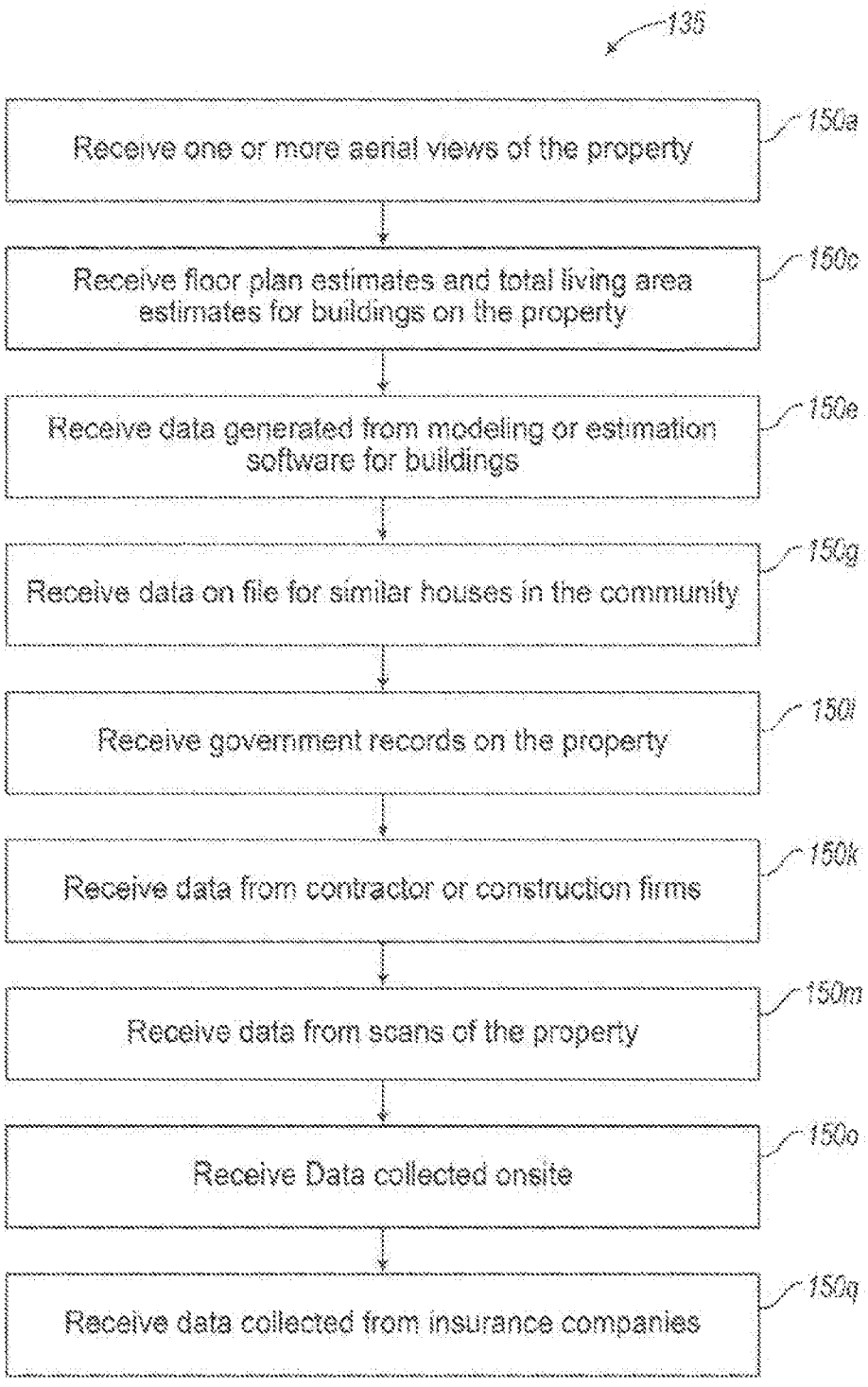

135
Receive one or more aerial views of the property
150a
Receive floor plan estimates and total living area estimates for buildings on the property
150c
Receive data generated from modeling or estimation software for buildings
150e
Receive data on file for similar houses in the community
150g
Receive government records on the property
150i
Receive data from contractor or construction firms
150k
Receive data from scans of the property
150m
Receive Data collected onsite
150o
Receive data collected from insurance companies
150q

Fig. 1F

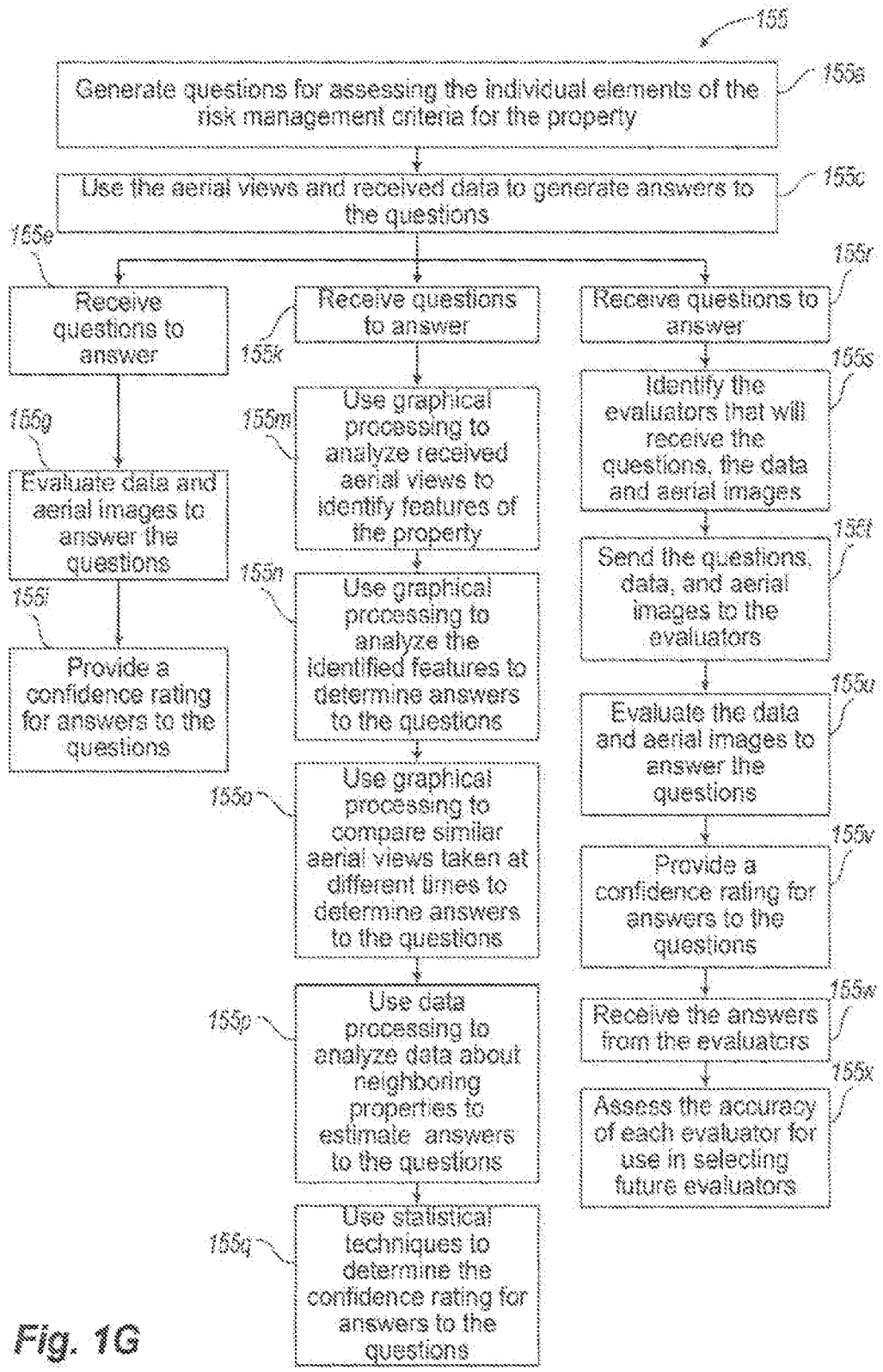

155
Generate questions for assessing the individual elements of the risk management criteria for the property
155a
Use the aerial views and received data to generate answers to the questions
155c
155e
Receive questions to answer
155g
Evaluate data and aerial images to answer the questions
155i
Provide a confidence rating for answers to the questions
Receive questions to answer
155k
155m
Use graphical processing to analyze received aerial views to identify features of the property
155n
Use graphical processing to analyze the identified features to determine answers to the questions
155o
Use graphical processing to compare similar aerial views taken at different times to determine answers to the questions
155p
Use data processing to analyze data about neighboring properties to estimate answers to the questions
155q
Use statistical techniques to determine the confidence rating for answers to the questions
155r
Receive questions to answer
155s
Identify the evaluators that will receive the questions, the data and aerial images
155t
Send the questions, data, and aerial images to the evaluators
155u
Evaluate the data and aerial images to answer the questions
155v
Provide a confidence rating for answers to the questions
155w
Receive the answers from the evaluators
155x
Assess the accuracy of each evaluator for use in selecting future evaluators

Fig. 1G

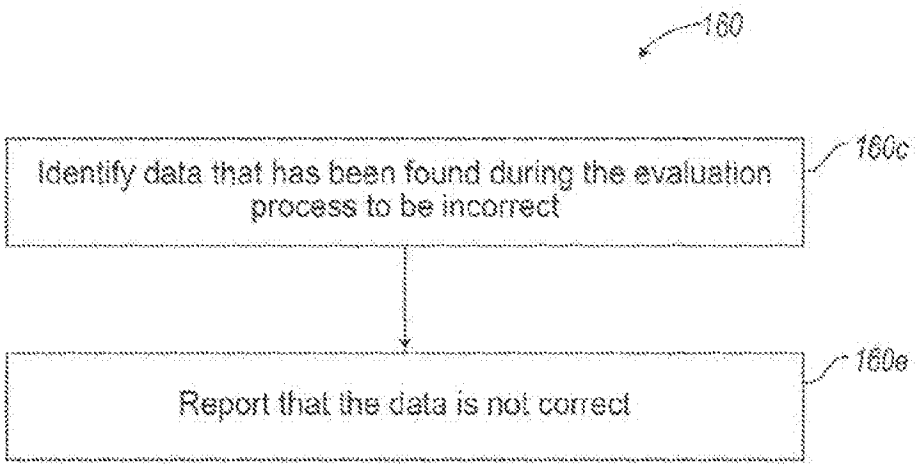

160
Identify data that has been found during the evaluation process to be incorrect
160c
Report that the data is not correct
160e

Fig. 1H

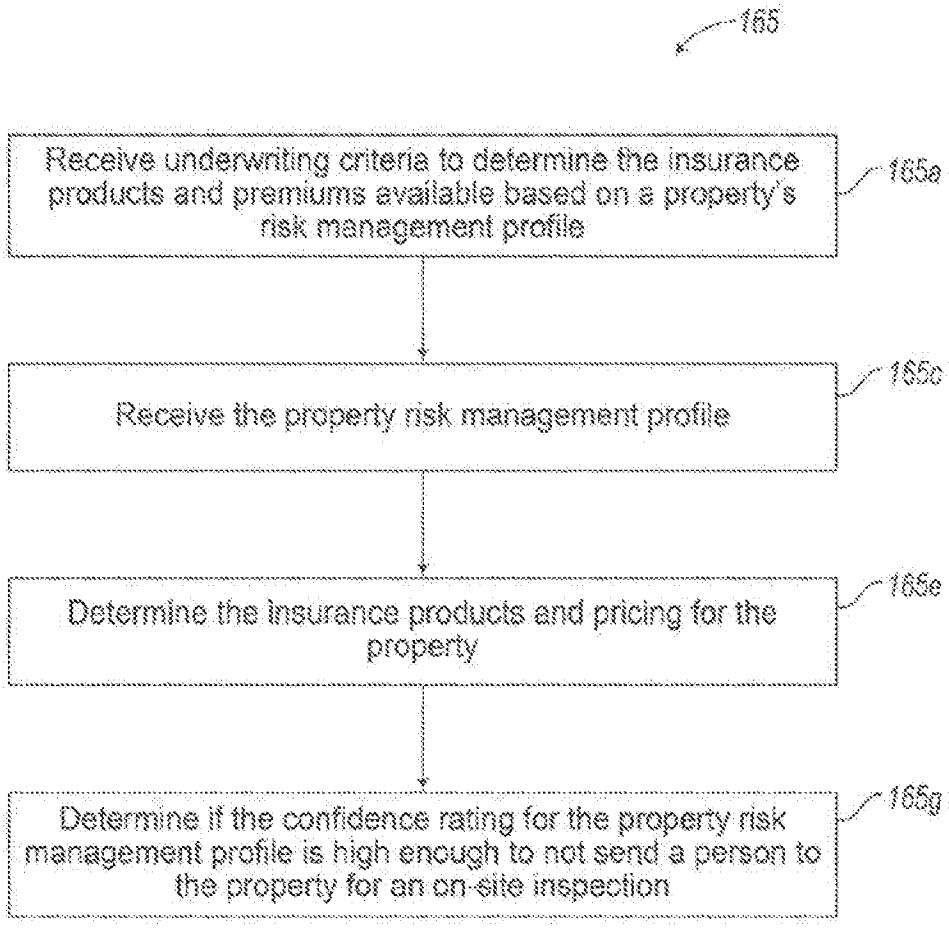

165
Receive underwriting criteria to determine the insurance products and premiums available based on a property's risk management profile
165a
Receive the property risk management profile
165c
Determine the insurance products and pricing for the property
165e
Determine if the confidence rating for the property risk management profile is high enough to not send a person to the property for an on-site inspection
165g

Fig. 11

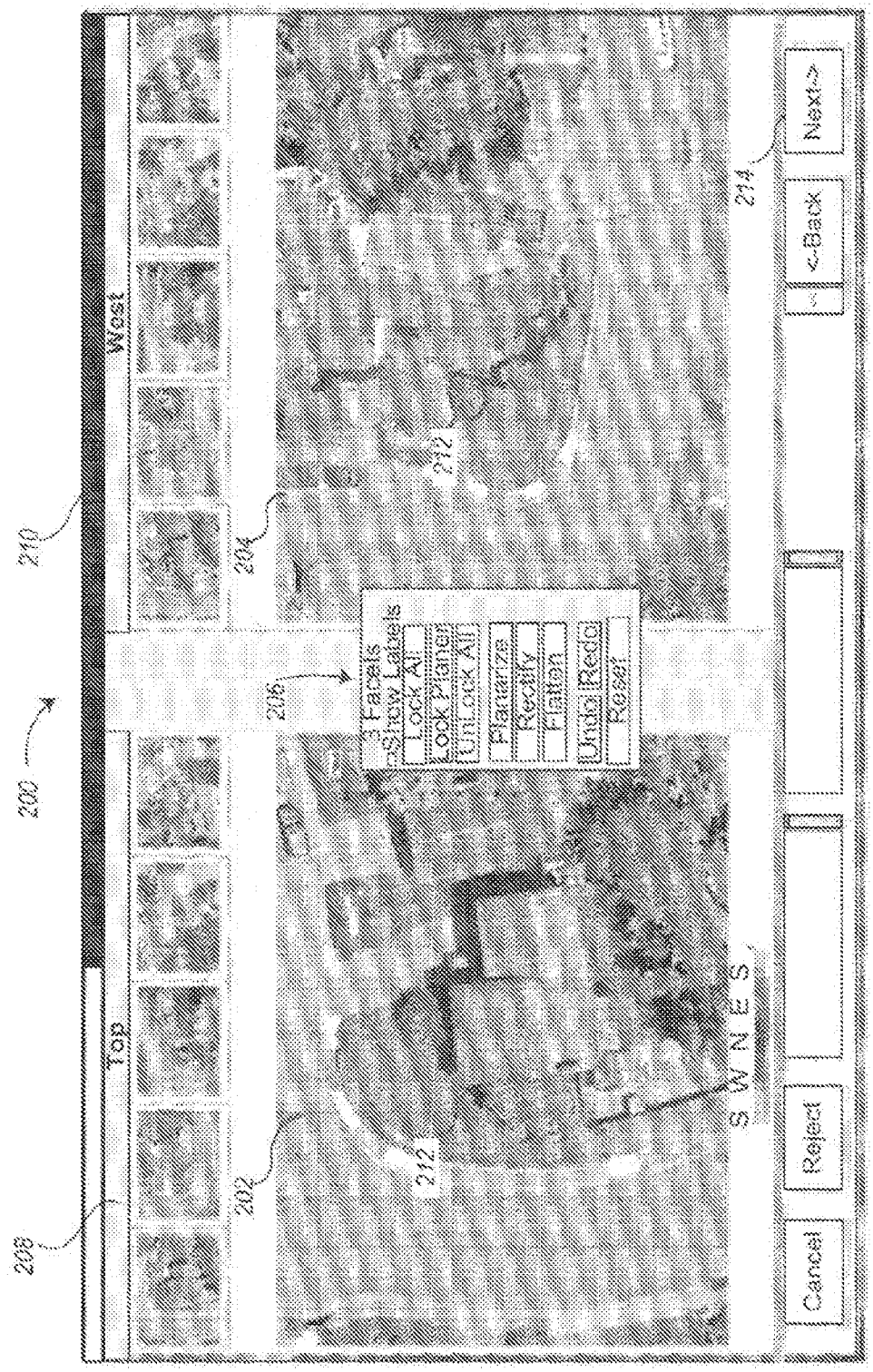

West
Top
Facets
Show Labels
Lock All
Lock Planer
UnLock All
Planarize
Rectify
Flatten
Undo Redo
Reset
Cancel
Reject
<-Back
Next->
S W N E S
200
202
204
206
208
210
212
214

Fig. 2

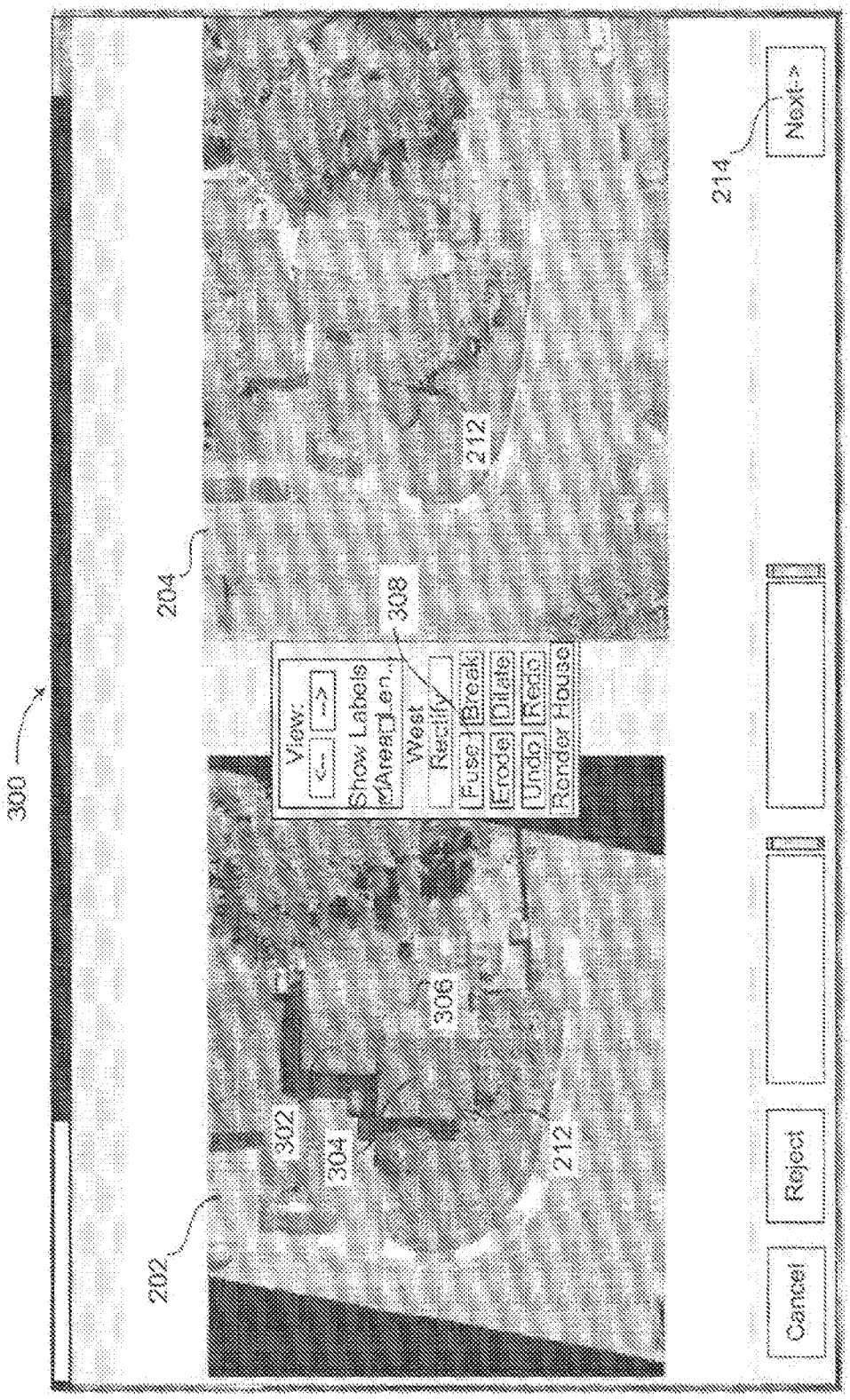

300
202
204
212
214
302
304
306
308
212
View:
<-
->
Show Labels
Area
Len.
West
Rectify
Fuse
Break
Erode
Dilate
Undo
Redo
Render House
Cancel
Reject
Next->
212

Fig. 3

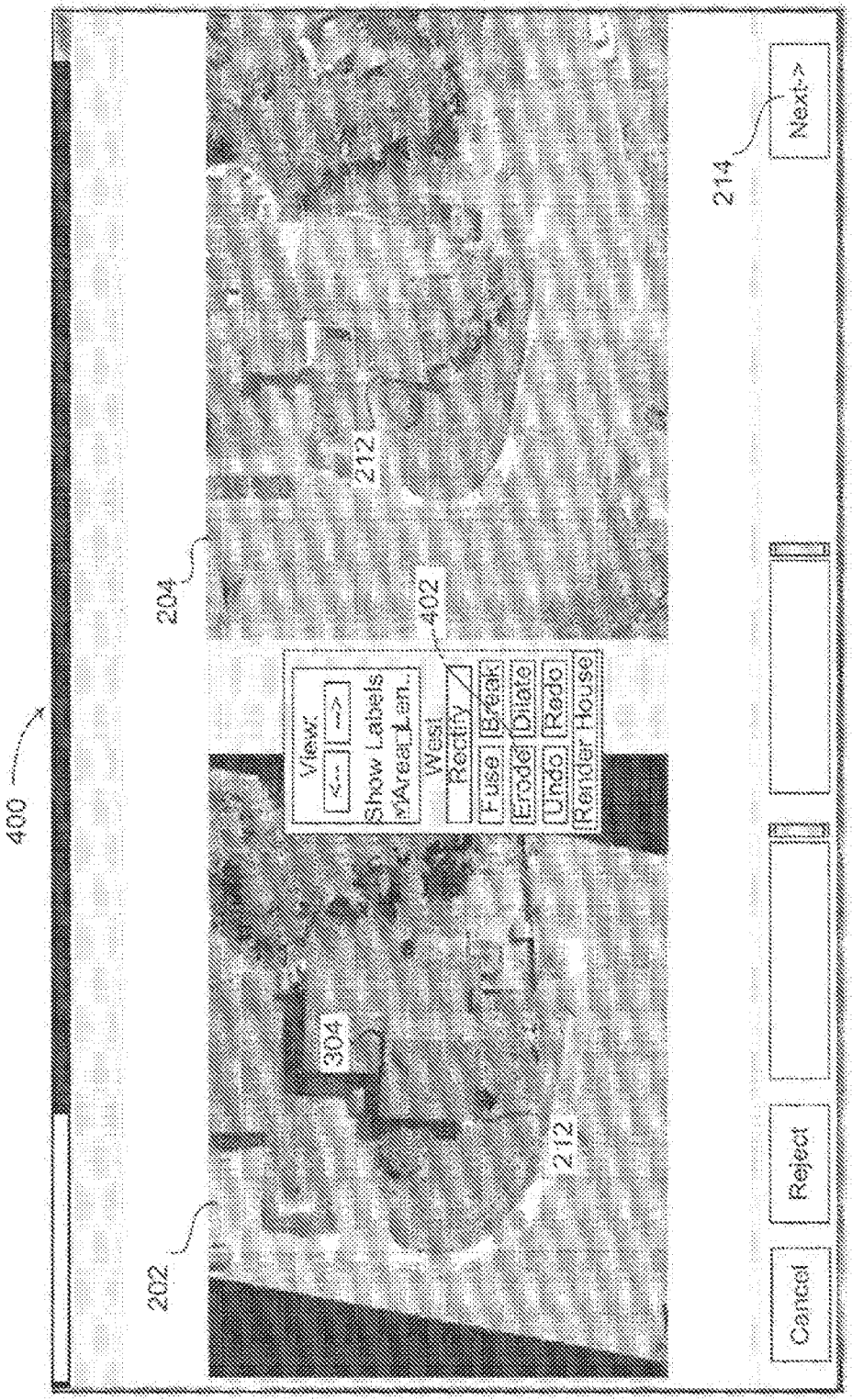
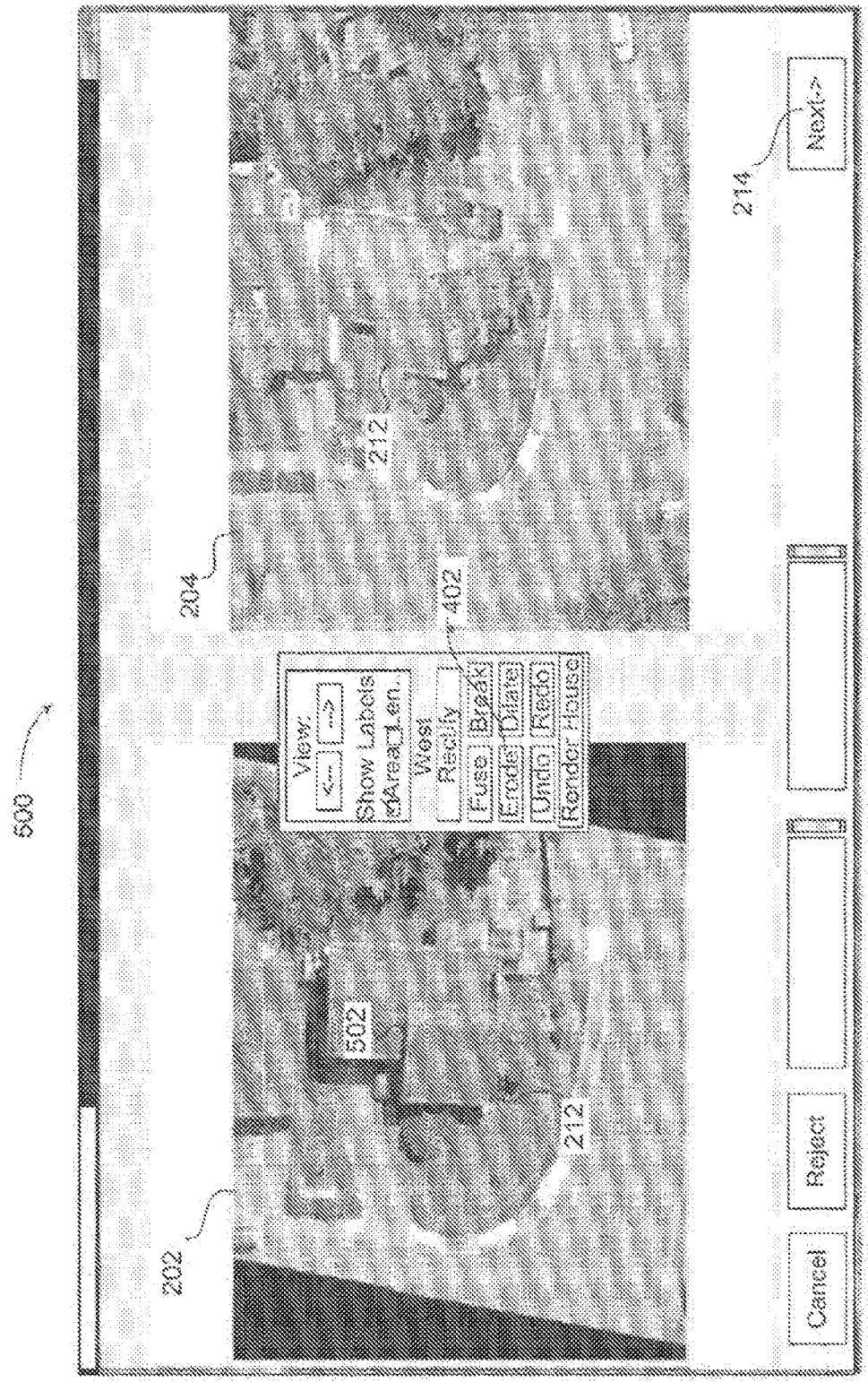

400
202
204
212
304
212
402
View
<--
-->
Show Labels
Area Len..
West
Rectify
Fuse
Break
Erode
Dilate
Undo
Redo
Render House
214
Next->
Cancel
Reject

Fig. 4


600
202
204
212
212
502
402
214
View:
<--
-->
Show Labels
Area
Len.
West
Rectify
Fuse
Break
Erode
Dilate
Undo
Redo
Render House
Cancel
Reject
Next->
Fig. 5

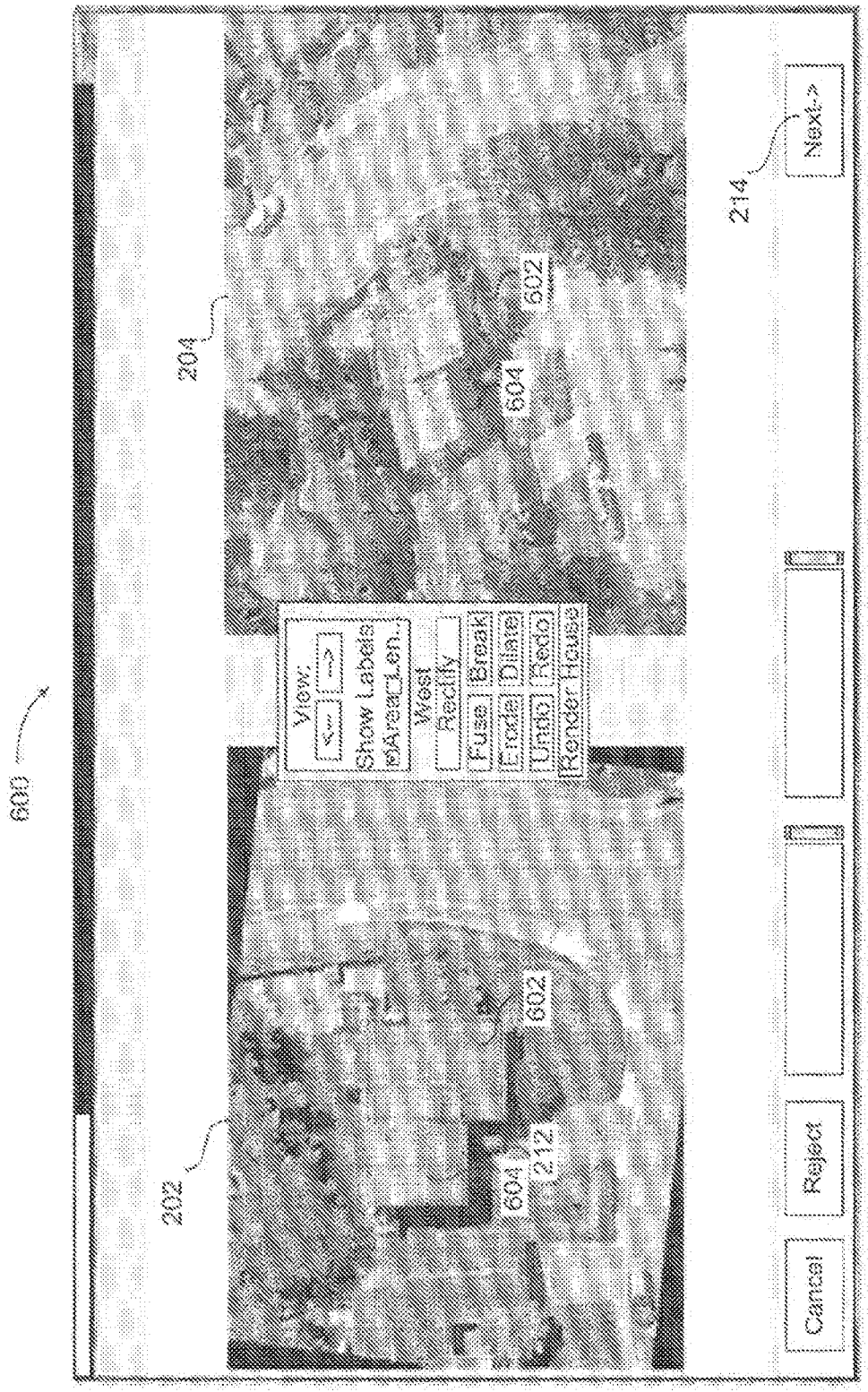

600
202
204
212
214
602
604
View:
<--
-->
Show Labels
AreaLen...
West
Rectify
Fuse
Break
Erode
Dilate
Undo
Redo
Render House
Cancel
Reject
Next->
604
602

Fig. 6

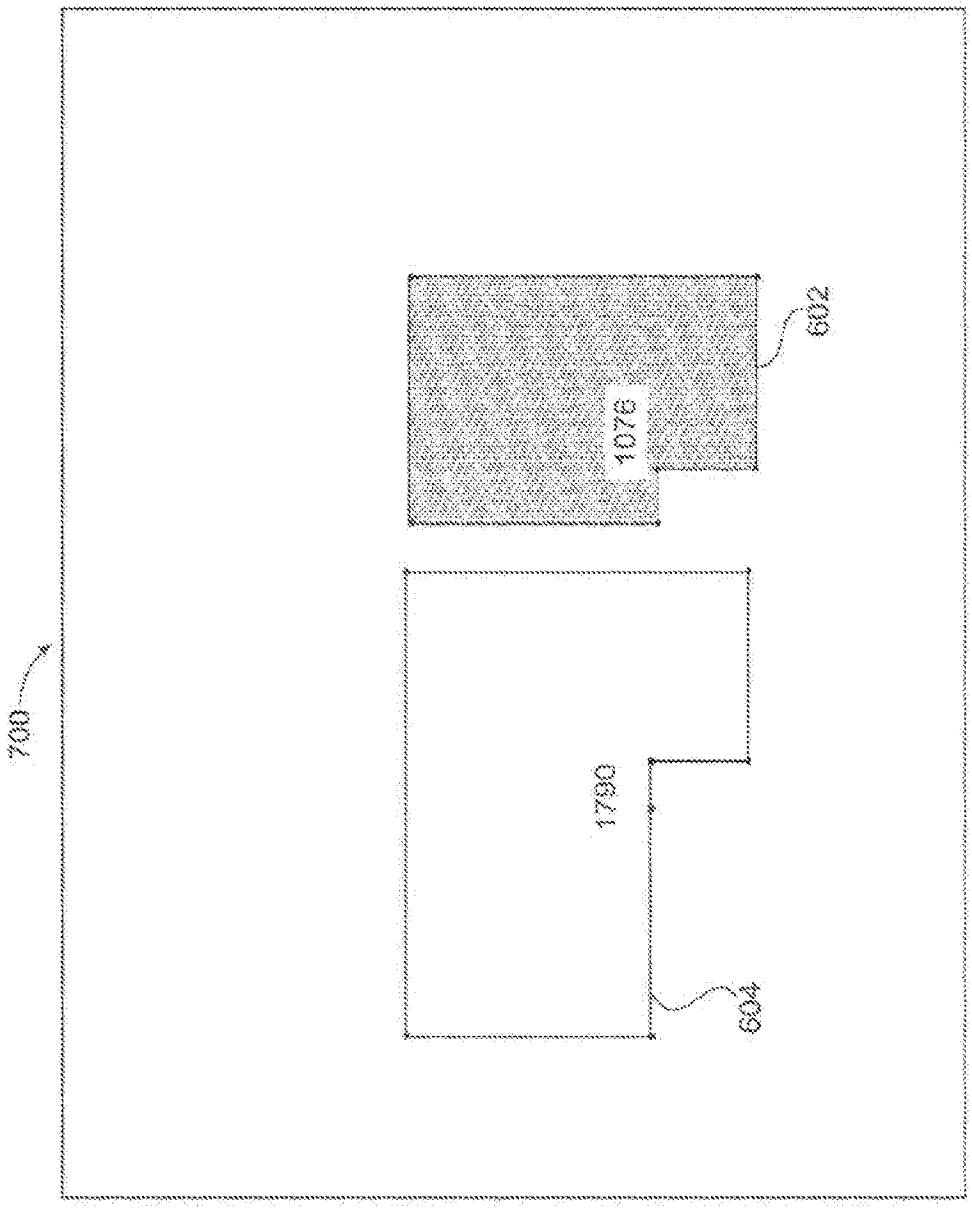


Fig. 7

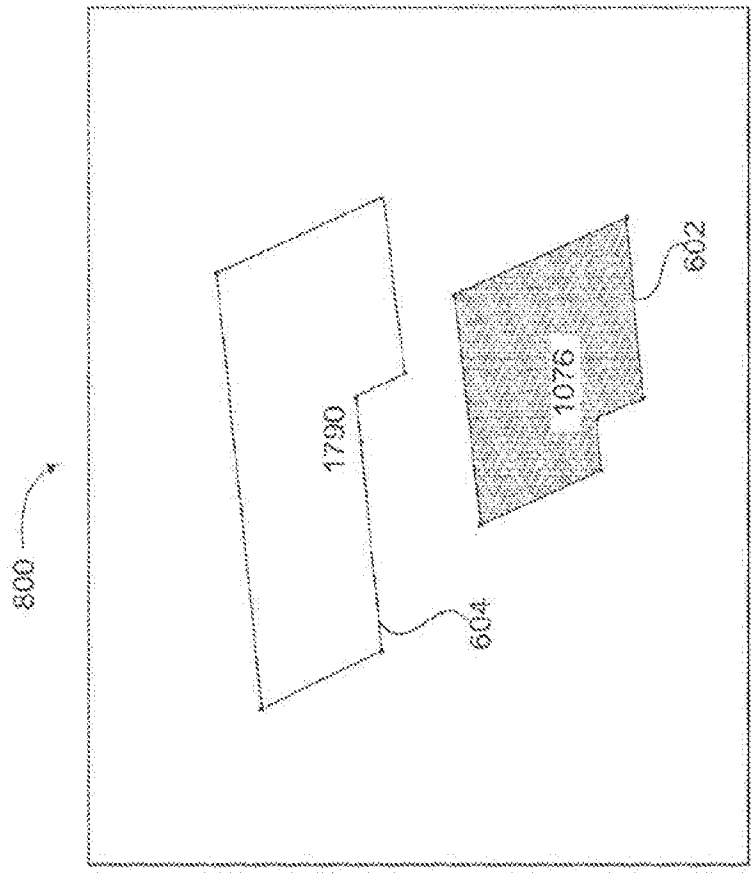


Fig. 8

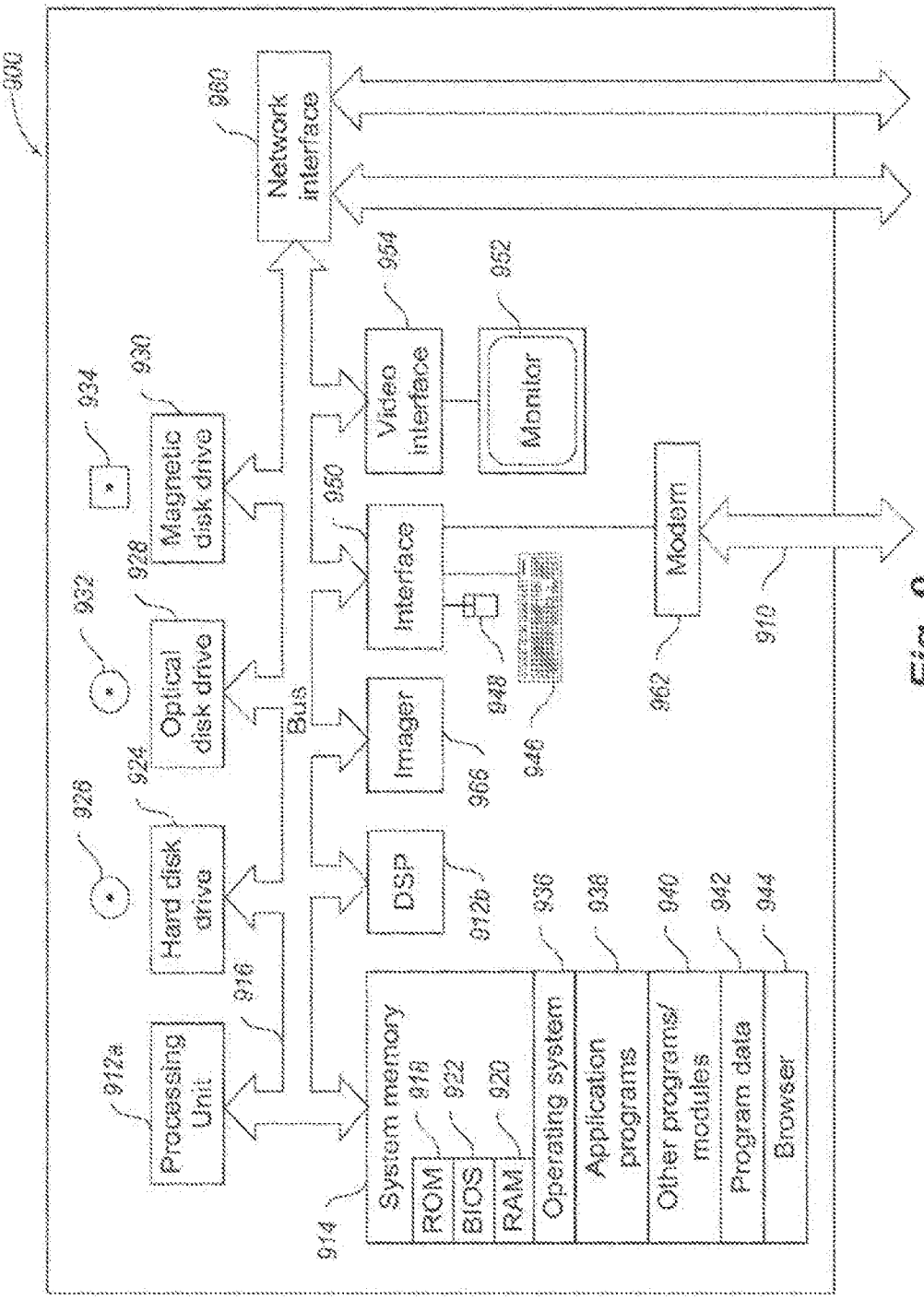

900
912a
Processing Unit
914
System memory
ROM 918
BIOS 922
RAM 920
916
Hard disk drive
924
928
Optical disk drive
926
932
Magnetic disk drive
930
934
Bus
DSP
912b
Imager
966
Interface
950
948
946
Video interface
954
Monitor
952
Modem
962
Network interface
960
910
Operating system 936
Application programs 938
Other programs/ modules 940
Program data 942
Browser 944

Fig. 9

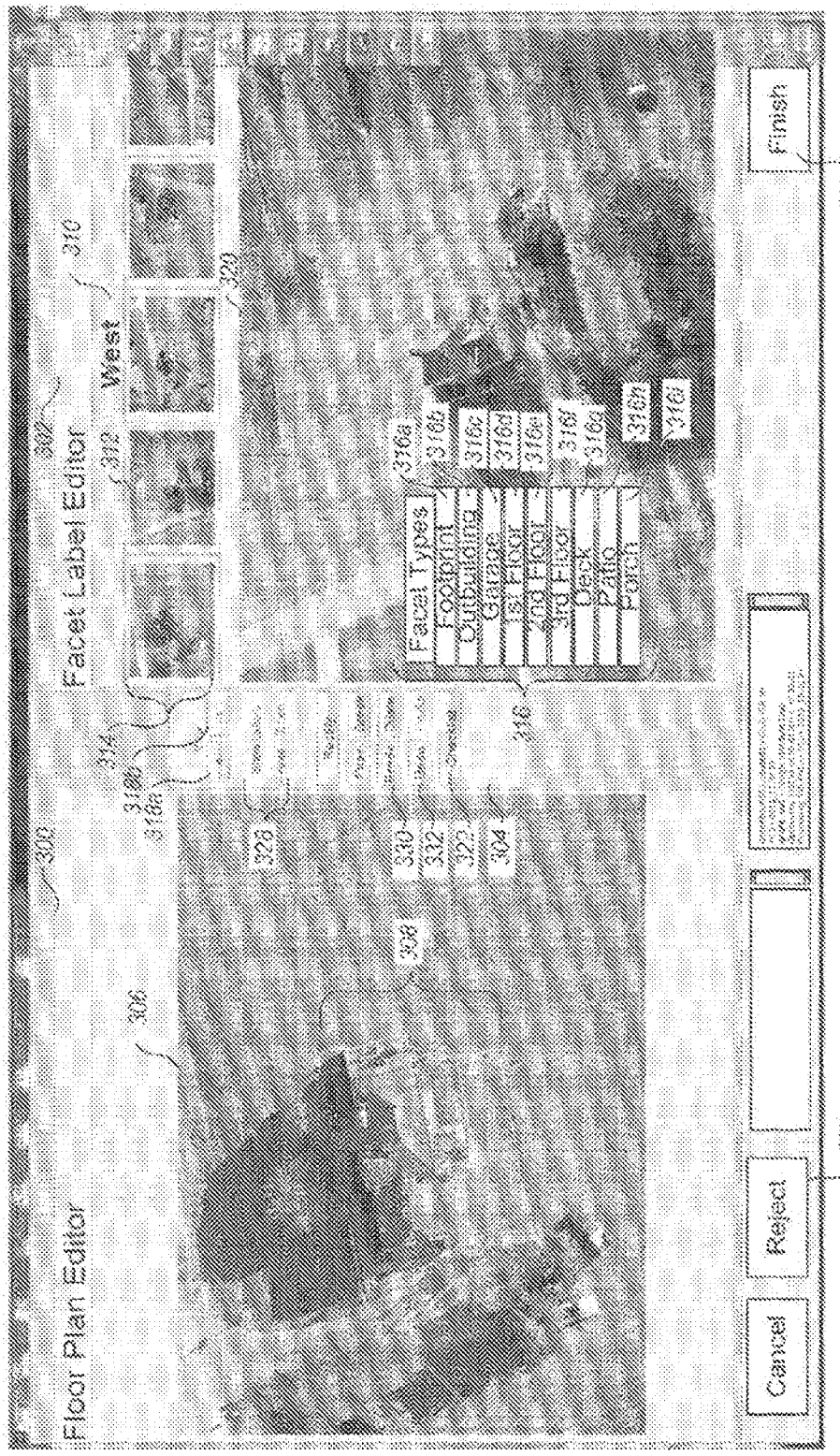

702
Floor Plan Editor
Facet Label Editor
West
Facet Types
Footprint
Outbuilding
Garage
1st Floor
2nd Floor
3rd Floor
Deck
Patio
Porch
Cancel
Reject
Finish
300
302
304
306
308
310
312
314
316a
316b
316c
316d
316e
316f
316g
316h
316i
320
322
324
326
328
330
332

Fig. 10

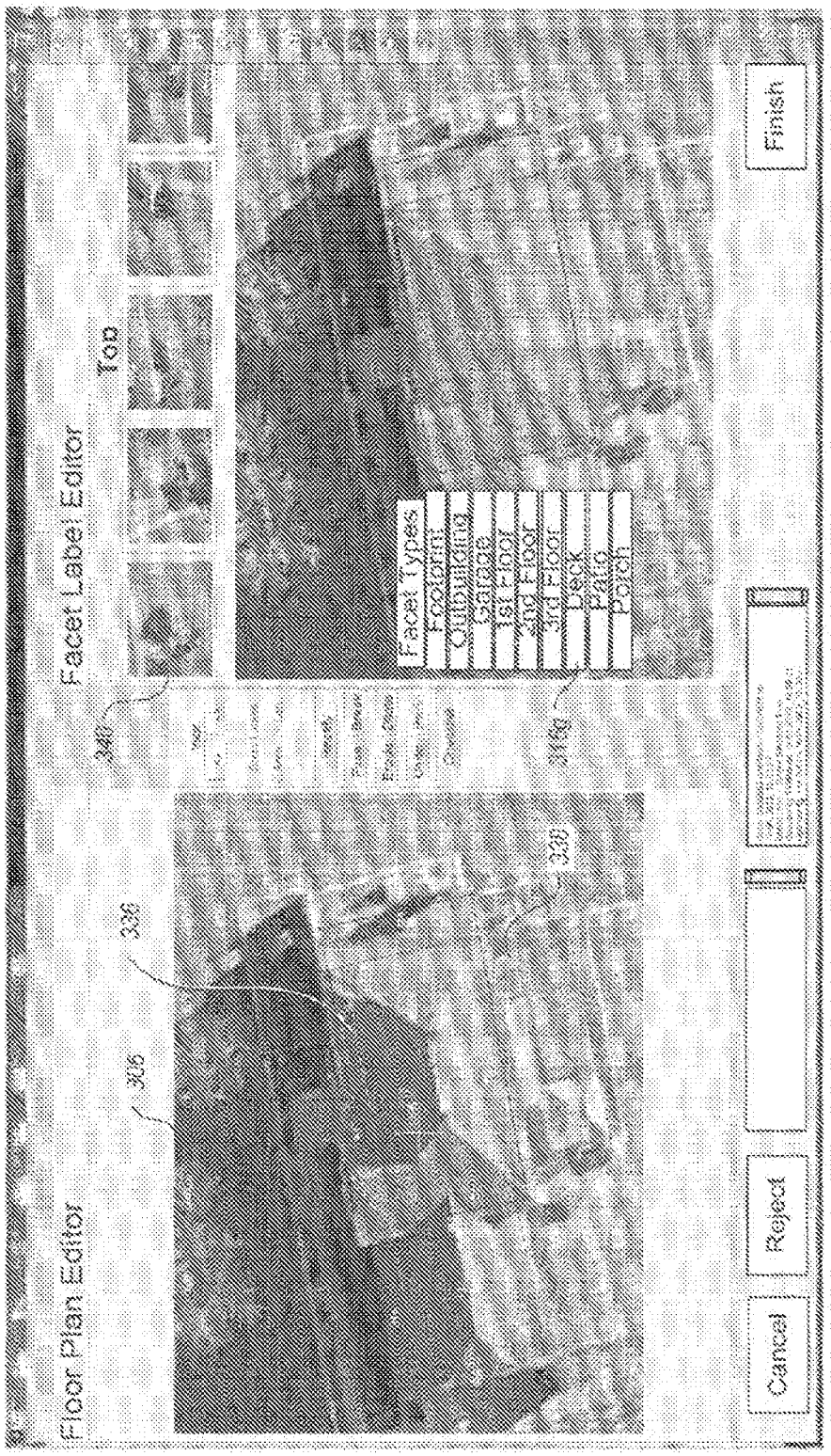

304
Facet Label Editor
Top
340
Facet Types
Footprint
Unfinished
Garage
1st Floor
2nd Floor
3rd Floor
Deck
Patio
Porch
310g
306
336
338
Floor Plan Editor
Cancel
Reject
Finish

Fig. 11

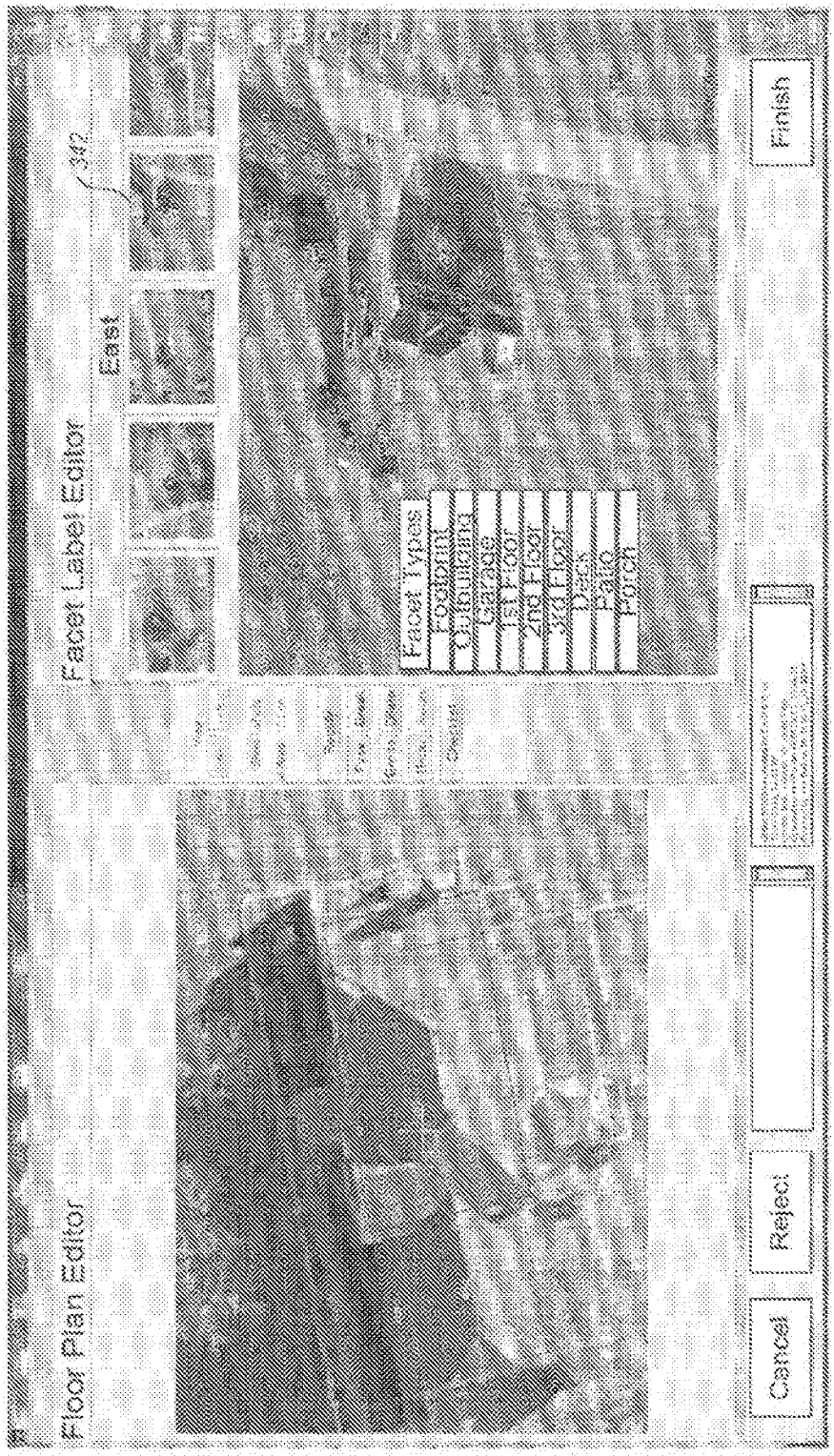

706
342
Facet Label Editor
East
Facet Types
Footprint
Outbuilding
Garage
1st Floor
2nd Floor
3rd Floor
Deck
Patio
Porch
Floor Plan Editor
Cancel
Reject
Finish

Fig. 12

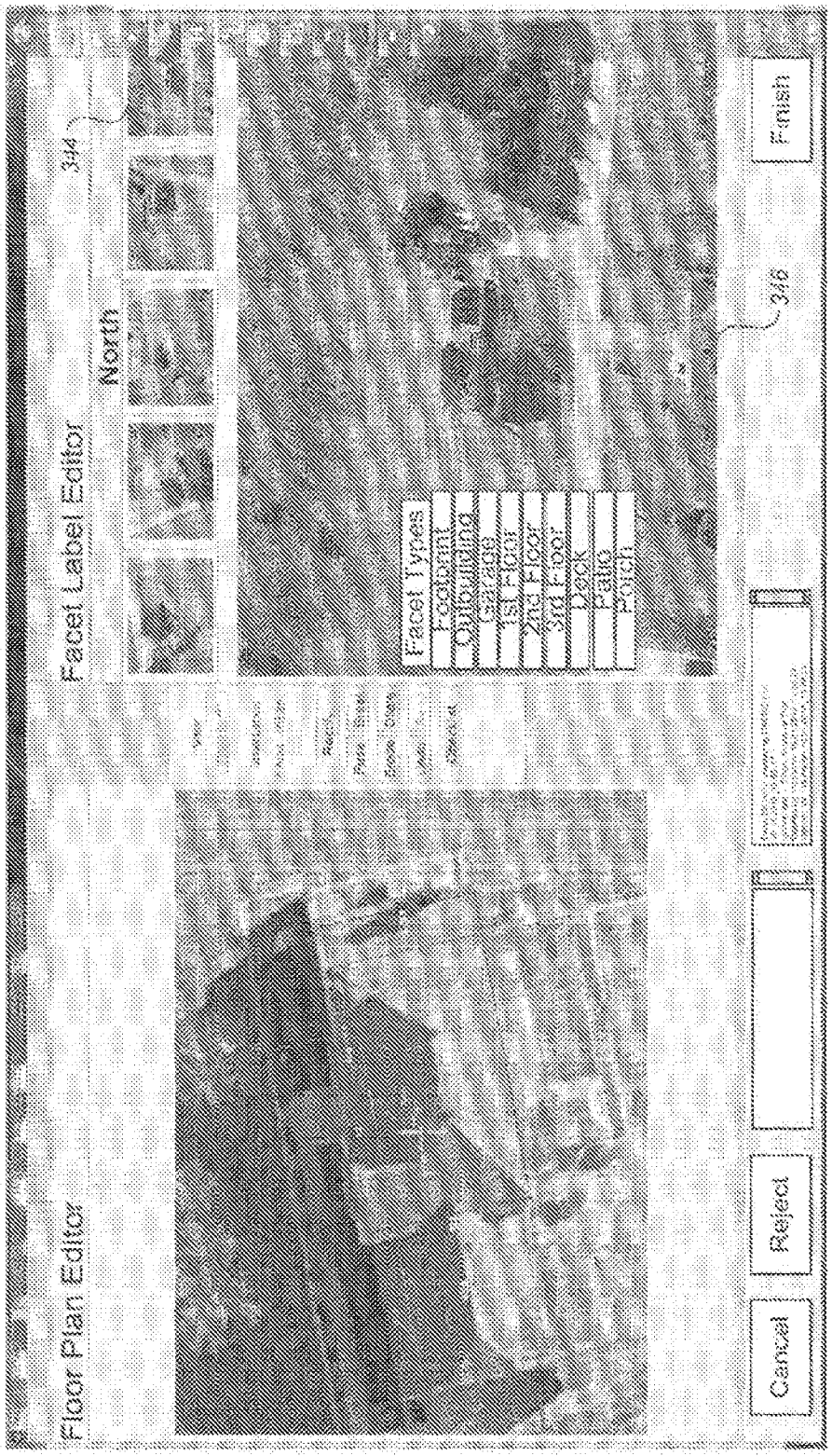

708
344
Facet Label Editor
North
Facet Types
Footprint
Outbuilding
Garage
1st Floor
2nd Floor
3rd Floor
Deck
Patio
Porch
Floor Plan Editor
346
Cancel
Reject
Finish

Fig. 13

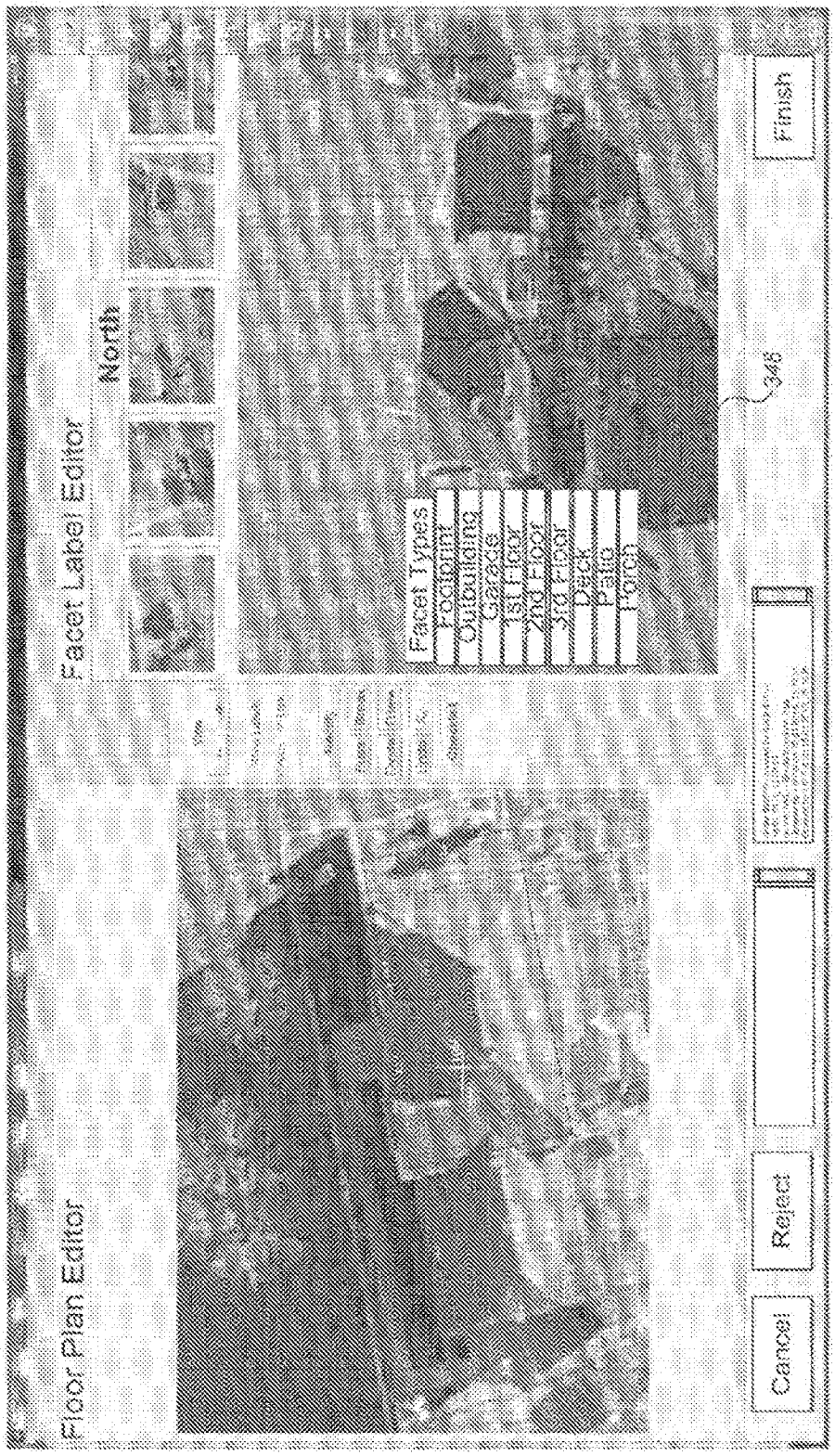

710
Floor Plan Editor
Facet Label Editor
North
Facet Types
Footprint
Outbuilding
Garage
1st Floor
2nd Floor
3rd Floor
Deck
Patio
Porch
345
Cancel
Reject
Finish

Fig. 14

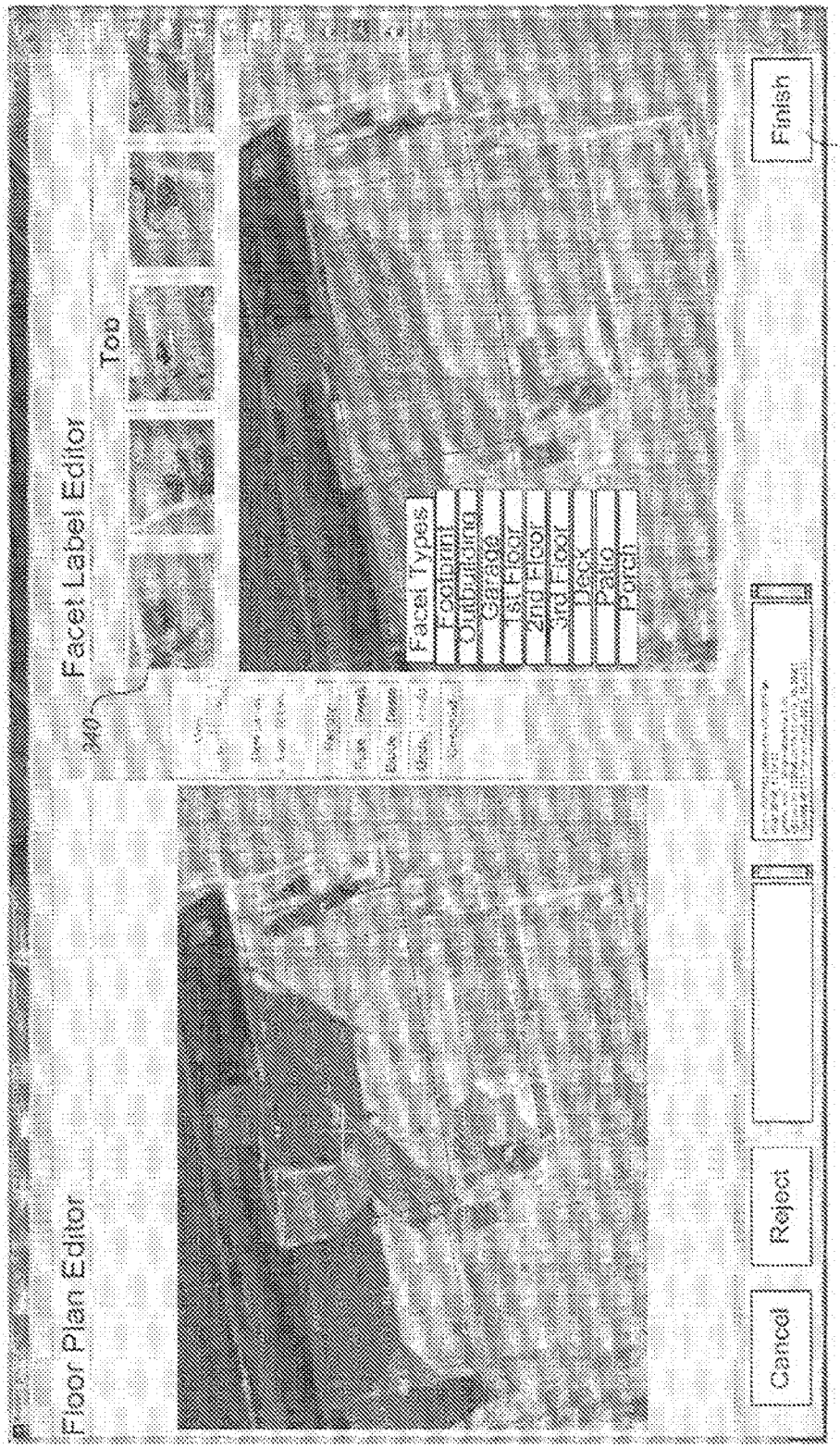

712
Floor Plan Editor
Facet Label Editor
Too
240
Facet Types
Footprint
Outbuilding
Garage
1st Floor
2nd Floor
3rd Floor
Deck
Patio
Porch
Cancel
Reject
Finish
326

Fig. 15

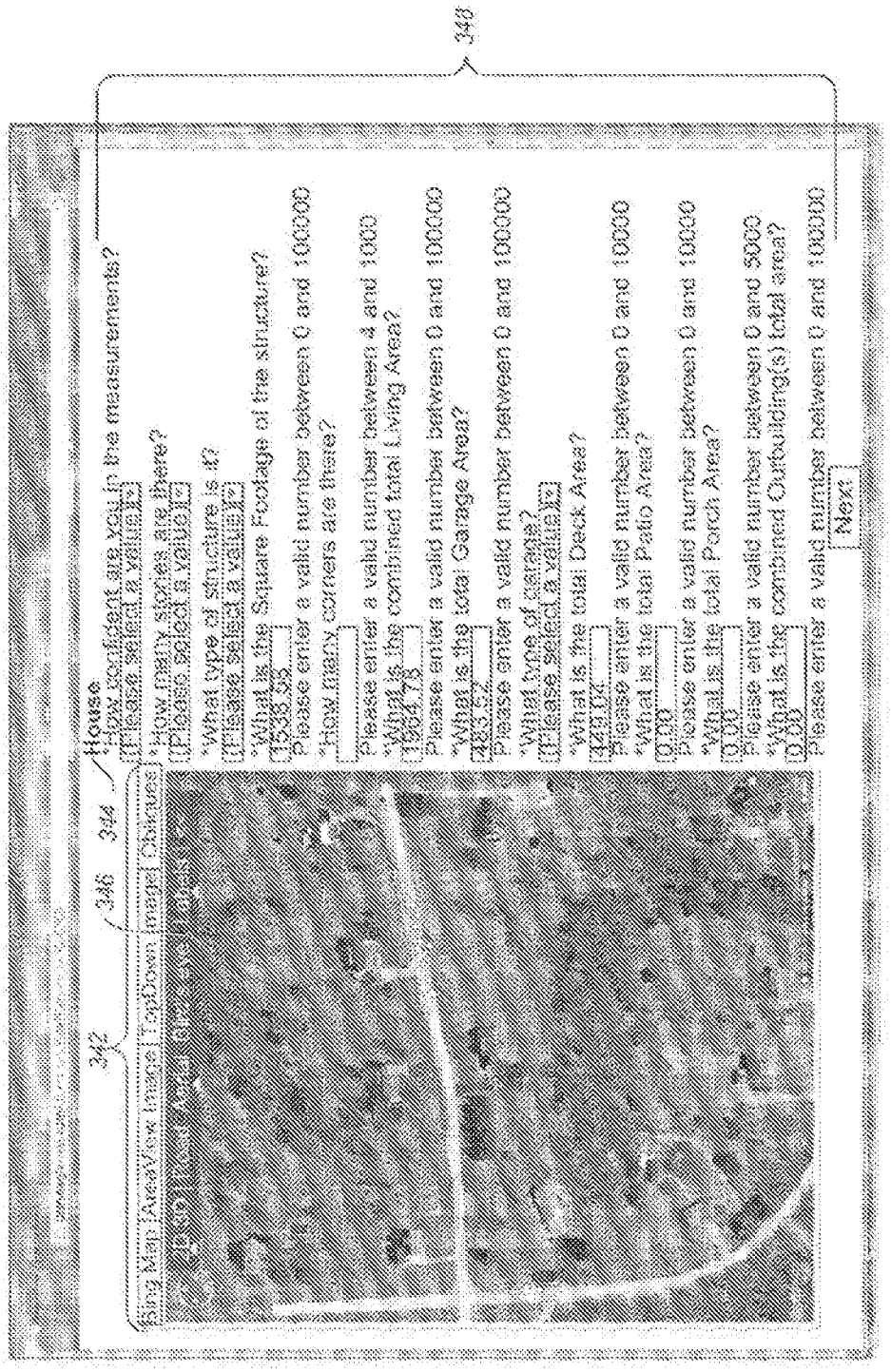

714
342
346
344
348
Bing Map | Aerial View | Image | Bird's Eye | Street Side | Oblique
House
How confident are you in the measurements?
Please select a value
*How many stories are there?
Please select a value
*What type of structure is it?
Please select a value
*What is the Square Footage of the structure?
1533.35
Please enter a valid number between 0 and 100000
*How many corners are there?
Please enter a valid number between 4 and 1000
*What is the combined total Living Area?
1504.78
Please enter a valid number between 0 and 100000
*What is the total Garage Area?
462.42
Please enter a valid number between 0 and 100000
*What type of garage?
Please select a value
*What is the total Deck Area?
320.72
Please enter a valid number between 0 and 10000
*What is the total Patio Area?
0.00
Please enter a valid number between 0 and 10000
*What is the total Porch Area?
0.00
Please enter a valid number between 0 and 5000
*What is the combined Outbuilding(s) total area?
0.00
Please enter a valid number between 0 and 100000
Next

Fig. 16

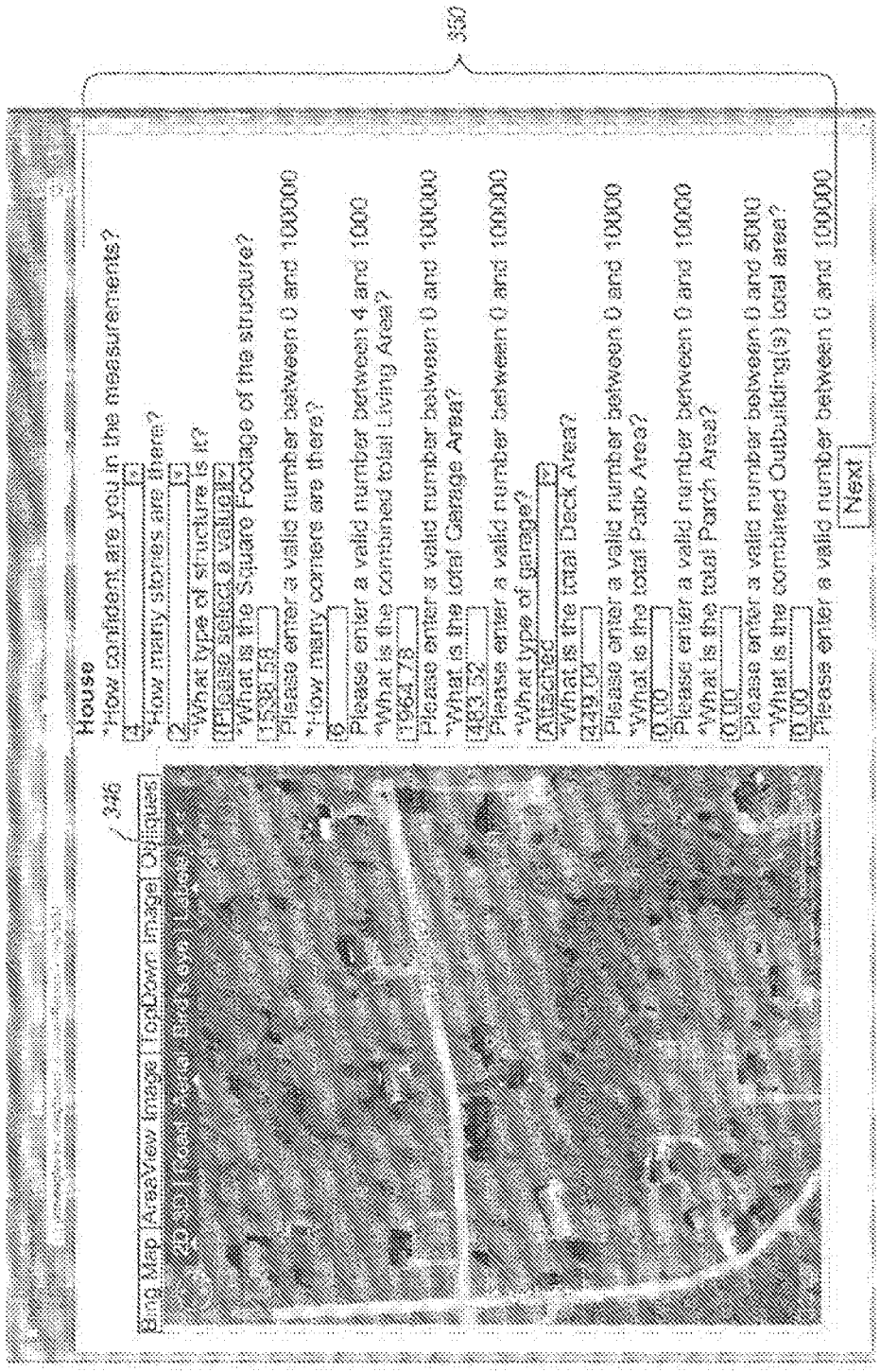

716
330
346
Bing Map | AreaView Image | TopDown Image | Obliques
House
*How confident are you in the measurements?
5
*How many stories are there?
2
*What type of structure is it?
[Private Select a value]
*What is the Square Footage of the structure?
1,530.58
Please enter a valid number between 0 and 100000
*How many corners are there?
6
Please enter a valid number between 4 and 1000
*What is the combined total Living Area?
1,964.78
Please enter a valid number between 0 and 100000
*What is the total Garage Area?
483.52
Please enter a valid number between 0 and 100000
*What type of garage?
Attached
*What is the total Deck Area?
0.00
Please enter a valid number between 0 and 10000
*What is the total Patio Area?
0.00
Please enter a valid number between 0 and 10000
*What is the total Porch Area?
0.00
Please enter a valid number between 0 and 5000
*What is the combined Outbuilding(s) total area?
0.00
Please enter a valid number between 0 and 100000
Next

Fig. 17

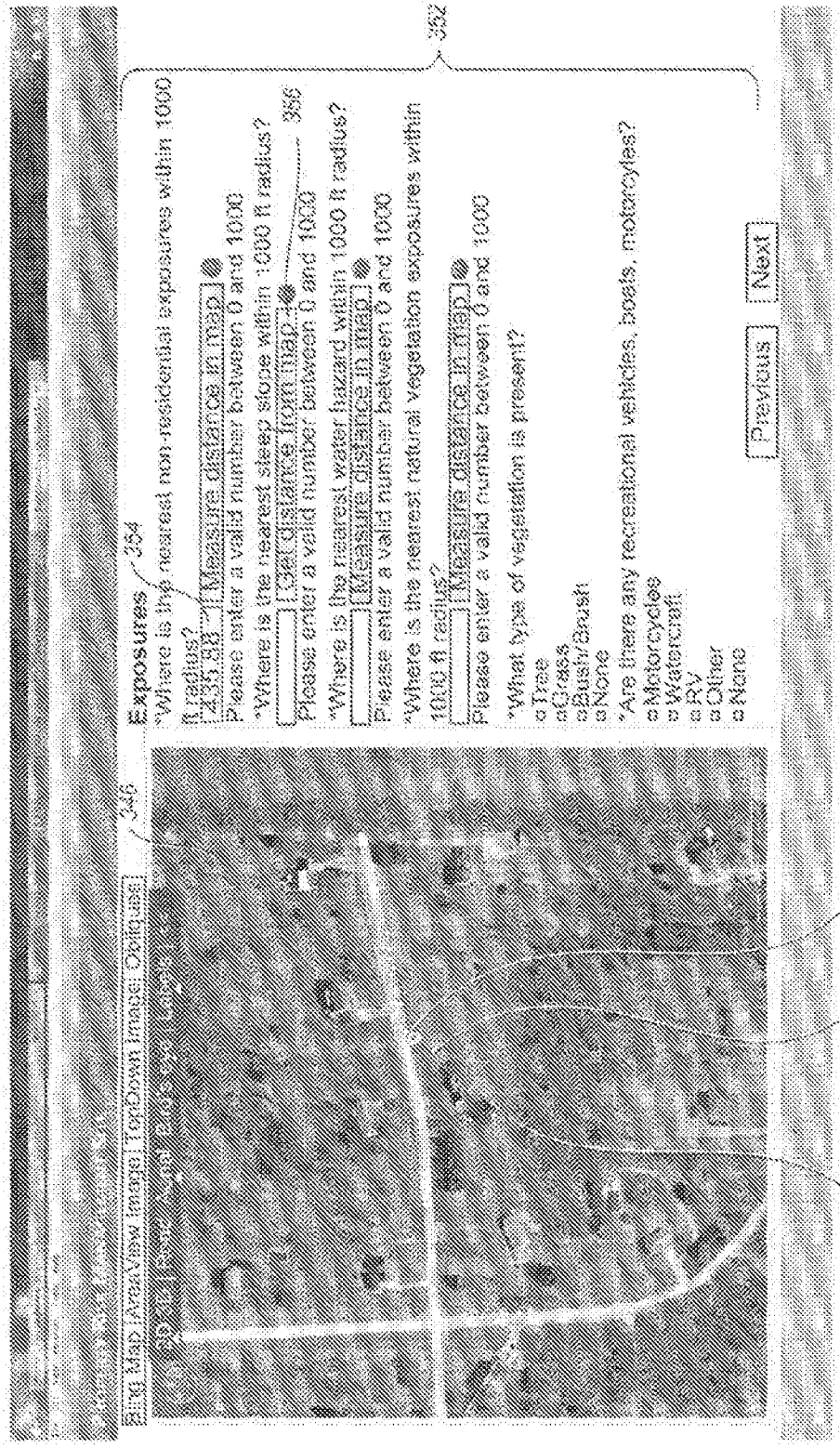

716
346
Bird Map Area View Image1 TopDown Image2 Oblique1
Exposures
354
*Where is the nearest non-residential exposures within 1000 ft radius?
Measure distance in map
Please enter a valid number between 0 and 1000
*Where is the nearest steep slope within 1000 ft radius?
Measure distance from map
356
Please enter a valid number between 0 and 1000
*Where is the nearest water hazard within 1000 ft radius?
Measure distance in map
Please enter a valid number between 0 and 1000
*Where is the nearest natural vegetation exposures within 1000 ft radius?
Measure distance in map
Please enter a valid number between 0 and 1000
*What type of vegetation is present?
Tree
Grass
Bush/Brush
None
*Are there any recreational vehicles, boats, motorcycles?
Motorcycles
Watercraft
RV
Other
None
Previous
Next
352
358
362
360

Fig. 18

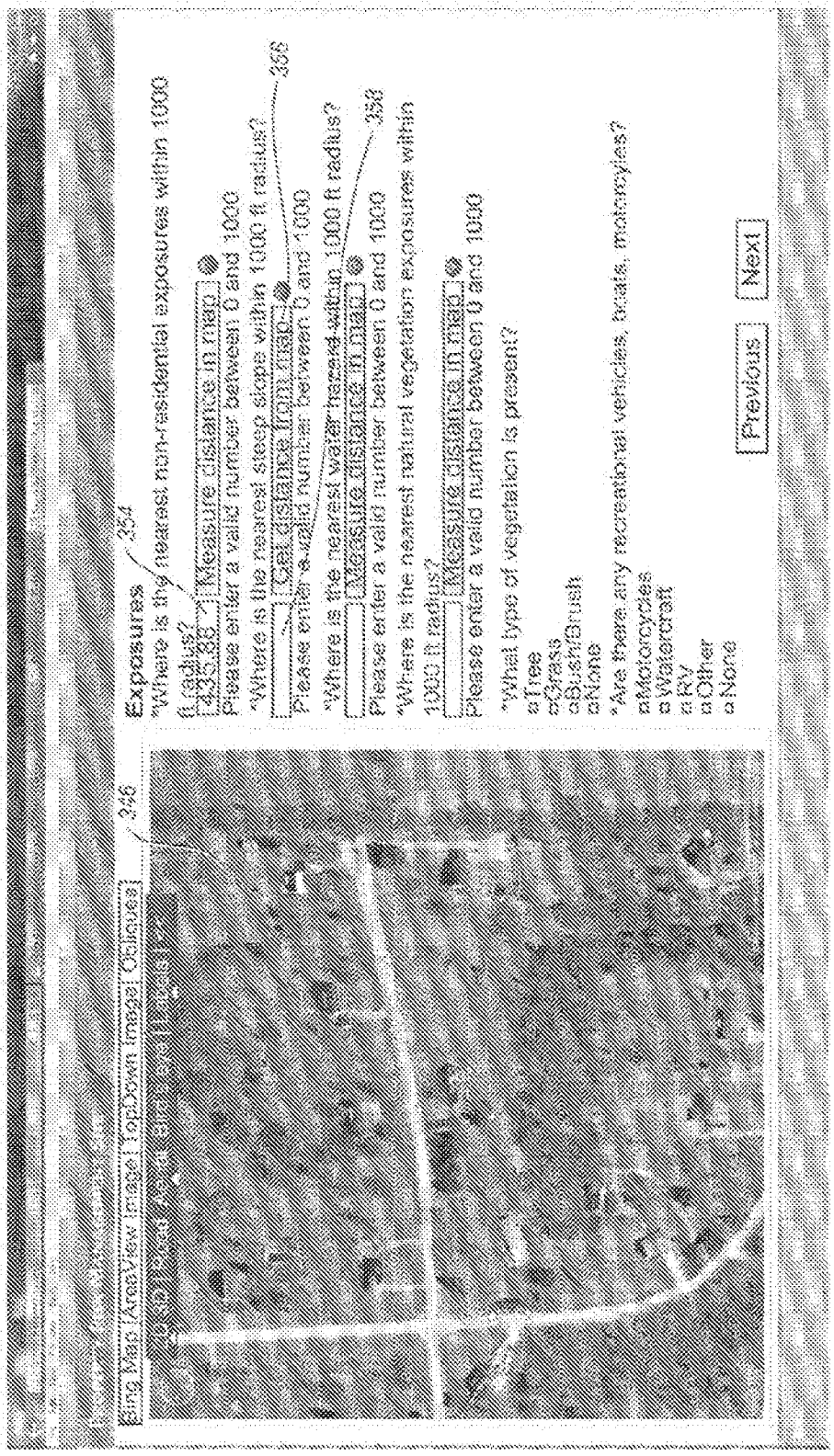

720
346
Bing Map | AreaView Image | TopDown Image | Obliques
Exposures
254
*Where is the nearest non-residential exposures within 1000 ft radius?
Measure distance in map
Please enter a valid number between 0 and 1000
356
*Where is the nearest steep slope within 1000 ft radius?
Get distance from map
Please enter a valid number between 0 and 1000
*Where is the nearest water hazard within 1000 ft radius?
Measure distance in map
358
Please enter a valid number between 0 and 1000
*Where is the nearest natural vegetation exposures within 1000 ft radius?
Measure distance in map
Please enter a valid number between 0 and 1000
*What type of vegetation is present?
Tree
Grass
Bush/Brush
None
*Are there any recreational vehicles, boats, motorcycles?
Motorcycles
Watercraft
RV
Other
None
Previous
Next

Fig. 19

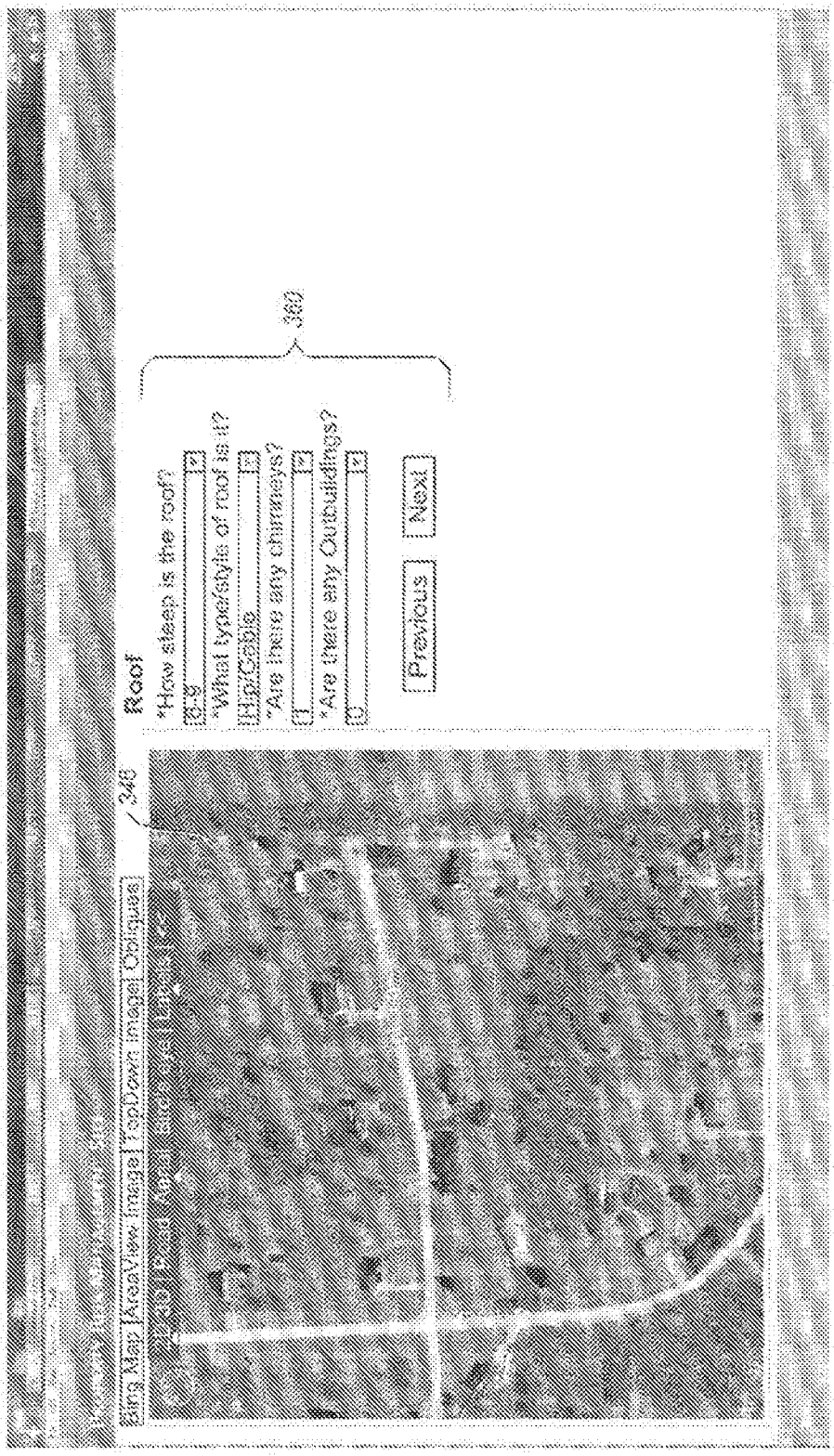

722
348
360
Bing Map
Roof
*How steep is the roof?
*What type/style of roof is it?
Hip/Gable
*Are there any chimneys?
*Are there any Outbuildings?
Previous
Next

Fig. 20

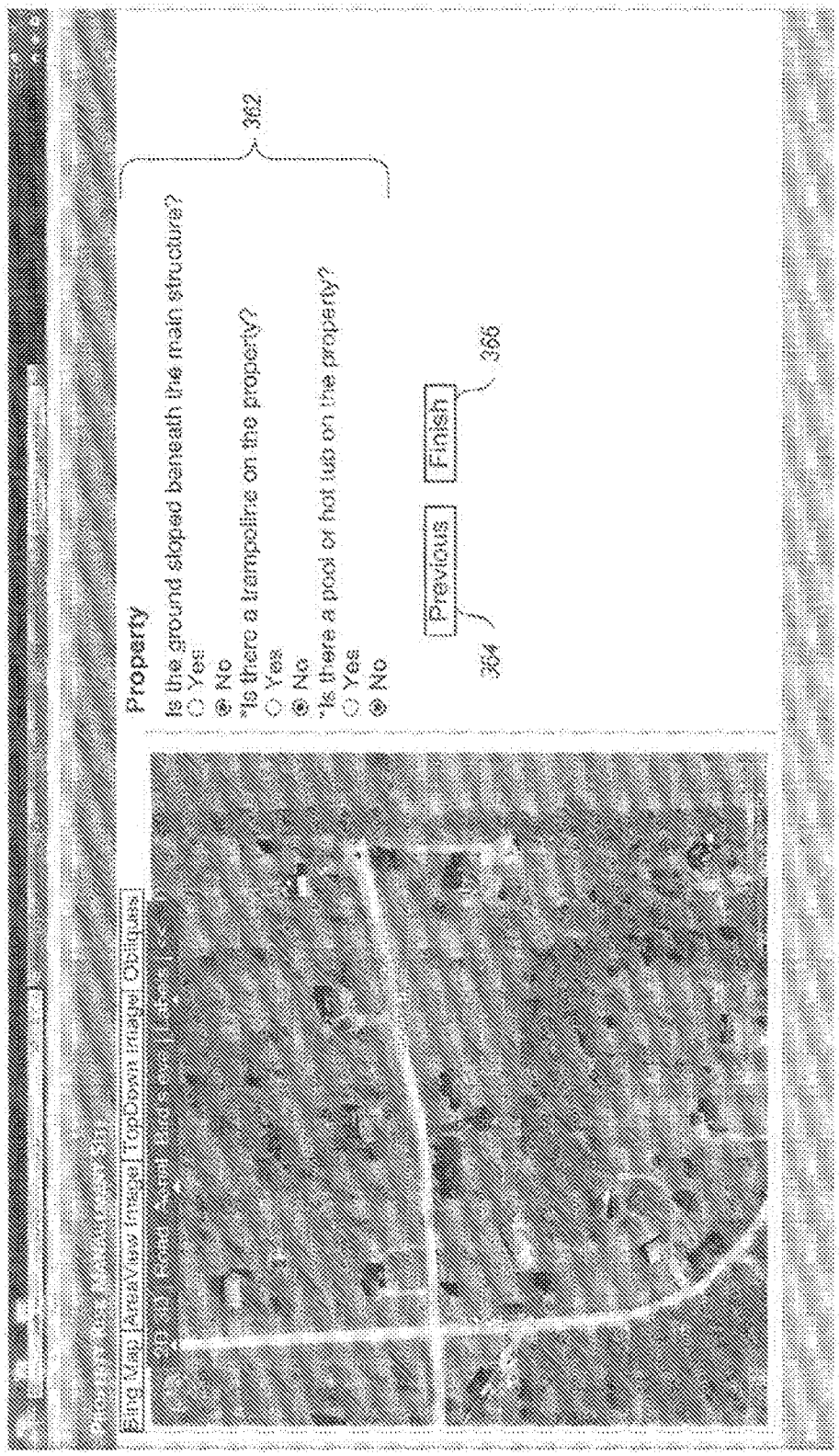

724
Property
Is the ground sloped beneath the main structure?
Yes
No
Is there a trampoline on the property?
Yes
No
Is there a pool or hot tub on the property?
Yes
No
362
Previous
Finish
364
366

Fig. 21

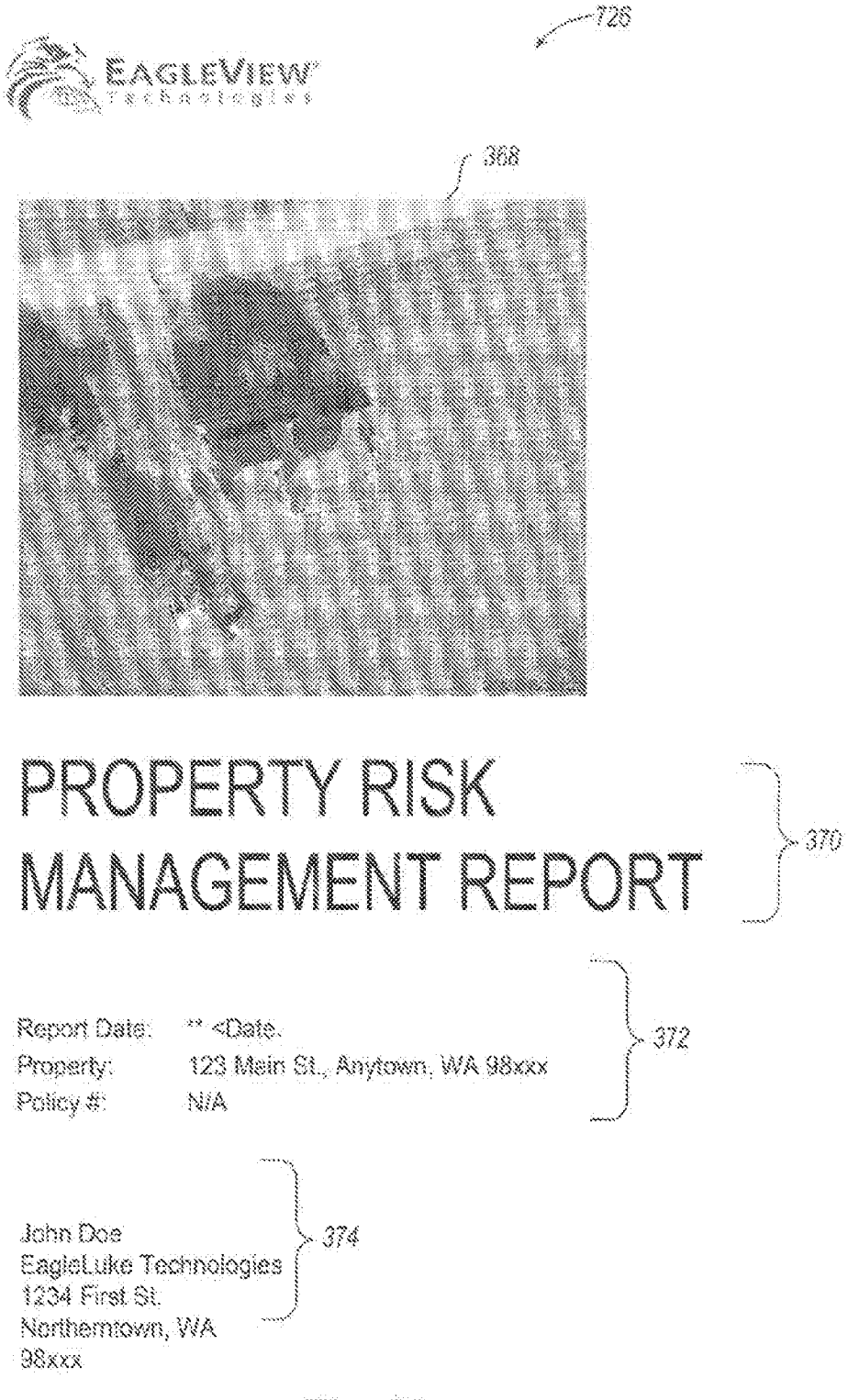

726
EagleView Technologies
368
PROPERTY RISK MANAGEMENT REPORT
370
Report Date: ** <Date.
Property: 123 Main St., Anytown, WA 98xxx
Policy #: N/A
372
John Doe
EagleLuke Technologies
1234 First St.
Northerntown, WA
98xxx
374

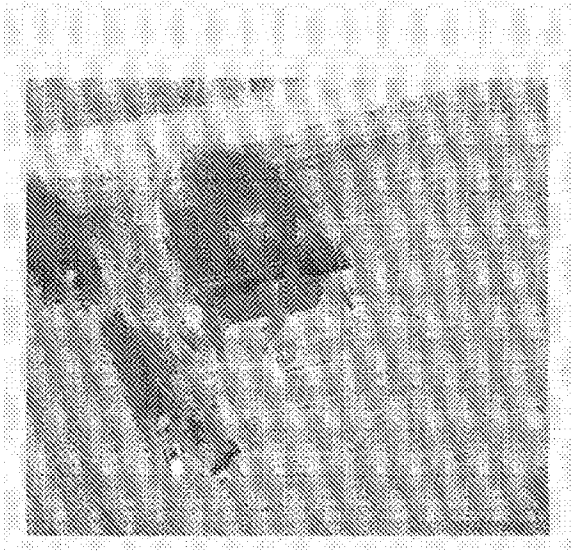
Fig. 22

728

EAGLEVIEW Technologies

Property Risk Management Report

[redacted] <Date>



REPORT DETAILS	
Report:	5635553
Policy:	N/A
Renewal Date:	N/A
Date of Photo:	12/13/2005
Geocode:	40.2119742, 93.8694994

BUILDING SUMMARY	
Year Built:	1983
Number of Stories:	2
Estimated Living Area:	1,965 sq. ft.
Garage (Attached)	484 sq. ft.

REPORT CONTENTS

Report Images.....2
Living Area Diagram.....6
Structural and Property Observations ..7

PREPARED FOR:
EagleLuke Technologies

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Fig. 23

730

EagleView Technologies

Property Risk Management Report

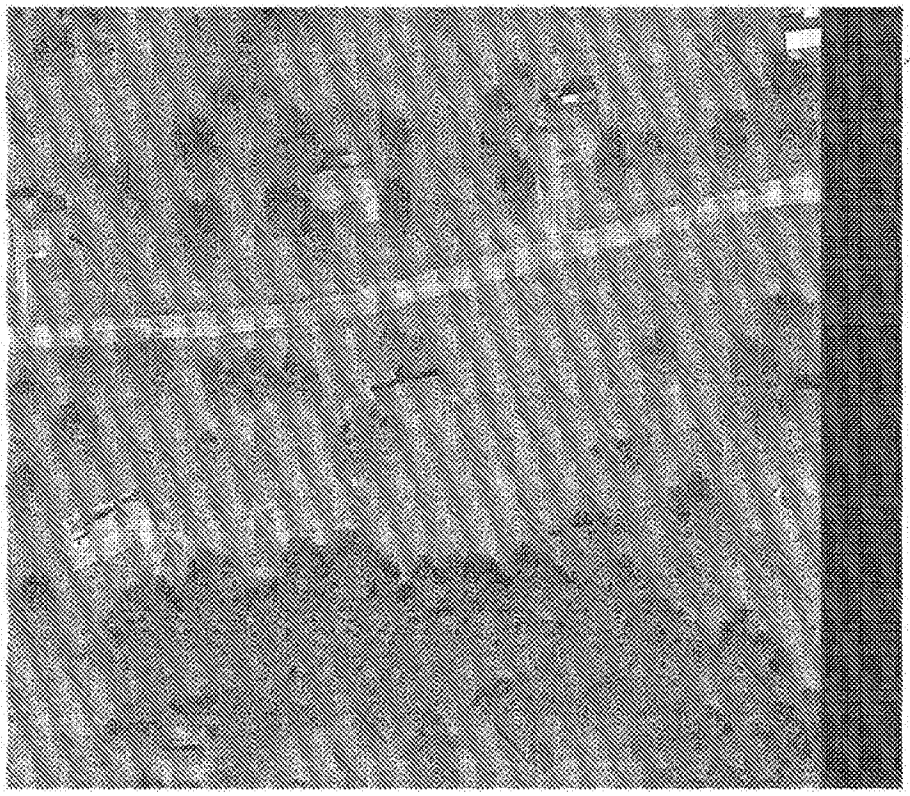
123 Main St, Anytown, WA 98xxx Date

REPORT IMAGES

Report #: 5835553
Geocode: 40.2119742, 93.8694994

The following aerial images show different angles of this structure for your reference. Additional images may have been used in the creation of this report and not included in this final document.

380



Area View

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Fig. 24

732

EagleView Technologies

Property Risk Management Report

25 Main St, Anytown, MA 02047 Page 2

REPORT IMAGES

Report #: 5635553
Geocode: 40.2118742, 93.8694894

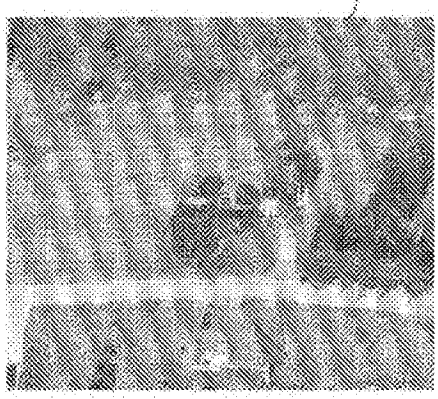
The following aerial images show different angles of this structure for your reference. Additional images may have been used in the creation of this report and not included in this final document.

382



North View

384



South View

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Fig. 25

734

EAGLEVIEW TECHNOLOGIES

Property Risk Management Report

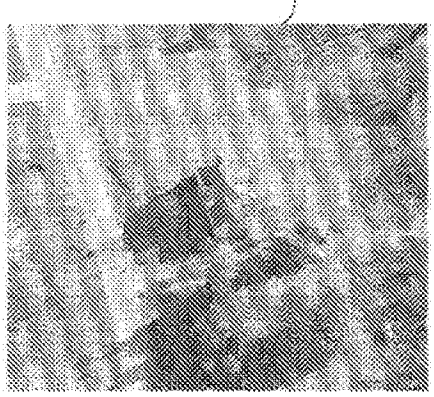
123 Main St, Anytown, WA 98000 Page 2

REPORT IMAGES

Report #: 5635553
Geocode: 40.2119742, 93.8694994

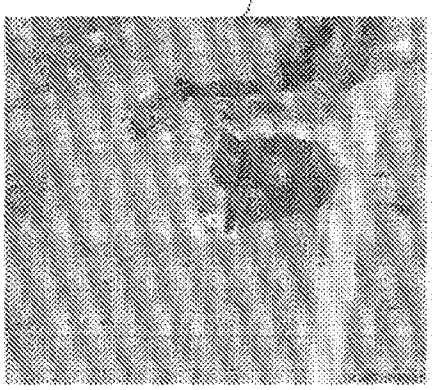
The following aerial images show different angles of this structure for your reference. Additional images may have been used in the creation of this report and not included in this final document.

386



East View

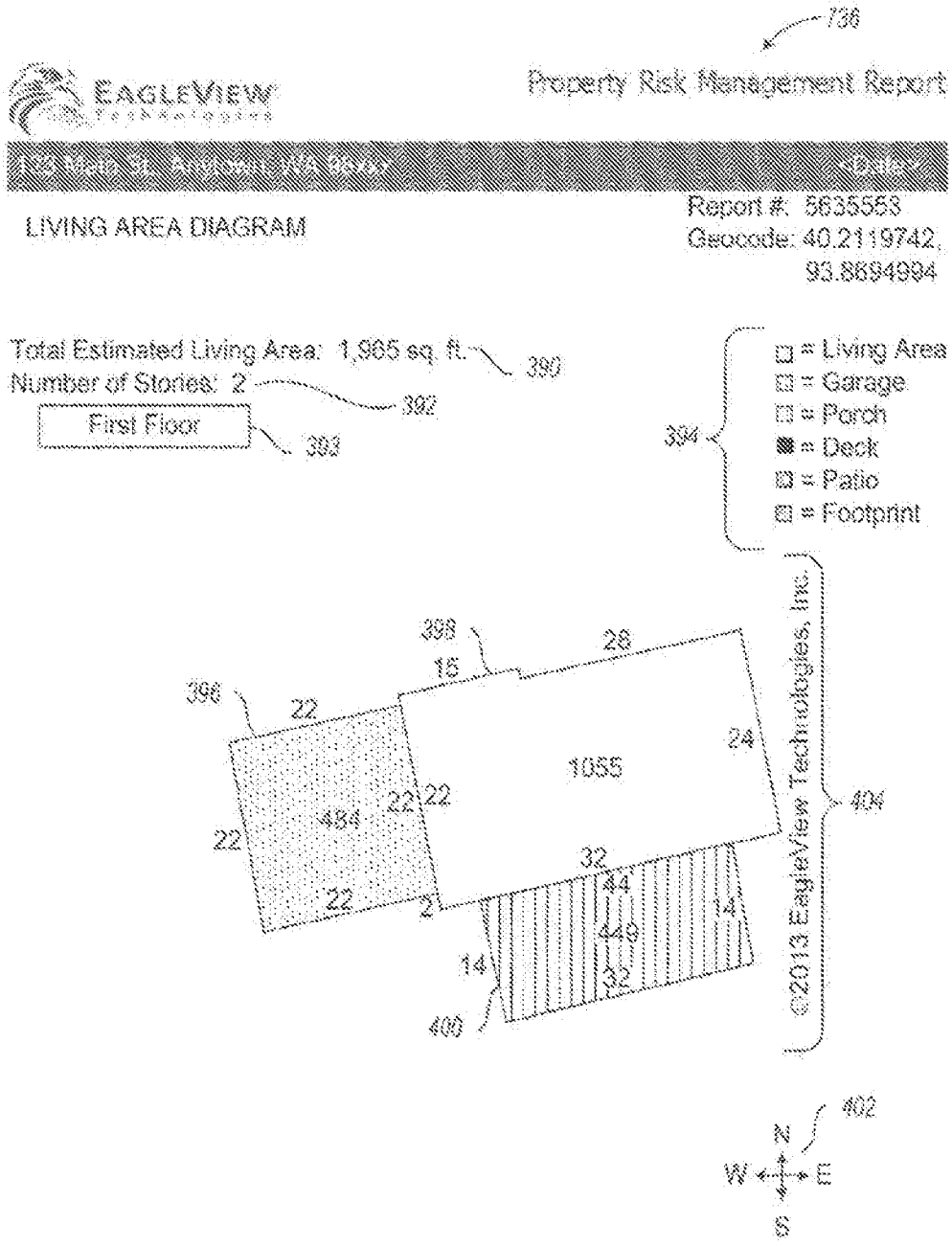
386



West View

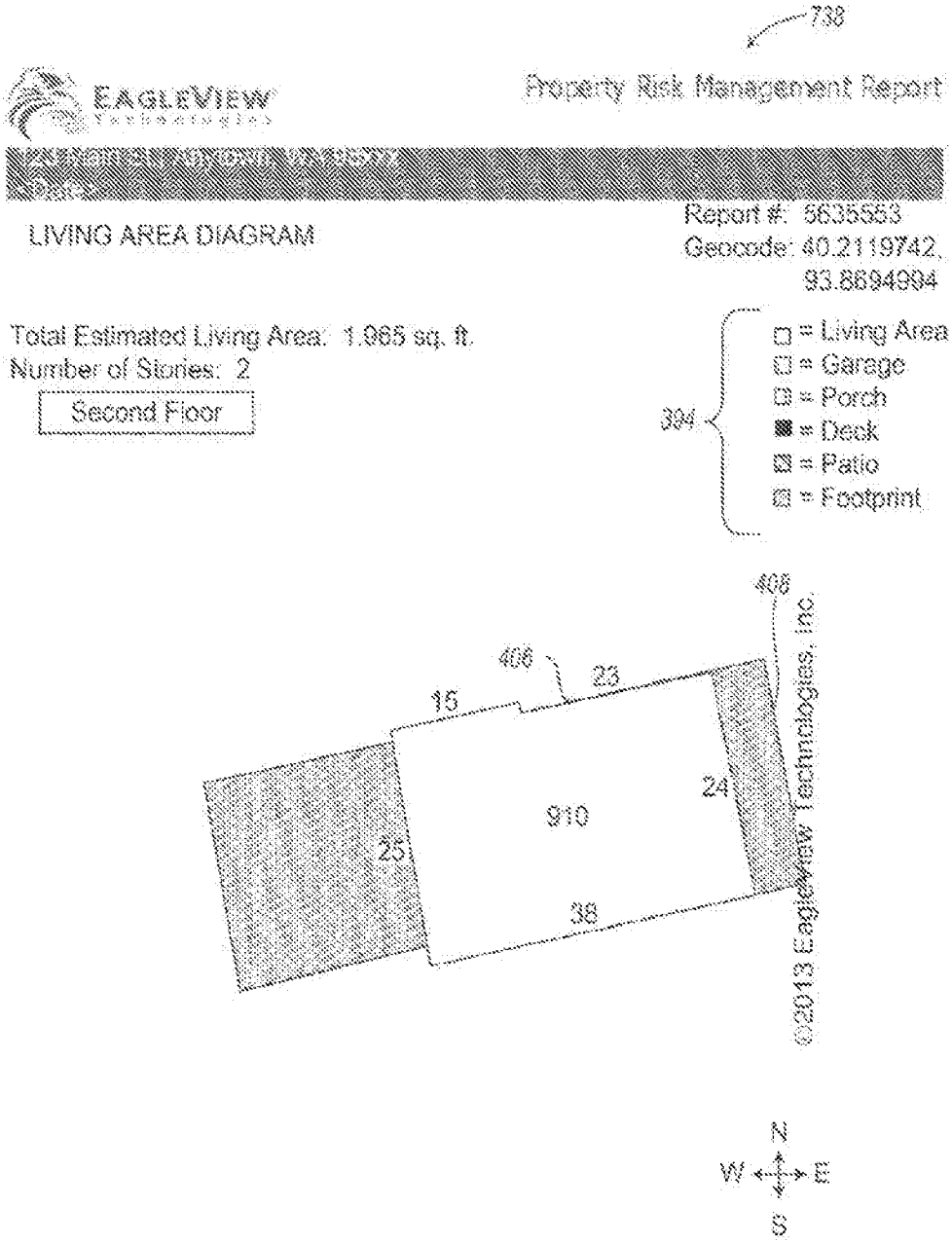
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Fig. 26



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Fig. 27



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Fig. 28

740

EAGLEVIEW TECHNOLOGIES

Property Risk Management Report

123 Main St, Anywhere, WA 98xxx Date:

STRUCTURAL & PROPERTY OBSERVATIONS

Report #: 5636553
Geocode: 40.2119742, 93.8694994

CONFIDENCE RATING: ■■■■ 410

4-Very High: Straightforward construction, often single story, easily-defined garage, quality images.

5-High: Potential for minor discrepancies, like vaulted ceilings on two stories home, or minor tree coverage.

2-Medium: Very complex construction with multiple stories often combined with poor or incomplete image sets.

1-Low: Very poor or incomplete images.

STRUCTURAL OBSERVATIONS 412

Year Built:	1983
Number of Stories:	2
Number of Family Structure:	Single Family
Structure Footprint:	1,539 sq. ft.
Corners:	8
Estimated Total Living Area:	1,955 sq. ft.
Garage Area:	464 sq. ft.
Garage Type:	Attached
Deck Area:	449 sq. ft.
Patio Area:	0 sq. ft.
Porch Area:	0 sq. ft.
Estimated Roof Pitch:	6-9
Roof Shape:	Hip/Gable
Number of Chimneys:	1
Outbuilding Count:	0
Outbuilding Total Area:	0 sq. ft.
Basement Area:	1,012 sq. ft.
Finished Basement Area:	1,012 sq. ft.
Basement Type:	Full
Basement Description:	Finished

For more information please see our ***Glossary of Terms.***

PROPERTY OBSERVATIONS 413

Building Permit:	No
EagleView Roof Report:	No
EagleView Wall Report:	No
Dist. To Commercial Exposure:	436 ft.
Distance to Steep Slope:	117 ft.
Distance to Water Hazard:	0 ft.
Distance to Vegetation:	161 ft.
Type of Vegetation:	Tree
Cross-Sell Identification:	Motorcycles
Slope on Property:	No
Trampoline:	No
Swimming Pool/Hot Tub:	No
Responding Fire Station:	Leavenworth County Fire Department District 1 Station 1
Responding Fire Station Type:	Combination
Responding Fire Station Dist.:	4-5 Miles
Owner Occupied:	N/A

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Fig. 29

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US14/25039

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - G06Q 40/08; G06F 7/60, 17/30 (2014.01)
USPC - 705/4, 7.28, 313
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC(8) - G06Q 40/00, 40/08; G06F 7/60, 17/10, 17/30, 17/50 (2014.01)
USPC - 705/1.1, 4, 7.28, 313, 400; 703/2; 382/286

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
MicroPatent (US-G, US-A, EP-A, EP-B, WO, JP-bib, DE-C,B, DE-A, DE-T, DE-U, GB-A, FR-A); ProQuest; IEEE; Google Scholar; risk management, assessment, criteria, flood, property, aerial view, insurance, underwriting

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 2009/0265193 A1 (COLLINS, D et al.) 22 October 2009; paragraphs [0074]-[0079], [0087]-[0088], [0097]-[0126]; claim 51	11-13, 15 --- 1-10, 14
Y	US 8,386,378 B2 (HALPER, SC et al.) 20 November 2012; figure 1; column 2, lines 60-61; column 3, lines 34-45; column 6, lines 39-67; column 7, lines 49-67; column 10, lines 7-31	1-10
Y	US 2008/0208637 A1 (MCKAY, S et al.) 28 August 2008; paragraph [0038]; claim 11	14
Y	US 2012/0123959 A1 (DAVIS, BL et al.) 17 May 2012; abstract; figures 2-3; paragraphs [0019]-[0086], [0110]-[0111]; claims 1, 10-12	6-7
P, X	US 2013/0262029 A1 (PERSHING, C) 03 October 2013; entire document	1-15
A	US 2012/0066187 A1 (PEARCY, BT et al.) 15 March 2012; entire document	1-15
A	US 2010/0070309 A1 (DEEDE, MW et al.) 18 March 2010; entire document	1-15

☐ Further documents are listed in the continuation of Box C. ☐

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Date of the actual completion of the international search	Date of mailing of the international search report
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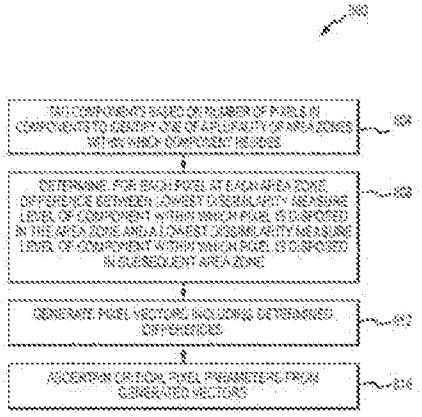


FIG.8

(57) Abstract: A system for automatically extracting or isolating structures or areas of interest (e.g., built-up structures such as buildings, houses, shelters, tents; agricultural areas; etc.) from HR/VHR overhead imagery data by way of making as little as a single pass through a hierarchical data structure of input image components (where pixels are grouped into components based on any appropriate definition or measure of dissimilarity between adjacent pixels of the input image) to identify candidate components (e.g., possible structures of interest) free of necessarily having to re-iterate the same operator configured with different threshold parameters for a plurality of values.

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AUTOMATIC EXTRACTION OF BUILT-UP FOOTPRINTS FROM HIGH RESOLUTION OVERHEAD IMAGERY THROUGH MANIPULATION OF ALPHA-TREE DATA STRUCTURES

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to U.S. Patent Patent No. 8,682,079, entitled "AUTOMATIC EXTRACTION OF BUILT-UP FOOTPRINTS FROM HIGH RESOLUTION OVERHEAD IMAGERY THROUGH MANIPULATION OF ALPHA-TREE DATA STRUCTURES, filed on November 25, 2013, which was a continuation of U.S. Patent App. No. 14/013,904, entitled "AUTOMATIC EXTRACTION OF BUILT-UP FOOTPRINTS FROM HIGH RESOLUTION OVERHEAD IMAGERY THROUGH MANIPULATION OF ALPHA-TREE DATA STRUCTURES," and filed on August 29, 2013, which claims priority from U.S. Patent App. No. 61/856,574, entitled "SCALABLE EXTRACTION OF OBJECT FOOTPRINTS FROM OVERHEAD IMAGE DATA," and filed on July 19, 2013, the entire contents of which are incorporated herein by reference as if set forth in full.

BACKGROUND

[0002] Information on human settlements is crucial for a wide range of applications including emergency response, disaster risk reduction, population estimation/analysis, and urban/regional planning. Urbanization pressure generates environmental impacts, indicates population growth, and relates to risk and disaster vulnerability. For instance, the global population passed the mark of 7.0 billion in 2011 with more than half of the population living in urban areas. Between 2011 and 2050, the urban population is expected to increase by about 2.7 billion, passing from 3.6 billion in 2011 to 6.3 billion in 2050. The population growth in urban areas is projected to be concentrated in the cities and towns of the less developed countries and continents. Asia, in particular, is projected to see its urban population increase by 1.4 billion, Africa by 0.9 billion, and Latin America and the Caribbean by 0.2 billion.

[0003] Population growth is therefore becoming largely an urban phenomenon concentrated in the developing world resulting in major challenges to manage the urban development in a sustainable manner. A central issue in this respect is the availability of up-to-date information on the extent and quality of the urban settlement (e.g., the urban "built-up" or "build-up," such as man-made 3-dimensional structures) which is largely unavailable in developing countries. For instance, cities are often growing at a pace that cannot be fully controlled by the local or regional mapping agencies. As demographic pressure increases exponentially at a global level, the ability to monitor, quantify and characterize urbanization processes around the world is becoming paramount. The information about the quality of urban development can provide precious input for understanding the vulnerability of the population living on our planet.

[0004] While overhead imagery such as satellite imagery could provide information about the world-wide built-up environment, there are few global data sets available that could be used to map the human settlements. Examples include the night-time lights of the world based on the Defense Meteorological Satellite Program - Operational

Linescan System (DMSP-OLS) sensor, Moderate Resolution Imaging Spectroradiometer (MODIS) based land use/land cover classifications, and global population data sets like LandScan™ or the gridded population of the world (GPW). While the aforementioned data sets are useful for global analysis, the data sets have the tendency to under-represent small, scattered rural settlements due to the low spatial resolution of the data sets between, for instance, 500 and 2,000m. Furthermore, the data sets represent single snap-shots in time that do not allow for regular monitoring and are typically not directly comparable when updated (e.g., the Landscan data set) due to changing input sources. Another example is the Global Human Settlement Layer (GHSL) of the Joint Research Centre of the European Commission that is a visual analytics tool for exploring the urban built-up in selected areas around the globe at high resolution. However, the GHSL does not deliver an actual information layer that can be used for further processing and parameter extraction.

SUMMARY

[0005] Although high resolution (HR, 1--10m spatial resolution) and even very high resolution (VHR, ≤ 1 m) overhead imagery data with an almost global coverage is or will be available with different sensors (e.g., System for Earth Observation (SPOT), China--Brazil Earth Resources Satellite program (CBERS), RapidEye, IKONOS® 2, QuickBird, WorldView-1, WorldView-2, WorldView-3), no consistent global coverage of built-up settlements derived from these datasets exists. Mapping and monitoring of urban areas at HR and VHR scales is mostly limited in terms of temporal and spatial coverage. The lack of a consistent global layer with HR/VHR spatial resolution can be attributed to a number of reasons. In one regard, global coverage is costly due to, for instance, the fact that most HR/VHR satellite missions are operated on a commercial basis. In another regard, no systems have yet been able to demonstrate the capacity to automatically extract global information layers about human settlement (built-up structures such as cities, refugee camps, etc.) from HR/VHR overhead data with relatively low levels of time, effort (e.g., low number of processor clock cycles), and other computational costs.

[0006] In this regard, disclosed herein are utilities (e.g., systems, methods, etc.) for automatically (e.g., in a manner that is substantially free of user input or intervention) extracting structures of interest (e.g., built-up such as buildings, houses, shelters, tents, etc.) from HR and VHR overhead imagery data (e.g., multispectral, panchromatic, red-green-blue (RGB), etc.) and presenting the extracted structures of interest in images of the same or similar extent/projection as the input images in a globally and regionally consistent manner. Stated differently, the disclosed utilities are operable to extract any desired structures of interest from HR/VHR input image data and automatically deliver footprints of the structures of interest (e.g., traces of 3-dimensional man-made ground structures approximated by discrete contours) free of any assumptions as to the type, shape, size, texture, etc. of the built-up or other structures of interest.

[0007] The utilities may extract all or substantially all candidates (e.g., pixels, components, etc.) and evaluate the candidates based on universal constraints. For instance, if it is specified that a house cannot be less than 16m^2 or larger than 20,000m^2, a building falling outside of these bounds may not be considered by the system while all others

may be identified and sorted based on their attributes. In addition to automatically generating maps or footprints of structures of interest, the disclosed utilities may also automatically determine, generate and/or present one or more side deliverables such as any appropriate footprint characteristics (e.g., size and/or shape information), clarity (e.g., contrast) of the structures of interest, density of the structures of interest, edges of the structures of interest (e.g., transition heat-maps from densely to less densely built-up areas), and/or the like. The disclosed utilities may be used in numerous contexts such as in assessing population densities, qualities of life, vulnerability factors, disaster risks, sufficiency of civil infrastructures, economic growth, poverty levels, event monitoring and evolution, change detection in human settlements, urban sprawl monitoring, and the like.

[0008] Broadly, the disclosed utilities are configured to organize (e.g., decompose) an input overhead image into a plurality of components of a hierarchical data structure (e.g., an "alpha-tree") based on any appropriate definition or measure of dissimilarity between adjacent pixels of the input image (e.g., maximum pixel intensity, native reflectance, etc.) and then utilize or manipulate the resulting hierarchical data structure in a number of manners to progressively refine, recluster, and/or filter information of the hierarchical data structure to allow for the automatic extraction and presentation of structures of interest from the input overhead image. For instance, a Differential Attribute Profile (DAP) vector field (VF) may be generated for the input overhead image using information from the hierarchical data structure to enrich each pixel with multi-scale information. A number of critical parameters (e.g., component lifetime, component scale, and/or pixel dissimilarity) may be derived from the DAP VF for each of the pixels. Respective image layers may be generated for each of the critical parameters which may be fused together in a number of manners to offer a drastic reduction in the traditional DAP VF and that automatically creates an image segmentation in which the pixels naturally shape up into a plurality of new components such that "dominant" components (e.g., with respect to size, contrast, and/or other attributes) may be automatically perceived to provide a map of built-up footprint candidates.

[0009] Non-target (e.g., non-built-up) regions of the input overhead image may be identified in a number of manners. For instance, components of the hierarchical data structure that include highly similar pixels (e.g., in relation to intensity, reflectance) and that represent regions greater than some size threshold (e.g., where non-built-up would most likely be represented by regions greater than the threshold, such as roads, rivers, and or other elongated areas) may be clustered and used to generate a mask for automatically eliminating corresponding portions of the input overhead image. Also, as previously discussed, the pixels in the image layers generated based on the one or more critical parameters (e.g., the lifetime parameters, the scale parameters, etc.) may automatically shape up or cluster into new components (e.g., different than those of the hierarchical data structure) based on similarities between one or more of the critical parameters (e.g., by component lifetime similarities). Geometric attribute filtering may then be performed on geometric attributes of the new components (e.g., contour, smoothness, linearity, entropy, moment invariants, and/or the like) to identify odd-shaped structures that are highly likely to not be of interest (e.g., non-built-up), such as via generation of a mask and application of the mask to the image layer fusion. As a further example, radiometric attributes (e.g., in relation to intensity, reflectance, etc.) of any previously identified non-target

portions/candidates may be used to further filter out any remaining portions of the image layer (e.g., image layer fusion) that are likely to be associated with non-target portions (e.g., non-built-up), such as via generation of a rule and application of the rule to radiometric attributes of remaining portions.

[0010] The resulting image layers or image layer fusions may be mapped or otherwise projected into a resulting image in any appropriate manner. In one arrangement, the resulting image may be color-coded accorded to the component scale and component lifetime such as by assigning colors to pixels based on respective component scales (e.g., size) and brightness to pixels based on respective component lifetimes. Furthermore, pixels in the resulting image having geometric attributes similar to those of artificial/man-made structures may be displayed more brightly than those pixels less likely to represent artificial/man-made structures to account for possible cross-image instabilities as contrast information is typically extracted on a tile basis instead of on a global basis.

[0011] In one aspect, a method for use in extracting structures of interest from overhead imagery data includes identifying, using a processor, a plurality of groups of pixels in at least one input overhead image of a geographical region, where each pixel in each group is adjacent to at least one other pixel in the group, where adjacent pixels in each group do not differ by more than a predetermined level of a dissimilarity measure between the adjacent pixels, where a plurality of such groups of pixels at each of a plurality of successive predetermined levels of the dissimilarity measure are identified, where the groups at one of the predetermined levels are hierarchically related to the groups at an adjacent one of the predetermined levels in a hierarchical data structure (e.g., an alpha-tree), and where each group is a first component. The resulting hierarchical data structure may be manipulated in a number of manners to progressively refine, recluster, and/or filter information of the hierarchical data structure to allow for the automatic extraction and presentation of structures of interest from the input overhead image.

[0012] In one arrangement, the method may include tagging, using the processor, each of the first components to identify one of a plurality of area zones within which the first component resides based on a number of pixels present in the first component, where each successive area zone includes first components having a greater number of pixels than do the first components of a previous area zone. This arrangement may also include generating for each pixel of the input overhead image, using the processor, a vector including a number of entries corresponding to each of the area zones from the tagging step, where each entry comprises a difference between a lowest dissimilarity measure level of a first component within which the pixel is disposed in the corresponding area zone and a lowest dissimilarity measure level of a first component within which the pixel is disposed in a subsequent area zone. Information from the vectors may be used to reduce the scale space representation coinciding with the hierarchical data structure to a reduced-band output in which dominant components (e.g., with respect to size and/or other parameters) may be extracted and used to identify possible candidates for structures of interest.

[0013] For instance, the method may include determining for each pixel of the input overhead image, using the processor, a largest entry in the vector corresponding to the pixel, where the largest entry is a lifetime parameter. The method may then include clustering pixels of the input overhead image having common respective lifetime

parameters into a plurality of corresponding second components. In one variation, the method may include obtaining at least one feature element (e.g., geometric or morphological attribute, such as contour smoothness, linearity, entropy, moment invariants, area, compactness, and/or the like) of each of the second components and ascertaining whether the at least one feature element of each of the second components is associated with a structure of interest in the at least one input overhead image.

[0014] To further refine the possible component candidates, the method may include obtaining at least one additional feature element (e.g., radiometric attribute) of each of the second components ascertained to not be structures of interest, obtaining at least one additional feature element (e.g., radiometric) of each of the second components ascertained to be structures of interest, analyzing the at least one additional feature elements of the second components ascertained to be structures of interest in view of the at least on additional feature elements of the second components ascertained to not be structures of interest, and obtaining a subset of the second components ascertained to be of interest based on the analyzing. Thereafter, the pixels of the subset of the second components ascertained to be structures of interest may be mapped into a resultant image that is associated with the geographic area. For instance, the mapped pixels may be color-coded based on the lifetime parameter of the corresponding second component of the mapped pixel.

[0015] Any of the embodiments, arrangements, or the like discussed herein may be used (either alone or in combination with other embodiments, arrangement, or the like) with any of the disclosed aspects. Merely introducing a feature in accordance with commonly accepted antecedent basis practice does not limit the corresponding feature to the singular. Any failure to use phrases such as "at least one" does not limit the corresponding feature to the singular. Use of the phrase "at least generally," "at least partially," "substantially" or the like in relation to a particular feature encompasses the corresponding characteristic and insubstantial variations thereof. Furthermore, a reference of a feature in conjunction with the phrase "in one embodiment" does not limit the use of the feature to a single embodiment.

[0016] In addition to the exemplary aspects and embodiments described above, further aspects and embodiments will become apparent by reference to the drawings and by study of the following descriptions.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] Figure 1 is a simplified block diagram illustrating a process of extracting structures of interest from overhead imagery data.

[0018] Figure 2 is a more detailed block diagram of an automated extraction system for obtaining structures of interest from overhead imagery data.

[0019] Figure 3 is a flow diagram of a method for extracting structures of interest from overhead imagery data.

[0020] Figure 4 is a schematic diagram of a plurality of pixel partitioning matrices corresponding to a plurality of successive predetermined levels of a dissimilarity measure for use in building an alpha-tree for at least one input overhead image.

[0021] Figure 5 is an alpha partition pyramid built from the partitioning matrices illustrated in Figure 4.

[0022] Figure 6 is a schematic diagram illustrating a pixel propagating through various components of a portion of an alpha tree and showing various "area zones" within which are located various ones of the components through which the pixel propagates.

[0023] Figure 7 is portion of a lifetime parameter image layer that illustrates clustering of pixels into second components based on common lifetime parameter values.

[0024] Figure 8 is a flow diagram of a method for obtaining critical parameters of pixels of an alpha tree.

[0025] Figure 9 is a flow diagram of a method for identifying non-target pixels in at least one input overhead image through use of geometric attribute filtering and generating a corresponding mask for isolating target candidates in the at least one input overhead image.

[0026] Figure 10 is a flow diagram of a method for performing radiometric attribute filtering to further refine the target candidates in the at least one input overhead image.

[0027] Figure 11 illustrates multispectral imagery acquired by the WorldView 2 satellite over a portion of Seattle, WA.

[0028] Figure 12 illustrates a mask for use in automatically removing non-target portions of the plurality of multispectral images of Figure 11.

[0029] Figure 13 illustrates a fusion of critical parameter layers of the plurality of multispectral images of Figure 11 after the mask of Figure 12 was used to automatically remove non-target portions of the image.

[0030] Figure 14 is similar to Figure 13 but with one of the critical parameters layers being replaced with a compactness layer.

[0031] Figure 15 is similar to Figure 13 but where components are color coded based on unique identifiers of the components.

DETAILED DESCRIPTION

[0032] Disclosed herein are utilities (e.g., systems, processes, etc.) for automatically extracting or isolating structures or areas of interest (e.g., built-up structures such as buildings, houses, shelters, tents; agricultural areas; etc.) from HR/VHR overhead imagery data by way of making as little as a single pass through a hierarchical data

structure of input image components (where pixels are grouped into components based on any appropriate definition or measure of dissimilarity between adjacent pixels of the input image) to identify candidate components (e.g., possible structures of interest) free of necessarily having to re-iterate the same operator configured with different threshold parameters for a plurality of values. One or more critical parameters for each input pixel may be identified based on the components of the hierarchical data structure and then used to generate one or more image layers in which the pixels naturally cluster into new components that facilitates detection of structures of interest (e.g., built-up) in the image layers. Non-target pixels and components (e.g., those that likely do not depict structures of interest) may be identified and/or removed at one or more positions in the process by way of performing any appropriate feature element (e.g., geometric, structural and/or radiometric attribute) filtering in one or more manners. Structures of interest may be mapped or otherwise projected into a resulting image in any appropriate manner. The resultant images can be used in numerous contexts such as in assessing population densities, qualities of life, vulnerability factors, disaster risks, sufficiency of civil infrastructures, economic growth, poverty levels, event monitoring and evolution, and the like.

[0033] At the outset, it is noted that, when referring to the earth herein, reference is made to any celestial body of which it may be desirable to acquire images or other remote sensing information. Furthermore, when referring to "overhead" imagery herein, such imagery may be obtained by any spacecraft, satellite, aircraft, and/or the like capable of acquiring images or other remote sensing information. Furthermore, the utilities described herein may also be applied to other imaging systems, including imaging systems located on the earth or in space that acquire images of other celestial bodies. It is also noted that the drawing figures contained herein are not necessarily drawn to scale and that such figures have been provided for the purposes of discussion and illustration only.

[0034] Generally, high resolution images of selected portions of a celestial body's surface have become a product desired and used by government agencies, corporations, and individuals. For instance, many consumer products in common use today include images of the Earth's surface, such as Google® Earth. Various types of remote sensing image collection platforms may be employed, including aircraft, earth-orbiting satellites, and the like. In the case of a consumer digital camera, as one non-limiting example, an image sensor is generally arranged in an area array (e.g., 3,000 rows of 3,000 pixels each, or 9,000,000 total pixels) which collects the image area in a single "snapshot." In the case of satellite-based imaging, as another non-limiting example, the "push-broom scanning" principle is sometimes employed whereby each image sensor includes a relatively small number of rows (e.g., a couple) of a great number of pixels (e.g., 50,000 or more) in each row. Each row of pixels may be scanned across the earth to build an image line by line, and the width of the image is the product of the number of pixels in the row times the pixel size or resolution (e.g., 50,000 pixels at 0.5 meter ground resolution produces an image that is 25,000 meters wide). The length of the image is controlled by the scan duration (i.e. number of lines), which is typically settable for each image collected. The resolution of overhead images varies depending on factors such as the particular instrumentation utilized, the altitude of the satellite's (or other aircraft's) orbit, and the like.

[0035] Image collection platforms (e.g., aircraft, earth-orbiting satellites, etc.) may collect or acquire various types of imagery in one or more manners. As one non-limiting example, image collection platforms may perform panchromatic collection of scenes of a celestial body which generally refers to the collection of image data across a single broad range of wavelengths (e.g., all visible light, from near infrared (NIR) to near ultraviolet (NUV), etc.). As another non-limiting example, image collection platforms may additionally or alternatively capture image data within the visible light band and include respective filters to separate the incoming light into red, green and blue portions. As a further non-limiting example, image collections platforms may additionally or alternatively perform multispectral collection of scenes of a celestial body which generally refers to the collection of image data at multiple specific spectral bands across the electromagnetic spectrum (e.g., within bands both inside and outside of the visible light range such as NIR, short wave infrared (SWIR), far infrared (FIR), etc.). For instance, a satellite may have one image sensor that is sensitive to electromagnetic radiation across only a first spectral band (e.g., the visible light band, such as a wavelength range of about 380-750 nm) in addition to one or more additional image sensors that are sensitive to electromagnetic radiation only across other spectral bands (e.g., NIR, 750-1400 nm; SWIR, 1400-3000 nm; etc.). Multi-spectral imaging may allow for the extraction of additional information from the radiance received at a satellite after being reflected from the Earth's surface (which may include atmospheric effects such as from aerosols, clouds, etc.).

[0036] As discussed previously, there are generally few global data sets available that could be used to map the human settlements, much less high resolution overhead image data sets (e.g., HR, VHR) that could be used to do so. For instance, current global data sets (e.g., MODIS 500m, Landscan, Corine Land Cover 2006, etc.) have the tendency to under-represent small, scattered rural settlements due to their low spatial resolution (e.g., between 500 and 2,000m). Furthermore, the data sets represent single snap-shots in time that do not allow for regular monitoring. Still further, if the data sets are updated, they are typically not directly comparable due to changing input sources.

[0037] In this regard, Figure 1 presents a simplified block diagram of a system 100 that may be used to generate and map regionally and globally consistent structures of interest such as human settlements (e.g., including built-up structures) in a manner that is compatible across various imaging sensors and with increased speed and performance in relation to currently available processes. At the heart of the system 100 may be the automated extraction 104 of structures of interest from HR/VHR overhead image data source(s) 108 (e.g., <1 - 10m spatial resolution overhead image data obtained by a number of heterogeneous platforms such as SPOT 2 and 5, CBERS 2B, RapidEye 2 and 4, IKONOS® 2, QuickBird 2, WorldView 1, 2, and/or 3) and generation of resultant images 116 that include the extracted structures of interest therein. Figure 2 presents a more detailed block diagram of an automated extraction system 200 that may be used to implement the automated extraction 104 of structures of interest shown in Figure 1. Although depicted as a single device (e.g., server, workstation, laptop, desktop, mobile device, and/or other computing device), one or more functionalities, processes or modules of the system 200 may be allocated or divided among a plurality of machines, devices and/or processes which may or may not be embodied in

a single housing. In one arrangement, functionalities of the server 200 may be embodied in any appropriate cloud or distributed computing environment.

[0038] Broadly, the system 200 may include memory 204 (e.g., one or more RAM or other volatile memory modules, etc.), a processing engine or unit 208 (e.g., one or more CPUs, processors, processor cores, or other similar pieces of hardware) for executing computer readable instructions from the memory 204, storage 212 (e.g., one or more magnetic disks or other non-volatile memory modules or non-transitory computer-readable mediums), and/or a number of other components 216 (e.g., input devices such as a keyboard and mouse, output devices such as a display and speakers, and the like), all of which may be appropriately interconnected by one or more buses 220. While not shown, the system 200 may include any appropriate number and arrangement of interfaces that facilitate interconnection between the one or more buses 220 and the various components of the system 200 as well as with other devices (e.g., network interfaces to allow for communication between the system 200 and other devices over one or more networks, such as LANs, WANs, the Internet, etc.).

[0039] The system 200 may retrieve any appropriate input overhead image(s) 224 (e.g., HR/VHR overhead image data such as from one or more HR/VHR overhead image data sources 108 of Figure 1) and store the same in any appropriate form in storage 212 (e.g., such as in one or more databases and manageable by any appropriate database management system (DBMS) to allow the definition, creation, querying, update, and administration of the databases). The processing engine 208 may execute a DBMS or the like to retrieve and load the input overhead image(s) 224 into the memory 204 for manipulation by a number of engines or modules of the system 200 that are discussed in more detail below.

[0040] As shown, the system 200 may include a "construction" engine 228 that is broadly configured to construct hierarchical data structures (e.g., alpha-trees) from input overhead images as a way to efficiently organize the pixels of the input overhead images for subsequent processing, a "non-target clustering" (NTC) engine 232 that is broadly configured to cluster together relatively large image regions represented by the alpha tree that are highly likely to identify non-target regions or candidates (e.g., areas that are likely not structures of interest, such as water, vegetation, roads, rivers, etc.), a "Differential Area Profile" (DAP) engine 236 that is broadly configured to generate DAP vectors for each pixel and then identify a number of critical parameters for each pixel based on its DAP vector, a "constrained connected component processing" (CCCP) engine 240 that is broadly configured to cluster the pixels into a plurality of new components based on at least one of their critical parameters and then perform any appropriate geometric or structural attribute filtering on the components to identify target and non-target candidates, a "radiominer" engine 244 that is configured to facilitate any appropriate attribute radiometric filtering on target candidates, and a "mapping" engine 248 that is configured to present target candidates (e.g., components that identify structures of interest) in any appropriate manner in one or more resultant images.

[0041] Each of the engines (and/or other engines, modules, logic, etc. disclosed and/or encompassed herein) may be in the form of one or more sets of computer-readable instructions for execution by the processing unit 208 and that

may be manipulated by users in any appropriate manner to perform automated extraction and presentation of structures of interest (e.g., built-up layers or the like) on a display (not shown). In this regard, the combination of the processor 208, memory 204, and/or storage 212 (i.e., machine/hardware components) on the one hand and the various engines/modules disclosed herein in one embodiment create a new machine that becomes a special purpose computer once it is programmed to perform particular functions of the extraction utilities disclosed herein (e.g., pursuant to instructions from program software). In one arrangement, any appropriate portal in communication with the various engines may run on the system 200 and be accessible by users (e.g., via any appropriate browser) to access the functionalities of the system 200. While the various engines have been depicted in Figure 2 as being separate or distinct modules, it is to be understood that the functionalities or instructions of two or more of the engines may actually be integrated as part of the same computer-readable instruction set and that the engines have been depicted in the manner shown in Figure 2 merely to highlight various functionalities of the system 200. Furthermore, while the engines have been illustrated as being resident within the (e.g., volatile) memory 204 (e.g., for execution by the processing engine 208), it is to be understood that the engines may be stored in (e.g., non-volatile) storage 212 (and/or other non-volatile storage in communication with the system 200) and loaded into the memory 204 as appropriate.

[0042] To facilitate the reader's understanding of the various engines of the system 200, additional reference is now made to Figure 3 which illustrates a method 300 for use in performing the automated extraction processes disclosed herein. While specific steps (and orders of steps) of the method 500 have been illustrated and will be discussed, other methods (including more, fewer or different steps than those illustrated) consistent with the teachings presented herein are also envisioned and encompassed within the present disclosure.

[0043] The method 300 may begin by constructing 304 a hierarchical data structure (e.g., alpha-tree) from the pixels of one or more HR/VHR input overhead images of a particular geographic area. Stated differently, the one or more input overhead images may be decomposed into nodes or components (e.g., each include a single pixel or a group of pixels that collectively define the input images as whole) of a hierarchical data structure that generally maps image partitions from fine to course. With reference to Figure 2, for instance, the construction engine 228 of the automated extraction system 200 may receive one or more input overhead images 224 of a particular geographic area (e.g., WorldView 2 multispectral imagery acquired over Seattle, WA as shown in Figure 11) and break the input overhead image(s) 224 down into a plurality of "first" components 252 (e.g., nodes or groups of pixels related by one or more appropriate metrics, parameters, etc.). The construction engine 228 then appropriately organizes or arranges the various first components 252 into a hierarchical data structure 256 whereby each first component 252 is hierarchically (e.g., ancestrally) related to at least one other first component 252. In one arrangement, each hierarchical data structure 256 may be a rooted, uni-directed tree with its leaves corresponding to reference connected components (e.g., where each includes pixels that are identical in relation intensity and/or the like) of the at least one input overhead image and the root corresponding to the tip of the hierarchy (e.g., the single component whose extent defines the image definition domain).

[0044] To better understand the step of constructing 304 a hierarchical data structure 256 from the pixels of the at least one input overhead image 224, additional reference is now made to Figure 4 which presents a plurality of pixel partitioning matrices 400 (e.g., matrices 400_0, 400_1, 400_2, 400_3, 400_4, 400_5) corresponding to a plurality of successive predetermined levels of a dissimilarity measure for use in building an alpha-tree (e.g., a hierarchical data structure 256) for at least one input overhead image. Generally, each matrix 400 includes a plurality of rows and columns of pixels 404 of the one or more input overhead images 224 (only 16 shown in Figure 4 in the interest of clarity) and arranged in a native format (e.g., in the same manner as the corresponding photosites of the image sensor(s)). As shown in Figure 3, one step of the construction step 304 may be selecting 308 at least one dissimilarity measure by which to group adjacent ones of the pixels 404 to form first components 252 of the hierarchical data structure 256 (where such adjacent pixels 404 do not differ by more than alpha according to the dissimilarity measure at each of a plurality of different alphas). For instance, dissimilarity measures may include the maximum pixel intensity difference between adjacent pixels, the maximum spectral angular distance difference between adjacent pixels, native reflectance difference, and/or the like. Such differences may be computed from a single band in the case of one or more panchromatic images, from all bands available in the case of one or more multispectral images, and/or the like.

[0045] The method 300 may also include grouping 312 (e.g., clustering) adjacent pixels (e.g., that border each other in either the "horizontal" or "vertical" direction of the matrix) into a plurality of components at each of a plurality of predetermined levels (e.g., alphas) of the selected dissimilarity measure and then constructing 314 the hierarchical data structure 256 from the components. Returning to Figure 4, each pixel 404 includes or is associated with a value 408 (e.g., pixel intensity such as grayscale value) by which a level of dissimilarity between the pixel 404 and each adjacent pixel 404 will be measured. In each matrix 400, pixels 404 may be grouped into components based on one of a plurality of predetermined levels of the dissimilarity measure (e.g., where each level corresponds to a different alpha (α)). In matrix 400_0 (e.g., corresponding to α=0) for instance, pixels 404 are grouped with adjacent pixels 404 to form components only when their respective values 408 differ by no more than zero (or, in other words, only when their values 408 are equal). In the event that a particular pixel 404 does not include any adjacent pixels 404 with equal values 408, the particular pixel 404 may form a component that includes only the particular pixel 404. As shown in this example, the matrix 400_0 includes a single multi-pixel component 412 (including three adjacent pixels 404 all having values 408 of one) and a plurality of single-pixel components (not labeled, but each such component being represented by its respective pixel 404).

[0046] With reference now to matrix 400_1 (e.g., corresponding to α=1), pixels 404 are grouped with adjacent pixels 404 to form components only when their respective values 408 differ by no more than one (or, in other words, only when their values 408 are equal or differ by one). In this regard, the matrix 400_1 includes a number of new components such as a new component 416 that includes all the pixels 404 of the component 412 from the matrix 400_0 in addition to a plurality of additional adjacent pixels 404 whose values 408 are different than that of at least one of the pixels of the component 412 by no more than one. See Figure 4. The matrix 400_1 also includes a new component 420 that includes four pixels (previous single-pixel components in the matrix 400_0), where the values 408

of adjacent pixels 404 in the new component 420 differ by no more than one. As shown, five components (all single-pixel components with values 408 of 3, 4, 1, 9 and 3; not labeled) remain unchanged between matrix 400_0 and 400_1. In one arrangement, a component may only be considered part of a particular matrix 400 when the component has changed since the preceding matrix 400. In this case, the five aforementioned single-pixel components may not be considered part of the matrix 400_1.

[0047] With reference to matrix 400_2 (e.g., corresponding to α=2), pixels 404 are grouped with adjacent pixels 404 to form components only when their respective values 408 differ by no more than two. In this regard, the matrix 400_2 includes a new component 424 (including all pixels 404 of component 416 from matrix 400_1 in addition to an additional adjacent pixel 404) and another new component 428 including two pixels whose values 408 (e.g., 1 and 3) are no more than two different from each other. The other remaining pixels in the matrix 400_2 are part of components that did not change (e.g., did not gain pixels) from the matrix 400_1 and thus may not form components of the 400_2. A similar clustering of pixels 404 based on the differences of their values 408 to form new components may be performed in matrix 400_3 corresponding to α=3, matrix 400_4 corresponding to α=4, matrix 400_5 corresponding to α=5, and/or a plurality of additional matrices at respective additional alpha levels until all pixels are included in the same component (e.g., a root component 432 or node, such as is represented in matrix 400_5). While the dissimilarity evaluation has been discussed in the context of vertical and horizontal neighbors of a particular pixel, it is to be understood that the dissimilarity evaluation may alternatively or additionally be made in relation to diagonal neighbors of a pixel (e.g., top-left, top-right, bottom-left, bottom-right), such as when increased granularity of components is required. As another example, one or more small neighborhoods of pixels (e.g., the first 24 pixels) around a particular pixel under study may be considered.

[0048] Turning now to Figure 5, an alpha partition pyramid 500 that may be constructed 314 from the components of the pixel partitioning matrices 400 of Figure 4 is illustrated. In one arrangement, the vertical axis of the alpha partition pyramid 500 may correspond to the plurality of respective alpha levels of the plurality of pixel partitioning matrices 400 (e.g., α=0, 1, 2, etc.) while the horizontal axis may correspond to any appropriate index by which to identify nodes 510 at a particular alpha level (where each node 510 identifies a respective component of one of the pixel partitioning matrices 400). It is noted that the terms nodes and components may be used interchangeably herein. Furthermore, it will be appreciated that many more complicated predetermined alpha levels may be utilized based on the particular dissimilarity measure being utilized. In any case, at α=0 for instance, nodes 510 corresponding to each of the components from the matrix 400_0 may be respectively disposed along the horizontal axis in any appropriate manner. In one arrangement, components may be selected from the matrix 400_0 for placement as nodes 510 in the alpha partition pyramid 500 starting with the leftmost component in the top row of pixels 404 and moving to the end of the row before starting with the leftmost component in the next row of pixels 404. If a component includes two or more pixels 404, the component may only be registered as a node 510 in the alpha partition pyramid 500 a single time. As shown in Figure 5, all of the nodes 510 at α=0 correspond to the single-pixel

components of the matrix 400_0 with the exception of node 512 which corresponds to the multiple-pixel component 412 of matrix 400_0.

[0049] At α=1 which corresponds to matrix 400_1, for instance, a number of observations may be made. As discussed previously, five components (all single-pixel components with values 408 of 3, 4, 1, 9 and 3; not labeled) remain unchanged between matrix 400_0 and 400_1. In this regard, the nodes 510 corresponding to these components are represented by concentric circles (or the like) at α=1 which indicates that such nodes 510 are "non-included" nodes 511 at α=1 (i.e., they are not to be considered nodes at α=1 as they are redundant in relation to the α=0 level). However, the nodes 511 may still form part of "included" nodes 513 (represented as single circles or the like) at later alpha levels. In this regard, it may be noted that an alpha tree of the alpha partition pyramid 500 would be similar to the alpha partition pyramid 500 but free of any non-included (e.g., redundant) nodes 511. For instance, in a corresponding alpha tree, the arrow currently drawn from the node corresponding to the first single-pixel component with a value of "3" would be drawn from the α=0 level directly to node 524 at the α=2 level.

[0050] In any event, and as also shown in Figure 5, the α=1 level includes two included nodes 513 which are labeled as 516 and 520 that respectively correspond to components 416 and 420 from 400_1 of Figure 4. In the case of node 516, for instance, it can be seen how a number of arrows (e.g., lines, connectors, etc.) may be drawn from a respective number of the nodes 510 at the α=0 level to node 516 at the α=1 level to indicate their inclusion in the node 516 at the α=1 level (which corresponds to the merging of component 412 and the plurality of single-pixel components of matrix 400_0 into a single component 416 in matrix 400_1. Arrows or the like may be similarly depicted from each of a number of respective nodes at the α=0 level to node 520 at the α=1 level.

[0051] A similar process may be performed to create additional included nodes 513 labeled as nodes 524 and 528 at the α=2 level (that correspond to components 424 and 428 from matrix 400_2 of Figure 4) and at further alpha levels (nodes not labeled in the interest of clarity) up to a root node 532 at the α=5 level (that corresponds to component 432 from matrix 400_5 of Figure 4) that includes the pixels of all components of the alpha partition pyramid 500 (and that points to itself as shown in Figure 5). As shown, the alpha partition pyramid 500 may include a plurality of paths or branches extending between each of the nodes 510 at the α=0 level and the root node 532 at the α=5 level. In one arrangement, the construction engine 228 may, after construction of the alpha partition pyramid 500, ascertain any appropriate feature elements or attributes 258 (e.g., structural, geometric, radiometric, statistical, etc.) of the various first components 252 (e.g., nodes) of the hierarchical data structure 256 (e.g., of the various nodes 510 of the alpha partition pyramid 500) in any appropriate manner for use in later processing as will be discussed below. In the case of node 512 in Figure 5, for instance, the construction engine 228 may determine an area or non-compactness collectively represented by all of the pixels 404 included in the component 412 of matrix 400_0. The same area or non-compactness value may then be used as part of determining the area or non-compactness of node 516 (where node 516 includes all the pixels 510 of node 512 in addition to a number of other nodes/pixels). A similar process may be performed to determine attributes of the remaining nodes/components of the alpha partition pyramid 500. In one

arrangement, all nodes/components may be processed starting at the α=1 level and continuing through the α=5 level (associated with the root node 532).

[0052] Returning to Figure 3, the method 300 may also include ascertaining 316 (e.g., by DAP engine 236) critical parameters (e.g., attributes) for pixels of the constructed hierarchical data structure 256 (e.g., the alpha partition pyramid 500) that allows for a reduction in the attribute scale space representation of the hierarchical data structure 256 and that automatically creates an image segmentation in which "dominant" nodes or components may be extracted from the hierarchical data structure 256 to at least begin to shape up a map of "target" candidates (e.g., pixels or components representing structures of interest, such as built-up). To more fully understand the ascertaining step 316, reference is now made to Figure 8 which presents a method 800 of obtaining critical parameters of pixels of an alpha tree (or other hierarchical data structure) as well as to Figure 6 which illustrates a pixel propagating through various components of a portion of an alpha tree and showing various "area zones" within which are located various ones of the components through which the pixel propagates.

[0053] At step 804, the DAP engine 236 may tag components (e.g., nodes) based on a number of pixels in the components to identify one of a plurality of "area zones" within which the components reside. As shown in Figure 6, a branch 600 of an alpha tree is illustrated (e.g., where the alpha tree is more complicated than the alpha tree 500 of Figure 5) and shows a particular pixel 604 as the pixel 604 propagates through various "included" components of the branch 600 (i.e., components that gained at least one pixel in relation to an immediately preceding component). For instance, the pixel 604 may form a single-pixel component 610_0 at the α=0 level and then form part of a multi-pixel component 610_1 at the α=1 level (e.g., where the component 610_1 includes three total pixels represented by squares). After the component 610_1, the pixel 604 does not, in this example, form part of another component until it joins a multi-pixel component 610_4 at the α=4 level implying that no new pixels were added to the component 610_1 at the α=2 level or the α=3 level (e.g., similar to how no pixels were added to "non-included" component 511 of Figure 5 (having a single pixel with a value of "3") at the α=1 level resulting in the component 511 not being considered as part of the branch or path between the α=0 level and the α=5 level). As shown, the pixel 604 may continue to be clustered or grouped into additional components up the tree (e.g., components 610_4, 610_5, 610_6, 610_{15}, 610_{16} and 610_{18}) which may or may not be disposed at successive alpha levels (depending on, as discussed herein, whether or not a size of the component changed from one alpha level to the next alpha level). While values (e.g., values 408) have not been shown, it is assumed for purposes of discussion that adjacent pixels in each component have values that are no more dissimilar than the particular alpha level at which the component is disposed.

[0054] With continued reference to Figure 6, each of the components 610 may be tagged to identify a particular area zone within which the component 610 resides that generally conveys a relative size (in pixels) of the component (e.g., where each area zone includes components having a particular number or number range of pixels). In this example, four area zones may be specified, where a first area zone 650 includes components having 1-4 pixels, a second area zone 654 includes components having 5-20 pixels, a third area zone 658 includes components having 21-40 pixels, and a fourth area zone 662 includes components having 41-84 pixels. Of course, additional or fewer

area zones associated with different pixel ranges than shown in Figure 6 are envisioned and encompassed herein. In any case, components 610_0 and 610_1 may be tagged with the first area zone 650 (as each includes between 1-4 pixels), components 610_4, 610_5 and 610_8 may be tagged with the second area zone 654 (as each includes between 5-21 pixels), and so on.

[0055] Once the particular area zone within which each component resides has been determined, the method 800 may proceed to determine 808, for each area zone, a difference between a) a lowest alpha level (e.g., lowest predetermined level of the dissimilarity measure) of a component within which the pixel 604 is disposed in the area zone, and b) a lowest alpha level of a component within which the pixel 604 is disposed in a subsequent area zone (e.g., the next area zone). The determined differences may then be used to generate DAP vectors 260 (see Figure 2) for each pixel. Generally, a DAP is a point-based multi-scale descriptor used in pattern analysis and image segmentation and may be defined through sets of size-based or other attribute-based segmentations of an alpha-tree of the one or more input overhead images. Operations on a DAP vector field (VF) or individual DAP vectors for some or all pixels of the one or more input overhead images can be computed free of necessarily first exporting the DAP VF (e.g., via the "one-pass method").

[0056] In the case of the first area zone 650, for instance, the difference would be the difference between the alpha of component 610_4 and the alpha of component 610_0 or, in other words, four. In the case of the second area zone 654, for instance, the difference would be the difference between the alpha of component 610_8 and the alpha of component 610_4 or, in other words, five. In the case of the third area zone 658, for instance, the difference would be the difference between the alpha of component 610_{18} and the alpha of component 610_9 or, in other words, nine. In the case of the fourth area zone 662, for instance, the difference would be the difference between the alpha of component 610_{19} and the alpha of component 610_{18} or, in other words, one. While not labeled, component 610_{19} may be disposed within a fifth (e.g., residual) area zone.

[0057] A vector (e.g., DAP vector) may then be generated 812 including entries that correspond to the aforementioned determined differences. In the case of the pixel 604 (e.g., represented by the variable "x"), the following vector may be generated:

[0058] DAP(x) = [4, 5, 9, 1]

[0059] The determining step 808 and generating step 812 may be performed for at least some or all pixels of the one or more input overhead images and combined into a vector field (e.g., a DAP VF) in any appropriate manner for subsequent processing. It is to be understood that a DAP vector of a pixel in reality may include many more than the four entries shown in the DAP vector of the pixel 604 (e.g., as alpha trees for input images including millions and millions of pixel may require many more area zones than are shown in Figure 6). Furthermore, it will be appreciated that the specific paths or branches followed by each pixel may be at least partially different than those followed by other ones of the pixels (e.g., except in the case of two or more pixels forming part of the same component at an α=0

level). With reference back to Figure 6, for instance, another pixel may initially form part of one or more different components in the first area zone 650 but then may join component 610_5 along with the pixel 604 at the α=5 level in the second area zone 654. As another example, another particular pixel may not join with the pixel 604 until it reaches the root component/node 610_{10}.

[0060] Once the various DAP vectors and/or DAP VF have or has been generated 812, the method 800 may include ascertaining 816 one or more critical parameters (e.g., LSD parameters 264 in Figure 2) for each of the pixels from their respective DAP vectors in any appropriate manner. One critical parameter referred to herein as a "lifetime" (L) parameter is the largest entry in the DAP vector and conveys a contrast equivalent notion of the maximal dissimilarity between all consecutive pairs of largest components to which a pixel belongs in the given multi-scale DAP decomposition of the image. A largest component is the component of an area zone defined at the highest possible value of alpha and still being of an area (e.g., pixel count) that matches the upper bound of the given area zone. Another critical parameter referred to herein as a "scale" (S) parameter is the first area zone, in ascending order, at which L was first encountered and may generally convey the dominant scale or zone of the DAP decomposition for each pixel. Another critical parameter referred to herein as a "dissimilarity" (D) parameter is the alpha value of the smallest component of the lowest area zone (in ascending order) to which a given pixel belongs and from which L was ascertained. The parameter D may generally convey an indication of regional smoothness in the resulting segmentation. In the case of the pixel 604 in Figure 6, the L, S and D parameters of the pixel 604 (e.g., represented by the variable "x") may be as follows:

[0061] L(x) = 9 (see the third entry in DAP(x));

[0062] S(x) = 3 (the area zone corresponding to the third entry in DAP(x)); and

[0063] D(x) = 9 (the lowest alpha level in the third area zone).

[0064] Output image layers 265 that respectively include the L, S and D parameters for the various pixels (and that naturally shape up the pixels therein into a number of connected second components 276 as discussed below) may be respectively generated and used in various manners to obtain information of interest from and/or present different visual appearances of the one or more input overhead images. For instance, the L, S and D layers may be fused into a single three-band model referred to herein as the "LSD" model to provide a drastic reduction of the DAP VF for use in image segmentation and semantic visualization (e.g., from what may be hundreds or even more of entries in a DAP vector for a pixel due to what may be hundreds or even more area zones through which the pixel propagates). In one arrangement, the L, S and D layers may be passed from the DAP engine 236 to the mapping engine 248 whereby the layers may be appropriately combined into a resultant image 290 and displayed for use by analysts and the like. For example, any appropriate Hue-Saturation-Value (HSV) transform/logic or the like may function to produce a color output whereby hue is mapped to the S layer (where the hue of a particular pixel or component changes based on its S value), value is mapped to L (where the value of a particular pixel or component changes

based on its L value), and where saturation is constant. As another example, color may be mapped directly to the S layer and color strength value (e.g., dark color value to bright color value) may be mapped to the L layer. See Figure 13.

[0065] As a further example, the L layer may be substituted with one or more geometric descriptors of connected components shaped within the L layer and consisting of iso-intensity pixels to reduce the occurrence of cross-image instabilities, present stable color representations, and enhance the appearance of structures of interest (e.g., built-up, such as three-dimensional man-made structures or the like) relative to portions of the image that are not structures of interest (e.g. non-man-made 3D structures, rivers, roads, etc.). For instance, one arrangement includes generating a compactness or a contour smoothness layer based on the respective attributes of the iso-intensity connected components shaped within the L layer (e.g., where high levels of component compactness would be more likely to signify a structure of interest such as built-up, in contrast to an elongated road or river which would be associated with lower levels of compactness). This example is referred to herein as the Attribute-Scale-Dissimilarity (ASD) model. See Figure 14.

[0066] Before or as part of mapping any of the aforementioned layers and/or additional layers into one or more resultant images 290, one or more filtering procedures may be performed on the pixels, components, layers, and/or the like to progressively identify and remove pixels, components, layers, etc. that are highly likely to be "non-target" candidates (e.g., not associated with structures of interest) so as to further refine a group of "target" candidates in the resultant images 290 of the geographic area corresponding to the one or more input overhead images 224 (e.g., pixels/components highly likely to identify structures of interest). In one arrangement, at least one of such filtering procedures may generate at least one non-target "mask" (e.g., a layer corresponding to the geographical area of the one or more input overhead images where first, white regions (e.g., logical "1") correspond to regions that are target regions/candidates (or are likely target candidates) and where second, black regions (e.g., logical "0") correspond to regions that are non-target regions/candidates (or are likely non-target candidates)). In this regard, application of such non-target masks to one or more of the image layers (e.g., an L-S-D image layer fusion; an A-S-D image layer fusion, etc.) may serve to automatically remove non-target regions from the one or more resultant images 290 (e.g., or from the one or more input overhead images themselves). In one arrangement, a plurality of the non-target masks may be fused into a single "fusion" mask (e.g., as shown in Figure 11) that may be applied over, for instance, the L, S, and D layer fusion to automatically remove non-target portions of the fusion.

[0067] Returning to Figure 3, the method 300 may include, for instance, performing geometric attribute filtering 320 with the first components 252 to remove non-target pixels and/or components from the one or more resultant images 290. With particular reference now to Figure 9, a method 900 for performing such geometric attribute filtering 320 using first components and generating a corresponding mask (e.g., via the NTC engine 232) is presented. Broadly, the NTC engine 232 may be configured to cluster regions that are highly likely to be non-target candidates. At 904, the NTC engine 232 may proceed to detect first components 252 of the hierarchical data structure 256 that each collectively identify a geometric attribute level (e.g., size, non-compactness, etc.) that is greater than a threshold level

for the geometric attribute. In the case of size, for instance, it may be assumed that structures of interest such as built-up may generally not exceed a certain size (e.g., area) threshold. For instance, first components 252 that are greater than a certain area threshold (e.g., as just one non-limiting example, 20,000m^2 may identify features such as water, vegetation, bare soil, and/or the like). In the case of non-compactness, for instance, it may be assumed that structures of interest such as built-up may generally not exceed a certain non-compactness threshold (e.g., as higher levels of non-compactness indicate highly elongated objects road networks, rail-lines, rivers, streams, etc., all of which would generally not be associated with three dimensional man-made structures such as buildings, houses, tents, etc.).

[0068] To reduce the likelihood of false positives, the NTC engine 232 may, in one arrangement, limit its focus to first components 252 at relatively low levels of alpha in the hierarchical data structure 256 (where all pixels in such components would be highly similar to each other in relation to the dissimilarity measure, such as in relation to intensity/grayscale or the like). For instance, the NTC engine 232 may analyze all "included" nodes 513 (e.g., components) at the α=0 and 1 levels in the alpha partition pyramid 500 of Figure 5 (e.g., which would include all nodes at the α=0 level and nodes 516 and 520 at the α=1 level) and determine whether any of such nodes represented an area on the ground greater than a threshold area (e.g., as determined by the number of pixels included in the component multiplied by the spatial resolution of the image sensor).

[0069] The resulting segmentation performed by the NTC engine 232 may yield a set of relatively homogeneous regions (i.e., the detected 904 first components) some of which may be target candidates (e.g., structures of interest, such as built-up) and some of which may not be non-target candidates (e.g., not structures of interest, such as non-built-up). To identify non-target candidates 268 (shown in Figure 2), the method 900 of Figure 9 may proceed to obtain 908 at least one attribute (e.g., feature elements such as contour-smoothness, linearity, entropy, moment invariants, and/or the like) of each of the detected 904 first components and then ascertain 912 whether the attributes are (e.g., likely are) or are not (e.g., are likely not) associated with structures of interest in the one or more input overhead images (e.g., via attribute filtering).

[0070] A non-target mask 272 may then be generated 916 by the NTC engine 232 to filter out non-target pixels and/or components from the one or more resultant images 280. After the one or more input overhead images have been segmented as discussed above to generate one or more image layers (e.g., L-S-D; A-S-D, etc.), the non-target mask 272 may be applied over the layer(s) to automatically remove portions that are highly likely to be non-target portions (e.g., portions that are not structures of interest). For instance, Figure 12 presents such a mask over the same portion of Seattle, WA as in Figure 11, where black regions correspond to the non-target candidates 268 and where white regions correspond to regions that are more likely than not to be target regions/candidates. Figure 13 illustrates a fusion of L and S layers over the portion of Seattle, WA of Figure 11 using an HSV transform to obtain a color output, where the mask of Figure 12 has been applied thereover to automatically remove non-target portions.

[0071] Another manner of further refining target regions/candidates in the resultant images 290 (e.g., by identifying and removing non-target pixels/components/etc.) may include the CCCP engine 240 clustering 324 the pixels of the one or input overhead images (e.g., either all of the pixels or just those of the target candidates after application of the non-target mask 272) based on one or more of the critical parameters (e.g., one of the L, S or D parameters 264) into a number of new or second components 276 and then performing geometric attribute filtering 328 on the second components (by way of filtering 332 out non-target second components based on at least one geometric attribute). Stated differently, the clustering step 324 may include re-clustering the pixels of the one or more input overhead images into components in a manner different than that performed by the construction engine 228 to generate the hierarchical data structure 228 (e.g., the alpha partition pyramid 500 of Figure 5).

[0072] For instance, Figure 7 is a simplified schematic view of a portion of an L-band image layer 700 that includes a plurality of rows and columns of pixels 704 of one or more input overhead images (only 49 shown in Figure 7 in the interest of clarity) and arranged in a native format (e.g., in the same manner as the corresponding photosites of the image sensor(s)). Each pixel 704 having an "x" thereon may represent a non-target pixel that was removed from the analysis via the NTC engine 232 or the like. The remaining pixels 704 include values 708 that correspond to, for instance, their respective L parameter (although other of the critical parameters may be used for clustering as well). As such, a number of second components 276 (labeled in Figure 2) each including pixels 704 having common (or substantially common) L parameters may be identified in the layer 700 such as second components 712, 716, 720 and 724.

[0073] One or more geometric or structural attributes 278 (e.g., contour-smoothness, linearity, entropy, moment invariants, etc.) of each of the second components 276 may be obtained in any appropriate manner and analyzed (e.g., via attribute filtering 280 as discussed herein) to identify non-target candidates 284 from the second components 276 (shown in Figure 2). A mask 288 corresponding to the particular geographic area of the one or more input overhead images may be constructed with the non-target candidates 284 and used (e.g., by the mapping engine 248) to remove non-target structures (e.g., trees, other odd-shaped structures, etc.) that were not removed by application of the non-target mask 272. For instance, a second component 276 with a low contour-smoothness measure (e.g., indicating a severely distorted contour) is highly unlikely to be a building and may be correspondingly removed from the one or more image layers (e.g., an L-S-D layer fusion; an A-S-D layer fusion, etc.).

[0074] Another manner of further refining target regions/candidates in the resultant images 290 may include obtaining radiometric attributes 289 of any non-target candidates 268 (e.g., first components 252) identified by the NTC engine 232 and/or radiometric attributes 285 of any non-target candidates 284 (e.g., second components 276) identified by the CCCP engine and using the radiometric attributes to essentially create a spectral signature that may be used to eliminate or remove additional second components 278 (e.g., their pixels) from any resultant images 290. For instance, such a spectral signature may be useful to remove a tree (e.g., not a structure of interest) from the resultant image 290 that was not removed by the non-target mask 288 of the CCCP engine 240 due to its having a similar size and shape as a building (e.g., a structure of interest). As shown in Figure 3, the method 300 may include

performing radiometric filtering 332 of the second components 278, such as via the radiominer engine 244 executing a rule generator 291 to generate rules 292 and then application of generated rules 292 to target candidates (e.g., to retained second components 278). While generation of rules 292 based on radiometric attributes of both non-target candidates 268 of the first components 252 and non-target candidates 284 of the second components 276 is discussed, other arrangements envision that such radiometric attribute filtering may be based on only one of the radiometric attributes of the non-target candidates 268 of the first components 252 or those of the non-target candidates 284 of the second components 276.

[0075] Turning to Figure 10, a method 1000 of performing radiometric attribute filtering is presented. At 1004, the method 1000 may include obtaining at least one radiometric attribute 285 (e.g., radiance, radiant flux, intensity, and/or the like) of any second components 278 determined to be non-target candidates 284 (e.g., during the geometric attribute filtering 280 and/or via application of a non-target mask 288). The method 1000 may also include obtaining 1008 at least one radiometric attribute 269 (e.g., radiance, radiant flux, intensity, and/or the like) of any first components 252 determined to be non-target candidates 268 (e.g., via application of a non-target mask 272). The method 1000 may then derive or generate 1012 one or more rules 292 for filtering out additional second components 278 (e.g., second components not via application of non-target masks 288) based on the radiometric attributes 287 obtained at 1004 and 1008.

[0076] As an example, the radiominer engine 244 may compute the Normalized Differential Vegetation Index (NDVI) and the Normalized Differential Water Index (NDWI) from the at least one input overhead image and maps the extent of each connected component under examination to the respective index images. In each index image, the mean spectral response of each connected component may be computed along with its proximity to the maximal index value. Based on empirical safe-estimate thresholds, components with close proximity to the index maximal value may be removed with high certainty of corresponding to vegetated regions on the ground or regions within water bodies. The radiominer engine 244 may be utilized if the non-target masks provided at the system input are not computed based on radiometric information but are instead semantics derived from geometrical, statistical or other image properties.

[0077] In one arrangement, the mapping engine 248 may apply one or more NT masks 294 (e.g., NT masks 272 and/or 288) to one or more image layers 293 (e.g., L-S-D, A-S-D, etc.) to obtain a set of target candidates 295 (e.g., pixels, components, second components) to which the rules 292 may be applied 1016 by a rule application module 296 (e.g. where any appropriate radiometric attributes of the target candidates 295 are obtained to which the rules 292 may be applied). The resulting candidates may be passed to one or more visualization tools 297 (e.g., HSV2RGB transform 298, labeling module 299, other color conversion tools, etc.) for generation of one or more resultant images 290 of structures of interest in any appropriate manner. In another arrangement, the rules 292 may be initially applied to any retained components in the NT masks 294 to further refine the NT masks 294 (e.g., by converting white, target portions to black, non-target portions). The refined NT masks 294 may then be applied to the

image layers 293 and the resulting portions may be passed to one or more of the visualization tools 297 for generation of resultant images 290.

[0078] As an example, Figure 11 presents one or more original 8-band WorldView 2 images over a portion of Seattle, WA. Figure 12 presents a fusion mask that, for instance, incorporates non-target masks 272 and 288 as well as any rules 292 generated by the radiominer engine 244 (e.g., where white portions correspond to target candidates that are to be retained and black portions correspond to non-target candidates that are to be removed). Figure 13 presents a fusion of L-S-D layers over the portion of Seattle, WA of Figure 11 using an HSV transform to obtain a color output, where the mask of Figure 12 has been applied thereover to automatically remove non-target portions so that target portions (e.g., built-up) is displayed. For instance, a number of different structures 1104, 1108, 1112, 1116 and 1120 identified in Figure 11 are differently colored in Figure 13 (e.g., green, blue, pink, purple and red as indicated by the appropriate hash marks in the Figure 13) to indicate that the structures are respectively associated with at least partially different L, S and/or D parameters.

[0079] As discussed previously, another fusion model is the A-S-D fusion whereby the L layer is substituted with one or more geometric descriptors of connected components shaped within the L layer and consisting of iso-intensity pixels to reduce the occurrence of cross-image instabilities. Figure 14 presents such a model whereby the structures 1104, 1108, 1112, 1116 and 1120 are again identified. While it may appear that the colors/shades/tones of the structures 1104, 1108, 1112, 1116 and 1120 remain the same between Figures 13-14, at least one or more colors/shades/tones of the structures 1104, 1108, 1112, 1116 and 1120 and/or other unlabeled structures in Figure 14 may change from those depicted in Figure 13 to appropriately convey any appropriate geometric descriptor of connected components in place of conveying L parameter values.

[0080] Figure 15 presents an image similar to Figures 13-14 but where the unique identifier (e.g., label) of each of the target candidates 295 (e.g., the retained second components 276) are color coded. Specifically, a label of each component may be an integer number from the index set of all connected components assigned explicitly to a single component in order to address it and/or differentiate it from others. The label can be assigned any randomly generated color to allow for visualization of the same. As shown, the structures 1104, 1108, 1112, 1116 and 1120 may be differently colored (e.g., pink, brown, pink, grey, and green as indicated by the appropriate hash marks in the Figure 15). It is noted that the various unlabeled structures have not been hashed to indicated appropriate color coding in Figures 13-15 in the interest of clarity.

[0081] The utilities disclosed herein may be used to generate a globally-consistent HR/VHR overhead image layer that includes structures of interest (e.g., built-up) and that is devoid of non-structures of interest. The globally-consistent layer can be used in numerous contexts such as in assessing population densities, qualities of life, vulnerability factors, disaster risks, sufficiency of civil infrastructures, economic growth, poverty levels, event monitoring and evolution, and the like.

[0082] It will be readily appreciated that many deviations and/or additions may be made from or to the specific embodiments disclosed in the specification without departing from the spirit and scope of the invention. In one arrangement, it is envisioned that different structures of interest (e.g., different types of built-up) may be differently shaded, colored, and/or the like in the resulting image to allow analysts to be able to quickly analyze the resulting image. As an example, the mapping engine 248 may analyze any appropriate feature elements (e.g., structural, geometric and/or radiometric attributes) of the target candidates 295 (e.g., second components 276 that identify structures of interest) to determine a type of built-up structure represented by the particular target candidate(s). For instance, buildings may exhibit one general type of feature element "signature" while tents may exhibit another type of feature element signature. The mapping engine 248 may have access to a database that correlates feature element signatures with respective colors, shades, and/or the like. During the mapping of the extracted target candidates into the resulting image, the mapping engine 295 may access the database and implement the colors, shades, etc. as appropriate.

[0083] In another arrangement, at least some attribute filtering may be performed on the one or more input overhead images before generation of DAP vectors 260 and LSD parameters 264 such that the DAP vectors 260 and LSD parameters 264 are only computed for pixels that are more likely than not to be structures of interest. In a further arrangement, the DAP engine 260 may tag the first components 252 of the hierarchical data structure 256 based on other types of geometric zones other than area zones (e.g., non-compactness zones and/or the like). Furthermore, it is not necessary that all of the various filtering steps disclosed herein are necessarily performed before presentation of the resultant images 290 for analysis by users. For instance, it may be advantageous in some contexts to observe one or more image layers (e.g., L-S-D fusion, etc.) that includes both structures of interest (e.g., built-up) and non-structures of interest (e.g., non-built-up).

[0084] Furthermore, it will be appreciated that a number of other 226 types of data or information (other than input overhead image data 224 and resultant images 290) may be stored in storage 212 as appropriate such as hierarchical data structures 256 and their first components 252, DAP vectors 260, LSD parameters 264, and the like. Still further, and as discussed herein, it is not necessary, unless otherwise specified, that the various functionalities disclosed herein are performed in the exact order and/or by the exact engine/module as illustrated and described herein.

[0085] Embodiments disclosed herein can be implemented as one or more computer program products, i.e., one or more modules of computer program instructions encoded on a computer-readable medium for execution by, or to control the operation of, data processing apparatus. For example, the logic or software of the construction engine 228, NTC engine 232, DAP engine 236, CCCP engine 240, radiominer engine 244 and mapping engine 248 responsible for the various functionalities disclosed herein may be provided in such computer-readable medium of the automated extraction system 200 and executed by the processor 208 as appropriate. The computer-readable medium can be a machine-readable storage device, a machine-readable storage substrate, a non-volatile memory device, a composition of matter affecting a machine-readable propagated signal, or a combination of one or more of

them. In this regard, the system 200 may encompass one or more apparatuses, devices, and machines for processing data, including by way of example a programmable processor, a computer, or multiple processors or computers. In addition to hardware, the system 200 may include code that creates an execution environment for the computer program in question, e.g., code that constitutes processor firmware, a protocol stack, a database management system, an operating system, or a combination of one or more of them.

[0086] A computer program (also known as a program, software, software application, script, or code) used to provide any of the functionalities described herein (e.g., construction of the first and second hierarchical data structures and the like) can be written in any appropriate form of programming language including compiled or interpreted languages, and it can be deployed in any form, including as a stand-alone program or as a module, component, subroutine, or other unit suitable for use in a computing environment. A computer program does not necessarily correspond to a file in a file system. A program can be stored in a portion of a file that holds other programs or data (e.g., one or more scripts stored in a markup language document), in a single file dedicated to the program in question, or in multiple coordinated files (e.g., files that store one or more modules, sub-programs, or portions of code). A computer program can be deployed to be executed on one computer or on multiple computers that are located at one site or distributed across multiple sites and interconnected by a communication network.

[0087] The processes and logic flows described in this specification can be performed by one or more programmable processors executing one or more computer programs to perform functions by operating on input data and generating output. The processes and logic flows can also be performed by, and apparatus can also be implemented as, special purpose logic circuitry, e.g., an FPGA (field programmable gate array) or an ASIC (application-specific integrated circuit). Processors suitable for the execution of a computer program may include, by way of example, both general and special purpose microprocessors, and any one or more processors of any kind of digital computer. Generally, a processor will receive instructions and data from a read-only memory or a random access memory or both. Generally, the elements of a computer are one or more processors for performing instructions and one or more memory devices for storing instructions and data. The techniques described herein may be implemented by a computer system configured to provide the functionality described.

[0088] While this specification contains many specifics, these should not be construed as limitations on the scope of the disclosure or of what may be claimed, but rather as descriptions of features specific to particular embodiments of the disclosure. Furthermore, certain features that are described in this specification in the context of separate embodiments can also be implemented in combination in a single embodiment. Conversely, various features that are described in the context of a single embodiment can also be implemented in multiple embodiments separately or in any suitable subcombination. Moreover, although features may be described above as acting in certain combinations and even initially claimed as such, one or more features from a claimed combination can in some cases be excised from the combination, and the claimed combination may be directed to a subcombination or variation of a subcombination.

[0089] Similarly, while operations are depicted in the drawings in a particular order, this should not be understood as requiring that such operations be performed in the particular order shown or in sequential order, or that all illustrated operations be performed, to achieve desirable results. In certain circumstances, multitasking and/or parallel processing may be advantageous. Moreover, the separation of various system components in the embodiments described above should not be understood as requiring such separation in all embodiments, and it should be understood that the described program components and systems can generally be integrated together in a single software and/or hardware product or packaged into multiple software and/or hardware products.

[0090] The above described embodiments including the preferred embodiment and the best mode of the invention known to the inventor at the time of filing are given by illustrative examples only.

WE CLAIM:

1. A method for use in extracting structures of interest from overhead imagery data, comprising:

identifying, using a processor, a plurality of groups of pixels in at least one input overhead image of a geographical region, wherein each pixel in each group is adjacent to at least one other pixel in the group, wherein adjacent pixels in each group do not differ by more than a predetermined level of a dissimilarity measure between the adjacent pixels, wherein a plurality of such groups of pixels at each of a plurality of successive predetermined levels of the dissimilarity measure are identified, wherein the groups at one of the predetermined levels are hierarchically related to the groups at an adjacent one of the predetermined levels in a hierarchical data structure, and wherein each group is a first component;

tagging, using the processor, each of the first components based on a number of pixels present in the first component to identify one of a plurality of area zones within which the first component resides, wherein each successive area zone includes first components having a greater number of pixels than do the first components of a previous area zone; and

generating for each pixel of the input overhead image, using the processor, a vector including a number of entries corresponding to each of the area zones from the tagging step, wherein each entry comprises a difference between a lowest dissimilarity measure level of a first component within which the pixel is disposed in the corresponding area zone and a lowest dissimilarity measure level of a first component within which the pixel is disposed in a subsequent area zone.

2. The method of claim 1, further comprising:

determining for each pixel of the input overhead image, using the processor, a largest entry in the vector corresponding to the pixel, wherein the largest entry is a lifetime parameter value.

3. The method of claim 2, further comprising:

generating an image layer that includes the lifetime parameter values of the pixels of the input overhead image, and mapping the lifetime parameter layer into a resultant image that is associated with the geographical region.

4. The method of claim 3, further comprising:

determining for each pixel of the input overhead image, using the processor, the area zone of the largest entry in the vector corresponding to the pixel, wherein the area zone of the largest entry is a scale parameter value;

generating an image layer that includes the scale parameter values of the pixels of the input overhead image; and

mapping the scale parameter layer into the resultant image that is associated with the geographical region.

5. The method of claim 4, further comprising:

determining for each pixel of the input overhead image, using the processor, the lowest predetermined level of the dissimilarity measure in the area zone of the largest entry in the vector corresponding to the pixel,

wherein the lowest predetermined level of the dissimilarity measure in the area zone of the largest entry in the vector corresponding to the pixel is a dissimilarity parameter value;

generating an image layer that includes the dissimilarity parameter values of the pixels of the input overhead image; and

mapping the dissimilarity parameter layer into the resultant image that is associated with the geographical region.

6. The method of claim 3, further comprising:

detecting first components in the hierarchical data structure that each include pixels collectively comprising a geometric attribute level greater than a threshold geometric attribute level, wherein the detected first components comprise lower predetermined levels of the dissimilarity measure than other of the predetermined levels of the dissimilarity measure.

7. The method of claim 6, further comprising:

obtaining at least one attribute of each of the detected first components;

ascertaining whether the at least one attribute of each of the detected first components is associated with a structure of interest in the at least one input overhead image;

generating a first mask corresponding to the image layer based on the detected first component ascertaining step that includes first regions that are ascertained to be associated with structures of interest and second regions that are ascertained to not be associated with structures of interest;

applying the first mask over the image layer to remove portions of the image layer that are not associated with structures of interest; and

mapping resulting portions of the image layer into a resultant image that is associated with the geographical region.

8. The method of claim 7, further comprising:

clustering pixels in the image layer having common respective lifetime parameters into a plurality of corresponding second components;

obtaining at least one feature element of each of the second components, wherein the at least one feature element comprises at least one geometric attribute; and

ascertaining whether each of the second components is associated with a structure of interest in the at least one input overhead image based on the at least one feature element.

9. The method of claim 8, further comprising:

generating a second mask corresponding to the image layer based on the second component ascertaining step that includes first regions that are ascertained to be associated with structures of interest and second regions that are ascertained to not be associated with structures of interest; and

applying the second mask over the image layer to remove portions of the image layer that are not associated with structures of interest.

10. The method of claim 9, further comprising: