AO 120 (Rev. 08/10)

TO:	Mail Stop 8 Director of the U.S. Patent and Trademark Office P.O. Box 1450 Alexandria, VA 22313-1450	REPORT ON THE FILING OR DETERMINATION OF AN ACTION REGARDING A PATENT OR TRADEMARK

In Compliance with 35 U.S.C. § 290 and/or 15 U.S.C. § 1116 you are hereby advised that a court action has been filed in the U.S. District Court for the District of Utah on the following

☐ Trademarks or ☒ Patents . (☐ the patent action involves 35 U.S.C. § 292.):

DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
2:21-cv-00283-TS	5/4/2021	District of Utah, 351 S. West Temple, Rm. 1.100, Salt Lake City, UT 84101

PLAINTIFF	DEFENDANT
EAGLE VIEW TECHNOLOGIES, INC. and PICTOMETRY INTERNATIONAL CORP.	NEARMAP US, INC.

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1	US 8,209,152 B2	6/26/2012	EagleView Technologies, Inc.
2	US 8,542,880 B2	9/24/2013	Pictometry International Corp.
3	US 8.593,518 B2	11/26/2013	Pictometry International Corp.
4	US 8,670,961 B2	3/11/2014	Eagle View Technologies, Inc.
5	US 9,135,737 B2	9/15/2015	Eagle View Technologies, Inc.

In the above—entitled case, the following patent(s)/ trademark(s) have been included:

DATE INCLUDED	INCLUDED BY ☐ Amendment ☐ Answer ☐ Cross Bill ☐ Other Pleading	
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1		
2		
3		
4		
5		

In the above—entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT

CLERK	(BY) DEPUTY CLERK	DATE
D. Mark Jones		

Copy 1—Upon initiation of action, mail this copy to Director Copy 3—Upon termination of action, mail this copy to Director
Copy 2—Upon filing document adding patent(s), mail this copy to Director Copy 4—Case file copy

NEARMAP-1002

(12) **INTER PARTES REVIEW CERTIFICATE** (1615th)
United States Patent
Pershing

(10) **Number: US 9,135,737 K1**
(45) **Certificate Issued: Jan. 16, 2020**

(54) **CONCURRENT DISPLAY SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION**

(71) Applicant: **Chris Pershing**

(72) Inventor: **Chris Pershing**

(73) Assignee: **Eagle View Technologies, Inc.**

Trial Number:

IPR2016-00592 filed Feb. 8, 2016

Inter Partes Review Certificate for:

Patent No.: **9,135,737**
Issued: **Sep. 15, 2015**
Appl. No.: **14/450,108**
Filed: **Aug. 1, 2014**

The results of IPR2016-00592 are reflected in this inter partes review certificate under 35 U.S.C. 318(b).

AS A RESULT OF THE INTER PARTES REVIEW PROCEEDING, IT HAS BEEN DETERMINED THAT:

Claims **1**, **9**, **10**, **16**, **19**, **22**, **25-28**, **31** and **34-36** are found patentable.

* * * * *

NOTE: This disposition is nonprecedential.

United States Court of Appeals for the Federal Circuit

XACTWARE SOLUTIONS, INC.,
Appellant

v.

EAGLE VIEW TECHNOLOGIES, INC.,
Appellee

2018-1053, 2018-1055, 2018-1056, 2018-1110

Appeals from the United States Patent and Trademark Office, Patent Trial and Appeal Board in Nos. IPR2016-00589, IPR2016-00590, IPR2016-00591, IPR2016-00592.

Decided: March 6, 2019

MARK NIKOLSKY, McCarter & English, LLP, Newark, NJ, argued for appellant. Also represented by SCOTT S. CHRISTIE, TIMOTHY PATRICK HOMLISH, MATTHEW ADAM SKLAR; LEE CARL BROMBERG, Boston, MA.

JOHN C. O'QUINN, Kirkland & Ellis LLP, Washington, DC, argued for appellee. Also represented by JASON M. WILCOX; ADAM R. ALPER, San Francisco, CA; GIANNI CUTRI, Chicago, IL.

Before PROST, *Chief Judge,* MOORE and WALLACH, *Circuit Judges.*

PROST, *Chief Judge.*

Xactware Solutions, Inc. ("Xactware") appeals the final written decisions of the Patent Trial and Appeal Board ("Board") in four *inter partes* reviews. As relevant to this appeal, the Board upheld the validity of certain claims of U.S. Patent Nos. 8,825,454 ("the '454 patent"); 8,818,770 ("the '770 patent"); 8,209,152 ("the '152 patent"); and 9,135,737 ("the '737 patent"). We affirm.

The parties spent most of their briefing in these appeals debating the evidentiary showing required for a patent owner to be given the presumption of nexus as to evidence it offers to show secondary considerations of non-obviousness. We do not reach that issue for two reasons. First, this was not clearly at issue in the parties' briefing before the Board. In its Patent Owner Response, Eagle View Technologies, Inc. ("Eagle View") argued that a nexus existed between its secondary considerations evidence and the patent claims because the relevant products "are the invention disclosed." *E.g.*, J.A. 1162. In its Reply, Xactware merely challenged the credibility of Eagle View's expert and argued that the expert's testimony failed to demonstrate that the products actually practiced the claimed inventions. *E.g.*, J.A. 1786–88. The evidentiary showing necessary to earn the presumption of nexus was simply not at issue before the Board. Second, substantial evidence supports the Board's finding of nexus based on the limited evidentiary record on this issue.

Appellant raises a few other arguments apart from the challenge to the Board's nexus finding. With respect to the '770 patent, we hold that substantial evidence supports the Board's finding that the "moving" and "movement" limitations are not disclosed in Yair Avrahami, et al., *Extraction of 3D Spatial Polygons Based on the Overlapping Criterion*

for Roof Extraction from Aerial Images, International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences, August 29–30, 2005 ("Avrahami"). We also see no error in the Board's decision not to consider Xactware's untimely-raised argument that Avrahami discloses the "moving" and "movement" limitations by the placement of subsequent seed points after placement of a first seed point, as well as the addition of segmentations around each seed point. As to Appellant's arguments regarding the '152 patent, we see no reversible error in the Board's treatment of claims 10, 15, and 25.

We have considered Appellant's remaining arguments and find them unpersuasive. We therefore affirm the Board's final written decisions in these four *inter partes* reviews.

AFFIRMED

United States Court of Appeals for the Federal Circuit

XACTWARE SOLUTIONS, INC.,
Appellant

v.

EAGLE VIEW TECHNOLOGIES, INC.,
Appellee

2018-1053, 2018-1055, 2018-1056, 2018-1110

Appeals from the United States Patent and Trademark Office, Patent Trial and Appeal Board in Nos. IPR2016-00589, IPR2016-00590, IPR2016-00591, IPR2016-00592.

JUDGMENT

THIS CAUSE having been considered, it is

ORDERED AND ADJUDGED:

AFFIRMED

ENTERED BY ORDER OF THE COURT

March 6, 2019

/s/ Peter R. Marksteiner
Peter R. Marksteiner
Clerk of Court

United States Court of Appeals for the Federal Circuit

XACTWARE SOLUTIONS, INC.,
Appellant

v.

EAGLE VIEW TECHNOLOGIES, INC.,
Appellee

2018-1053, 2018-1055, 2018-1056, 2018-1110

Appeals from the United States Patent and Trademark Office, Patent Trial and Appeal Board in Nos. IPR2016-00589, IPR2016-00590, IPR2016-00591, IPR2016-00592.

MANDATE

In accordance with the judgment of this Court, entered March 6, 2019, and pursuant to Rule 41 of the Federal Rules of Appellate Procedure, the formal mandate is hereby issued.

FOR THE COURT

April 12, 2019

/s/ Peter R. Marksteiner
Peter R. Marksteiner
Clerk of Court

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	REQUEST ID
14/450,108	08/01/2014	Eagle View Technologies, Inc.	6339.086	66153

Acknowledgement of Loss of Entitlement to Entity Status Discount

The entity status change request below filed through Private PAIR on 06/19/2018 has been accepted.

CERTIFICATIONS:

Change of Entity Status:

X Applicant changing to regular undiscounted fee status.

NOTE: Checking this box will be taken to be notification of loss of entitlement to small or micro entity status, as applicable.

This portion must be completed by the signatory or signatories making the entity status change in accordance with 37 CFR 1.4(d)(4).

Signature:	/marcabrockhaus/
Name:	Marc A. Brockhaus
Registration Number:	40923

McCARTER &ENGLISH
ATTORNEYS AT LAW

OCT 26 PM 4:06

VIA HAND DELIVERY

October 26, 2017

Director of the United States Patent and Trademark Office
c/o Office of the General Counsel
10B20, Madison Building East
600 Dulany Street
Alexandria, VA 22314

Re: Our File: 097171-00269
Petitioner's Notice of Appeal to the United States Court of Appeals for the Federal Circuit
Case IPR2016-00592
Inter Partes Review of U.S. Patent No. 9,135,737

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BOSTON
HARTFORD
STAMFORD
NEW YORK
NEWARK
EAST BRUNSWICK
PHILADELPHIA
WILMINGTON
WASHINGTON, DC

Dear Director:

Please find enclosed a copy of the following documents that were filed today, October 26, 2017, with the United States Patent and Trademark Office in connection with the above-identified *inter partes* review proceeding, and served on counsel for Patent Owner:

1. Petitioner's Notice of Appeal to the United States Court of Appeals for the Federal Circuit.

2. Certificate of Service.

3. Copy of Final Written Decision issued by the Patent Trial and Appeal Board in Case IPR2016-00592 on August 25, 2017.

Any inquiry in connection with this matter can be made directly to Mark E. Nikolsky, Esq. in our Newark office at (973) 639-6987. Thank you.

Very truly yours,

Mark E. Nikolsky
Counsel for Petitioner, Xactware Solutions, Inc.

MN/th

Enclosures

cc: counsel for Patent Owner; Gianni Cutri, Esq.; Jared Barcenas, Esq.; Marc Brockhaus, Esq.

ME1 25948933v.1

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

XACTWARE SOLUTIONS, INC.
Petitioner

v.

EAGLE VIEW TECHNOLOGIES, INC.
Patent Owner

Case IPR2016-00592
U.S. Patent No. 9,135,737

PETITIONER'S NOTICE OF APPEAL TO THE UNITED STATES COURT OF APPEALS FOR THE FEDERAL CIRCUIT

Hand Delivery
Director of the United States Patent and Trademark Office
c/o Office of the General Counsel
10B20, Madison Building East
600 Dulany Street
Alexandria, VA

E-Filed Via PTAB E2E
Mail Stop PATENT BOARD
Patent Trial and Appeal Board
United States Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450

Pursuant to 35 U.S.C. § 141, 35 U.S.C. § 142, 35 U.S.C. § 319, and 37 C.F.R. § 90.2, and 37 C.F.R. § 90.3, Petitioner Xactware Solutions, Inc. ("Petitioner" or "Xactware") hereby appeals to the United States Court of Appeals for the Federal Circuit and gives notice of its appeal. Xactware hereby appeals from the Final Written Decision in IPR2016-00592 entered by the United States Patent and Trademark Office's Patent Trial and Appeal Board ("Board") on August 25, 2017 ("Decision") and from all orders, decisions, rulings, and opinions of the Decision, those orders, decisions, rulings, and opinions underlying, supporting, leading up to and/or incorporated into the Decision; and any orders, decisions, rulings, and opinions that adversely affected Xactware. A copy of the Decision is attached.

In accordance with 37 C.F.R. § 90.2(a)(3)(ii), Xactware further indicates that the issues on appeal include, but are not limited to, the Board's determination that Petitioner has not shown by a preponderance of the evidence that Claims 1, 9, 10, 16, 19, 22, 25–28, 31, and 34–36 of U.S. Patent No. 9,135,737 B2 ("the '737 patent") are unpatentable; the Board's determination that Patent Owner Eagle View Technologies, Inc.'s products embody all of the elements of the challenged Claims of the '737 patent; the Board's conclusion that there is a nexus between the merits of the claimed invention of the '737 patent and the purported evidence of secondary considerations of non-obviousness proffered by Patent Owner Eagle

View Technologies, Inc.; the Board's conclusions regarding the purported commercial success and industry praise of Patent Owner Eagle View Technologies, Inc.'s products; the Board's analysis with respect to secondary considerations of non-obviousness; the Board's analysis with respect to objective evidence of non-obviousness; the Board's determination that Petitioner has not shown by a preponderance of the evidence that Claims 1, 9, 10, 16, 19, 22, 25–28, 31, and 34–36 of the '737 patent are unpatentable under 35 U.S.C. § 103(a); the Board's determination that Petitioner has not shown by a preponderance of the evidence that Claims 1, 9, 16, 19, 22, 25–28, 31, and 34–36 of the '737 patent are unpatentable as obvious over the combination of Yair Avrahami et al., *Extraction of 3D Spatial Polygons Based on the Overlapping Criterion for Roof Extraction from Aerial Images*, IAPRS, Vol. XXXVI, Part 3/W24, Aug. 29-30, 2005 ("Avrahami")(Ex. 1004) and Appli-cad, *Product Bulletin – November 2002: Key Features Of Our Roofing Software*, Nov. 2002 ("Applicad")(Ex. 1005); the Board's determination that Petitioner has not shown by a preponderance of the evidence that Claim 10 of the '737 patent is unpatentable as obvious over the combination of Avrahami, Applicad, and Frederick P. Perlant et al., *Scene Registration in Aerial Image Analysis*, Photogrammetric Engineering and Remote Sensing, Vol. 56, No. 4, Apr. 1990 ("Perlant") (Ex. 1006); any applicable claim construction issues; the Board's failure to consider the evidence of record and/or

the evidence and materials proffered by Xactware; the Board's findings that conflict with the evidence of record and/or that are not supported by substantial evidence and/or that are otherwise inconsistent with the evidence and materials proffered by Xactware; any other adverse finding or determination made in support of the Decision; and all findings or determinations supporting or related to any or all of those issues, as well as any other issues that were decided adversely to Xactware in any orders, decisions, rulings, and opinions underlying, supporting, leading up to and/or incorporated into the Decision.

Xactware is concurrently filing true and correct copies of this Notice of Appeal to the United States Court of Appeals for the Federal Circuit, along with the required fees, with the Clerk of the United States Court of Appeals for the Federal Circuit and serving this Notice of Appeal to the United States Court of Appeals for the Federal Circuit on the Director of the United States Patent and Trademark Office.

October 26, 2017
Dated

/Mark E. Nikolsky/

By: Mark E. Nikolsky (Lead Counsel)

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Attorneys for
Petitioner Xactware Solutions, Inc.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

XACTWARE SOLUTIONS, INC.
Petitioner

v.

EAGLE VIEW TECHNOLOGIES, INC.
Patent Owner

Case IPR2016-00592
U.S. Patent No. 9,135,737

CERTIFICATE OF SERVICE

Hand Delivery
Director of the United States Patent and Trademark Office
c/o Office of the General Counsel
10B20, Madison Building East
600 Dulany Street
Alexandria, VA

E-Filed Via PTAB E2E
Mail Stop PATENT BOARD
Patent Trial and Appeal Board
United States Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450

I hereby certify that on October 26, 2017 the original version of this PETITIONER'S NOTICE OF APPEAL TO THE UNITED STATES COURT OF APPEALS FOR THE FEDERAL CIRCUIT, including this Certificate of Service, was served by hand on the Director of the United States Patent and Trademark Office, at the following address:

Director of the United States Patent and Trademark Office
c/o Office of the General Counsel
10B20, Madison Building East
600 Dulany Street
Alexandria, Virginia

I hereby certify that a true and correct copy of this PETITIONER'S NOTICE OF APPEAL TO THE UNITED STATES COURT OF APPEALS FOR THE FEDERAL CIRCUIT, including this Certificate of Service, was filed on October 26, 2017 electronically through the Patent Trial and Appeal Board's PTAB E2E system:

Mail Stop PATENT BOARD
Patent Trial and Appeal Board
United States Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450

I hereby certify that a true and correct copy of this PETITIONER'S NOTICE OF APPEAL TO THE UNITED STATES COURT OF APPEALS FOR THE FEDERAL CIRCUIT, including this Certificate of Service, was filed electronically, and the requisite fees are being paid, on October 26, 2017 with the

Clerk's Office of the United States Court of Appeals for the Federal Circuit, 717 Madison Place, NW, Washington, DC 20439 in accordance with the rules of that Court. On October 26, 2017, a true and correct copy of this PETITIONER'S NOTICE OF APPEAL TO THE UNITED STATES COURT OF APPEALS FOR THE FEDERAL CIRCUIT, including this Certificate of Service, is also being mailed via Priority Mail Express® to Clerk of Court, United States Court of Appeals for the Federal Circuit, 717 Madison Place, NW, Washington, DC 20439. On October 26, 2017, a true and correct copy of this PETITIONER'S NOTICE OF APPEAL TO THE UNITED STATES COURT OF APPEALS FOR THE FEDERAL CIRCUIT, including this Certificate of Service, is also being served via hand service on the Clerk of Court, United States Court of Appeals for the Federal Circuit, 717 Madison Place, NW, Washington, DC 20439. I further certify that, on October 26, 2017, the requisite number of copies of this PETITIONER'S NOTICE OF APPEAL TO THE UNITED STATES COURT OF APPEALS FOR THE FEDERAL CIRCUIT, including this Certificate of Service, were served on the United States Court of Appeals for the Federal Circuit, 717 Madison Place, NW, Washington, DC 20439 in accordance with the rules of that Court.

I hereby certify that a true and correct copy of this PETITIONER'S NOTICE OF APPEAL TO THE UNITED STATES COURT OF APPEALS FOR THE FEDERAL CIRCUIT, including this Certificate of Service, has been

served in its entirety on October 26, 2017 via electronic mail and Priority Mail Express® to the following counsel of record for Patent Owner:

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October 26, 2017
Dated

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Paper 50
Entered: August 25, 2017

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

XACTWARE SOLUTIONS, INC.,
Petitioner,

v.

EAGLE VIEW TECHNOLOGIES, INC.,
Patent Owner.

Case IPR2016-00592
Patent 9,135,737 B2

Before BRYAN F. MOORE, STACEY G. WHITE, and GARTH D. BAER, *Administrative Patent Judges.*

BAER, *Administrative Patent Judge.*

FINAL WRITTEN DECISION
35 U.S.C. § 318(a) and 37 C.F.R. § 42.73

I. INTRODUCTION

Xactware Solutions, Inc.. ("Petitioner"), filed a Second Corrected Petition requesting an *inter partes* review of claims 1, 8–10, 16, 19, 22, 25–28, 31, and 33–36 of U.S. Patent No. 9,135,737 B2 (Ex. 1001, "the '737 patent"). Paper 9 ("Pet." or "Petition"). Pursuant to 35 U.S.C. § 314(a), we determined the Petition showed a reasonable likelihood that Petitioner would prevail in establishing the unpatentability of claims 1, 9, 10, 16, 19, 22, 25–28, 31, and 34–36, and instituted an *inter partes* review of those claims. Paper 14, 20. Patent Owner filed a Patent Owner Response (Paper 31, "PO Resp.") and Petitioner filed a Reply to Patent Owner's Response (Paper 35, "Reply"). Patent Owner also filed a Motion to Strike Petitioner's Reply (Paper 37) and a Motion to Exclude certain deposition testimony of Petitioner's Expert (Paper 41). An oral hearing was held before the Board. Paper 49.

We issue this Final Written Decision pursuant to 35 U.S.C. § 318(a) and 37 C.F.R. § 42.73. Having considered the record before us, we determine Petitioner has not shown by a preponderance of the evidence that claims 1, 9, 10, 16, 19, 22, 25–28, 31, and 34–36 of the '737 patent are unpatentable. *See* 35 U.S.C. § 316(e).

II. BACKGROUND

A. RELATED PROCEEDINGS

The '737 patent is also the subject of IPR2017-00363, and Xactware Solutions, Inc., is the Petitioner in that proceeding. Patents related to the '737 patent are involved in IPR2016-00582, IPR2016-00586, IPR2016-00587, IPR2016-00589, IPR2016-00590, IPR2016-00593, IPR2016-00594,

IPR2016-01775, IPR2017-00021, IPR2017-00025, IPR2017-00027, and IPR2017-00034. The '737 patent is involved in the following district court matter: *Eagle View Technologies, Inc., v. Xactware Solutions, Inc.*, No. 2:15-cv-07025 (D.N.J.). Pet. 1–2; Paper 7, 2–3.

B. THE '737 PATENT

The '737 patent relates to a roof estimation system that provides a user interface configured to facilitate roof model generation based on one or more aerial images of a building roof. Ex. 1001, at (57). Figure 1 of the '737 patent is reproduced below.

Fig. 1

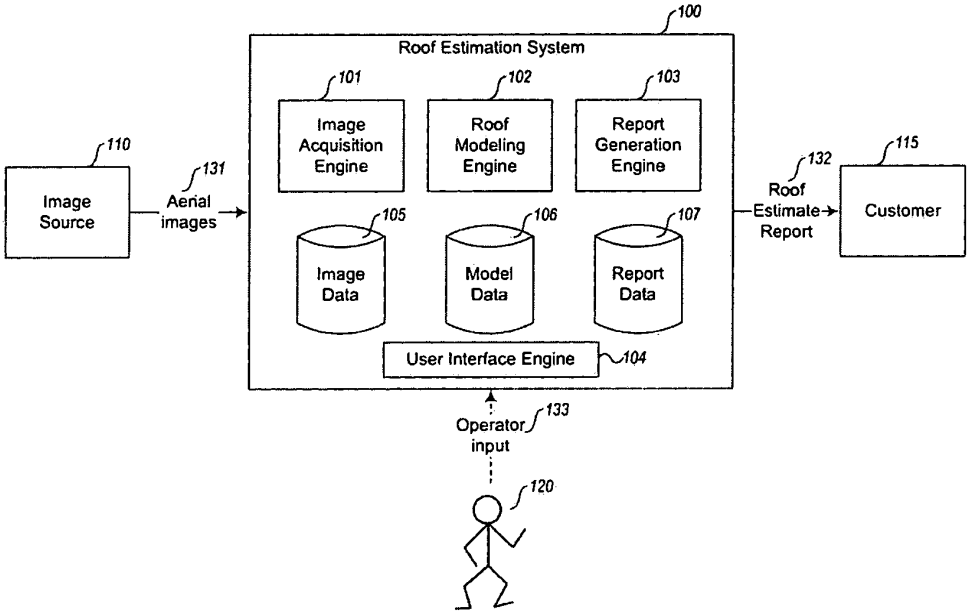


Figure 1 is a block diagram of an example Roof Estimation System ("RES"). Ex. 1001, 3:42–44. RES 100 includes image acquisition engine 101, roof modeling engine 102, report generation engine 103, image data 105, model data 106, and report data 107. *Id.* at 3:44–46. RES 100 is

communicatively coupled to image source 110, customer 115, and operator 120. *Id.* at 3:47–48. RES 100 is configured to generate roof estimate report 132 for a specified building, based on aerial images 131 of the building received from the image source 110. *Id.* at 3:52–55.

C. ILLUSTRATIVE CLAIM

Claims 1, 16, and 26 are independent. Claim 1 is illustrative and reproduced below.

> 1. A computer-implemented method in a roof estimate report system including at least one processor and a memory coupled to the at least one processor, the method comprising:
>
> displaying, by the at least one processor of the roof estimate report system, a plurality of aerial images of a roof at the same time, each of the aerial images providing a different view, taken from a different angle of the same roof;
>
> displaying, by the at least one processor of the roof estimate report system, respective line drawings representing features of the roof, the respective line drawings overlying a first and a second aerial image of the plurality of aerial images of the roof, the line drawing overlying the first aerial image of the roof having features in common with the line drawing overlying the second aerial image of the roof;
>
> in response to user input, changing, by the at least one processor of the roof estimate report system, the line drawing representing a feature of the roof that overlies the first aerial image of the roof;
>
> in response to the changing, making corresponding changes, by the at least one processor of the roof estimate report system, to the line drawing overlying the second aerial image; and
>
> generating and outputting a roof estimate report using a report generation engine, wherein the roof estimate report includes numerical values for corresponding slope, area, or lengths of edges of at least some of a plurality of planar roof sections of the roof, wherein the generated roof estimate report

> is provided for repair and/or constructing the roof structure of the building.

Ex. 1001, 23:55–24:19.

D. INSTITUTED GROUNDS OF UNPATENTABILITY

We instituted *inter partes* review on the following grounds of unpatentability.

Reference(s)	Basis	Challenged Claim(s)
Avrahami[1] and Applicad[2]	§ 103(a)	1, 9, 16, 19, 22, 25–28, 31, and 34–36
Avrahami, Applicad, and Perlant[3]	§ 103(a)	10

Inst. Dec. 20.

[1] Yair Avrahami et al., *Extraction of 3D Spatial Polygons Based on the Overlapping Criterion for Roof Extraction from Aerial Images*, XXXVI, CMRT05, IAPRS (2005) (Ex. 1004, "Avrahami").
[2] APPLICAD PRODUCT BULLETIN, KEY FEATURES OF OUR ROOFING SOFTWARE (2002) (Ex. 1005, "Applicad").
[3] Frederick P. Perlant et al., *Scene Registration in Aerial Image Analysis*, Photogrammetric Engineering and Remote Sensing, Vol. 56, No. 4, Apr. 1990 (Ex. 1006, "Perlant").

III. ANALYSIS

A. PRINCIPLES OF LAW

Petitioner bears the burden of proving unpatentability of the challenged claims, and that burden never shifts to Patent Owner. *Dynamic Drinkware, LLC v. Nat'l Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015). To prevail, Petitioner must establish the facts supporting its challenge by a preponderance of the evidence. 35 U.S.C. § 316(e); 37 C.F.R. § 42.1(d).

A patent claim is unpatentable under 35 U.S.C. § 103(a) if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious to a person of ordinary skill in the art at the time the invention was made. *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007). Obviousness is resolved based on underlying factual determinations, including: (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of ordinary skill in the art; and (4) objective evidence of nonobviousness, i.e., secondary considerations. *See Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966).

B. CLAIM CONSTRUCTION

We conclude no express claim constructions are necessary to resolve whether Petitioner has shown by a preponderance of the evidence that claims 1, 9, 10, 16, 19, 22, 25–28, 31, and 34–36 are unpatentable. *See Vivid Techs., Inc. v. Am. Sci. & Eng'g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999) ("[O]nly those terms need be construed that are in controversy, and only to the extent necessary to resolve the controversy.").

C. ASSERTED PRIOR ART

1. Overview of Avrahami (Ex. 1004)

Avrahami is a paper titled "Extraction of 3D Spatial Polygons Based on the Overlapping Criterion for Roof Extraction from Aerial Images." Ex. 1004, 43. It discusses semi-automatic algorithms for extracting a 3D image from an aerial image. *Id.* at Abstract. The algorithm discussed in Avrahami has the following steps: (1) the operator manually points to the center of the left space area, (2) the left space area is segmented and a bounding polygon is extracted, (3) estimated height is calculated, (4) the right space area is segmented and a bounding polygon is extracted, and (5) an iterative process is performed that matches both polygons followed by extraction of the spatial polygon. *Id.* at 43. The algorithm is semi-automatic because the first step is performed manually and the rest of the steps are performed automatically. *Id.* Figure 1 of Avrahami is reproduced below.



Figure 1. Result of the iterative matching process between the polygons in the right image space

Figure 1 depicts the results of Avrahami's matching process. *Id.* at 45. The top two images show the left and right polygons and the lower two

images show the process of matching the polygons from the left and right images. *Id.*

2. Applicad (Ex. 1005)

Applicad is a product bulletin for a roofing software product. Ex. 1005, 1. Relevant to this case, Applicad teaches generating a roof estimate report based on a three-dimensional model. *Id.* at 2, 39–40.

3. Perlant (Ex. 1006)

Relevant to this case, Perlant discloses a system for scene registration in aerial image analysis. *See* Ex. 1006, 481–92. In particular, Perlant teaches a system in which a marker is displayed on an aerial image to specify a point or part of the image. *See, e.g., id.* at 482, FIG. 2. Based on the points selected on the aerial image, Perlant teaches registering aerial images to a reference grid. *See id.* at 482, FIG. 4.

D. OBVIOUSNESS OF CLAIMS 1, 9, 10, 16, 19, 22, 25–28, 31, AND 34–36

Petitioner asserts claims 1, 9, 10, 16, 19, 22, 25–28, 31, and 34–36 would have been obvious over the combination of Avrahami and Applicad (Pet. 37–56) and claim 10 would have been obvious over the combination of Avrahami, Applicad, and Perlant and Avrahami and Applicad Aerowest (Pet. 56–57). Petitioner provides detailed claim charts and points out where each claim limitation is described by the reference. *Id.* at 41–54, 57. According to Petitioner, Avrahami teaches a roof estimation method for displaying two aerial images. *Id.* at 43 (citing Ex. 1004, Abstract, 43, 46, Figs. 1, 3). The claimed first and second line drawings representing roof features overlaid on first and second aerial images are taught by Avrahami's discussion of the user indicating areas on the left image with seed points and the system transferring those seed points to the right image. *Id.* at 43–44

(citing Ex. 1004, 43–45). Petitioner contends that Avrahami teaches changing a line drawing through its discussion of seed points and polygons that are generated automatically on the right image based on the user's input on the left image. *Id.* at 44–46 (citing Ex. 1004, 45–46, Fig. 1). According to Petitioner, Avrahami's iterative process of matching seed points from the left to the right images teaches the recited corresponding change to the second line drawing in response to changes in the first line drawing. Avrahami describes the iterative process as a series of steps in which points are inputted manually and then detected by the system for use in the opposing image. *See* Ex. 1004, Fig. 2. This back and forth of point input and point detection serves as input for "[b]uilding the topology between the roof planes, intersecting them and reconstructing the 3D roof." *Id.*; *see* Pet. 44–46 (citing Ex. 1004, 45, Fig. 1). Petitioner relies on Applicad to teach generating a roof estimate report. Pet. 20–23 (citing Ex. 1005); *see also id.* at 46. Applicad discusses the generation of detailed quotations for roofing work and provides example reports. Ex. 1005, 40–41. Petitioner relies on Perlant to teach the additional reference grid registration limitation in dependent claim 10. Pet. 57.

Patent Owner argues that the disclosures of Avrahami, Applicad, and Perlant fail to teach multiple claim limitations, and that Petitioner failed to meet its burden to demonstrate that one of ordinary skill in the art would have combined the relevant teachings in the asserted prior art. PO Resp. 9–49. Patent Owner also asserts it has provided objective evidence of non-obviousness that outweighs any evidence presented in Petitioner's affirmative case. *Id.* at 49–71. As outlined below, while we agree with Petitioner that the asserted prior art teaches all the challenged claims'

limitations and that one skilled in the art would have reason to combine those teachings in the manner Petitioner proposes, we agree with Patent Owner that objective indicia of non-obviousness are ultimately decisive in this case.

1. Disputed Elements

a. "displaying" (claims 1, 16, and 28)

Claim 1 requires "displaying . . . a plurality of aerial images of a roof at the same time, each of the aerial images providing a different view, taken from a different angle of the same roof; displaying . . . respective line drawings representing features of the roof." Claims 16 and 28 recite similar limitations. Patent Owner contends that Petitioner has not shown that these limitations are disclosed by the asserted art. PO Resp. 9–11. The crux of Patent Owner's argument is that while "Avrahami includes illustrative Figures 1, 3, and 5 that show side-by-side images of a roof, those are included in the paper to graphically illustrate the ***internal*** operation of the Avrahami algorithm." *Id.* at 9. According to Patent Owner, "[t]he mere presence of those figures does not teach or disclose that the images in the figures should be displayed during performance of the algorithm." *Id.* Further, Patent Owner asserts that the algorithm performed in Avrahami does not require the use of a second image because it provides a first image in which the user selects seed points and then the remainder of the algorithm occurs automatically. *Id.* at 10.

Petitioner disputes this reading of Avrahami and posits that the images shown in Avrahami are not renderings of internal operations, but rather images from a MATLAB implementation of Avrahami's system. Reply 1; *see also* Ex. 1004, 46 ("In the course of research, a semi-automatic system

for performing extraction from aerial images was developed using the MATLAB® environment, in order to examine the algorithm efficiency."). As part of its discussion of testing performed in MATLAB, Avrahami notes that "Figures 3 and 5 show the extraction of polygons in the image space in test areas 1 and 2, accordingly." Ex. 1004, 47. Based on those disclosures, Petitioner argues that "Figures 1, 3, and 5 of Avrahami clearly show a user interface with left and right image spaces of a roof," and "[t]he depictions of these spaces is enough to teach a POSITA to display both a right and left image space, particularly where the left space must be displayed." Reply 2; *see also* Ex. 2017, 69:14–21 (testimony of Petitioner's expert that the figures shown in Avrahami are images that were shown on a computer screen).

We agree with Petitioner. Avrahami describes its algorithm as providing "for semi-automatic 3D spatial *polygon extraction from a pair of colored aerial images* with a known external model solution." Ex. 1004, 43 (emphasis added). Avrahami touts that one of the advantages of its system is that "the operator can identify *at a glance* which buildings can be mapped by this method so as to combine it with traditional manual extraction or other semi-automatic method." *Id.* at 48 (emphasis added). Figure 1 shows a side-by-side comparison of the images in the pair. *See id.* at Fig. 1 (displaying left and right polygons going through Avrahami's iterative matching process). Further, we credit the testimony from Petitioner's expert, Mr. Harold Schuch, that one skilled in the art would understand Avrahami's images to be what "you see . . . on a computer screen" as "part of the production." Ex. 2017, 69:20–21; *see also id.* at 71:2–4 (explaining that "[t]his is an actual production image"). Therefore, we find that

Petitioner has proffered sufficient evidence that Avrahami discloses the disputed "displaying" limitation.

b. "in response to user input, changing . . . the line drawing . . . that overlies the first aerial image of the roof" (claim 1)

Independent claim 1 requires "in response to user input, changing, by the at least one processor of the roof estimate report system, the line drawing representing a feature of the roof that overlies the first aerial image of the roof." Patent Owner asserts that Avrahami does not teach this limitation because "[t]he only user interaction disclosed in Avrahami is the manual placement of a seed point on an aerial image at the outset of the algorithm, which occurs *before* any line drawings even exist, and thus cannot constitute a 'change' in the line drawing." PO Resp. 12. Patent Owner contends that once the seed point is placed, there are no further user interactions during the process and thus there is no point in time in which the line drawing is modified in response to a user input. *Id.* at 13. Patent Owner further contends that "the selection by the user of an initial 'seed *point*' in Avrahami is not a change to a *line* drawing. Rather than indicating a change in a line, the initial 'seed point' merely reflects 'manual pointing to the center' of an area on the left image." *Id.* at 16 (citing Ex. 1004, 43).

Petitioner responds by arguing that Avrahami's seed points are processed one at a time and the resulting "spatial polygons" (line drawings) are modified as the seed points are processed. Reply 3–4. Avrahami states that "[p]rior to the final stage we must ensure that each polygon in both images includes one seed point. If there are two or more pointers for a single polygon, then these pointers must be merged and consequently the areas which are represented by the pointers are also merged." Ex. 1004, 46. In other words, a polygon is generated based on a single seed point and then

modified to account for the existence of an additional seed point. We find that these disclosures would teach or at least suggest to one of ordinary skill in the art that the first line drawing is changed in response to user input. Therefore, we find that Petitioner has proffered sufficient evidence to show that one of ordinary skill in the art would have learned the disputed limitation from the cited disclosures in Avrahami.

c. *"in response to the changing, making corresponding changes . . . to the line drawing overlying the second aerial image" (claims 1, 16, and 26)*

Claim 1 requires "in response to the changing, making corresponding changes, by the at least one processor of the roof estimate report system, to the line drawing overlying the second aerial image." Claims 16 and 26 recite similar limitations. We interpret this language to mean that there are two line drawings that share common elements and that a user-driven change to one line drawing will cause a commensurate change to the second line drawing.

Avrahami's method uses at least two aerial images and these images have corresponding features, but may have differences attributable to things such as images taken from different camera angles. Ex. 1004, 46. The polygon overlaying the left image is created with user input ("seed points") via a flood fill operation. *Id.* at 43. The polygon overlaying the right image is created, in part, based on calculations made regarding the height of the polygon overlaid on the left image. *Id.* at 45. The seed point from the left image is transferred to the right image and the right image's polygon is calculated using the same flood fill technique that created the left image's polygon. *Id.* The homologous points between the two polygons are found by "matching" points via a process that iteratively "slides" the left polygon

over to the right image. *Id.* In particular, the points in the left polygon are assigned the estimated average height, which was calculated previously. With each iteration, these heights of points in the left polygon are updated until the conditional equation is optimized. During the iterations the left polygon "slides" in the direction of the epipolar line in the right image space. *Id.*

Patent Owner first argues that Avrahami does not teach or suggest allowing the user to change any line drawing. PO Resp. 18. This argument is a restatement of the argument addressed above and we do not find it persuasive for reasons previously discussed. *See* § III.D.1.b. Patent Owner also argues that the iterative sliding process described in Avrahami does not teach the recited change to a second line drawing because that process "does not make changes to the left polygon which are then propagated to the right polygon." *Id.* at 18–19. Instead, according to Patent Owner, "the left and right polygons . . . are created independently using a flood fill technique that is performed separately for each of the two images." *Id.* at 19.

Petitioner argues that Avrahami teaches this limitation because it "discloses that the flood fill operation in the right image is *based on* the operations in the left image." Reply 6. In particular, Petitioner explains, "[a]fter the system of Avrahami changes the first line drawing by extracting a polygon for a seed point in the left image, the system will transfer that exact seed point to the right image and change the second line drawing in the right image "**in the same way as in the left image**." Reply 6 (quoting Ex. 1004, 45 (emphasis Petitioner's)). Thus, "[t]he change to the second line drawing is based on the change in the first line drawing because the left polygon itself is the change in the first line drawing and that polygon causes

the change to the second line drawing by sliding to the right image." Reply 7–8.

As discussed above, we agree with the Petitioner's argument that the changes to the first line drawing are responsive to the placement of the seed point. As to the second line drawing, we find that this is a much closer call. While the operator's input (the seed point) is used to generate the first line drawing, the relationship between the seed point and second line drawing is more attenuated. The claim recites, in relevant part, making "corresponding changes" to the second line drawing "in response to" changing the first line drawing. In our view, it is a close call as to whether in Avrahami the change occurs in the second line drawing in response to the change in the first line drawing, or whether it is a change made in response to user input, without regard to the first line drawing. Based on the evidence presented in this case, we are persuaded that one of ordinary skill in the art probably would have learned this limitation from Avrahami. *See* Ex. 1007 ¶¶ 61–63 (Petitioner's expert describing Avrahami's algorithm); Ex. 1010, 22:12–18, 23:24–24:5 (Patent Owner's expert acknowledging "a relationship" and "a dependency" between the seed point and the second line drawing). We find, however, that Petitioner has not made a strong showing as to this element.

d. "generat[ing] and output[ting] a roof estimate report" (claims 1, 16, and 26)

Claims 1, 16, and 26 require "generat[ing] and output[ting] a roof estimate report using a report generation engine, wherein the roof estimate report includes numerical values for corresponding slope, area, or lengths of edges of at least some of a plurality of planar roof sections of the roof." Patent Owner argues that the specific limitations detailing the content of the roof estimate report are entitled to patentable weight. PO Resp. 24–29.

Patent Owner also argues that Applicad's disclosures do not include all of the elements of the roof estimate report stated in the claims. PO. Resp. 29–34.

Patent Owner asserts that the detailed and specific requirements of the roof estimate report have a functional and structural relationship to the substrate. *Id.* at 25–27. According to Patent Owner, the benefits of the claimed invention would not be fully obtained without a roof report that provides the specific values set forth in the claim. *Id.* at 26. Further, "[t]he informational content of the report and types of annotations contained in the report are inexorably linked to the method, as the method allows for those values to be accurately derived from aerial images." *Id.* at 26–27.

We do not agree. The '737 patent claims the content of information that may be provided on a piece of paper. *See, e.g.*, Ex. 1001, 8:10–12 ("FIGS. 3A-3F illustrate individual pages of an example roof estimate report generated by an example embodiment of a roof estimation system"). First, we must ascertain whether the "matter [is] claimed for what it communicates." *In re DiStefano*, 808 F.3d 845, 850 (Fed. Cir. 2015). Here, the claim recites plan views (one or more drawings) annotated with numerical values to communicate quantities such as slope, area, or lengths of edges to a human viewer. Next, we must determine "if the claimed informational content has a functional or structural relation to the substrate." *Id.* "Only if the limitation in question is determined to be printed matter does one turn to the question of whether the printed matter nevertheless should be given patentable weight. Printed matter is given such weight if the claimed informational content has a functional or structural relation to the substrate." *Id.*

We are persuaded that the drawings and numerical values are not functionally or structurally related to the substrate, whether the substrate might be computer memory, a computer display, an electronic file, or a piece of paper. *See* Manual of Patent Examining Procedure (MPEP) § 2111.05 (9th ed., Rev. 07.2015, Nov. 2015) ("[W]here the claim as a whole is directed [to] conveying a message or meaning to a human reader independent of the intended computer system, and/or the computer-readable medium merely serves as a support for information or data, no functional relationship exists."). Patent Owner asserts that "[t]here is a strong functional relationship between that method and the contents of the roof report because those contents—i.e., slope, area, and lengths of edges of the roof—are the product of the method, thus improving it by allowing it to be useful for purposes of roof estimation." PO Resp. 28.

We do not find this to be sufficient because the numbers on the page are not themselves used as part of the method. This stands in stark contrast to *In re Miller,* 418 F.2d 1392 (CCPA 1969), where the numbers printed on the measuring cup were used to carry out the intent of the claimed invention and not just to document the outcome. In *Miller,* there was "a new and unobvious functional relationship between a measuring receptacle, volumetric indicia thereon indicating volume in a certain ratio to actual volume, and a legend indicating the ratio, and in our judgment the appealed claims properly define this relationship." *Id.* at 1396. Here, we are presented with no such relationship. The roof report is merely a printed description of the method's output and it adds no functional or structural elements to the paper or computer screen on which the report appears. We are persuaded that the content of the information does not modify or

otherwise affect the underlying computer or paper, nor does it represent a new and non-obvious relationship with the substrate. Thus, the claimed content of the information is not entitled to weight in the patentability analysis. *See In re Ngai*, 367 F.3d 1336, 1338 (Fed. Cir. 2004); *Ex parte Nehls*, 88 USPQ2d 1883, 1887–90 (BPAI 2008) (precedential) (discussing non-functional descriptive material). In other words, what the content of the information, graphical or textual, may convey to the human mind does not change the functionality of the computer-implemented method and fails to distinguish over generating and displaying any graphical or textual information.

We are cognizant that the challenged claims include claims drawn to a method rather than an apparatus or a manufacture. The printed matter analysis, however, applies equally to process claims. The step of generating and outputting a roof estimate report "wherein the roof estimate report includes" particular information is similar to the "informing" step in *King Pharmaceuticals, Inc. v. Eon Labs, Inc.*, 616 F.3d 1267, 1274–79 (Fed. Cir. 2010). In *King Pharmaceuticals*, the subject matter of dependent claim 21, which recited "informing" the patient that the drug administered in accordance with base claim 1 had certain therapeutic effects, was subject to the rationale of "printed matter" cases even though the claims were cast as a method. The content of the "informing" was thus not given patentable weight. *See id.* Thus, we are persuaded that the detailed requirements as to the contents of the roof estimate report are not entitled to patentable weight.

e. *"transmitting roof measurement information based . . . on the change of the line drawing" (claim 9)*

Claim 9 requires "transmitting roof measurement information based at least in part on the change of the line drawing representing a feature of the

roof that overlies the first aerial image of the roof." In addition to reiterating its earlier "modifying" argument, Patent Owner argues Avrahami does not generate or transmit "roof measurement information." PO Resp. 36–40. We disagree.

Avrahami creates and displays a model in a local coordinate system as depicted in Figures 4 and 6 (reproduced below):

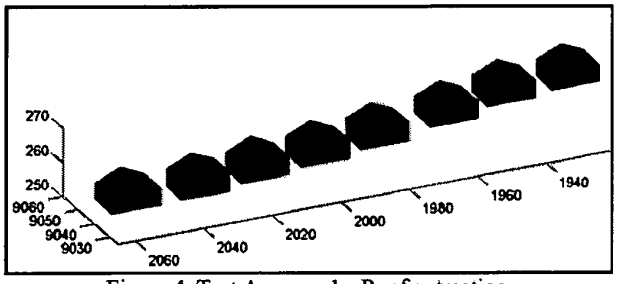


Figure 4. Test Area no. 1 - Roof extraction

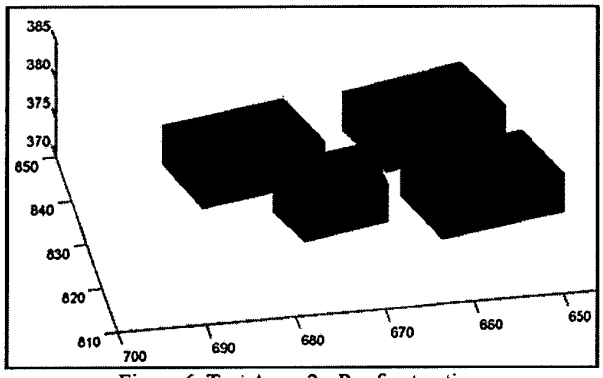


Figure 6. Test Area. 2 - Roof extraction

Figures 4 and 6 present extracted roofs in a local coordinate system. Ex. 1004, 47. We agree with Petitioner that Avrahami displays "roof measurement information" by displaying a roof in a local coordinate system, even though Avrahami does not label its measurement units. *See* Pet. 47; Reply 15–16. That is, because the claim term at issue does not require any particular units of measure, the numerical values along the axes in figures 4

and 6 convey "roof measurement information," as claimed. We also agree with Petitioner automatic extraction of the 3D roof in a local coordinate system (i.e., "query[ing] and present[ing]" spatial data, Ex. 1004, 43) is a description of *transmitting* roof measurement information, as claimed. *See* Pet. 46; Reply 16–17. The claim term at issue requires only "transmit[ting]" roof measurement information—it does not specify any particular source or destination for the transmission. The '737 patent's specification references transmission within the same system. *See* Reply 16 (citing Ex. 1001, 16:15–17, Fig. 8). Thus, it is of no moment that Avrahami does not disclose transmitting roof measurement information to a third-party system or separate computer, as Patent Owner argues. *See* PO Resp. 38–39.

f. "modifying a three dimensional model of the roof" (claim 25)

Patent Owner argues that Avrahami does not disclose "modifying a three dimensional model of the roof based at least on the modification of the line drawing overlaid on the first aerial image," as recited in claim 25. PO Resp. 40–45. Petitioner relies on the algorithm shown in Figure 2 as corresponding to modifying a three-dimensional model as claimed. Pet. 50–51.

As explained above, Avrahami's system uses an iterative method for maximal matching between the two polygons by "sliding" the left polygon in the direction of the epipolar line in the right image space until the polygons achieve a maximum overlap in the right image space. Ex. 1004, 45; Ex. 1007 ¶ 63. Figure 2 of Avrahami is reproduced below:

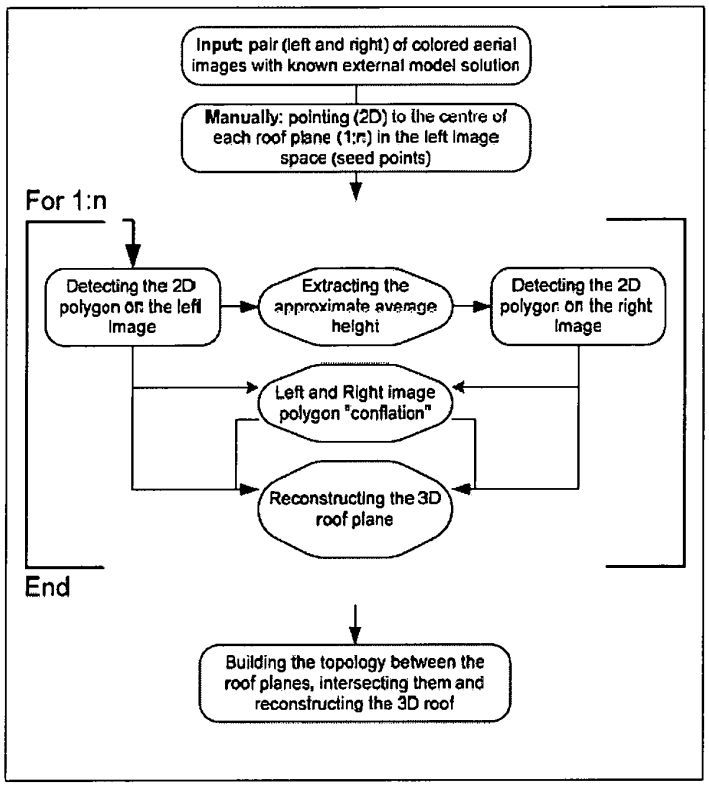


Figure 2. Flowchart of the roof extraction

Ex. 1004, 46. Figure 2 depicts a flowchart of Avrahami's roof extraction by matching right and left polygons. The algorithm consists of three main stages: manual pointing (seed points in 2D to the center area of each roof plane); performing an automatic process for extraction of the roof planes for each seed point; and building topology between the planes, with the outcome being a 3D roof. *Id.* at 46.

Patent Owner argues that Avrahami's algorithm does not modify a three-dimensional model of the roof based on the received indication of the feature of the building because Avrahami's "algorithm builds a three dimensional model of the ***roof*** only ***once***, at the very end of the process, which is never subsequently modifiable." PO Resp. 41. According to Patent

Owner, "[t]he creation of individual spatial polygons are merely intermediary steps on the path to initial creation of the model . . . before this final stage, Avrahami only creates individual spatial polygons ***that are not yet part of any model of a roof***." *Id.* at 42. We disagree.

As Petitioner explains, Patent Owner's argument is based on an incorrect assumption that modifying a three-dimensional model of the roof requires first generating a fully-assembled model and then making a modification to that fully-assembled model. Reply 17. The claim language at issue is not so limited. The '737 patent's specification explains that "[m]odifying the 3D model may include adding or updating" features on an otherwise incomplete model. Ex. 1001, 22:44–46; *see id.* at 22:52–59. Avrahami discloses creating individual roof planes, modifying those planes prior to assembly, and assembling the planes into a final three-dimensional model. *See* Ex. 1004 at 44–46. Even though, as Patent Owner asserts, Avrahami's final 3D roof model is not modified post-assembly, Avrahami teaches the limitation at issue because an *incomplete* or partial model of the roof is still a model of the roof. Thus, modifying a three-dimensional model of the roof includes modifying individual roof planes prior to assembly and sequentially adding roof planes to a three-dimensional model, as Avrahami teaches.

g. "reference grid" (Claim 10)

Patent Owner argues that the combination of Avrahami and Perlant do not render claim 10 obvious because Perlant does not teach or suggest "registering, based on the received indication of the point, the aerial image to a reference grid corresponding to a three-dimensional model" as required by claim 10. PO Resp. 45–48. Patent Owner asserts Perlant fails to teach

the disputed limitation because Perlant does not disclose a three-dimensional reference grid or a three dimensional model. *See id.* at 45.

We disagree with Patent Owner. As Petitioner explains, "[c]laim 10 only requires a 'reference grid,' not a *three-dimensional* reference grid." Reply 20. In addition, Perlant's alleged failure to disclose generating or modifying a three-dimensional roof model does not undermine Petitioner's obviousness challenge because Avrahami discloses that limitation. *See* Ex. 1004, Figs. 4, 6. Thus, we agree with Petitioner that the combination of Avrahami and Perlant teaches "registering, based on the received indication of the point, the aerial image to a reference grid corresponding to the three-dimensional model," as required by claim 10.

2. Remaining Undisputed Elements

Petitioner contends the combination of Avrahami and Applicad discloses the remaining limitations of claims 1, 9, 16, 19, 22, 25–28, 31, and 34–36, and that the combination of Avrahami, Applicad, and Perlant discloses the remaining limitations of claim 10. *See* Pet. 37–54. Patent Owner does not address the merits of Petitioner's assertions regarding the remaining limitations. *See* PO Resp. 9–49. We agree with Petitioner's assertions and adopt them as our own.

3. Rationale for Combining the Asserted Teachings in the Prior Art

a. Reason to Combine Avrahami and Applicad

Petitioner argues that "[i]t would have been obvious to a person of ordinary skill in the art to include an annotated roof report, as taught by Applicad, with the system of Avrahami for easy and effective communication of roof measurement results to a user." Pet. 56. Petitioner asserts that Applicad discloses importing a drawing from another system and

then creating a report based on that input. *Id.* at 29. According to Petitioner, Avrahami's line drawing system could be used as input for Applicad's reporting system. *Id.* at 12; *see id.* at 20–23, 46. Petitioner asserts that this combination would be within the skills of one or ordinary skill in the art. *Id.* at 54–55.

Patent Owner asserts that one skilled in the art would not combine Avrahami and Applicad as Petitioner suggests. PO. Resp. 34–36. According to Patent Owner, "Avrahami and Applicad are fundamentally incompatible because Applicad cannot import three-dimensional models" from other programs. PO. Resp. 34.

Petitioner responds that this mischaracterizes its argument because its challenge is not predicated on a physical combination of Avrahami and Applicad, but rather the predictable results that would have been achieved by using the teachings of Applicad in conjunction with a 3D CAD system. Reply 13–15. Further, Petitioner directs us to Applicad's discussion of importing drawings in a ".dxf format" and Applicad's reference to its software "sit[ting] on top of a very powerful 3 dimensional CAD package." *Id.* at 14 (quoting Ex. 1005, 3); *see* Ex. 1007 ¶ 57 ("Further, the Applicad system can also import a model generated in another computer program, in the form of a roof or wall outline in three dimensions. *See, e.g.,* Applicad, pp. 2, 4.").

We find Patent Owner's assertions that Applicad cannot be incorporated in Avrahami to be unpersuasive because the obviousness analysis is not predicated on the physical combinability of the references, but whether the claimed invention is rendered obvious by the teachings of the prior art as a whole. *In re Etter*, 756 F.2d 852, 859 (Fed. Cir. 1985) (en

banc). This is true because "[t]he test for obviousness is not whether the features of a secondary reference may be bodily incorporated into the structure of the primary reference . . . but rather whether 'a skilled artisan would have been motivated to combine the teachings of the prior art references to achieve the claimed invention.'" *Allied Erecting & Dismantling Co. v. Genesis Attachments, LLC*, 825 F.3d 1373, 1381 (Fed. Cir. 2016) (internal citations omitted). We are persuaded by Petitioner's argument that one of ordinary skill in the art would have combined the teachings of the references in order to achieve the "easy and effective communication of roof measurement results to a user." Pet. 56. Thus, the combination of the teachings of Applicad and Avrahami would have allowed one of ordinary skill in the art to achieve a predictable result. *See KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 401 (2007). Therefore, we are persuaded that Petitioner has put forth sufficient rationale to support the combination of the teachings of Applicad and Avrahami.

b. *Reason to Combine Perlant*

Petitioner explains that one skilled in the art would have found it obvious to combine Perlant's scene registration process with the line drawing and matching features of Avrahami because "Perlant improves this device with registration functionality and the result would be predictable." Pet. 59; *see* Pet. 32 (noting that "Perlant discloses the ability to augment 3D model generation by scene registration in aerial images" (citing Ex. 1006, 485)). In light of that explanation, we find Petitioner has articulated sufficient reasoning with some rational underpinning to support the legal conclusion that its proffered combination of references would have been obvious to one of ordinary skill in the art. *See KSR*, 550 U.S. at 418. That

is, we agree with Petitioner that claim 10 represents a combination of familiar elements according to known methods (i.e., Avrahami's line drawing and matching features, Applicad's roof estimate report, and Perlant's scene registration process), yielding only a predictable result. *See id.*

4. Secondary Considerations of Nonobviousness

Notwithstanding what the teachings of the prior art would have suggested to one skilled in the art, objective evidence of nonobviousness may lead to a conclusion that the challenged claims would not have been obvious. *In re Piasecki*, 745 F.2d 1468, 1471–72 (Fed. Cir. 1984). Objective evidence of nonobviousness "may often be the most probative and cogent evidence in the record" and "may often establish that an invention appearing to have been obvious in light of the prior art was not." *Transocean Offshore Deepwater Drilling, Inc. v. Maersk Drilling USA, Inc.*, 699 F.3d 1340, 1349 (Fed. Cir. 2012). To contest obviousness, in addition to the arguments outlined above, Patent Owner asserts that objective indicia of nonobviousness—commercial success and industry praise in particular—confirms that the claimed invention is nonobvious. *See* PO Resp. 49–71. We agree with Patent Owner that objective indicia of non-obviousness are decisive in this case, as explained below.

a. Nexus

To be relevant, evidence of nonobviousness must be commensurate in scope with the claimed invention. *In re Huai-Hung Kao*, 639 F.3d 1057, 1068 (Fed. Cir. 2011). Thus, to be accorded substantial weight, there must be a nexus between the merits of the claimed invention and the evidence of secondary considerations. *In re GPAC Inc.*, 57 F.3d 1573, 1580 (Fed. Cir.

1995). "[N]exus" is a legally and factually sufficient connection between the objective evidence and the claimed invention, such that the objective evidence should be considered in determining nonobviousness. *Demaco Corp. v. F. Von Langsdorff Licensing Ltd.*, 851 F.2d 1387, 1392 (Fed. Cir. 1988). There is a "presumption of a nexus" when a product is "coextensive" with a patent claim. *Teva Pharms. USA, Inc. v. Sandoz, Inc.*, 723 F.3d 1363, 1372 (Fed. Cir. 2013).

We are persuaded by Patent Owner's extensive evidence of nexus between its Render House and Twister products and the challenged claims. Patent Owner steps through each challenged claim on an element-by-element basis and directs us to images and specific passages from its Render House and Twister user guides that it argues embody the limitations of each challenged claim. PO. Resp. 52–65. Patent Owner also supports its assertion of nexus with testimony in the form of a Declaration from its expert, Dr. Chandrajit Bajaj, that includes a claim chart detailing where each limitation of the challenged claim is found in its Twister and Render House products. Ex. 2031, 41–100.[4]

The Federal Circuit has held that "if the marketed product embodies the claimed features, and is coextensive with them, then a nexus is presumed and the burden shifts to the party asserting obviousness to present evidence to rebut the presumed nexus." *Brown & Williamson Tobacco Corp. v. Philip Morris Inc.*, 229 F.3d 1120, 1130 (Fed. Cir. 2000). Patent Owner has put forth sufficient evidence to show that its Twister and Render House

[4] Here, we cited to page number and not paragraphs of Dr. Bajaj's report because the paragraph containing the claim charts stretches over many pages.

products embody the elements of the challenged claims and thus, we look to Petitioner to rebut this presumed nexus and acknowledge that the presumption "cannot be rebutted with mere argument; evidence must be put forth." *Id.* Petitioner argues that we should discount Patent Owner's evidence of nexus because "Dr. Bajaj formed his opinion on Twister and Render House in a WebEx presentation with Patent Owner's engineers," but did not actually use the Twister or Render House products himself. Reply 22.

Under Federal Rule of Evidence 702, an expert witness may offer opinion testimony if (a) the expert's scientific, technical, or other specialized knowledge will help the trier of fact to understand the evidence or to determine a fact in issue; (b) the testimony is based on sufficient facts or data; (c) the testimony is the product of reliable principles and methods; and (d) the expert has reliably applied the principles and methods to the facts of the case. Petitioner has not moved to exclude Dr. Bajaj's testimony as impermissible under Rule 702, but instead has argued that we should not rely on Dr. Bajaj's testimony because it is not evidence that that we can use to explain whether the sequence of screenshots provided by Patent Owner's counsel embodies the elements of the challenged claims. Reply 22–23. We do not agree with Petitioner.

Dr. Bajaj testified that he "discussed these products with engineers at Patent Owner who use the Twister and Render House products on a regular basis" and that during those discussions he "personally directed Patent Owner's engineers to operate the Twister and Render House software to confirm [his] understanding of the products' operation." Ex. 2031 ¶ 84. He also testified that "[m]y understanding of the features of the Twister and

Render House products are further confirmed based on my review of user manuals for these two products." *Id.* We find this explanation credible. Petitioner objects to the screenshots in Dr. Bajaj's declaration because they were not personally prepared by Dr. Bajaj. Reply 22–23. Dr. Bajaj, however, is testifying as to his opinion of the capabilities and features of the Twister and Render House products and these screenshots are merely visual aids to assist the Panel in understanding how Dr. Bajaj reached his conclusion. We see no impropriety in his use of images collected from other sources to document his opinions as to the operation of the products at issue. Thus, we are not persuaded by Petitioner's arguments and we find that Patent Owner has provided sufficient evidence to establish a nexus between the challenged claims and the Twister and Render House products.

b. Commercial Success

Patent Owner contends that its Twister and Render House products "used the patented invention to achieve tremendous commercial success by creating accurate roof estimate reports faster and at less expense than previous solutions." PO Resp. 66. Patent Owner asserts that Petitioner recognized the benefits of those products and "entered a contract with Patent Owner for its roof reports soon after the release of Patent Owner's first product." *Id.* at 67 (citing Ex. 2021 ("EagleView and Xactware announced a new technology integration that will allow Xactware customers to access EagleView's breakthrough roof measurement capabilities.")). Patent Owner also provides evidence of rapid growth of its business after the introduction of these products. *Id.* at 67 (citing Ex. 2022 (noting "three-year revenue growth of 2,406 percent")). Patent Owner directs us to statements from Scott Stephenson, President and CEO of Verisk Analytics, which is

Petitioner's parent company. *Id.* at 68–69 (citing Ex. 2023). In a call with investors, Mr. Stephenson "announced the acquisition of EagleView Technologies Corporation, or EVT, for a purchase price of $650 million. EVT is the parent company of both Pictometry International, a recognized leader in imagery, and EagleView, which is well known in the insurance industry." Ex. 2023, 3. He also touted Patent Owner's "significant intellectual property, including over 20 issued patents" and its position as a market leader, noting that:

> Eagle View division is a leading provider of reports on structures used in claims processes in the property and casualty insurance and the contractor markets. The Eagle View division does at least some business with 24 of the top 25 insurance companies, as well as with over 30,000 building contractors.

Id.

Patent Owner further provided unrebutted evidence that "approximately 96 percent of the top 25 insurance carriers rely on [Eagle View Technologies 3D aerial roof measurement reports] in their claims departments." Ex. 2020, 1; *see also* Ex. 2029, 8 (Verisk Analytics presentation noting that 24 of top 25 insurance companies and 30,000 contractors are Eagle View customers). In addition, Patent Owner's evidence shows that its products are used by "about one-fifth of the roofing contractor market, according to an estimate by market researcher IbisWorld." Ex. 2024. Patent Owner's financial reports show both that it sold a significant number of roofing reports and that its sales grew significantly between 2009 and 2015. *See* PO Resp. 67–68. We find that this information, taken together with statement from others in the industry (*see* Ex. 2029) gives us a view of Patent Owner's place in the relevant

market and persuades us that Patent Owner's Twister and Render House products experienced significant commercial success and wide-spread use in the industry.

Finally, Patent Owner offers the testimony of Chris Johnson, Vice President of Eagle View Technologies, to discuss financial reports for the years 2009–2012. Ex. 2011. In his declaration, Mr. Johnson testifies that the reports submitted into evidence all "reflect sales of reports created using the Twister and Render House products." *Id.* ¶¶ 3–6.

Petitioner asserts that "Patent Owner has failed to prove a nexus exists between the claims of the '737 patent and the purported commercial success." Reply 24. Our reviewing court has held that for evidence of commercial success to be relevant, "the patentee must establish a nexus between the evidence of commercial success and the patented invention." *Wyers v. Master Lock Co.*, 616 F.3d 1231, 1246 (Fed. Cir. 2010). As noted above, however, Patent Owner has provided extensive evidence that the Twister and Render House products are coextensive with the challenged claims and that the reports sold were created using the Twister and Render House products. Thus, we are persuaded that nexus exists between the challenged claims and the commercially successful products at issue.

Petitioner also asserts that we should discount Patent Owner's evidence of commercial success because it "relates to the sale of the roof reports, not the license or sale of the Twister and Render House products themselves." Reply 24. We do not find this argument persuasive. As noted above, Patent Owner provided extensive evidence that the Twister and Render House products are coextensive with the challenged claims, and that the commercially successful reports were created using the Twister and

Render House products. A patent challenger may respond to an allegation of presumed nexus by presenting evidence that shows the proffered objective evidence was "due to extraneous factors other than the patented invention." *Demaco Corp. v. F. Von Langsdorff Licensing Ltd.*, 851 F.2d 1387, 1393 (Fed. Cir. 1988). Such extraneous factors include additional unclaimed features or arguably, as is the case here, features to which little or no patentable weight has be ascribed. *See, e.g., Ecolochem, Inc. v. S. Cal. Edison Co.*, 227 F.3d 1361, 1378 (Fed. Cir. 2000) (applying presumption even though commercial embodiment had unclaimed mobility feature). As noted above, however, patent challenger cannot successfully rebut the presumption with argument alone—it must present evidence. *Brown & Williamson*, 229 F.3d at 1130 (citing *Demaco*, 851 F.2d at 1393). Petitioner has not done so in this case.

Patent Owner may commercialize its technology in many different ways. The choice to sell the output of the claimed method or claimed apparatus, as opposed to selling or licensing software that practices the claims does not undermine Patent Owner's commercial success in the marketplace that is attributable to its claimed invention. Patent Owner is tasked with providing evidence tying the commercial success and the claims. That commercial success may take many forms and may be the result of many different business strategies, but in the end, for our purposes, the question is whether Patent Owner has shown a sufficient nexus between the commercial success and the claims. We are persuaded that Patent Owner has provided such evidence here. As noted above, Patent Owner and its declarant have extensively analyzed the Twister and Render House products and shown that these products embody the challenged claims in order to

generate the roofing reports that it sold, and that the reports sold were created using the Twister and Render House products. Petitioner has not made any showing that the commercial success is based on something other than the contributions of the claimed invention to the generation of roofing reports. Thus, in light of extensive evidence of nexus, we are persuaded that it is proper for Patent Owner to rely upon financial information relating to the sale of reports generated by the Twister and Render House products.

c. Industry Praise

Praise from industry participants, especially competitors, is probative as to obviousness because such participants "are not likely to praise an obvious advance over the known art. Thus, if there is evidence of industry praise of the claimed invention in the record, it weighs in favor of the non-obviousness of the claimed invention." *Apple Inc. v. Samsung Elecs. Co.*, 839 F.3d 1034, 1053 (Fed. Cir. 2016). Petitioner described Patent Owner's products as "[u]sing aerial photography and patent-pending software [to] accurately calculate[] measurements for the roof's ridges, rafters, valleys, slopes and more." Ex. 2021, 1. Petitioner further noted that the "process saves contractors and roofers hours of time spent measuring and scoping a roof." *Id.*

Verisk Analytics described Patent Owner as "a leader in sophisticated imagery for uses in the property and casualty, contractor, government, and commercial spaces." Ex. 2023, 3. Verisk's CEO stated that Patent Owner is "a leading provider of reports on structures used in claims processes in the property and casualty insurance and the contractor markets." *Id.* He also noted that "[Patent Owner's] solutions provide detailed, accurate

measurements without the danger and added time of an adjustor climbing onto a roof." *Id.* at 4.

Patent Owner directs us to an article from Bloomberg in which a roofer touts the accuracy of Patent Owner's products, stating that "most insurance carriers at this point treat [Patent Owner's roofing reports] as gospel." Ex. 2024, 2. Patent Owner also directs us to an article from CNN Money in which a partner at a claim investigation company stated that "[h]aving an Eagle View report has become an industry accepted standard." Ex. 2025, 1. An article from the California Business Journal states that "Eagle View made one of the biggest breakthroughs in the history of the industry by creating a state-of-the-art software program that remotely snaps sophisticated aerial pictures of roofs and accurately measures lengths, pitches, valleys and other hard-to-see areas on roofs." Ex. 2027, 2. In that article, a roofer is quoted as saying that "Eagle View changed the industry forever with this technology." *Id.* We find Patent Owner's extensive evidence of industry praise weighs in favor of the non-obviousness of the claimed invention.

d. Conclusions on Obviousness

We have considered Petitioner's evidence and arguments about the asserted prior art's teachings and the reasons why one skilled in the art would combine them. We have also weighed the objective indicia of non-obviousness presented by Patent Owner. As noted above (*see supra* § III.D.1.c), we find certain aspects of Petitioner's obviousness allegations to be at best a close call. On the other side, we are persuaded that Patent Owner has shown strong evidence of nexus between the challenged claims and the Twister and Render House products used to produce the

commercially successful reports. We are persuaded also that Patent Owner has shown strong evidence of industry praise. "These real world indicators of whether the combination would have been obvious to the skilled artisan in this case 'tip the scales of patentability.'" *Apple Inc. v. Samsung Elecs. Co.*, 839 F.3d 1034, 1058. Thus, upon consideration of the strength of Petitioner's obviousness allegations and the strength of Patent Owner's contentions as to secondary considerations of non-obviousness, we are persuaded that Petitioner has not met its burden to show that the challenged claims would have been obvious over the asserted prior art.

IV. PATENT OWNER'S MOTION TO EXCLUDE DEPOSITION TESTIMONY AND MOTION TO STRIKE PETITIONER'S REPLY

Patent Owner filed a Motion to Exclude the re-direct deposition testimony of Petitioner's expert (pages 117–120 of Ex. 2017). Paper 41. Because this Decision does not rely on that testimony, we deny Patent Owner's Motion as moot.

Patent Owner also filed a Motion to Strike Petitioner's Reply for "improperly include[ing] new arguments" related to claim 25's "modifying" limitation. Paper 37, 1. Upon considering Patent Owner's arguments (Paper 37, 1–3) and Petitioner's Opposition to the Motion to Strike (Paper 38, 1–3), we deny Patent Owner's Motion to Strike because we agree with Petitioner that its arguments submitted with the Reply, including the arguments addressing the "modifying" claim limitation, fall within the proper scope of a reply. *See* Paper 38, 1–3.

V. CONCLUSION

In conclusion, Petitioner has not shown by a preponderance of the evidence that claims 1, 9, 10, 16, 19, 22, 25–28, 31, and 34–36 of the '737 patent are unpatentable under 35 U.S.C. § 103(a).

VI. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that Petitioner has not shown by a preponderance of the evidence that claims 1, 9, 16, 19, 22, 25–28, 31, and 34–36 of the '737 patent are unpatentable as obvious over the combination of Avrahami and Applicad; and

FURTHER ORDERED that Petitioner has not shown by a preponderance of the evidence that claim 10 of the '737 patent is unpatentable as obvious over the combination of Avrahami, Applicad, and Perlant; and

FURTHER ORDERED that Patent Owner's Motion to Exclude (Paper 41) is DENIED as moot; and

FURTHER ORDERED that Patent Owner's Motion to Strike Petitioner's Reply (Paper 37) is DENIED; and

FURTHER ORDERED that, because this is a Final Written Decision, the parties to the proceeding seeking judicial review of the decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

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Paper 50
Entered: August 25, 2017

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

XACTWARE SOLUTIONS, INC.,
Petitioner,

v.

EAGLE VIEW TECHNOLOGIES, INC.,
Patent Owner.

Case IPR2016-00592
Patent 9,135,737 B2

Before BRYAN F. MOORE, STACEY G. WHITE, and GARTH D. BAER, *Administrative Patent Judges*.

BAER, *Administrative Patent Judge*.

FINAL WRITTEN DECISION
35 U.S.C. § 318(a) and 37 C.F.R. § 42.73

I. INTRODUCTION

Xactware Solutions, Inc.. ("Petitioner"), filed a Second Corrected Petition requesting an *inter partes* review of claims 1, 8–10, 16, 19, 22, 25–28, 31, and 33–36 of U.S. Patent No. 9,135,737 B2 (Ex. 1001, "the '737 patent"). Paper 9 ("Pet." or "Petition"). Pursuant to 35 U.S.C. § 314(a), we determined the Petition showed a reasonable likelihood that Petitioner would prevail in establishing the unpatentability of claims 1, 9, 10, 16, 19, 22, 25–28, 31, and 34–36, and instituted an *inter partes* review of those claims. Paper 14, 20. Patent Owner filed a Patent Owner Response (Paper 31, "PO Resp.") and Petitioner filed a Reply to Patent Owner's Response (Paper 35, "Reply"). Patent Owner also filed a Motion to Strike Petitioner's Reply (Paper 37) and a Motion to Exclude certain deposition testimony of Petitioner's Expert (Paper 41). An oral hearing was held before the Board. Paper 49.

We issue this Final Written Decision pursuant to 35 U.S.C. § 318(a) and 37 C.F.R. § 42.73. Having considered the record before us, we determine Petitioner has not shown by a preponderance of the evidence that claims 1, 9, 10, 16, 19, 22, 25–28, 31, and 34–36 of the '737 patent are unpatentable. *See* 35 U.S.C. § 316(e).

II. BACKGROUND

A. RELATED PROCEEDINGS

The '737 patent is also the subject of IPR2017-00363, and Xactware Solutions, Inc., is the Petitioner in that proceeding. Patents related to the '737 patent are involved in IPR2016-00582, IPR2016-00586, IPR2016-00587, IPR2016-00589, IPR2016-00590, IPR2016-00593, IPR2016-00594,

IPR2016-01775, IPR2017-00021, IPR2017-00025, IPR2017-00027, and IPR2017-00034. The '737 patent is involved in the following district court matter: *Eagle View Technologies, Inc., v. Xactware Solutions, Inc.*, No. 2:15-cv-07025 (D.N.J.). Pet. 1–2; Paper 7, 2–3.

B. THE '737 PATENT

The '737 patent relates to a roof estimation system that provides a user interface configured to facilitate roof model generation based on one or more aerial images of a building roof. Ex. 1001, at (57). Figure 1 of the '737 patent is reproduced below.

Fig. 1

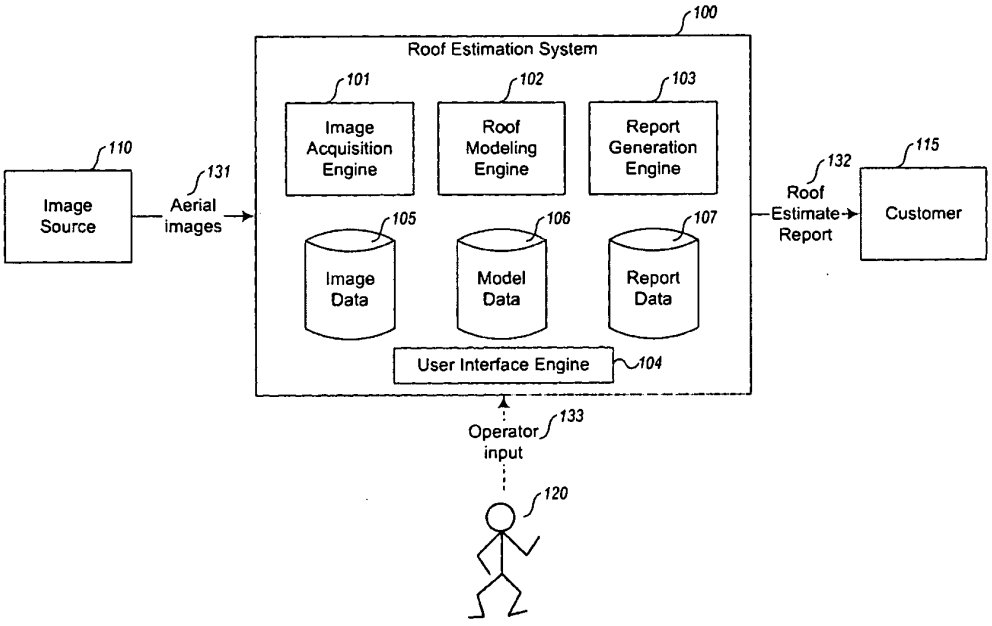


Figure 1 is a block diagram of an example Roof Estimation System ("RES"). Ex. 1001, 3:42–44. RES 100 includes image acquisition engine 101, roof modeling engine 102, report generation engine 103, image data 105, model data 106, and report data 107. *Id.* at 3:44–46. RES 100 is

communicatively coupled to image source 110, customer 115, and operator 120. *Id.* at 3:47–48. RES 100 is configured to generate roof estimate report 132 for a specified building, based on aerial images 131 of the building received from the image source 110. *Id.* at 3:52–55.

C. ILLUSTRATIVE CLAIM

Claims 1, 16, and 26 are independent. Claim 1 is illustrative and reproduced below.

> 1. A computer-implemented method in a roof estimate report system including at least one processor and a memory coupled to the at least one processor, the method comprising:
>
> displaying, by the at least one processor of the roof estimate report system, a plurality of aerial images of a roof at the same time, each of the aerial images providing a different view, taken from a different angle of the same roof;
>
> displaying, by the at least one processor of the roof estimate report system, respective line drawings representing features of the roof, the respective line drawings overlying a first and a second aerial image of the plurality of aerial images of the roof, the line drawing overlying the first aerial image of the roof having features in common with the line drawing overlying the second aerial image of the roof;
>
> in response to user input, changing, by the at least one processor of the roof estimate report system, the line drawing representing a feature of the roof that overlies the first aerial image of the roof;
>
> in response to the changing, making corresponding changes, by the at least one processor of the roof estimate report system, to the line drawing overlying the second aerial image; and
>
> generating and outputting a roof estimate report using a report generation engine, wherein the roof estimate report includes numerical values for corresponding slope, area, or lengths of edges of at least some of a plurality of planar roof sections of the roof, wherein the generated roof estimate report

> is provided for repair and/or constructing the roof structure of the building.

Ex. 1001, 23:55–24:19.

D. INSTITUTED GROUNDS OF UNPATENTABILITY

We instituted *inter partes* review on the following grounds of unpatentability.

Reference(s)	Basis	Challenged Claim(s)
Avrahami[1] and Applicad[2]	§ 103(a)	1, 9, 16, 19, 22, 25–28, 31, and 34–36
Avrahami, Applicad, and Perlant[3]	§ 103(a)	10

Inst. Dec. 20.

[1] Yair Avrahami et al., *Extraction of 3D Spatial Polygons Based on the Overlapping Criterion for Roof Extraction from Aerial Images*, XXXVI, CMRT05, IAPRS (2005) (Ex. 1004, "Avrahami").
[2] APPLICAD PRODUCT BULLETIN, KEY FEATURES OF OUR ROOFING SOFTWARE (2002) (Ex. 1005, "Applicad").
[3] Frederick P. Perlant et al., *Scene Registration in Aerial Image Analysis*, Photogrammetric Engineering and Remote Sensing, Vol. 56, No. 4, Apr. 1990 (Ex. 1006, "Perlant").

III. ANALYSIS

A. PRINCIPLES OF LAW

Petitioner bears the burden of proving unpatentability of the challenged claims, and that burden never shifts to Patent Owner. *Dynamic Drinkware, LLC v. Nat'l Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015). To prevail, Petitioner must establish the facts supporting its challenge by a preponderance of the evidence. 35 U.S.C. § 316(e); 37 C.F.R. § 42.1(d).

A patent claim is unpatentable under 35 U.S.C. § 103(a) if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious to a person of ordinary skill in the art at the time the invention was made. *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007). Obviousness is resolved based on underlying factual determinations, including: (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of ordinary skill in the art; and (4) objective evidence of nonobviousness, i.e., secondary considerations. *See Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966).

B. CLAIM CONSTRUCTION

We conclude no express claim constructions are necessary to resolve whether Petitioner has shown by a preponderance of the evidence that claims 1, 9, 10, 16, 19, 22, 25–28, 31, and 34–36 are unpatentable. *See Vivid Techs., Inc. v. Am. Sci. & Eng'g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999) ("[O]nly those terms need be construed that are in controversy, and only to the extent necessary to resolve the controversy.").

C. ASSERTED PRIOR ART

1. Overview of Avrahami (Ex. 1004)

Avrahami is a paper titled "Extraction of 3D Spatial Polygons Based on the Overlapping Criterion for Roof Extraction from Aerial Images." Ex. 1004, 43. It discusses semi-automatic algorithms for extracting a 3D image from an aerial image. *Id.* at Abstract. The algorithm discussed in Avrahami has the following steps: (1) the operator manually points to the center of the left space area, (2) the left space area is segmented and a bounding polygon is extracted, (3) estimated height is calculated, (4) the right space area is segmented and a bounding polygon is extracted, and (5) an iterative process is performed that matches both polygons followed by extraction of the spatial polygon. *Id.* at 43. The algorithm is semi-automatic because the first step is performed manually and the rest of the steps are performed automatically. *Id.* Figure 1 of Avrahami is reproduced below.

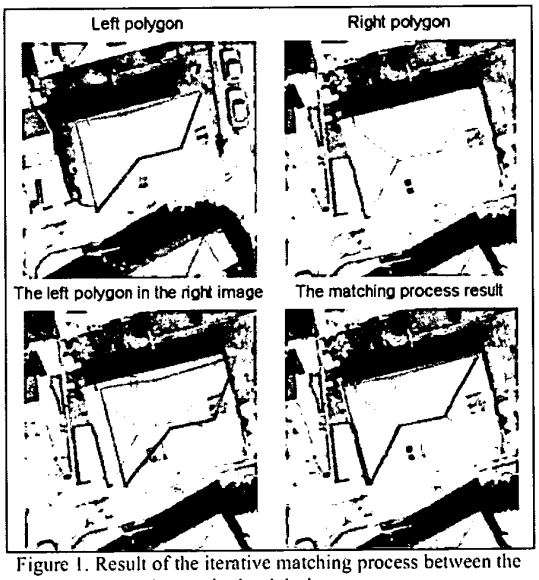


Figure 1. Result of the iterative matching process between the polygons in the right image space

Figure 1 depicts the results of Avrahami's matching process. *Id.* at 45. The top two images show the left and right polygons and the lower two

images show the process of matching the polygons from the left and right images. *Id.*

2. Applicad (Ex. 1005)

Applicad is a product bulletin for a roofing software product. Ex. 1005, 1. Relevant to this case, Applicad teaches generating a roof estimate report based on a three-dimensional model. *Id.* at 2, 39–40.

3. Perlant (Ex. 1006)

Relevant to this case, Perlant discloses a system for scene registration in aerial image analysis. *See* Ex. 1006, 481–92. In particular, Perlant teaches a system in which a marker is displayed on an aerial image to specify a point or part of the image. *See, e.g., id.* at 482, FIG. 2. Based on the points selected on the aerial image, Perlant teaches registering aerial images to a reference grid. *See id.* at 482, FIG. 4.

D. OBVIOUSNESS OF CLAIMS 1, 9, 10, 16, 19, 22, 25–28, 31, AND 34–36

Petitioner asserts claims 1, 9, 10, 16, 19, 22, 25–28, 31, and 34–36 would have been obvious over the combination of Avrahami and Applicad (Pet. 37–56) and claim 10 would have been obvious over the combination of Avrahami, Applicad, and Perlant and Avrahami and Applicad Aerowest (Pet. 56–57). Petitioner provides detailed claim charts and points out where each claim limitation is described by the reference. *Id.* at 41–54, 57. According to Petitioner, Avrahami teaches a roof estimation method for displaying two aerial images. *Id.* at 43 (citing Ex. 1004, Abstract, 43, 46, Figs. 1, 3). The claimed first and second line drawings representing roof features overlaid on first and second aerial images are taught by Avrahami's discussion of the user indicating areas on the left image with seed points and the system transferring those seed points to the right image. *Id.* at 43–44

(citing Ex. 1004, 43–45). Petitioner contends that Avrahami teaches changing a line drawing through its discussion of seed points and polygons that are generated automatically on the right image based on the user's input on the left image. *Id.* at 44–46 (citing Ex. 1004, 45–46, Fig. 1). According to Petitioner, Avrahami's iterative process of matching seed points from the left to the right images teaches the recited corresponding change to the second line drawing in response to changes in the first line drawing. Avrahami describes the iterative process as a series of steps in which points are inputted manually and then detected by the system for use in the opposing image. *See* Ex. 1004, Fig. 2. This back and forth of point input and point detection serves as input for "[b]uilding the topology between the roof planes, intersecting them and reconstructing the 3D roof." *Id.*; *see* Pet. 44–46 (citing Ex. 1004, 45, Fig. 1). Petitioner relies on Applicad to teach generating a roof estimate report. Pet. 20–23 (citing Ex. 1005); *see also id.* at 46. Applicad discusses the generation of detailed quotations for roofing work and provides example reports. Ex. 1005, 40–41. Petitioner relies on Perlant to teach the additional reference grid registration limitation in dependent claim 10. Pet. 57.

Patent Owner argues that the disclosures of Avrahami, Applicad, and Perlant fail to teach multiple claim limitations, and that Petitioner failed to meet its burden to demonstrate that one of ordinary skill in the art would have combined the relevant teachings in the asserted prior art. PO Resp. 9–49. Patent Owner also asserts it has provided objective evidence of non-obviousness that outweighs any evidence presented in Petitioner's affirmative case. *Id.* at 49–71. As outlined below, while we agree with Petitioner that the asserted prior art teaches all the challenged claims'

limitations and that one skilled in the art would have reason to combine those teachings in the manner Petitioner proposes, we agree with Patent Owner that objective indicia of non-obviousness are ultimately decisive in this case.

1. Disputed Elements

a. "displaying" (claims 1, 16, and 28)

Claim 1 requires "displaying . . . a plurality of aerial images of a roof at the same time, each of the aerial images providing a different view, taken from a different angle of the same roof; displaying . . . respective line drawings representing features of the roof." Claims 16 and 28 recite similar limitations. Patent Owner contends that Petitioner has not shown that these limitations are disclosed by the asserted art. PO Resp. 9–11. The crux of Patent Owner's argument is that while "Avrahami includes illustrative Figures 1, 3, and 5 that show side-by-side images of a roof, those are included in the paper to graphically illustrate the ***internal*** operation of the Avrahami algorithm." *Id.* at 9. According to Patent Owner, "[t]he mere presence of those figures does not teach or disclose that the images in the figures should be displayed during performance of the algorithm." *Id.* Further, Patent Owner asserts that the algorithm performed in Avrahami does not require the use of a second image because it provides a first image in which the user selects seed points and then the remainder of the algorithm occurs automatically. *Id.* at 10.

Petitioner disputes this reading of Avrahami and posits that the images shown in Avrahami are not renderings of internal operations, but rather images from a MATLAB implementation of Avrahami's system. Reply 1; *see also* Ex. 1004, 46 ("In the course of research, a semi-automatic system

for performing extraction from aerial images was developed using the MATLAB® environment, in order to examine the algorithm efficiency."). As part of its discussion of testing performed in MATLAB, Avrahami notes that "Figures 3 and 5 show the extraction of polygons in the image space in test areas 1 and 2, accordingly." Ex. 1004, 47. Based on those disclosures, Petitioner argues that "Figures 1, 3, and 5 of Avrahami clearly show a user interface with left and right image spaces of a roof," and "[t]he depictions of these spaces is enough to teach a POSITA to display both a right and left image space, particularly where the left space must be displayed." Reply 2; *see also* Ex. 2017, 69:14–21 (testimony of Petitioner's expert that the figures shown in Avrahami are images that were shown on a computer screen).

We agree with Petitioner. Avrahami describes its algorithm as providing "for semi-automatic 3D spatial *polygon extraction from a pair of colored aerial images* with a known external model solution." Ex. 1004, 43 (emphasis added). Avrahami touts that one of the advantages of its system is that "the operator can identify *at a glance* which buildings can be mapped by this method so as to combine it with traditional manual extraction or other semi-automatic method." *Id.* at 48 (emphasis added). Figure 1 shows a side-by-side comparison of the images in the pair. *See id.* at Fig. 1 (displaying left and right polygons going through Avrahami's iterative matching process). Further, we credit the testimony from Petitioner's expert, Mr. Harold Schuch, that one skilled in the art would understand Avrahami's images to be what "you see . . . on a computer screen" as "part of the production." Ex. 2017, 69:20–21; *see also id.* at 71:2–4 (explaining that "[t]his is an actual production image"). Therefore, we find that

Petitioner has proffered sufficient evidence that Avrahami discloses the disputed "displaying" limitation.

b. "in response to user input, changing . . . the line drawing . . . that overlies the first aerial image of the roof" (claim 1)

Independent claim 1 requires "in response to user input, changing, by the at least one processor of the roof estimate report system, the line drawing representing a feature of the roof that overlies the first aerial image of the roof." Patent Owner asserts that Avrahami does not teach this limitation because "[t]he only user interaction disclosed in Avrahami is the manual placement of a seed point on an aerial image at the outset of the algorithm, which occurs *before* any line drawings even exist, and thus cannot constitute a 'change' in the line drawing." PO Resp. 12. Patent Owner contends that once the seed point is placed, there are no further user interactions during the process and thus there is no point in time in which the line drawing is modified in response to a user input. *Id.* at 13. Patent Owner further contends that "the selection by the user of an initial 'seed *point*' in Avrahami is not a change to a *line* drawing. Rather than indicating a change in a line, the initial 'seed point' merely reflects 'manual pointing to the center' of an area on the left image." *Id.* at 16 (citing Ex. 1004, 43).

Petitioner responds by arguing that Avrahami's seed points are processed one at a time and the resulting "spatial polygons" (line drawings) are modified as the seed points are processed. Reply 3–4. Avrahami states that "[p]rior to the final stage we must ensure that each polygon in both images includes one seed point. If there are two or more pointers for a single polygon, then these pointers must be merged and consequently the areas which are represented by the pointers are also merged." Ex. 1004, 46. In other words, a polygon is generated based on a single seed point and then

modified to account for the existence of an additional seed point. We find that these disclosures would teach or at least suggest to one of ordinary skill in the art that the first line drawing is changed in response to user input. Therefore, we find that Petitioner has proffered sufficient evidence to show that one of ordinary skill in the art would have learned the disputed limitation from the cited disclosures in Avrahami.

c. *"in response to the changing, making corresponding changes . . . to the line drawing overlying the second aerial image" (claims 1, 16, and 26)*

Claim 1 requires "in response to the changing, making corresponding changes, by the at least one processor of the roof estimate report system, to the line drawing overlying the second aerial image." Claims 16 and 26 recite similar limitations. We interpret this language to mean that there are two line drawings that share common elements and that a user-driven change to one line drawing will cause a commensurate change to the second line drawing.

Avrahami's method uses at least two aerial images and these images have corresponding features, but may have differences attributable to things such as images taken from different camera angles. Ex. 1004, 46. The polygon overlaying the left image is created with user input ("seed points") via a flood fill operation. *Id.* at 43. The polygon overlaying the right image is created, in part, based on calculations made regarding the height of the polygon overlaid on the left image. *Id.* at 45. The seed point from the left image is transferred to the right image and the right image's polygon is calculated using the same flood fill technique that created the left image's polygon. *Id.* The homologous points between the two polygons are found by "matching" points via a process that iteratively "slides" the left polygon

over to the right image. *Id.* In particular, the points in the left polygon are assigned the estimated average height, which was calculated previously. With each iteration, these heights of points in the left polygon are updated until the conditional equation is optimized. During the iterations the left polygon "slides" in the direction of the epipolar line in the right image space. *Id.*

Patent Owner first argues that Avrahami does not teach or suggest allowing the user to change any line drawing. PO Resp. 18. This argument is a restatement of the argument addressed above and we do not find it persuasive for reasons previously discussed. *See* § III.D.1.b. Patent Owner also argues that the iterative sliding process described in Avrahami does not teach the recited change to a second line drawing because that process "does not make changes to the left polygon which are then propagated to the right polygon." *Id.* at 18–19. Instead, according to Patent Owner, "the left and right polygons . . . are created independently using a flood fill technique that is performed separately for each of the two images." *Id.* at 19.

Petitioner argues that Avrahami teaches this limitation because it "discloses that the flood fill operation in the right image is *based on* the operations in the left image." Reply 6. In particular, Petitioner explains, "[a]fter the system of Avrahami changes the first line drawing by extracting a polygon for a seed point in the left image, the system will transfer that exact seed point to the right image and change the second line drawing in the right image "**in the same way as in the left image**." Reply 6 (quoting Ex. 1004, 45 (emphasis Petitioner's)). Thus, "[t]he change to the second line drawing is based on the change in the first line drawing because the left polygon itself is the change in the first line drawing and that polygon causes

the change to the second line drawing by sliding to the right image." Reply 7–8.

As discussed above, we agree with the Petitioner's argument that the changes to the first line drawing are responsive to the placement of the seed point. As to the second line drawing, we find that this is a much closer call. While the operator's input (the seed point) is used to generate the first line drawing, the relationship between the seed point and second line drawing is more attenuated. The claim recites, in relevant part, making "corresponding changes" to the second line drawing "in response to" changing the first line drawing. In our view, it is a close call as to whether in Avrahami the change occurs in the second line drawing in response to the change in the first line drawing, or whether it is a change made in response to user input, without regard to the first line drawing. Based on the evidence presented in this case, we are persuaded that one of ordinary skill in the art probably would have learned this limitation from Avrahami. *See* Ex. 1007 ¶¶ 61–63 (Petitioner's expert describing Avrahami's algorithm); Ex. 1010, 22:12–18, 23:24–24:5 (Patent Owner's expert acknowledging "a relationship" and "a dependency" between the seed point and the second line drawing). We find, however, that Petitioner has not made a strong showing as to this element.

d. "generat[ing] and output[ting] a roof estimate report" (claims 1, 16, and 26)

Claims 1, 16, and 26 require "generat[ing] and output[ting] a roof estimate report using a report generation engine, wherein the roof estimate report includes numerical values for corresponding slope, area, or lengths of edges of at least some of a plurality of planar roof sections of the roof." Patent Owner argues that the specific limitations detailing the content of the roof estimate report are entitled to patentable weight. PO Resp. 24–29.

Patent Owner also argues that Applicad's disclosures do not include all of the elements of the roof estimate report stated in the claims. PO. Resp. 29–34.

Patent Owner asserts that the detailed and specific requirements of the roof estimate report have a functional and structural relationship to the substrate. *Id.* at 25–27. According to Patent Owner, the benefits of the claimed invention would not be fully obtained without a roof report that provides the specific values set forth in the claim. *Id.* at 26. Further, "[t]he informational content of the report and types of annotations contained in the report are inexorably linked to the method, as the method allows for those values to be accurately derived from aerial images." *Id.* at 26–27.

We do not agree. The '737 patent claims the content of information that may be provided on a piece of paper. *See, e.g.*, Ex. 1001, 8:10–12 ("FIGS. 3A-3F illustrate individual pages of an example roof estimate report generated by an example embodiment of a roof estimation system"). First, we must ascertain whether the "matter [is] claimed for what it communicates." *In re DiStefano*, 808 F.3d 845, 850 (Fed. Cir. 2015). Here, the claim recites plan views (one or more drawings) annotated with numerical values to communicate quantities such as slope, area, or lengths of edges to a human viewer. Next, we must determine "if the claimed informational content has a functional or structural relation to the substrate." *Id.* "Only if the limitation in question is determined to be printed matter does one turn to the question of whether the printed matter nevertheless should be given patentable weight. Printed matter is given such weight if the claimed informational content has a functional or structural relation to the substrate." *Id.*

We are persuaded that the drawings and numerical values are not functionally or structurally related to the substrate, whether the substrate might be computer memory, a computer display, an electronic file, or a piece of paper. *See* Manual of Patent Examining Procedure (MPEP) § 2111.05 (9th ed., Rev. 07.2015, Nov. 2015) ("[W]here the claim as a whole is directed [to] conveying a message or meaning to a human reader independent of the intended computer system, and/or the computer-readable medium merely serves as a support for information or data, no functional relationship exists."). Patent Owner asserts that "[t]here is a strong functional relationship between that method and the contents of the roof report because those contents—i.e., slope, area, and lengths of edges of the roof—are the product of the method, thus improving it by allowing it to be useful for purposes of roof estimation." PO Resp. 28.

We do not find this to be sufficient because the numbers on the page are not themselves used as part of the method. This stands in stark contrast to *In re Miller,* 418 F.2d 1392 (CCPA 1969), where the numbers printed on the measuring cup were used to carry out the intent of the claimed invention and not just to document the outcome. In *Miller,* there was "a new and unobvious functional relationship between a measuring receptacle, volumetric indicia thereon indicating volume in a certain ratio to actual volume, and a legend indicating the ratio, and in our judgment the appealed claims properly define this relationship." *Id.* at 1396. Here, we are presented with no such relationship. The roof report is merely a printed description of the method's output and it adds no functional or structural elements to the paper or computer screen on which the report appears. We are persuaded that the content of the information does not modify or

otherwise affect the underlying computer or paper, nor does it represent a new and non-obvious relationship with the substrate. Thus, the claimed content of the information is not entitled to weight in the patentability analysis. *See In re Ngai*, 367 F.3d 1336, 1338 (Fed. Cir. 2004); *Ex parte Nehls*, 88 USPQ2d 1883, 1887–90 (BPAI 2008) (precedential) (discussing non-functional descriptive material). In other words, what the content of the information, graphical or textual, may convey to the human mind does not change the functionality of the computer-implemented method and fails to distinguish over generating and displaying any graphical or textual information.

We are cognizant that the challenged claims include claims drawn to a method rather than an apparatus or a manufacture. The printed matter analysis, however, applies equally to process claims. The step of generating and outputting a roof estimate report "wherein the roof estimate report includes" particular information is similar to the "informing" step in *King Pharmaceuticals, Inc. v. Eon Labs, Inc.*, 616 F.3d 1267, 1274–79 (Fed. Cir. 2010). In *King Pharmaceuticals*, the subject matter of dependent claim 21, which recited "informing" the patient that the drug administered in accordance with base claim 1 had certain therapeutic effects, was subject to the rationale of "printed matter" cases even though the claims were cast as a method. The content of the "informing" was thus not given patentable weight. *See id.* Thus, we are persuaded that the detailed requirements as to the contents of the roof estimate report are not entitled to patentable weight.

e. "transmitting roof measurement information based . . . on the change of the line drawing" (claim 9)

Claim 9 requires "transmitting roof measurement information based at least in part on the change of the line drawing representing a feature of the

roof that overlies the first aerial image of the roof." In addition to reiterating its earlier "modifying" argument, Patent Owner argues Avrahami does not generate or transmit "roof measurement information." PO Resp. 36–40. We disagree.

Avrahami creates and displays a model in a local coordinate system as depicted in Figures 4 and 6 (reproduced below):

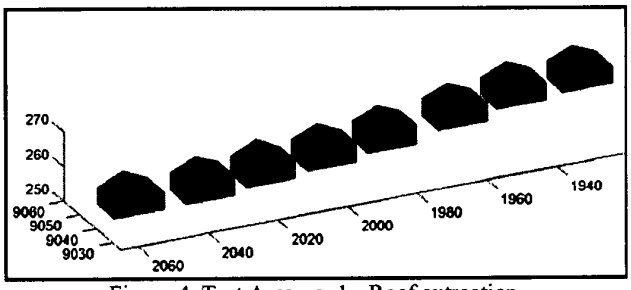


Figure 4. Test Area no. 1 - Roof extraction

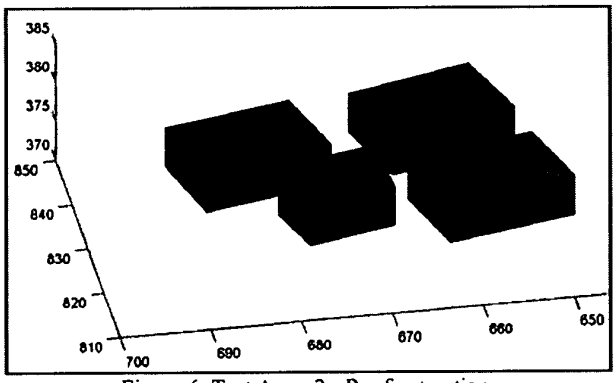


Figure 6. Test Area. 2 - Roof extraction

Figures 4 and 6 present extracted roofs in a local coordinate system. Ex. 1004, 47. We agree with Petitioner that Avrahami displays "roof measurement information" by displaying a roof in a local coordinate system, even though Avrahami does not label its measurement units. *See* Pet. 47; Reply 15–16. That is, because the claim term at issue does not require any particular units of measure, the numerical values along the axes in figures 4

and 6 convey "roof measurement information," as claimed. We also agree with Petitioner automatic extraction of the 3D roof in a local coordinate system (i.e., "query[ing] and present[ing]" spatial data, Ex. 1004, 43) is a description of *transmitting* roof measurement information, as claimed. *See* Pet. 46; Reply 16–17. The claim term at issue requires only "transmit[ting]" roof measurement information—it does not specify any particular source or destination for the transmission. The '737 patent's specification references transmission within the same system. *See* Reply 16 (citing Ex. 1001, 16:15–17, Fig. 8). Thus, it is of no moment that Avrahami does not disclose transmitting roof measurement information to a third-party system or separate computer, as Patent Owner argues. *See* PO Resp. 38–39.

f. "modifying a three dimensional model of the roof" (claim 25)

Patent Owner argues that Avrahami does not disclose "modifying a three dimensional model of the roof based at least on the modification of the line drawing overlaid on the first aerial image," as recited in claim 25. PO Resp. 40–45. Petitioner relies on the algorithm shown in Figure 2 as corresponding to modifying a three-dimensional model as claimed. Pet. 50–51.

As explained above, Avrahami's system uses an iterative method for maximal matching between the two polygons by "sliding" the left polygon in the direction of the epipolar line in the right image space until the polygons achieve a maximum overlap in the right image space. Ex. 1004, 45; Ex. 1007 ¶ 63. Figure 2 of Avrahami is reproduced below:

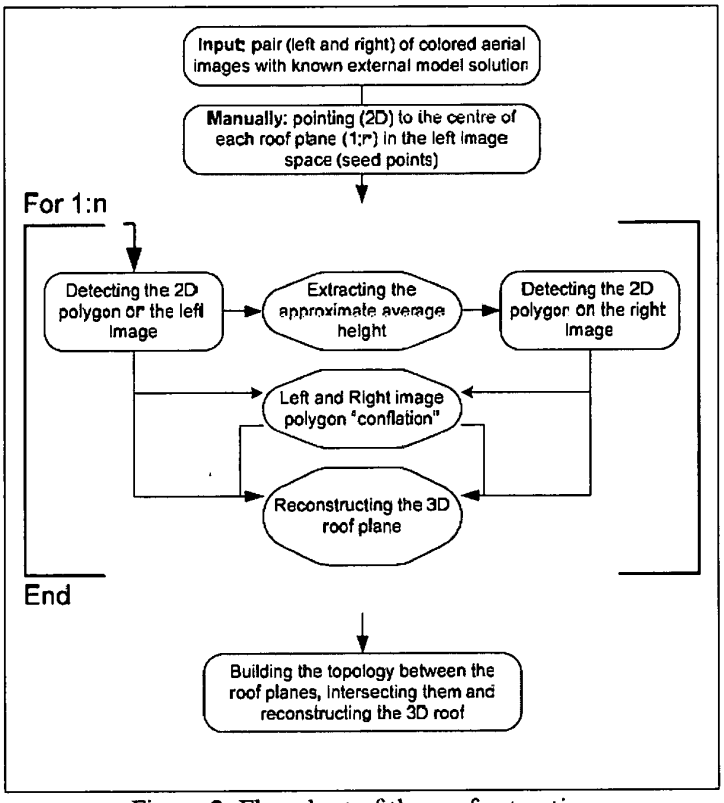


Figure 2. Flowchart of the roof extraction

Ex. 1004, 46. Figure 2 depicts a flowchart of Avrahami's roof extraction by matching right and left polygons. The algorithm consists of three main stages: manual pointing (seed points in 2D to the center area of each roof plane); performing an automatic process for extraction of the roof planes for each seed point; and building topology between the planes, with the outcome being a 3D roof. *Id.* at 46.

Patent Owner argues that Avrahami's algorithm does not modify a three-dimensional model of the roof based on the received indication of the feature of the building because Avrahami's "algorithm builds a three dimensional model of the ***roof*** only ***once***, at the very end of the process, which is never subsequently modifiable." PO Resp. 41. According to Patent

Owner, "[t]he creation of individual spatial polygons are merely intermediary steps on the path to initial creation of the model . . . before this final stage, Avrahami only creates individual spatial polygons ***that are not yet part of any model of a roof***." *Id.* at 42. We disagree.

As Petitioner explains, Patent Owner's argument is based on an incorrect assumption that modifying a three-dimensional model of the roof requires first generating a fully-assembled model and then making a modification to that fully-assembled model. Reply 17. The claim language at issue is not so limited. The '737 patent's specification explains that "[m]odifying the 3D model may include adding or updating" features on an otherwise incomplete model. Ex. 1001, 22:44–46; *see id.* at 22:52–59. Avrahami discloses creating individual roof planes, modifying those planes prior to assembly, and assembling the planes into a final three-dimensional model. *See* Ex. 1004 at 44–46. Even though, as Patent Owner asserts, Avrahami's final 3D roof model is not modified post-assembly, Avrahami teaches the limitation at issue because an *incomplete* or partial model of the roof is still a model of the roof. Thus, modifying a three-dimensional model of the roof includes modifying individual roof planes prior to assembly and sequentially adding roof planes to a three-dimensional model, as Avrahami teaches.

g. "reference grid" (Claim 10)

Patent Owner argues that the combination of Avrahami and Perlant do not render claim 10 obvious because Perlant does not teach or suggest "registering, based on the received indication of the point, the aerial image to a reference grid corresponding to a three-dimensional model" as required by claim 10. PO Resp. 45–48. Patent Owner asserts Perlant fails to teach

the disputed limitation because Perlant does not disclose a three-dimensional reference grid or a three dimensional model. *See id.* at 45.

We disagree with Patent Owner. As Petitioner explains, "[c]laim 10 only requires a 'reference grid,' not a *three-dimensional* reference grid." Reply 20. In addition, Perlant's alleged failure to disclose generating or modifying a three-dimensional roof model does not undermine Petitioner's obviousness challenge because Avrahami discloses that limitation. *See* Ex. 1004, Figs. 4, 6. Thus, we agree with Petitioner that the combination of Avrahami and Perlant teaches "registering, based on the received indication of the point, the aerial image to a reference grid corresponding to the three-dimensional model," as required by claim 10.

2. Remaining Undisputed Elements

Petitioner contends the combination of Avrahami and Applicad discloses the remaining limitations of claims 1, 9, 16, 19, 22, 25–28, 31, and 34–36, and that the combination of Avrahami, Applicad, and Perlant discloses the remaining limitations of claim 10. *See* Pet. 37–54. Patent Owner does not address the merits of Petitioner's assertions regarding the remaining limitations. *See* PO Resp. 9–49. We agree with Petitioner's assertions and adopt them as our own.

3. Rationale for Combining the Asserted Teachings in the Prior Art

a. Reason to Combine Avrahami and Applicad

Petitioner argues that "[i]t would have been obvious to a person of ordinary skill in the art to include an annotated roof report, as taught by Applicad, with the system of Avrahami for easy and effective communication of roof measurement results to a user." Pet. 56. Petitioner asserts that Applicad discloses importing a drawing from another system and

then creating a report based on that input. *Id.* at 29. According to Petitioner, Avrahami's line drawing system could be used as input for Applicad's reporting system. *Id.* at 12; *see id.* at 20–23, 46. Petitioner asserts that this combination would be within the skills of one or ordinary skill in the art. *Id.* at 54–55.

Patent Owner asserts that one skilled in the art would not combine Avrahami and Applicad as Petitioner suggests. PO. Resp. 34–36. According to Patent Owner, "Avrahami and Applicad are fundamentally incompatible because Applicad cannot import three-dimensional models" from other programs. PO. Resp. 34.

Petitioner responds that this mischaracterizes its argument because its challenge is not predicated on a physical combination of Avrahami and Applicad, but rather the predictable results that would have been achieved by using the teachings of Applicad in conjunction with a 3D CAD system. Reply 13–15. Further, Petitioner directs us to Applicad's discussion of importing drawings in a ".dxf format" and Applicad's reference to its software "sit[ting] on top of a very powerful 3 dimensional CAD package." *Id.* at 14 (quoting Ex. 1005, 3); *see* Ex. 1007 ¶ 57 ("Further, the Applicad system can also import a model generated in another computer program, in the form of a roof or wall outline in three dimensions. *See, e.g.,* Applicad, pp. 2, 4.").

We find Patent Owner's assertions that Applicad cannot be incorporated in Avrahami to be unpersuasive because the obviousness analysis is not predicated on the physical combinability of the references, but whether the claimed invention is rendered obvious by the teachings of the prior art as a whole. *In re Etter*, 756 F.2d 852, 859 (Fed. Cir. 1985) (en

banc). This is true because "[t]he test for obviousness is not whether the features of a secondary reference may be bodily incorporated into the structure of the primary reference . . . but rather whether 'a skilled artisan would have been motivated to combine the teachings of the prior art references to achieve the claimed invention.'" *Allied Erecting & Dismantling Co. v. Genesis Attachments, LLC*, 825 F.3d 1373, 1381 (Fed. Cir. 2016) (internal citations omitted). We are persuaded by Petitioner's argument that one of ordinary skill in the art would have combined the teachings of the references in order to achieve the "easy and effective communication of roof measurement results to a user." Pet. 56. Thus, the combination of the teachings of Applicad and Avrahami would have allowed one of ordinary skill in the art to achieve a predictable result. *See KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 401 (2007). Therefore, we are persuaded that Petitioner has put forth sufficient rationale to support the combination of the teachings of Applicad and Avrahami.

b. *Reason to Combine Perlant*

Petitioner explains that one skilled in the art would have found it obvious to combine Perlant's scene registration process with the line drawing and matching features of Avrahami because "Perlant improves this device with registration functionality and the result would be predictable." Pet. 59; *see* Pet. 32 (noting that "Perlant discloses the ability to augment 3D model generation by scene registration in aerial images" (citing Ex. 1006, 485)). In light of that explanation, we find Petitioner has articulated sufficient reasoning with some rational underpinning to support the legal conclusion that its proffered combination of references would have been obvious to one of ordinary skill in the art. *See KSR*, 550 U.S. at 418. That

is, we agree with Petitioner that claim 10 represents a combination of familiar elements according to known methods (i.e., Avrahami's line drawing and matching features, Applicad's roof estimate report, and Perlant's scene registration process), yielding only a predictable result. *See id.*

4. Secondary Considerations of Nonobviousness

Notwithstanding what the teachings of the prior art would have suggested to one skilled in the art, objective evidence of nonobviousness may lead to a conclusion that the challenged claims would not have been obvious. *In re Piasecki*, 745 F.2d 1468, 1471–72 (Fed. Cir. 1984). Objective evidence of nonobviousness "may often be the most probative and cogent evidence in the record" and "may often establish that an invention appearing to have been obvious in light of the prior art was not." *Transocean Offshore Deepwater Drilling, Inc. v. Maersk Drilling USA, Inc.*, 699 F.3d 1340, 1349 (Fed. Cir. 2012). To contest obviousness, in addition to the arguments outlined above, Patent Owner asserts that objective indicia of nonobviousness—commercial success and industry praise in particular—confirms that the claimed invention is nonobvious. *See* PO Resp. 49–71. We agree with Patent Owner that objective indicia of non-obviousness are decisive in this case, as explained below.

a. Nexus

To be relevant, evidence of nonobviousness must be commensurate in scope with the claimed invention. *In re Huai-Hung Kao*, 639 F.3d 1057, 1068 (Fed. Cir. 2011). Thus, to be accorded substantial weight, there must be a nexus between the merits of the claimed invention and the evidence of secondary considerations. *In re GPAC Inc.*, 57 F.3d 1573, 1580 (Fed. Cir.

1995). "[N]exus" is a legally and factually sufficient connection between the objective evidence and the claimed invention, such that the objective evidence should be considered in determining nonobviousness. *Demaco Corp. v. F. Von Langsdorff Licensing Ltd.*, 851 F.2d 1387, 1392 (Fed. Cir. 1988). There is a "presumption of a nexus" when a product is "coextensive" with a patent claim. *Teva Pharms. USA, Inc. v. Sandoz, Inc.*, 723 F.3d 1363, 1372 (Fed. Cir. 2013).

We are persuaded by Patent Owner's extensive evidence of nexus between its Render House and Twister products and the challenged claims. Patent Owner steps through each challenged claim on an element-by-element basis and directs us to images and specific passages from its Render House and Twister user guides that it argues embody the limitations of each challenged claim. PO. Resp. 52–65. Patent Owner also supports its assertion of nexus with testimony in the form of a Declaration from its expert, Dr. Chandrajit Bajaj, that includes a claim chart detailing where each limitation of the challenged claim is found in its Twister and Render House products. Ex. 2031, 41–100.[4]

The Federal Circuit has held that "if the marketed product embodies the claimed features, and is coextensive with them, then a nexus is presumed and the burden shifts to the party asserting obviousness to present evidence to rebut the presumed nexus." *Brown & Williamson Tobacco Corp. v. Philip Morris Inc.*, 229 F.3d 1120, 1130 (Fed. Cir. 2000). Patent Owner has put forth sufficient evidence to show that its Twister and Render House

[4] Here, we cited to page number and not paragraphs of Dr. Bajaj's report because the paragraph containing the claim charts stretches over many pages.

products embody the elements of the challenged claims and thus, we look to Petitioner to rebut this presumed nexus and acknowledge that the presumption "cannot be rebutted with mere argument; evidence must be put forth." *Id.* Petitioner argues that we should discount Patent Owner's evidence of nexus because "Dr. Bajaj formed his opinion on Twister and Render House in a WebEx presentation with Patent Owner's engineers," but did not actually use the Twister or Render House products himself. Reply 22.

Under Federal Rule of Evidence 702, an expert witness may offer opinion testimony if (a) the expert's scientific, technical, or other specialized knowledge will help the trier of fact to understand the evidence or to determine a fact in issue; (b) the testimony is based on sufficient facts or data; (c) the testimony is the product of reliable principles and methods; and (d) the expert has reliably applied the principles and methods to the facts of the case. Petitioner has not moved to exclude Dr. Bajaj's testimony as impermissible under Rule 702, but instead has argued that we should not rely on Dr. Bajaj's testimony because it is not evidence that that we can use to explain whether the sequence of screenshots provided by Patent Owner's counsel embodies the elements of the challenged claims. Reply 22–23. We do not agree with Petitioner.

Dr. Bajaj testified that he "discussed these products with engineers at Patent Owner who use the Twister and Render House products on a regular basis" and that during those discussions he "personally directed Patent Owner's engineers to operate the Twister and Render House software to confirm [his] understanding of the products' operation." Ex. 2031 ¶ 84. He also testified that "[m]y understanding of the features of the Twister and

Render House products are further confirmed based on my review of user manuals for these two products." *Id.* We find this explanation credible. Petitioner objects to the screenshots in Dr. Bajaj's declaration because they were not personally prepared by Dr. Bajaj. Reply 22–23. Dr. Bajaj, however, is testifying as to his opinion of the capabilities and features of the Twister and Render House products and these screenshots are merely visual aids to assist the Panel in understanding how Dr. Bajaj reached his conclusion. We see no impropriety in his use of images collected from other sources to document his opinions as to the operation of the products at issue. Thus, we are not persuaded by Petitioner's arguments and we find that Patent Owner has provided sufficient evidence to establish a nexus between the challenged claims and the Twister and Render House products.

b. *Commercial Success*

Patent Owner contends that its Twister and Render House products "used the patented invention to achieve tremendous commercial success by creating accurate roof estimate reports faster and at less expense than previous solutions." PO Resp. 66. Patent Owner asserts that Petitioner recognized the benefits of those products and "entered a contract with Patent Owner for its roof reports soon after the release of Patent Owner's first product." *Id.* at 67 (citing Ex. 2021 ("EagleView and Xactware announced a new technology integration that will allow Xactware customers to access EagleView's breakthrough roof measurement capabilities.")). Patent Owner also provides evidence of rapid growth of its business after the introduction of these products. *Id.* at 67 (citing Ex. 2022 (noting "three-year revenue growth of 2,406 percent")). Patent Owner directs us to statements from Scott Stephenson, President and CEO of Verisk Analytics, which is

Petitioner's parent company. *Id.* at 68–69 (citing Ex. 2023). In a call with investors, Mr. Stephenson "announced the acquisition of EagleView Technologies Corporation, or EVT, for a purchase price of $650 million. EVT is the parent company of both Pictometry International, a recognized leader in imagery, and EagleView, which is well known in the insurance industry." Ex. 2023, 3. He also touted Patent Owner's "significant intellectual property, including over 20 issued patents" and its position as a market leader, noting that:

> Eagle View division is a leading provider of reports on structures used in claims processes in the property and casualty insurance and the contractor markets. The Eagle View division does at least some business with 24 of the top 25 insurance companies, as well as with over 30,000 building contractors.

Id.

Patent Owner further provided unrebutted evidence that "approximately 96 percent of the top 25 insurance carriers rely on [Eagle View Technologies 3D aerial roof measurement reports] in their claims departments." Ex. 2020, 1; *see also* Ex. 2029, 8 (Verisk Analytics presentation noting that 24 of top 25 insurance companies and 30,000 contractors are Eagle View customers). In addition, Patent Owner's evidence shows that its products are used by "about one-fifth of the roofing contractor market, according to an estimate by market researcher IbisWorld." Ex. 2024. Patent Owner's financial reports show both that it sold a significant number of roofing reports and that its sales grew significantly between 2009 and 2015. *See* PO Resp. 67–68. We find that this information, taken together with statement from others in the industry (*see* Ex. 2029) gives us a view of Patent Owner's place in the relevant

market and persuades us that Patent Owner's Twister and Render House products experienced significant commercial success and wide-spread use in the industry.

Finally, Patent Owner offers the testimony of Chris Johnson, Vice President of Eagle View Technologies, to discuss financial reports for the years 2009–2012. Ex. 2011. In his declaration, Mr. Johnson testifies that the reports submitted into evidence all "reflect sales of reports created using the Twister and Render House products." *Id.* ¶¶ 3–6.

Petitioner asserts that "Patent Owner has failed to prove a nexus exists between the claims of the '737 patent and the purported commercial success." Reply 24. Our reviewing court has held that for evidence of commercial success to be relevant, "the patentee must establish a nexus between the evidence of commercial success and the patented invention." *Wyers v. Master Lock Co.*, 616 F.3d 1231, 1246 (Fed. Cir. 2010). As noted above, however, Patent Owner has provided extensive evidence that the Twister and Render House products are coextensive with the challenged claims and that the reports sold were created using the Twister and Render House products. Thus, we are persuaded that nexus exists between the challenged claims and the commercially successful products at issue.

Petitioner also asserts that we should discount Patent Owner's evidence of commercial success because it "relates to the sale of the roof reports, not the license or sale of the Twister and Render House products themselves." Reply 24. We do not find this argument persuasive. As noted above, Patent Owner provided extensive evidence that the Twister and Render House products are coextensive with the challenged claims, and that the commercially successful reports were created using the Twister and

Render House products. A patent challenger may respond to an allegation of presumed nexus by presenting evidence that shows the proffered objective evidence was "due to extraneous factors other than the patented invention." *Demaco Corp. v. F. Von Langsdorff Licensing Ltd.*, 851 F.2d 1387, 1393 (Fed. Cir. 1988). Such extraneous factors include additional unclaimed features or arguably, as is the case here, features to which little or no patentable weight has be ascribed. *See, e.g., Ecolochem, Inc. v. S. Cal. Edison Co.*, 227 F.3d 1361, 1378 (Fed. Cir. 2000) (applying presumption even though commercial embodiment had unclaimed mobility feature). As noted above, however, patent challenger cannot successfully rebut the presumption with argument alone—it must present evidence. *Brown & Williamson*, 229 F.3d at 1130 (citing *Demaco*, 851 F.2d at 1393). Petitioner has not done so in this case.

Patent Owner may commercialize its technology in many different ways. The choice to sell the output of the claimed method or claimed apparatus, as opposed to selling or licensing software that practices the claims does not undermine Patent Owner's commercial success in the marketplace that is attributable to its claimed invention. Patent Owner is tasked with providing evidence tying the commercial success and the claims. That commercial success may take many forms and may be the result of many different business strategies, but in the end, for our purposes, the question is whether Patent Owner has shown a sufficient nexus between the commercial success and the claims. We are persuaded that Patent Owner has provided such evidence here. As noted above, Patent Owner and its declarant have extensively analyzed the Twister and Render House products and shown that these products embody the challenged claims in order to

generate the roofing reports that it sold, and that the reports sold were created using the Twister and Render House products. Petitioner has not made any showing that the commercial success is based on something other than the contributions of the claimed invention to the generation of roofing reports. Thus, in light of extensive evidence of nexus, we are persuaded that it is proper for Patent Owner to rely upon financial information relating to the sale of reports generated by the Twister and Render House products.

c. Industry Praise

Praise from industry participants, especially competitors, is probative as to obviousness because such participants "are not likely to praise an obvious advance over the known art. Thus, if there is evidence of industry praise of the claimed invention in the record, it weighs in favor of the non-obviousness of the claimed invention." *Apple Inc. v. Samsung Elecs. Co.*, 839 F.3d 1034, 1053 (Fed. Cir. 2016). Petitioner described Patent Owner's products as "[u]sing aerial photography and patent-pending software [to] accurately calculate[] measurements for the roof's ridges, rafters, valleys, slopes and more." Ex. 2021, 1. Petitioner further noted that the "process saves contractors and roofers hours of time spent measuring and scoping a roof." *Id.*

Verisk Analytics described Patent Owner as "a leader in sophisticated imagery for uses in the property and casualty, contractor, government, and commercial spaces." Ex. 2023, 3. Verisk's CEO stated that Patent Owner is "a leading provider of reports on structures used in claims processes in the property and casualty insurance and the contractor markets." *Id.* He also noted that "[Patent Owner's] solutions provide detailed, accurate

measurements without the danger and added time of an adjustor climbing onto a roof." *Id.* at 4.

Patent Owner directs us to an article from Bloomberg in which a roofer touts the accuracy of Patent Owner's products, stating that "most insurance carriers at this point treat [Patent Owner's roofing reports] as gospel." Ex. 2024, 2. Patent Owner also directs us to an article from CNN Money in which a partner at a claim investigation company stated that "[h]aving an Eagle View report has become an industry accepted standard." Ex. 2025, 1. An article from the California Business Journal states that "Eagle View made one of the biggest breakthroughs in the history of the industry by creating a state-of-the-art software program that remotely snaps sophisticated aerial pictures of roofs and accurately measures lengths, pitches, valleys and other hard-to-see areas on roofs." Ex. 2027, 2. In that article, a roofer is quoted as saying that "Eagle View changed the industry forever with this technology." *Id.* We find Patent Owner's extensive evidence of industry praise weighs in favor of the non-obviousness of the claimed invention.

d. Conclusions on Obviousness

We have considered Petitioner's evidence and arguments about the asserted prior art's teachings and the reasons why one skilled in the art would combine them. We have also weighed the objective indicia of non-obviousness presented by Patent Owner. As noted above (*see supra* § III.D.1.c), we find certain aspects of Petitioner's obviousness allegations to be at best a close call. On the other side, we are persuaded that Patent Owner has shown strong evidence of nexus between the challenged claims and the Twister and Render House products used to produce the

commercially successful reports. We are persuaded also that Patent Owner has shown strong evidence of industry praise. "These real world indicators of whether the combination would have been obvious to the skilled artisan in this case 'tip the scales of patentability.'" *Apple Inc. v. Samsung Elecs. Co.*, 839 F.3d 1034, 1058. Thus, upon consideration of the strength of Petitioner's obviousness allegations and the strength of Patent Owner's contentions as to secondary considerations of non-obviousness, we are persuaded that Petitioner has not met its burden to show that the challenged claims would have been obvious over the asserted prior art.

IV. PATENT OWNER'S MOTION TO EXCLUDE DEPOSITION TESTIMONY AND MOTION TO STRIKE PETITIONER'S REPLY

Patent Owner filed a Motion to Exclude the re-direct deposition testimony of Petitioner's expert (pages 117–120 of Ex. 2017). Paper 41. Because this Decision does not rely on that testimony, we deny Patent Owner's Motion as moot.

Patent Owner also filed a Motion to Strike Petitioner's Reply for "improperly include[ing] new arguments" related to claim 25's "modifying" limitation. Paper 37, 1. Upon considering Patent Owner's arguments (Paper 37, 1–3) and Petitioner's Opposition to the Motion to Strike (Paper 38, 1–3), we deny Patent Owner's Motion to Strike because we agree with Petitioner that its arguments submitted with the Reply, including the arguments addressing the "modifying" claim limitation, fall within the proper scope of a reply. *See* Paper 38, 1–3.

V. CONCLUSION

In conclusion, Petitioner has not shown by a preponderance of the evidence that claims 1, 9, 10, 16, 19, 22, 25–28, 31, and 34–36 of the '737 patent are unpatentable under 35 U.S.C. § 103(a).

VI. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that Petitioner has not shown by a preponderance of the evidence that claims 1, 9, 16, 19, 22, 25–28, 31, and 34–36 of the '737 patent are unpatentable as obvious over the combination of Avrahami and Applicad; and

FURTHER ORDERED that Petitioner has not shown by a preponderance of the evidence that claim 10 of the '737 patent is unpatentable as obvious over the combination of Avrahami, Applicad, and Perlant; and

FURTHER ORDERED that Patent Owner's Motion to Exclude (Paper 41) is DENIED as moot; and

FURTHER ORDERED that Patent Owner's Motion to Strike Petitioner's Reply (Paper 37) is DENIED; and

FURTHER ORDERED that, because this is a Final Written Decision, the parties to the proceeding seeking judicial review of the decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

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Paper No. 9
Entered: July 18, 2017

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

XACTWARE SOLUTIONS, INC.,
Petitioner,

v.

EAGLE VIEW TECHNOLOGIES, INC.,
Patent Owner.

Case IPR2017-00363
Patent 9,135,737 B2

Before BRYAN F. MOORE, STACEY G. WHITE, and GARTH D. BAER, *Administrative Patent Judges*.

WHITE, *Administrative Patent Judge*.

DECISION
Denying Institution of *Inter Partes* Review
35 U.S.C. § 314(a) and 37 C.F.R. § 42.108

Xactware Solutions, Inc. ("Petitioner") filed a Petition (Paper 1, "Second Petition" or "Second Pet.") requesting *inter partes* review of claims 1, 8, 16, 25, 26, and 33 of U.S. Patent No. 9,135,737 B2 (Ex. 1001, "the '737 patent"). Eagle View Technologies, Inc. ("Patent Owner") filed a Preliminary Response (Paper 8, "Prelim. Resp.").

For the reasons explained below, we exercise our discretion under 35 U.S.C. § 314(a) and 37 C.F.R. § 42.108(a) not to institute *inter partes* review of claims 1, 8, 16, 25, 26, and 33 of the '737 patent.

I. BACKGROUND

A. RELATED MATTERS

The '737 patent is also the subject of the instituted proceeding in IPR2016-00592, and Xactware Solutions, Inc., is the Petitioner in that proceeding. *See Xactware Solutions, Inc. v. Eagle View Techs., Inc.*, Case IPR2016-00592 ("IPR2016-00592"), Paper 9 ("First Petition" or "First Pet.").

Patents related to the '737 patent are involved in IPR2016-00582, IPR2016-00586, IPR2016-00587, IPR2016-00589, IPR2016-00590, IPR2016-00591, IPR2016-00593, IPR2016-00594, IPR2016-01775, IPR2017-00021, IPR2017-00025, IPR2017-00034, and IPR2017-000363. Second Pet. 2–3, Paper 3, 2–3. The '737 patent is involved in the following district court matter: *Eagle View Technologies, Inc., v. Xactware Solutions, Inc.*, No. 2:15-cv-07025 (D.N.J.). Second Pet. 2; Paper 3, 2.

B. THE CHALLENGED PATENT

The '737 patent relates to systems and methods for determining roof measurement information based on one or more aerial images of a roof. Ex. 1001, 1:19–23. The embodiment described in the specification of the

'737 patent is the Roof Estimation System ("RES") that provides a roof estimate report for a building. *Id.* at 2:57–60. Figure 1 of the '737 patent is reproduced below.

Fig. 1

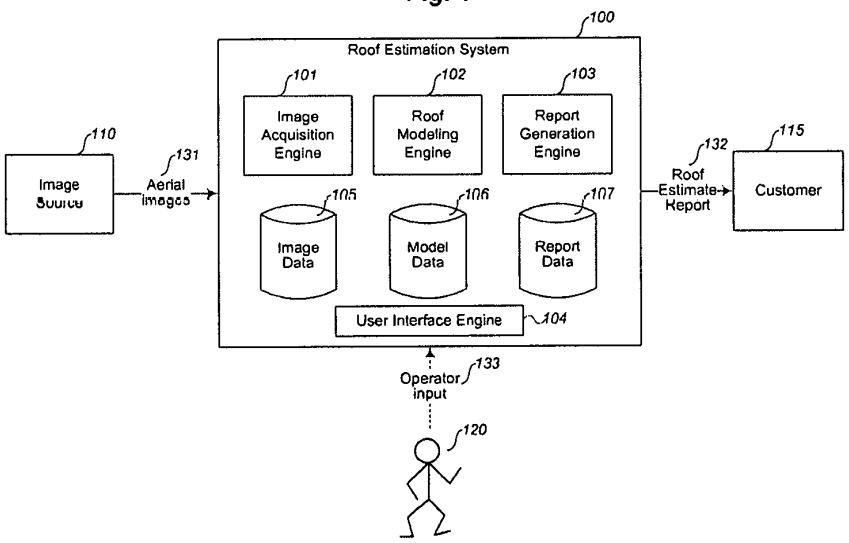


Figure 1 is a block diagram of an example Roof Estimation System ("RES"). Ex. 1001, 3:42–44. RES 100 includes image acquisition engine 101, roof modeling engine 102, report generation engine 103, image data 105, model data 106, and report data 107. *Id.* at 3:44–46. RES 100 is communicatively coupled to image source 110, customer 115, and operator 120. *Id.* at 3:47–48. RES 100 is configured to generate roof estimate report 132 for a specified building, based on aerial images 131 of the building received from the image source 110. *Id.* at 3:52–55.

C. ILLUSTRATIVE CLAIM

As noted above, Petitioner challenges claims 1, 8, 16, 25, 26, and 33 of the '737 patent, of which claims 1, 16, and 26 are independent. Claim 1 is illustrative of the challenged claims and is reproduced below:

1. A computer-implemented method in a roof estimate report system including at least one processor and a memory coupled to the at least one processor, the method comprising:

displaying, by the at least one processor of the roof estimate report system, a plurality of aerial images of a roof at the same time, each of the aerial images providing a different view, taken from a different angle of the same roof;

displaying, by the at least one processor of the roof estimate report system, respective line drawings representing features of the roof, the respective line drawings overlying a first and a second aerial image of the plurality of aerial images of the roof, the line drawing overlying the first aerial image of the roof having features in common with the line drawing overlying the second aerial image of the roof;

in response to user input, changing, by the at least one processor of the roof estimate report system, the line drawing representing a feature of the roof that overlies the first aerial image of the roof;

in response to the changing, making corresponding changes, by the at least one processor of the roof estimate report system, to the line drawing overlying the second aerial image; and

generating and outputting a roof estimate report using a report generation engine, wherein the roof estimate report includes numerical values for corresponding slope, area, or lengths of edges of at least some of a plurality of planar roof sections of the roof, wherein the generated roof estimate report is provided for repair and/or constructing the roof structure of the building..

Ex. 1001, 23: 54–24:19.

D. ASSERTED GROUNDS OF UNPATENTABILITY

Petitioner asserts the following grounds of unpatentability:

References	Basis	Challenged Claims
Avrahami [1] and Applicad[2]	§ 103(a)	8 and 33
Avrahami, Applicad, and McKeown[3]	§ 103(a)	8 and 33
McKeown and Applicad	§ 103(a)	1, 8, 16, 25, 26, and 33

Second Pet. 9.

II. ANALYSIS

A. DISCRETIONARY NON-INSTITUTION

1. Petitioner's First Petition in IPR2016-00592

Petitioner previously filed its First Petition requesting an *inter partes* review of claims 1, 8–10, 16, 19, 22, 25–28, 31, and 33–36 of the '737 patent. *See* First Pet. 6–40. The First Petition asserted the following grounds of unpatentability under § 103:

References	Claim(s) Challenged
Avrahami and Applicad	1, 9, 10, 16, 19, 22, 25–28, 31, and 34–36

[1] Yair Avrahami et al., *Extraction of 3D Spatial Polygons Based on the Overlapping Criterion for Roof Extraction from Aerial Images*, CMRT05, IAPRS, Vol. XXXVI, Part 3/W24, Vienna, Austria, Aug. 29–30, 2005 (Ex. 1004, "Avrahami").

[2] APPLICAD PRODUCT BULLETIN, KEY FEATURES OF OUR ROOFING SOFTWARE" (Nov. 2002) (Ex. 1005, "Applicad").

[3] David M. McKeown, et al., *Feature Extraction and Object Recognition: Automatic Cartographic Feature Extraction Using Photogrammetric Principles*, Digital Photogrammetry: an Addendum to the Manual of Photogrammetry, American Society For Photogrammetry and Remote Sensing, 1996 (Ex. 1006, "McKeown").

References	Claim(s) Challenged
Avrahami, Applicad, and Perlant[4]	10
Hsieh[5] and Applicad	1, 8–10, 16, 19, 22, 25–28, 31, and 33–36
Hsieh, Applicad, and Perlant	10

See IPR2016-00592, slip op. at 5–6 (PTAB Aug. 31, 2016) (Paper 14) ("IPR2016-00592 Inst. Dec."). Based on the First Petition, we instituted review of claims 1, 9, 16, 19, 22, 25–28, 31, and 34–36 as obvious over Avrahami and Applicad and claim 10 as obvious over Avrahami, Applicad, and Perlant. *Id.* at 18–19. We denied institution on all grounds involving Hsieh because we found Petitioner had not made a sufficient showing that Hsieh was prior art. *Id.* at 8–9.

2. *The Board's Discretion to Deny Institution*

Institution of an *inter partes* review is discretionary. *See* 35 U.S.C. § 314(a) (authorizing institution of an *inter partes* review under particular circumstances, but not requiring institution under any circumstances); 37 C.F.R. § 42.108(a) ("the Board *may* authorize the review to proceed") (emphasis added); *Harmonic Inc. v. Avid Tech., Inc.*, 815 F.3d 1356, 1367 (Fed. Cir. 2016) (explaining that under § 314(a), "the PTO is permitted, but never compelled, to institute an IPR proceeding").

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[4] Frederic P. Perlant et al., Scene Registration in Aerial Image Analysis, PHOTOGRAMMETRIC ENGINEERING AND REMOTE SENSING, Vol. 56, No. 4, 481–93, Apr. 1990 ("Perlant") (IPR2016-00592 Ex. 1006).
[5] Yuan Hsieh, DESIGN AND EVALUATION OF A SEMI-AUTOMATED SITE MODELING SYSTEM, Carnegie Mellon, Nov. 1995 ("Hsieh") (Ex. 1003).

3. Discussion

Petitioner asserts that 35 U.S.C. § 325(d) does not apply to this case because there has been no substantive adjudication of the grounds asserted against claims 8 and 33. Second Pet. 6. Petitioner notes that the Board declined to institute the challenge to claims 8 and 33 in the prior case due to the Board's findings regarding the public accessibility of Hsieh. *Id.* Thus, Petitioner argues that § 325(d) does not apply because the Board never considered the substantive merits of the challenge directed to claims 8 and 33. *Id.* Further, Petitioner asserts that McKeown, which was not asserted in the First Petition, is not substantially the same prior art as Hsieh. *Id.* at 6.

Patent Owner argues that we should decline to institute under § 325(d) because (1) Petitioner's repetitive challenges have already greatly taxed the resources of the Board, (2) Petitioner previously filed a petition directed to the same claims of the same patent, (3) the Second Petition raises substantially the same art and nearly identical arguments that were already submitted by the same petitioner in its First Petition, (4) Petitioner knew of the references it asserts in the Second Petition when it filed the First Petition, (5) Petitioner had received Patent Owner's preliminary response to the First Petition and the Board's decision whether to institute review in the First Petition, and (6) Petitioner waited nearly the maximum amount of time possible between filing its two petitions. PO Prelim. Resp. 5–28. As explained below, we agree with Patent Owner that the circumstances here do not favor institution of an *inter partes* review.

Our concern is not primarily that "the same or substantially the same prior art or arguments previously were presented to the Office" as expressed in § 325(d), but rather the potential inequity of Petitioner filing multiple

attacks, adjusting along the way based on Patent Owner's contentions and the Board's decision responding to a prior challenge. *See NVIDIA Corp. v. Samsung Elec. Co.*, Case IPR2016-00134, slip op. at 8 (PTAB. May 4, 2016) (Paper 9). We view the following factors as relevant to that concern, and therefore helpful in deciding whether to exercise our discretion to not institute review under § 314(a):

(a) whether the same petitioner previously filed a petition directed to the same claims of the same patent,

(b) whether the petitioner knew or should have known of the prior art asserted in the later petition when it filed its earlier petition, and

(c) whether at the time of filing of the later petition, the petitioner already received the patent owner's preliminary response to the first petition or received the Board's decision on whether to institute review in the earlier petition, and

(d) the length of time that elapsed between when the petitioner had the patent owner's or Board's analysis on the earlier petition and when petitioner filed the later petition,[6]

(e) whether the petitioner provides adequate explanation why we should permit another attack on the same claims of the same patent.

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[6] As Patent Owner notes, past Board decisions have considered the length of time that elapsed between the time petitioner learned of the prior art asserted in the second petition and filing of the second petition. *See, e.g., NVIDIA Corp. v. Samsung Elec. Co.*, Case IPR2016-00134 (PTAB May 4, 2016) (Paper 9); *LG Elecs. Inc. v. Core Wireless Licensing S.A.R.L.*, Case IPR2016-00986 (PTAB Aug. 22, 2016) (Paper 12). We view the more relevant delay to be that between when Petitioner had the First Petition feedback, and when it filed the Second Petition. That delay affords Petitioner the unfair advantage of adjusting its litigation positions based on the Patent Owner's and the Board's responses to the First Petition.

a. *Petitioner Previously Filed a Petition Directed to the Same Claims of the Same Patent*

As explained above, Petitioner's First Petition included challenges to all six of claims—claims 1, 8, 16, 25, 26, and 33 of the '737 patent—that Petitioner challenges in the Second Petition at issue here. As to claims 1, 16, 25, and 26, we instituted *inter partes* review based on the First Petition. For claims 8 and 33, we did not. IPR2016-00592 Inst. Dec. 20.

b. *Petitioner Knew of the Prior Art Asserted in the Second Petition When It Filed the First Petition*

Out of concern for fundamental fairness, in determining whether to deny institution on subsequent petitions challenging the same claims of the same patent, we look to whether a petitioner knew or should have known of the prior art asserted in its later case when it filed the earlier one. *See Conopco, Inc. v. Proctor & Gamble Co.*, Case IPR2014-00506, slip op. at 4–5 (PTAB Dec. 10, 2014) (Paper 25) (Informative). Here, Petitioner knew of the prior art asserted in the Second Petition when it filed the First Petition. The Second Petition relies on three references: Avrahami, Applicad, and McKeown. Petitioner knew of Avrahami and Applicad when it filed its First Petition because the First Petition asserted grounds involving those three references. First Pet. 4. Petitioner also knew of McKeown when it filed the First Petition because Petitioner included McKeown in its district court invalidity contentions, which Petitioner served just one day after it filed the First Petition. *See* Ex. 2003, 8 (identifying McKeown), 165 (showing service on Feb. 9, 2016); *see also* IPR2016-00592 Paper 1[7] (dated Feb. 8, 2016).

[7] Petitioner filed its original Petition on February 8, 2016. Due to issues regarding the proper use of claim charts, Petitioner was ordered to and did file a Corrected Petition on March 3, 2016, and a Second Corrected Petition

Because Petitioner knew of the three references asserted in its Second Petition when it filed its First Petition, this factor weighs against institution.

c. *Petitioner Had Patent Owner's Preliminary Response and the Board's Decision on Whether to Institute Review in the First Petition When Petitioner Filed the Second Petition*

Patent Owner filed its Preliminary Response to the First Petition on June 2, 2016. *See* IPR2016-00592, Paper 10. We issued our Institution Decision addressing the First Petition on August 31, 2016. IPR2016-00592 Inst. Dec. Thus, when Petitioner filed the Second Petition on November 30, 2016 (*see* Second Pet.), Petitioner had both Patent Owner's Preliminary Response and the Board's Decision on whether to institute review addressing the First Petition.

d. *The Elapsed Time between When Petitioner Had Patent Owner's and the Board's Analysis on the First Petition and When Petitioner Filed the Second Petition*

The delay between when Petitioner had Patent Owner's Preliminary Response and the Board's Institution Decision addressing the First Petition and when Petitioner filed the Second Petition left Petitioner with sufficient time to take advantage of Patent Owner's and the Board's responses to the First Petition. When Petitioner filed its Second Petition on November 30, 2016, Petitioner had Patent Owner's Preliminary Response to the First Petition for nearly six months, and our Institution Decision addressing the First Petition for nearly three months. *See* IPR2016-00592, Paper 10 (showing June 2, 2016 filing date for Patent Owner's Preliminary Response); IPR2016-00592 Inst. Dec. (showing Aug. 31, 2016 issue date for our

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on April 8, 2016. The original Petition contained the same asserted grounds of unpatentability as the Corrected Petition and Second Corrected Petition. *Compare* IPR2016-00592 Paper 1, 4 *with* Paper 7, 4 and First Pet. 4.

Institution Decision). Thus, Petitioner not only had the relevant materials from Patent Owner and the Board when it filed its Second Petition, but had ample time to take advantage of those materials in crafting its Second Petition. Moreover, in related proceedings before the district court, Petitioner indicated that taking advantage of our Decision on institution was the reason Petitioner delayed filing its Second Petition as long as it did. *See* Ex. 2005 (Nov. 30, 2016 Hr'g Tr. at 26:6–9) (Petitioner's counsel explaining to the district court that "to the extent that there is concern about waiting till the end of the process to file these follow-on IPRs, it's by virtue of the chronology. We didn't get the rulings from the Patent Office [on the First Petitions] until the end of August.").

e. *Petitioner Has Not Provided an Adequate Reason Why We Should Permit another Attack on the Same Patent Claims*

Weighed against the factors outlined above are any non-strategic reasons Petitioner offers for the delay in filing its Second Petition or any other justification for allowing its Second Petition to go forward. Petitioner addresses our discretion to deny institution by asserting that its second challenge is substantively different than the one we previously denied in the First Petition. *See* Second Pet. 10–13. That difference, however, does not justify permitting Petitioner to gain an unfair advantage by waiting to file its Second Petition so that it can take advantage of our Decision on the First Petition.

We view Petitioner's strategy—withholding additional challenges until receiving the Board's feedback to help shape those challenges—as unfair to Patent Owner. With Patent Owner's Preliminary Response and the Board's Decision for the First Petition and ample time to take advantage of those materials, Petitioner made several substantive shifts in its Second

Petition. After our Institution Decision outlined deficiencies in the presentation of Hsieh as prior art, Petitioner's Second Petition asserts McKeown to account for the claim elements it previously mapped to Hsieh. *See* Prelim. Resp. 16–21. In addition, after our Institution Decision's favorable outcome for obviousness grounds involving Avrahami and Applicad, Petitioner shifted to now also challenge claims 8 and 33 under that same ground.

We do not take lightly denying a petition on grounds unrelated to its substantive patentability challenges. Here, however, Petitioner's strategy of morphing its challenges over multiple petitions based on the Board's feedback imposes inequities on Patent Owner. Weighing the respective factors here, we view the prejudice to Patent Owner to be greater than that to Petitioner in denying institution. We, therefore, decline to institute *inter partes* review here.

III. CONCLUSION

For all of the reasons discussed above, we exercise our discretion under 35 U.S.C. § 314(a) and 37 C.F.R. § 42.108(a) not to institute review in this proceeding with respect to claims 1, 8, 16, 25, 26, and 33.

IV. ORDER

It is:

ORDERED that the Petition is denied as to claims 1, 8, 16, 25, 26, and 33 of the '737 patent; and

FURTHER ORDERED that no *inter partes* review is instituted.

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
14/450,108	08/01/2014	Chris Pershing	290115.406C2

CONFIRMATION NO. 8641

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SEATTLE, WA 98104

POWER OF ATTORNEY NOTICE

OC000000087831339

Date Mailed: 12/13/2016

NOTICE REGARDING CHANGE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 12/09/2016.

- The Power of Attorney to you in this application has been revoked by the applicant. Future correspondence will be mailed to the new address of record(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**.

/ltaba/

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
14/450,108	08/01/2014	Chris Pershing	6339.086

CONFIRMATION NO. 8641

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POA ACCEPTANCE LETTER

OC000000087831366

Date Mailed: 12/13/2016

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 12/09/2016.

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**.

/ltaba/

PTO/AIA/80 (07-12)
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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: 30589

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: 30589

OR

☐	Firm or Individual Name	DUNLAP CODDING, P.C.		
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Assignee Name and Address: Eagle View Technologies, Inc.
3700 Monte Villa Pkwy, Ste 200
Bothell, WA 98021

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	[signature]	Date	November 11, 2016
Name	Richard Jacobs	Telephone	
Title	Assistant Secretary, Eagle View Technologies, Inc.		

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.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Electronically Filed: 12/09/2016

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No.	:	14/450,108
Filed	:	August 1, 2014
Patent No.	:	9,135,737
Issued	:	September 15, 2015
Applicant(s)	:	Chris Pershing
TC/AU	:	2123
Examiner	:	Pierre Louis, Andre
Title	:	CONCURRENT DISPLAY SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION
Docket No.	:	6339.086
Customer No.	:	30589

Mail Stop M - Correspondence
Director of the U.S. Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450

Assertion of Small Entity Status (37 C.F.R. § 1.27(c)(1))

Applicant hereby states that applicant is a small entity and that status as a small entity is asserted for this

[ ] application

[x] patent

12/09/2016
Date

Ann M. Robl

[ ] Inventor(s)

[ ] Assignee(s) of complete interest

[ ] Person authorized to sign on behalf of assignee

[x] Practitioner of record § 34(b)

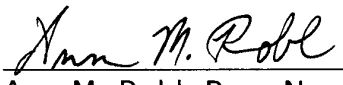
[ ] filed under § 34(a)

Reg. No.:

Customer No.: 30589

Telephone No. (405) 607-8600

Respectfully submitted,



Ann M. Robl, Reg. No. 71,541
DUNLAP, CODDING, P.C.
P.O. Box 16370
Oklahoma City, Oklahoma 73113
Customer No. 30589
Telephone: (405) 607-8600
Facsimile: (405) 607-8686

Attorney for Applicant(s)

Electronic Acknowledgement Receipt	
EFS ID:	27743488
Application Number:	14450108
International Application Number:	
Confirmation Number:	8641
Title of Invention:	CONCURRENT DISPLAY SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION
First Named Inventor/Applicant Name:	Chris Pershing
Customer Number:	500
Filer:	Ann M. Robl/Lori Martin
Filer Authorized By:	Ann M. Robl
Attorney Docket Number:	290115.406C2
Receipt Date:	09-DEC-2016
Filing Date:	01-AUG-2014
Time Stamp:	11:30:06
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	Transmittal Letter	6339086_Transmittal12092016.pdf	120004 5676b24929bf24724d464bd5e7d5e5be863e2467	no	1

Warnings:

Information:					
2	Power of Attorney	6339086_POA.pdf	305854 3d1ef2b1f80b0f394bb0d3ead3513c299e377274	no	1
Warnings:					
Information:					
3	Miscellaneous Incoming Letter	6339086_AssertionSmallEntity.pdf	89040 bdfc4e32b61edde7d0e3c479243f3b78f18f8b0d	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	514898	

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.

<u>New Applications Under 35 U.S.C. 111</u>
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.

<u>National Stage of an International Application under 35 U.S.C. 371</u>
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.

<u>New International Application Filed with the USPTO as a Receiving Office</u>
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.

Doc Code: TRAN.LET

Document Description: Transmittal Letter

PTO/SB/21 (07-09)
Approved for use through 07/31/2012. 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 displays a valid OMB control number.

TRANSMITTAL FORM

(to be used for all correspondence after initial filing)

Total Number of Pages in This Submission

Application Number	14/450,108
Filing Date	08/01//2014
First Named Inventor	Chris Pershing
Art Unit	2123
Examiner Name	Pierre Louis, Andre
Attorney Docket Number	6339.086

ENCLOSURES *(Check all that apply)*

- ☐ Fee Transmittal Form
  - ☐ Fee Attached
- ☐ Amendment/Reply
  - ☐ After Final
  - ☐ Affidavits/declaration(s)
- ☐ Extension of Time Request
- ☐ Express Abandonment Request
- ☐ Information Disclosure Statement
- ☐ Certified Copy of Priority Document(s)
- ☐ Reply to Missing Parts/ Incomplete Application
  - ☐ Reply to Missing Parts under 37 CFR 1.52 or 1.53
- ☐ Drawing(s)
- ☐ Licensing-related Papers
- ☐ Petition
- ☐ Petition to Convert to a Provisional Application
- ☑ Power of Attorney, Revocation Change of Correspondence Address
- ☐ Terminal Disclaimer
- ☐ Request for Refund
- ☐ CD, Number of CD(s) _____
  - ☐ Landscape Table on CD
- ☐ After Allowance Communication to TC
- ☐ Appeal Communication to Board of Appeals and Interferences
- ☐ Appeal Communication to TC **(Appeal Notice, Brief, Reply Brief)**
- ☐ Proprietary Information
- ☐ Status Letter
- ☑ Other Enclosure(s) (please Identify below):
  See Remarks

Remarks

ELECTRONICALLY TRANSMITTED:
1. SB21 Transmittal Form (1 pg);
2. Power of Attorney (1 pg); and
3. Assertion of Small Entity Status (2 pgs).

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT

Firm Name	DUNLAP CODDING, P.C.		
Signature	Ann M. Robl		
Printed name	Ann M. Robl		
Date	12/09/2016	Reg. No.	71,541

CERTIFICATE OF TRANSMISSION/MAILING

I hereby certify that this correspondence is being facsimile transmitted to the USPTO or deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on the date shown below:

Signature	Ann M. Robl		
Typed or printed name	Ann M. Robl	Date	12/09/2016

This collection of information is required by 37 CFR 1.5. 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 and1.14. This collection is estimated to 2 hours 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.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 9,135,737 B2
APPLICATION NO. : 14/450108
DATED : September 15, 2015
INVENTOR(S) : Chris Pershing

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Item (56):
"8,145,578 B2 3/2012 Pershing" should read --8,145,578 B2 3/2012 Pershing et al.--.

Item (56):
"Gaillard et al., :Automatic reconstruction of piecewise planar models from multiple views, CVPR99, vol. 2, 1999, pp. 559-565, 7 pages." should read --Baillard et al., "Automatic reconstruction of piecewise planar models from multiple views," CVPR99, vol. 2, 1999, pp. 559-565, 7 pages.--.

Colum 28, lines 7-9:
"displaying roof measurement information on the same display concurrently with the first line drawing being displayed." should read --displaying roof measurement information concurrently with the first line drawing being displayed.--.

Signed and Sealed this
Twenty-third Day of February, 2016

Michelle K. Lee

Michelle K. Lee
Director of the United States Patent and Trademark Office

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
U.S. Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
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www.uspto.gov

500 e 2016-01-28

SEED INTELLECTUAL PROPERTY LAW GROUP PLLC
701 FIFTH AVE
SUITE 5400
SEATTLE, WA 98104

Paper No.

Application No.:	**14/450,108**	**Date Mailed:**	**2016-01-28** **PAPER**
First Named Inventor:	Chris Pershing	Examiner:	PIERRE LOUIS, ANDRE
Attorney Docket No.:	290115.406C2	Art Unit:	2123
Confirmation No.:	8641	Filing Date:	08/01/2014

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

Commissioner for Patents

PTO-90c (Rev.08-06)

Response to the Request for Certificate of Correction	Patent No. 9135737	Applicant(s) PERSHING, CHRIS
	Issue Date 15 September, 2015	Docket No. 290115.406C2

This is in response to the request for a Certificate of Correction filed 17 December, 2015

☒ **Request Approval- In- Part** – Consideration has been given to your request for the issuance of a Certificate of Correction under the provisions of 37 CFR 1.322 and/or 37 CFR 1.323. The Request is improper and approved in part for the reason(s) below:

☐ **Supersede/Vacate** – The Certificate of Correction issued in error, in that error(s) was made in identifying the patent number and/or keying text/corrections. See 'Other Comments' below:

1. ☐ Assignees' names and addresses (assignment data) printed in a patent, are based solely on information supplied in the appropriate space for identifying the assignment data on the Issue Fee Transmittal Form (PTOL-85b). Any request for a patent to be corrected to state the name of the assignee, must state that the assignment was submitted for recordation as set forth in in 37 CFR 3.11 before issuance of the patent. The petition fee set forth in 37 CFR 1.17(i)(1) (currently $140, $70, $35 for large, small and micro entities, respectively.

2. ☐ The alleged error in , is in fact an Amendment and/or Change made by the examiner and considered to be in accordance with the permissible amendments enumerated in the Manual of Patent Examining Procedure (MPEP) Section 1302.04. Applicant did not file objection or amendment under 37 CFR 1.312 prior to payment of the issue fee.

3. ☐ A petition under CFR 1.182 is required to correct the alleged errors in spelling or order of inventor's names, since inventor's names are printed solely in accordance with the type-written names, and in the order of the type-written names on the Application Data Sheet (ADS).

4. ☐ With respect to the alleged error in changing the inventor name on the patent due to clerical error in ADS/OATH of related patents. The inventor's name is printed in accordance with the OATH/ADS submitted at the time of filing the application. However, your attention is directed to C.F.R. 1.324, wherein a request is being made to change, add or delete inventor(s), after issuance of the patent.

5. ☒ With respect to the alleged error in **item 56 on the title page "RoofCAD"** , comparison of the printed patent with the corresponding location in the application file reveals that there is no discrepancy.

6. ☐ With respect to 37 CFR 1.72, the title should be brief but technically accurate and descriptive and should contain fewer than 500 characters. Inasmuch as the words "new," "improved," "improvement of," and "improvement in" are not considered as part of the title of an invention, these words should not be included at the beginning of the title of the invention and will be deleted when the Office enters the title into the Office's computer records, and when any patent issues.

7. ☐ The fee for correction under 37 CFR 1.323 is set forth in 37 CFR 1.20(a). ☐ Partial fee ☐ No fee was received with your request. Full fee payment is required before further action is taken on this request.

8. ☐ With respect to the request for corrected Letters Patent (Grant), corrections to the original Letters Patent are made under the provisions of Rule 1.322(b), not Rule1.323, unless a petition is granted.

9. ☐ Other Comments:

Further correspondence concerning this matter should be filed and directed to the Certificates of Correction Branch.

Legal Instrument Examiner: **/VIRGINIA TOLBERT/** Phone: (571)272-0460

Certificates of Correction Branch email: CustomerServiceCoC@uspto.gov CoC Central Phone Number: (703) 756-1814

If applicable, information regarding a petition under 37 CFR 1.183 should be directed to the attention of the Commissioner for Patents using the FAX number (571) 273-8300

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Patent No.	:	9,135,737 B2
Issue Date	:	September 15, 2015
Inventor	:	Chris Pershing
	Docket No.	: 290115.406C2
	Date	: December 17, 2015

Mail Stop Certificate of Correction
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

REQUEST FOR CERTIFICATE OF CORRECTION

Commissioner for Patents:

A certificate of correction is respectfully requested in the above-identified patent. The following errors have been made:

Item (56), References Cited, U.S. Patent Documents, "8,145,578 B2 3/2012 Pershing" is incorrect. As set forth in the Information Disclosure Statement filed August 1, 2014 with the United States Patent and Trademark Office, the correct reference should read --8,145,578 B2 3/2012 Pershing et al.--.

Item (56), References Cited, Other Publications, "Gaillard et al., :Automatic reconstruction of piecewise planar models from multiple views, CVPR99, vol. 2, 1999, pp. 559-565, 7 pages." is incorrect. As set forth in the Information Disclosure Statement filed August 1, 2014 with the United States Patent and Trademark Office, the correct reference should read --Baillard et al., "Automatic reconstruction of piecewise planar models from multiple views," CVPR99, vol. 2, 1999, pp. 559-565, 7 pages.--.

Item (56), References Cited, Other Publications, "RoofCAD, "Satellite Takeoff Tutorial-Pitched Roof" received Jan. 31, 2012, 25 pages." is incorrect. As set forth in the Information Disclosure Statement filed August 1, 2014 with the United States Patent and Trademark Office, the correct reference should read --RoofCAD, "Satellite Takeoff Tutorial-Pitched Roof," received Jan. 31, 2012, 25 pages.--.

In the claims, column 28, issued claim 34, lines 7-9, "displaying roof measurement information on the same display concurrently with the first line drawing being displayed." is incorrect. As set forth in the Amendment filed July 31, 2015 with the United States Patent and Trademark Office, the correct lines should read --displaying roof measurement information concurrently with the first line drawing being displayed.--.

Attached is the certificate of correction, which indicates the corrections to be made, by reference to the item, column, and line numbers in the printed patent. Because the errors were made by the Patent Office, no fee is necessary. However if the errors are determined to be our errors, the Director is hereby authorized to charge payment of any fees associated with this communication to Deposit Account No. 19-1090.

Respectfully submitted,
SEED Intellectual Property Law Group PLLC

/Jeremiah J. Baunach/
Jeremiah J. Baunach
Registration No. 44,527

JJB:bwo

Enclosure:
Certificate of Correction

SEED Intellectual Property Law Group PLLC
701 Fifth Avenue, Suite 5400
Seattle, Washington 98104-7092
Phone: (206) 622-4900
Fax: (206) 682-6031
4539619_1

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO : 9,135,737 B2
APPLICATION NO. : 14/450,108
DATED : September 15, 2015
INVENTOR : Chris Pershing

It is certified that errors appear in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Item (56):
"8,145,578 B2 3/2012 Pershing" should read --8,145,578 B2 3/2012 Pershing et al.--.

Item (56):
"Gaillard et al., :Automatic reconstruction of piecewise planar models from multiple views, CVPR99, vol. 2, 1999, pp. 559-565, 7 pages." should read --Baillard et al., "Automatic reconstruction of piecewise planar models from multiple views," CVPR99, vol. 2, 1999, pp. 559-565, 7 pages.--.

Item (56):
"RoofCAD, "Satellite Takeoff Tutorial-Pitched Roof" received Jan. 31, 2012, 25 pages." should read --RoofCAD, "Satellite Takeoff Tutorial-Pitched Roof," received Jan. 31, 2012, 25 pages.--.

Colum 28, lines 7-9:
"displaying roof measurement information on the same display concurrently with the first line drawing being displayed." should read --displaying roof measurement information concurrently with the first line drawing being displayed.--.

MAILING ADDRESS OF SENDER:
Jeremiah J. Baunach
Seed Intellectual Property Law Group PLLC
701 Fifth Avenue, Suite 5400
Seattle, Washington 98104

PATENT NO. 9,135,737 B2

No. of additional copies: 0

SEND TO: Attention Certificate of Corrections Branch, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450

Electronic Acknowledgement Receipt	
EFS ID:	24401399
Application Number:	14450108
International Application Number:	
Confirmation Number:	8641
Title of Invention:	CONCURRENT DISPLAY SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION
First Named Inventor/Applicant Name:	Chris Pershing
Customer Number:	500
Filer:	Jeremiah J. Baunach/Ben Olsen
Filer Authorized By:	Jeremiah J. Baunach
Attorney Docket Number:	290115.406C2
Receipt Date:	17-DEC-2015
Filing Date:	01-AUG-2014
Time Stamp:	17:50:35
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	Request for Certificate of Correction	290115_406c2_request_for_certificate_of_correction.pdf	100996 2eab017fedea453f3cd393eb52537b912212d0d7	no	3
Warnings:					
Information:					

Total Files Size (in bytes):	100996

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 NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/450,108	08/01/2014	Chris Pershing	290115.406C2	8641

7590 09/11/2015

SEED INTELLECTUAL PROPERTY LAW GROUP PLLC
701 FIFTH AVE
SUITE 5400
SEATTLE, WA 98104

EXAMINER	
PIERRE LOUIS, ANDRE	

ART UNIT	PAPER NUMBER
2123	

MAIL DATE	DELIVERY MODE
09/11/2015	PAPER

Letter Withdrawing a Notice Requiring Inventor's Oath or Declaration

The Notice Requiring Inventor's Oath or Declaration mailed on 6/22/15 was sent in error, and is hereby withdrawn. The time period set forth in the Notice of Allowance and Fee(s) Due to file a reply and pay the required fees continues to run from the mailing date of the Notice of Allowance and Fee(s) Due. Any time period set forth in the Notice of Allowability continues to run from the mailing date of the Notice of Allowability.

Questions relating to this Notice should be directed to the Application Assistance Unit at 571-272-4200.

(571)-272-4200 or 1(888)-786-0101
Patent Publication Branch
Office of Data Management

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 NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/450,108	09/15/2015	9135737	290115.406C2	8641

500 7590 08/26/2015

SEED INTELLECTUAL PROPERTY LAW GROUP PLLC
701 FIFTH AVE
SUITE 5400
SEATTLE, WA 98104

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

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

The Patent Term Adjustment is 0 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

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 Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site http://pair.uspto.gov for additional applicants):

Chris Pershing, Redmond, WA;
Eagle View Technologies, Inc., Bothell, WA;

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The USA offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to encourage and facilitate business investment. To learn more about why the USA is the best country in the world to develop technology, manufacture products, and grow your business, visit SelectUSA.gov.

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 NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/450,108	08/01/2014	Chris Pershing	290115.406C2	8641

500 7590 08/12/2015

SEED INTELLECTUAL PROPERTY LAW GROUP PLLC
701 FIFTH AVE
SUITE 5400
SEATTLE, WA 98104

EXAMINER	
PIERRE LOUIS, ANDRE	

ART UNIT	PAPER NUMBER
2123	

MAIL DATE	DELIVERY MODE
08/12/2015	PAPER

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.

Response to Rule 312 Communication	Application No.	Applicant(s)
	14/450,108	PERSHING, CHRIS
	Examiner	Art Unit
	ANDRE PIERRE-LOUIS	2123

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

1. ☒ The amendment filed on *31 July 2015* under 37 CFR 1.312 has been considered, and has been:

a) ☒ entered.

b) ☐ entered as directed to matters of form not affecting the scope of the invention.

c) ☐ disapproved because the amendment was filed after the payment of the issue fee.
Any amendment filed after the date the issue fee is paid must be accompanied by a petition under 37 CFR 1.313(c)(1) and the required fee to withdraw the application from issue.

d) ☐ disapproved. See explanation below.

e) ☐ entered in part. See explanation below.

/Kamini S Shah/ Supervisory Patent Examiner, Art Unit 2123	/A. P./ Examiner, Art Unit 2123

OK To Enter
08/05/2015
/AP/

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor	:	Chris Pershing
Application No.	:	14/450,108
Filed	:	August 1, 2014
For	:	CONCURRENT DISPLAY SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION

Examiner	:	Andre Pierre Louis
Art Unit	:	2668
Date of Notice of Allowance	:	June 22, 2015
Docket No.	:	290115.406C2
Date	:	July 31, 2015

Mail Stop Issue Fee
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

AMENDMENT AFTER ALLOWANCE

(UNDER 37 CFR 1.312)

Commissioner for Patents:

In response to the Examiner's request in section 5, page 2, in the Notice of Allowance dated June 22, 2015, and pursuant to the Examiner Interview held over the telephone on July 31, 2015, please amend the application as follows:

Amendments to the Claims are reflected in the listing of claims which begins on page 2 of this paper.

Remarks begin on page 11 of this paper.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (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.

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500 7590 06/22/2015

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SEATTLE, WA 98104

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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 facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/450,108	08/01/2014	Chris Pershing	290115.406C2	8641

TITLE OF INVENTION: CONCURRENT DISPLAY SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	~~SMALL~~ LARGE	~~$480~~ $960	$0	$0	~~$480~~ $960	09/22/2015

EXAMINER	ART UNIT	CLASS-SUBCLASS
PIERRE LOUIS, ANDRE	2123	703-001000

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 03-02 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.

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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 has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE: Eagle View Technologies, Inc.

(B) RESIDENCE: (CITY and STATE OR COUNTRY): Bothell, Washington

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

4a. The following fee(s) are submitted:

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

☐ Applicant certifying micro entity status. See 37 CFR 1.29

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☐ Applicant asserting small entity status. See 37 CFR 1.27

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☒ Applicant changing to regular undiscounted fee status.

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Authorized Signature /Jeremiah J. Baunach/ Date July 31, 2015

Typed or printed name Jeremiah J. Baunach Registration No. 44,527

PTOL-85 Part B (10-13) Approved for use through 10/31/2013. OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor	:	Chris Pershing
Application No.	:	14/450,108
Filed	:	August 1, 2014
For	:	CONCURRENT DISPLAY SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION

Examiner	:	Andre Pierre Louis
Art Unit	:	2668
Date of Notice of Allowance	:	June 22, 2015
Docket No.	:	290115.406C2
Date	:	July 31, 2015

Mail Stop Issue Fee
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

AMENDMENT AFTER ALLOWANCE

(UNDER 37 CFR 1.312)

Commissioner for Patents:

In response to the Examiner's request in section 5, page 2, in the Notice of Allowance dated June 22, 2015, and pursuant to the Examiner Interview held over the telephone on July 31, 2015, please amend the application as follows:

Amendments to the Claims are reflected in the listing of claims which begins on page 2 of this paper.

Remarks begin on page 11 of this paper.

Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1. (Currently Amended) A computer-implemented method in a roof estimate report system including at least one processor and a memory coupled to the at least one processor, the method comprising:

displaying, by the at least one processor of the roof estimate report system, a plurality of aerial images of a roof at the same time ~~on a single display~~, each of the aerial images providing a different view, taken from a different angle of the same roof;

displaying, by the at least one processor of the roof estimate report system, respective line drawings representing features of the roof, the respective line drawings overlying a first and a second aerial image of the plurality of aerial images of the roof ~~on the single display~~, the line drawing overlying the first aerial image of the roof having features in common with the line drawing overlying the second aerial image of the roof;

in response to user input, changing, by the at least one processor of the roof estimate report system, the line drawing representing a feature of the roof that overlies the first aerial image of the roof;

in response to the changing, making corresponding changes, by the at least one processor of the roof estimate report system, to the line drawing overlying the second aerial image; and

generating and outputting a roof estimate report using a report generation engine, wherein the roof estimate report includes numerical values for corresponding slope, area, or lengths of edges of at least some of a plurality of planar roof sections of the roof, wherein the generated roof estimate report is ~~used to~~ provided for repair and/or constructing the roof structure of the building.

2. (Original) The method of claim 1 further comprising, before the displaying the respective line drawings, modifying a three-dimensional model of the roof based on a received indication of a roof feature by adding a planar roof section to the three-dimensional model.

3. (Original) The method of claim 2 wherein the indicated roof feature is at least one of: a point on the roof, a section of the roof, a ridgeline of the roof, a valley of the roof, a rake edge of the roof, an eave of the roof, a hip ridge of the roof, an edge of a section of the roof, and a corner of a section of the roof.

4. (Original) The method of claim 1 wherein the displaying the respective line drawings comprises:

displaying the respective line drawing overlying the first aerial image at a first time; and

displaying the respective the line drawing overlying the second aerial image at a second time that is substantially coincident to the first time.

5. (Original) The method of claim 1 further comprising receiving an indication of one of the features of the roof at a first time, and wherein the displaying the respective line drawings occurs at a second time that is substantially coincident to the first time.

6. (Original) The method of claim 1 wherein the displaying the respective line drawings includes initiating display of a line on the first and second image.

7. (Original) The method of claim 1 wherein the first image provides a substantially top plan view of the roof of the building, and wherein the second image provides a perspective view of the roof of the building.

8. (Original) The method of claim 1 wherein the first image provides a first perspective view of the roof of the building and the second image provides a second perspective view of the roof of the building.

9. (Original) The method of claim 1 further comprising:

transmitting roof measurement information based at least in part on the change of the line drawing representing a feature of the roof that overlies the first aerial image of the roof.

10. (Original) The method of claim 1 further comprising:

displaying a marker operable to specify a point on an image;

receiving, via the marker, an indication of a point on the first aerial image; and

registering, based on the received indication of the point, the aerial image to a reference grid corresponding to a three-dimensional model of the roof.

11. (Original) The method of claim 1 further comprising:

displaying a lean correction marker operable to indicate a vertical axis of an aerial image;

receiving, via the lean correction marker, an indication of a vertical axis of the first aerial image; and

registering, based on the received indication of the vertical axis, the first aerial image to a reference grid corresponding to a three-dimensional model of the roof.

12. (Currently Amended) A computing system for generating a roof estimate report, the computing system comprising:

a memory;

at least one processor coupled to the memory; and

a roof estimation module that is stored on the memory and that is configured, when executed by at least one processor of the computing system for generating the roof estimate report, to:

overlay a line drawing of a roof feature on corresponding locations of the feature on first and second aerial images of the roof;

in response to user input causing addition of another roof feature in the line drawing overlaid on the first aerial image, make a corresponding addition of the other roof feature to the line drawing overlaid on the second aerial image; and

generate and output a roof estimate report using a report generation engine, wherein the roof estimate report includes numerical values for corresponding slope, area, or lengths of edges of at least some of a plurality of planar roof sections of the roof, wherein the generated roof estimate report is ~~used to~~ provided for repair and/or constructing the roof structure of the building.

13. (Original) The computing system of claim 12 wherein the roof estimation module includes an interactive roof modeling user interface.

14. (Previously Presented) The computing system of claim 12 wherein the other roof feature is a planar roof section.

15. (Original) The computing system of claim 12 wherein the roof estimation module is part of a network accessible roof modeling program executing on the computing system.

16. (Currently Amended) A non-transitory computer-readable storage medium, having computer executable instructions stored thereon that, when executed by at least one computer processor, cause the at least one processor to enable a computing system to generate a roof estimate report for a building having a roof, by performing a method comprising:

overlaying a line drawing on corresponding locations of a roof feature of the roof on first and second aerial images of the roof, wherein the first aerial image provides a first view of the roof of the building and the second aerial image provides a second view of the roof of the building;

in response to changes in the line drawing overlaid on the first aerial image, displaying corresponding changes to the line drawing overlaid on the second aerial image; and

generate and output a roof estimate report using a report generation engine, wherein the roof estimate report includes numerical values for corresponding slope, area, or lengths of edges of at least some of a plurality of planar roof sections of the roof, wherein the generated roof estimate report is ~~used to~~ provided for repair and/or constructing the roof structure of the building.

17. (Original) The non-transitory computer-readable storage medium of claim 16 wherein the method further comprises modifying a three-dimensional model of the roof by adding a planar roof section to the three-dimensional model.

18. (Previously Presented) The non-transitory computer-readable storage medium of claim 16 wherein the method further comprises:

receiving an indication of the roof feature by receiving position information of the feature in the first aerial image;

translating the received position information into position information of the roof feature in a three-dimensional model; and

translating the position information of the feature in the three-dimensional model into position information of the feature in the second aerial image.

19. (Previously Presented) The non-transitory computer-readable storage medium of claim 16 further comprising:

displaying the roof feature in the first aerial image at a first time; and

displaying the roof feature in the second aerial image at a second time that is within two seconds of the first time.

20. (Previously Presented) The non-transitory computer-readable storage medium of claim 16 wherein the method further comprises displaying a projection of the roof

feature onto the first aerial image substantially concurrently with receiving an indication of the roof feature.

21. (Previously Presented) The non-transitory computer-readable storage medium of claim 16 wherein the method further comprises displaying a projection of the roof feature at substantially the same time as receiving an indication of the roof feature of the building.

22. (Original) The non-transitory computer-readable storage medium of claim 16 wherein the method is performed iteratively, and the method further comprising:

providing an operator with an interactive model generation experience.

23. (Previously Presented) The non-transitory computer-readable storage medium of claim 16 wherein the method further comprises initiating displaying a projection of the roof feature on the first and second image by initiating display of a line on the first and second image.

24. (Original) The non-transitory computer-readable storage medium of claim 16 wherein the first image provides a perspective view of the roof of the building, and wherein the second image provides a substantially top plan view of the roof of the building.

25. (Previously Presented) The non-transitory computer-readable storage medium of claim 16 wherein the method further comprises:

modifying a three dimensional model of the roof based at least on the modification of the line drawing overlaid on the first aerial image.

26. (Currently Amended) A computer-implemented method in a roof estimate report system including a computer system and a memory coupled to the computer system, the method comprising:

changing, by the computer system of the roof estimate report system, a line in a first line drawing representing a feature of a roof that overlies a first aerial image of the roof;

changing, by the computer system of the roof estimate report system, a line in a second line drawing that corresponds to the same feature in the first line drawing that was changed, the change in the second line drawing being made by the computer system in response to the change that was made in the first line drawing; and

generating and outputting a roof estimate report using a report generation engine, wherein the roof estimate report includes numerical values for corresponding slope, area, or lengths of edges of at least some of a plurality of planar roof sections of the roof, wherein the generated roof estimate report is ~~used to~~ provided for repair and/or constructing the roof structure of the building.

27. (Original) The method of claim 26 wherein the roof feature is at least one of: a ridgeline of the roof, a valley of the roof, a rake edge of the roof, an eave of the roof, a hip ridge of the roof, and an edge of a section of the roof.

28. (Previously Presented) The method of claim 26 further comprising displaying the second line drawing after the first line drawing has been displayed.

29. (Original) The method of claim 26 wherein the step of changing, by the computer system of the roof estimate report system, a feature in the second line drawing overlying the second aerial image comprises:

changing the second line drawing at a time that is substantially concurrent to the time the changes are being made by the user in the first line drawing.

30. (Previously Presented) The method of claim 26 further comprising:

displaying the second line drawing overlying the second aerial image concurrently with displaying the first line drawing overlying the first aerial image of the roof.

31. (Previously Presented) The method of claim 26 further comprising:

displaying the second line drawing overlying the second aerial image at a later time, after the displaying of the first line drawing overlying the first aerial image of the roof on the display.

32. (Original) The method of claim 26 wherein the first image provides a substantially top plan view of the roof of the building, and the second image provides an oblique view of the roof of the building.

33. (Original) The method of claim 26 wherein the first image provides a first oblique view from a first compass bearing of the roof of the building, and the second image provides a second oblique view from a second compass bearing of the roof of the building.

34. (Previously Presented) The method of claim 26 further comprising:

displaying roof measurement information concurrently with the first line drawing being displayed.

35. (Previously Presented) The method of claim 34 wherein the step of displaying roof measurement information comprises:

displaying the roof measurement information in a location that overlays the first line drawing itself.

36. (Previously Presented) The method of claim 26 further comprising:

displaying a wire frame model of the roof in isolation from any images of the roof.

37. (Original) The method of claim 26 further comprising:

modifying a wire frame model of the roof based on input received from a user; and

making, by the computer system of the roof estimate report system, corresponding changes in a 3D model of the roof based on the changes made by the user to the wire frame model.

REMARKS

Claims 1-37 are pending. Claims 1, 12, 16 and 26 are amended herein. No claims are being canceled or added herein. No new matter is being presented by way of this Amendment.

At the outset, Applicant thanks Examiner Louis for his time and consideration during the Examiner Interview held over the telephone on July 31, 2015, in which it was agreed that the amendments herein would be entered without withdrawing the Application from issue and that the Application is in condition for allowance with the amendments herein.

The Director is authorized to charge any additional fees due by way of this Amendment, or credit any overpayment, to our Deposit Account No. 19-1090.

All of the claims remaining in the application are now clearly allowable. Favorable consideration and entry of this Amendment are earnestly solicited.

Respectfully submitted,

SEED Intellectual Property Law Group PLLC

/Jeremiah J. Baunach/
Jeremiah J. Baunach
Registration No. 44,527

JJB:tq

701 Fifth Avenue, Suite 5400
Seattle, Washington 98104
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4226543_1.docx

Electronic Patent Application Fee Transmittal

Application Number:	14450108
Filing Date:	01-Aug-2014
Title of Invention:	CONCURRENT DISPLAY SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION
First Named Inventor/Applicant Name:	Chris Pershing
Filer:	Jeremiah J. Baunach/Terrie Quillin
Attorney Docket Number:	290115.406C2

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Utility Appl Issue Fee	1501	1	960	960

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
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Printed Copy of Patent - No Color	8001	2	3	6
		Total in USD ($)		**966**

Electronic Acknowledgement Receipt	
EFS ID:	23088646
Application Number:	14450108
International Application Number:	
Confirmation Number:	8641
Title of Invention:	CONCURRENT DISPLAY SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION
First Named Inventor/Applicant Name:	Chris Pershing
Customer Number:	500
Filer:	Jeremiah J. Baunach/Terrie Quillin
Filer Authorized By:	Jeremiah J. Baunach
Attorney Docket Number:	290115.406C2
Receipt Date:	31-JUL-2015
Filing Date:	01-AUG-2014
Time Stamp:	19:06:29
Application Type:	Utility under 35 USC 111(a)

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Warnings:					
Information:					
2		EFS_312_Amendment_07_31_15.pdf	87983 b8e3004afb4398baaf1915545f7443e1a4fc9074	yes	11

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Amendment after Notice of Allowance (Rule 312)	1	1
	Claims	2	10
	Applicant Arguments/Remarks Made in an Amendment	11	11

Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	32358 028c92eb7e3440d98533a58f4a47f53596d56728	no	2
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EXAMINER
PIERRE LOUIS, ANDRE

ART UNIT	PAPER NUMBER
2123	

DATE MAILED: 06/22/2015

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/450,108	08/01/2014	Chris Pershing	290115.406C2	8641

TITLE OF INVENTION: CONCURRENT DISPLAY SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$480	$0	$0	$480	09/22/2015

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.

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(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/450,108	08/01/2014	Chris Pershing	290115.406C2	8641

TITLE OF INVENTION: CONCURRENT DISPLAY SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION

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nonprovisional	SMALL	$480	$0	$0	$480	09/22/2015

EXAMINER	ART UNIT	CLASS-SUBCLASS
PIERRE LOUIS, ANDRE	2123	703-001000

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 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list

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(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 _____

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3 _____

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

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(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. The following fee(s) are submitted:

❑ Issue Fee

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❑ Payment by credit card. Form PTO-2038 is attached.

❑ The director is hereby authorized to charge the required fee(s), any deficiency, or credits any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

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

❑ Applicant certifying micro entity status. See 37 CFR 1.29

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.

❑ Applicant asserting small entity status. See 37 CFR 1.27

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.

❑ Applicant changing to regular undiscounted fee 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. _____

PTOL-85 Part B (10-13) Approved for use through 10/31/2013. OMB 0651-0033 U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

UNITED STATES PATENT AND TRADEMARK OFFICE

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/450,108	08/01/2014	Chris Pershing	290115.406C2	8641

500 7590 06/22/2015

SEED INTELLECTUAL PROPERTY LAW GROUP PLLC
701 FIFTH AVE
SUITE 5400
SEATTLE, WA 98104

EXAMINER	
PIERRE LOUIS, ANDRE	

ART UNIT	PAPER NUMBER
2123	

DATE MAILED: 06/22/2015

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.

Notice Requiring Inventor's Oath or Declaration	Application No. 14/450,108	Applicant(s) Chris Pershing	
	Examiner PIERRE LOUIS, ANDRE	Art Unit 2123	

This notice is an attachment to the Notice of Allowability (PTOL-37), or the Notice of Allowability For A Design Application (PTOL-37D).

An inventor's oath or declaration in compliance with 37 CFR 1.63 or 1.64 executed by or with respect to each inventor has not yet been submitted.

An oath or declaration in compliance with 37 CFR 1.63, or a substitute statement in compliance with 37 CFR 1.64, executed by or with respect to each inventor (for any inventor for which a compliant oath, declaration, or substitute statement has not yet been submitted) MUST be filed no later than the date on which the issue fee is paid. See 35 U.S.C. 115(f). Failure to timely comply will result in ABANDONMENT of this application.

A properly executed inventor's oath to declaration has not been received for the following inventor(s):

If applicant previously filed one or more oaths, declarations, or substitute statements, applicant may have received an informational notice regarding deficiencies therein.

The following deficiencies are noted:

INFORMAL ACTION PROBLEMS

- A properly executed inventor's oath or declaration has not been received for the following inventor(s): **Chris Pershing**.
  Applicant may submit the inventor's oath or declaration at any time before the Notice of Allowance and Fee(s) Due, PTOL-85, is mailed.

Questions relating to this Notice should be directed to the Application Assistance Unit at 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 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, 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. 14/450,108	Applicant(s) PERSHING, CHRIS	
	Examiner ANDRE PIERRE-LOUIS	Art Unit 2123	AIA (First Inventor to File) Status No

-- 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 *06/01/2015*.
   ☐ 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 *1-37*. 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 a reply 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 06/01/2015
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 _____.

/A. P./
Examiner, Art Unit 2123

DETAILED ACTION

1. The present application is being examined under the pre-AIA first to invent provisions.

2. The amendment filed on 06/01/2015 has been received and fully considered.

3. Claims 1-37 are presented for examination.

4. The Terminal Disclaimer (TD) filed 06/01/2015 has been received and fully considered; it has been approved.

EXAMINER'S AMENDMENT

5. An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.

5.0 Authorization for this examiner's amendment was given in a telephone interview with *Jeremiah J. Baunach (Reg. No. 44,527)* on *06/12/2015.*

5.1 The application is amended as follow:

Claim 1. (**Currently Amended**) A computer-implemented method in a roof estimate report system including at least one processor and a memory coupled to the at least one processor, the method comprising:

displaying, by the at least one processor of the roof estimate report system, a plurality of aerial images of a roof at the same time on a single display, each of the aerial images providing a different view, taken from a different angle of the same roof;

displaying, by the at least one processor of the roof estimate report system, respective line drawings representing features of the roof, the respective line drawings overlying a first and a second aerial image of the plurality of aerial images of the roof on the single display, the line drawing overlying the first aerial image of the roof having features in common with the line drawing overlying the second aerial image of the roof;

in response to user input, changing, by the at least one processor of the roof estimate report system, the line drawing representing a feature of the roof that overlies the first aerial image of the roof;

in response to the changing, making corresponding changes, by the at least one processor of the roof estimate report system, to the line drawing overlying the second aerial image; and

generating and outputting a roof estimate report using a report generation engine, wherein the roof estimate report includes numerical values for corresponding slope, area, or lengths of edges of at least some of a plurality of planar roof sections of the roof, wherein the generated roof estimate report is used to provide for repair and/or constructing the roof structure of the building.

Claim 12. (**Currently Amended**) A computing system for generating a roof estimate report, the computing system comprising:

a memory;

at least one processor coupled to the memory; and a roof estimation module that is stored on the memory and that is configured, when executed by at least one processor of the computing system for generating the roof estimate report, to:

overlay a line drawing of a roof feature on corresponding locations of the feature on first and second aerial images of the roof;

in response to user input causing addition of another roof feature in the line drawing overlaid on the first aerial image, make a corresponding addition of the other roof feature to the line drawing overlaid on the second aerial image; and

generate and output a roof estimate report using a report generation engine, wherein the roof estimate report includes numerical values for corresponding slope, area, or lengths of edges of at least some of a plurality of planar roof sections of the roof, wherein the generated roof estimate report is used to provide for repair and/or constructing the roof structure of the building.

Claim 16. (**Currently Amended**) A non-transitory computer-readable storage medium, having computer executable instructions stored thereon that, when executed by at least one computer processor, cause the at least one processor to enable a computing system to generate a roof estimate report for a building having a roof, by performing a method comprising:

overlaying a line drawing on corresponding locations of a roof feature of the roof on first and second aerial images of the roof, wherein the first aerial image provides a first view of the roof of the building and the second aerial image provides a second view of the roof of the building;

in response to changes in the line drawing overlaid on the first aerial image, displaying corresponding changes to the line drawing overlaid on the second aerial image; and

generate and output a roof estimate report using a report generation engine, wherein the roof estimate report includes numerical values for corresponding slope, area, or lengths of edges of at

least some of a plurality of planar roof sections of the roof, wherein the generated roof estimate report is used to provide for repair and/or constructing the roof structure of the building.

Claim 26. (**Currently Amended**) A computer-implemented method in a roof estimate report system including a computer system and a memory coupled to the computer system, the method comprising:

changing, by the computer system of the roof estimate report system, a line in a first line drawing representing a feature of a roof that overlies a first aerial image of the roof;

changing, by the computer system of the roof estimate report system, a line in a second line drawing that corresponds to the same feature in the first line drawing that was changed, the change in the second line drawing being made by the computer system in response to the change that was made in the first line drawing; and

generating and outputting a roof estimate report using a report generation engine, wherein the roof estimate report includes numerical values for corresponding slope, area, or lengths of edges of at least some of a plurality of planar roof sections of the roof, wherein the generated roof estimate report is used to provide for repair and/or constructing the roof structure of the building.

Allowable Subject Matter

6. Claims 1-37 are allowed.

6.1 The following is an Examiner's statement of reasons for allowance:

6.2 *In view of the Terminal Disclaimer filed on 06/01/2015, claims 1-37 are allowed for the same reason stated in the parent application 13474504*; as neither Kennedy et al. nor Slatter or Meder et al. (US Patent No. 7,305,983), taken either alone or in combination with the

prior art of record discloses a computer-implemented method in a roof estimate report system, that includes a step of generating and outputting a roof estimate report using a report generation engine, wherein the roof estimate report includes one or more top plan views of a model of the roof annotated with numerical values for corresponding slope, area, lengths of the edges of at least some of the plurality of planar roof sections of the model of the roof, wherein the generated roof estimate report is used to provide for repair and/or constructing the roof structure of the building, *as specifically shown in the claims*, in combination with the remaining elements and features of the instant invention, it is for these reasons that the applicant's invention defines over the prior art of record.

6.3 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

7. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Andre Pierre-Louis whose telephone number is 571-272-8636. The examiner can normally be reached on Mon-Fri, 8:00AM-4:30PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Kamini S. Shah can be reached on 571-272-2279. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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.

/Kamini S Shah/

Supervisory Patent Examiner, Art Unit 2123

/A. P./
Examiner, Art Unit 2123
June 12, 2015

Notice of References Cited	Application/Control No. 14/450,108	Applicant(s)/Patent Under Reexamination PERSHING, CHRIS	
	Examiner ANDRE PIERRE-LOUIS	Art Unit 2123	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-7,305,983	12-2007	Meder et al.	126/621
	B	US-			
	C	US-			
	D	US-			
	E	US-			
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	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.

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BIB DATA SHEET

CONFIRMATION NO. 8641

SERIAL NUMBER	FILING or 371(c) DATE RULE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
14/450,108	08/01/2014	703	2123	290115.406C2

APPLICANTS
Eagle View Technologies, Inc., Bothell, WA;

INVENTORS
Chris Pershing, Redmond, WA;

**** CONTINUING DATA **************************
This application is a CON of 13/474,504 05/17/2012 PAT 8825454
which is a CON of 12/467,250 05/15/2009 PAT 8209152
which claims benefit of 61/197,904 10/31/2008

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

**** IF REQUIRED, FOREIGN FILING LICENSE GRANTED **** ** SMALL ENTITY **
08/07/2014

Foreign Priority claimed ☐ Yes ☑ No 35 USC 119(a-d) conditions met ☐ Yes ☑ No Verified and Acknowledged /ANDRE PIERRE LOUIS/ Examiner's Signature	☐ Met after Allowance Initials	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
		WA	29	37	4

ADDRESS

SEED INTELLECTUAL PROPERTY LAW GROUP PLLC
701 FIFTH AVE
SUITE 5400
SEATTLE, WA 98104
UNITED STATES

TITLE

CONCURRENT DISPLAY SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION

FILING FEE RECEIVED		
3520	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

BIB (Rev. 05/07).

Receipt date: 06/01/2015

U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTY. DOCKET NO. 290115.406C2	APPLICATION NO. 14/450,108
INFORMATION DISCLOSURE STATEMENT (Use several sheets if necessary)	INVENTOR Chris Pershing	
	FILING DATE August 1, 2014	GROUP ART UNIT 2123

U.S. PATENT DOCUMENTS

*EXAMINER INITIAL		DOCUMENT NUMBER	KIND CODE	DATE	NAME	FILING DATE IF APPROPRIATE
	1	8,145,578		03/27/12	Pershing	
	2	8,204,341		06/19/12	Schultz	
	3	8,818,770		08/26/14	Pershing	
	4	8,825,454		09/02/14	Pershing	
	5	2003/0103651		06/05/03	Novak	
	6	2005/0267657		12/01/05	Devdhar	
	7	2006/0137736		06/29/06	Nishitani et al.	
	8	2008/0162380		07/03/08	SUGA et al.	
	9	2010/0241406		09/23/10	Rahmes et al.	
	10	2011/0086201		04/14/11	Shiao et al.	
	11	2012/0035887		02/09/12	Augenbraun et al.	
	12	2012/0209782		08/16/12	Pershing et al.	
	13	2013/0202157		08/08/13	Pershing	
	14	2013/0204575		08/08/13	Pershing	
	15	2013/0226515		08/29/13	Pershing et al.	
	16	2013/0262029		10/03/13	Pershing	
	17	2015/0016689		01/15/15	Pershing	

FOREIGN PATENT DOCUMENTS

*EXAMINER INITIAL		DOCUMENT NUMBER	KIND CODE	DATE	COUNTRY	TRANSLATION YES	TRANSLATION NO
	1						

NON-PATENT LITERATURE DOCUMENTS *(Including Author, Title, Date, Pertinent Pages, Etc.)*

	1		Canadian Office Action, dated March 24, 2014, for Canadian Application No. 2,703,423, 2 pages.
	2		Pershing, "PITCH DETERMINATION SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION," Office Action for USAN 13/438,288, mailed December 16, 2013, 23 pages.

EXAMINER	/Andre Pierre Louis/ (06/10/2015)	DATE CONSIDERED	(06/10/2015)

* EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

3758591_1.docx June 1, 2015

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /APL/

Receipt date: 06/01/2015

OPAP ARLINGTON, VA
JUN 01 2015
PATENT & TRADEMARK OFFICE

EXPRESS MAIL NO. EM086839681US

U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTY. DOCKET NO. 290115.406C2	APPLICATION NO. 14/450,108
INFORMATION DISCLOSURE STATEMENT (Use several sheets if necessary)	INVENTOR Chris Pershing	
	FILING DATE August 1, 2014	GROUP ART UNIT 2123

U.S. PATENT DOCUMENTS

*EXAMINER INITIAL		DOCUMENT NUMBER	KIND CODE	DATE	NAME	FILING DATE IF APPROPRIATE
	1					

FOREIGN PATENT DOCUMENTS

*EXAMINER INITIAL		DOCUMENT NUMBER	KIND CODE	DATE	COUNTRY	TRANSLATION YES	TRANSLATION NO
	1						

NON-PATENT LITERATURE DOCUMENTS *(Including Author, Title, Date, Pertinent Pages, Etc.)*

	1		Transcription of points of potential interest in the attached YouTube video titled: "Pictometry Online Demo," retrieved on February 10, 2010, 1 page.
	2		YouTube, "Pictometry Online Demo," DVD, February 25, 2010.

EXAMINER /Andre Pierre Louis/ (06/10/2015)	DATE CONSIDERED (06/10/2015)

* EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /APL/

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14450108	PERSHING, CHRIS
	Examiner	**Art Unit**
	ANDRE PIERRE LOUIS	2123

CPC						
Symbol					**Type**	**Version**
G06T	/	11	/	60	F	2013-01-01
G06F	/	17	/	5004	I	2013-01-01
G06T	/	7	/	0075	I	2013-01-01
G06T	/	17	/	20	I	2013-01-01
G06T	/	2207	/	10012	A	2013-01-01
G06T	/	2207	/	30184	A	2013-01-01
G06K	/	9	/	00637	I	2013-01-01
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CPC Combination Sets							
Symbol					**Type**	**Set**	**Ranking**	**Version**
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	/		/					

/ANDRE PIERRE LOUIS/ Examiner.Art Unit 2123	06/10/2015	**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	37	
/KAMINI S SHAH/ Supervisory Patent Examiner.Art Unit 2123	06/17/2015	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	10

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14450108	PERSHING, CHRIS
	Examiner	**Art Unit**
	ANDRE PIERRE LOUIS	2123

US ORIGINAL CLASSIFICATION		INTERNATIONAL CLASSIFICATION										
CLASS	SUBCLASS	CLAIMED					NON-CLAIMED					
703	1	G	0	6	F	17 / 50 (2006.01.01)						
CROSS REFERENCE(S)		G	0	6	F	17 / 10 (2006.01.01)						
		G	0	6	F	7 / 60 (2006.01.01)						

CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)				
703	2				

/ANDRE PIERRE LOUIS/ Examiner.Art Unit 2123	06/10/2015	**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	37	
/KAMINI S SHAH/ Supervisory Patent Examiner.Art Unit 2123	06/17/2015	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	10

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14450108	PERSHING, CHRIS
	Examiner	**Art Unit**
	ANDRE PIERRE LOUIS	2123

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

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
	1		17		33										
	2		18		34										
	3		19		35										
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	15		31												
	16		32												

/ANDRE PIERRE LOUIS/ Examiner.Art Unit 2123	06/10/2015	**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	37	
/KAMINI S SHAH/ Supervisory Patent Examiner.Art Unit 2123	06/17/2015	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	10

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14450108	PERSHING, CHRIS
	Examiner	Art Unit
	ANDRE PIERRE LOUIS	2123

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

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

CLAIM		DATE								
Final	Original	06/10/2015								
	1	=								
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	4	=								
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Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14450108	PERSHING, CHRIS
	Examiner	**Art Unit**
	ANDRE PIERRE LOUIS	2123

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

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

CLAIM		DATE								
Final	Original	06/10/2015								
	37	=								

EAST Search History

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S210	2497	(703/1).CCLS.	US-PGPUB; UPAD	OR	OFF	2015/06/10 16:00
S211	89	(roof with estimat$4) and pitch$2	US-PGPUB; UPAD	OR	OFF	2015/06/10 16:00
S212	35	S211 and (aerial with image$s)	US-PGPUB; UPAD	OR	OFF	2015/06/10 16:00
S213	14	(roof with estimat$4).ti. and pitch$2	US-PGPUB; UPAD	OR	OFF	2015/06/10 16:01
S214	12	(roof with estimat$4 with report with generat$4 with pitch$2)	US-PGPUB; UPAD	OR	OFF	2015/06/10 16:01
S215	12	roof and estimat$4 and (pitch$2 with marker$2)	US-PGPUB; UPAD	OR	OFF	2015/06/10 16:13
S216	395	roof and estimat$4 and (pitch$2 with determin$4)	US-PGPUB; UPAD	OR	OFF	2015/06/10 16:13
S217	8	S216 and (aerial with image$2) and (modif$4 with three with dimension$3)	US-PGPUB; UPAD	OR	OFF	2015/06/10 16:13
S218	1	S216 and (aerial with image$2) and (modif$4 with 3d with dimension$3)	US-PGPUB; UPAD	OR	OFF	2015/06/10 16:14
S219	62	S211 and modif$4	US-PGPUB; UPAD	OR	OFF	2015/06/10 16:14
S220	35	S219 and (aerial with image$2)	US-PGPUB; UPAD	OR	OFF	2015/06/10 16:14
S221	101	(G06F17/20).CPC.	US-PGPUB; UPAD	OR	OFF	2015/06/10 16:15
S222	676	(G06F17/5004).CPC.	US-PGPUB; UPAD	OR	OFF	2015/06/10 16:15
S223	1112	(G06T7/0042).CPC.	US-PGPUB; UPAD	OR	OFF	2015/06/10 16:15
S224	1569	(G06T7/0083).CPC.	US-PGPUB; UPAD	OR	OFF	2015/06/10 16:15
S225	929	(G06T2200/24).CPC.	US-PGPUB;	OR	OFF	2015/06/10 16:15

			UPAD			
S226	92	(G06T2207/30184).CPC.	US-PGPUB; UPAD	OR	OFF	2015/06/10 16:15
S227	199	(G06T2207/10032).CPC.	US-PGPUB; UPAD	OR	OFF	2015/06/10 16:15
S228	81	(G06K9/00637).CPC.	US-PGPUB; UPAD	OR	OFF	2015/06/10 16:15
S229	4537	(S221 OR S222 OR S223 OR S224 OR S225 OR S226 OR S227 OR S228)	US-PGPUB; UPAD	OR	OFF	2015/06/10 16:15
S230	50	S223 and S224	US-PGPUB; UPAD	OR	OFF	2015/06/10 16:16
S231	3	S222 and S224	US-PGPUB; UPAD	OR	OFF	2015/06/10 16:16
S232	13	S223 and S227	US-PGPUB; UPAD	OR	OFF	2015/06/10 16:16
S233	7	S227 and S225	US-PGPUB; UPAD	OR	OFF	2015/06/10 16:17
S234	148	(roof with estimat$4) and roof and image$2	US-PGPUB; UPAD	OR	OFF	2015/06/10 16:17
S235	38	(roof with estimat$4 with generat$4) and roof and image$2	US-PGPUB; UPAD	OR	OFF	2015/06/10 16:17
S236	9	(roof with estimat$4 with report with annotat$4 with pitch$2)	US-PGPUB; UPAD	OR	OFF	2015/06/10 16:18
S237	148	(roof with estimat$4) and roof and image$2	US-PGPUB; UPAD	OR	OFF	2015/06/10 16:18
S238	21	S237 and (chang$4 and correlat$4) and (roof with line with drawing)	US-PGPUB; UPAD	OR	OFF	2015/06/10 16:18

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Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14450108	PERSHING, CHRIS
	Examiner	Art Unit
	ANDRE PIERRE LOUIS	2123

CPC- SEARCHED		
Symbol	Date	Examiner
G06F17/20; G06F17/5004; G06T7/0042; G 06T7/0083; G06T2200/24; G06T2207/30184; G06T2207/10032; G06K9/00637	6/10/2015	AP

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
703	1	12/23/2014	AP
Above	Search Updated	6/10/2015	AP

SEARCH NOTES		
Search Notes	Date	Examiner
Inventor Name Search	12/23/2014	AP
Google NPL Text Search (Roof Estimate and Earial images and lines drawing display)	12/23/2014	AP
EAST (EAST (US- PGPUB;USPAT;USOCR;EPO;JPO;r ERWENT:IBM TDB-- SEE Search History	12/23/2014	AP
Above Search Updated	6/10/2015	AP

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner
USPG_PUB	Interference Text Search	6/10/2015	AP

/A.P./ Examiner.Art Unit 2123	

Doc Code: DIST.E.FILE **Document Description: Electronic Terminal Disclaimer - Filed**	PTO/SB/26 U.S. Patent and Trademark Office Department of Commerce

Electronic Petition Request	**TERMINAL DISCLAIMER TO OBVIATE A DOUBLE PATENTING REJECTION OVER A "PRIOR" PATENT**
Application Number	14450108
Filing Date	01-Aug-2014
First Named Inventor	Chris Pershing
Attorney Docket Number	290115.406C2
Title of Invention	CONCURRENT DISPLAY SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION

☒ Filing of terminal disclaimer does not obviate requirement for response under 37 CFR 1.111 to outstanding Office Action

☒ This electronic Terminal Disclaimer is not being used for a Joint Research Agreement.

Owner	Percent Interest
Eagle View Technologies, Inc.	100%

The owner(s) with percent interest listed above in the instant application hereby disclaims, except as provided below, the terminal part of the statutory term of any patent granted on the instant application which would extend beyond the expiration date of the full statutory term of prior patent number(s)

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as the term of said prior patent is presently shortened by any terminal disclaimer. The owner hereby agrees that any patent so granted on the instant application shall be enforceable only for and during such period that it and the prior patent are commonly owned. This agreement runs with any patent granted on the instant application and is binding upon the grantee, its successors or assigns.

In making the above disclaimer, the owner does not disclaim the terminal part of the term of any patent granted on the instant application that would extend to the expiration date of the full statutory term of the prior patent, "as the term of said prior patent is presently shortened by any terminal disclaimer," in the event that said prior patent later:
- expires for failure to pay a maintenance fee;
- is held unenforceable;
- is found invalid by a court of competent jurisdiction;
- is statutorily disclaimed in whole or terminally disclaimed under 37 CFR 1.321;
- has all claims canceled by a reexamination certificate;
- is reissued; or
- is in any manner terminated prior to the expiration of its full statutory term as presently shortened by any terminal disclaimer.

◉ Terminal disclaimer fee under 37 CFR 1.20(d) is included with Electronic Terminal Disclaimer request.

○	I certify, in accordance with 37 CFR 1.4(d)(4), that the terminal disclaimer fee under 37 CFR 1.20(d) required for this terminal disclaimer has already been paid in the above-identified application.

Applicant claims the following fee status:

◉ Small Entity

○ Micro Entity

○ Regular Undiscounted

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

THIS PORTION MUST BE COMPLETED BY THE SIGNATORY OR SIGNATORIES

I certify, in accordance with 37 CFR 1.4(d)(4) that I am:

◉ An attorney or agent registered to practice before the Patent and Trademark Office who is of record in this application

Registration Number 44527

○ A sole inventor

○ A joint inventor; I certify that I am authorized to sign this submission on behalf of all of the inventors as evidenced by the power of attorney in the application

○ A joint inventor; all of whom are signing this request

Signature	/Jeremiah J. Baunach/
Name	Jeremiah J. Baunach

*Statement under 37 CFR 3.73(b) is required if terminal disclaimer is signed by the assignee (owner).
Form PTO/SB/96 may be used for making this certification. See MPEP § 324.

Electronic Patent Application Fee Transmittal

Application Number:	14450108
Filing Date:	01-Aug-2014
Title of Invention:	CONCURRENT DISPLAY SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION
First Named Inventor/Applicant Name:	Chris Pershing
Filer:	Jeremiah J. Baunach
Attorney Docket Number:	290115.406C2

Filed as Small Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Statutory or Terminal Disclaimer	1814	1	160	160
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**160**

Doc Code: DISQ.E.FILE
Document Description: Electronic Terminal Disclaimer – Approved

Application No.: 14450108

Filing Date: 01-Aug-2014

Applicant/Patent under Reexamination: Pershing et al.

Electronic Terminal Disclaimer filed on June 1, 2015

☒ APPROVED

This patent is subject to a terminal disclaimer

☐ DISAPPROVED

Approved/Disapproved by: Electronic Terminal Disclaimer automatically approved by EFS-Web

U.S. Patent and Trademark Office

Electronic Acknowledgement Receipt	
EFS ID:	22498202
Application Number:	14450108
International Application Number:	
Confirmation Number:	8641
Title of Invention:	CONCURRENT DISPLAY SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION
First Named Inventor/Applicant Name:	Chris Pershing
Customer Number:	500
Filer:	Jeremiah J. Baunach
Filer Authorized By:	
Attorney Docket Number:	290115.406C2
Receipt Date:	01-JUN-2015
Filing Date:	01-AUG-2014
Time Stamp:	15:58:58
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$160
RAM confirmation Number	2380
Deposit Account	
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Electronic Terminal Disclaimer-Filed	eTerminal-Disclaimer.pdf	33442 07b33671db2e6b03f998ad61cda37db15eecbf72	no	2
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30320 16d3cbbaa7583a6e17b9e19d386bba2f24a00dd5	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	63762		

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.

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor	:	Chris Pershing
Application No.	:	14/450,108
Filed	:	August 1, 2014
For	:	CONCURRENT DISPLAY SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION
Examiner	:	Andre Pierre Louis
Art Unit	:	2123
Docket No.	:	290115.406C2
Date	:	June 1, 2015

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

AMENDMENT

Commissioner for Patents:

In response to the Office Action dated December 30, 2014, please extend the period of time for response two months, to expire on May 30, 2015 (Sunday). Enclosed are a Petition for an Extension of Time and the requisite fee. Please amend the application as follows:

Amendments to the Claims are reflected in the listing of claims which begins on page 2 of this paper.

Remarks begin on page 12 of this paper.

Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1. (Currently Amended) A computer-implemented method in a roof estimate report system including at least one processor and a memory coupled to the at least one processor, the method comprising:

displaying, by the at least one processor of the roof estimate report system, a plurality of aerial images of a roof at the same time ~~on a single display~~, each of the aerial images providing a different view, taken from a different angle of the same roof;

displaying, by the at least one processor of the roof estimate report system, respective line drawings representing features of the roof, the respective line drawings overlying a first and a second aerial image of the plurality of aerial images of the roof ~~on the single display~~, the line drawing overlying the first aerial image of the roof having features in common with the line drawing overlying the second aerial image of the roof;

in response to user input, changing, by the at least one processor of the roof estimate report system, the line drawing representing a feature of the roof that overlies the first aerial image of the roof;

~~correlating, by the at least one processor of the roof estimate report system, a location of the feature on the roof represented by the line drawing that has been changed to a location of a corresponding feature represented by the line drawing overlying the second aerial image; and~~

~~based on the correlation,~~ in response to the changing, making corresponding changes~~changing~~, by the at least one processor of the roof estimate report system, ~~the corresponding feature in~~ to the line drawing overlying the second aerial image; and ~~according to the change of the line drawing representing the feature of the roof that overlies the first aerial image~~

generating and outputting a roof estimate report using a report generation engine, wherein the roof estimate report includes numerical values for corresponding slope, area, or lengths of edges of at least some of a plurality of planar roof sections of the roof.

2. (Original) The method of claim 1 further comprising, before the displaying the respective line drawings, modifying a three-dimensional model of the roof based on a received indication of a roof feature by adding a planar roof section to the three-dimensional model.

3. (Original) The method of claim 2 wherein the indicated roof feature is at least one of: a point on the roof, a section of the roof, a ridgeline of the roof, a valley of the roof, a rake edge of the roof, an eave of the roof, a hip ridge of the roof, an edge of a section of the roof, and a corner of a section of the roof.

4. (Original) The method of claim 1 wherein the displaying the respective line drawings comprises:

displaying the respective line drawing overlying the first aerial image at a first time; and

displaying the respective the line drawing overlying the second aerial image at a second time that is substantially coincident to the first time.

5. (Original) The method of claim 1 further comprising receiving an indication of one of the features of the roof at a first time, and wherein the displaying the respective line drawings occurs at a second time that is substantially coincident to the first time.

6. (Original) The method of claim 1 wherein the displaying the respective line drawings includes initiating display of a line on the first and second image.

7. (Original) The method of claim 1 wherein the first image provides a substantially top plan view of the roof of the building, and wherein the second image provides a perspective view of the roof of the building.

8. (Original) The method of claim 1 wherein the first image provides a first perspective view of the roof of the building and the second image provides a second perspective view of the roof of the building.

9. (Original) The method of claim 1 further comprising:

transmitting roof measurement information based at least in part on the change of the line drawing representing a feature of the roof that overlies the first aerial image of the roof.

10. (Original) The method of claim 1 further comprising:

displaying a marker operable to specify a point on an image;

receiving, via the marker, an indication of a point on the first aerial image; and

registering, based on the received indication of the point, the aerial image to a reference grid corresponding to a three-dimensional model of the roof.

11. (Original) The method of claim 1 further comprising:

displaying a lean correction marker operable to indicate a vertical axis of an aerial image;

receiving, via the lean correction marker, an indication of a vertical axis of the first aerial image; and

registering, based on the received indication of the vertical axis, the first aerial image to a reference grid corresponding to a three-dimensional model of the roof.

12. (Currently Amended) A computing system for generating a roof estimate report, the computing system comprising:

a memory;

at least one processor coupled to the memory; and

a roof estimation module that is stored on the memory and that is configured, when executed by at least one processor of the computing system for generating the roof estimate report, to:

~~substantially concurrently display a projection of a roof feature onto first and second aerial images as a line drawing of the roof feature;~~

overlay ~~the~~ a line drawing of ~~the~~ a roof feature on corresponding locations of the feature on ~~the~~ first and second aerial images of the roof; ~~and~~

in response to user input causing ~~modification of~~addition of another roof feature in the line drawing overlaid on the first aerial image, make a corresponding ~~changes~~ addition of the other roof feature to the line drawing overlaid on the second aerial image; and

generate and output a roof estimate report using a report generation engine, wherein the roof estimate report includes numerical values for corresponding slope, area, or lengths of edges of at least some of a plurality of planar roof sections of the roof.

13. (Original) The computing system of claim 12 wherein the roof estimation module includes an interactive roof modeling user interface.

14. (Currently Amended) The computing system of claim 12 wherein the ~~computing system is a desktop computer and the roof estimation module is part of an interactive roof modeling program executing on the computing system~~other roof feature is a planar roof section.

15. (Original) The computing system of claim 12 wherein the roof estimation module is part of a network accessible roof modeling program executing on the computing system.

16. (Currently Amended) A non-transitory computer-readable storage medium, having computer executable instructions stored thereon that, when executed by at least

one computer processor, cause the at least one processor to enable a computing system to generate a roof estimate report for a building having a roof, by performing a method comprising:

~~substantially concurrently displaying a projection of a roof feature as a line drawing of the feature onto a first aerial image of the roof that provides a first view of the roof of the building and onto a second aerial image that provides a second view of the roof of the building;~~

overlaying ~~the~~ a line drawing on corresponding locations of ~~the~~ a roof feature of the roof on ~~the~~ first and second aerial images of the roof, wherein the first aerial image provides a first view of the roof of the building and the second aerial image provides a second view of the roof of the building; ~~and~~

in response to ~~user input causing modification of~~changes in the line drawing overlaid on the first aerial image, ~~making~~ displaying corresponding changes to the line drawing overlaid on the second aerial image; and

generate and output a roof estimate report using a report generation engine, wherein the roof estimate report includes numerical values for corresponding slope, area, or lengths of edges of at least some of a plurality of planar roof sections of the roof.

17. (Original) The non-transitory computer-readable storage medium of claim 16 wherein the method further comprises modifying a three-dimensional model of the roof by adding a planar roof section to the three-dimensional model.

18. (Currently Amended) The non-transitory computer-readable storage medium of claim 16 wherein the method further comprises:

receiving an indication of the roof feature ~~of the building~~ by receiving position information of the feature in the first aerial ~~image, and wherein substantially concurrently displaying the projection of the feature includes:~~image;

translating the received position information into position information of the roof feature in a three-dimensional model; and

translating the position information of the feature in the three-dimensional model into position information of the feature in the second aerial image.

19. (Currently Amended) The non-transitory computer-readable storage medium of claim 16 ~~wherein displaying the projection of the feature comprises~~further comprising:

displaying the roof feature in the first aerial image at a first time; and

displaying the roof feature in the second aerial image at a second time that is within two seconds of the first time.

20. (Currently Amended) The non-transitory computer-readable storage medium of claim 16 wherein the method further comprises ~~displaying the projection of the feature includes~~ displaying ~~the~~ a projection of the roof feature onto the first aerial image substantially concurrently with receiving an indication of the roof feature ~~of the building~~.

21. (Currently Amended) The non-transitory computer-readable storage medium of claim 16 wherein the method further comprises ~~displaying the projection of the feature includes~~ displaying ~~the~~ a projection of the roof feature at substantially the same time as receiving an indication of the roof feature of the building.

22. (Original) The non-transitory computer-readable storage medium of claim 16 wherein the method is performed iteratively, and the method further comprising:

providing an operator with an interactive model generation experience.

23. (Currently Amended) The non-transitory computer-readable storage medium of claim 16 wherein the method further comprises initiating displaying ~~the~~ a projection of the roof feature on the first and second image by ~~includes~~ initiating display of a line on the first and second image.

24. (Original) The non-transitory computer-readable storage medium of claim 16 wherein the first image provides a perspective view of the roof of the building, and wherein the second image provides a substantially top plan view of the roof of the building.

25. (Currently Amended) The non-transitory computer-readable storage medium of claim 16 wherein the method further comprises:

modifying a three dimensional model of the roof based at least on the modification of the line drawing overlaid on the first aerial image~~; and~~

~~generating a roof estimate report based at least in part on the modified three-dimensional model~~.

26. (Currently Amended) A computer-implemented method in a roof estimate report system including a computer system and a memory coupled to the computer system, the method comprising:

~~displaying, by the computer system of the roof estimate report system, a first aerial image of a roof on a single display;~~

~~displaying, by the computer system of the roof estimate report system, a second aerial image of the same roof on the same single display, the second aerial image providing a different view than the first aerial image, taken from a different angle of the same roof;~~

~~displaying, by the computer system of the roof estimate report system, a first line drawing representing features of the roof overlaid on the first aerial image of the roof;~~

~~displaying, by the computer system of the roof estimate report system, a second line drawing representing features of the roof overlaid on the second aerial image of the roof, the second line drawings having features in common with and that correspond to features in the first line drawing;~~

~~in response to user input,~~ changing, by the computer system of the roof estimate report system, a line in ~~the~~ a first line drawing representing a feature of ~~the~~ a roof that overlies ~~the~~ a first aerial image of the roof;

changing, by the computer system of the roof estimate report system, a line in ~~the~~ a second line drawing that corresponds to the same feature in the first line drawing that was changed ~~by the user~~, the change in the second line drawing being made by the computer system in response to the change that was made ~~by the user~~ in the first line drawing; and

generating and outputting a roof estimate report using a report generation engine, wherein the roof estimate report includes numerical values for corresponding slope, area, or lengths of edges of at least some of a plurality of planar roof sections of the roof.

27. (Original) The method of claim 26 wherein the roof feature is at least one of: a ridgeline of the roof, a valley of the roof, a rake edge of the roof, an eave of the roof, a hip ridge of the roof, and an edge of a section of the roof.

28. (Currently Amended) The method of claim 26 ~~wherein the step of displaying, by the computer system of the roof estimate report system, a second line drawing representing features of the roof overlaid on the second aerial image of the roof comprises:~~further comprising displaying the second line drawing after the first line drawing has been displayed.

29. (Original) The method of claim 26 wherein the step of changing, by the computer system of the roof estimate report system, a feature in the second line drawing overlying the second aerial image comprises:

changing the second line drawing at a time that is substantially concurrent to the time the changes are being made by the user in the first line drawing.

30. (Currently Amended) The method of claim 26 further comprising:

displaying the second line drawing overlying the second aerial image ~~on the same display~~ concurrently with displaying the first line drawing overlying the first aerial image of the roof ~~on the same, single display~~.

31. (Currently Amended) The method of claim 26 further comprising:

displaying the second line drawing overlying the second aerial image ~~on the same display~~ at a later time, after the displaying of the first line drawing overlying the first aerial image of the roof on the display.

32. (Original) The method of claim 26 wherein the first image provides a substantially top plan view of the roof of the building, and the second image provides an oblique view of the roof of the building.

33. (Original) The method of claim 26 wherein the first image provides a first oblique view from a first compass bearing of the roof of the building, and the second image provides a second oblique view from a second compass bearing of the roof of the building.

34. (Currently Amended) The method of claim 26 further comprising:

displaying roof measurement information ~~on the same display~~ concurrently with the first line drawing being displayed.

35. (Currently Amended) The method of claim 34 wherein the step of displaying roof measurement information ~~on the same display concurrently with the first line drawing being displayed~~ comprises:

displaying the roof measurement information in a location that overlays the first line drawing itself.

36. (Currently Amended) The method of claim 26 further comprising:

displaying a wire frame model of the roof in isolation from any images of the roof ~~on the same display~~.

37. (Original) The method of claim 26 further comprising:

modifying a wire frame model of the roof based on input received from a user; and

making, by the computer system of the roof estimate report system, corresponding changes in a 3D model of the roof based on the changes made by the user to the wire frame model.

REMARKS

Claims 1-37 are pending. Claims 1, 12, 14, 16, 18-21, 23, 25, 26, 28, 30, 31 and 34-36 are amended herein. No claims are being canceled or added herein. No new matter is being presented by way of this amendment.

At the outset, Applicant thanks Examiner Pierre Louis for his time and consideration during the Examiner interviews over the phone on December 23, 2014, and December 24, 2014. During the Examiner interview on December 24, 2014, it was agreed that including in the claims allowable subject matter from the parent application (U.S. Patent Application No. 13/474,504, now U.S. Patent No. 8,825,454; Attorney Docket No. 290115.406C1) regarding generating and outputting a roof estimate report and overcoming the double patenting rejection would put the application in condition for allowance. Applicant has included what Applicant believes are the pertinent features of such allowable subject matter in the claims and has amended the claims herein to overcome the double patenting rejection. Also, Applicant submits herewith a Terminal Disclaimer with respect to U.S. Patent No. 8,825,454, as agreed to in the Examiner interview, in order to expedite prosecution of the Application by avoiding any obviousness-type double patenting allegations with respect to U.S. Patent No. 8,825,454. Therefore, Applicant respectfully submits the application is in condition for allowance.

Objection to Specification

The Examiner objected to the specification because it does not show the priority data of the Application. Applicant respectfully submits that there is no requirement to include priority data in the Application specification. Applicant notes the correct priority data is shown on the corresponding Application Data Sheet.

Therefore, Applicant respectfully requests the objection be withdrawn.

Double Patenting

Claims 1-37 were rejected under 35 U.S.C. § 101 as claiming the same invention as that of claims 1-37 of prior U.S. Patent No. 8,825,454 (Attorney Docket No. 290115.406C1).

Applicant does not acquiesce to the merits of the rejection. However, amendments have been made herein to the claims that further distinguish them from the claims of U.S. Patent No. 8,825,454 and thus, the claims as amended do not claim the same invention as any of the claims of U.S. Patent No. 8,825,454. Also, Applicant submits herewith a Terminal Disclaimer with respect to U.S. Patent No. 8,825,454, as agreed in the Examiner interview, to avoid any obviousness-type double patenting issues with respect to U.S. Patent No. 8,825,454.

Therefore, Applicant respectfully requests the rejection be withdrawn.

Rejections under 35 U.S.C. § 103

Claims 1-21 and 23-37 are rejected under pre-AIA 35 U.S.C. § 103(a) as being unpatentable over Kennedy et al. (U.S. Patent Application Publication No. 2011/0205245, hereinafter "Kennedy") in view of Slatter (U.S. Patent Application Publication No. 2002/0101594, hereinafter "Slatter").

Claim 22 is rejected under pre-AIA 35 U.S.C. § 103(a) as being unpatentable over Kennedy in view of Slatter, further in view of Royan et al. (U.S. Patent No. 8,131,514, hereinafter "Royan").

Applicant respectfully traverses the rejections under 35 U.S.C. § 103.

Kennedy and Slatter, alone or in combination, do not teach or suggest all the features of claim 1 as amended.

In particular, claim 1 as amended recites (emphasis added):

> 1. A computer-implemented method in a roof estimate report system including at least one processor and a memory coupled to the at least one processor, the method comprising:
>
> displaying, by the at least one processor of the roof estimate report system, a plurality of aerial images of a roof at the same time, each of the aerial images providing a different view, taken from a different angle of the same roof;
>
> displaying, by the at least one processor of the roof estimate report system, respective line drawings representing features of the roof, the respective line drawings overlying a first and a second aerial image of the plurality of aerial images of the roof, the line drawing overlying the first aerial image of the roof having features in common with the line drawing overlying the second aerial image of the roof;

> in response to user input, ***changing***, by the at least one processor of the roof estimate report system, ***the line drawing representing a feature of the roof that overlies the first aerial image of the roof;***
>
> ***in response to the changing, making corresponding changes***, by the at least one processor of the roof estimate report system, ***to the line drawing overlying the second aerial image***; and
>
> generating and outputting a roof estimate report using a report generation engine, wherein the roof estimate report includes numerical values for corresponding slope, area, or lengths of edges of at least some of a plurality of planar roof sections of the roof.

Kennedy does not teach or suggest "changing…the line drawing representing a feature of the roof that overlies the first aerial image of the roof; in response to the changing, making corresponding changes…to the line drawing overlying the second aerial image" as recited in claim 1 as amended. Kennedy shows line drawings on different images in general (See Figures 7 and 8) but there is no discussion of making changes to a line drawing on a second image according to changes to a corresponding feature in a line drawing on a first image.

The Slatter reference is directed to a measurement apparatus in which an operator draws around an area of interest on an image of the object (see Abstract of Slatter). The system of Slatter "creates a virtual shape to match the selected area and overlays it on the image" (see paragraph 23 of Slatter). However, nowhere does Slatter mention anything about a "first aerial image" and a "second aerial image", much less changing the corresponding feature in the line drawing overlying the second aerial image based on something occurring in a different first aerial image. To the extent Slatter does describe any line drawing, Slatter only discloses such a line drawing as marking "area 22" on the same image (see "area 22" in the image displayed on "screen 16" in Figures 2-4 and associated description in paragraphs 21-23 of Slatter).

Therefore, Kennedy and Slatter, alone or in combination, do not teach or suggest "changing…the line drawing representing a feature of the roof that overlies the first aerial image of the roof; in response to the changing, making corresponding changes…to the line drawing overlying the second aerial image" as recited in claim 1 as amended.

Furthermore, during the Examiner interview on December 24, 2014, it was agreed that including in the claims allowable subject matter from the parent application (U.S. Patent Application No.13/438,288, now U.S. Patent No. 8,818,770; Attorney Docket No.

290115.403C1) regarding generating and outputting a roof estimate report and overcoming the double patenting rejection would put the application in condition for allowance. Applicant has included what Applicant believes are the pertinent features of such allowable subject matter in the claims and has amended the claims herein to overcome the double patenting rejection. In particular claim 1 as amended recites "generating and outputting a roof estimate report using a report generation engine, wherein the roof estimate report includes numerical values for corresponding slope, area, or lengths of edges of at least some of a plurality of planar roof sections of the roof".

Therefore, Applicant respectfully submits that independent claim 1 is allowable for at least the reasons presented above.

Applicant respectfully submits that claims 2-11 are allowable for at least the reason that they depend from allowable claim 2 and further for the additional limitations respectively recited therein.

Although the language of claims 12-37 is not identical to that of claims 2-12, the novelty and nonobviousness of claims 12-37 will be apparent in view of the above discussion.

In particular, independent system claim 12 as amended recites, in part, "in response to user input causing addition of another roof feature in the line drawing overlaid on the first aerial image, make a corresponding addition of the other roof feature to the line drawing overlaid on the second aerial image". These limitations are also not taught or suggested by the references relied on by the Examiner.

Therefore, Applicant respectfully submits that independent claim 12 is allowable.

Applicant respectfully submits that claims 13-15 are allowable for at least the reason that they depend from allowable claim 12 and further for the additional limitations respectively recited therein.

Independent claim 16 is directed to a non-transitory computer-readable storage medium and recites, in part, "in response to changes in the line drawing overlaid on the first aerial image, displaying corresponding changes to the line drawing overlaid on the second aerial image". These limitations are also not taught or suggested by the references relied on by the Examiner.

Therefore, Applicant respectfully submits that independent claim 16 is allowable.

Applicant respectfully submits that claims 17-25 are allowable for at least the reason that they depend from allowable claim 16 and further for the additional limitations respectively recited therein.

Claim 22 depends from independent claim 16. The Royan reference describes transmitting a roof structure for constructing a three-dimensional representation of a building (see Abstract of Royan). However, Royan does not teach or suggest the above cited limitations of independent claim 16 that Kennedy and Slatter lack, and the Examiner does not allege Royan discloses these limitations noted above that Kennedy and Slatter lack. As Royan does not teach or suggest the above cited limitations that Kennedy and Slatter lack, a combination of Kennedy, Slatter and Royan does not teach all of the limitations of claim 16. Therefore, Applicant respectfully submits that claim 22 is allowable for at least the reason that it depends from allowable claim 16.

Independent claim 26 is directed to a method and recites, in part, "changing, by the computer system of the roof estimate report system, a line in a first line drawing representing a feature of a roof that overlies a first aerial image of the roof; changing, by the computer system of the roof estimate report system, a line in a second line drawing that corresponds to the same feature in the first line drawing that was changed, the change in the second line drawing being made by the computer system in response to the change that was made in the first line drawing". These limitations are also not taught or suggested by the references relied on by the Examiner. As explained previously, neither Slatter Kennedy, nor Royan describe causing the computer system to make changes in the second line drawing based on the user making changes in the first line drawing.

Applicant respectfully submits that claims 27-37 are allowable for at least the reason that they depend from allowable claim 26 and further for the additional limitations respectively recited therein.

Applicant also notes that Kennedy is a cited as a reference only under 102(e) and is not admitted by Applicant to be prior art. At some future time, Applicant may elect to remove Kennedy as a reference by swearing behind its filing dates, however, since Kennedy does not

teach the features as currently claimed and all the present claims clearly define over Kennedy even if it is used a reference, it is not necessary to swear behind Kennedy at this time. Applicant will swear behind Kennedy in this case or a continuation of this case as needed and reserves the right to do so.

Conclusion

Applicant respectfully submits that the pending claims are in condition for allowance. Any remarks in support of patentability of one claim should not be imputed to any other claim, even if similar terminology is used. Any remarks referring to only a portion of a claim should not be understood to base patentability on that portion; rather, patentability must rest on each claim taken as a whole. A number of clarifying amendments have also been made to the above claim set. Applicant does not acquiesce to each of the Examiner's rejections and to each of the Examiner's assertions regarding what the cited references show or teach, even if not expressly discussed herein. Although changes to the claims have been made, no acquiescence or estoppel is or should be implied thereby; such amendments are made only to expedite prosecution of the present application and are without prejudice to the presentation or assertion, in the future, of claims relating to the same or similar subject matter.

If the undersigned attorney has overlooked a relevant teaching in any of the references, the Examiner is requested to point out specifically where such teaching may be found. In light of the above amendments and remarks, Applicant respectfully submits that all pending claims are allowable. Applicant, therefore, respectfully requests that the Examiner reconsider this application and timely allow all pending claims. The Examiner is encouraged to contact the undersigned by telephone to discuss the above and any other distinctions between the claims and the applied references, if desired. If the Examiner notes any informalities in the claims, the Examiner is encouraged to contact the undersigned by telephone to expediently correct such informalities.

All of the claims remaining in the application are now clearly allowable. Favorable consideration and a Notice of Allowance are earnestly solicited.

Respectfully submitted,

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PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor	:	Chris Pershing
Application No.	:	14/450,108
Filed	:	August 1, 2014
For	:	CONCURRENT DISPLAY SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION

Examiner	:	Andre Pierre Louis
Art Unit	:	2123
Docket No.	:	290115.406C2
Date	:	June 1, 2015

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

INFORMATION DISCLOSURE STATEMENT TRANSMITTAL

Commissioner for Patents:

In accordance with 37 CFR 1.56 and 1.97 through 1.98, applicant wishes to make known to the U.S. Patent and Trademark Office the references set forth on the attached Information Disclosure Statement. Copies of cited U.S. patents and published patent applications are not required and accordingly have not been provided. Copies of any other cited references are enclosed. As to any reference cited, applicant does not admit that it is "prior art" under 35 U.S.C. §§ 102 or 103. Although the aforesaid references are made known to the Patent and Trademark Office in compliance with applicant's duty to disclose all information he/she is aware of which is believed relevant to the examination of the above-identified application, applicant believes that his/her invention is patentable.

Applicant notes that the following art is being submitted on this same date via U.S. Express Mail and the fee is being paid on EFS for the IDS inclusive of the e-filing and express mail filing. A YouTube™ video, formerly available online but now no longer available

at that location, is being provided on a DVD as well as a transcription of points of potential interest in the attached YouTube video titled: "Pictometry Online Demo".

A fee of $90 is submitted in accordance with 37 CFR 1.97(c). The Director is authorized to charge any other fees due by way of this Information Disclosure Statement, or credit any overpayment to Deposit Account No. 19-1090.

Please acknowledge receipt of this Information Disclosure Statement and kindly make the cited references of record in the above-identified application.

Respectfully submitted,

SEED Intellectual Property Law Group PLLC

/Jeremiah J. Baunach/
Jeremiah J. Baunach
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Enclosures:
Information Disclosure Statement
Cited References (2)

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U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTY. DOCKET NO. 290115.406C2	APPLICATION NO. 14/450,108
INFORMATION DISCLOSURE STATEMENT (Use several sheets if necessary)	INVENTOR Chris Pershing	
	FILING DATE August 1, 2014	GROUP ART UNIT 2123

U.S. PATENT DOCUMENTS

*EXAMINER INITIAL		DOCUMENT NUMBER	KIND CODE	DATE	NAME	FILING DATE IF APPROPRIATE
	1	8,145,578		03/27/12	Pershing	
	2	8,204,341		06/19/12	Schultz	
	3	8,818,770		08/26/14	Pershing	
	4	8,825,454		09/02/14	Pershing	
	5	2003/0103651		06/05/03	Novak	
	6	2005/0267657		12/01/05	Devdhar	
	7	2006/0137736		06/29/06	Nishitani et al.	
	8	2008/0162380		07/03/08	SUGA et al.	
	9	2010/0241406		09/23/10	Rahmes et al.	
	10	2011/0086201		04/14/11	Shiao et al.	
	11	2012/0035887		02/09/12	Augenbraun et al.	
	12	2012/0209782		08/16/12	Pershing et al.	
	13	2013/0202157		08/08/13	Pershing	
	14	2013/0204575		08/08/13	Pershing	
	15	2013/0226515		08/29/13	Pershing et al.	
	16	2013/0262029		10/03/13	Pershing	
	17	2015/0016689		01/15/15	Pershing	

FOREIGN PATENT DOCUMENTS

*EXAMINER INITIAL		DOCUMENT NUMBER	KIND CODE	DATE	COUNTRY	TRANSLATION YES	TRANSLATION NO
	1						

NON-PATENT LITERATURE DOCUMENTS *(Including Author, Title, Date, Pertinent Pages, Etc.)*

	1		Canadian Office Action, dated March 24, 2014, for Canadian Application No. 2,703,423, 2 pages.
	2		Pershing, "PITCH DETERMINATION SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION," Office Action for USAN 13/438,288, mailed December 16, 2013, 23 pages.

EXAMINER	DATE CONSIDERED
* EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.	

3758591_1.docx June 1, 2015

Electronic Patent Application Fee Transmittal					
Application Number:	14450108				
Filing Date:	01-Aug-2014				
Title of Invention:	CONCURRENT DISPLAY SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION				
First Named Inventor/Applicant Name:	Chris Pershing				
Filer:	Jeremiah J. Baunach/Terrie Quillin				
Attorney Docket Number:	290115.406C2				
Filed as Small Entity					
Filing Fees for **Utility under 35 USC 111(a)**					
Description		**Fee Code**	**Quantity**	**Amount**	**Sub-Total in USD($)**
Basic Filing:					
Pages:					
Claims:					
Miscellaneous-Filing:					
Petition:					
Patent-Appeals-and-Interference:					
Post-Allowance-and-Post-Issuance:					
Extension-of-Time:					

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension - 2 months with $0 paid	2252	1	300	300
Miscellaneous:				
Submission- Information Disclosure Stmt	2806	1	90	90
		Total in USD ($)		**390**

Electronic Acknowledgement Receipt	
EFS ID:	22483420
Application Number:	14450108
International Application Number:	
Confirmation Number:	8641
Title of Invention:	CONCURRENT DISPLAY SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION
First Named Inventor/Applicant Name:	Chris Pershing
Customer Number:	500
Filer:	Jeremiah J. Baunach/Terrie Quillin
Filer Authorized By:	Jeremiah J. Baunach
Attorney Docket Number:	290115.406C2
Receipt Date:	01-JUN-2015
Filing Date:	01-AUG-2014
Time Stamp:	16:17:37
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$390
RAM confirmation Number	2744
Deposit Account	
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Non Patent Literature	NPL_CA_OA_2641373_Jan_9_12_4_pages.pdf	341125 d300d062a0a4f5f2cc3d65c5dcc0159f64721357	no	4
Warnings:					
Information:					
2	Non Patent Literature	NPL_OA_USAN13438288_Dec_16_13_23_pages.pdf	1062240 d906f0c122c8bc8172edc02bf118eaacd4f6d916	no	23
Warnings:					
Information:					
3	Miscellaneous Incoming Letter	EFS_FDA_06_01_15.pdf	47545 ff7100c8e06d60b9c96c704cc20ceef610f945d2	no	1
Warnings:					
Information:					
4	Extension of Time	EFS_2m_ext_06_01_15.pdf	684943 d5183dfe6f7ecc1c508e2ce2739d4c5b9bf7f723	no	2
Warnings:					
Information:					
5		EFS_Amendment_06_01_15.pdf	132306 a8ad991fe90557e568cb57b5c155e8a6ea487026	yes	18

Multipart Description/PDF files in .zip description

Document Description	Start	End
Amendment/Req. Reconsideration-After Non-Final Reject	1	1
Claims	2	11
Applicant Arguments/Remarks Made in an Amendment	12	18

Warnings:					
Information:					
6	Transmittal Letter	EFS_IDS_Transmittal_06_01_15.pdf	52276 98950053dabb434a8bcde5486b9457f7d17f1c49	no	2

Warnings:					
Information:					
7	Information Disclosure Statement (IDS) Form (SB08)	EFS_IDS_06_01_15.pdf	105015 05a28cf6ca65634e03da1b63ccb455ae64701abd	no	1
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
8	Fee Worksheet (SB06)	fee-info.pdf	32758 5af611eddc7d8cac15c2945d8a1dcc5f13c9b973	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	2458208		

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.

<u>New Applications Under 35 U.S.C. 111</u>
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.

<u>National Stage of an International Application under 35 U.S.C. 371</u>
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.

<u>New International Application Filed with the USPTO as a Receiving Office</u>
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.

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor	:	Chris Pershing
Application No.	:	14/450,108
Filed	:	August 1, 2014
For	:	CONCURRENT DISPLAY SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION
Examiner	:	Andre Pierre Louis
Art Unit	:	2668
Docket No.	:	290115.406C2
Date	:	June 1, 2015

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

FEE DEFICIENCY AUTHORIZATION FORM

Commissioner for Patents:

Applicant(s) hereby authorize(s) the Director to charge any deficiencies or credit any overpayment in fees due by way of the enclosed papers only to Deposit Account No. 19-1090.

Respectfully submitted,

SEED Intellectual Property Law Group PLLC

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PTO/AIA/22 (03-13)
Approved for use through 7/31/2016. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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PETITION FOR EXTENSION OF TIME UNDER 37 CFR 1.136(a)	Docket Number (Optional) 290115.406C2
Application Number 14/450,108	Filed August 1, 2014
For CONCURRENT DISPLAY SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION	
Art Unit 2668	Examiner Andre Pierre Louis

This is a request under the provisions of 37 CFR 1.136(a) to extend the period for filing a reply in the above-identified application.

The requested extension and fee are as follows (check time period desired and enter the appropriate fee below):

		Fee	Small Entity Fee	Micro Entity Fee	
☐	One month (37 CFR 1.17(a)(1))	$200	$100	$50	$
☑	Two months (37 CFR 1.17(a)(2))	$600	$300	$150	$ 300
☐	Three months (37 CFR 1.17(a)(3))	$1,400	$700	$350	$
☐	Four months (37 CFR 1.17(a)(4))	$2,200	$1,100	$550	$
☐	Five months (37 CFR 1.17(a)(5))	$3,000	$1,500	$750	$

☑ Applicant asserts small entity status. See 37 CFR 1.27.

☐ Applicant certifies micro entity status. See 37 CFR 1.29.
Form PTO/SB/15A or B or equivalent must either be enclosed or have been submitted previously.

☐ A check in the amount of the fee is enclosed.

☐ Payment by credit card. Form PTO-2038 is attached.

☐ The Director has already been authorized to charge fees in this application to a Deposit Account.

☐ The Director is hereby authorized to charge any fees which may be required, or credit any overpayment, to Deposit Account Number _____.

☑ Payment made via EFS-Web.

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

I am the

☐ applicant.

☑ attorney or agent of record. Registration number 44,527.

☐ attorney or agent acting under 37 CFR 1.34. Registration number _____.

/Jeremiah J. Baunach/	June 1, 2015
Signature	Date
Jeremiah J. Baunach	206-622-4900
Typed or printed name	Telephone Number

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. Submit multiple forms if more than one signature is required, see below*.

☐ * Total of _____ forms are submitted.

This collection of information is required by 37 CFR 1.136(a). 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 6 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: Mail Stop PCT, 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 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/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
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 displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 14/450,108	Filing Date 08/01/2014	☐ 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 $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =	
☐ 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

AMENDMENT **06/01/2015**

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 37	Minus	** 37	= 0	X $40 =	0
Independent (37 CFR 1.16(h))	* 4	Minus	***4	= 0	X $210 =	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

AMENDMENT

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =	
☐ 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.
** 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 number found in the appropriate box in column 1.

LIE
/TRINA STEPTOE/

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.**
If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.



EXPRESS MAIL NO. EM086839681US

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor	:	Chris Pershing
Application No.	:	14/450,108
Filed	:	August 1, 2014
For	:	CONCURRENT DISPLAY SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION

Examiner	:	Andre Pierre Louis
Art Unit	:	2123
Docket No.	:	290115.406C2
Date	:	June 1, 2015

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

INFORMATION DISCLOSURE STATEMENT TRANSMITTAL

Commissioner for Patents:

In accordance with 37 CFR 1.56 and 1.97 through 1.98, applicant wishes to make known to the U.S. Patent and Trademark Office the references set forth on the attached Information Disclosure Statement. Copies of cited U.S. patents and published patent applications are not required and accordingly have not been provided. Copies of any other cited references are enclosed. As to any reference cited, applicant does not admit that it is "prior art" under 35 U.S.C. §§ 102 or 103, and specifically reserves the right to traverse or antedate any such reference, as by a showing under 37 CFR 1.131 or other method. Although the aforesaid references are made known to the Patent and Trademark Office in compliance with applicant's duty to disclose all information he/she is aware of which is believed relevant to the examination of the above-identified application, applicant believes that his/her invention is patentable.

Applicant wishes to note that the art provided includes a YouTube™ video, formerly available online at the location http://www.youtube.com/watch?v=jURSK7o0OD0 but

now no longer available at that location, that is provided on a DVD. The video has a total length of about 3 minutes. It was published at least as early as February 25, 2010 and thus qualifies as prior art to this application.

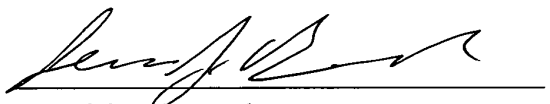
The Examiner is particularly directed to two locations on the video: one at 50 seconds and the other at 2:20. To assist the Examiner and to ensure full consideration, a transcription of the spoken words at these two locations is submitted as an additional reference on the enclosed IDS. Applicant requests that the Examiner view the entire YouTube video on the DVD and to mark the video as being considered on the attached IDS once it has been viewed.

Applicant submits this document for consideration by the Examiner to make clear that the present claims define over this YouTube video.

Please acknowledge receipt of this Information Disclosure Statement and kindly make the cited references of record in the above-identified application.

Applicant believes this Information Disclosure Statement has been timely filed, however, the Director is authorized to charge any fee due by way of this Information Disclosure Statement to our Deposit Account No. 19-1090.

Respectfully submitted,
Seed Intellectual Property Law Group PLLC



Jeremiah J. Baunach
Registration No. 44,527

JJB:srw

Enclosures:
Information Disclosure Statement
Cited References (2)

701 Fifth Avenue, Suite 5400
Seattle, Washington 98104
Phone: (206) 622-4900
Fax: (206) 682-6031

2889898_1.docx

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JUN 01 2015
PATENT & TRADEMARK OFFICE

EXPRESS MAIL NO. EM086839681US

Sheet 1 of 1

U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTY. DOCKET NO. 290115.406C2	APPLICATION NO. 14/450,108
INFORMATION DISCLOSURE STATEMENT (Use several sheets if necessary)	INVENTOR Chris Pershing	
	FILING DATE August 1, 2014	GROUP ART UNIT 2123

U.S. PATENT DOCUMENTS

*EXAMINER INITIAL		DOCUMENT NUMBER	KIND CODE	DATE	NAME	FILING DATE IF APPROPRIATE
	1					

FOREIGN PATENT DOCUMENTS

*EXAMINER INITIAL		DOCUMENT NUMBER	KIND CODE	DATE	COUNTRY	TRANSLATION YES	TRANSLATION NO
	1						

NON-PATENT LITERATURE DOCUMENTS *(Including Author, Title, Date, Pertinent Pages, Etc.)*

	1		Transcription of points of potential interest in the attached YouTube video titled: "Pictometry Online Demo," retrieved on February 10, 2010, 1 page.
	2		YouTube, "Pictometry Online Demo," DVD, February 25, 2010.

EXAMINER	DATE CONSIDERED

* EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant

3766515_1.docx June 1, 2015

The PTO did not receive the following listed item(s) MPC

ARTIFACT SHEET

Enter artifact number below. Artifact number is application number + artifact type code (see list below) + sequential letter (A, B, C …). The first artifact folder for an artifact type receives the letter A, the second B, etc.. Examples: 59123456PA, 59123456PB, 59123456ZA, 59123456ZB

14450108UA

Indicate quantity of a single type of artifact received but not scanned. Create individual artifact folder/box and artifact number for each Artifact Type.

[1] CD(s) containing:

computer program listing [ ]
Doc Code: Computer Artifact Type Code: P

pages of specification and/or sequence listing and/or table [ ]
Doc Code: Artifact Artifact Type Code: S

content unspecified or combined [1]
Doc Code: Artifact Artifact Type Code: U

[ ] Stapled Set(s) Color Documents or B/W Photographs
Doc Code: Artifact Artifact Type Code: C

[ ] Microfilm(s)
Doc Code: Artifact Artifact Type Code: F

[ ] Video tape(s)
Doc Code: Artifact Artifact Type Code: V

[ ] Model(s)
Doc Code: Artifact Artifact Type Code: M

[ ] Bound Document(s)
Doc Code: Artifact Artifact Type Code: B

[ ] Confidential Information Disclosure Statement or Other Documents marked Proprietary, Trade Secrets, Subject to Protective Order, Material Submitted under MPEP 724.02, etc.
Doc Code: Artifact Artifact Type Code X

[ ] Other, description: _____
Doc Code: Artifact Artifact Type Code: Z

March 8, 2004

6-3-15

IFW



EXPRESS MAIL NO. EM086839681US

TRANSMITTAL FORM

(To be used for all correspondence after initial filing)

Application Number	14/450,108
Filing Date	August 1, 2014
First Named Inventor	Chris Pershing
Art Unit	2123
Examiner Name	Andre Pierre Louis
Attorney Docket No.	290115.406C2

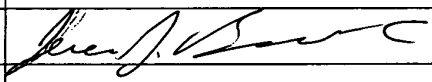
ENCLOSURES (*check all that apply*)

- ☐ Fee Transmittal Form
  - ☐ Fee Attached
- ☐ Amendment/Response
  - ☐ After Final
  - ☐ Affidavits/declaration(s)
- ☐ Extension of Time Request
- ☐ Express Abandonment Request
- ☒ Information Disclosure Statement and Transmittal
- ☒ Cited References
- ☐ Certified Copy of Priority Document(s)
- ☐ Response to Missing Parts under 37 CFR 1.52 or 1.53
- ☐ Response to Missing Parts/Incomplete Application
- ☐ Drawing(s)
- ☐ Request for Corrected Filing Receipt
- ☐ Licensing-related Papers
- ☐ Petition
- ☐ Petition to Convert to a Provisional Application
- ☐ Power of Attorney, Revocation, Change of Correspondence Address
- ☐ Declaration
- ☐ Statement under 37 CFR 3.73(b)
- ☐ Terminal Disclaimer
- ☐ Request for Refund
- ☐ CD, Number of CD(s) _____
  - ☐ Landscape Table on CD
- ☐ After Allowance Communication to TC
- ☐ Appeal Communication to Board of Appeals and Interferences
- ☐ Appeal Communication to TC *(Appeal Notice, Brief, Reply Brief)*
- ☐ Proprietary Information
- ☐ Status Letter
- ☒ Return Receipt Postcard
- ☐ Other Enclosure(s) *(please identify below)*:

_____
_____
_____
_____

Remarks

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT

Firm Name	Seed Intellectual Property Law Group PLLC	Customer Number	00500
Signature			
Printed Name	**Jeremiah J. Baunach**		
Date	**June 1, 2015**	Reg. No.	**44,527**

CERTIFICATE OF TRANSMISSION/MAILING

I hereby certify that this correspondence is being facsimile transmitted to the USPTO or deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on the date shown below.

Signature		
Typed or printed name		Date:

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

3574979_1.doc

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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P.O. Box 1450
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www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
14/450,108	08/01/2014	Chris Pershing	290115.406C2

CONFIRMATION NO. 8641

500
SEED INTELLECTUAL PROPERTY LAW GROUP PLLC
701 FIFTH AVE
SUITE 5400
SEATTLE, WA 98104

PUBLICATION NOTICE



Title:CONCURRENT DISPLAY SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION

Publication No.US-2015-0015605-A1
Publication Date:01/15/2015

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 Office of Public Records. The Office of Public Records can be reached by telephone at (703) 308-9726 or (800) 972-6382, by facsimile at (703) 305-8759, by mail addressed to the United States Patent and Trademark Office, Office of Public Records, 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 http://pair.uspto.gov/. 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

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 NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
14/450,108	08/01/2014	Chris Pershing	290115.406C2	8641

500 7590 12/30/2014

SEED INTELLECTUAL PROPERTY LAW GROUP PLLC
701 FIFTH AVE
SUITE 5400
SEATTLE, WA 98104

EXAMINER
PIERRE LOUIS, ANDRE

ART UNIT	PAPER NUMBER
2123	

MAIL DATE	DELIVERY MODE
12/30/2014	PAPER

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.

Office Action Summary	Application No. 14/450,108	Applicant(s) PERSHING, CHRIS	
	Examiner ANDRE PIERRE LOUIS	Art Unit 2123	AIA (First Inventor to File) Status No

-- 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 _____.

☐ 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) *1-37* 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) *1-37* 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 *08/01/2014* 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 *08/01/2014*.

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

4) ☐ Other: _____.

DETAILED ACTION

1. The present application is being examined under the pre-AIA first to invent provisions.

2. Claims1-37 are pending and presented for examination.

Specification

3. The disclosure is objected to because of the following informalities: the first paragraph of the specification needs to be amended to show the priority data as shown in the application bib data sheet, as follow:

> This application is a CON of 13/474,504 05/17/2012 PAT 8825454
> which is a CON of 12/467,250 05/15/2009 PAT 8209152
> which claims benefit of 61/197,904 10/31/2008

Appropriate correction is required.

Double Patenting

4. A rejection based on double patenting of the "same invention" type finds its support in the language of 35 U.S.C. 101 which states that "whoever invents or discovers any new and useful process... may obtain a patent therefor..." (Emphasis added). Thus, the term "same invention," in this context, means an invention drawn to identical subject matter. See *Miller v. Eagle Mfg. Co.*, 151 U.S. 186 (1894); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); and *In re Ockert*, 245 F.2d 467, 114 USPQ 330 (CCPA 1957).

A statutory type (35 U.S.C. 101) double patenting rejection can be overcome by canceling or amending the claims that are directed to the same invention so they are no longer coextensive in scope. The filing of a terminal disclaimer cannot overcome a double patenting rejection based upon 35 U.S.C. 101.

4.1 Claims 1-37 are rejected under 35 U.S.C. 101 as claiming the same invention as that of claim 1-37 of prior U.S. Patent No. 8,825,454. This is a statutory double patenting rejection.

Claim 1: A computer-implemented method in a roof estimate report system including at least one processor and a memory coupled to the at least one processor, the method comprising:

displaying, by the at least one processor of the roof estimate report system, a plurality of aerial images of a roof at the same time on a single display, each of the aerial images providing a different view, taken from a different angle of the same roof;

displaying, by the at least one processor of the roof estimate report system, respective line drawings representing features of the roof, the respective line drawings overlying a first and a second aerial image of the plurality of aerial images of the roof on the single display, the line drawing overlying the first aerial image of the roof having features in common with the line drawing overlying the second aerial image of the roof;

in response to user input, changing, by the at least one processor of the roof estimate report system, the line drawing representing a feature of the roof that overlies the first aerial image of the roof;

correlating, by the at least one processor of the roof estimate report system, a location of the feature on the roof represented by the line drawing that has been changed to a location of a corresponding feature represented by the line drawing overlying the second aerial image;

based on the correlation, changing, by the at least one processor of the roof estimate report system, the corresponding feature in the line drawing overlying the second aerial image according to the change of the line drawing representing the feature of the roof that overlies the first aerial image; and

1. A computer-implemented method in a roof estimate report system including at least one processor and a memory coupled to the at least one processor, the method comprising:

displaying, by the at least one processor of the roof estimate report system, a plurality of aerial images of a roof at the same time on a single display, each of the aerial images providing a different view, taken from a different angle of the same roof;

displaying, by the at least one processor of the roof estimate report system, respective line drawings representing features of the roof, the respective line drawings overlying a first and a second aerial image of the plurality of aerial images of the roof on the single display, the line drawing overlying the first aerial image of the roof having features in common with the line drawing overlying the second aerial image of the roof;

in response to user input, changing, by the at least one processor of the roof estimate report system, the line drawing representing a feature of the roof that overlies the first aerial image of the roof;

correlating, by the at least one processor of the roof estimate report system, a location of the feature on the roof represented by the line drawing that has been changed to a location of a corresponding feature represented by the line drawing overlying the second aerial image; and

based on the correlation, changing, by the at least one processor of the roof estimate report system, the corresponding feature in the line drawing overlying the second aerial image according to the change of the line drawing representing the feature of the roof that overlies the first aerial image.

Claim Rejections - 35 USC § 103

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are

> such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

5.0 Claims 1-21, 23-37 are rejected under pre-AIA 35 U.S.C. 103 (a) as being unpatentable over Kennedy ET al. (USPG_PUB No. 2011/0205245), in view of Slatter (USPG_PUB No. 2002/0101594).

5.1 In considering claims 1, 26, Kennedy et al. teaches a computer-implemented method in a roof estimate report system including at least one processor and a memory coupled to the at least one processor, the method comprising:

displaying, by the at least one processor of the roof estimate report system, a plurality of aerial images of a roof at the same time on a single display, each of the aerial images providing a different view, taken from a different angle of the same roof (Kennedy appears to provides a GUI for displaying at least a first and a second images (see fig.1 (153, 154, and 5(553, 554) displaying at the same on a screen, each providing a difference view of the roof, para 53);

displaying, by the at least one processor of the roof estimate report system, respective line drawings representing features of the roof, the respective line drawings overlying a first and a second aerial image of the plurality of aerial images of the roof on the single display, the line drawing overlying the first aerial image of the roof having features in common with the line

drawing overlying the second aerial image of the roof (fig.7-8, show a displayed of images having the lines drawings overlies on the corresponding roof sections, see further para 84, 87);

in response to user input, changing, by the at least one processor of the roof estimate report system, the line drawing representing a feature of the roof that overlies the first aerial image of the roof (the user interacting with the roof moves a crosshair marker to a plurality of locations indicating by numeral 711, 707, 709 of fig.7, also see para 84);

While Kennedy does not specifically show the correlation, as specified, he provides a scaling unit for scaling points corresponding to the images, wherein adjustment is made so that the real world images corresponds to selected reference axis of the displayed image (see para 104-105), and would clearly be understood by of ordinary skilled in the art.

Nevertheless, Slatter teaches correlating, by the at least one processor of the roof estimate report system, a location of the feature on the roof represented by the line drawing that has been changed to a location of a corresponding feature represented by the line drawing overlying the second aerial image (see fig.3, para 23, user matching virtual shape to selected area, the user may alter or change the size, pitch angle to match the area of interest, including automatic matching and fitting, para 26-27); and

based on the correlation, changing, by the at least one processor of the roof estimate report system, the corresponding feature in the line drawing overlying the second aerial image according to the change of the line drawing representing the feature of the roof that overlies the first aerial image (fig.3, virtual shape 20 may be altered including dragging into the image, and user may alter or change the size, pitch angle to match the area of interest, including automatic matching and fitting, para 26-27).

Kennedy and Slatter are analogous art because they are from the same field of endeavor and that the model analyzes by Slatter is similar to that of Kennedy. Therefore, it would have been obvious to one of ordinary skilled in the art to combine the measurement apparatus of Slatter with the method of Kennedy because Slatter teaches the advantage of obtaining parameters in quick and efficient manner (para 25).

5.2 As per claims 2 and 17, the combined teachings of Kennedy and Slatter teach that before the displaying the respective line drawings, modifying a three-dimensional model of the roof based on a received indication of a roof feature by adding a planar roof section to the three-dimensional model (Kennedy, para 89, given points defining the area of the first and second orientation of the roof, a modeling system including a translation unit takes the data and provides modification, also see calibration of the tool before displaying, para 92-93; the dimension of the of the first and second model can be adjusted to match the object, para 106).

5.3 With regards to claims 3, 27, the combined teachings of Kennedy and Slatter teach that wherein the indicated roof feature is at least one of: a point on the roof, a section of the roof, a ridgeline of the roof, a valley of the roof, a rake edge of the roof, an eave of the roof, a hip ridge of the roof, an edge of a section of the roof, and a comer of a section of the roof (see Kennedy, line drawn by placing the marker on different corner on the roof, ridge line marker, para 94).

5.4 Regarding claim 4, 19, and 28, the combined teachings of Kennedy and Slatter teach that wherein the displaying the respective line drawings comprises:

displaying the respective line drawing overlying the first aerial image at a first time (Kennedy appears to display the first images having the line indicated by the user (see fig.7-8,

para 84, 87); and displaying the respective the line drawing overlying the second aerial image at a second time that is substantially coincident to the first time (Kennedy, as the user moves the marker the second line drawing is displayed, see fig.7-8, para 87).

5.5 With regards to claim 5, the combined teachings of Kennedy and Slatter teach the step of receiving an indication of one of the features of the roof at a first time, and wherein the displaying the respective line drawings occurs at a second time that is substantially coincident to the first time (see Kennedy fig.7-8, para 84, a user using a cross hair marker provides a first indication at a first time and moves to a different position thereby display the line drawing substantially at the same time).

5.6 Regarding claim 6, the combined teachings of Kennedy and Slatter teach that wherein the displaying the respective line drawings includes initiating display of a line on the first and second image (see Slatter fig.3-4, and Kennedy fig.7-8, para 84, 87).

5.7 As per claim 7, the combined teachings of Kennedy and Slatter teach that wherein the first image provides a substantially top plan view of the roof of the building (see Kennedy fig.7, para 53, top view), and wherein the second image provides a perspective view of the roof of the building (see Kennedy fig.13, also see para 53 perspective view).

5.8 As per claims 8 and 24, the combined teachings of Kennedy and Slatter teach that wherein the first image provides a first perspective view of the roof of the building and the second image provides a second perspective view of the roof of the building (see Kennedy fig.6 and 9, the top plan and perspective views described by para 22, 75).

5.9 With regards to claim 9, the combined teachings of Kennedy and Slatter teach the step of transmitting roof measurement information based at least in part on the change of the line

drawing representing a feature of the roof that overlies the first aerial image of the roof (see Kennedy roofing quoting system having user interact with a system to provide quotes to commercial enterprises, government agencies, etc. para 148, 163).

5.10 As per claim 10, the combined teachings of Kennedy and Slatter teach the step of displaying a marker operable to specify a point on an image (see Kennedy marker showing in fig.7-8); receiving, via the marker, an indication of a point on the first aerial image (see Kennedy first position set by a user using the cross hair marker, para 84); and
registering, based on the received indication of the point, the aerial image to a reference grid corresponding to a three-dimensional model of the roof (see Kennedy para 91, 93, measure installation surface, image registration for installation, a user position tool over the roof and adjustments or alignment is made to the corresponding surface).

5.11 With regards to claim 11, the combined teachings of Kennedy and Slatter teach the step of displaying a lean correction marker operable to indicate a vertical axis of an aerial image (see Kennedy images are scaled to ensure x pixels in a display, such that a vertical direction corresponds to a selected reference axis, para 105); receiving, via the lean correction marker, an indication of a vertical axis of the first aerial image (Kennedy adjust of dimensions with respect to specific axis, para 96, 105); and registering, based on the received indication of the vertical axis, the first aerial image to a reference grid corresponding to a three-dimensional model of the roof (Kennedy para 91, 93, measure installation surface (image registration for installation), a user position tool over the roof and adjustments or alignment is made to the corresponding surface).

5.12 As per claims 12 and 16, the combined teachings of Kennedy and Slatter teach a computing system for generating a roof estimate report, the computing system comprising: a memory (see Kennedy the memory describes para 44);
at least one processor coupled to the memory (see Kennedy the processor describes para 44); and a roof estimation module that is stored on the memory and that is configured, when executed by at least one processor of the computing system for generating the roof estimate report to: substantially concurrently display a projection of a roof feature onto first and second aerial images as a line drawing of the roof feature (Kennedy first and second images with different views may be displayed in the GUI of roof estimation system fig.1, 5, para 53, 84);
overlay the line drawing of the roof feature on corresponding locations of the feature on the first and second aerial images (see Kennedy fig.7-8, show a displayed of images having the lines drawings of the marker overlies on the corresponding roof sections, see further para 84, 87); and in response to user input causing modification of the line drawing overlaid on the first aerial image, make corresponding changes to the line drawing overlaid on the second aerial image (see Slatter fig.3, para 23, 26-27, also in Kennedy, as marked by the user 507, para 88 further teaches that data corresponding to the model site and/or measuring tool can be adjusted by a user to more closely match that of the site under consideration with respect to the 3D axis of the roof, para 98, 106, 141).

5.13 With regards to claim 13, the combined teachings of Kennedy and Slatter teach that wherein the roof estimation module includes an interactive roof modeling user interface (see Kennedy para 56).

5.14 As per claim 14, the combined teachings of Kennedy and Slatter teach that wherein the computing system is a desktop computer and the roof estimation module is part of an interactive roof modeling program executing on the computing system (see Kennedy fig.5, para 72).

5.15 As per claim 15, the combined teachings of Kennedy and Slatter teach that wherein the roof estimation module is part of a network accessible roof modeling program executing on the computing system (see Kennedy fig.5, para 54, 72).

5.16 Regarding claim 18, the combined teachings of Kennedy and Slatter teach that the step of receiving an indication of the feature of the building by receiving position information of the feature in the first aerial image (Kennedy user set position indicator on the roof, para 84), and wherein substantially concurrently displaying the projection of the feature includes translating the received position information into position information of the feature in a three-dimensional model (Kennedy translation unit uses displacement information to generate 3D model of roof 600, see Kennedy fig.5 (596), para 103); and translating the position information of the feature in the three-dimensional model into position information of the feature in the second aerial image (see Kennedy fig.5 (596), translator unit, para 78, 81).

5.17 Regarding claim 20, the combined teachings of Kennedy and Slatter teach the step of displaying the projection of the feature substantially concurrently with receiving an indication of the feature of the building (see Kennedy fig.7-8 of Kennedy and para 87, also Slatter fig.3).

5.18 As per claim 21, the combined teachings of Kennedy and Slatter teach the step of displaying the projection of the feature at substantially the same time as receiving an indication of the feature of the building (see Kennedy fig.7-8 of Kennedy and para 87, Slatter fig.3-4).

5.19 As per claim 23, the combined teachings of Kennedy and Slatter teach that wherein displaying the projection of the feature includes initiating display of a line on the first and second image (Kennedy line drawing showing in the displayed images, fig.7-8).

5.20 Regarding claim 25, the combined teachings of Kennedy and Slatter teach the step of modifying a three dimensional model of the roof based at least on the modification of the line drawing overlaid on the first aerial image (Kennedy tool being adjusted thereby modify the line drawing, para 89, 93); and generating a roof estimate report based at least in part on the modified three-dimensional model (see Kennedy para 156, 158, 163, packages are provided by on calculated components size and displayed to customers).

5.21 Regarding claim 29, the combined teachings of Kennedy and Slatter teach the step of changing the second line drawing at a time that is substantially concurrent to the time the changes are being made by the user in the first line drawing (see fig.3, Slatter para 23, 26).

5.22 As per claim 30, the combined teachings of Kennedy and Slatter teach the step of displaying the second line drawing overlying the second aerial image on the same display concurrently with displaying the first line drawing overlying the first aerial image of the roof on the same, single display (see fig.3, Slatter para 23, 26, Kennedy fig.7-8).

5.23 With regards to claim 31, the combined teachings of Kennedy and Slatter teach the step of displaying the second line drawing overlying the second aerial image on the same

display at a later time, after the displaying of the first line drawing overlying the first aerial image of the roof on the display (see Slatter fig.3, Kennedy fig.7-8, para 84, 87).

5.24 As per claim 32-33, 24, the combined teachings of Kennedy and Slatter teach that wherein the first image provides a substantially top plan view of the roof of the building, and the second image provides an oblique view of the roof of the building (see Kennedy fig.6 and 9, para 53).

5.25 Regarding claim 34, the combined teachings of Kennedy and Slatter teach the step of displaying roof measurement information on the same display concurrently with the first line drawing being displayed (see Slatter, fig.4, para 24).

5.26 With regards to claim 35, the combined teachings of Kennedy and Slatter teach the step of displaying the roof measurement information in a location that overlay the line drawing itself (see Kennedy fig.7-8, line marker overlays the roof model, and Slatter fig.2-3).

5.27 As per claim 36, the combined teachings of Kennedy and Slatter teach the step of displaying a wire frame model of the roof in isolation from any images of the roof on the same display (see Slatter fig.2, para 21).

5.28 With regards to claim 37, the combined teachings of Kennedy and Slatter teach the step of modifying a wire frame model of the roof based on input received from a user (see Slatter para 23, 26-27); and making, by the computer system of the roof estimate report system, corresponding changes in a 3D model of the roof based on the changes made by the user to the wire frame model (see Slatter fig.3, para 23, 26-27).

6. Claim 22 is rejected under pre-AIA 35 U.S.C. 103 (a) as being unpatentable over Kennedy ET al. (USPG_PUB No. 2011/0205245), in view of Slatter (USPG_PUB No. 2002/0101594), further in view of Royan et al. (US Patent No. 8,131,514).

6.1 With regards to claim 22, Kennedy, as modified by Slatter, teaches most of the instant invention including providing an operator with an interactive model generation experience (user interaction with the GUI and tool, para 73, 93); however, he does not expressly teach that wherein the method is performed iteratively.

Royan et al. teaches using an iterative method to provide roof estimate (see col.5 line 8, and col.12 line 27). Kennedy, Slatter and Royan et al. are analogous art because they are from the same field of endeavor and that the model analyzes by Royan is similar to that of Kennedy and Slatter. Therefore, it would have been obvious to one of ordinary skilled in the art to combine the techniques of Royan with the method of Kennedy because Royan teaches the generation of data stream to be transmitted that is more compact (see col.12 lines 59-64).

Information Disclosure Statement

The Information Disclosure Statement (IDS) filed on 08/01/2014 has been received and fully considered; however, one or more document has been lined through because they were not submitted with the IDS nor with any of the referred parent application.

Conclusion

7. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

7.1 Neumann et al. (USPG_PUB No. 2004/0105573) teaches an augmented virtual environment.

7.2 Meder et al. (US Patent No. 7,305,983) teaches an assessment of solar energy potential on existing building in a region.

7.3 Noronha et al, (Detection and Modeling of Buildings from Multiple Aerial Images, 2001_32 pages).

8. Claims 1-37 are rejected and THIS ACTION IS Non-FINAL. Any inquiry concerning this communication or earlier communications from the examiner should be directed to ANDRE PIERRE LOUIS whose telephone number is (571)272-8636. The examiner can normally be reached on Mon-Fri, 8:00AM-4:30PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Kamini S. Shah can be reached on 571-272-2279. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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.

/ANDRE PIERRE LOUIS/
Examiner, Art Unit 2123
December 24, 2014

Notice of References Cited	Application/Control No. 14/450,108	Applicant(s)/Patent Under Reexamination PERSHING, CHRIS	
	Examiner ANDRE PIERRE LOUIS	Art Unit 2123	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-2011/0205245	08-2011	Kennedy et al.	345/636
*	B	US-2002/0101594	08-2002	Slatter, David Neil	356/601
*	C	US-8,131,514	03-2012	Royan et al.	703/1
*	D	US-2004/0105573	06-2004	Neumann et al.	382/103
*	E	US-7,305,983	12-2007	Meder et al.	126/621
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

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

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	Noronha et al, (Detection and Modeling of Buildings from Multiple Aerial Images, 2001_32 pages).
	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.

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	1	"8,818,770"	USPAT	OR	OFF	2014/12/23 20:17
L2	5571	(703/1).CCLS.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2014/12/23 20:29
L3	38	(roof$3 with model$4) and pitch$3 and building$2 and marker$2	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2014/12/23 20:30
L4	38	L3 and display$4	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2014/12/23 20:30
L5	17	L4 and (aerial with display$4)	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2014/12/23 20:30
L6	178	(roof$3 with model$4) and pitch$3 and building$2	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2014/12/23 20:30
L7	56	L6 and aerial and (roof with estimat$4)	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2014/12/23 20:30
L8	55	L7 and display$4	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2014/12/23 20:30
L9	44	L8 and modif$4	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2014/12/23 20:30
L10	38	(roof$3 with model$4) and pitch$3 and building$2 and marker$2	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2014/12/23 20:30
L12	38	(roof$3 with model$4) and pitch$3 and building$2 and marker$2	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2014/12/23 20:31
L13	20	L12 and ((graphical with user with interface) or GUI)	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2014/12/23 20:31
L14	20	L13 and roof$2 and image$2 and display$4 and building and address$2	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2014/12/23 20:31
L15	8	L14 and crosshair$2	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2014/12/23 20:31
L16	64	(wire with frame with roof) and display$4	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2014/12/23 20:32
L17	48	L16 and (modif$5 or edit$4 or adjust$4)	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2014/12/23 20:32
L18	4	6 and (pitch with marker$2)	USPAT	OR	OFF	2014/12/23 20:35
L19	10	"7,305,983"	USPAT	OR	OFF	2014/12/23 20:42
L20	10	(aerial with roof with estimat$4) and (pitch with marker$2)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/12/23 21:06
L21	10	20 and (display$4 with marker$2 with roof$2)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	OFF	2014/12/23 21:07

			DERWENT; IBM_TDB			
L24	269	(roof with estimat$4) and roof and image$2	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/12/23 21:20
L25	38	(roof$3 with model$4) and pitch$3 and building$2 and marker$2	US-PGPUB; USPAT; EPO; JPO; DERWENT	OR	OFF	2014/12/23 21:21
L26	28	L25 and correlat$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/12/23 21:21
L27	28	24 and (chang$4 and correlat$4) and (roof with line with drawing$2)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/12/23 21:21
L28	57	24 and (perspective with view$2)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/12/23 21:22
L29	28	28 and (roof with (marker%2 or (line with drawing$2)))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/12/23 21:23
L30	34	28 and (roof with (marker$2 or (line with drawing$2)))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/12/23 21:23
L31	15	28 and (pitch with (marker$2 or (line with drawing$2)))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2014/12/23 21:23

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BIB DATA SHEET

CONFIRMATION NO. 8641

SERIAL NUMBER	FILING or 371(c) DATE RULE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
14/450,108	08/01/2014	703	2123	290115.406C2

APPLICANTS
Eagle View Technologies, Inc., Bothell, WA, Assignee (with 37 CFR 1.172 Interest);

INVENTORS
Chris Pershing, Redmond, WA;

**** CONTINUING DATA **************************
This application is a CON of 13/474,504 05/17/2012 PAT 8825454
which is a CON of 12/467,250 05/15/2009 PAT 8209152
which claims benefit of 61/197,904 10/31/2008

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

**** IF REQUIRED, FOREIGN FILING LICENSE GRANTED ****
08/07/2014

Foreign Priority claimed ☐ Yes ☑ No 35 USC 119(a-d) conditions met ☐ Yes ☑ No Verified and Acknowledged /ANDRE PIERRE LOUIS/ Examiner's Signature	☐ Met after Allowance Initials	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
		WA	29	37	4

ADDRESS
SEED INTELLECTUAL PROPERTY LAW GROUP PLLC
701 FIFTH AVE
SUITE 5400
SEATTLE, WA 98104
UNITED STATES

TITLE
CONCURRENT DISPLAY SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION

FILING FEE RECEIVED		
3520	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

BIB (Rev. 05/07).

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14450108	PERSHING, CHRIS
	Examiner	Art Unit
	ANDRE PIERRE LOUIS	2123

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

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

CLAIM		DATE								
Final	Original	12/23/2014								
	1	✓								
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	36	✓								

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14450108	PERSHING, CHRIS
	Examiner	**Art Unit**
	ANDRE PIERRE LOUIS	2123

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

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

CLAIM		DATE								
Final	Original	12/23/2014								
	37	✓								

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	14450108	PERSHING, CHRIS
	Examiner	Art Unit
	ANDRE PIERRE LOUIS	2123

CPC- SEARCHED		
Symbol	Date	Examiner

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
703	1	12/23/2014	AP

SEARCH NOTES		
Search Notes	Date	Examiner
Inventor Name Search	12/23/2014	AP
Google NPL Text Search (Roof Estimate and Earial images and lines drawing display)	12/23/2014	AP
EAST (EAST (US- PGPUB;USPAT;USOCR;EPO;JPO;r ERWENT:IBM TDB-- SEE Search History	12/23/2014	AP

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner

/A.P./ Examiner.Art Unit 2123	

Receipt date: 08/01/2014

U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTY. DOCKET NO. 290115.406C2	APPLICATION NO. 14450108 - GAU: 2123
	INVENTOR Chris Pershing	
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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	CONCURRENT DISPLAY SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION

As the below named inventor, I hereby declare that:

This declaration is directed to:

- ☐ The attached application, or
- ☒ United States application or PCT international application number 14/450,108 filed on August 1, 2014.

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: Chris Pershing Date (Optional): 12/5/14

Signature: Ch Pe

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.**

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 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.

Electronic Acknowledgement Receipt	
EFS ID:	20903128
Application Number:	14450108
International Application Number:	
Confirmation Number:	8641
Title of Invention:	CONCURRENT DISPLAY SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION
First Named Inventor/Applicant Name:	Chris Pershing
Customer Number:	500
Filer:	Jeremiah J. Baunach/Donald Saunderson
Filer Authorized By:	Jeremiah J. Baunach
Attorney Docket Number:	290115.406C2
Receipt Date:	09-DEC-2014
Filing Date:	01-AUG-2014
Time Stamp:	11:45:30
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	Oath or Declaration filed	290115_406C2_DECLARATION.pdf	1753488 f716c8642a530df38725b00c92121e70b6827921	no	2

Warnings:
Information:

Total Files Size (in bytes):	1753488

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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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
14/450,108	08/01/2014	2668	3520	290115.406C2	37	4

CONFIRMATION NO. 8641

UPDATED FILING RECEIPT

500
SEED INTELLECTUAL PROPERTY LAW GROUP PLLC
701 FIFTH AVE
SUITE 5400
SEATTLE, WA 98104



Date Mailed: 10/06/2014

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)

Chris Pershing, Redmond, WA;

Applicant(s)

Eagle View Technologies, Inc., Bothell, WA

Power of Attorney: The patent practitioners associated with Customer Number 00500

Domestic Priority data as claimed by applicant

This application is a CON of 13/474,504 05/17/2012 PAT 8825454
which is a CON of 12/467,250 05/15/2009 PAT 8209152
which claims benefit of 61/197,904 10/31/2008

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 - A proper **Authorization to Permit Access to Application by Participating Offices** (PTO/SB/39 or its equivalent) has been received by the USPTO.

If Required, Foreign Filing License Granted: 08/07/2014
The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 14/450,108**
Projected Publication Date: 01/15/2015
Non-Publication Request: No
Early Publication Request: No

Title

CONCURRENT DISPLAY SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION

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).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

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UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
14/450,108	08/01/2014	Chris Pershing	290115.406C2

CONFIRMATION NO. 8641

500
SEED INTELLECTUAL PROPERTY LAW GROUP PLLC
701 FIFTH AVE
SUITE 5400
SEATTLE, WA 98104

NOTICE

OC000000071139778

Date Mailed: 10/06/2014

INFORMATIONAL NOTICE TO APPLICANT

Applicant is notified that the above-identified application contains the deficiencies noted below. No period for reply is set forth in this notice for correction of these deficiencies. However, if a deficiency relates to the inventor's oath or declaration, the applicant must file an oath or declaration in compliance with 37 CFR 1.63, or a substitute statement in compliance with 37 CFR 1.64, executed by or with respect to each actual inventor no later than the expiration of the time period set in the "Notice of Allowability" to avoid abandonment. See 37 CFR 1.53(f).

The item(s) indicated below are also required and should be submitted with any reply to this notice to avoid further processing delays.

- A properly executed inventor's oath or declaration has not been received for the following inventor(s):
  Chris Pershing

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 14/450,108

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))	37 minus 20 =	* 17			OR	x 80 =	1360
INDEPENDENT CLAIMS (37 CFR 1.16(h))	4 minus 3 =	* 1				x 420 =	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).						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	3380

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.

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventors	:	Chris Pershing
Application No.	:	14/450,108
Filed	:	August 1, 2014
For	:	CONCURRENT DISPLAY SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION

Art Unit	:	2668
Docket No.	:	290115.406C2
Date	:	September 30, 2014

Mail Stop Missing Parts
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

PRELIMINARY AMENDMENT

Commissioner for Patents:

Please amend the above-identified application as follows:

Amendments to the Specification begin on page 2 of this paper.

Remarks begin on page 3 of this paper.

Amendments to the Specification:

Please replace the specification with the attached substitute specification. Also attached is a redlined substitute specification reflecting the changes. The substitute specification enclosed herein contains no new matter.

Attachments: Redlined Substitute Specification
Substitute Specification

REMARKS

The specification is amended herein to remove the "cross-reference to related applications" paragraph and to correct minor typographical errors. No new matter is being added to the application by way of this Amendment.

The Director is authorized to charge any additional fees due by way of this Amendment, or credit any overpayment, to our Deposit Account No. 19-1090.

All of the claims remaining in the application are now clearly allowable. Favorable consideration and a Notice of Allowance are earnestly solicited.

Respectfully submitted,

SEED Intellectual Property Law Group PLLC

/Jeremiah J. Baunach/
Jeremiah J. Baunach
Registration No. 44,527

JJB:tq

701 Fifth Avenue, Suite 5400
Seattle, Washington 98104
Phone: (206) 622-4900
Fax: (206) 682-6031

3489849_1

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
14/450,108	08/01/2014	Chris Pershing	290115.406C2

CONFIRMATION NO. 8641

500
SEED INTELLECTUAL PROPERTY LAW GROUP PLLC
701 FIFTH AVE
SUITE 5400
SEATTLE, WA 98104

FORMALITIES LETTER

OC000000070075541

Date Mailed: 08/08/2014

NOTICE TO FILE CORRECTED APPLICATION PAPERS

Filing Date Granted

An application number and filing date have been accorded to this application. The application is informal since it does not comply with the regulations for the reason(s) indicated below. Applicant is given TWO MONTHS from the date of this Notice within which to correct the informalities indicated below. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

The required item(s) identified below must be timely submitted to avoid abandonment:

- A substitute specification excluding claims in compliance with 37 CFR 1.52, 1.121(b)(3), and 1.125 is required. The substitute specification must be submitted with markings and be accompanied by a clean version (without markings) as set forth in 37 CFR 1.125(c) and a statement that the substitute specification contains no new matter (see 37 CFR 1.125(b)). Since a preliminary amendment was present on the filing date of the application and such amendment is part of the original disclosure of the application, the substitute specification must include all of the desired changes made in the preliminary amendment. See 37 CFR 1.115 and 1.215.

Applicant is cautioned that correction of the above items may cause the specification and drawings page count to exceed 100 pages. If the specification and drawings exceed 100 pages, applicant will need to submit the required application size fee.

Items Required To Avoid Processing Delays:

Applicant is notified that the above-identified application contains the deficiencies noted below. No period for reply is set forth in this notice for correction of these deficiencies. However, if a deficiency relates to the inventor's oath or declaration, the applicant must file an oath or declaration in compliance with 37 CFR 1.63, or a substitute statement in compliance with 37 CFR 1.64, executed by or with respect to each actual inventor no later than the expiration of the time period set in the "Notice of Allowability" to avoid abandonment. See 37 CFR 1.53(f).

- A properly executed inventor's oath or declaration has not been received for the following inventor(s):
  Chris Pershing

Replies must be received in the USPTO within the set time period or must include a proper Certificate of Mailing or Transmission under 37 CFR 1.8 with a mailing or transmission date within the set time period. For more information and a suggested format, see Form PTO/SB/92 and MPEP 512.

Replies should be mailed to:

Mail Stop Missing Parts
Commissioner for Patents
P.O. Box 1450
Alexandria VA 22313-1450

Registered users of EFS-Web may alternatively submit their reply to this notice via EFS-Web, including a copy of this Notice and selecting the document description "Applicant response to Pre-Exam Formalities Notice". https://sportal.uspto.gov/authenticate/AuthenticateUserLocalEPF.html

For more information about EFS-Web please call the USPTO Electronic Business Center at **1-866-217-9197** or visit our website at http://www.uspto.gov/ebc.

If you are not using EFS-Web to submit your reply, you must include a copy of this notice.

/tnguyen/

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

CONCURRENT DISPLAY SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION

~~CROSS REFERENCE TO RELATED APPLICATIONS~~

~~This application is a continuation of U.S. Patent Application No. 12/467,250, entitled "CONCURRENT DISPLAY SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION", filed May 15, 2009 and claims the benefit of U.S. Provisional Patent Application No. 61/197,904, entitled "USER INTERFACE TECHNIQUES FOR ROOF ESTIMATION," filed October 31, 2008, which applications are incorporated herein by reference in their entirety.~~

BACKGROUND

1. Field of the Invention:

[0001] This invention relates to systems and methods for estimating construction projects, and more particularly, to such systems and methods for determining roof measurement information based on one or more aerial images of a roof of a building.

2. Description of the Related Art:

[0002] The information provided below is not admitted to be part of the present invention, but is provided solely to assist the understanding of the reader.

[0003] Homeowners typically ask several roofing contractors to provide written estimates to repair or replace a roof on a house. Heretofore, the homeowners would make an appointment with each roofing contractor to visit the house to determine the style of roof, take measurements, and to inspect the area around the house for access and cleanup. Using this information, the roofing contractor then prepares a written estimate and then timely delivers it to the homeowner. After receiving several estimates from different ~~roofing~~ roofing contractors, the homeowner then selects one.

[0004] There are factors that impact a roofing contractor's ability to provide a timely written estimate. One factor is the size of the roof contractor's company and the location of the roofing jobs currently underway. Most roof contractors provide roofing services and estimates to building owners over a large geographical area. Larger roof contractor companies hire one or more trained individuals who travel throughout the entire area providing written estimates. With smaller roofing contractors, the owner or a key trained person is appointed to provide estimates. With both types of companies, roofing estimates are normally scheduled for buildings located in the same area on a particular day. If an estimate is needed suddenly at a distant location, the time for travel and the cost of commuting can be prohibitive. If the roofing contractor is a small company, the removal of the owner or key person on a current job site can be time prohibitive.

[0005] Another factor that may impact the roofing contractor's ability to provide a written estimate is weather and traffic.

[0006] Recently, solar panels have become popular. In order to install solar panels, the roof's slope, geometrical shape, and size as well as its orientation with respect to the sun all must be determined in order to provide an estimate of the number and type of solar panels required. Unfortunately, not all roofs on a building are proper size, geometrical shape, or orientation for use with solar panels.

SUMMARY

[0007] These and other objects are met by the systems and methods disclosed herein that determine and provide roof measurement information about the sizes, dimensions, slopes and orientations of the roof sections of a building roof. Roof measurement information may be used to generate a roof estimate report that provides and graphically shows this information. A roof estimation system that practices at least some of the techniques described herein may include an image acquisition engine, a roof modeling engine, and a report generation engine. The roof estimation system is configured to generate a model of a roof of a building, based on

one or more aerial images. In addition, the roof estimation system is configured to determine roof measurement information and generate a roof estimate report based on the generated model and/or the determined roof measurement information.

[0008] In some embodiments, the roof estimation system includes a user interface engine which provides access to at least some of the functions of the roof estimation system. In one embodiment, the user interface engine provides interactive user interface components operable by an operator to perform various functions related to generating a model of a roof of a building, including image registration, lean correction, pitch determination, feature identification, and model review and/or correction.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] Figure 1 is a block diagram illustrating example functional elements of one embodiment of a roof estimation system.

[0010] Figures 2A-2B illustrate aerial images of a building at a particular address.

[0011] Figures 3A-3F illustrate individual pages of an example roof estimate report generated by an example embodiment of a roof estimation system.

[0012] Figures 4A-4F are screen displays illustrating image registration and image lean correction in an example embodiment. (Also shows lean correction.)

[0013] Figures 5A-5D are screen displays illustrating pitch determination in an example embodiment.

[0014] Figures 6A-6D are screen displays illustrating model construction and concurrent display of operator specified roof features in an example embodiment.

[0015] Figures 7A-7C are screen displays illustrating roof model review in an example embodiment.

[0016] Figure 8 is an example block diagram of a computing system for practicing embodiments of a roof estimation system.

[0017] Figure 9 is an example flow diagram of an image registration routine provided by an example embodiment.

[0018] Figure 10 is an example flow diagram of a pitch determination routine provided by an example embodiment.

[0019] Figure 11 is an example flow diagram of concurrent feature display routine provided by an example embodiment.

DETAILED DESCRIPTION

[0020] Embodiments described herein provide enhanced computer- and network-based methods, techniques, and systems for estimating construction projects based on one or more images of a structure. Example embodiments provide a Roof Estimation System ("RES") that is operable to provide a roof estimate report for a specified building, based on one or more aerial images of the building. In one embodiment, a customer of the RES specifies the building by providing an address of the building. The RES then obtains one or more aerial images showing at least portions of the roof of the building. Next, the RES generates a model of the roof of the building, which is then utilized to determine roof measurement information. The roof measurement information may include measurements such as lengths of the edges of sections of the roof, pitches of sections of the roof, areas of sections of the roof, etc. The model of the roof and/or the roof measurement information is then used to generate a roof estimate report. The roof estimate report includes one or more line drawings of the roof of the building, which are annotated with information about the roof, such as lengths of the edges of sections of the roof, pitches of sections of the roof, areas of sections of the roof, etc.

[0021] Some embodiments of the roof estimation system include an interactive user interface configured to provide access to one or more of the functions of the roof estimation system. In one embodiment, the roof estimation system includes user interface controls that facilitate image registration, image lean correction, roof model generation, pitch determination, and roof model review. Image registration includes aligning, based at least in part on operator inputs, one or more images of a building roof to a set of reference points within a single three-dimensional ("3D") grid that is

shared between the one or more images. Roof model generation includes generating a 3D model of a roof, based at least in part on operator inputs specifying various features and/or dimensional attributes of the roof. Roof model generation may further include the determination of the pitches of various planar sections of a roof. Roof model review includes display of a model of a roof, possibly in conjunction with one or more images of the roof, so that an operator may review the model for accuracy and possibly make adjustments and/or corrections to the roof model. In other embodiments, all or some of the functions of the roof estimation system may be performed automatically. For example, image registration may include automatically identifying building features for the placement of reference markers. Further, roof model generation may include automatically recognizing features, dimensional attributes, and/or pitches of various planar roof sections of the roof.

[0022] The described user interface is also configured to concurrently display roof features onto multiple images of a roof. For example, in the context of roof model generation, an operator may indicate a roof feature, such as an edge or a corner of a section of the roof, in a first image of the roof. As the roof estimation system receives the indication of the roof feature, the user interface concurrently displays that feature in one or more other images of the roof, so that the operator may obtain feedback regarding the accuracy of the roof model, the image registration, etc.

[0023] In the following, Figures 1-3 provide an overview of the operation of an example roof estimation system. Figures 4-7 provide additional details related to an example interactive user interface provided by one embodiment of the roof estimation system. Figures 8-11 provide details related to roof estimation system implementation techniques.

1. Roof Estimation System Overview

[0024] Figure 1 is a block diagram illustrating example functional elements of one embodiment of a roof estimation system. In particular, Figure 1 shows an example Roof Estimation System ("RES") 100 comprising an image acquisition engine 101, a

roof modeling engine 102, a report generation engine 103, image data 105, model data 106, and report data 107. The RES 100 is communicatively coupled to an image source 110, a customer 115, and optionally an operator 120. The RES 100 and its components may be implemented as part of a computing system, as will be further described with reference to Figure 8.

[0025] More specifically, in the illustrated embodiment of Figure 1, the RES 100 is configured to generate a roof estimate report 132 for a specified building, based on aerial images 131 of the building received from the image source 110. The image source 110 may be any provider of images of the building for which a roof estimate is being generated. In one embodiment, the image source 110 includes a computing system that provides access to a repository of aerial images of one or more buildings. In addition, the aerial images 131 may include images obtained via manned or unmanned aircraft (*e.g.*, airplane, helicopter, blimp, drone, etc.), satellite, etc. Furthermore, the aerial images 131 may include images ~~obtain~~ obtained via one or more ground-based platforms, such as a vehicle-mounted camera that obtains street-level images of buildings, a nearby building, a hilltop, etc. In some cases, a vehicle-mounted camera may be mounted in an elevated position, such as a boom. Example aerial images are described further with reference to Figures 2A-2B

[0026] The image acquisition engine 101 obtains one or more aerial images of the specified building by, for example, providing an indicator of the location of the specified building (*e.g.*, street address, GPS coordinates, lot number, etc.) to the image source 110. In response, the image source 110 provides to the image acquisition engine 101 the one or more aerial images of the building. The image acquisition engine 101 then stores the received aerial images as image data 105, for further processing by other components of the RES 100. Obtaining aerial images of a specified building may include various forms of geo-coding, performed by the image acquisition engine 101 and/or the image source 110. In one embodiment, the image source geo-codes a provided street address into latitude and longitude coordinates,

which are then used to look up (*e.g.*, query a database) aerial images of the provided street address.

[0027] Next, the roof modeling engine 102 generates a model of the roof of the specified building. In the illustrated embodiment, the roof modeling engine 102 generates a three-dimensional ("3D") model, although in other embodiments, a two-dimensional (*e.g.*, top-down roof plan) may be generated instead or in addition. Generating a model of the roof may generally include image calibration, in which the distance between two pixels on a given image is converted into a physical length. Image calibration may be performed automatically, such as based on meta-information provided along with the aerial images 131.

[0028] A variety of automatic and semi-automatic techniques may be employed to generate a model of the roof of the building. In one embodiment, generating such a model is based at least in part on a correlation between at least two of the aerial images of the building. For example, the roof modeling engine 102 receives an indication of a corresponding feature that is shown in each of the two aerial images. In one embodiment, an operator 120, viewing two or more images of the building, inputs an indication in at least some of the images, the indications identifying which points of the images correspond to each other for model generation purposes.

[0029] The corresponding feature may be, for example, a vertex of the roof of the building, the corner of one of the roof planes of the roof, a point of a gable or hip of the roof, etc. The corresponding feature may also be a linear feature, such as a ridge or valley line between two roof planes of the roof. In one embodiment, the indication of a corresponding feature on the building includes "registration" of a first point in a first aerial image, and a second point in a second aerial image, the first and second points corresponding ~~the~~ to substantially the same point on the roof of the building. Generally, point registration may include the identification of any feature shown in both aerial images. Thus, the feature need not be a point on the roof of the building. Instead, it may be, for example, any point that is visible on both aerial images, such as on a nearby building (*e.g.*, a garage, neighbor's building, etc.), on a nearby structure

(*e.g.*, swimming pool, tennis court, etc.), on a nearby natural feature (*e.g.*, a tree, boulder, etc.), etc.

[0030] In some embodiments, the roof modeling engine 102 determines the corresponding feature automatically, such as by employing on one or more image processing techniques used to identify vertexes, edges, or other features of the roof. In other embodiments, the roof modeling engine 102 determines the corresponding feature by receiving, from the human operator 120 as operator input 133, indications of the feature shown in multiple images of the building.

[0031] In one example embodiment, the RES 100 generates a model of the roof of the building in the following manner. First, a set of reference points are be identified in each of the images. These reference points are identified by the operator 120 utilizing a suitable input device, such as a mouse or joystick. The roof modeling engine 102 then uses these reference points and any acceptable algorithm to co-register the images and reconstruct the three-dimensional geometry of the object identified by the reference points. There are a variety of photogrammetric algorithms that can be utilized to perform this reconstruction. One such algorithm used by the RES 100 uses photographs taken from two or more view points to "triangulate" points of interest on the object in three-dimensional ("3D") space. This triangulation can be visualized as a process of projecting a line originating from the location of the photograph's observation point that passes through a particular reference point in the image. The intersection of these projected lines from the set of observation points to a particular reference point identifies the location of that point in 3D space. Repeating the process for all such reference points allows the software to determine a 3D volume suitable for building a 3D model of the structure. The choice of reconstruction algorithm depends on a number of factors such as the spatial relationships between the photographs, the number and locations of the reference points, and any assumptions that are made about the geometry and symmetry of the object being reconstructed. Several such algorithms are described in detail in textbooks, trade journals, and academic publications.

[0032] In addition, generating a model of the roof of a building may include correcting one or more of the aerial images for various imperfections. For example, the vertical axis of a particular aerial image sometimes will not substantially match the actual vertical axis of its scene. This will happen, for example, if the aerial images were taken at different distances from the building, or at a different pitch, roll, or yaw angles of the aircraft from which the images were produced. In such cases, an aerial image may be corrected by providing the operator 120 with a user interface control operable to adjust the scale and/or relative angle of the aerial image to correct for such errors. The correction may be either applied directly to the aerial image, or instead be stored (*e.g.*, as an offset) for use in model generation or other functions of the RES 100.

[0033] Generating a model of the roof of a building further includes the automatic or semi-automatic identification of features of the roof of the building. In one embodiment, one or more user interface controls may be provided, such that the operator 120 may indicate (*e.g.*, draw, paint, etc.) various features of the roof, such as valleys, ridges, hips, vertexes, planes, edges, etc. As these features are indicated by the operator 120, a corresponding three-dimensional ("3D") model may be updated accordingly to include those features. These features are identified by the operator based on a visual inspection of the images and by providing inputs that identify various features as valleys, ridges, hips, etc. In some cases, a first and a second image view of the roof (*e.g.*, a north and east view) are simultaneously presented to the operator 120, such that when the operator 120 indicates a feature in the first image view, a projection of that feature is automatically presented in the second image view. By presenting a view of the 3D model, simultaneously projected into multiple image views, the operator 120 is provided with useful visual cues as to the correctness of the 3D model and/or the correspondence between the aerial images.

[0034] In addition, generating a model of the roof of a building may include determining the pitch of one or more of the sections of the roof. In some embodiments, one or more user interface controls are provided, such that the operator 120 may accurately determine the pitch of each of the one or more roof

sections. An accurate determination of the roof pitch may be employed (by a human or the RES 100) to better determine an accurate cost estimate, as roof sections having a low pitch are typically less costly surfaces to repair and/or replace.

[0035] The generated model typically includes a plurality of planar roof sections that each correspond to one of the planar sections of the roof of the building. Each of the planar roof sections in the model has a number of associated dimensions and/or attributes, among them slope, area, and length of each edge of the roof section. Other information may include any information relevant to a roof builder or other entity having an interest in construction of, or installation upon, the roof. For example, the other information may include identification of valleys, ridges, rakes, eaves, or hip ridges of the roof and/or its sections; roof and/or roof section perimeter dimensions and/or outlines; measurements of step heights between different roof levels (*e.g.*, terraces); bearing and/or orientation of each roof section; light exposure and/or shadowing patterns due to chimneys, other structures, trees, latitude, etc.; roofing material; etc[[?]]. Once a 3D model has been generated to the satisfaction of the roof modeling engine 102 and/or the operator 120, the generated 3D model is stored as model data 106 for further processing by the RES 100. In one embodiment, the generated 3D model is then stored in a quality assurance queue, from which it is reviewed and possibly corrected by a quality control operator.

[0036] The report generation engine 103 generates a final roof estimate report based on a model stored as model data 106, and then stores the generated report as report data 107. Such a report typically includes one or more plan (top-down) views of the model, annotated with numerical values for the slope, area, and/or lengths of the edges of at least some of the plurality of planar roof sections of the model of the roof. The report may also include information about total area of the roof, identification and measurement of ridges and/or valleys of the roof, and/or different elevation views rendered from the 3D model (top, side, front, etc). An example report is illustrated and discussed with respect to Figures 3A-3E, below.

[0037] In some embodiments, generating a report includes labeling one or more views of the model with annotations that are readable to a human user. Some models include a large number of small roof details, such as dormers or other sections, such that applying uniformly sized, oriented, and positioned labels to roof section views results in a visually cluttered diagram. Accordingly, various techniques may be employed to generate a readable report, including automatically determining an optimal or near-optimal label font size, label position, and/or label orientation, such that the resulting report may be easily read and understood by the customer 115.

[0038] In addition, in some embodiments, generating a report includes automatically determining a cost estimate, based on specified costs, such as those of materials, labor, transportation, etc. For example, the customer 115 provides indications of material and labor costs to the RES 100. In response, the report generation engine 103 generates a roof estimate report that includes a cost estimate, based on the costs provided by the customer 115 and the attributes of the particular roof, such as area, pitch, etc.

[0039] In one embodiment, the generated report is then provided to a customer. The generated report can be represented, for example, as an electronic file (*e.g.*, a PDF file) or a paper document. In the illustrated example, roof estimate report 132 is transmitted to the customer 115. The customer 115 may be or include any human, organization, or computing system that is the recipient of the roof estimate report 132. For example, the customer 115 may be a property owner, a property manager, a roof construction/repair company, a general contractor, an insurance company, a solar power panel installer, a climate control (*e.g.*, heating, ventilation, and/or air conditioning) system installer, a roof gutter installer, an awning installer, etc. Reports may be transmitted electronically, such as via a network (*e.g.*, as an email, Web page, etc.) or by some shipping mechanism, such as the postal service, a courier service, etc.

[0040] In some embodiments, one or more of the models stored as model data 106 are provided directly to the customer or other computing system, without first being

transformed into a report. For example, a model and/or roof measurement information based thereon may be exported and/or transmitted as a data file, in any suitable format, that may be consumed or otherwise utilized by some other computing system, such as a computer-aided design ("CAD") tool, a drawing program, a labor and material estimation software, a project management/estimation software, etc.

[0041] The RES 100 may be operated by various types of entities. In one embodiment, the RES 100 is operated by a roof estimation service that provides roof estimate reports to customers, such as roofing contractors, in exchange for payment. In another embodiment, the RES 100 is operated by a roof construction/repair company, to generate roof estimate reports that are used internally and/or provided to customers, such as property owners.

[0042] In addition, the RES 100 may be operated in various ways. In one embodiment, the RES 100 executes as a desktop computer application that is operated by the operator 120. In another embodiment, the RES 100 executes as a network-accessible service, such as by a Web server, that may be operated remotely by the operator 120 and/or the customer 115. Additional details regarding the implementation of an example roof estimation system are provided with respect to Figure 8, below.

[0043] Figures 2A-2B illustrate aerial images of a building at a particular address. In the illustrated example, the aerial images are represented as stylized line drawings for clarity of explanation. As noted above, such aerial images may be acquired in various ways. In one embodiment, an aircraft, such as an airplane or helicopter is utilized to take photographs while flying over one or more properties. Such aircraft may be manned or unmanned. In another embodiment, a ground-based vehicle, such as a car or truck, is utilized to take photographs (*e.g.*, "street view" photographs) while driving past one or more properties. In such an embodiment, a camera may be mounted on a boom or other elevating member, such that images of building roofs may be obtained. In another embodiment, photographs may be taken from a fixed position, such as a tall building, hilltop, tower, etc.

[0044] In particular, Figure 2A shows a top plan (top-down) aerial image 210 of a building 200. The roof of the building 200 includes multiple planar roof sections 200a-200d. Figure 2A also shows a second aerial image 211 providing a perspective (oblique) view of the building 200. The roof sections 200a and 200c are also visible in image 211.

[0045] Figure 2B shows a top-down, wide angle image 212 of the building 200. The image 212 includes details of the surrounding areas 220 of the building 220. Information about the surrounding areas 220 of the building 220 are in some embodiments used to determine additional cost factors related to a roof estimate. For example, the cleanup of, or access to, a worksite at building 220 may be complicated by various factors, including a substantial amount of landscaping; steeply sloped building sites; proximity to environmentally sensitive areas; etc. In such cases, the roof estimation system may automatically increase a cost factor in a corresponding roof estimate report.

[0046] In some embodiments, an aerial image has corresponding meta-information. Such meta-information may include details about the type of camera used (*e.g.*, focal length, exposure, etc.), the position of the camera (*e.g.*, GPS coordinates of the aircraft at the time the image was captured), the orientation of the camera (*e.g.*, the angle of the camera), the time and/or date the image was captured, etc.

[0047] Figures 3A-3F illustrate individual pages of an example roof estimate report generated by an example embodiment of a roof estimation system. As discussed with respect to Figure 1, a roof estimate report is generated by the roof estimation system based on one or more aerial images of a building. The roof estimate report may be based on a computer model (*e.g.*, a 3D model) of the roof, and includes one or more views of the model. In this example, the various views of the model are presented as annotated line drawings, which provide information about the roof, such as the roof section areas, roof section edge lengths, roof section pitches, etc. The roof estimate report may be in an electronic format (*e.g.*, a PDF file) and/or paper format (*e.g.*, a

printed report). In some embodiments, the roof estimate report may be in a format that may be consumed by a computer-aided design program.

[0048] Figure 3A shows a cover page 301 of the report and includes the address 301a of a building 301c and an overhead aerial image 301b of the building 301c.

[0049] Figure 3B shows a second page 302 of the report and includes two wide perspective (oblique) views 302a and 302b of the building 301c at the address with the surrounding areas more clearly shown.

[0050] Figure 3C shows a third page 303 of the report and includes a line drawing 303a of the building roof showing ridge lines 303b and 303c, and a compass indicator 303d. In addition, a building roof having valleys would result in a line drawing including one or more valley lines. The ridge and/or valley lines may be called out in particular colors. For example, ridge lines 303b and 303c may be illustrated in red, while valley lines may be illustrated in blue. The line drawing 303a is also annotated with the dimensions of the planar sections of the building roof. In this case, the dimensions are the lengths of the edges of the planar roof sections.

[0051] ~~Fig~~ Figure 3D shows a fourth page 304 of the report and includes a line drawing 304a of the building roof showing the pitch of each roof section along with a compass indicator. The pitch in this example is given in inches, and it represents the number of vertical inches that the labeled planar roof section drops over 12 inches of horizontal run. The slope can be easily calculated from such a representation using basic trigonometry. The use of a numerical value of inches of rise per foot of run is a well known measure of slope in the roofing industry. A roof builder typically uses this information to assist in the repair and/or construction of a roof. Of course, other measures and/or units of slope may be utilized as well, including percent grade, angle in degrees, etc.

[0052] Figure 3E shows a fifth page 305 of the report and includes a line drawing 305a of the building roof showing the square footage of each roof section along with the total square foot area value. Of course, other units of area may be used as well, such

as square meters or the number of "squares" of roofing material required for covering each roof section.

[0053] Figure 3F shows a fifth page 306 of the report and includes a line drawing 306a of the building roof where notes or comments may be written. The line drawing 306a includes a label for each roof section (shown here as "A", "B", "C"), such that comments may be conveniently related to specific roof sections.

[0054] In other embodiments, more or less information may be provided, or the illustrated information may be arranged in different ways. For example, the report may be provided in electronic form, such as a PDF file or a computer aided design software format. In some embodiments, the report may be "active" or editable, such that the user of the report may make changes to the report, based on on-site observations.

2. Roof Estimation System User Interface

[0055] Figures 4A-4F, 5A-5D, 6A-6D, and 7A-7C describe an example interactive user interface provided by one embodiment of the roof estimation system. As noted, the RES 100 described with reference to Figure 1 includes a user interface engine 104 that is configured to provide access to one or more functions of the RES 100, including image registration (described with respect to Figures 4A-4F), roof pitch determination (described with respect to Figures 5A-5D), roof model construction (described with reference to Figures 6A-6D), and roof model review (described with respect to Figures 7A-7C).

A. Image Registration

[0056] Figures 4A-4F are screen displays illustrating image registration and image lean correction in an example embodiment. In particular, Figure 4A shows a user interface screen 400 that is utilized by an operator to generate a three dimensional model of a roof of a building. The user interface screen 400 shows a roof modeling project in an initial state, after the operator has specified an address of a building and

after images of the building have been obtained and loaded into the roof estimation system.

[0057] The user interface screen 400 includes a control panel 401 and five images 402-406 of a building roof 407. The control panel 401 includes user selectable controls (*e.g.*, buttons, check boxes, menus, etc.) for various roof modeling tasks, such as setting reference points for the images, setting the vertical (Z) axis for the images, switching between different images, saving the model, and the like. Each of the images 402-406 provides a different view of the building roof 407. In particular, images 402-406 respectively provide substantially top-down, south, north, west, and east views of the building roof 407. Each image 402-406 includes four marker controls (also called "reference points" or "registration markers") that are used by the operator to set reference points in the image for purposes of image registration. The registration markers will be described further with respect to an enlargement of image portion 408 described with respect to Figures 4B-4C, below.

[0058] Figures 4B-4C show an enlarged view of image portion 408 during the process of image registration for image 402, which provides a top-down view of the building roof 407. As shown in Figure 4B, image portion 408 includes the building roof 407 and registration markers 410-413. The markers 410-413 are interactive user interface controls that can be directly manipulated (*e.g.*, moved, rotated, etc.) by the operator in order to specify points to use for purposes of image registration. In particular, image registration includes determining a transformation between each of one or more images and a uniform 3D reference grid. The uniform 3D reference grid is used as a coordinate system for a 3D model of the roof. By registering multiple images to the reference grid, an operator may indicate a roof feature on an image (such as a roof edge), which may then be translated from the coordinate system of the image to the coordinate system of the reference grid, for purposes of including ~~of~~ the indicated feature in the 3D model.

[0059] Marker 410 is an origin marker control, and includes arms 410a-410c. Arms 410a and 410b are horizontal arms that are utilized to specify the X and Y axes (*e.g.*,

the horizontal plane) of the reference grid. Arm 410c is a vertical arm that may be utilized to specify the Z axis (*e.g.*, the vertical axis) of the reference grid. The use of the vertical arm to specify the Z axis will be further described with respect to Figure 4E, below.

[0060] Typically, markers 410-413 are color coded, such that they may be distinguished from one another. For example, marker 411-413 may be respectively colored red, blue, and green. Origin marker 410 has a different appearance than markers 411-413, so may be of any color. In other embodiments, markers 411-413 may be distinguished in other ways, such as by utilizing different sized dashed lines, different line thicknesses, etc. In still other embodiments, markers are not distinguished any way from each other, such as by being of uniform shape, color, etc.

[0061] Figure 4C shows image portion 408 with markers 410-413 after they have been placed by an operator. Typically, registration markers are placed at four spatially distributed corners of the roof. As shown in Figure 4C, the operator has placed markers 410-413 at four different corners of the building roof 407. In particular, the operator first placed the origin marker 410 at the lower left corner of the building roof 407, and has adjusted (*e.g.*, rotated) the arms 410a and 410b to align with the major horizontal axes of the roof. By adjusting the arms 410a and 410b of the origin marker 410, the rotational orientation of markers 411-413 is automatically adjusted by the roof estimation system. Next, the operator places markers 411-413 on some other corners of the roof. In general, the operator can place registration marker over any roof feature, but roof corners are typically utilized because they are more easily identified by the operator. After the operator is satisfied with the placement of markers 410-413, the operator typically registers a next image of the building roof 407, as will be described next.

[0062] Figures 4D-4F illustrate image registration for image 404, which provides a north view of the building roof 407. In particular, Figure 4D shows the user interface screen 400 described with reference to Figure 4A. Here, image 402 has been minimized, while image 404 has been enlarged so that the operator may register that

image by placing markers on image 404, as will be described below with respect to an enlarged view of image portion 418.

[0063] Figure 4E shows an enlarged view of image portion 418 during the process of image registration for image 404. Image portion 418 includes the building roof 407 and registration markers 420-423. Markers 420-423 respectively correspond to markers 410-413 described above. In particular, marker 420 is an origin marker control that includes arms 420a-420c. Arms 420a and 420b are horizontal arms that are utilized to specify the X and Y axes of the reference grid. Arm 420c is a vertical arm that may be utilized to specify the Z axis of the reference grid.

[0064] In the example of Figure 4E, the operator has moved each of markers 420-423 to a corner of the roof 407. Note that the markers 420-423 are moved to roof corners that correspond to those selected by the operator with markers 410-413, as described with reference to Figure 4C. In particular, origin marker 420 has been moved to the corner of the roof 407 selected with origin marker 410 in image 408; marker 421 has been moved to the corner selected with marker 411 in image 408; marker 422 has been moved to the corner selected with marker 412 in image 408; and marker 423 has been moved to the corner selected with marker 413 in image 408. In addition, markers 420-423 have been rotated, by operator rotation of the origin marker 420, to align with the major axes of the roof 407.

[0065] As noted, the operator can utilize the origin marker 420 to specify the vertical axis of the reference grid. In particular, the operator can adjust (*e.g.*, by dragging with a mouse or other pointing device) arm 420c of marker 420 to specify the vertical (Z) axis of the image. In some cases, aerial images may include some amount of lean, due to the orientation of the aircraft during image capture. For example, pitch, yaw, or roll of an aircraft during the course of image capture may result in images that are misaligned with respect to the vertical axis of the building and its roof. Typically, an operator may adjust arm 420c to line up with a feature of a building or roof that is known to be substantially vertical, such as a wall of a house or a chimney. Then, based on the angle of arm 420c with respect to the vertical axis of the image, the roof

estimation system can determine a correction between the reference grid and the image.

[0066] Figure 4F shows an enlarged view of image portion 418 after registration of image 404. Once the operator has placed and adjusted markers 420-423, the operator may direct (*e.g.*, by clicking a button) the roof estimation system to register the image to the reference grid, based on the positions and orientations of markers 420-423. Once the roof estimation system registers the image, it provides the operator with feedback so that the operator may determine the correctness or accuracy of the registration.

[0067] In the example of Figure 4F, the operator has directed the roof estimation system to register image 404, and the roof estimation system has updated image portion 418 with registration indicators 430-433. Registration indicators 430-433 provide the operator with feedback so that the operator may judge the accuracy of the registration of image 404.

[0068] Registration indicator 430 is an origin registration indicator that includes two arms 430a-430b and three reference grid indicators 430c-430e, shown as dashed lines. The reference grid indicators 430c-430e show the vertical axis (430c) and the two horizontal axes (430d and 430e) of the reference grid determined based on the placement and orientation of the markers 420-423. Arms 430a and 430b correspond to the placement of arms 420a-420c of origin marker 420. If the arms 430a and 430b do not substantially align with the corresponding reference grid indicators 430e and 430d, then the determined reference grid is out of alignment with the specified axes of the house. Typically, an operator will return to the view of Figure 4E to make adjustments to origin marker, such as adjusting one or more of the vertical or horizontal axes, in order to refine the registration of the image. Although the arms 430a-430b and the reference grid indicators 430c-430e are here illustrated as solid and dashed lines, in other embodiments they may be color coded. For example, arms 430a-430b may be red, while reference grid indicators 430c-430e may be blue.

[0069] Registration indicators 431-433 provide the operator with information regarding the accuracy of the placement of markers 421-423. In particular, each registration indicator 431-433 includes a solid crosshairs and a reference indicator, shown for example as a dashed line 432a. The crosshair of a registration indicator corresponds to the placement of a marker. For example, the crosshairs of registration indicator 431 corresponds to the placement of marker 421 in Figure 4E. If the reference indicator intersects the center (or substantially near the center) of the crosshairs of a registration indicator, then the operator knows that the placement of the corresponding marker is accurate. On the other hand, if the reference indicator does not intersect the center of the crosshairs of a registration indicator, then the operator knows that the placement of the corresponding marker is inaccurate. Typically, such an inaccuracy arises when the placement of markers in the top view of the roof does not agree with (correspond to) the placement of corresponding markers in another view of the roof. In such cases, the operator can return to the view of Figure 4C or 4E to adjust the position of one or more markers.

[0070] After registering image 404, the operator will proceed to register additional images of the building roof 407 utilizing a process similar to that described above. In this example, the operator will register images 403, 405, and 406. Although the operator is here described as registering a total of five images, in other cases more or fewer images may be registered.

B. Roof Model Construction

[0071] Figures 5A-5D and 6A-6C generally illustrate aspects of the process of roof model generation based on multiple registered images. In particular, these figures illustrate the construction of a roof model by an operator. Model generation/construction may include identification of roof features shown in various images of the roof, such as edges, planar sections, vertexes, and the like, as well as determination of roof pitch and other dimensional attributes of the roof. Each identified roof feature is incorporated by the roof estimation system into a 3D model of

the roof, based on a translation between an image in which the feature is identified and the reference grid, as determined by the process described with reference to Figures 4A-4F, above.

[0072] Figures 5A-5D are screen displays illustrating pitch determination in an example embodiment. In particular, Figure 5A shows the user interface screen 400 after images 402-406 have been registered. In this example, the operator is using a pitch determination control (also called a "pitch determination marker" or "pitch determination tool") to specify the pitch of a planar roof section of the building roof 407 visible in image 406. The pitch determination control will be further described in Figure 5B, below, with respect to an enlargement of image portion 508.

[0073] Figure 5B shows an enlarged view of image portion 508 during the process of pitch determination for image 406, which provides an east perspective view of the building roof 407. As shown in Figure 5B, the image portion 508 includes the building roof 407 and a pitch determination marker 510 (also called a "protractor tool"). The pitch determination marker 510 is an interactive user interface control that can be directly manipulated by the operator in order to specify the pitch of a section of the building roof 407.

[0074] The pitch determination marker 510 includes arms 510a-510d. Arms 510a-510c are axes, which are automatically aligned, based on the registration of image 406, with the major (X, Y, and Z) axes of the building roof. Arm 510d is a "protractor" arm that is adjustable by the operator to specify roof pitch.

[0075] The marker 510 is typically first moved by the operator to a convenient location on the building roof 407, usually corner of a planar section of the roof 407. Next, the operator adjusts arm 510d so that ~~is~~ it substantially aligns with the sloped edge of the planar roof section. Then, the roof estimation system determines the pitch of the roof section, based on the configuration of the marker 510 with respect to the image and the reference grid.

[0076] After specifying the pitch of a planar roof section, the operator will typically specify other information about the planar roof section, such as its outline, as will be

described with reference to Figures 6A-6D. Note that as the operator provides additional information about the geometry of the roof 407, the roof estimation system may automatically determine the pitch and/or other features of at least some of the other planar roof sections, based on the provided geometric information and/or assumptions about roof symmetry or other standard architectural practices.

[0077] Figure 5C shows a second type of pitch determination marker being used in the context of image 403 which provides a south perspective view of the building roof 407. The illustrated pitch determination marker may be used in addition to, or instead of, the pitch determination marker 510 described with respect to Figures 5A-5B, above. In particular, Figure 5C shows a pitch determination marker 520 (also called an "envelope tool") that includes surfaces 520a and 520b. The pitch determination marker 520 is an interactive user interface control that can be directly manipulated by the operator in order to specify the pitch of a section of the building roof 407. In particular, the pitch determination marker 520 may be moved and/or adjusted so that it appears to lie substantially atop two adjacent planar sections of roof 407.

[0078] Figure 5D shows the pitch determination marker 520 after the operator has used it to specify the pitch of two sections of roof 407. Here, the operator has moved the marker 520 to a position in which the spine of the marker 520 is substantially aligned with the ridge line of roof 407. Then, the operator has adjusted the angle of the surfaces 520a and 520b so that they appear to lie substantially atop corresponding sections of roof 407. Then, the roof estimation system determines the pitch of the roof sections, based on the configuration of the marker 520 with respect to the image and the reference grid. Also illustrated are pitch indicators 521 and 522. Pitch indicator 521 corresponds to the measured pitch of surface 520a, and pitch indicator 522 corresponds to the measured pitch of surface 520b. As the operator adjusts the angle of surfaces 520a and/or 520b, the corresponding pitch indicators 521-522 are automatically updated to reflect the determined pitch. In this example, the pitch of both surfaces is given as 4 inches of rise per foot of run.

[0079] The envelope pitch determination marker 520 may be adjusted in other ways, to specify pitches for types of roofs other than the gabled roof shown in image 403. For example, when measuring pitch of roof sections that form a roof hip, point 520c may be manipulated by the operator, such as by dragging it to the left or right, to adjust the shape of the surfaces 520a and 520b, so that the surfaces align with the edges formed by the intersection of the sections that form the roof hip.

[0080] Figures 6A-6D are screen displays illustrating model construction and concurrent display of operator specified roof features in an example embodiment. In particular, Figures 6A-6D illustrate the construction of a three dimensional wire frame model of a building roof, based on the specification of roof features by an operator. In addition, Figures 6A-6D illustrate the concurrent display of operator specified roof features in multiple views of a building roof.

[0081] Figure 6A shows the user interface screen 400 after images 402-406 have been registered, and after roof pitches have been determined. In this example, the operator is specifying sections of roof 407, visible in image 406, that are to be added to a 3D wire frame model of the roof 407 maintained by the roof estimation system. The specification of roof sections will be further described with reference to enlarged portion 608 of image 406 in Figure 6B, below. In addition, as the operator specifies roof sections in image 406, the roof estimation system concurrently displays the specified roof sections in each of the other images 402-405. The concurrent display of operator specified roof features will be further described with reference to enlarged portion 609 of image 402 in Figure 6C, below.

[0082] Figure 6B is an enlarged view of image portion 608 during the process of wire frame model construction in the context of image 406, which provides an east perspective view of the building roof 407. As shown in Figure 6B, the image portion 608 includes the building roof 407, drawing tool 610, and wire frame 611. The drawing tool 610 (also called a “drawing marker” or a “drawing control”) is an interactive user interface control that can be directly manipulated by the operator in order to specify roof features, such as edges, ridges, valleys, corners, etc. In the

illustrated embodiment, the operator uses the drawing tool 610 to trace or outline planar sections of the roof 407, leading to the generation of wire frame 611. The drawing tool 610 may be used to establish a series of connected line segments that result in a closed polygon representing a planar roof section. As the operator specifies a planar roof section in this manner, the roof estimation system determines, based on the image and the reference grid, the geometry of the planar roof section, and includes (adds) the specified planar roof section in a 3D model that corresponds to roof 407.

[0083] Figure 6C is an enlarged view of image portion 609 illustrating the concurrent display of operator specified roof features, in the context of image 402, which provides a top plan view of the building roof 407. As the operator specifies roof sections as described with respect to Figure 6B, the roof estimation system concurrently displays the specified roof features in one or more of the other images displayed by the user interface screen 400. More specifically, image portion 609 includes building roof 407 and wire frame 612. Wire frame 612 corresponds to wire frame 611 constructed by the operator with reference to Figure 6B, except that wire frame 612 is automatically displayed as a projection from the 3D model into the top-down view of image 402. Changes that the operator makes to wire frame 611 are concurrently displayed by the roof estimation system as wire frame 612 in image portion 609. For example, if a new planar roof section is added by the operator to wire frame 611, the new planar roof section is automatically displayed in wire frame 612. By concurrently displaying operator identified features in multiple views of building roof 407, the operator obtains feedback regarding the correctness and/or accuracy of the 3D model or other aspects of the model generation process, such as image registration and pitch determination.

[0084] Generally, the roof estimation system can be configured to concurrently display any operator-identified features, such as corners, ridges, valleys, planar sections, and the like, in multiple views of a building.

[0085] Furthermore, the concurrently displayed wire frame 612 is an interactive user interface element, in that the operator can make changes to the wire frame 612, which

are then concurrently displayed in wire frame 611. Wire frames similar to those described above are also projected by the roof estimation system into images 403, 404, and 405 displayed by the user interface screen 400. In this manner, the operator can switch between various images of the building roof 407, making refinements to the 3D model by adjusting the wire frame in whichever image is more convenient and/or provides a more suitable perspective/view of the model.

[0086] Figure 6D shows the user interface screen 400 during construction of a 3D model of the building roof 407. In particular, the user interface 400 includes a shaded wire frame 613 representation of the 3D model constructed as described above. In this view, the operator can review the wire frame 613 in isolation from any images to determine whether the wire frame 613 accurately represents the building roof 407. The wire frame 613 is an interactive user interface component, in that it can be directly manipulated (*e.g.*, moved, rotated, resized, etc.). In some embodiments, manipulating the wire frame 613, such as by changing its shape, results in corresponding changes in the underlying 3D model.

C. Roof Model Review

[0087] Figures 7A-7C are screen displays illustrating roof model review in an example embodiment. In particular, Figures 7A-7C illustrate various techniques to facilitate the review of a roof model by an operator. Reviewing the roof model may include reviewing roof section pitches (*e.g.*, to determine whether they conform to the building roof and/or standard construction practices), reviewing the shape and/or location of the roof model (*e.g.*, to determine whether it substantially conforms to the building roof), etc.

[0088] Figure 7A shows the user interface screen 400 after the operator has constructed a model of the roof 407 using one or more of the images 402-406. In this example, a wire frame has been projected onto (superimposed upon) image 402 and annotated with roof section pitches, as will be described further with respect to enlarged portion 708 of image 402 in Figure 7B, below.

[0089] Figure 7B is an enlarged view of image portion 708 during the process of roof model review in the context of image 402, which provides a substantially top plan view of the building roof 407. As shown in Figure 7B, the image portion 708 includes a wire frame 710 and labels 711a-711c that indicate pitches of corresponding sections of roof 407. The wire frame 710 and the illustrated pitches are determined by the roof estimation system based on the pitch determination described with respect to Figures 5A-5D, above, and the operator's specification of the wire frame model described with respect to Figures 6A-6D, above.

[0090] The wire frame 710 includes multiple vertexes connected by line segments. Each vertex includes a handle, such as handle 710a. The handles may be directly manipulated (individually or in groups) by the operator to make adjustments/modifications to the wire frame 710. For example, when an operator drags handle 710a to a new location, the ends of the two line segments connected to handle 710a will also move to the new location.

[0091] Figure 7C is an alternative view of the 3D model of roof 407 during the process of roof model review. In Figure 7C, the user interface screen 400 includes a wire frame 720 representation of the 3D model of the roof 407. The wire frame 720 consists of multiple line segments corresponding to edges of planar roof sections. Each line segment is annotated with a label, such as label 723, indicating the determined length of the corresponding roof section edge. Furthermore, some of the line segments indicate that they correspond to a particular roof feature. For example, line segments 721 and 722 may be colored (*e.g.*, red) so as to indicate that they correspond to roof ridges. Other line segments may be differently colored (*e.g.*, blue) so as to indicate a correspondence to roof valleys or other features. In addition, the wire frame 720 may be directly manipulated by the operator in order to make adjustments to the underlying model of the roof 407. For example, the operator could increase or decrease the length of line segment 721, resulting in a change in the corresponding feature of the 3D model of roof 407.

[0092] Note that although the operator is shown, in Figures 5-7 above, operating upon a total of five images, in other cases, fewer images may be used. For example, in some cases fewer images may be available, or some images may provide obstructed views of the building roof, such as due to tree cover, neighboring buildings, etc.

3. Implementation Techniques

[0093] Figure 8 is an example block diagram of a computing system for practicing embodiments of a roof estimation system. Figure 8 shows a computing system 800 that may be utilized to implement a Roof Estimation System ("RES") 810. One or more general purpose or special purpose computing systems may be used to implement the RES 810. More specifically, the computing system 800 may comprise one or more distinct computing systems present at distributed locations. In addition, each block shown may represent one or more such blocks as appropriate to a specific embodiment or may be combined with other blocks. Moreover, the various blocks of the RES 810 may physically reside on one or more machines, which use standard inter-process communication mechanisms (*e.g.*, TCP/IP) to communicate with each other. Further, the RES 810 may be implemented in software, hardware, firmware, or in some combination to achieve the capabilities described herein.

[0094] In the embodiment shown, computing system 800 comprises a computer memory ("memory") 801, a display 802, one or more Central Processing Units ("CPU") 803, Input/Output devices 804 (*e.g.*, keyboard, mouse, joystick, track pad, CRT or LCD display, and the like), other computer-readable media 805, and network connections 806. The RES 810 is shown residing in memory 801. In other embodiments, some portion of the contents, some of, or all of the components of the RES 810 may be stored on and/or transmitted over the other computer-readable media 805. The components of the RES 810 preferably execute on one or more CPUs 803 and generate roof estimate reports, as described herein. Other code or programs 830 (*e.g.*, a Web server, a database management system, and the like) and potentially other data repositories, such as data repository 820, also reside in the

memory 801, and preferably execute on one or more CPUs 803. Not all of the components in Figure 8 are required for each implementation. For example, some embodiments embedded in other software do not provide means for user input, for display, for a customer computing system, or other components.

[0095] In a typical embodiment, the RES 810 includes an image acquisition engine 811, a roof modeling engine 812, a report generation engine 813, an interface engine 814, and a roof estimation system data repository 816. Other and/or different modules may be implemented. In addition, the RES 810 interacts via a network 850 with an image source computing system 855, an operator computing system 865, and/or a customer computing system 860.

[0096] The image acquisition engine 811 performs at least some of the functions of the image acquisition engine 101 described with reference to Figure 1. In particular, the image acquisition engine 811 interacts with the image source computing system 855 to obtain one or more images of a building, and stores those images in the RES data repository 816 for processing by other components of the RES 810. In some embodiments, the image acquisition engine 811 may act as an image cache manager, such that it preferentially provides images to other components of the RES 810 from the RES data repository 816, while obtaining images from the image source computing system 855 when they are not already present in the RES data repository 816. In other embodiments, images may be obtained in an “on demand” manner, such that they are provided, either by the image acquisition engine 811 or the image source computing system 855, directly to modules of the RES 810 and/or the operator computing system 865, without intervening storage in the RES data repository 816.

[0097] The roof modeling engine 812 performs at least some of the functions of the roof modeling engine 102 described with reference to Figure 1. In particular, the roof modeling engine 812 generates a model based on one or more images of a building that are obtained from the RES data repository 816 or directly from the image source computing system 855. As noted, model generation may be performed semi-automatically, based on at least some inputs received from the computing system

865. In addition, at least some aspects of the model generation may be performed automatically, based on image processing and/or image understanding techniques. After the roof modeling engine 812 generates a model, it stores the generated model in the RES data repository 816 for further processing by other components of the RES 810.

[0098] The report generation engine 813 performs at least some of the functions of the report generation engine 103 described with reference to Figure 1. In particular, the report generation engine 813 generates roof reports based on models stored in the RES data repository 816. Generating a roof report may include preparing one or more views of a given 3D model of a roof, annotating those views with indications of various characteristics of the model, such as dimensions of sections or other features (*e.g.*, ridges, valleys, etc.) of the roof, slopes of sections of the roof, areas of sections of the roof, etc. In some embodiments, the report generation engine 813 facilitates transmission of roof measurement information that may or may not be incorporated into a roof estimate report. For example, the roof generation engine 813 may transmit roof measurement information based on, or derived from, models stored in the RES data repository 816. Such roof measurement information may be provided to, for example, third-party systems that generate roof estimate reports based on the provided information.

[0099] The interface engine 814 provides a view and a controller that facilitate user interaction with the RES 810 and its various components. For example, the interface engine 814 implements a user interface engine 104 described with reference to Figure 1. Thus, the interface engine 814 provides an interactive graphical user interface that can be used by a human user operating the operator computing system 865 to interact with, for example, the roof modeling engine 812, to perform functions related to the generation of models, such as point registration, feature indication, pitch estimation, etc. In other embodiments, the interface engine 814 provides access directly to a customer operating the customer computing system 860, such that the customer may place an order for a roof estimate report for an indicated building

location. In at least some embodiments, access to the functionality of the interface engine 814 is provided via a Web server, possibly executing as one of the other programs 830.

[00100] In some embodiments, the interface engine 814 provides programmatic access to one or more functions of the RES 810. For example, the interface engine 814 provides a programmatic interface (*e.g.*, as a Web service, static or dynamic library, etc.) to one or more roof estimation functions of the RES 810 that may be invoked by one of the other programs 830 or some other module. In this manner, the interface engine 814 facilitates the development of third-party software, such as user interfaces, plug-ins, adapters (*e.g.*, for integrating functions of the RES 810 into desktop applications, Web-based applications, embedded applications, etc.), and the like. In addition, the interface engine 814 may be in at least some embodiments invoked or otherwise accessed via remote entities, such as the operator computing system 865, the image source computing system 855, and/or the customer computing system 860, to access various roof estimation functionality of the RES 810.

[00101] The RES data repository 816 stores information related to the roof estimation functions performed by the RES 810. Such information may include image data 105, model data 106, and/or report data 107 described with reference to Figure 1. In addition, the RES data repository 816 may include information about customers, operators, or other individuals or entities associated with the RES 810.

[00102] In an example embodiment, components/modules of the RES 810 are implemented using standard programming techniques. For example, the RES 810 may be implemented as a "native" executable running on the CPU 803, along with one or more static or dynamic libraries. In other embodiments, the RES 810 is implemented as instructions processed by virtual machine that executes as one of the other programs 830. In general, a range of programming languages known in the art may be employed for implementing such example embodiments, including representative implementations of various programming language paradigms, including but not limited to, object-oriented (*e.g.*, Java, C++, C#, Matlab, Visual

Basic.NET, Smalltalk, and the like), functional (*e.g.*, ML, Lisp, Scheme, and the like), procedural (*e.g.*, C, Pascal, Ada, Modula, and the like), scripting (*e.g.*, Perl, Ruby, Python, JavaScript, VBScript, and the like), declarative (*e.g.*, SQL, Prolog, and the like).

[00103] The embodiments described above may also use well-known synchronous or asynchronous client-server computing techniques. However, the various components may be implemented using more monolithic programming techniques as well, for example, as an executable running on a single CPU computer system, or alternatively decomposed using a variety of structuring techniques known in the art, including but not limited to, multiprogramming, multithreading, client-server, or peer-to-peer, running on one or more computer systems each having one or more CPUs. Some embodiments execute concurrently and asynchronously, and communicate using message passing techniques. Equivalent synchronous embodiments are also supported by an RES implementation. Also, other functions could be implemented and/or performed by each component/module, and in different orders, and by different components/modules, yet still achieve the functions of the RES.

[00104] In addition, programming interfaces to the data stored as part of the RES 810, such as in the RES data repository 816, can be available by standard mechanisms such as through C, C++, C#, and Java APIs; libraries for accessing files, databases, or other data repositories; through scripting languages such as XML; or through Web servers, FTP servers, or other types of servers providing access to stored data. For example, the RES data repository 816 may be implemented as one or more database systems, file systems, memory buffers, or any other technique for storing such information, or any combination of the above, including implementations using distributed computing techniques.

[00105] Also, the example RES 810 can be implemented in a distributed environment comprising multiple, even heterogeneous, computer systems and networks. For example, in one embodiment, the image acquisition engine 811, the roof modeling engine 812, the report generation engine 813, the interface engine 814, and the data

repository 816 are all located in physically different computer systems. In another embodiment, various modules of the RES 810 are hosted each on a separate server machine and are remotely located from the tables which are stored in the data repository 816. Also, one or more of the modules may themselves be distributed, pooled or otherwise grouped, such as for load balancing, reliability or security reasons. Different configurations and locations of programs and data are contemplated for use with techniques ~~of~~ as described herein. A variety of distributed computing techniques are appropriate for implementing the components of the illustrated embodiments in a distributed manner including but not limited to TCP/IP sockets, RPC, RMI, HTTP, Web Services (XML-RPC, JAX-RPC, SOAP, and the like).

[00106] Furthermore, in some embodiments, some or all of the components of the RES are implemented or provided in other manners, such as at least partially in firmware and/or hardware, including, but not limited to one or more application-specific integrated circuits (ASICs), standard integrated circuits, controllers (*e.g.*, by executing appropriate instructions, and including microcontrollers and/or embedded controllers), field-programmable gate arrays (FPGAs), complex programmable logic devices (CPLDs), and the like Some or all of the system components and/or data structures may also be stored (*e.g.*, as software instructions or structured data) on a computer-readable medium, such as a hard disk, a memory, a network, or a portable media article to be read by an appropriate drive or via an appropriate connection. The system components and data structures may also be stored as data signals (*e.g.*, by being encoded as part of a carrier wave or included as part of an analog or digital propagated signal) on a variety of computer-readable transmission mediums, which are then transmitted, including across wireless-based and wired/cable-based mediums, and may take a variety of forms (*e.g.*, as part of a single or multiplexed analog signal, or as multiple discrete digital packets or frames). Such computer program products may also take other forms in other embodiments. Accordingly, embodiments of this disclosure may be practiced with other computer system configurations.

[00107] Figure 9 is an example flow diagram of an image registration routine provided by an example embodiment. The illustrated routine 900 may be provided by, for example, execution of the roof estimation system 810 described with respect to Figure 8. The illustrated routine 900 facilitates image registration based upon operator indicated registration points and/or image lean corrections.

[00108] More specifically, the routine begins in step 901, where it displays, on a user interface screen, an aerial image of a building having a roof. As part of the user interface screen, the routine also displays user interface controls such as markers that may be used by an operator for purposes of image registration and/or lean correction, as described with reference to Figure 4A, above.

[00109] In step 902, the routine receives, via one or more registration markers, indications of one or more points on the aerial image. The registration markers are manipulated by the operator to specify points on the aerial image, as described with reference to Figures 4A-4E. Typically, the points are visually identifiable features, such as corners of the roof of the building. For example, if the roof has four corners (*e.g.*, a northwest, southwest, northeast, and ~~southwest~~ southeast corner) the operator may place one registration marker on each of the four corners as shown in the aerial image. Then, the positions (*e.g.*, coordinates on the aerial image) of the markers are transmitted to the routine for use in registering the aerial image, as described below.

[00110] In step 903, the routine receives, via a lean correction marker, an indication of the vertical axis of the building roof. In at least some cases, the aerial image of the building is out of alignment with respect to the vertical axis of the building. This may be caused, for example, by pitch, roll, and/or yaw experienced by the aircraft during the process of photographing the building. To correct for such misalignment, the lean correction marker is manipulated by the operator to indicate a vertical axis of the building. Typically, the operator aligns the lean correction marker with known, substantially vertical feature of the building, such as a chimney, wall corner, etc., as described with reference to Figure 4E, above. After the operator has aligned the lean

correction marker, the position (*e.g.*, angle of the marker, coordinates of the endpoints of the marker, etc.) of the lean correction marker is transmitted to the routine for use in registering the aerial image, as described below.

[00111] Particular benefits may be obtained from lean correction performed in the context of an overhead, or "top down," view. An "overhead lean" occurs when the camera is not directly overhead with respect to the building when the photo is taken. In some cases, leans in excess of 5 degrees have been observed in "top down" photos. Furthermore, unlike oblique, perspective views, a top-down lean is typically less likely to include a convenient visual marker that provides sufficient angle to assess the lean direction and magnitude, such as the edge of the building or a tall chimney. An overhead lean affects the perceived location of the roof lines in a top down view. This effect is amplified as the pitch of the roof increases and/or as the vertical separation between disconnected roof sections increases. Without lean correction, superimposing a wire frame over the visible ridgelines (and other features of a building that reside at different elevations) may produce asymmetries in otherwise symmetric structures. Further, an absence of lean correction may introduce errors in pitch estimation, as the wire frame may not appear consistent between top and oblique view points. More specifically, without top view lean correction, the positions for the roof lines in an otherwise correct (*i.e.*, accurate with respect to the actual geometry of the roof) wire frame will typically not line up on the visible roof lines in the overhead reference photo. This often leads the user (or software) to either introduce errors by incorrectly drawing the wire frame to the image lines or perform a subjective determination of where and how to shift the wire frame lines off the image lines to produce a correct model. Top view lean correction allows the roof estimation system to trace to, or substantially to, the actual roof lines seen in the top image while still producing an accurate wire frame model.

[00112] Image misalignment may be specified in other ways. For example, in other embodiments, the operator may instead rotate the image to a position in which the

building appears to be in a substantially vertical position. Then, the angle of rotation of the image may be transmitted to the routine for use in registering the aerial image.

[00113] In step 904, the routine registers, based on the received indications of the points and/or the received indication of the vertical axis, the aerial image to a reference grid. Registering the image to a reference grid may include determining a transformation between the reference grid and the image, based on the indicated points and/or the indicated vertical axis. Determining such a transformation may be based on other information as well, such as meta-information associated with the aerial image. In some embodiments, the aerial image has corresponding meta-information that includes image capture conditions, such as camera type, focal length, time of day, camera position (*e.g.*, latitude, longitude, and/or elevation), etc.

[00114] In step 905, the routine determines whether there are additional aerial images to be registered, and if so, returns to step 901, else proceeds to step 906. During execution of the loop of steps 901-905, the operator typically indicates, for each registration marker, the same feature (*e.g.*, corner) of the roof as shown in each of multiple images, such that the routine can register the multiple images to a single, uniform reference grid. Upon completion of the registration process, the routine has determined a uniform coordinate system for the multiple aerial images, for use during other phases of model construction, such as pitch determination or feature identification.

[00115] In step 906, the routine generates a three-dimensional model based at least in part on the aerial image(s) and the reference grid. As discussed above with reference to Figures 5A-5D and 6A-6D, model generation includes identification of roof features shown in various images of the roof, such as edges, planar sections, vertexes, and the like, as well as determination of roof pitch and other dimensional attributes of the roof. In other embodiments, the routine performs other functions with the registered images, such as storing them for later use (*e.g.*, by an automated model generation module), transmitting them to another computing (*e.g.*, for use in a third-party design application), etc. After step 906, the routine ends.

[00116] Note that in at least some embodiments, aspects of the routine 900 may be performed in an automated manner. For example, operations discussed above as being performed by an operator, such as the determination of the location of image registration points of step 902 and/or the indication of lean of step 903, may be performed by automated image processing techniques.

[00117] Figure 10 is an example flow diagram of a pitch determination routine provided by an example embodiment. The illustrated routine 1000 may be provided by, for example, execution of the roof estimation system 810 described with respect to Figure 8. The illustrated routine 1000 facilitates the determination of the pitch of a section of a roof, by displaying a pitch determination marker and modifying a 3D model of a roof based on an indication of roof pitch received via the pitch determination marker.

[00118] More specifically, the routine begins at step 1001 where it displays an aerial image of a building having a roof comprising a plurality of planar roof sections that each have a corresponding pitch. The aerial image is displayed in the context of a user interface screen, such as is described with reference to Figures 4A-6C, above. The aerial images may be received from, for example, the image source computing system 855 and/or from the RES data repository 816 described with reference to Figure 8. As discussed above, aerial images may be originally created by cameras mounted on airplanes, balloons, satellites, etc. In some embodiments, images obtained from ground-based platforms (*e.g.*, vehicle-mounted cameras) may be used instead or in addition.

[00119] In step 1002, the routine displays a pitch determination marker operable to indicate pitch of a planar roof section. The pitch determination marker may be, for example, a pitch determination marker 510 ("protractor tool") or 520 ("envelope tool"), such as are respectively described with respect to Figures 5B and 5C, above. The routine displays the pitch determination marker by, for example, presenting it on a user interface screen displayed on a computer monitor or other display device. The pitch determination marker is a direct manipulation user interface control, in that an operator may manipulate it (*e.g.*, adjust an angle, change its shape, alter its position,

etc.) in order to indicate pitch of a planar roof section. Additional details regarding pitch determination controls are provided with respect to Figures 5A-5D, above.

[00120] In step 1003, the routine receives, via the displayed pitch determination marker, an indication of the pitch of one of the plurality of planar roof sections of the roof of the building. Receiving an indication of the pitch includes receiving an indication (*e.g.*, via an event, callback, etc.) that the marker has been manipulated by the operator, and then determining an angle based on the shape and/or position of the marker. In some embodiments, such an indication may be received on an event driven basis, such as every time the marker is manipulated in some manner. In other embodiments, the routine may poll the marker from time to time to determine its current state. In addition, the operator may explicitly indicate that the current state of the marker is to be transmitted to the routine, such as by pressing a button or other indication.

[00121] In step 1004, the routine modifies a three-dimensional model of the roof based on the received indication of the pitch of the one planar roof section. Modifying the 3D model of the roof includes associating the indicated pitch with a portion of the model corresponding to the one planar roof section. For example, the 3D model may include one or more data structures representing planar roof sections, and the indicated pitch may be included as part of the data structure representing the one planar roof section. In some embodiments, the 3D model may not at this point include representations of the planar roof sections, such as because the operator has not yet specified them. In such a case, the routine may store the indicated pitch in association with the location and orientation at which the pitch was specified by the operator, as determined from the aerial image. Then, at a later time, when the operator specifies a roof section that has the same orientation as the stored pitch and that includes or is near the stored location, the roof estimation system can store the indicated pitch in association with the specified roof section.

[00122] After step 1004, the routine ends. In other embodiments, the routine may instead return to step 1001, to determine the pitch for another planar roof section (of the same or different roof).

[00123] Figure 11 is an example flow diagram of concurrent feature display routine provided by an example embodiment. The illustrated routine 1100 may be provided by, for example, execution of the roof estimation system 810 described with respect to Figure 8. The illustrated routine 1100 concurrently displays operator indicated features in multiple aerial images of a building roof.

[00124] More specifically, the routine begins in step 1101, where it displays a first and a second aerial image of a building having a roof, each of the aerial images providing a different view of the roof of the building. The aerial images are displayed in the context of a user interface screen, such as is described with reference to Figures 6A-6C, above.

[00125] In step 1102, the routine receives an indication of a feature of the building shown in the first aerial image. The indication is typically received via a user interface control, such as a drawing tool or marker, upon its manipulation by an operator. For example, the operator may manipulate a drawing tool in order to specify one or more features of the building roof, such as a corner on the roof, an edge of the roof, an outline of a section of the roof, etc. In one embodiment, the operator utilizes a drawing tool to indicate roof section corner points and roof section edges connecting those corner points. Additional details regarding feature indication are provided with respect to Figures 6A-6C, above.

[00126] In step 1103, the routine modifies a three-dimensional model of the roof based on the received indication of the feature of the building. Modifying the 3D model may include adding or updating the indicated feature to a wire frame model of the roof. For example, if the indicated feature is a roof section corner point, the corner point will be added to the 3D model, along with the location (*e.g.*, the X, Y, and Z position of the point) of the point. The location of the point is automatically determined based on a translation of the position of the point in the image to a point in the uniform reference

grid associated with the image. If the indicated feature is a roof section edge, the edge will be added to the 3D model, such as by associating the edge with two points corresponding to the end points of the edge. Higher-level features can also be indicated. For example, a planar roof section may be indicated by "closing" a sequence of two or more connected line segments, to create a closed polygon that represents the outline or perimeter of the planar roof section.

[00127] In step 1104, the routine concurrently displays a projection of the feature from the modified three-dimensional model onto the first and second aerial images. In one embodiment, displaying the feature from the modified three-dimensional model includes projecting the three-dimensional model onto both the first and second aerial images. For example, if the first image (for which the indicated feature was received) provides a west view of the building, and the second image provides an east view of the building, the routine will concurrently display a projection of the indicated feature from the 3D model onto both the first and second images. The projection of the indicated feature into the second image is based at least in part on a translation from the position of the feature in the reference grid to a position in the second image. In addition, the concurrent display onto two or more images occurs at substantially the same time (within a short time interval, at times that are substantially coincident) as the indication of the feature of the building in step 1102, giving the operator the illusion that as they are indicating a feature in the first image, the feature is being simultaneously projected into the second image.

[00128] After step 1104, the routine ends. In other embodiments, the routine may instead return to step 1101, to perform an interactive loop of steps 1101-1104 with the operator, so that the routine can concurrently display multiple features as they are indicated by the operator. Note that in such an embodiment, each iteration of the loop of steps 1101-1104 may be performed at near real-time speeds, so as to provide a fluid, interactive model generation experience for the operator enabling the operator to drag, draw, or otherwise indicate/manipulate features in a first image and view the results of their work concurrently projected into a second image.

[00129] All of the above 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, including but not limited to U.S. Provisional Patent Application No. 61/197,904, entitled "USER INTERFACE SYSTEMS AND METHODS FOR ROOF ESTIMATION," filed October 31, 2008, are incorporated herein by reference, in their entireties.

[00130] From the foregoing it will be appreciated that, although specific embodiments have been described herein for purposes of illustration, various modifications may be made without deviating from the spirit and scope of the present disclosure. For example, the methods, systems, and techniques for generating and providing roof estimate reports discussed herein are applicable to other architectures other than the illustrated architecture or a particular roof estimation system implementation. Also, the methods and systems discussed herein are applicable to differing network protocols, communication media (optical, wireless, cable, etc.) and devices (such as wireless handsets, electronic organizers, personal digital assistants, portable email machines, game machines, pagers, navigation devices such as GPS receivers, etc.). Further, the methods and systems discussed herein may be utilized by and/or applied to other contexts or purposes, such as by or for solar panel installers, roof gutter installers, awning companies, HVAC contractors, general contractors, and/or insurance companies.

CONCURRENT DISPLAY SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION

BACKGROUND

1. Field of the Invention:

[0001] This invention relates to systems and methods for estimating construction projects, and more particularly, to such systems and methods for determining roof measurement information based on one or more aerial images of a roof of a building.

2. Description of the Related Art:

[0002] The information provided below is not admitted to be part of the present invention, but is provided solely to assist the understanding of the reader.

[0003] Homeowners typically ask several roofing contractors to provide written estimates to repair or replace a roof on a house. Heretofore, the homeowners would make an appointment with each roofing contractor to visit the house to determine the style of roof, take measurements, and to inspect the area around the house for access and cleanup. Using this information, the roofing contractor then prepares a written estimate and then timely delivers it to the homeowner. After receiving several estimates from different roofing contractors, the homeowner then selects one.

[0004] There are factors that impact a roofing contractor's ability to provide a timely written estimate. One factor is the size of the roof contractor's company and the location of the roofing jobs currently underway. Most roof contractors provide roofing services and estimates to building owners over a large geographical area. Larger roof contractor companies hire one or more trained individuals who travel throughout the entire area providing written estimates. With smaller roofing contractors, the owner or a key trained person is appointed to provide estimates. With both types of companies, roofing estimates are normally scheduled for buildings located in the same area on a particular day. If an estimate is needed suddenly at a distant location,

the time for travel and the cost of commuting can be prohibitive. If the roofing contractor is a small company, the removal of the owner or key person on a current job site can be time prohibitive.

[0005] Another factor that may impact the roofing contractor's ability to provide a written estimate is weather and traffic.

[0006] Recently, solar panels have become popular. In order to install solar panels, the roof's slope, geometrical shape, and size as well as its orientation with respect to the sun all must be determined in order to provide an estimate of the number and type of solar panels required. Unfortunately, not all roofs on a building are proper size, geometrical shape, or orientation for use with solar panels.

SUMMARY

[0007] These and other objects are met by the systems and methods disclosed herein that determine and provide roof measurement information about the sizes, dimensions, slopes and orientations of the roof sections of a building roof. Roof measurement information may be used to generate a roof estimate report that provides and graphically shows this information. A roof estimation system that practices at least some of the techniques described herein may include an image acquisition engine, a roof modeling engine, and a report generation engine. The roof estimation system is configured to generate a model of a roof of a building, based on one or more aerial images. In addition, the roof estimation system is configured to determine roof measurement information and generate a roof estimate report based on the generated model and/or the determined roof measurement information.

[0008] In some embodiments, the roof estimation system includes a user interface engine which provides access to at least some of the functions of the roof estimation system. In one embodiment, the user interface engine provides interactive user interface components operable by an operator to perform various functions related to generating a model of a roof of a building, including image registration, lean

correction, pitch determination, feature identification, and model review and/or correction.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] Figure 1 is a block diagram illustrating example functional elements of one embodiment of a roof estimation system.

[0010] Figures 2A-2B illustrate aerial images of a building at a particular address.

[0011] Figures 3A-3F illustrate individual pages of an example roof estimate report generated by an example embodiment of a roof estimation system.

[0012] Figures 4A-4F are screen displays illustrating image registration and image lean correction in an example embodiment. (Also shows lean correction.)

[0013] Figures 5A-5D are screen displays illustrating pitch determination in an example embodiment.

[0014] Figures 6A-6D are screen displays illustrating model construction and concurrent display of operator specified roof features in an example embodiment.

[0015] Figures 7A-7C are screen displays illustrating roof model review in an example embodiment.

[0016] Figure 8 is an example block diagram of a computing system for practicing embodiments of a roof estimation system.

[0017] Figure 9 is an example flow diagram of an image registration routine provided by an example embodiment.

[0018] Figure 10 is an example flow diagram of a pitch determination routine provided by an example embodiment.

[0019] Figure 11 is an example flow diagram of concurrent feature display routine provided by an example embodiment.

DETAILED DESCRIPTION

[0020] Embodiments described herein provide enhanced computer- and network-based methods, techniques, and systems for estimating construction projects based

on one or more images of a structure. Example embodiments provide a Roof Estimation System ("RES") that is operable to provide a roof estimate report for a specified building, based on one or more aerial images of the building. In one embodiment, a customer of the RES specifies the building by providing an address of the building. The RES then obtains one or more aerial images showing at least portions of the roof of the building. Next, the RES generates a model of the roof of the building, which is then utilized to determine roof measurement information. The roof measurement information may include measurements such as lengths of the edges of sections of the roof, pitches of sections of the roof, areas of sections of the roof, etc. The model of the roof and/or the roof measurement information is then used to generate a roof estimate report. The roof estimate report includes one or more line drawings of the roof of the building, which are annotated with information about the roof, such as lengths of the edges of sections of the roof, pitches of sections of the roof, areas of sections of the roof, etc.

[0021] Some embodiments of the roof estimation system include an interactive user interface configured to provide access to one or more of the functions of the roof estimation system. In one embodiment, the roof estimation system includes user interface controls that facilitate image registration, image lean correction, roof model generation, pitch determination, and roof model review. Image registration includes aligning, based at least in part on operator inputs, one or more images of a building roof to a set of reference points within a single three-dimensional ("3D") grid that is shared between the one or more images. Roof model generation includes generating a 3D model of a roof, based at least in part on operator inputs specifying various features and/or dimensional attributes of the roof. Roof model generation may further include the determination of the pitches of various planar sections of a roof. Roof model review includes display of a model of a roof, possibly in conjunction with one or more images of the roof, so that an operator may review the model for accuracy and possibly make adjustments and/or corrections to the roof model. In other embodiments, all or some of the functions of the roof estimation system may be

performed automatically. For example, image registration may include automatically identifying building features for the placement of reference markers. Further, roof model generation may include automatically recognizing features, dimensional attributes, and/or pitches of various planar roof sections of the roof.

[0022] The described user interface is also configured to concurrently display roof features onto multiple images of a roof. For example, in the context of roof model generation, an operator may indicate a roof feature, such as an edge or a corner of a section of the roof, in a first image of the roof. As the roof estimation system receives the indication of the roof feature, the user interface concurrently displays that feature in one or more other images of the roof, so that the operator may obtain feedback regarding the accuracy of the roof model, the image registration, etc.

[0023] In the following, Figures 1-3 provide an overview of the operation of an example roof estimation system. Figures 4-7 provide additional details related to an example interactive user interface provided by one embodiment of the roof estimation system. Figures 8-11 provide details related to roof estimation system implementation techniques.

1. Roof Estimation System Overview

[0024] Figure 1 is a block diagram illustrating example functional elements of one embodiment of a roof estimation system. In particular, Figure 1 shows an example Roof Estimation System ("RES") 100 comprising an image acquisition engine 101, a roof modeling engine 102, a report generation engine 103, image data 105, model data 106, and report data 107. The RES 100 is communicatively coupled to an image source 110, a customer 115, and optionally an operator 120. The RES 100 and its components may be implemented as part of a computing system, as will be further described with reference to Figure 8.

[0025] More specifically, in the illustrated embodiment of Figure 1, the RES 100 is configured to generate a roof estimate report 132 for a specified building, based on aerial images 131 of the building received from the image source 110. The image

source 110 may be any provider of images of the building for which a roof estimate is being generated. In one embodiment, the image source 110 includes a computing system that provides access to a repository of aerial images of one or more buildings. In addition, the aerial images 131 may include images obtained via manned or unmanned aircraft (*e.g.*, airplane, helicopter, blimp, drone, etc.), satellite, etc. Furthermore, the aerial images 131 may include images obtained via one or more ground-based platforms, such as a vehicle-mounted camera that obtains street-level images of buildings, a nearby building, a hilltop, etc. In some cases, a vehicle-mounted camera may be mounted in an elevated position, such as a boom. Example aerial images are described further with reference to Figures 2A-2B

[0026] The image acquisition engine 101 obtains one or more aerial images of the specified building by, for example, providing an indicator of the location of the specified building (*e.g.*, street address, GPS coordinates, lot number, etc.) to the image source 110. In response, the image source 110 provides to the image acquisition engine 101 the one or more aerial images of the building. The image acquisition engine 101 then stores the received aerial images as image data 105, for further processing by other components of the RES 100. Obtaining aerial images of a specified building may include various forms of geo-coding, performed by the image acquisition engine 101 and/or the image source 110. In one embodiment, the image source geo-codes a provided street address into latitude and longitude coordinates, which are then used to look up (*e.g.*, query a database) aerial images of the provided street address.

[0027] Next, the roof modeling engine 102 generates a model of the roof of the specified building. In the illustrated embodiment, the roof modeling engine 102 generates a three-dimensional ("3D") model, although in other embodiments, a two-dimensional (*e.g.*, top-down roof plan) may be generated instead or in addition. Generating a model of the roof may generally include image calibration, in which the distance between two pixels on a given image is converted into a physical length.

Image calibration may be performed automatically, such as based on meta-information provided along with the aerial images 131.

[0028] A variety of automatic and semi-automatic techniques may be employed to generate a model of the roof of the building. In one embodiment, generating such a model is based at least in part on a correlation between at least two of the aerial images of the building. For example, the roof modeling engine 102 receives an indication of a corresponding feature that is shown in each of the two aerial images. In one embodiment, an operator 120, viewing two or more images of the building, inputs an indication in at least some of the images, the indications identifying which points of the images correspond to each other for model generation purposes.

[0029] The corresponding feature may be, for example, a vertex of the roof of the building, the corner of one of the roof planes of the roof, a point of a gable or hip of the roof, etc. The corresponding feature may also be a linear feature, such as a ridge or valley line between two roof planes of the roof. In one embodiment, the indication of a corresponding feature on the building includes "registration" of a first point in a first aerial image, and a second point in a second aerial image, the first and second points corresponding to substantially the same point on the roof of the building. Generally, point registration may include the identification of any feature shown in both aerial images. Thus, the feature need not be a point on the roof of the building. Instead, it may be, for example, any point that is visible on both aerial images, such as on a nearby building (*e.g.*, a garage, neighbor's building, etc.), on a nearby structure (*e.g.*, swimming pool, tennis court, etc.), on a nearby natural feature (*e.g.*, a tree, boulder, etc.), etc.

[0030] In some embodiments, the roof modeling engine 102 determines the corresponding feature automatically, such as by employing on one or more image processing techniques used to identify vertexes, edges, or other features of the roof. In other embodiments, the roof modeling engine 102 determines the corresponding feature by receiving, from the human operator 120 as operator input 133, indications of the feature shown in multiple images of the building.

[0031] In one example embodiment, the RES 100 generates a model of the roof of the building in the following manner. First, a set of reference points are be identified in each of the images. These reference points are identified by the operator 120 utilizing a suitable input device, such as a mouse or joystick. The roof modeling engine 102 then uses these reference points and any acceptable algorithm to co-register the images and reconstruct the three-dimensional geometry of the object identified by the reference points. There are a variety of photogrammetric algorithms that can be utilized to perform this reconstruction. One such algorithm used by the RES 100 uses photographs taken from two or more view points to "triangulate" points of interest on the object in three-dimensional ("3D") space. This triangulation can be visualized as a process of projecting a line originating from the location of the photograph's observation point that passes through a particular reference point in the image. The intersection of these projected lines from the set of observation points to a particular reference point identifies the location of that point in 3D space. Repeating the process for all such reference points allows the software to determine a 3D volume suitable for building a 3D model of the structure. The choice of reconstruction algorithm depends on a number of factors such as the spatial relationships between the photographs, the number and locations of the reference points, and any assumptions that are made about the geometry and symmetry of the object being reconstructed. Several such algorithms are described in detail in textbooks, trade journals, and academic publications.

[0032] In addition, generating a model of the roof of a building may include correcting one or more of the aerial images for various imperfections. For example, the vertical axis of a particular aerial image sometimes will not substantially match the actual vertical axis of its scene. This will happen, for example, if the aerial images were taken at different distances from the building, or at a different pitch, roll, or yaw angles of the aircraft from which the images were produced. In such cases, an aerial image may be corrected by providing the operator 120 with a user interface control operable to adjust the scale and/or relative angle of the aerial image to correct for such errors.

The correction may be either applied directly to the aerial image, or instead be stored (*e.g.*, as an offset) for use in model generation or other functions of the RES 100.

[0033] Generating a model of the roof of a building further includes the automatic or semi-automatic identification of features of the roof of the building. In one embodiment, one or more user interface controls may be provided, such that the operator 120 may indicate (*e.g.*, draw, paint, etc.) various features of the roof, such as valleys, ridges, hips, vertexes, planes, edges, etc. As these features are indicated by the operator 120, a corresponding three-dimensional ("3D") model may be updated accordingly to include those features. These features are identified by the operator based on a visual inspection of the images and by providing inputs that identify various features as valleys, ridges, hips, etc. In some cases, a first and a second image view of the roof (*e.g.*, a north and east view) are simultaneously presented to the operator 120, such that when the operator 120 indicates a feature in the first image view, a projection of that feature is automatically presented in the second image view. By presenting a view of the 3D model, simultaneously projected into multiple image views, the operator 120 is provided with useful visual cues as to the correctness of the 3D model and/or the correspondence between the aerial images.

[0034] In addition, generating a model of the roof of a building may include determining the pitch of one or more of the sections of the roof. In some embodiments, one or more user interface controls are provided, such that the operator 120 may accurately determine the pitch of each of the one or more roof sections. An accurate determination of the roof pitch may be employed (by a human or the RES 100) to better determine an accurate cost estimate, as roof sections having a low pitch are typically less costly surfaces to repair and/or replace.

[0035] The generated model typically includes a plurality of planar roof sections that each correspond to one of the planar sections of the roof of the building. Each of the planar roof sections in the model has a number of associated dimensions and/or attributes, among them slope, area, and length of each edge of the roof section. Other information may include any information relevant to a roof builder or other entity

having an interest in construction of, or installation upon, the roof. For example, the other information may include identification of valleys, ridges, rakes, eaves, or hip ridges of the roof and/or its sections; roof and/or roof section perimeter dimensions and/or outlines; measurements of step heights between different roof levels (*e.g.*, terraces); bearing and/or orientation of each roof section; light exposure and/or shadowing patterns due to chimneys, other structures, trees, latitude, etc.; roofing material; etc[[?]]. Once a 3D model has been generated to the satisfaction of the roof modeling engine 102 and/or the operator 120, the generated 3D model is stored as model data 106 for further processing by the RES 100. In one embodiment, the generated 3D model is then stored in a quality assurance queue, from which it is reviewed and possibly corrected by a quality control operator.

[0036] The report generation engine 103 generates a final roof estimate report based on a model stored as model data 106, and then stores the generated report as report data 107. Such a report typically includes one or more plan (top-down) views of the model, annotated with numerical values for the slope, area, and/or lengths of the edges of at least some of the plurality of planar roof sections of the model of the roof. The report may also include information about total area of the roof, identification and measurement of ridges and/or valleys of the roof, and/or different elevation views rendered from the 3D model (top, side, front, etc). An example report is illustrated and discussed with respect to Figures 3A-3E, below.

[0037] In some embodiments, generating a report includes labeling one or more views of the model with annotations that are readable to a human user. Some models include a large number of small roof details, such as dormers or other sections, such that applying uniformly sized, oriented, and positioned labels to roof section views results in a visually cluttered diagram. Accordingly, various techniques may be employed to generate a readable report, including automatically determining an optimal or near-optimal label font size, label position, and/or label orientation, such that the resulting report may be easily read and understood by the customer 115.

[0038] In addition, in some embodiments, generating a report includes automatically determining a cost estimate, based on specified costs, such as those of materials, labor, transportation, etc. For example, the customer 115 provides indications of material and labor costs to the RES 100. In response, the report generation engine 103 generates a roof estimate report that includes a cost estimate, based on the costs provided by the customer 115 and the attributes of the particular roof, such as area, pitch, etc.

[0039] In one embodiment, the generated report is then provided to a customer. The generated report can be represented, for example, as an electronic file (*e.g.*, a PDF file) or a paper document. In the illustrated example, roof estimate report 132 is transmitted to the customer 115. The customer 115 may be or include any human, organization, or computing system that is the recipient of the roof estimate report 132. For example, the customer 115 may be a property owner, a property manager, a roof construction/repair company, a general contractor, an insurance company, a solar power panel installer, a climate control (*e.g.*, heating, ventilation, and/or air conditioning) system installer, a roof gutter installer, an awning installer, etc. Reports may be transmitted electronically, such as via a network (*e.g.*, as an email, Web page, etc.) or by some shipping mechanism, such as the postal service, a courier service, etc.

[0040] In some embodiments, one or more of the models stored as model data 106 are provided directly to the customer or other computing system, without first being transformed into a report. For example, a model and/or roof measurement information based thereon may be exported and/or transmitted as a data file, in any suitable format, that may be consumed or otherwise utilized by some other computing system, such as a computer-aided design ("CAD") tool, a drawing program, a labor and material estimation software, a project management/estimation software, etc.

[0041] The RES 100 may be operated by various types of entities. In one embodiment, the RES 100 is operated by a roof estimation service that provides roof estimate reports to customers, such as roofing contractors, in exchange for payment.

In another embodiment, the RES 100 is operated by a roof construction/repair company, to generate roof estimate reports that are used internally and/or provided to customers, such as property owners.

[0042] In addition, the RES 100 may be operated in various ways. In one embodiment, the RES 100 executes as a desktop computer application that is operated by the operator 120. In another embodiment, the RES 100 executes as a network-accessible service, such as by a Web server, that may be operated remotely by the operator 120 and/or the customer 115. Additional details regarding the implementation of an example roof estimation system are provided with respect to Figure 8, below.

[0043] Figures 2A-2B illustrate aerial images of a building at a particular address. In the illustrated example, the aerial images are represented as stylized line drawings for clarity of explanation. As noted above, such aerial images may be acquired in various ways. In one embodiment, an aircraft, such as an airplane or helicopter is utilized to take photographs while flying over one or more properties. Such aircraft may be manned or unmanned. In another embodiment, a ground-based vehicle, such as a car or truck, is utilized to take photographs (*e.g.*, "street view" photographs) while driving past one or more properties. In such an embodiment, a camera may be mounted on a boom or other elevating member, such that images of building roofs may be obtained. In another embodiment, photographs may be taken from a fixed position, such as a tall building, hilltop, tower, etc.

[0044] In particular, Figure 2A shows a top plan (top-down) aerial image 210 of a building 200. The roof of the building 200 includes multiple planar roof sections 200a-200d. Figure 2A also shows a second aerial image 211 providing a perspective (oblique) view of the building 200. The roof sections 200a and 200c are also visible in image 211.

[0045] Figure 2B shows a top-down, wide angle image 212 of the building 200. The image 212 includes details of the surrounding areas 220 of the building 220. Information about the surrounding areas 220 of the building 220 are in some

embodiments used to determine additional cost factors related to a roof estimate. For example, the cleanup of, or access to, a worksite at building 220 may be complicated by various factors, including a substantial amount of landscaping; steeply sloped building sites; proximity to environmentally sensitive areas; etc. In such cases, the roof estimation system may automatically increase a cost factor in a corresponding roof estimate report.

[0046] In some embodiments, an aerial image has corresponding meta-information. Such meta-information may include details about the type of camera used (*e.g.*, focal length, exposure, etc.), the position of the camera (*e.g.*, GPS coordinates of the aircraft at the time the image was captured), the orientation of the camera (*e.g.*, the angle of the camera), the time and/or date the image was captured, etc.

[0047] Figures 3A-3F illustrate individual pages of an example roof estimate report generated by an example embodiment of a roof estimation system. As discussed with respect to Figure 1, a roof estimate report is generated by the roof estimation system based on one or more aerial images of a building. The roof estimate report may be based on a computer model (*e.g.*, a 3D model) of the roof, and includes one or more views of the model. In this example, the various views of the model are presented as annotated line drawings, which provide information about the roof, such as the roof section areas, roof section edge lengths, roof section pitches, etc. The roof estimate report may be in an electronic format (*e.g.*, a PDF file) and/or paper format (*e.g.*, a printed report). In some embodiments, the roof estimate report may be in a format that may be consumed by a computer-aided design program.

[0048] Figure 3A shows a cover page 301 of the report and includes the address 301a of a building 301c and an overhead aerial image 301b of the building 301c.

[0049] Figure 3B shows a second page 302 of the report and includes two wide perspective (oblique) views 302a and 302b of the building 301c at the address with the surrounding areas more clearly shown.

[0050] Figure 3C shows a third page 303 of the report and includes a line drawing 303a of the building roof showing ridge lines 303b and 303c, and a compass indicator

303d. In addition, a building roof having valleys would result in a line drawing including one or more valley lines. The ridge and/or valley lines may be called out in particular colors. For example, ridge lines 303b and 303c may be illustrated in red, while valley lines may be illustrated in blue. The line drawing 303a is also annotated with the dimensions of the planar sections of the building roof. In this case, the dimensions are the lengths of the edges of the planar roof sections.

[0051] Figure 3D shows a fourth page 304 of the report and includes a line drawing 304a of the building roof showing the pitch of each roof section along with a compass indicator. The pitch in this example is given in inches, and it represents the number of vertical inches that the labeled planar roof section drops over 12 inches of horizontal run. The slope can be easily calculated from such a representation using basic trigonometry. The use of a numerical value of inches of rise per foot of run is a well known measure of slope in the roofing industry. A roof builder typically uses this information to assist in the repair and/or construction of a roof. Of course, other measures and/or units of slope may be utilized as well, including percent grade, angle in degrees, etc.

[0052] Figure 3E shows a fifth page 305 of the report and includes a line drawing 305a of the building roof showing the square footage of each roof section along with the total square foot area value. Of course, other units of area may be used as well, such as square meters or the number of “squares” of roofing material required for covering each roof section.

[0053] Figure 3F shows a fifth page 306 of the report and includes a line drawing 306a of the building roof where notes or comments may be written. The line drawing 306a includes a label for each roof section (shown here as “A”, “B”, “C”), such that comments may be conveniently related to specific roof sections.

[0054] In other embodiments, more or less information may be provided, or the illustrated information may be arranged in different ways. For example, the report may be provided in electronic form, such as a PDF file or a computer aided design software format. In some embodiments, the report may be “active” or editable, such

that the user of the report may make changes to the report, based on on-site observations.

2. Roof Estimation System User Interface

[0055] Figures 4A-4F, 5A-5D, 6A-6D, and 7A-7C describe an example interactive user interface provided by one embodiment of the roof estimation system. As noted, the RES 100 described with reference to Figure 1 includes a user interface engine 104 that is configured to provide access to one or more functions of the RES 100, including image registration (described with respect to Figures 4A-4F), roof pitch determination (described with respect to Figures 5A-5D), roof model construction (described with reference to Figures 6A-6D), and roof model review (described with respect to Figures 7A-7C).

A. Image Registration

[0056] Figures 4A-4F are screen displays illustrating image registration and image lean correction in an example embodiment. In particular, Figure 4A shows a user interface screen 400 that is utilized by an operator to generate a three dimensional model of a roof of a building. The user interface screen 400 shows a roof modeling project in an initial state, after the operator has specified an address of a building and after images of the building have been obtained and loaded into the roof estimation system.

[0057] The user interface screen 400 includes a control panel 401 and five images 402-406 of a building roof 407. The control panel 401 includes user selectable controls (*e.g.*, buttons, check boxes, menus, etc.) for various roof modeling tasks, such as setting reference points for the images, setting the vertical (Z) axis for the images, switching between different images, saving the model, and the like. Each of the images 402-406 provides a different view of the building roof 407. In particular, images 402-406 respectively provide substantially top-down, south, north, west, and east views of the building roof 407. Each image 402-406 includes four marker

controls (also called "reference points" or "registration markers") that are used by the operator to set reference points in the image for purposes of image registration. The registration markers will be described further with respect to an enlargement of image portion 408 described with respect to Figures 4B-4C, below.

[0058] Figures 4B-4C show an enlarged view of image portion 408 during the process of image registration for image 402, which provides a top-down view of the building roof 407. As shown in Figure 4B, image portion 408 includes the building roof 407 and registration markers 410-413. The markers 410-413 are interactive user interface controls that can be directly manipulated (*e.g.*, moved, rotated, etc.) by the operator in order to specify points to use for purposes of image registration. In particular, image registration includes determining a transformation between each of one or more images and a uniform 3D reference grid. The uniform 3D reference grid is used as a coordinate system for a 3D model of the roof. By registering multiple images to the reference grid, an operator may indicate a roof feature on an image (such as a roof edge), which may then be translated from the coordinate system of the image to the coordinate system of the reference grid, for purposes of including the indicated feature in the 3D model.

[0059] Marker 410 is an origin marker control, and includes arms 410a-410c. Arms 410a and 410b are horizontal arms that are utilized to specify the X and Y axes (*e.g.*, the horizontal plane) of the reference grid. Arm 410c is a vertical arm that may be utilized to specify the Z axis (*e.g.*, the vertical axis) of the reference grid. The use of the vertical arm to specify the Z axis will be further described with respect to Figure 4E, below.

[0060] Typically, markers 410-413 are color coded, such that they may be distinguished from one another. For example, marker 411-413 may be respectively colored red, blue, and green. Origin marker 410 has a different appearance than markers 411-413, so may be of any color. In other embodiments, markers 411-413 may be distinguished in other ways, such as by utilizing different sized dashed lines,

different line thicknesses, etc. In still other embodiments, markers are not distinguished any way from each other, such as by being of uniform shape, color, etc.

[0061] Figure 4C shows image portion 408 with markers 410-413 after they have been placed by an operator. Typically, registration markers are placed at four spatially distributed corners of the roof. As shown in Figure 4C, the operator has placed markers 410-413 at four different corners of the building roof 407. In particular, the operator first placed the origin marker 410 at the lower left corner of the building roof 407, and has adjusted (*e.g.*, rotated) the arms 410a and 410b to align with the major horizontal axes of the roof. By adjusting the arms 410a and 410b of the origin marker 410, the rotational orientation of markers 411-413 is automatically adjusted by the roof estimation system. Next, the operator places markers 411-413 on some other corners of the roof. In general, the operator can place registration marker over any roof feature, but roof corners are typically utilized because they are more easily identified by the operator. After the operator is satisfied with the placement of markers 410-413, the operator typically registers a next image of the building roof 407, as will be described next.

[0062] Figures 4D-4F illustrate image registration for image 404, which provides a north view of the building roof 407. In particular, Figure 4D shows the user interface screen 400 described with reference to Figure 4A. Here, image 402 has been minimized, while image 404 has been enlarged so that the operator may register that image by placing markers on image 404, as will be described below with respect to an enlarged view of image portion 418.

[0063] Figure 4E shows an enlarged view of image portion 418 during the process of image registration for image 404. Image portion 418 includes the building roof 407 and registration markers 420-423. Markers 420-423 respectively correspond to markers 410-413 described above. In particular, marker 420 is an origin marker control that includes arms 420a-420c. Arms 420a and 420b are horizontal arms that are utilized to specify the X and Y axes of the reference grid. Arm 420c is a vertical arm that may be utilized to specify the Z axis of the reference grid.

[0064] In the example of Figure 4E, the operator has moved each of markers 420-423 to a corner of the roof 407. Note that the markers 420-423 are moved to roof corners that correspond to those selected by the operator with markers 410-413, as described with reference to Figure 4C. In particular, origin marker 420 has been moved to the corner of the roof 407 selected with origin marker 410 in image 408; marker 421 has been moved to the corner selected with marker 411 in image 408; marker 422 has been moved to the corner selected with marker 412 in image 408; and marker 423 has been moved to the corner selected with marker 413 in image 408. In addition, markers 420-423 have been rotated, by operator rotation of the origin marker 420, to align with the major axes of the roof 407.

[0065] As noted, the operator can utilize the origin marker 420 to specify the vertical axis of the reference grid. In particular, the operator can adjust (*e.g.*, by dragging with a mouse or other pointing device) arm 420c of marker 420 to specify the vertical (Z) axis of the image. In some cases, aerial images may include some amount of lean, due to the orientation of the aircraft during image capture. For example, pitch, yaw, or roll of an aircraft during the course of image capture may result in images that are misaligned with respect to the vertical axis of the building and its roof. Typically, an operator may adjust arm 420c to line up with a feature of a building or roof that is known to be substantially vertical, such as a wall of a house or a chimney. Then, based on the angle of arm 420c with respect to the vertical axis of the image, the roof estimation system can determine a correction between the reference grid and the image.

[0066] Figure 4F shows an enlarged view of image portion 418 after registration of image 404. Once the operator has placed and adjusted markers 420-423, the operator may direct (*e.g.*, by clicking a button) the roof estimation system to register the image to the reference grid, based on the positions and orientations of markers 420-423. Once the roof estimation system registers the image, it provides the operator with feedback so that the operator may determine the correctness or accuracy of the registration.

[0067] In the example of Figure 4F, the operator has directed the roof estimation system to register image 404, and the roof estimation system has updated image portion 418 with registration indicators 430-433. Registration indicators 430-433 provide the operator with feedback so that the operator may judge the accuracy of the registration of image 404.

[0068] Registration indicator 430 is an origin registration indicator that includes two arms 430a-430b and three reference grid indicators 430c-430e, shown as dashed lines. The reference grid indicators 430c-430e show the vertical axis (430c) and the two horizontal axes (430d and 430e) of the reference grid determined based on the placement and orientation of the markers 420-423. Arms 430a and 430b correspond to the placement of arms 420a-420c of origin marker 420. If the arms 430a and 430b do not substantially align with the corresponding reference grid indicators 430e and 430d, then the determined reference grid is out of alignment with the specified axes of the house. Typically, an operator will return to the view of Figure 4E to make adjustments to origin marker, such as adjusting one or more of the vertical or horizontal axes, in order to refine the registration of the image. Although the arms 430a-430b and the reference grid indicators 430c-430e are here illustrated as solid and dashed lines, in other embodiments they may be color coded. For example, arms 430a-430b may be red, while reference grid indicators 430c-430e may be blue.

[0069] Registration indicators 431-433 provide the operator with information regarding the accuracy of the placement of markers 421-423. In particular, each registration indicator 431-433 includes a solid crosshairs and a reference indicator, shown for example as a dashed line 432a. The crosshair of a registration indicator corresponds to the placement of a marker. For example, the crosshairs of registration indicator 431 corresponds to the placement of marker 421 in Figure 4E. If the reference indicator intersects the center (or substantially near the center) of the crosshairs of a registration indicator, then the operator knows that the placement of the corresponding marker is accurate. On the other hand, if the reference indicator does not intersect the center of the crosshairs of a registration indicator, then the operator

knows that the placement of the corresponding marker is inaccurate. Typically, such an inaccuracy arises when the placement of markers in the top view of the roof does not agree with (correspond to) the placement of corresponding markers in another view of the roof. In such cases, the operator can return to the view of Figure 4C or 4E to adjust the position of one or more markers.

[0070] After registering image 404, the operator will proceed to register additional images of the building roof 407 utilizing a process similar to that described above. In this example, the operator will register images 403, 405, and 406. Although the operator is here described as registering a total of five images, in other cases more or fewer images may be registered.

B. Roof Model Construction

[0071] Figures 5A-5D and 6A-6C generally illustrate aspects of the process of roof model generation based on multiple registered images. In particular, these figures illustrate the construction of a roof model by an operator. Model generation/construction may include identification of roof features shown in various images of the roof, such as edges, planar sections, vertexes, and the like, as well as determination of roof pitch and other dimensional attributes of the roof. Each identified roof feature is incorporated by the roof estimation system into a 3D model of the roof, based on a translation between an image in which the feature is identified and the reference grid, as determined by the process described with reference to Figures 4A-4F, above.

[0072] Figures 5A-5D are screen displays illustrating pitch determination in an example embodiment. In particular, Figure 5A shows the user interface screen 400 after images 402-406 have been registered. In this example, the operator is using a pitch determination control (also called a “pitch determination marker” or “pitch determination tool”) to specify the pitch of a planar roof section of the building roof 407 visible in image 406. The pitch determination control will be further described in Figure 5B, below, with respect to an enlargement of image portion 508.

[0073] Figure 5B shows an enlarged view of image portion 508 during the process of pitch determination for image 406, which provides an east perspective view of the building roof 407. As shown in Figure 5B, the image portion 508 includes the building roof 407 and a pitch determination marker 510 (also called a "protractor tool"). The pitch determination marker 510 is an interactive user interface control that can be directly manipulated by the operator in order to specify the pitch of a section of the building roof 407.

[0074] The pitch determination marker 510 includes arms 510a-510d. Arms 510a-510c are axes, which are automatically aligned, based on the registration of image 406, with the major (X, Y, and Z) axes of the building roof. Arm 510d is a "protractor" arm that is adjustable by the operator to specify roof pitch.

[0075] The marker 510 is typically first moved by the operator to a convenient location on the building roof 407, usually corner of a planar section of the roof 407. Next, the operator adjusts arm 510d so that it substantially aligns with the sloped edge of the planar roof section. Then, the roof estimation system determines the pitch of the roof section, based on the configuration of the marker 510 with respect to the image and the reference grid.

[0076] After specifying the pitch of a planar roof section, the operator will typically specify other information about the planar roof section, such as its outline, as will be described with reference to Figures 6A-6D. Note that as the operator provides additional information about the geometry of the roof 407, the roof estimation system may automatically determine the pitch and/or other features of at least some of the other planar roof sections, based on the provided geometric information and/or assumptions about roof symmetry or other standard architectural practices.

[0077] Figure 5C shows a second type of pitch determination marker being used in the context of image 403 which provides a south perspective view of the building roof 407. The illustrated pitch determination marker may be used in addition to, or instead of, the pitch determination marker 510 described with respect to Figures 5A-5B, above. In particular, Figure 5C shows a pitch determination marker 520 (also called an

"envelope tool") that includes surfaces 520a and 520b. The pitch determination marker 520 is an interactive user interface control that can be directly manipulated by the operator in order to specify the pitch of a section of the building roof 407. In particular, the pitch determination marker 520 may be moved and/or adjusted so that it appears to lie substantially atop two adjacent planar sections of roof 407.

[0078] Figure 5D shows the pitch determination marker 520 after the operator has used it to specify the pitch of two sections of roof 407. Here, the operator has moved the marker 520 to a position in which the spine of the marker 520 is substantially aligned with the ridge line of roof 407. Then, the operator has adjusted the angle of the surfaces 520a and 520b so that they appear to lie substantially atop corresponding sections of roof 407. Then, the roof estimation system determines the pitch of the roof sections, based on the configuration of the marker 520 with respect to the image and the reference grid. Also illustrated are pitch indicators 521 and 522. Pitch indicator 521 corresponds to the measured pitch of surface 520a, and pitch indicator 522 corresponds to the measured pitch of surface 520b. As the operator adjusts the angle of surfaces 520a and/or 520b, the corresponding pitch indicators 521-522 are automatically updated to reflect the determined pitch. In this example, the pitch of both surfaces is given as 4 inches of rise per foot of run.

[0079] The envelope pitch determination marker 520 may be adjusted in other ways, to specify pitches for types of roofs other than the gabled roof shown in image 403. For example, when measuring pitch of roof sections that form a roof hip, point 520c may be manipulated by the operator, such as by dragging it to the left or right, to adjust the shape of the surfaces 520a and 520b, so that the surfaces align with the edges formed by the intersection of the sections that form the roof hip.

[0080] Figures 6A-6D are screen displays illustrating model construction and concurrent display of operator specified roof features in an example embodiment. In particular, Figures 6A-6D illustrate the construction of a three dimensional wire frame model of a building roof, based on the specification of roof features by an operator. In

addition, Figures 6A-6D illustrate the concurrent display of operator specified roof features in multiple views of a building roof.

[0081] Figure 6A shows the user interface screen 400 after images 402-406 have been registered, and after roof pitches have been determined. In this example, the operator is specifying sections of roof 407, visible in image 406, that are to be added to a 3D wire frame model of the roof 407 maintained by the roof estimation system. The specification of roof sections will be further described with reference to enlarged portion 608 of image 406 in Figure 6B, below. In addition, as the operator specifies roof sections in image 406, the roof estimation system concurrently displays the specified roof sections in each of the other images 402-405. The concurrent display of operator specified roof features will be further described with reference to enlarged portion 609 of image 402 in Figure 6C, below.

[0082] Figure 6B is an enlarged view of image portion 608 during the process of wire frame model construction in the context of image 406, which provides an east perspective view of the building roof 407. As shown in Figure 6B, the image portion 608 includes the building roof 407, drawing tool 610, and wire frame 611. The drawing tool 610 (also called a “drawing marker” or a “drawing control”) is an interactive user interface control that can be directly manipulated by the operator in order to specify roof features, such as edges, ridges, valleys, corners, etc. In the illustrated embodiment, the operator uses the drawing tool 610 to trace or outline planar sections of the roof 407, leading to the generation of wire frame 611. The drawing tool 610 may be used to establish a series of connected line segments that result in a closed polygon representing a planar roof section. As the operator specifies a planar roof section in this manner, the roof estimation system determines, based on the image and the reference grid, the geometry of the planar roof section, and includes (adds) the specified planar roof section in a 3D model that corresponds to roof 407.

[0083] Figure 6C is an enlarged view of image portion 609 illustrating the concurrent display of operator specified roof features, in the context of image 402, which provides

a top plan view of the building roof 407. As the operator specifies roof sections as described with respect to Figure 6B, the roof estimation system concurrently displays the specified roof features in one or more of the other images displayed by the user interface screen 400. More specifically, image portion 609 includes building roof 407 and wire frame 612. Wire frame 612 corresponds to wire frame 611 constructed by the operator with reference to Figure 6B, except that wire frame 612 is automatically displayed as a projection from the 3D model into the top-down view of image 402. Changes that the operator makes to wire frame 611 are concurrently displayed by the roof estimation system as wire frame 612 in image portion 609. For example, if a new planar roof section is added by the operator to wire frame 611, the new planar roof section is automatically displayed in wire frame 612. By concurrently displaying operator identified features in multiple views of building roof 407, the operator obtains feedback regarding the correctness and/or accuracy of the 3D model or other aspects of the model generation process, such as image registration and pitch determination.

[0084] Generally, the roof estimation system can be configured to concurrently display any operator-identified features, such as corners, ridges, valleys, planar sections, and the like, in multiple views of a building.

[0085] Furthermore, the concurrently displayed wire frame 612 is an interactive user interface element, in that the operator can make changes to the wire frame 612, which are then concurrently displayed in wire frame 611. Wire frames similar to those described above are also projected by the roof estimation system into images 403, 404, and 405 displayed by the user interface screen 400. In this manner, the operator can switch between various images of the building roof 407, making refinements to the 3D model by adjusting the wire frame in whichever image is more convenient and/or provides a more suitable perspective/view of the model.

[0086] Figure 6D shows the user interface screen 400 during construction of a 3D model of the building roof 407. In particular, the user interface 400 includes a shaded wire frame 613 representation of the 3D model constructed as described above. In this view, the operator can review the wire frame 613 in isolation from any images to

determine whether the wire frame 613 accurately represents the building roof 407. The wire frame 613 is an interactive user interface component, in that it can be directly manipulated (*e.g.*, moved, rotated, resized, etc.). In some embodiments, manipulating the wire frame 613, such as by changing its shape, results in corresponding changes in the underlying 3D model.

C. Roof Model Review

[0087] Figures 7A-7C are screen displays illustrating roof model review in an example embodiment. In particular, Figures 7A-7C illustrate various techniques to facilitate the review of a roof model by an operator. Reviewing the roof model may include reviewing roof section pitches (*e.g.*, to determine whether they conform to the building roof and/or standard construction practices), reviewing the shape and/or location of the roof model (*e.g.*, to determine whether it substantially conforms to the building roof), etc.

[0088] Figure 7A shows the user interface screen 400 after the operator has constructed a model of the roof 407 using one or more of the images 402-406. In this example, a wire frame has been projected onto (superimposed upon) image 402 and annotated with roof section pitches, as will be described further with respect to enlarged portion 708 of image 402 in Figure 7B, below.

[0089] Figure 7B is an enlarged view of image portion 708 during the process of roof model review in the context of image 402, which provides a substantially top plan view of the building roof 407. As shown in Figure 7B, the image portion 708 includes a wire frame 710 and labels 711a-711c that indicate pitches of corresponding sections of roof 407. The wire frame 710 and the illustrated pitches are determined by the roof estimation system based on the pitch determination described with respect to Figures 5A-5D, above, and the operator's specification of the wire frame model described with respect to Figures 6A-6D, above.

[0090] The wire frame 710 includes multiple vertexes connected by line segments. Each vertex includes a handle, such as handle 710a. The handles may be directly

manipulated (individually or in groups) by the operator to make adjustments/modifications to the wire frame 710. For example, when an operator drags handle 710a to a new location, the ends of the two line segments connected to handle 710a will also move to the new location.

[0091] Figure 7C is an alternative view of the 3D model of roof 407 during the process of roof model review. In Figure 7C, the user interface screen 400 includes a wire frame 720 representation of the 3D model of the roof 407. The wire frame 720 consists of multiple line segments corresponding to edges of planar roof sections. Each line segment is annotated with a label, such as label 723, indicating the determined length of the corresponding roof section edge. Furthermore, some of the line segments indicate that they correspond to a particular roof feature. For example, line segments 721 and 722 may be colored (*e.g.*, red) so as to indicate that they correspond to roof ridges. Other line segments may be differently colored (*e.g.*, blue) so as to indicate a correspondence to roof valleys or other features. In addition, the wire frame 720 may be directly manipulated by the operator in order to make adjustments to the underlying model of the roof 407. For example, the operator could increase or decrease the length of line segment 721, resulting in a change in the corresponding feature of the 3D model of roof 407.

[0092] Note that although the operator is shown, in Figures 5-7 above, operating upon a total of five images, in other cases, fewer images may be used. For example, in some cases fewer images may be available, or some images may provide obstructed views of the building roof, such as due to tree cover, neighboring buildings, etc.

3. Implementation Techniques

[0093] Figure 8 is an example block diagram of a computing system for practicing embodiments of a roof estimation system. Figure 8 shows a computing system 800 that may be utilized to implement a Roof Estimation System ("RES") 810. One or more general purpose or special purpose computing systems may be used to implement the RES 810. More specifically, the computing system 800 may comprise

one or more distinct computing systems present at distributed locations. In addition, each block shown may represent one or more such blocks as appropriate to a specific embodiment or may be combined with other blocks. Moreover, the various blocks of the RES 810 may physically reside on one or more machines, which use standard inter-process communication mechanisms (*e.g.*, TCP/IP) to communicate with each other. Further, the RES 810 may be implemented in software, hardware, firmware, or in some combination to achieve the capabilities described herein.

[0094] In the embodiment shown, computing system 800 comprises a computer memory ("memory") 801, a display 802, one or more Central Processing Units ("CPU") 803, Input/Output devices 804 (*e.g.*, keyboard, mouse, joystick, track pad, CRT or LCD display, and the like), other computer-readable media 805, and network connections 806. The RES 810 is shown residing in memory 801. In other embodiments, some portion of the contents, some of, or all of the components of the RES 810 may be stored on and/or transmitted over the other computer-readable media 805. The components of the RES 810 preferably execute on one or more CPUs 803 and generate roof estimate reports, as described herein. Other code or programs 830 (*e.g.*, a Web server, a database management system, and the like) and potentially other data repositories, such as data repository 820, also reside in the memory 801, and preferably execute on one or more CPUs 803. Not all of the components in Figure 8 are required for each implementation. For example, some embodiments embedded in other software do not provide means for user input, for display, for a customer computing system, or other components.

[0095] In a typical embodiment, the RES 810 includes an image acquisition engine 811, a roof modeling engine 812, a report generation engine 813, an interface engine 814, and a roof estimation system data repository 816. Other and/or different modules may be implemented. In addition, the RES 810 interacts via a network 850 with an image source computing system 855, an operator computing system 865, and/or a customer computing system 860.

[0096] The image acquisition engine 811 performs at least some of the functions of the image acquisition engine 101 described with reference to Figure 1. In particular, the image acquisition engine 811 interacts with the image source computing system 855 to obtain one or more images of a building, and stores those images in the RES data repository 816 for processing by other components of the RES 810. In some embodiments, the image acquisition engine 811 may act as an image cache manager, such that it preferentially provides images to other components of the RES 810 from the RES data repository 816, while obtaining images from the image source computing system 855 when they are not already present in the RES data repository 816. In other embodiments, images may be obtained in an "on demand" manner, such that they are provided, either by the image acquisition engine 811 or the image source computing system 855, directly to modules of the RES 810 and/or the operator computing system 865, without intervening storage in the RES data repository 816.

[0097] The roof modeling engine 812 performs at least some of the functions of the roof modeling engine 102 described with reference to Figure 1. In particular, the roof modeling engine 812 generates a model based on one or more images of a building that are obtained from the RES data repository 816 or directly from the image source computing system 855. As noted, model generation may be performed semi-automatically, based on at least some inputs received from the computing system 865. In addition, at least some aspects of the model generation may be performed automatically, based on image processing and/or image understanding techniques. After the roof modeling engine 812 generates a model, it stores the generated model in the RES data repository 816 for further processing by other components of the RES 810.

[0098] The report generation engine 813 performs at least some of the functions of the report generation engine 103 described with reference to Figure 1. In particular, the report generation engine 813 generates roof reports based on models stored in the RES data repository 816. Generating a roof report may include preparing one or more views of a given 3D model of a roof, annotating those views with indications of

various characteristics of the model, such as dimensions of sections or other features (*e.g.*, ridges, valleys, etc.) of the roof, slopes of sections of the roof, areas of sections of the roof, etc. In some embodiments, the report generation engine 813 facilitates transmission of roof measurement information that may or may not be incorporated into a roof estimate report. For example, the roof generation engine 813 may transmit roof measurement information based on, or derived from, models stored in the RES data repository 816. Such roof measurement information may be provided to, for example, third-party systems that generate roof estimate reports based on the provided information.

[0099] The interface engine 814 provides a view and a controller that facilitate user interaction with the RES 810 and its various components. For example, the interface engine 814 implements a user interface engine 104 described with reference to Figure 1. Thus, the interface engine 814 provides an interactive graphical user interface that can be used by a human user operating the operator computing system 865 to interact with, for example, the roof modeling engine 812, to perform functions related to the generation of models, such as point registration, feature indication, pitch estimation, etc. In other embodiments, the interface engine 814 provides access directly to a customer operating the customer computing system 860, such that the customer may place an order for a roof estimate report for an indicated building location. In at least some embodiments, access to the functionality of the interface engine 814 is provided via a Web server, possibly executing as one of the other programs 830.

[00100] In some embodiments, the interface engine 814 provides programmatic access to one or more functions of the RES 810. For example, the interface engine 814 provides a programmatic interface (*e.g.*, as a Web service, static or dynamic library, etc.) to one or more roof estimation functions of the RES 810 that may be invoked by one of the other programs 830 or some other module. In this manner, the interface engine 814 facilitates the development of third-party software, such as user interfaces, plug-ins, adapters (*e.g.*, for integrating functions of the RES 810 into desktop

applications, Web-based applications, embedded applications, etc.), and the like. In addition, the interface engine 814 may be in at least some embodiments invoked or otherwise accessed via remote entities, such as the operator computing system 865, the image source computing system 855, and/or the customer computing system 860, to access various roof estimation functionality of the RES 810.

[00101] The RES data repository 816 stores information related to the roof estimation functions performed by the RES 810. Such information may include image data 105, model data 106, and/or report data 107 described with reference to Figure 1. In addition, the RES data repository 816 may include information about customers, operators, or other individuals or entities associated with the RES 810.

[00102] In an example embodiment, components/modules of the RES 810 are implemented using standard programming techniques. For example, the RES 810 may be implemented as a "native" executable running on the CPU 803, along with one or more static or dynamic libraries. In other embodiments, the RES 810 is implemented as instructions processed by virtual machine that executes as one of the other programs 830. In general, a range of programming languages known in the art may be employed for implementing such example embodiments, including representative implementations of various programming language paradigms, including but not limited to, object-oriented (*e.g.*, Java, C++, C#, Matlab, Visual Basic.NET, Smalltalk, and the like), functional (*e.g.*, ML, Lisp, Scheme, and the like), procedural (*e.g.*, C, Pascal, Ada, Modula, and the like), scripting (*e.g.*, Perl, Ruby, Python, JavaScript, VBScript, and the like), declarative (*e.g.*, SQL, Prolog, and the like).

[00103] The embodiments described above may also use well-known synchronous or asynchronous client-server computing techniques. However, the various components may be implemented using more monolithic programming techniques as well, for example, as an executable running on a single CPU computer system, or alternatively decomposed using a variety of structuring techniques known in the art, including but not limited to, multiprogramming, multithreading, client-server, or peer-to-peer,

running on one or more computer systems each having one or more CPUs. Some embodiments execute concurrently and asynchronously, and communicate using message passing techniques. Equivalent synchronous embodiments are also supported by an RES implementation. Also, other functions could be implemented and/or performed by each component/module, and in different orders, and by different components/modules, yet still achieve the functions of the RES.

[00104] In addition, programming interfaces to the data stored as part of the RES 810, such as in the RES data repository 816, can be available by standard mechanisms such as through C, C++, C#, and Java APIs; libraries for accessing files, databases, or other data repositories; through scripting languages such as XML; or through Web servers, FTP servers, or other types of servers providing access to stored data. For example, the RES data repository 816 may be implemented as one or more database systems, file systems, memory buffers, or any other technique for storing such information, or any combination of the above, including implementations using distributed computing techniques.

[00105] Also, the example RES 810 can be implemented in a distributed environment comprising multiple, even heterogeneous, computer systems and networks. For example, in one embodiment, the image acquisition engine 811, the roof modeling engine 812, the report generation engine 813, the interface engine 814, and the data repository 816 are all located in physically different computer systems. In another embodiment, various modules of the RES 810 are hosted each on a separate server machine and are remotely located from the tables which are stored in the data repository 816. Also, one or more of the modules may themselves be distributed, pooled or otherwise grouped, such as for load balancing, reliability or security reasons. Different configurations and locations of programs and data are contemplated for use with techniques as described herein. A variety of distributed computing techniques are appropriate for implementing the components of the illustrated embodiments in a distributed manner including but not limited to TCP/IP sockets, RPC, RMI, HTTP, Web Services (XML-RPC, JAX-RPC, SOAP, and the like).

[00106] Furthermore, in some embodiments, some or all of the components of the RES are implemented or provided in other manners, such as at least partially in firmware and/or hardware, including, but not limited to one or more application-specific integrated circuits (ASICs), standard integrated circuits, controllers (*e.g.*, by executing appropriate instructions, and including microcontrollers and/or embedded controllers), field-programmable gate arrays (FPGAs), complex programmable logic devices (CPLDs), and the like Some or all of the system components and/or data structures may also be stored (*e.g.*, as software instructions or structured data) on a computer-readable medium, such as a hard disk, a memory, a network, or a portable media article to be read by an appropriate drive or via an appropriate connection. The system components and data structures may also be stored as data signals (*e.g.*, by being encoded as part of a carrier wave or included as part of an analog or digital propagated signal) on a variety of computer-readable transmission mediums, which are then transmitted, including across wireless-based and wired/cable-based mediums, and may take a variety of forms (*e.g.*, as part of a single or multiplexed analog signal, or as multiple discrete digital packets or frames). Such computer program products may also take other forms in other embodiments. Accordingly, embodiments of this disclosure may be practiced with other computer system configurations.

[00107] Figure 9 is an example flow diagram of an image registration routine provided by an example embodiment. The illustrated routine 900 may be provided by, for example, execution of the roof estimation system 810 described with respect to Figure 8. The illustrated routine 900 facilitates image registration based upon operator indicated registration points and/or image lean corrections.

[00108] More specifically, the routine begins in step 901, where it displays, on a user interface screen, an aerial image of a building having a roof. As part of the user interface screen, the routine also displays user interface controls such as markers that may be used by an operator for purposes of image registration and/or lean correction, as described with reference to Figure 4A, above.

[00109] In step 902, the routine receives, via one or more registration markers, indications of one or more points on the aerial image. The registration markers are manipulated by the operator to specify points on the aerial image, as described with reference to Figures 4A-4E. Typically, the points are visually identifiable features, such as corners of the roof of the building. For example, if the roof has four corners (*e.g.*, a northwest, southwest, northeast, and southeast corner) the operator may place one registration marker on each of the four corners as shown in the aerial image. Then, the positions (*e.g.*, coordinates on the aerial image) of the markers are transmitted to the routine for use in registering the aerial image, as described below.

[00110] In step 903, the routine receives, via a lean correction marker, an indication of the vertical axis of the building roof. In at least some cases, the aerial image of the building is out of alignment with respect to the vertical axis of the building. This may be caused, for example, by pitch, roll, and/or yaw experienced by the aircraft during the process of photographing the building. To correct for such misalignment, the lean correction marker is manipulated by the operator to indicate a vertical axis of the building. Typically, the operator aligns the lean correction marker with known, substantially vertical feature of the building, such as a chimney, wall corner, etc., as described with reference to Figure 4E, above. After the operator has aligned the lean correction marker, the position (*e.g.*, angle of the marker, coordinates of the endpoints of the marker, etc.) of the lean correction marker is transmitted to the routine for use in registering the aerial image, as described below.

[00111] Particular benefits may be obtained from lean correction performed in the context of an overhead, or “top down,” view. An “overhead lean” occurs when the camera is not directly overhead with respect to the building when the photo is taken. In some cases, leans in excess of 5 degrees have been observed in “top down” photos. Furthermore, unlike oblique, perspective views, a top-down lean is typically less likely to include a convenient visual marker that provides sufficient angle to assess the lean direction and magnitude, such as the edge of the building or a tall chimney. An overhead lean affects the perceived location of the roof lines in a top

down view. This effect is amplified as the pitch of the roof increases and/or as the vertical separation between disconnected roof sections increases. Without lean correction, superimposing a wire frame over the visible ridgelines (and other features of a building that reside at different elevations) may produce asymmetries in otherwise symmetric structures. Further, an absence of lean correction may introduce errors in pitch estimation, as the wire frame may not appear consistent between top and oblique view points. More specifically, without top view lean correction, the positions for the roof lines in an otherwise correct (*i.e.*, accurate with respect to the actual geometry of the roof) wire frame will typically not line up on the visible roof lines in the overhead reference photo. This often leads the user (or software) to either introduce errors by incorrectly drawing the wire frame to the image lines or perform a subjective determination of where and how to shift the wire frame lines off the image lines to produce a correct model. Top view lean correction allows the roof estimation system to trace to, or substantially to, the actual roof lines seen in the top image while still producing an accurate wire frame model.

[00112] Image misalignment may be specified in other ways. For example, in other embodiments, the operator may instead rotate the image to a position in which the building appears to be in a substantially vertical position. Then, the angle of rotation of the image may be transmitted to the routine for use in registering the aerial image.

[00113] In step 904, the routine registers, based on the received indications of the points and/or the received indication of the vertical axis, the aerial image to a reference grid. Registering the image to a reference grid may include determining a transformation between the reference grid and the image, based on the indicated points and/or the indicated vertical axis. Determining such a transformation may be based on other information as well, such as meta-information associated with the aerial image. In some embodiments, the aerial image has corresponding meta-information that includes image capture conditions, such as camera type, focal length, time of day, camera position (*e.g.*, latitude, longitude, and/or elevation), etc.

[00114] In step 905, the routine determines whether there are additional aerial images to be registered, and if so, returns to step 901, else proceeds to step 906. During execution of the loop of steps 901-905, the operator typically indicates, for each registration marker, the same feature (*e.g.*, corner) of the roof as shown in each of multiple images, such that the routine can register the multiple images to a single, uniform reference grid. Upon completion of the registration process, the routine has determined a uniform coordinate system for the multiple aerial images, for use during other phases of model construction, such as pitch determination or feature identification.

[00115] In step 906, the routine generates a three-dimensional model based at least in part on the aerial image(s) and the reference grid. As discussed above with reference to Figures 5A-5D and 6A-6D, model generation includes identification of roof features shown in various images of the roof, such as edges, planar sections, vertexes, and the like, as well as determination of roof pitch and other dimensional attributes of the roof. In other embodiments, the routine performs other functions with the registered images, such as storing them for later use (*e.g.*, by an automated model generation module), transmitting them to another computing (*e.g.*, for use in a third-party design application), etc. After step 906, the routine ends.

[00116] Note that in at least some embodiments, aspects of the routine 900 may be performed in an automated manner. For example, operations discussed above as being performed by an operator, such as the determination of the location of image registration points of step 902 and/or the indication of lean of step 903, may be performed by automated image processing techniques.

[00117] Figure 10 is an example flow diagram of a pitch determination routine provided by an example embodiment. The illustrated routine 1000 may be provided by, for example, execution of the roof estimation system 810 described with respect to Figure 8. The illustrated routine 1000 facilitates the determination of the pitch of a section of a roof, by displaying a pitch determination marker and modifying a 3D model of a roof based on an indication of roof pitch received via the pitch determination marker.

[00118] More specifically, the routine begins at step 1001 where it displays an aerial image of a building having a roof comprising a plurality of planar roof sections that each have a corresponding pitch. The aerial image is displayed in the context of a user interface screen, such as is described with reference to Figures 4A-6C, above. The aerial images may be received from, for example, the image source computing system 855 and/or from the RES data repository 816 described with reference to Figure 8. As discussed above, aerial images may be originally created by cameras mounted on airplanes, balloons, satellites, etc. In some embodiments, images obtained from ground-based platforms (*e.g.*, vehicle-mounted cameras) may be used instead or in addition.

[00119] In step 1002, the routine displays a pitch determination marker operable to indicate pitch of a planar roof section. The pitch determination marker may be, for example, a pitch determination marker 510 ("protractor tool") or 520 ("envelope tool"), such as are respectively described with respect to Figures 5B and 5C, above. The routine displays the pitch determination marker by, for example, presenting it on a user interface screen displayed on a computer monitor or other display device. The pitch determination marker is a direct manipulation user interface control, in that an operator may manipulate it (*e.g.*, adjust an angle, change its shape, alter its position, etc.) in order to indicate pitch of a planar roof section. Additional details regarding pitch determination controls are provided with respect to Figures 5A-5D, above.

[00120] In step 1003, the routine receives, via the displayed pitch determination marker, an indication of the pitch of one of the plurality of planar roof sections of the roof of the building. Receiving an indication of the pitch includes receiving an indication (*e.g.*, via an event, callback, etc.) that the marker has been manipulated by the operator, and then determining an angle based on the shape and/or position of the marker. In some embodiments, such an indication may be received on an event driven basis, such as every time the marker is manipulated in some manner. In other embodiments, the routine may poll the marker from time to time to determine its current state. In addition, the operator may explicitly indicate that the current state of

the marker is to be transmitted to the routine, such as by pressing a button or other indication.

[00121] In step 1004, the routine modifies a three-dimensional model of the roof based on the received indication of the pitch of the one planar roof section. Modifying the 3D model of the roof includes associating the indicated pitch with a portion of the model corresponding to the one planar roof section. For example, the 3D model may include one or more data structures representing planar roof sections, and the indicated pitch may be included as part of the data structure representing the one planar roof section. In some embodiments, the 3D model may not at this point include representations of the planar roof sections, such as because the operator has not yet specified them. In such a case, the routine may store the indicated pitch in association with the location and orientation at which the pitch was specified by the operator, as determined from the aerial image. Then, at a later time, when the operator specifies a roof section that has the same orientation as the stored pitch and that includes or is near the stored location, the roof estimation system can store the indicated pitch in association with the specified roof section.

[00122] After step 1004, the routine ends. In other embodiments, the routine may instead return to step 1001, to determine the pitch for another planar roof section (of the same or different roof).

[00123] Figure 11 is an example flow diagram of concurrent feature display routine provided by an example embodiment. The illustrated routine 1100 may be provided by, for example, execution of the roof estimation system 810 described with respect to Figure 8. The illustrated routine 1100 concurrently displays operator indicated features in multiple aerial images of a building roof.

[00124] More specifically, the routine begins in step 1101, where it displays a first and a second aerial image of a building having a roof, each of the aerial images providing a different view of the roof of the building. The aerial images are displayed in the context of a user interface screen, such as is described with reference to Figures 6A-6C, above.

[00125] In step 1102, the routine receives an indication of a feature of the building shown in the first aerial image. The indication is typically received via a user interface control, such as a drawing tool or marker, upon its manipulation by an operator. For example, the operator may manipulate a drawing tool in order to specify one or more features of the building roof, such as a corner on the roof, an edge of the roof, an outline of a section of the roof, etc. In one embodiment, the operator utilizes a drawing tool to indicate roof section corner points and roof section edges connecting those corner points. Additional details regarding feature indication are provided with respect to Figures 6A-6C, above.

[00126] In step 1103, the routine modifies a three-dimensional model of the roof based on the received indication of the feature of the building. Modifying the 3D model may include adding or updating the indicated feature to a wire frame model of the roof. For example, if the indicated feature is a roof section corner point, the corner point will be added to the 3D model, along with the location (*e.g.*, the X, Y, and Z position of the point) of the point. The location of the point is automatically determined based on a translation of the position of the point in the image to a point in the uniform reference grid associated with the image. If the indicated feature is a roof section edge, the edge will be added to the 3D model, such as by associating the edge with two points corresponding to the end points of the edge. Higher-level features can also be indicated. For example, a planar roof section may be indicated by "closing" a sequence of two or more connected line segments, to create a closed polygon that represents the outline or perimeter of the planar roof section.

[00127] In step 1104, the routine concurrently displays a projection of the feature from the modified three-dimensional model onto the first and second aerial images. In one embodiment, displaying the feature from the modified three-dimensional model includes projecting the three-dimensional model onto both the first and second aerial images. For example, if the first image (for which the indicated feature was received) provides a west view of the building, and the second image provides an east view of the building, the routine will concurrently display a projection of the indicated feature

from the 3D model onto both the first and second images. The projection of the indicated feature into the second image is based at least in part on a translation from the position of the feature in the reference grid to a position in the second image. In addition, the concurrent display onto two or more images occurs at substantially the same time (within a short time interval, at times that are substantially coincident) as the indication of the feature of the building in step 1102, giving the operator the illusion that as they are indicating a feature in the first image, the feature is being simultaneously projected into the second image.

[00128] After step 1104, the routine ends. In other embodiments, the routine may instead return to step 1101, to perform an interactive loop of steps 1101-1104 with the operator, so that the routine can concurrently display multiple features as they are indicated by the operator. Note that in such an embodiment, each iteration of the loop of steps 1101-1104 may be performed at near real-time speeds, so as to provide a fluid, interactive model generation experience for the operator enabling the operator to drag, draw, or otherwise indicate/manipulate features in a first image and view the results of their work concurrently projected into a second image.

[00129] All of the above 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, including but not limited to U.S. Provisional Patent Application No. 61/197,904, entitled "USER INTERFACE SYSTEMS AND METHODS FOR ROOF ESTIMATION," filed October 31, 2008, are incorporated herein by reference, in their entireties.

[00130] From the foregoing it will be appreciated that, although specific embodiments have been described herein for purposes of illustration, various modifications may be made without deviating from the spirit and scope of the present disclosure. For example, the methods, systems, and techniques for generating and providing roof estimate reports discussed herein are applicable to other architectures other than the illustrated architecture or a particular roof estimation system implementation. Also,

the methods and systems discussed herein are applicable to differing network protocols, communication media (optical, wireless, cable, etc.) and devices (such as wireless handsets, electronic organizers, personal digital assistants, portable email machines, game machines, pagers, navigation devices such as GPS receivers, etc.). Further, the methods and systems discussed herein may be utilized by and/or applied to other contexts or purposes, such as by or for solar panel installers, roof gutter installers, awning companies, HVAC contractors, general contractors, and/or insurance companies.

Electronic Acknowledgement Receipt	
EFS ID:	20285081
Application Number:	14450108
International Application Number:	
Confirmation Number:	8641
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First Named Inventor/Applicant Name:	Chris Pershing
Customer Number:	500
Filer:	Jeremiah J. Baunach/Terrie Quillin
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Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		EFS_Prelim_Amendment_09_30_14.pdf	68638 b93621fe0699ee6c3b8383c4ce54963072a29630	yes	3

	Multipart Description/PDF files in .zip description				
	Document Description		**Start**	**End**	
	Preliminary Amendment		1	1	
	Specification		2	2	
	Applicant Arguments/Remarks Made in an Amendment		3	3	
Warnings:					
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2	Applicant Response to Pre-Exam Formalities Notice	EFS_Notice_to_File_Corr_App_Papers_09_30_14.pdf	673257 61b77f3e86c80b0c152d0fe01aa7d4538c7209ae	no	2
Warnings:					
Information:					
3	Specification	EFS_Redlined_Spec_09_30_14.pdf	151067 810d9556aecbf08d7a4fd054b0ec5e7a751eb5e0	no	40
Warnings:					
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4	Specification	EFS_Clean_Subsitute_Spec_09_30_14.pdf	145679 3915a2decdaa1c1cdc3cfa013ed0213266d93943	no	40
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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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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
14/450,108	08/01/2014	2668	3520	290115.406C2	37	4

CONFIRMATION NO. 8641

500
SEED INTELLECTUAL PROPERTY LAW GROUP PLLC
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FILING RECEIPT

OC000000070075540

Date Mailed: 08/08/2014

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)

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Applicant(s)

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Power of Attorney: The patent practitioners associated with Customer Number 00500

Domestic Priority data as claimed by applicant

This application is a CON of 13/474,504 05/17/2012
which is a CON of 12/467,250 05/15/2009 PAT 8209152
which claims benefit of 61/197,904 10/31/2008

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.

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If Required, Foreign Filing License Granted: 08/07/2014
The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 14/450,108**
Projected Publication Date: To Be Determined - pending completion of Corrected Papers
Non-Publication Request: No
Early Publication Request: No

Title

CONCURRENT DISPLAY SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION

Preliminary Class

382

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

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Title 37, Code of Federal Regulations, 5.11 & 5.15

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
14/450,108	08/01/2014	Chris Pershing	290115.406C2

CONFIRMATION NO. 8641

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SEATTLE, WA 98104

FORMALITIES LETTER

OC000000070075541

Date Mailed: 08/08/2014

NOTICE TO FILE CORRECTED APPLICATION PAPERS

Filing Date Granted

An application number and filing date have been accorded to this application. The application is informal since it does not comply with the regulations for the reason(s) indicated below. Applicant is given TWO MONTHS from the date of this Notice within which to correct the informalities indicated below. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

The required item(s) identified below must be timely submitted to avoid abandonment:

- A substitute specification excluding claims in compliance with 37 CFR 1.52, 1.121(b)(3), and 1.125 is required. The substitute specification must be submitted with markings and be accompanied by a clean version (without markings) as set forth in 37 CFR 1.125(c) and a statement that the substitute specification contains no new matter (see 37 CFR 1.125(b)). Since a preliminary amendment was present on the filing date of the application and such amendment is part of the original disclosure of the application, the substitute specification must include all of the desired changes made in the preliminary amendment. See 37 CFR 1.115 and 1.215.

Applicant is cautioned that correction of the above items may cause the specification and drawings page count to exceed 100 pages. If the specification and drawings exceed 100 pages, applicant will need to submit the required application size fee.

Items Required To Avoid Processing Delays:

Applicant is notified that the above-identified application contains the deficiencies noted below. No period for reply is set forth in this notice for correction of these deficiencies. However, if a deficiency relates to the inventor's oath or declaration, the applicant must file an oath or declaration in compliance with 37 CFR 1.63, or a substitute statement in compliance with 37 CFR 1.64, executed by or with respect to each actual inventor no later than the expiration of the time period set in the "Notice of Allowability" to avoid abandonment. See 37 CFR 1.53(f).

- A properly executed inventor's oath or declaration has not been received for the following inventor(s):
  Chris Pershing

Replies must be received in the USPTO within the set time period or must include a proper Certificate of Mailing or Transmission under 37 CFR 1.8 with a mailing or transmission date within the set time period. For more information and a suggested format, see Form PTO/SB/92 and MPEP 512.

Replies should be mailed to:

Mail Stop Missing Parts
Commissioner for Patents
P.O. Box 1450
Alexandria VA 22313-1450

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/tnguyen/

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

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 14/450,108

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))	37 minus 20 =	* 17			OR	x 80 =	1360
INDEPENDENT CLAIMS (37 CFR 1.16(h))	4 minus 3 =	* 1				x 420 =	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).						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	3380

APPLICATION AS AMENDED - PART II

AMENDMENT A

	(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($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
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	

AMENDMENT B

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE($)	ADDITIONAL FEE($)	OR	RATE($)	ADDITIONAL FEE($)
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.

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Present Application:

Inventor	:	Chris Pershing
Title	:	CONCURRENT DISPLAY SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION
Docket No.	:	290115.406C2
Date	:	August 1, 2014

Prior Application:

Examiner	:	Andre Pierre Louis
Art Unit	:	2123
Application No.	:	13/474,504

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

PRELIMINARY AMENDMENT

Commissioner for Patents:

Please amend the above-identified application as follows:

Amendments to the Specification begin on page 2 of this paper.

Remarks begin on page 8 of this paper.

Amendments to the Specification:

Please delete the paragraph beginning at page 1, paragraph [0001], and the title line just above this paragraph:

~~CROSS-REFERENCE TO RELATED APPLICATIONS~~

~~This application is a continuation of U.S. Patent Application No. 12/467,250, entitled "CONCURRENT DISPLAY SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION", filed May 15, 2009 and claims the benefit of U.S. Provisional Patent Application No. 61/197,904, entitled "USER INTERFACE TECHNIQUES FOR ROOF ESTIMATION," filed October 31, 2008, which applications are incorporated herein by reference in their entirety.~~

Please replace the paragraph beginning at page 1, paragraph [0004], with the following marked paragraph:

Homeowners typically ask several roofing contractors to provide written estimates to repair or replace a roof on a house. Heretofore, the homeowners would make an appointment with each roofing contractor to visit the house to determine the style of roof, take measurements, and to inspect the area around the house for access and cleanup. Using this information, the roofing contractor then prepares a written estimate and then timely delivers it to the homeowner. After receiving several estimates from different ~~rooting~~ roofing contractors, the homeowner then selects one.

Please replace the paragraph beginning at page 5, paragraph [0024], with the following marked paragraph:

In the following, Figures 1-3 provide an overview of the operation of an example roof estimation system. Figures 4-7 provide additional details related to an example interactive user interface provided by one embodiment of the roof estimation system. Figures 8-11 provide details related to roof estimation system implementation techniques.

Please replace the paragraph beginning at page 6, paragraph [0026], with the following marked paragraph:

More specifically, in the illustrated embodiment of Figure 1, the RES 100 is configured to generate a roof estimate report 132 for a specified building, based on aerial images 131 of the building received from the image source 110. The image source 110 may be any provider of images of the building for which a roof estimate is being generated. In one embodiment, the image source 110 includes a computing system that provides access to a repository of aerial images of one or more buildings. In addition, the aerial images 131 may include images obtained via manned or unmanned aircraft (*e.g.*, airplane, helicopter, blimp, drone, etc.), satellite, etc. Furthermore, the aerial images 131 may include images ~~obtain~~ obtained via one or more ground-based platforms, such as a vehicle-mounted camera that obtains street-level images of buildings, a nearby building, a hilltop, etc. In some cases, a vehicle-mounted camera may be mounted in an elevated position, such as a boom. Example aerial images are described further with reference to Figures 2A-2B

Please replace the paragraph beginning at page 7, paragraph [0030], with the following marked paragraph:

The corresponding feature may be, for example, a vertex of the roof of the building, the corner of one of the roof planes of the roof, a point of a gable or hip of the roof, etc. The corresponding feature may also be a linear feature, such as a ridge or valley line between two roof planes of the roof. In one embodiment, the indication of a corresponding feature on the building includes "registration" of a first point in a first aerial image, and a second point in a second aerial image, the first and second points corresponding ~~the~~ to substantially the same point on the roof of the building. Generally, point registration may include the identification of any feature shown in both aerial images. Thus, the feature need not be a point on the roof of the building. Instead, it may be, for example, any point that is visible on both aerial images, such as on a nearby building (*e.g.*, a garage, neighbor's building, etc.), on a nearby structure (*e.g.*, swimming pool, tennis court, etc.), on a nearby natural feature (*e.g.*, a tree, boulder, etc.), etc.

Please replace the paragraph beginning at page 10, paragraph [0036], with the following marked paragraph:

The generated model typically includes a plurality of planar roof sections that each correspond to one of the planar sections of the roof of the building. Each of the planar roof sections in the model has a number of associated dimensions and/or attributes, among them slope, area, and length of each edge of the roof section. Other information may include any information relevant to a roof builder or other entity having an interest in construction of, or installation upon, the roof. For example, the other information may include identification of valleys, ridges, rakes, eaves, or hip ridges of the roof and/or its sections; roof and/or roof section perimeter dimensions and/or outlines; measurements of step heights between different roof levels (*e.g.*, terraces); bearing and/or orientation of each roof section; light exposure and/or shadowing patterns due to chimneys, other structures, trees, latitude, etc.; roofing material; etc[[?]]. Once a 3D model has been generated to the satisfaction of the roof modeling engine 102 and/or the operator 120, the generated 3D model is stored as model data 106 for further processing by the RES 100. In one embodiment, the generated 3D model is then stored in a quality assurance queue, from which it is reviewed and possibly corrected by a quality control operator.

Please replace the paragraph beginning at page 14, paragraph [0052], with the following marked paragraph:

~~Fig~~ Figure 3D shows a fourth page 304 of the report and includes a line drawing 304a of the building roof showing the pitch of each roof section along with a compass indicator. The pitch in this example is given in inches, and it represents the number of vertical inches that the labeled planar roof section drops over 12 inches of horizontal run. The slope can be easily calculated from such a representation using basic trigonometry. The use of a numerical value of inches of rise per foot of run is a well known measure of slope in the roofing industry. A roof builder typically uses this information to assist in the repair and/or construction of a roof. Of course, other measures and/or units of slope may be utilized as well, including percent grade, angle in degrees, etc.

Please replace the paragraph beginning at page 16, paragraph [0059], with the following marked paragraph:

Figures 4B-4C show an enlarged view of image portion 408 during the process of image registration for image 402, which provides a top-down view of the building roof 407. As shown in Figure 4B, image portion 408 includes the building roof 407 and registration markers 410-413. The markers 410-413 are interactive user interface controls that can be directly manipulated (*e.g.*, moved, rotated, etc.) by the operator in order to specify points to use for purposes of image registration. In particular, image registration includes determining a transformation between each of one or more images and a uniform 3D reference grid. The uniform 3D reference grid is used as a coordinate system for a 3D model of the roof. By registering multiple images to the reference grid, an operator may indicate a roof feature on an image (such as a roof edge), which may then be translated from the coordinate system of the image to the coordinate system of the reference grid, for purposes of including ~~of~~ the indicated feature in the 3D model.

Please replace the paragraph beginning at page 21, paragraph [0076], with the following marked paragraph:

The marker 510 is typically first moved by the operator to a convenient location on the building roof 407, usually corner of a planar section of the roof 407. Next, the operator adjusts arm 510d so that ~~is~~ it substantially aligns with the sloped edge of the planar roof section. Then, the roof estimation system determines the pitch of the roof section, based on the configuration of the marker 510 with respect to the image and the reference grid.

Please replace the paragraph beginning at page 30, paragraph [00102], with the following marked paragraph:

The RES data repository 816 stores information related to the roof estimation functions performed by the RES 810. Such information may include image data 105, model data 106, and/or report data 107 described with reference to Figure 1. In addition, the RES data repository 816 may include information about customers, operators, or other individuals or entities associated with the RES 810.

Please replace the paragraph beginning at page 32, paragraph [00106], with the following marked paragraph:

Also, the example RES 810 can be implemented in a distributed environment comprising multiple, even heterogeneous, computer systems and networks. For example, in one embodiment, the image acquisition engine 811, the roof modeling engine 812, the report generation engine 813, the interface engine 814, and the data repository 816 are all located in physically different computer systems. In another embodiment, various modules of the RES 810 are hosted each on a separate server machine and are remotely located from the tables which are stored in the data repository 816. Also, one or more of the modules may themselves be distributed, pooled or otherwise grouped, such as for load balancing, reliability or security reasons. Different configurations and locations of programs and data are contemplated for use with techniques ~~of~~ as described herein. A variety of distributed computing techniques are appropriate for implementing the components of the illustrated embodiments in a distributed manner including but not limited to TCP/IP sockets, RPC, RMI, HTTP, Web Services (XML-RPC, JAX-RPC, SOAP, and the like).

Please replace the paragraph beginning at page 33, paragraph [00110], with the following marked paragraph:

In step 902, the routine receives, via one or more registration markers, indications of one or more points on the aerial image. The registration markers are manipulated by the operator to specify points on the aerial image, as described with reference to Figures 4A-4E. Typically, the points are visually identifiable features, such as corners of the roof of the building.

For example, if the roof has four corners (*e.g.*, a northwest, southwest, northeast, and ~~southwest~~ southeast corner) the operator may place one registration marker on each of the four corners as shown in the aerial image. Then, the positions (*e.g.*, coordinates on the aerial image) of the markers are transmitted to the routine for use in registering the aerial image, as described below.

Please replace the paragraph beginning at page 39, paragraph [00129], with the following marked paragraph:

After step 1104, the routine ends. In other embodiments, the routine may instead return to step 1101, to perform an interactive loop of steps 1101-1104 with the operator, so that the routine can concurrently display multiple features as they are indicated by the operator. Note that in such an embodiment, each iteration of the loop of steps 1101-1104 may be performed at near real-time speeds, so as to provide a fluid, interactive model generation experience for the operator enabling the operator to drag, draw, or otherwise indicate/manipulate features in a first image and view the results of their work concurrently projected into a second image.

REMARKS

The specification is amended herein to remove the "cross-reference to related applications" paragraph and to correct minor typographical errors. Claims 1-37 are pending. No claims are being amended. No new matter is being added to the application by way of this Amendment.

The Director is authorized to charge any additional fees due by way of this Amendment, or credit any overpayment, to our Deposit Account No. 19-1090.

All of the claims remaining in the application are now clearly allowable. Favorable consideration and a Notice of Allowance are earnestly solicited.

Respectfully submitted,

SEED Intellectual Property Law Group PLLC

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PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor	:	Chris Pershing
For	:	CONCURRENT DISPLAY SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION

Docket No.	:	290115.406C2
Date	:	August 1, 2014

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

INFORMATION DISCLOSURE STATEMENT TRANSMITTAL

Commissioner for Patents:

In accordance with 37 CFR 1.56 and 1.97 through 1.98, applicant wishes to make known to the U.S. Patent and Trademark Office the 319 references set forth on the attached Information Disclosure Statement. This application relies, under 35 U.S.C. § 120, on the earlier filing date of prior Application No. 12/467,250, filed May 15, 2009 and prior Application No. 13/474,504, filed May 17, 2012. The references listed on the attached Information Disclosure Statement, with the exception of, Non-Patent Literature Documents Nos. 44, 147-148 and 158, were submitted to and/or cited by the Patent and Trademark Office in this prior application and, therefore, are not required to be provided in this application. If the Examiner wishes, copies will be provided upon request. As to any reference supplied, applicant does not admit that it is "prior art" under 35 U.S.C. §§ 102 or 103. Although the aforesaid references are made known to the Patent and Trademark Office in compliance with applicant's duty to disclose all information he is aware of which is believed relevant to the examination of the above-identified application, applicant believes that his invention is patentable.

Please acknowledge receipt of this Information Disclosure Statement and kindly make the cited references of record in the above-identified application.

Applicant believes this Information Disclosure Statement has been timely filed, however, the Director is authorized to charge any fee due by way of this Information Disclosure Statement to our Deposit Account No. 19-1090.

Respectfully submitted,

SEED Intellectual Property Law Group PLLC

/Jeremiah J. Baunach/
Jeremiah J. Baunach
Registration No. 44,527

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Enclosures:
Information Disclosure Statement
Cited References (4)

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3349307_1

U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTY. DOCKET NO. 290115.406C2	APPLICATION NO.
INFORMATION DISCLOSURE STATEMENT (Use several sheets if necessary)	INVENTOR Chris Pershing	
	FILING DATE	ART UNIT

U.S. PATENT DOCUMENTS

*EXAMINER INITIAL		DOCUMENT NUMBER	KIND CODE	DATE	NAME	FILING DATE IF APPROPRIATE
	1	2,791,151		05/07/57	Pennington	
	2	3,617,016		11/02/71	Bolsey	
	3	5,247,356		09/21/93	Ciampa	
	4	5,379,105		01/03/95	Iki et al.	
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	24	7,324,666		01/29/08	Zoken et al.	
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EXAMINER	DATE CONSIDERED

* EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTY. DOCKET NO. 290115.406C2	APPLICATION NO.
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EXAMINER	DATE CONSIDERED

* EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

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	FILING DATE	ART UNIT

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*EXAMINER INITIAL		DOCUMENT NUMBER	KIND CODE	DATE	NAME	FILING DATE IF APPROPRIATE
	79	2005/0267657		12/01/05	Devdhar	
	80	2005/0288959		12/29/05	Eraker et al.	
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	92	2011/0187713		08/04/11	Pershing et al.	
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	94	2012/0066187		03/15/12	Pearcy et al.	
	95	2012/0035887		02/09/12	Augenbraun et al.	
	96	2012/0191424		07/26/12	Pershing et al.	
	97	2012/0209782		08/16/12	Pershing et al.	
	98	2012/0223965		09/06/12	Pershing	
	99	2013/0202157		08/08/13	Pershing	
	100	2013/0204575		08/08/13	Pershing	
	101	2013/0226515		08/29/13	Pershing et al.	
	102	2013/0262029		10/03/13	Pershing	

EXAMINER	DATE CONSIDERED
* EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.	

U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTY. DOCKET NO. 290115.406C2	APPLICATION NO.
INFORMATION DISCLOSURE STATEMENT (Use several sheets if necessary)	INVENTOR Chris Pershing	
	FILING DATE	ART UNIT

FOREIGN PATENT DOCUMENTS

*EXAMINER INITIAL		DOCUMENT NUMBER	KIND CODE	DATE	COUNTRY	TRANSLATION YES	TRANSLATION NO
	1	2008230031	B8	11/05/09	AU		
	2	2,191,954	A1	12/14/95	CA		
	3	102194120	A	09/21/11	CN (with English Abstract)		X
	4	198 57 667	A1	08/17/00	DE (with English Abstract and Translation)	X	
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	149		Pershing, "CONCURRENT DISPLAY SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION," Office Action mailed August 28, 2012, for USAN 13/474,504, 8 pages.
	150		Pershing, "CONCURRENT DISPLAY SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION," Office Action mailed June 19, 2013, for USAN 13/474,504, 14 pages.
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	152		Pershing, "CONCURRENT DISPLAY SYSTEMS ANF METHODS FOR AERIAL ROOF ESTIMATION," Office Action mailed September 7, 2011, for USAN 12/467,250, 14 pages.
	153		Pershing, "PITCH DETERMINATION SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION," Notice of Allowance mailed February 16, 2012, for USAN 12/467,244, 20 pages.
	154		Pershing, "PITCH DETERMINATION SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION," Office Action for USAN 13/438,288, August 24, 2012, 8 pages.
	155		Pershing, "PITCH DETERMINATION SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION," Office Action mailed May 21, 2013, for USAN 13/438,288, 11 pages.
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U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTY. DOCKET NO. 290115.406C2	APPLICATION NO.
	INVENTOR Chris Pershing	
INFORMATION DISCLOSURE STATEMENT (Use several sheets if necessary)	FILING DATE	ART UNIT

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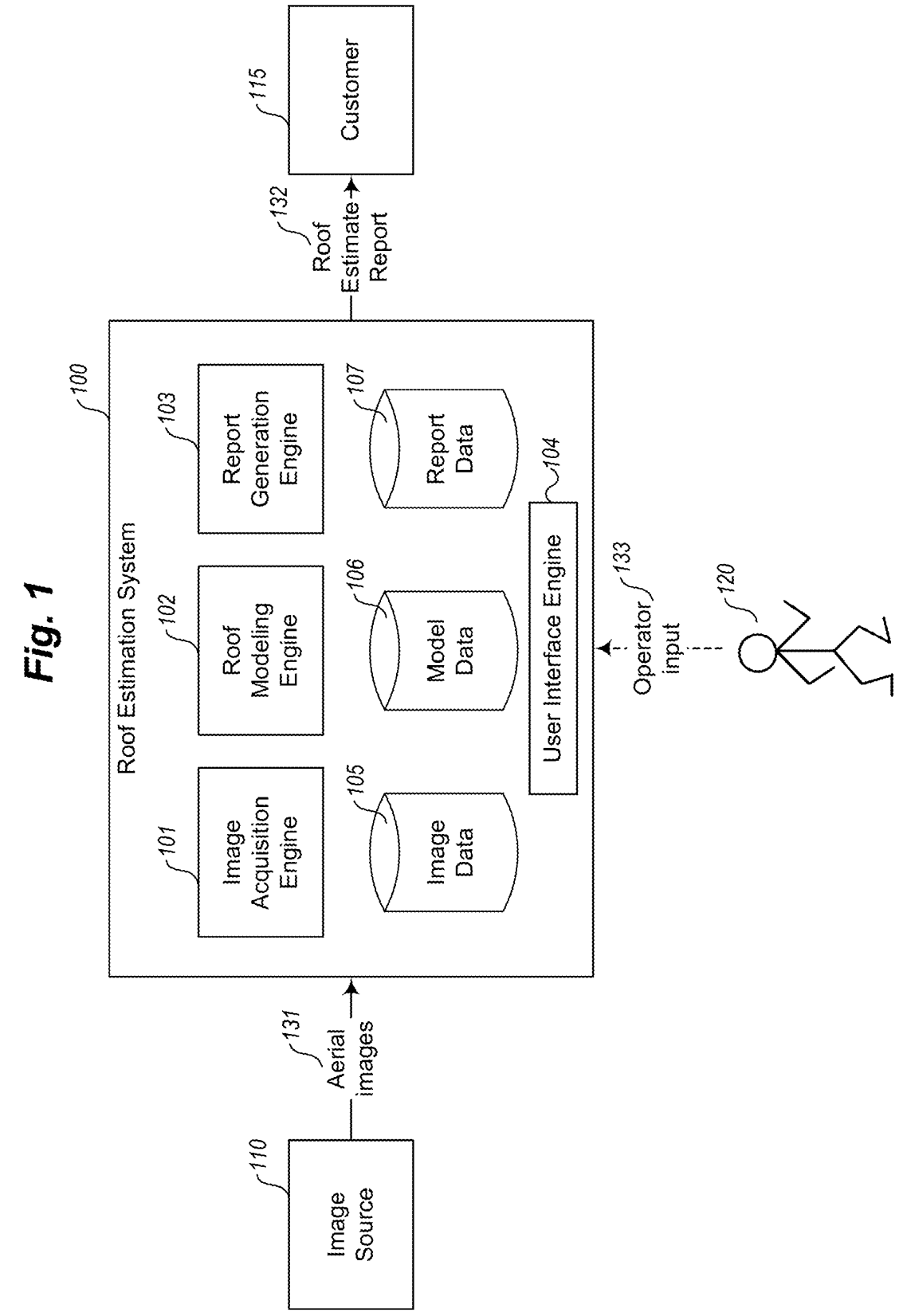
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NON-PATENT LITERATURE DOCUMENTS *(Including Author, Title, Date, Pertinent Pages, Etc.)*

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Fig. 1


Customer
115
132
Roof Estimate Report
100
Roof Estimation System
Report Generation Engine
103
Report Data
107
Roof Modeling Engine
102
Model Data
106
Image Acquisition Engine
101
Image Data
105
User Interface Engine
104
133
Operator input
120
131
Aerial images
110
Image Source

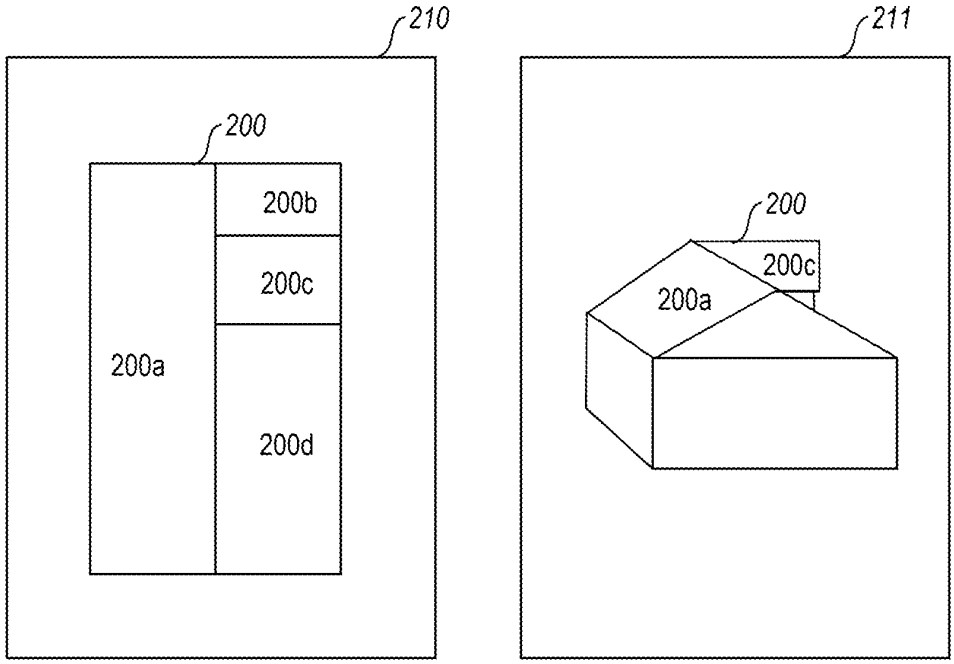

210
200
200b
200c
200a
200d
211
200
200c
200a

Fig. 2A

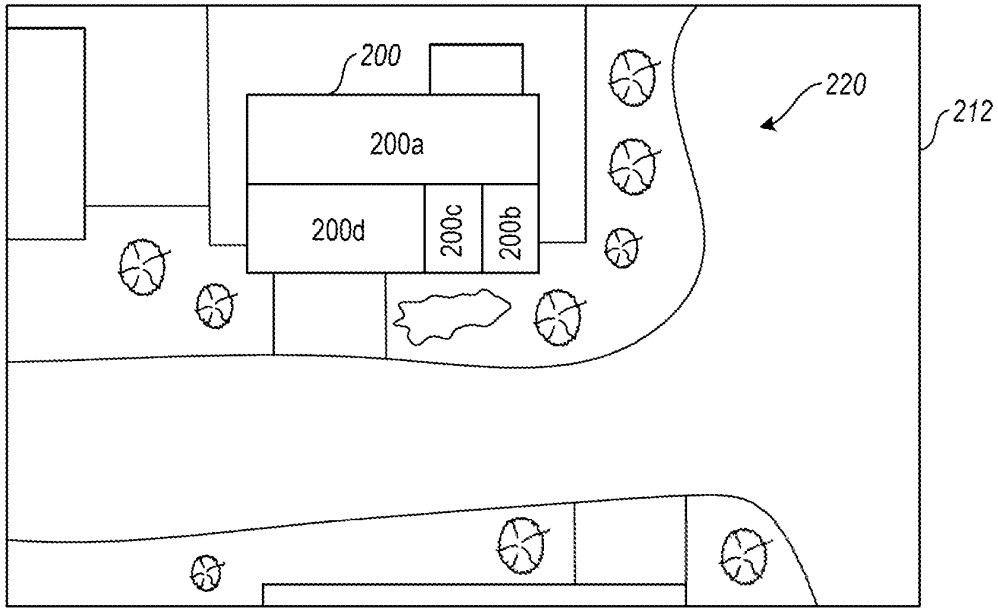

200
200a
200d
200c
200b
220
212

Fig. 2B

1234 Main Street, Redmond, WA

Order: 2468

<Customer Name Here>

4/16/2008

301a

1234 Main Street, Redmond, WA

301b



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301

Fig. 3A

1234 Main Street, Redmond, WA

Images:



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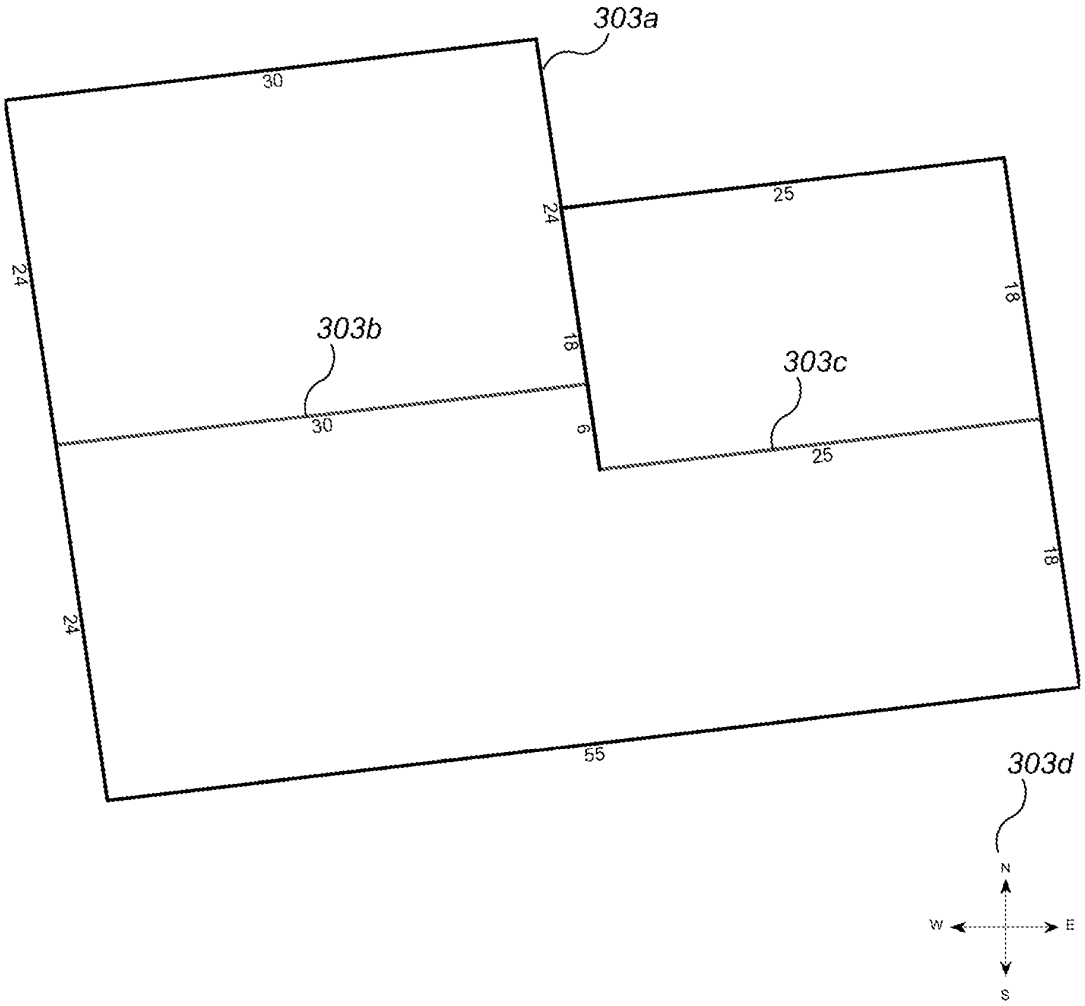
302

Fig. 3B

1234 Main Street, Redmond, WA

Length Diagram:

All measurements are rounded to the nearest foot
Ridge Length = 55 ft [Red Lines]
Valley Length = 0 ft [Blue lines]



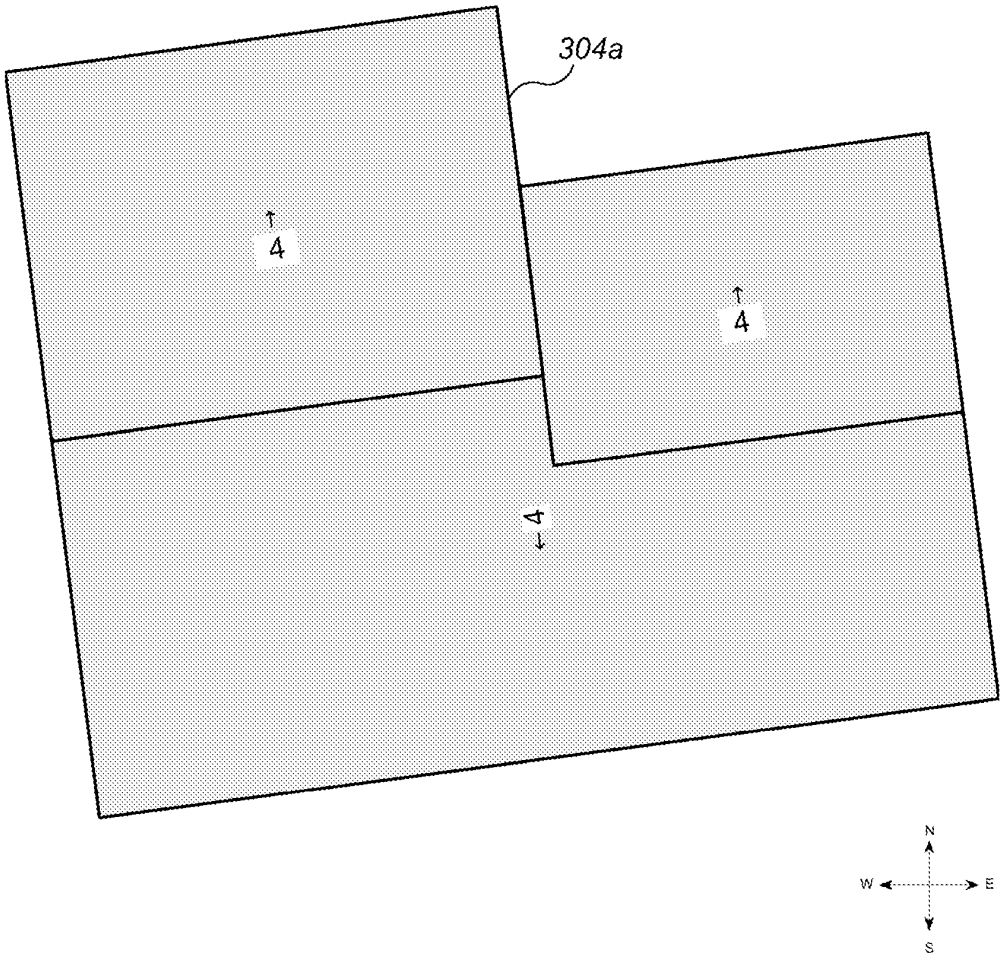
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303

Fig. 3C

1234 Main Street, Redmond, WA

Pitch Diagram:
Pitch units are inches per foot.



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304

Fig. 3D

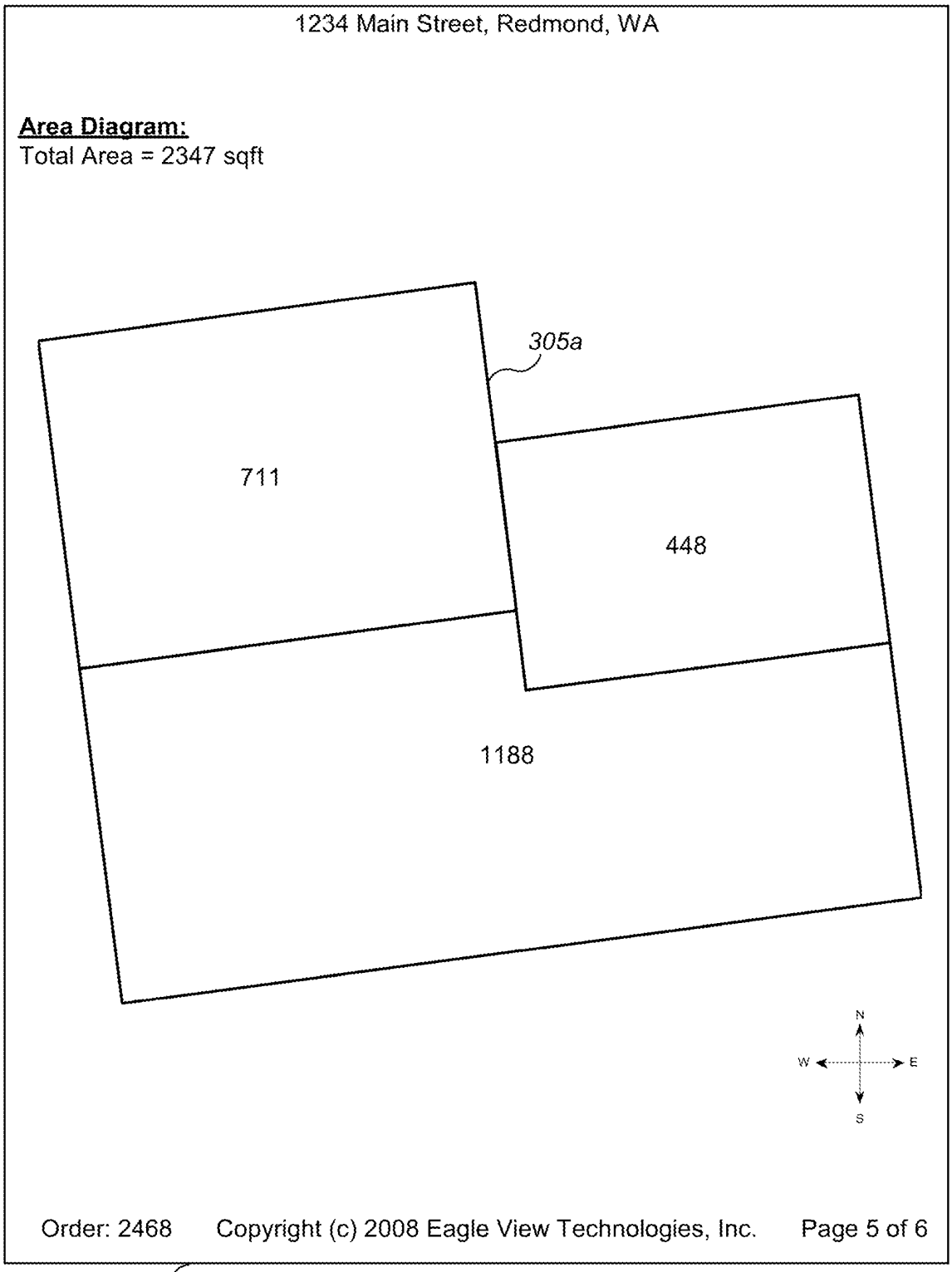

1234 Main Street, Redmond, WA
Area Diagram:
Total Area = 2347 sqft
305a
711
448
1188
N
W
E
S
Order: 2468
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Page 5 of 6
305

Fig. 3E

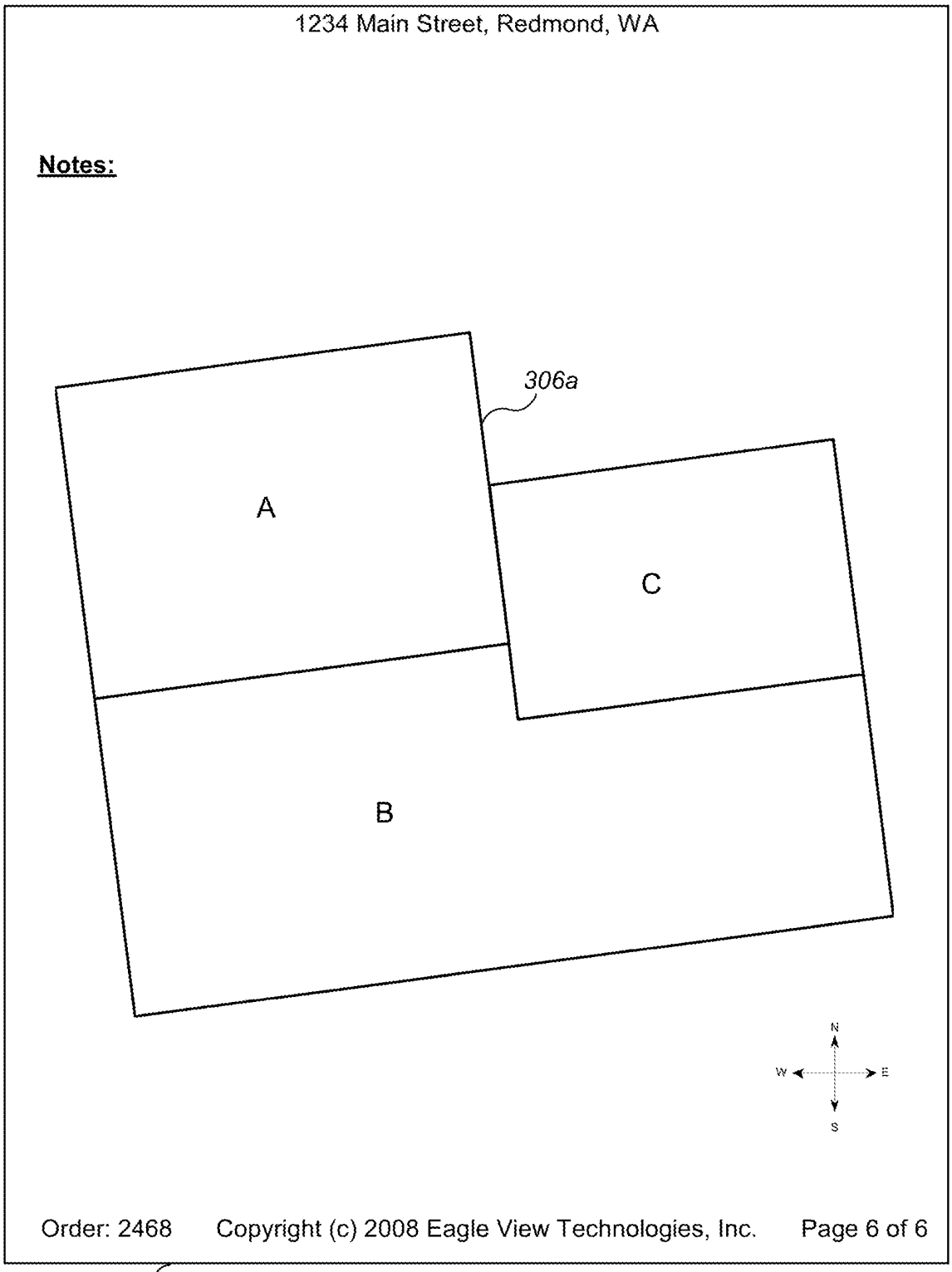

1234 Main Street, Redmond, WA
Notes:
306a
A
B
C
N
W
E
S
Order: 2468
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Page 6 of 6
306

Fig. 3F

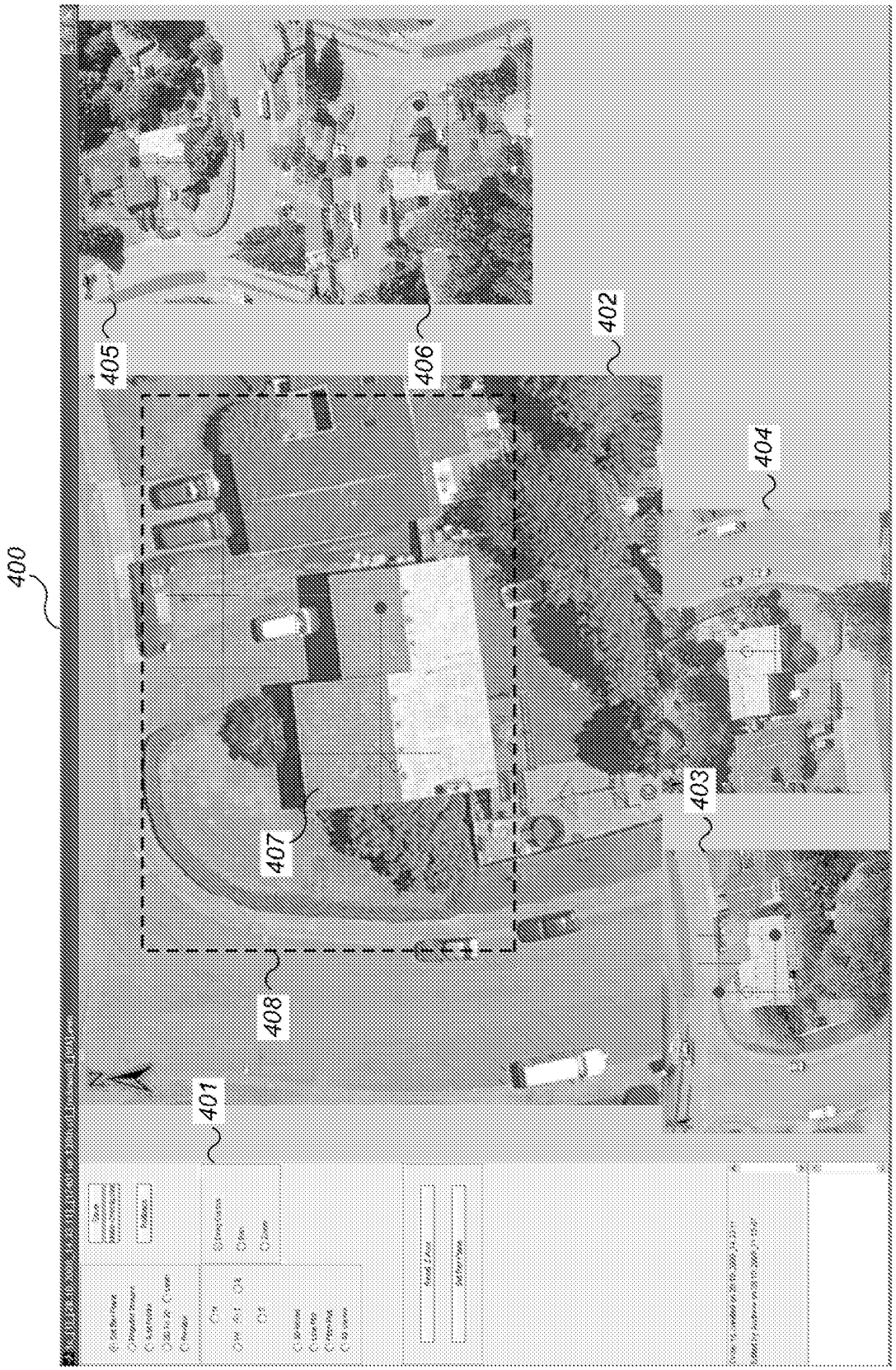


Fig. 4A

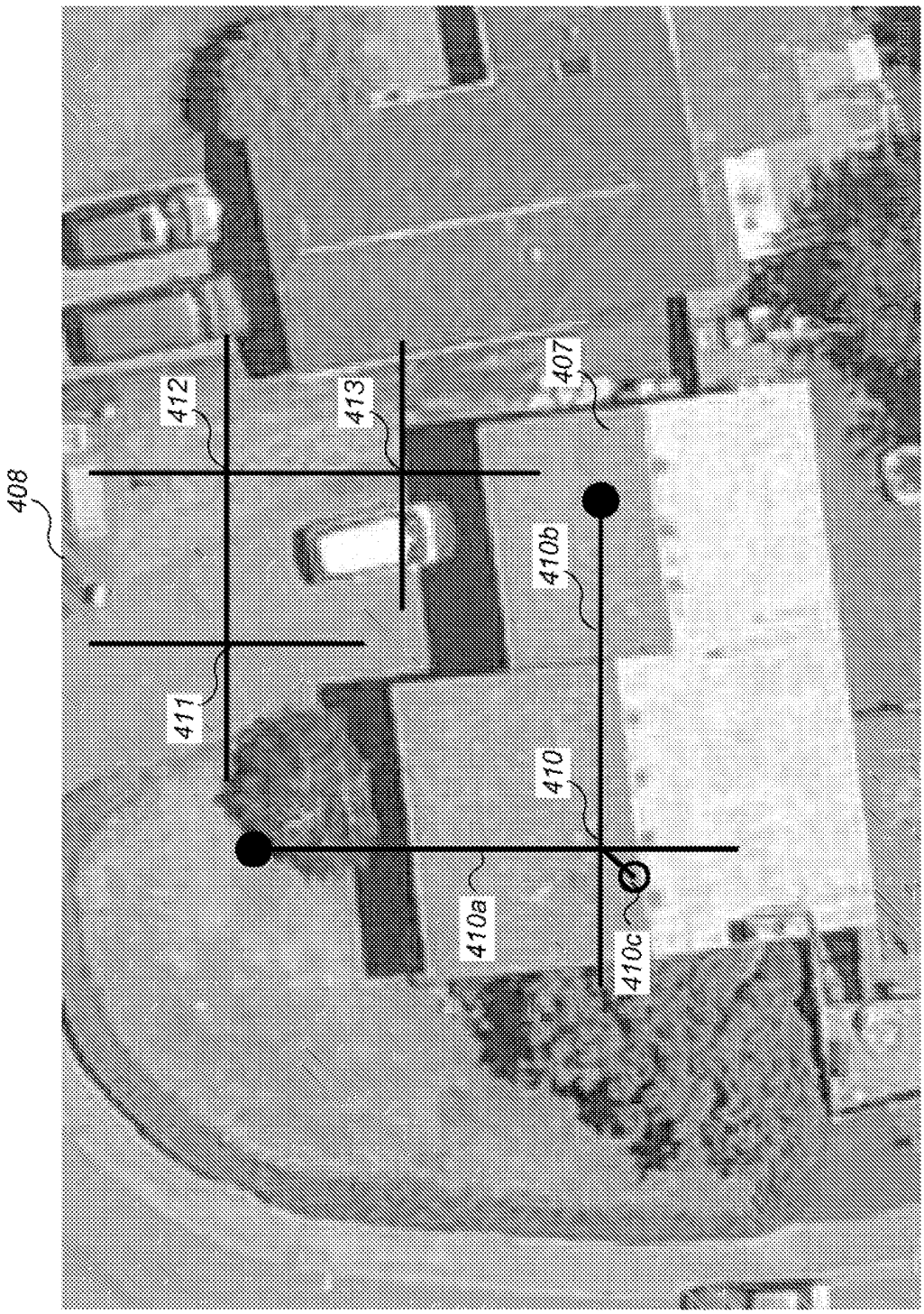


Fig. 4B

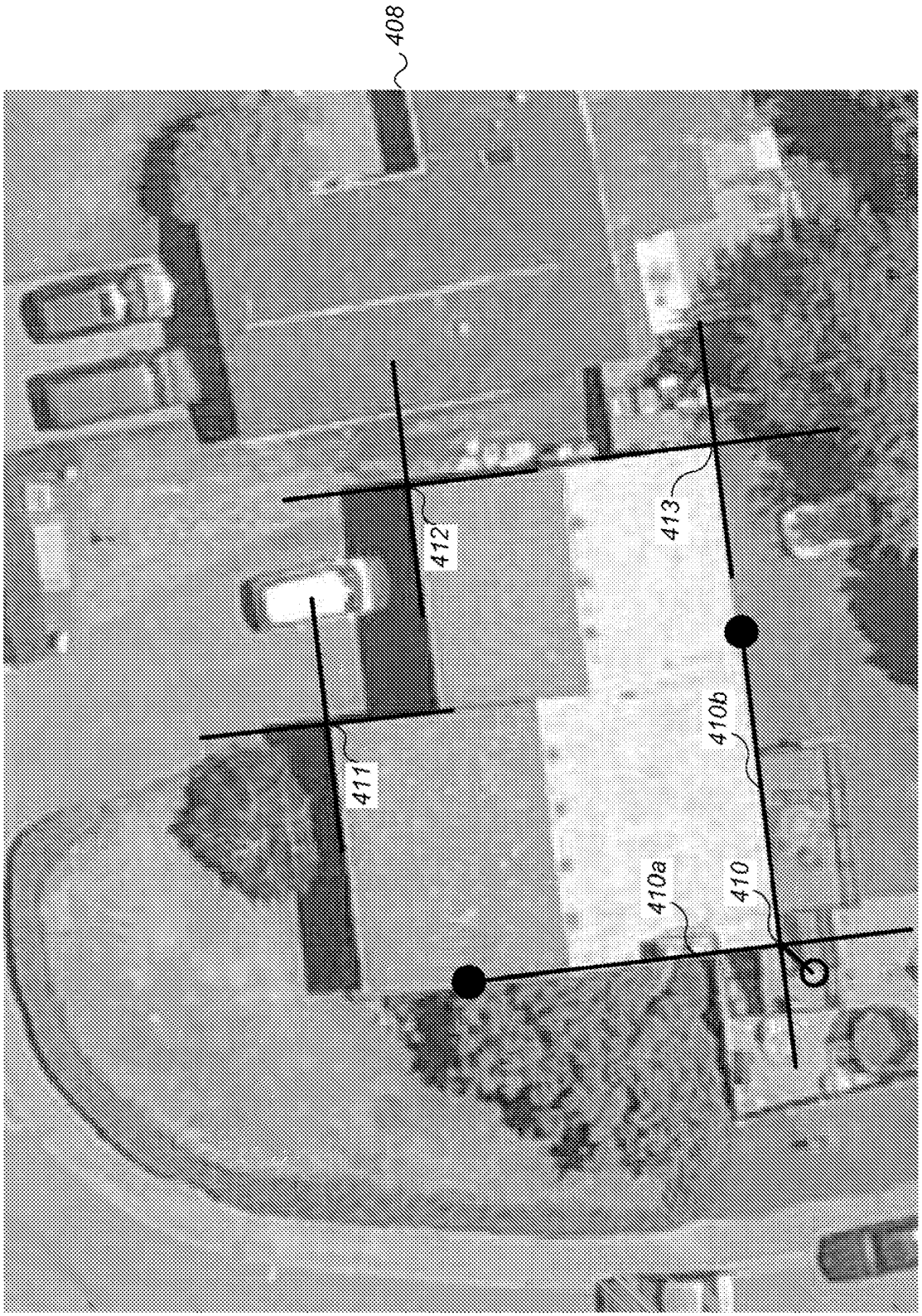


Fig. 4C

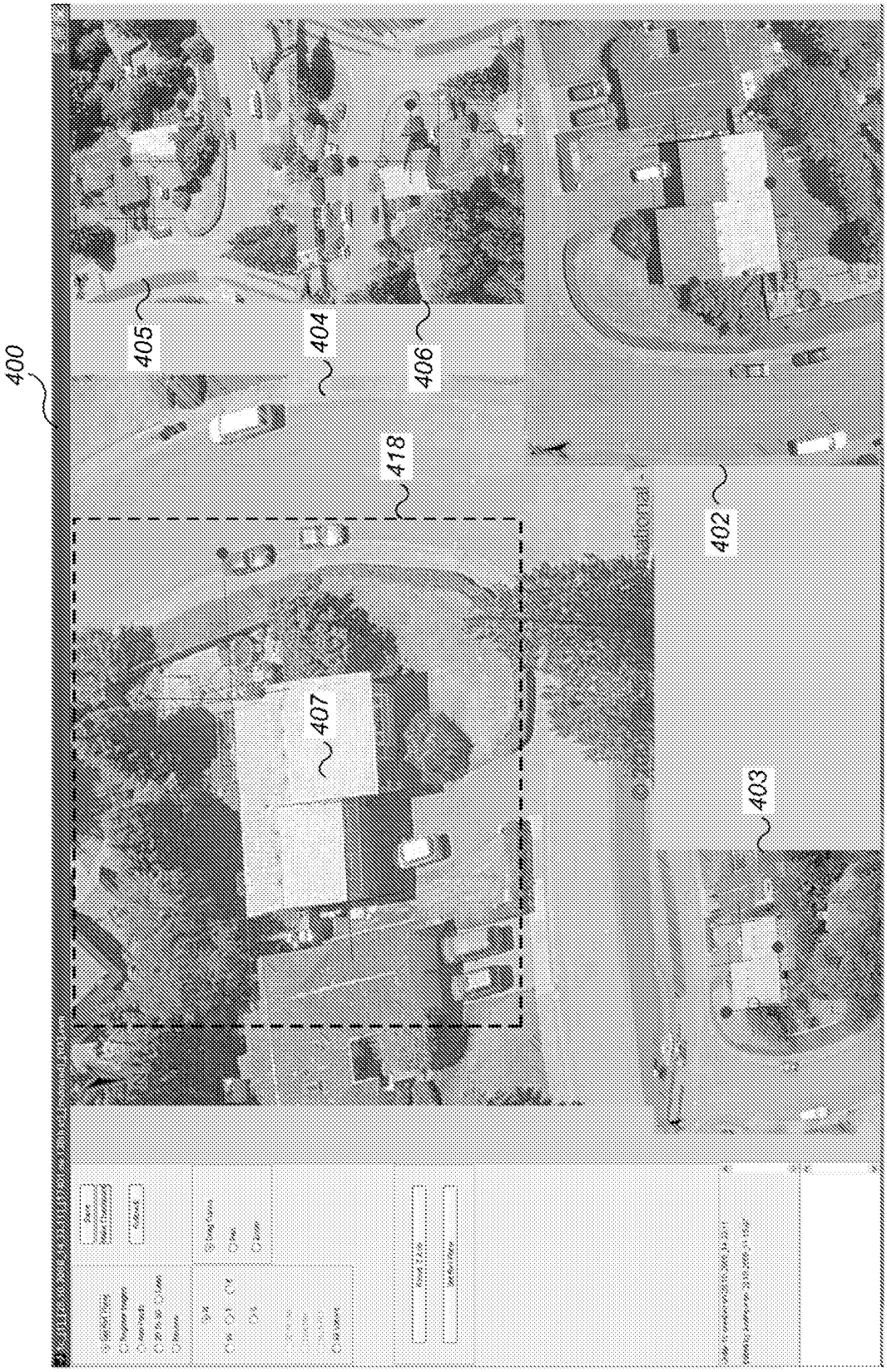


Fig. 4D

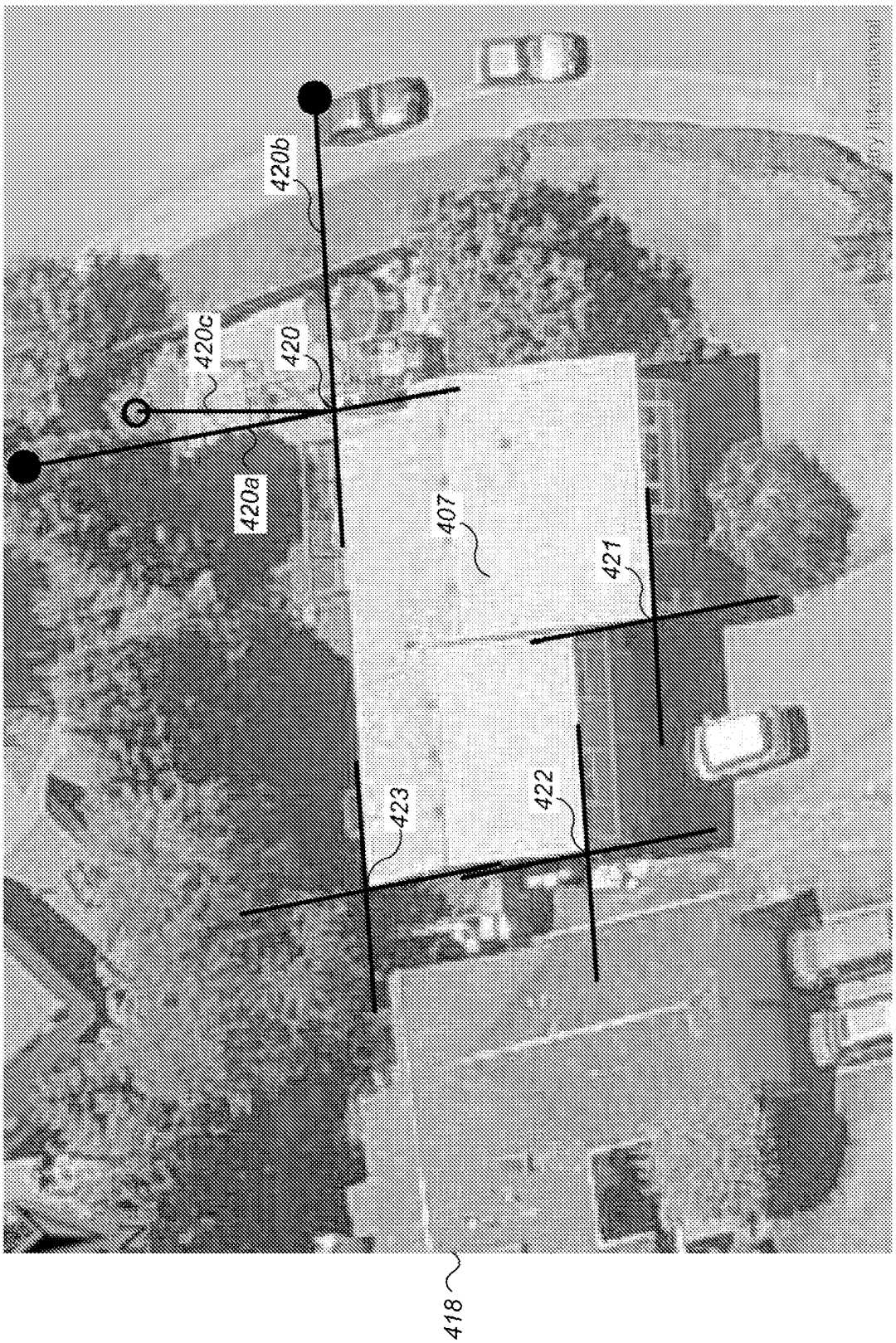


Fig. 4E



Fig. 4F

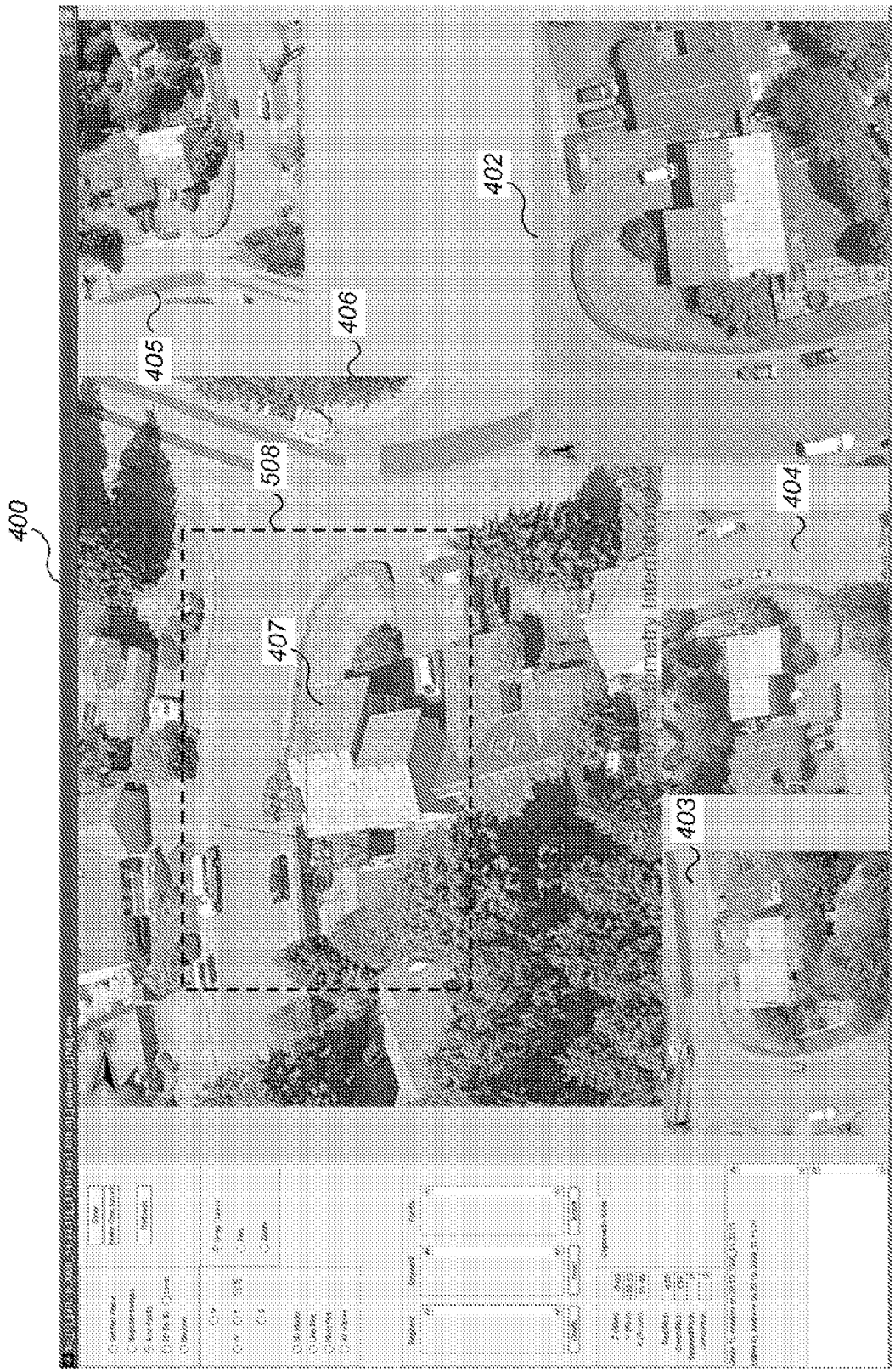


Fig. 5A

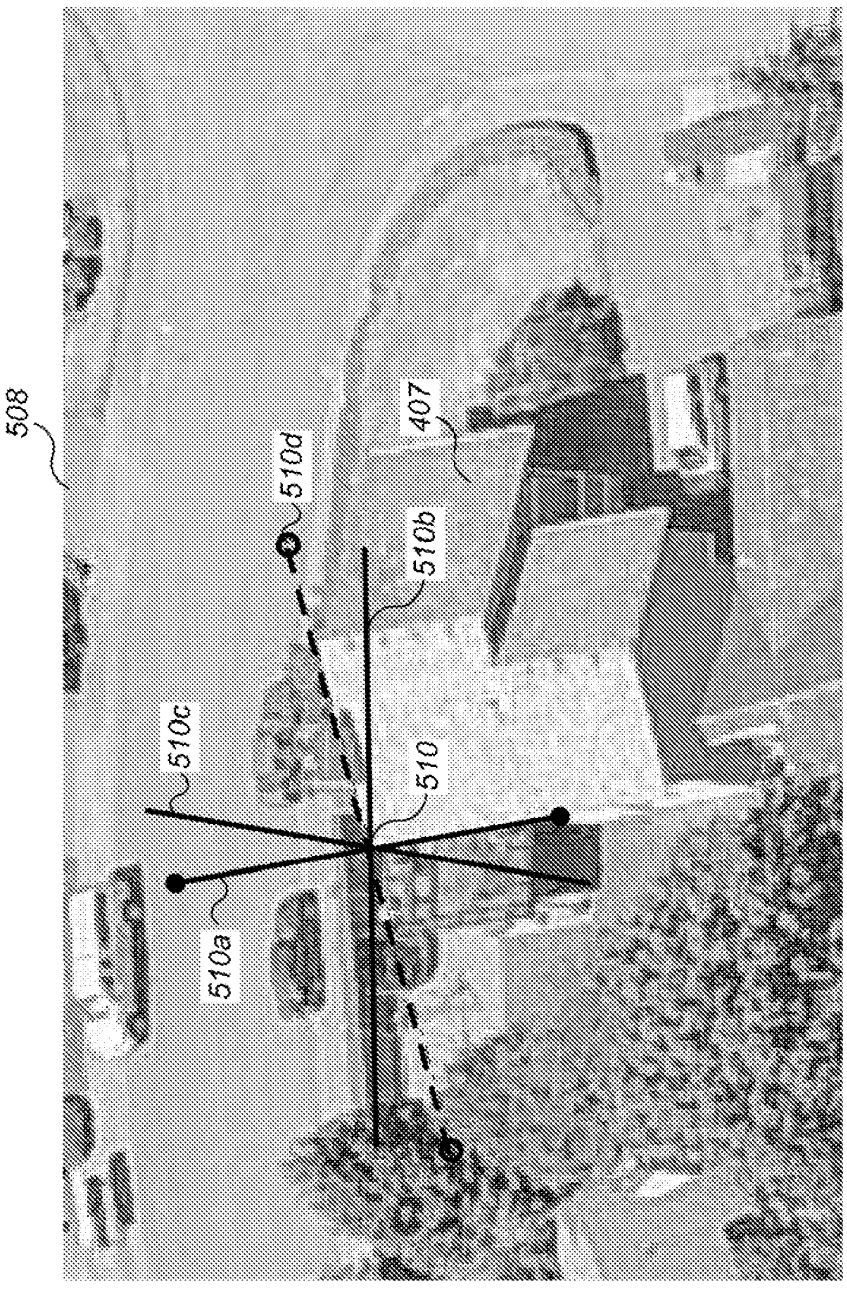


Fig. 5B

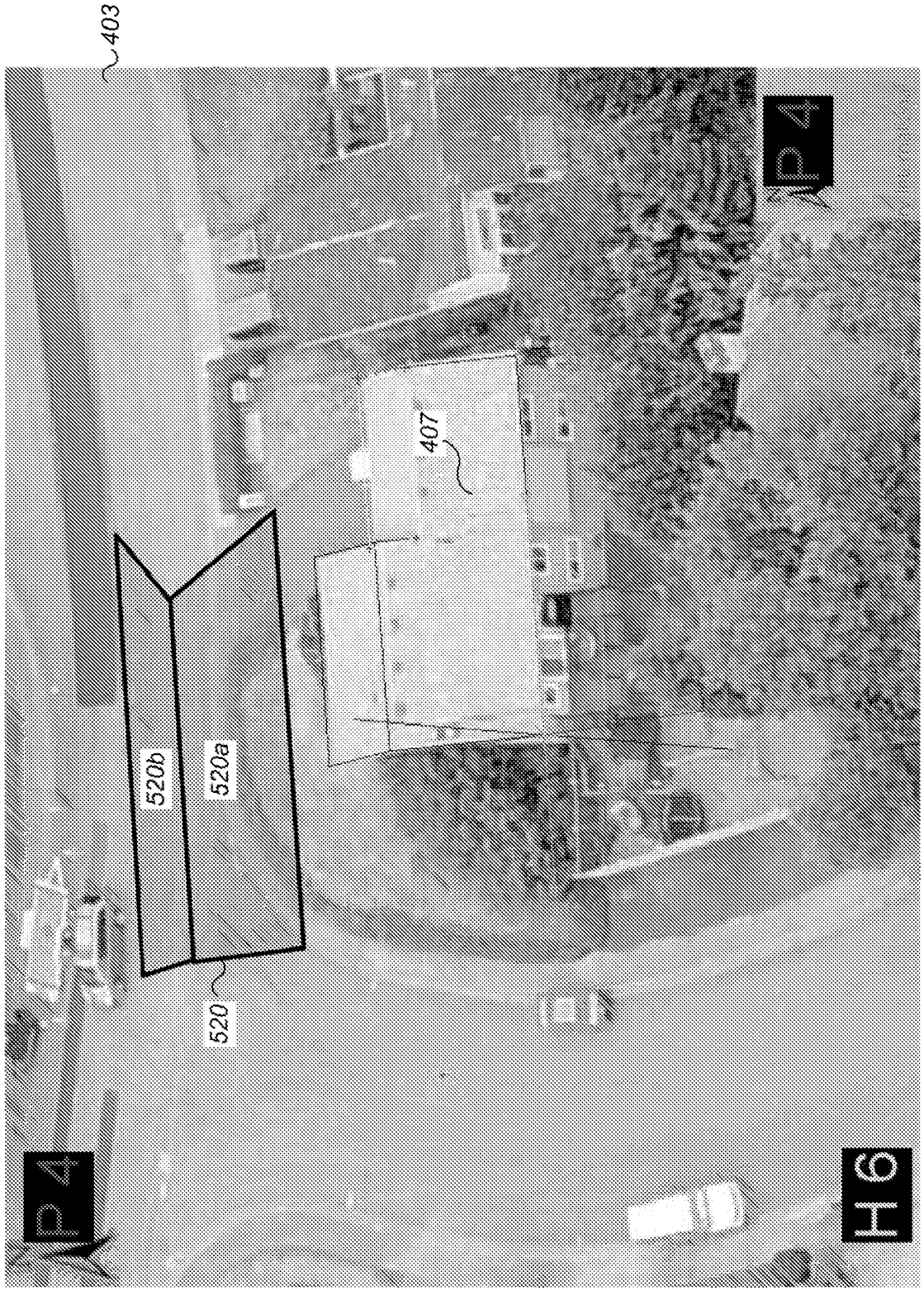


Fig. 5C

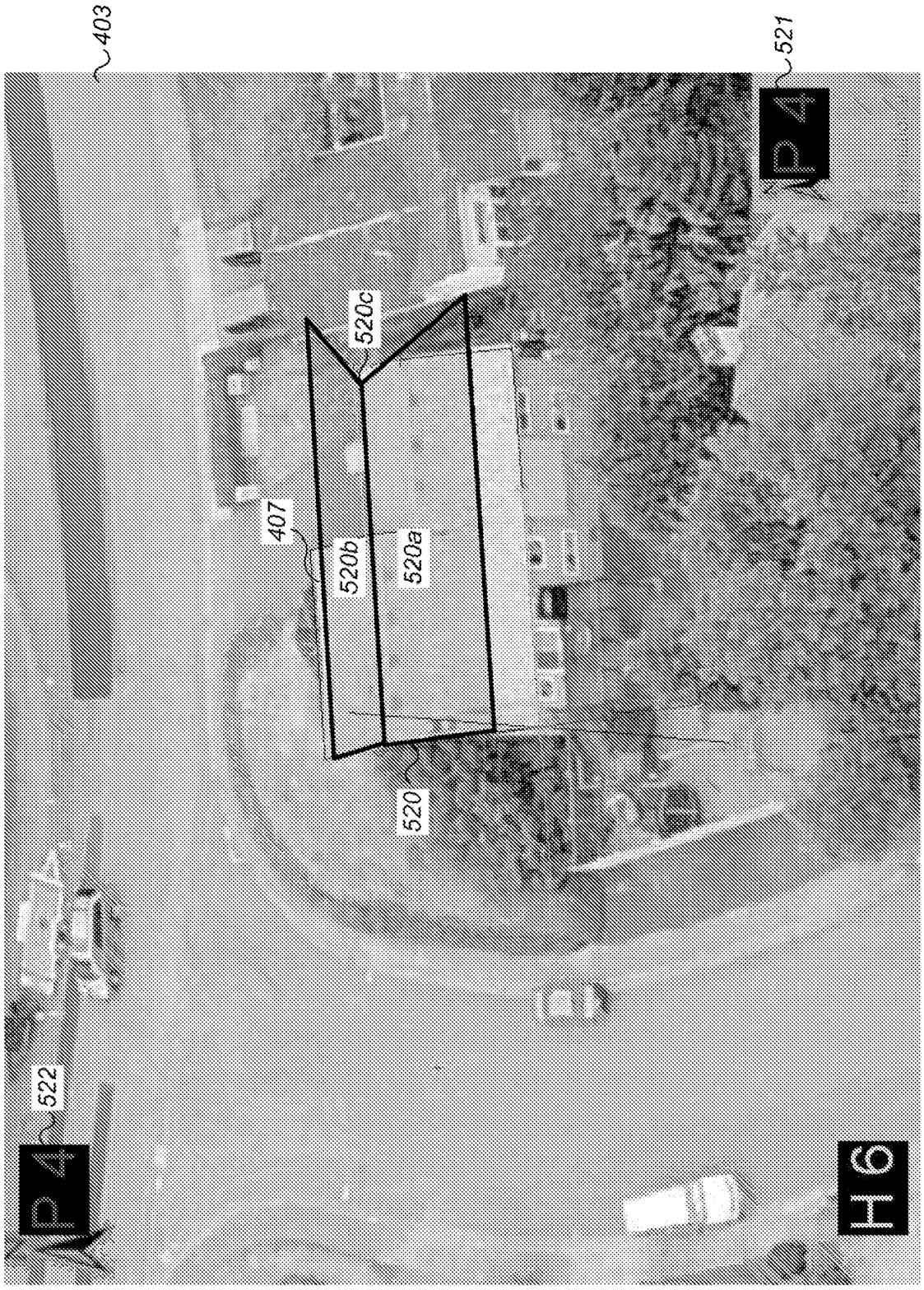


Fig. 5D

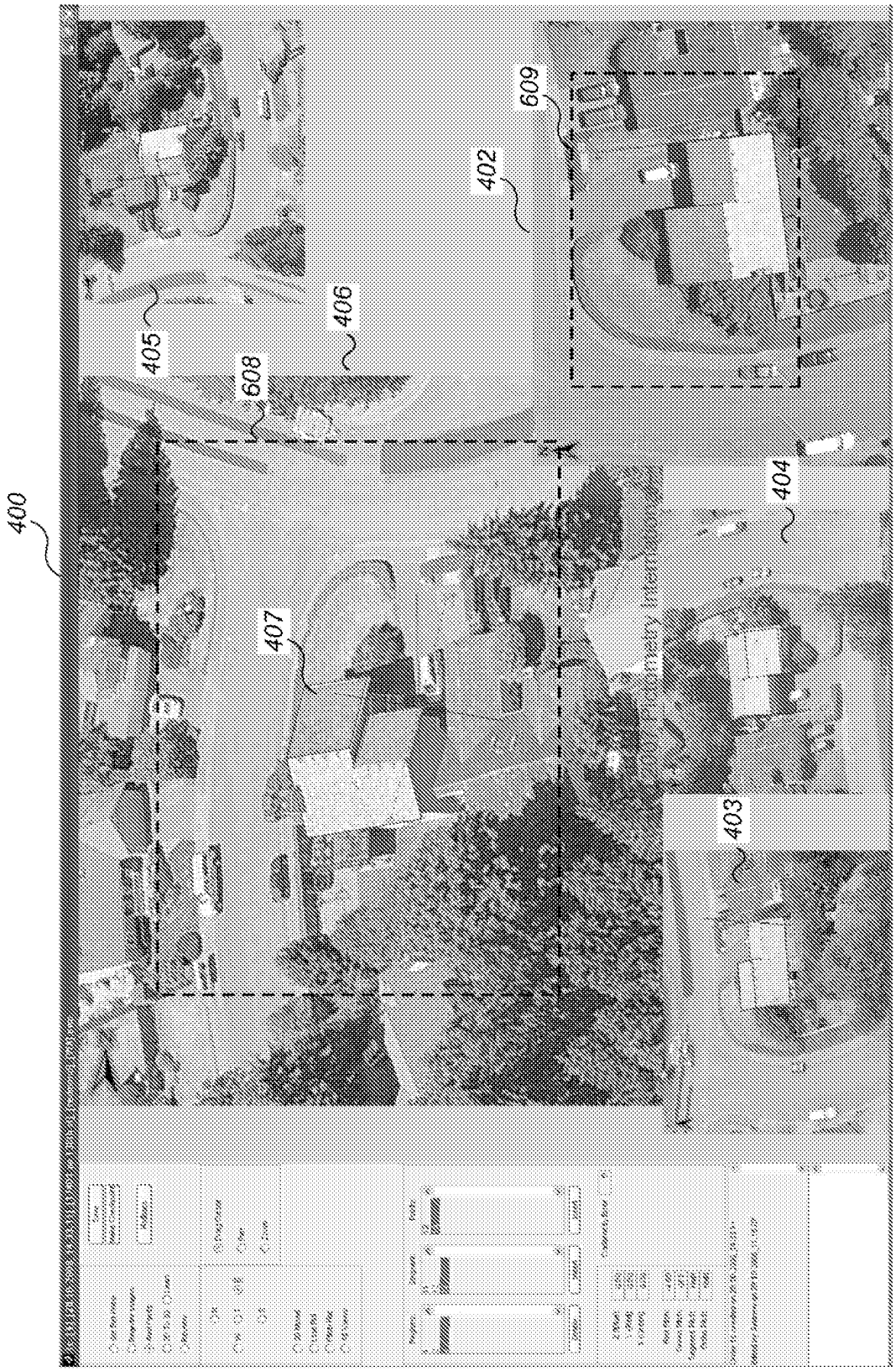


Fig. 6A

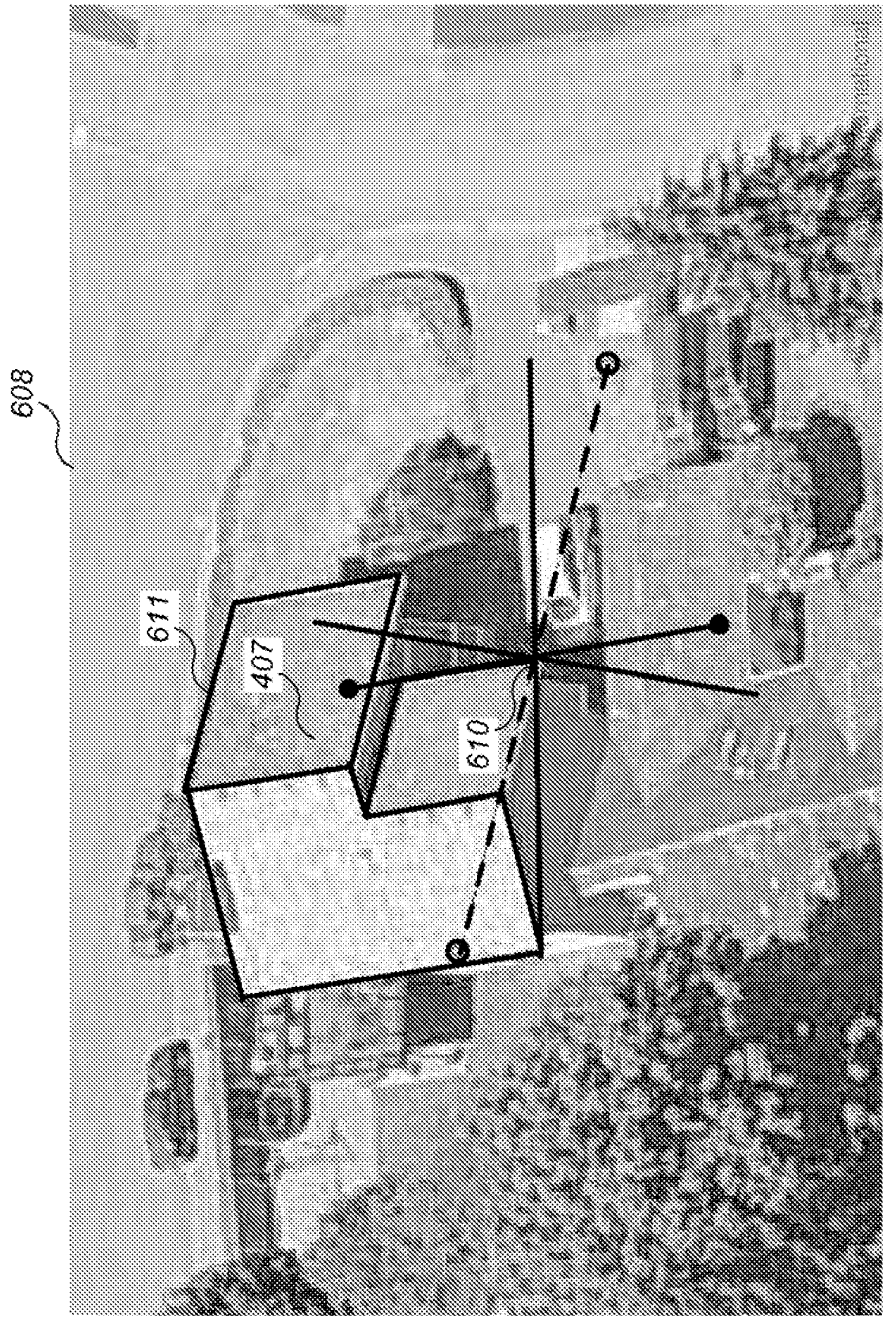


Fig. 6B



Fig. 6C

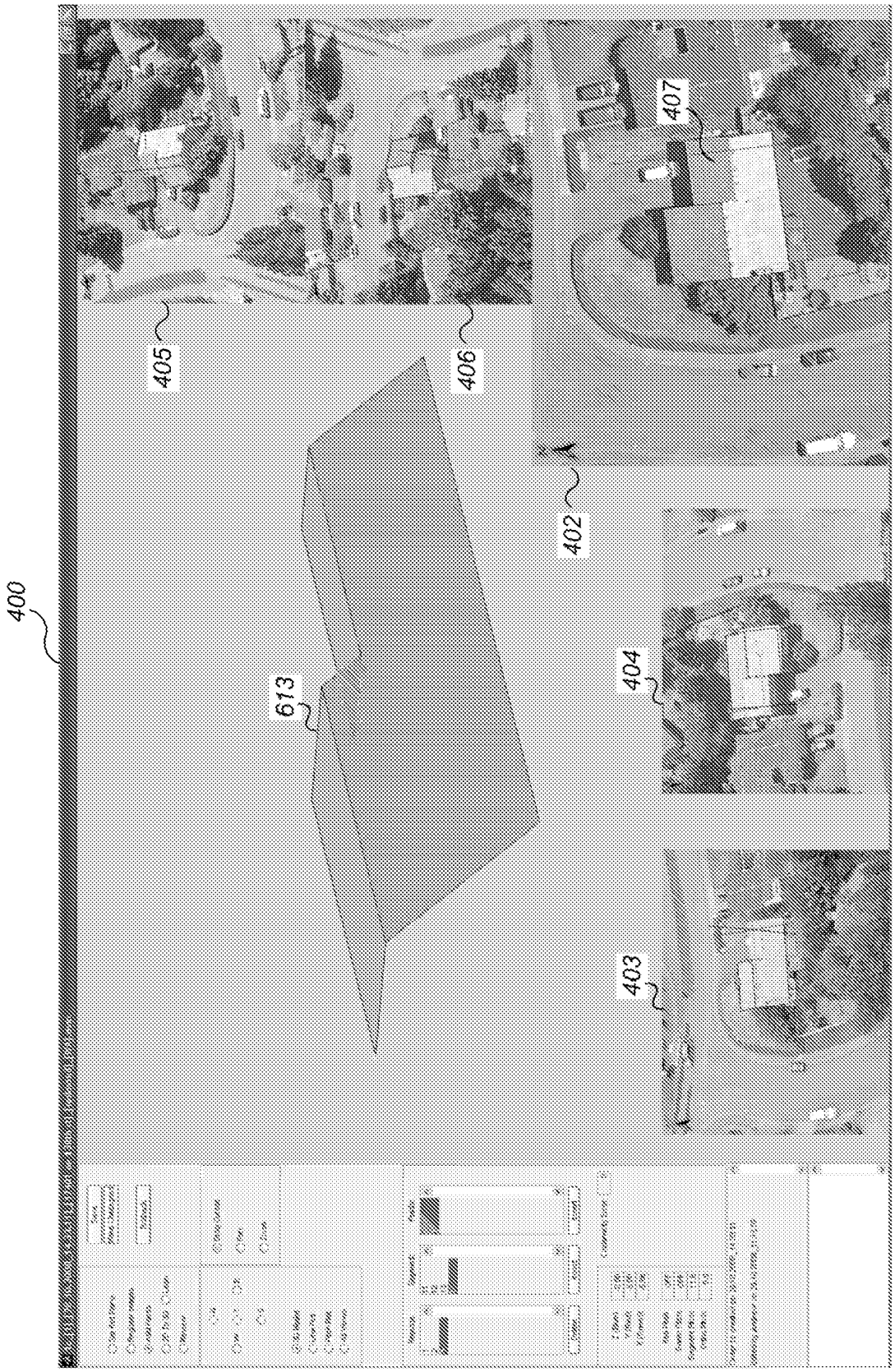


Fig. 6D

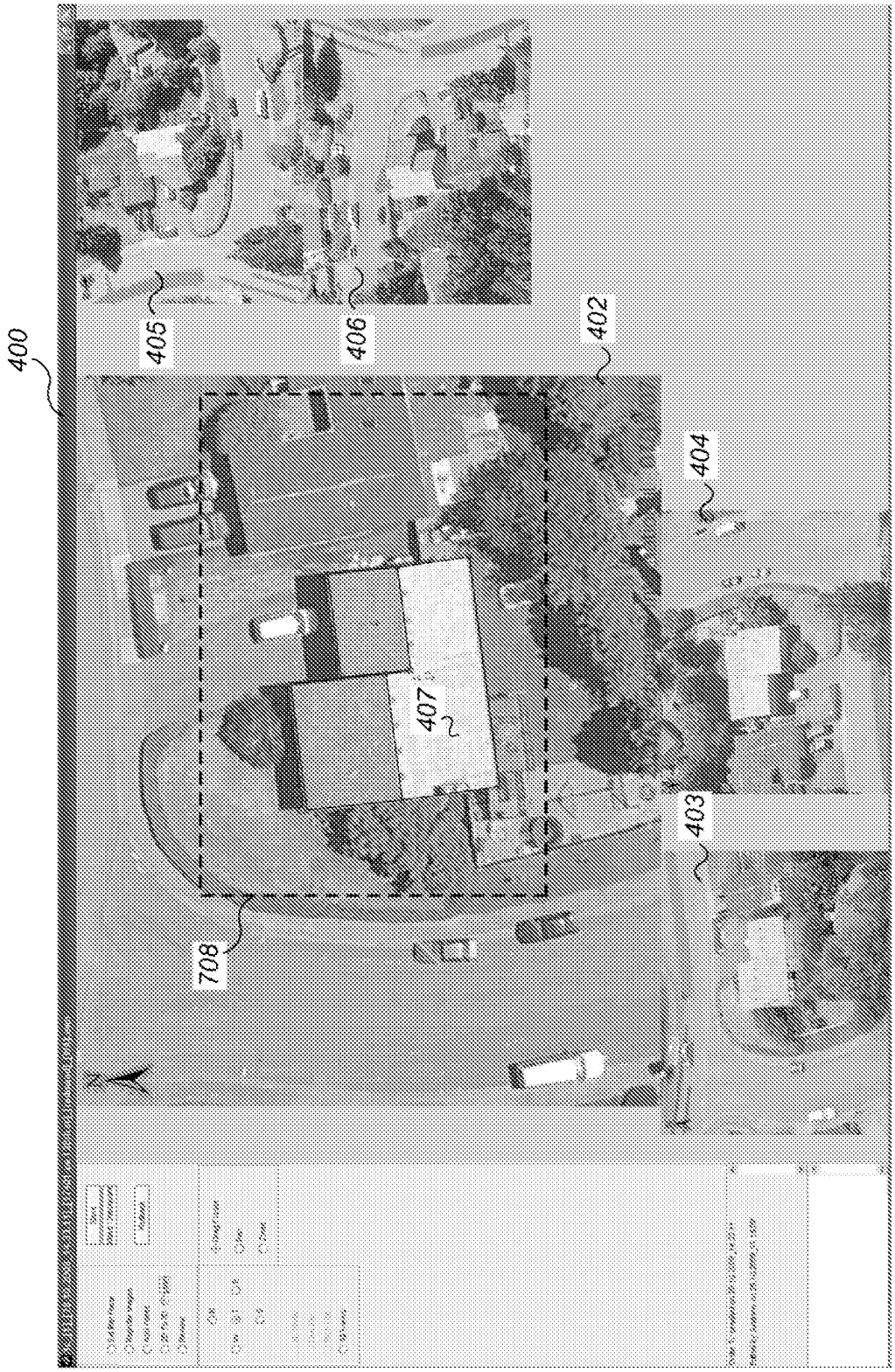


Fig. 7A

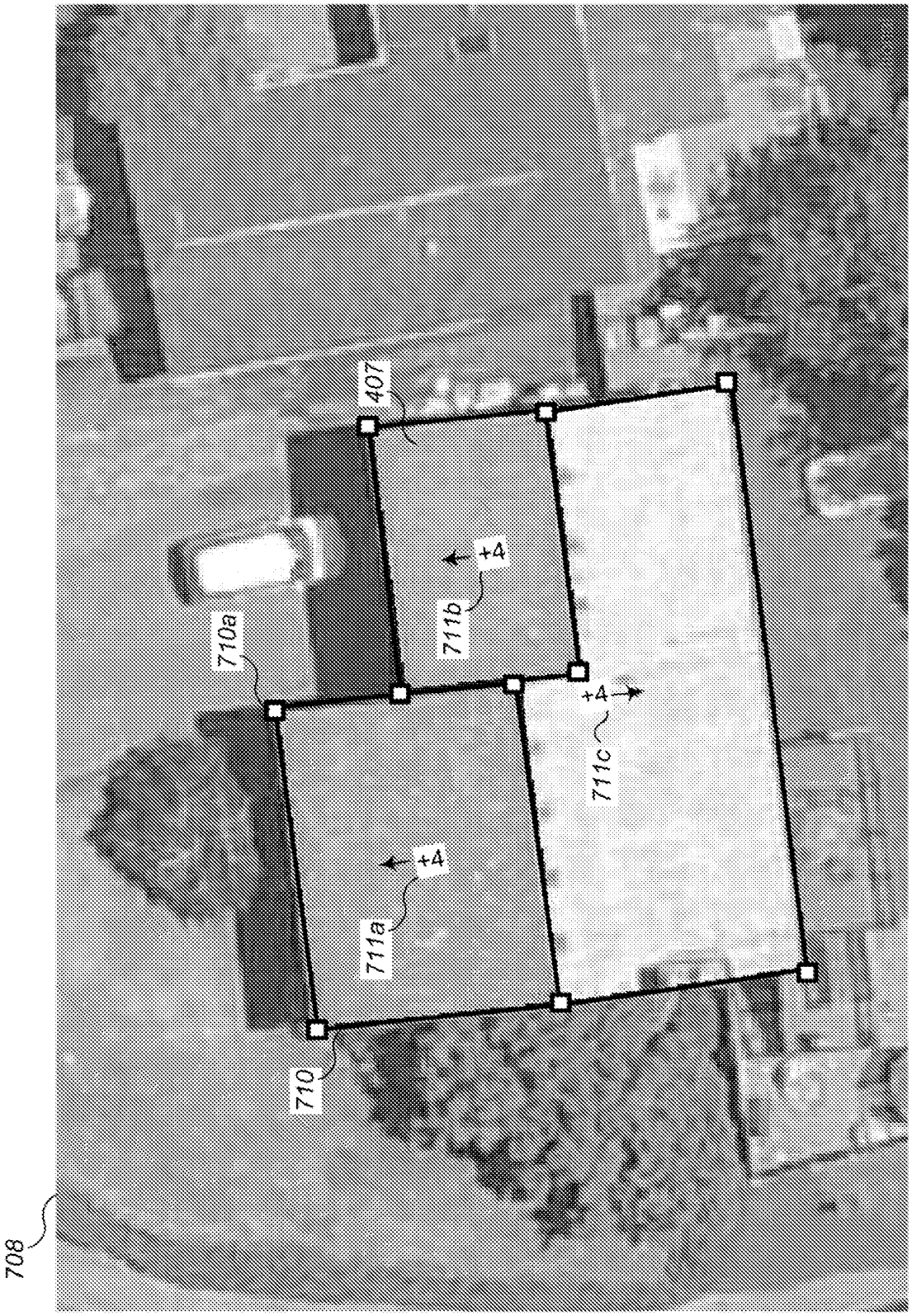


Fig. 7B

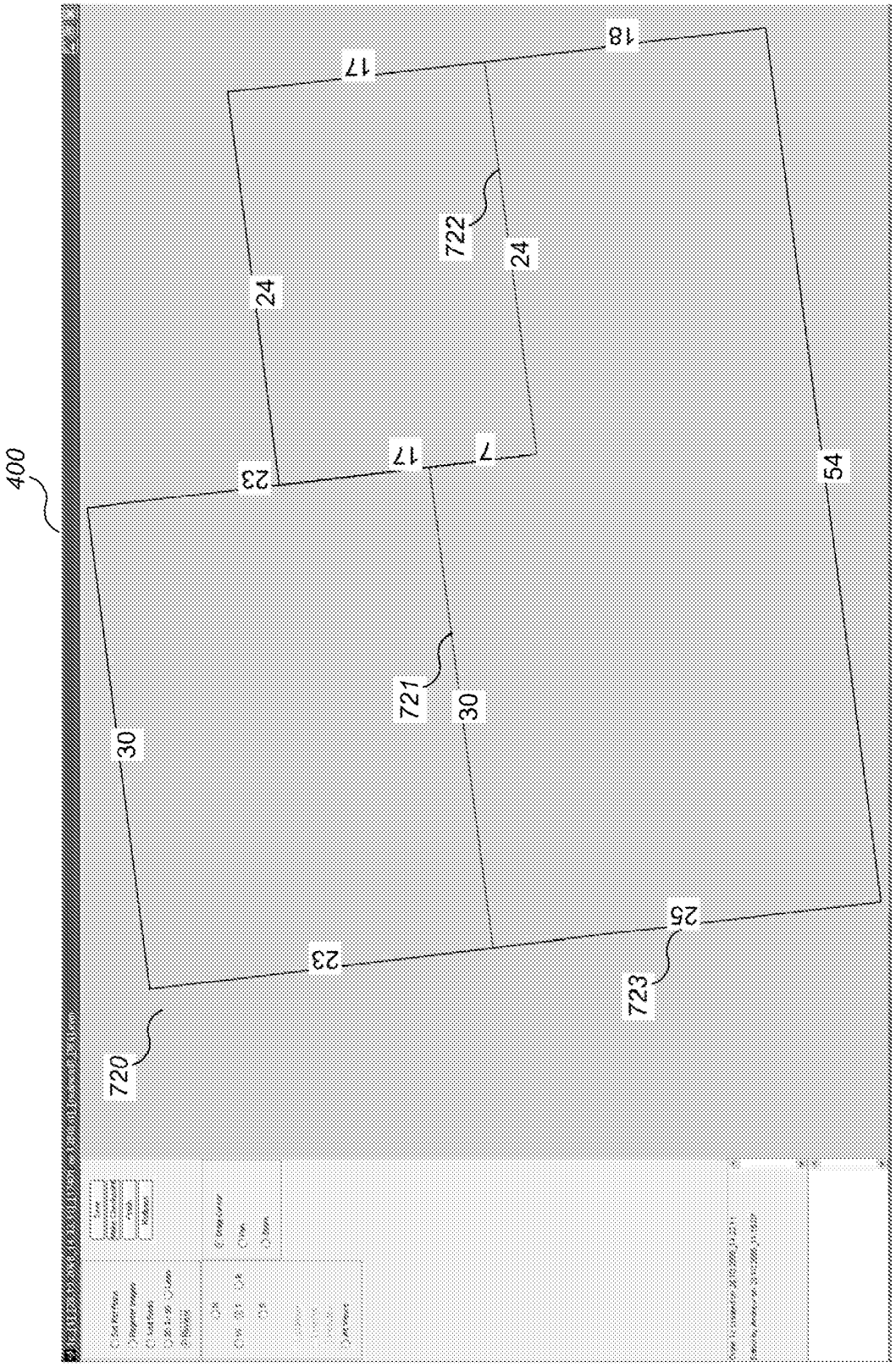


Fig. 7C

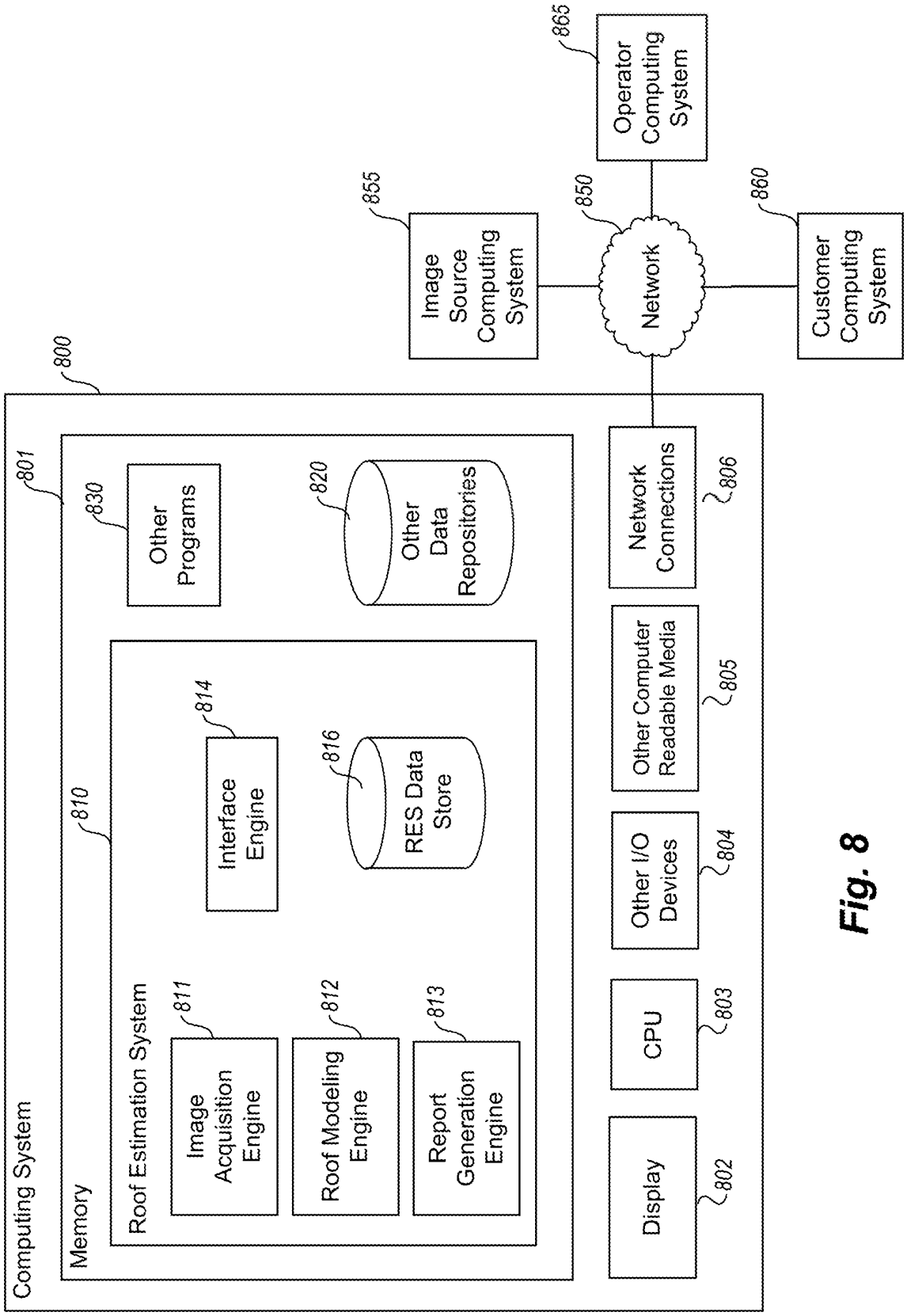

Computing System
800
Memory
801
Roof Estimation System
810
Image Acquisition Engine
811
Roof Modeling Engine
812
Report Generation Engine
813
Interface Engine
814
RES Data Store
816
Other Programs
830
Other Data Repositories
820
Display
802
CPU
803
Other I/O Devices
804
Other Computer Readable Media
805
Network Connections
806
Image Source Computing System
855
Network
850
Operator Computing System
865
Customer Computing System
860

Fig. 8

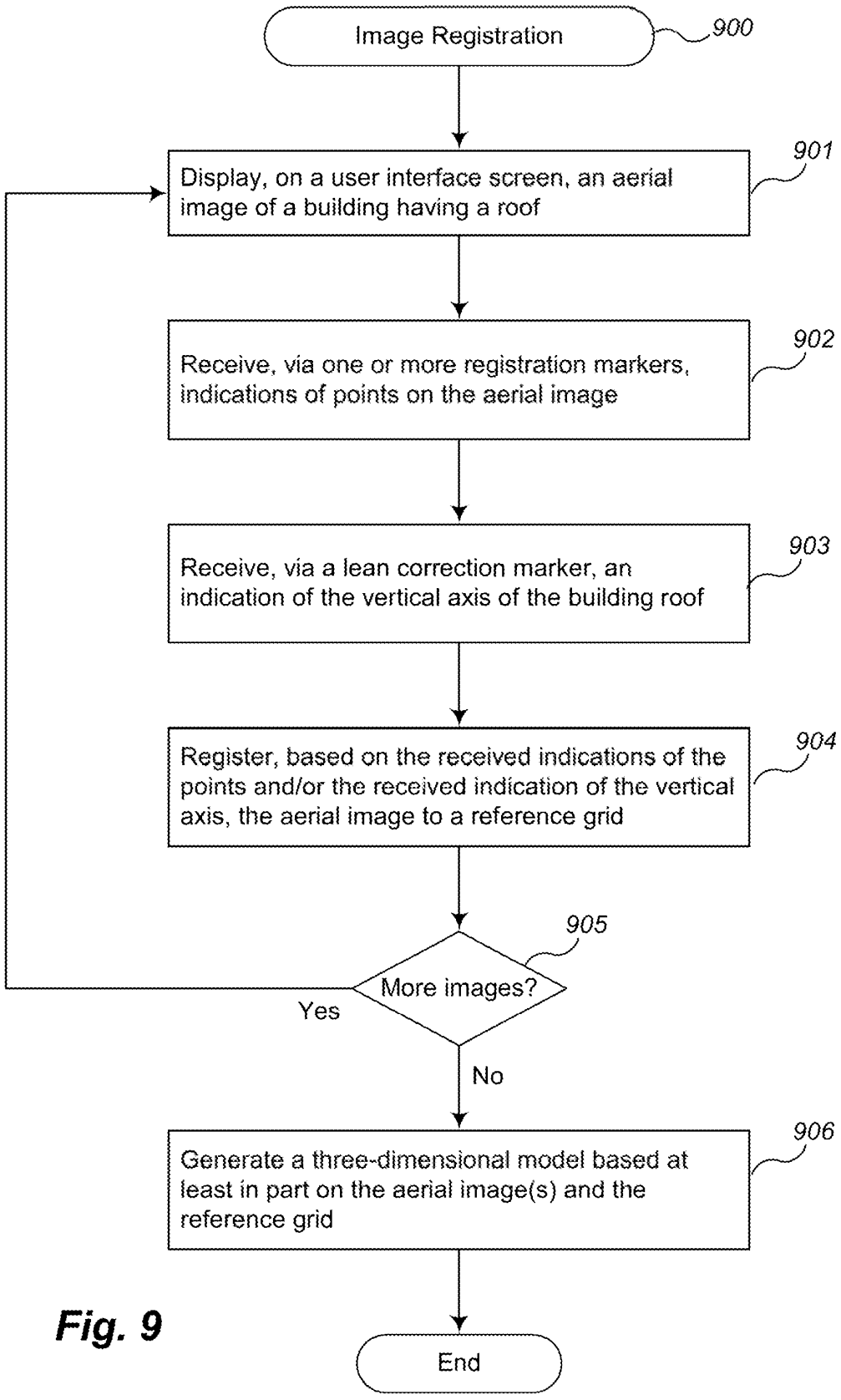

Image Registration
900
Display, on a user interface screen, an aerial image of a building having a roof
901
Receive, via one or more registration markers, indications of points on the aerial image
902
Receive, via a lean correction marker, an indication of the vertical axis of the building roof
903
Register, based on the received indications of the points and/or the received indication of the vertical axis, the aerial image to a reference grid
904
More images?
905
Yes
No
Generate a three-dimensional model based at least in part on the aerial image(s) and the reference grid
906
End

Fig. 9

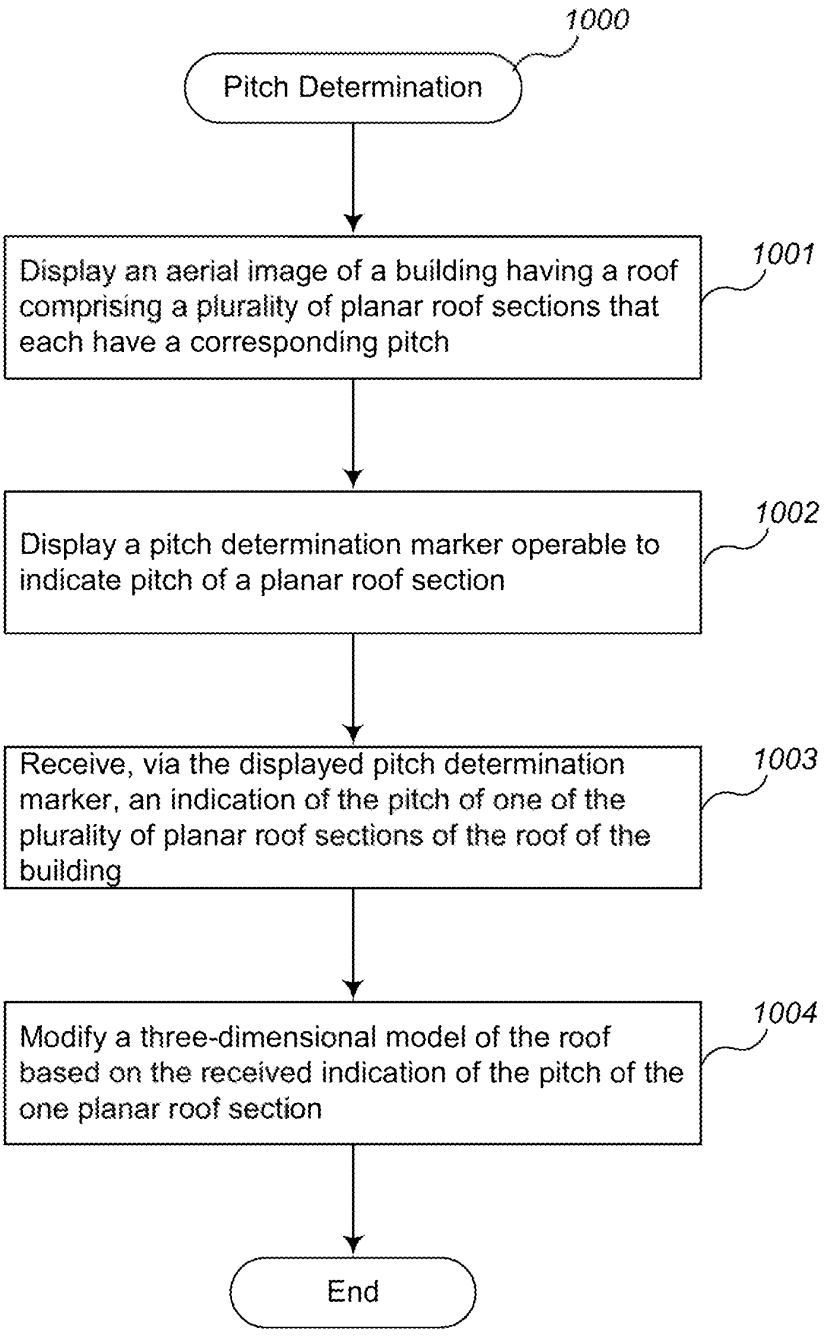

1000
Pitch Determination
Display an aerial image of a building having a roof comprising a plurality of planar roof sections that each have a corresponding pitch
1001
Display a pitch determination marker operable to indicate pitch of a planar roof section
1002
Receive, via the displayed pitch determination marker, an indication of the pitch of one of the plurality of planar roof sections of the roof of the building
1003
Modify a three-dimensional model of the roof based on the received indication of the pitch of the one planar roof section
1004
End

Fig. 10

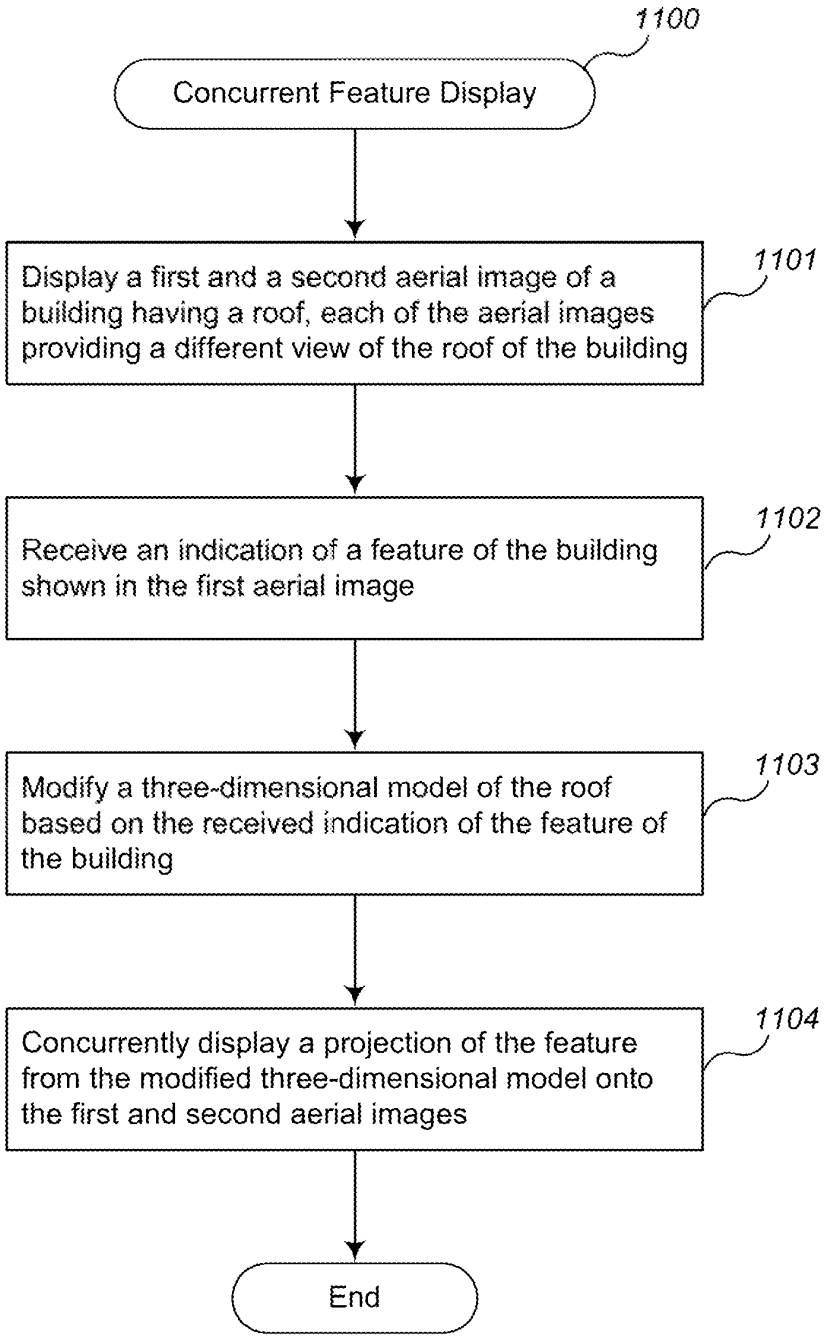

1100
Concurrent Feature Display
Display a first and a second aerial image of a building having a roof, each of the aerial images providing a different view of the roof of the building
1101
Receive an indication of a feature of the building shown in the first aerial image
1102
Modify a three-dimensional model of the roof based on the received indication of the feature of the building
1103
Concurrently display a projection of the feature from the modified three-dimensional model onto the first and second aerial images
1104
End

Fig. 11

Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	CONCURRENT DISPLAY SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION
First Named Inventor/Applicant Name:	Chris Pershing
Filer:	Jeremiah J. Baunach/Terrie Quillin
Attorney Docket Number:	290115.406C2

Filed as Large Entity

Utility under 35 USC 111(a) Filing Fees

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:				
Claims in Excess of 20	1202	17	80	1360
Independent claims in excess of 3	1201	1	420	420
Miscellaneous-Filing:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Late Filing Fee for Oath or Declaration	1051	1	140	140
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**3520**

Electronic Acknowledgement Receipt	
EFS ID:	19758223
Application Number:	14450108
International Application Number:	
Confirmation Number:	8641
Title of Invention:	CONCURRENT DISPLAY SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION
First Named Inventor/Applicant Name:	Chris Pershing
Customer Number:	500
Filer:	Jeremiah J. Baunach/Terrie Quillin
Filer Authorized By:	Jeremiah J. Baunach
Attorney Docket Number:	290115.406C2
Receipt Date:	01-AUG-2014
Filing Date:	
Time Stamp:	19:13:54
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$3520
RAM confirmation Number	4571
Deposit Account	
Authorized User	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)

1	Miscellaneous Incoming Letter	EFS_FDA_08_01_14.pdf	44881 aa05b27f17cb9d8700fee1f652da3b7a51169983	no	1
Warnings:					
Information:					
2	Power of Attorney	EFS_POA_Transmittal_08_01_14.pdf	1033685 86ad7e683ac66eb8c5b829699090ad540c0359a3	no	1
Warnings:					
Information:					
3	Power of Attorney	EFS_POA_08_01_14.pdf	1301054 e534febc16179878b1c7bd901c4fa910e0b45754	no	2
Warnings:					
Information:					
4	Application Data Sheet	EFS_ADS_08_01_14.pdf	1561658 e5a9a08d3a09298132e308660bde17a3ada516c6	no	7
Warnings:					
Information:					
5		EFS_App_08_01_14.pdf	162912 74d57005e7041bed290d4f9ed6a86e281c5ddbf4	yes	50

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Specification	1	40
	Claims	41	49
	Abstract	50	50

Warnings:					
Information:					
6		EFS_Prelim_Amend_08_01_14.pdf	96069 4a89013a351f8c9419e8144fe03b98ee42f11e66	yes	8

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Preliminary Amendment	1	1
	Specification	2	7

	Applicant Arguments/Remarks Made in an Amendment		8	8	
Warnings:					
Information:					
7	Transmittal Letter	EFS_IDS_Transmittal_08_01_14.pdf	47822 3167bfe7416e51e8aee6db7b0838e2b58fc5346b	no	2
Warnings:					
Information:					
8	Information Disclosure Statement (IDS) Form (SB08)	EFS_IDS_08_01_14.pdf	185761 2c46b8787725d3e7abbcb7b64b9c5e16f53359a9	no	16
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
9	Other Reference-Patent/App/Search documents	EFS_NPL_OA_13438288_08_01_14.pdf	4909989 f384202f518e01fd0a7f474f259eab8014a0f117	no	14
Warnings:					
Information:					
10	Other Reference-Patent/App/Search documents	EFS_NPL_AU_OA_2011210538_08_01_14.pdf	1077505 246caf739b83d06526cabe1254777db9feeda949	no	3
Warnings:					
Information:					
11	Other Reference-Patent/App/Search documents	EFS_NPL_NoA_13474504_08_01_14.pdf	5434987 6c6972e8064c4d2f73468641413a965dbfdaf43b	no	13
Warnings:					
Information:					
12	Other Reference-Patent/App/Search documents	EFS_NPL_NoA_13438288_08_01_14.pdf	5124191 f9cc8ec4c7bf297be4e95eb99255ee0023bf102e	no	12
Warnings:					
Information:					
13	Drawings-only black and white line drawings	EFS_Dwgs_08_01_14.pdf	20729177 0e45fe0e2d684b42f2040ad604b9424a87bc9724	no	29
Warnings:					
Information:					
14	Fee Worksheet (SB06)	fee-info.pdf	39770 28c25dd3ddd5a4fb6a028f09bae740a91015f636	no	2
Warnings:					

Information:	
Total Files Size (in bytes):	41749461

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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.

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor	:	Chris Pershing
For	:	CONCURRENT DISPLAY SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION
Docket No.	:	290115.406C2
Date	:	August 1, 2014

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

FEE DEFICIENCY AUTHORIZATION FORM

Commissioner for Patents:

Applicant(s) hereby authorize(s) the Director to charge any deficiencies or credit any overpayment in fees due by way of the enclosed papers only to Deposit Account No. 19-1090.

Respectfully submitted,

SEED Intellectual Property Law Group PLLC

/Jeremiah J. Baunach/
Jeremiah J. Baunach
Registration No. 44,527

701 Fifth Avenue, Suite 5400
Seattle, Washington 98104
Phone: (206) 622-4900
Fax: (206) 682-6031

3347245_1

Doc Code: PA..

Document Description: Power of Attorney

PTO/AIA/82B(07-12)
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POWER OF ATTORNEY BY APPLICANT

I hereby revoke all previous powers of attorney given in the application identified in the attached transmittal letter.

☒ I hereby appoint Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A or equivalent):

00500

OR

☐ I hereby appoint Practitioner(s) named below as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A or equivalent):

Name	Registration Number	Name	Registration Number

Please recognize or change the correspondence address for the application identified in the attached transmittal letter to:

☒ The address associated with the above-mentioned Customer Number.

OR

☐ The address associated with Customer Number:

OR

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

I am the Applicant:

☐ Inventor or Joint Inventor

☐ Legal Representative of a Deceased or Legally Incapacitated Inventor

☒ Assignee or Person to Whom the Inventor is Under an Obligation to Assign

☐ Person Who Otherwise Shows Sufficient Proprietary Interest (*e.g.*, a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document)

SIGNATURE of Applicant for Patent

Signature		Date	5/28/13
Name	Chris Pershing	Telephone	866-659-8439 x501
Title and Company	CTO; Eagle View Technologies, Inc.		

NOTE: Signature - This form must be signed by the applicant in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. Submit multiple forms for more than one signature, see below *.

☐ *Total of _____ forms are submitted.

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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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	290115.406C2
	Application Number	
Title of Invention	CONCURRENT DISPLAY SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION	

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
	Chris		Pershing	

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

City	Redmond	State/Province	WA	Country of Residence i	US

Mailing Address of Inventor:

Address 1	17401 Northeast 138th Street		
Address 2			
City	Redmond	State/Province	WA
Postal Code	98052	Country i	US

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	00500		
Email Address	jimb.docketing@seedip.com	Add Email	Remove Email

Application Information:

Title of the Invention	CONCURRENT DISPLAY SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION		
Attorney Docket Number	290115.406C2	Small Entity Status Claimed	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	29	Suggested Figure for Publication (if any)	

Filing By Reference :

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	290115.406C2
	Application Number	
Title of Invention	CONCURRENT DISPLAY SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION	

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 [i]

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	00500		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, or 365(c) or indicate National Stage entry from a PCT application. Providing this 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 blank.

Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	Continuation of	13474504	2012-05-17

Prior Application Status	Patented				Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
13474504	Continuation of	12467250	2009-05-15	8209152	2012-06-26

Prior Application Status	Expired	Remove

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	290115.406C2
	Application Number	
Title of Invention	CONCURRENT DISPLAY SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION	

Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
12467250	Claims benefit of provisional	61197904	2008-10-31

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

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(d). 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(h)(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.

Authorization to Permit Access:

☒ Authorization to Permit Access to the Instant Application by the Participating Offices

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	290115.406C2
	Application Number	
Title of Invention	CONCURRENT DISPLAY SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION	

If 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 World Intellectual Property Office (WIPO), and any other intellectual property offices in which a foreign application claiming priority to the instant patent application is filed access to the instant patent application. See 37 CFR 1.14(c) and (h). This box should not be checked if the applicant does not wish the EPO, JPO, KIPO, WIPO, or other intellectual property office in which a foreign application claiming priority to the instant patent application is filed to have access to the instant patent application.

In accordance with 37 CFR 1.14(h)(3), access will be provided to a copy of the instant patent application with respect to: 1) the instant patent application-as-filed; 2) any foreign application to which the instant patent application claims priority under 35 U.S.C. 119(a)-(d) if a copy of the foreign application that satisfies the certified copy requirement of 37 CFR 1.55 has been filed in the instant patent application; and 3) any U.S. application-as-filed from which benefit is sought in the instant patent application.

In accordance with 37 CFR 1.14(c), access may be provided to information concerning the date of filing this Authorization.

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	Eagle View Technologies, Inc.		
Mailing Address Information:			
Address 1	3700 Monte Villa Parkway, Suite 200		
Address 2			
City	Bothell	**State/Province**	WA
Country [i]	US	Postal Code	98021
Phone Number		Fax Number	

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	290115.406C2
	Application Number	
Title of Invention	CONCURRENT DISPLAY SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION	

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 subsitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

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. ☐

Prefix	**Given Name**	Middle Name	**Family Name**	Suffix

Mailing Address Information For Assignee including Non-Applicant Assignee:

Address 1			
Address 2			
City		**State/Province**	
Country i		Postal Code	
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 form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications

Signature	/Jeremiah J. Baunach/			Date (YYYY-MM-DD)	2014-08-01
First Name	Jeremiah J.	Last Name	Baunach	Registration Number	44527

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	290115.406C2
	Application Number	
Title of Invention	CONCURRENT DISPLAY SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION	

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CONCURRENT DISPLAY SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation of U.S. Patent Application No. 12/467,250, entitled "CONCURRENT DISPLAY SYSTEMS AND METHODS FOR AERIAL ROOF ESTIMATION", filed May 15, 2009 and claims the benefit of U.S. Provisional Patent Application No. 61/197,904, entitled "USER INTERFACE TECHNIQUES FOR ROOF ESTIMATION," filed October 31, 2008, which applications are incorporated herein by reference in their entirety.

BACKGROUND

1. Field of the Invention:

[0002] This invention relates to systems and methods for estimating construction projects, and more particularly, to such systems and methods for determining roof measurement information based on one or more aerial images of a roof of a building.

2. Description of the Related Art:

[0003] The information provided below is not admitted to be part of the present invention, but is provided solely to assist the understanding of the reader.

[0004] Homeowners typically ask several roofing contractors to provide written estimates to repair or replace a roof on a house. Heretofore, the homeowners would make an appointment with each roofing contractor to visit the house to determine the style of roof, take measurements, and to inspect the area around the house for access and cleanup. Using this information, the roofing contractor then prepares a written estimate and then timely delivers it to the homeowner. After receiving several estimates from different rooting contractors, the homeowner then selects one.

[0005] There are factors that impact a roofing contractor's ability to provide a timely written estimate. One factor is the size of the roof contractor's company and the location of the roofing jobs currently underway. Most roof contractors provide roofing services and estimates to building owners over a large geographical area. Larger roof contractor companies hire one or more trained individuals who travel throughout the entire area providing written estimates. With smaller roofing contractors, the owner or a key trained person is appointed to provide estimates. With both types of companies, roofing estimates are normally scheduled for buildings located in the same area on a particular day. If an estimate is needed suddenly at a distant location, the time for travel and the cost of commuting can be prohibitive. If the roofing contractor is a small company, the removal of the owner or key person on a current job site can be time prohibitive.

[0006] Another factor that may impact the roofing contractor's ability to provide a written estimate is weather and traffic.

[0007] Recently, solar panels have become popular. In order to install solar panels, the roof's slope, geometrical shape, and size as well as its orientation with respect to the sun all must be determined in order to provide an estimate of the number and type of solar panels required. Unfortunately, not all roofs on a building are proper size, geometrical shape, or orientation for use with solar panels.

SUMMARY

[0008] These and other objects are met by the systems and methods disclosed herein that determine and provide roof measurement information about the sizes, dimensions, slopes and orientations of the roof sections of a building roof. Roof measurement information may be used to generate a roof estimate report that provides and graphically shows this information. A roof estimation system that practices at least some of the techniques described herein may include an image acquisition engine, a roof modeling engine, and a report generation engine. The roof

estimation system is configured to generate a model of a roof of a building, based on one or more aerial images. In addition, the roof estimation system is configured to determine roof measurement information and generate a roof estimate report based on the generated model and/or the determined roof measurement information.

[0009] In some embodiments, the roof estimation system includes a user interface engine which provides access to at least some of the functions of the roof estimation system. In one embodiment, the user interface engine provides interactive user interface components operable by an operator to perform various functions related to generating a model of a roof of a building, including image registration, lean correction, pitch determination, feature identification, and model review and/or correction.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] Figure 1 is a block diagram illustrating example functional elements of one embodiment of a roof estimation system.

[0011] Figures 2A-2B illustrate aerial images of a building at a particular address.

[0012] Figures 3A-3F illustrate individual pages of an example roof estimate report generated by an example embodiment of a roof estimation system.

[0013] Figures 4A-4F are screen displays illustrating image registration and image lean correction in an example embodiment. (Also shows lean correction.)

[0014] Figures 5A-5D are screen displays illustrating pitch determination in an example embodiment.

[0015] Figures 6A-6D are screen displays illustrating model construction and concurrent display of operator specified roof features in an example embodiment.

[0016] Figures 7A-7C are screen displays illustrating roof model review in an example embodiment.

[0017] Figure 8 is an example block diagram of a computing system for practicing embodiments of a roof estimation system.

[0018] Figure 9 is an example flow diagram of an image registration routine provided by an example embodiment.

[0019] Figure 10 is an example flow diagram of a pitch determination routine provided by an example embodiment.

[0020] Figure 11 is an example flow diagram of concurrent feature display routine provided by an example embodiment.

DETAILED DESCRIPTION

[0021] Embodiments described herein provide enhanced computer- and network-based methods, techniques, and systems for estimating construction projects based on one or more images of a structure. Example embodiments provide a Roof Estimation System ("RES") that is operable to provide a roof estimate report for a specified building, based on one or more aerial images of the building. In one embodiment, a customer of the RES specifies the building by providing an address of the building. The RES then obtains one or more aerial images showing at least portions of the roof of the building. Next, the RES generates a model of the roof of the building, which is then utilized to determine roof measurement information. The roof measurement information may include measurements such as lengths of the edges of sections of the roof, pitches of sections of the roof, areas of sections of the roof, etc. The model of the roof and/or the roof measurement information is then used to generate a roof estimate report. The roof estimate report includes one or more line drawings of the roof of the building, which are annotated with information about the roof, such as lengths of the edges of sections of the roof, pitches of sections of the roof, areas of sections of the roof, etc.

[0022] Some embodiments of the roof estimation system include an interactive user interface configured to provide access to one or more of the functions of the roof estimation system. In one embodiment, the roof estimation system includes user interface controls that facilitate image registration, image lean correction, roof model

generation, pitch determination, and roof model review. Image registration includes aligning, based at least in part on operator inputs, one or more images of a building roof to a set of reference points within a single three-dimensional ("3D") grid that is shared between the one or more images. Roof model generation includes generating a 3D model of a roof, based at least in part on operator inputs specifying various features and/or dimensional attributes of the roof. Roof model generation may further include the determination of the pitches of various planar sections of a roof. Roof model review includes display of a model of a roof, possibly in conjunction with one or more images of the roof, so that an operator may review the model for accuracy and possibly make adjustments and/or corrections to the roof model. In other embodiments, all or some of the functions of the roof estimation system may be performed automatically. For example, image registration may include automatically identifying building features for the placement of reference markers. Further, roof model generation may include automatically recognizing features, dimensional attributes, and/or pitches of various planar roof sections of the roof.

[0023] The described user interface is also configured to concurrently display roof features onto multiple images of a roof. For example, in the context of roof model generation, an operator may indicate a roof feature, such as an edge or a corner of a section of the roof, in a first image of the roof. As the roof estimation system receives the indication of the roof feature, the user interface concurrently displays that feature in one or more other images of the roof, so that the operator may obtain feedback regarding the accuracy of the roof model, the image registration, etc.

[0024] In the following, Figures 1-3 provide an overview of the operation of an example roof estimation system. Figures 4-7 provide additional details related an example interactive user interface provided by one embodiment of the roof estimation system. Figures 8-11 provide details related to roof estimation system implementation techniques.

1. Roof Estimation System Overview

[0025] Figure 1 is a block diagram illustrating example functional elements of one embodiment of a roof estimation system. In particular, Figure 1 shows an example Roof Estimation System ("RES") 100 comprising an image acquisition engine 101, a roof modeling engine 102, a report generation engine 103, image data 105, model data 106, and report data 107. The RES 100 is communicatively coupled to an image source 110, a customer 115, and optionally an operator 120. The RES 100 and its components may be implemented as part of a computing system, as will be further described with reference to Figure 8.

[0026] More specifically, in the illustrated embodiment of Figure 1, the RES 100 is configured to generate a roof estimate report 132 for a specified building, based on aerial images 131 of the building received from the image source 110. The image source 110 may be any provider of images of the building for which a roof estimate is being generated. In one embodiment, the image source 110 includes a computing system that provides access to a repository of aerial images of one or more buildings. In addition, the aerial images 131 may include images obtained via manned or unmanned aircraft (*e.g.*, airplane, helicopter, blimp, drone, etc.), satellite, etc. Furthermore, the aerial images 131 may include images obtain via one or more ground-based platforms, such as a vehicle-mounted camera that obtains street-level images of buildings, a nearby building, a hilltop, etc. In some cases, a vehicle-mounted camera may be mounted in an elevated position, such as a boom. Example aerial images are described further with reference to Figures 2A-2B.

[0027] The image acquisition engine 101 obtains one or more aerial images of the specified building by, for example, providing an indicator of the location of the specified building (*e.g.*, street address, GPS coordinates, lot number, etc.) to the image source 110. In response, the image source 110 provides to the image acquisition engine 101 the one or more aerial images of the building. The image acquisition engine 101 then stores the received aerial images as image data 105, for further processing by other components of the RES 100. Obtaining aerial images of a

specified building may include various forms of geo-coding, performed by the image acquisition engine 101 and/or the image source 110. In one embodiment, the image source geo-codes a provided street address into latitude and longitude coordinates, which are then used to look up (*e.g.*, query a database) aerial images of the provided street address.

[0028] Next, the roof modeling engine 102 generates a model of the roof of the specified building. In the illustrated embodiment, the roof modeling engine 102 generates a three-dimensional ("3D") model, although in other embodiments, a two-dimensional (*e.g.*, top-down roof plan) may be generated instead or in addition. Generating a model of the roof may generally include image calibration, in which the distance between two pixels on a given image is converted into a physical length. Image calibration may be performed automatically, such as based on meta-information provided along with the aerial images 131.

[0029] A variety of automatic and semi-automatic techniques may be employed to generate a model of the roof of the building. In one embodiment, generating such a model is based at least in part on a correlation between at least two of the aerial images of the building. For example, the roof modeling engine 102 receives an indication of a corresponding feature that is shown in each of the two aerial images. In one embodiment, an operator 120, viewing two or more images of the building, inputs an indication in at least some of the images, the indications identifying which points of the images correspond to each other for model generation purposes.

[0030] The corresponding feature may be, for example, a vertex of the roof of the building, the corner of one of the roof planes of the roof, a point of a gable or hip of the roof, etc. The corresponding feature may also be a linear feature, such as a ridge or valley line between two roof planes of the roof. In one embodiment, the indication of a corresponding feature on the building includes "registration" of a first point in a first aerial image, and a second point in a second aerial image, the first and second points corresponding the substantially the same point on the roof of the building. Generally, point registration may include the identification of any feature shown in both aerial

images. Thus, the feature need not be a point on the roof of the building. Instead, it may be, for example, any point that is visible on both aerial images, such as on a nearby building (*e.g.*, a garage, neighbor's building, etc.), on a nearby structure (*e.g.*, swimming pool, tennis court, etc.), on a nearby natural feature (*e.g.*, a tree, boulder, etc.), etc.

[0031] In some embodiments, the roof modeling engine 102 determines the corresponding feature automatically, such as by employing on one or more image processing techniques used to identify vertexes, edges, or other features of the roof. In other embodiments, the roof modeling engine 102 determines the corresponding feature by receiving, from the human operator 120 as operator input 133, indications of the feature shown in multiple images of the building.

[0032] In one example embodiment, the RES 100 generates a model of the roof of the building in the following manner. First, a set of reference points are be identified in each of the images. These reference points are identified by the operator 120 utilizing a suitable input device, such as a mouse or joystick. The roof modeling engine 102 then uses these reference points and any acceptable algorithm to co-register the images and reconstruct the three-dimensional geometry of the object identified by the reference points. There are a variety of photogrammetric algorithms that can be utilized to perform this reconstruction. One such algorithm used by the RES 100 uses photographs taken from two or more view points to "triangulate" points of interest on the object in three-dimensional ("3D") space. This triangulation can be visualized as a process of projecting a line originating from the location of the photograph's observation point that passes through a particular reference point in the image. The intersection of these projected lines from the set of observation points to a particular reference point identifies the location of that point in 3D space. Repeating the process for all such reference points allows the software to determine a 3D volume suitable for building a 3D model of the structure. The choice of reconstruction algorithm depends on a number of factors such as the spatial relationships between the photographs, the number and locations of the reference points, and any

assumptions that are made about the geometry and symmetry of the object being reconstructed. Several such algorithms are described in detail in textbooks, trade journals, and academic publications.

[0033] In addition, generating a model of the roof of a building may include correcting one or more of the aerial images for various imperfections. For example, the vertical axis of a particular aerial image sometimes will not substantially match the actual vertical axis of its scene. This will happen, for example, if the aerial images were taken at different distances from the building, or at a different pitch, roll, or yaw angles of the aircraft from which the images were produced. In such cases, an aerial image may be corrected by providing the operator 120 with a user interface control operable to adjust the scale and/or relative angle of the aerial image to correct for such errors. The correction may be either applied directly to the aerial image, or instead be stored (*e.g.*, as an offset) for use in model generation or other functions of the RES 100.

[0034] Generating a model of the roof of a building further includes the automatic or semi-automatic identification of features of the roof of the building. In one embodiment, one or more user interface controls may be provided, such that the operator 120 may indicate (*e.g.*, draw, paint, etc.) various features of the roof, such as valleys, ridges, hips, vertexes, planes, edges, etc. As these features are indicated by the operator 120, a corresponding three-dimensional ("3D") model may be updated accordingly to include those features. These features are identified by the operator based on a visual inspection of the images and by providing inputs that identify various features as valleys, ridges, hips, etc. In some cases, a first and a second image view of the roof (*e.g.*, a north and east view) are simultaneously presented to the operator 120, such that when the operator 120 indicates a feature in the first image view, a projection of that feature is automatically presented in the second image view. By presenting a view of the 3D model, simultaneously projected into multiple image views, the operator 120 is provided with useful visual cues as to the correctness of the 3D model and/or the correspondence between the aerial images.

[0035] In addition, generating a model of the roof of a building may include determining the pitch of one or more of the sections of the roof. In some embodiments, one or more user interface controls are provided, such that the operator 120 may accurately determine the pitch of each of the one or more roof sections. An accurate determination of the roof pitch may be employed (by a human or the RES 100) to better determine an accurate cost estimate, as roof sections having a low pitch are typically less costly surfaces to repair and/or replace.

[0036] The generated model typically includes a plurality of planar roof sections that each correspond to one of the planar sections of the roof of the building. Each of the planar roof sections in the model has a number of associated dimensions and/or attributes, among them slope, area, and length of each edge of the roof section. Other information may include any information relevant to a roof builder or other entity having an interest in construction of, or installation upon, the roof. For example, the other information may include identification of valleys, ridges, rakes, eaves, or hip ridges of the roof and/or its sections; roof and/or roof section perimeter dimensions and/or outlines; measurements of step heights between different roof levels (*e.g.*, terraces); bearing and/or orientation of each roof section; light exposure and/or shadowing patterns due to chimneys, other structures, trees, latitude, etc.; roofing material; etc? Once a 3D model has been generated to the satisfaction of the roof modeling engine 102 and/or the operator 120, the generated 3D model is stored as model data 106 for further processing by the RES 100. In one embodiment, the generated 3D model is then stored in a quality assurance queue, from which it is reviewed and possibly corrected by a quality control operator.

[0037] The report generation engine 103 generates a final roof estimate report based on a model stored as model data 106, and then stores the generated report as report data 107. Such a report typically includes one or more plan (top-down) views of the model, annotated with numerical values for the slope, area, and/or lengths of the edges of at least some of the plurality of planar roof sections of the model of the roof. The report may also include information about total area of the roof, identification and

measurement of ridges and/or valleys of the roof, and/or different elevation views rendered from the 3D model (top, side, front, etc). An example report is illustrated and discussed with respect to Figures 3A-3E, below.

[0038] In some embodiments, generating a report includes labeling one or more views of the model with annotations that are readable to a human user. Some models include a large number of small roof details, such as dormers or other sections, such that applying uniformly sized, oriented, and positioned labels to roof section views results in a visually cluttered diagram. Accordingly, various techniques may be employed to generate a readable report, including automatically determining an optimal or near-optimal label font size, label position, and/or label orientation, such that the resulting report may be easily read and understood by the customer 115.

[0039] In addition, in some embodiments, generating a report includes automatically determining a cost estimate, based on specified costs, such as those of materials, labor, transportation, etc. For example, the customer 115 provides indications of material and labor costs to the RES 100. In response, the report generation engine 103 generates a roof estimate report that includes a cost estimate, based on the costs provided by the customer 115 and the attributes of the particular roof, such as area, pitch, etc.

[0040] In one embodiment, the generated report is then provided to a customer. The generated report can be represented, for example, as an electronic file (*e.g.*, a PDF file) or a paper document. In the illustrated example, roof estimate report 132 is transmitted to the customer 115. The customer 115 may be or include any human, organization, or computing system that is the recipient of the roof estimate report 132. For example, the customer 115 may be a property owner, a property manager, a roof construction/repair company, a general contractor, an insurance company, a solar power panel installer, a climate control (*e.g.*, heating, ventilation, and/or air conditioning) system installer, a roof gutter installer, an awning installer, etc. Reports may be transmitted electronically, such as via a network (*e.g.*, as an email, Web page,

etc.) or by some shipping mechanism, such as the postal service, a courier service, etc.

[0041] In some embodiments, one or more of the models stored as model data 106 are provided directly to the customer or other computing system, without first being transformed into a report. For example, a model and/or roof measurement information based thereon may be exported and/or transmitted as a data file, in any suitable format, that may be consumed or otherwise utilized by some other computing system, such as a computer-aided design ("CAD") tool, a drawing program, a labor and material estimation software, a project management/estimation software, etc.

[0042] The RES 100 may be operated by various types of entities. In one embodiment, the RES 100 is operated by a roof estimation service that provides roof estimate reports to customers, such as roofing contractors, in exchange for payment. In another embodiment, the RES 100 is operated by a roof construction/repair company, to generate roof estimate reports that are used internally and/or provided to customers, such as property owners.

[0043] In addition, the RES 100 may be operated in various ways. In one embodiment, the RES 100 executes as a desktop computer application that is operated by the operator 120. In another embodiment, the RES 100 executes as a network-accessible service, such as by a Web server, that may be operated remotely by the operator 120 and/or the customer 115. Additional details regarding the implementation of an example roof estimation system are provided with respect to Figure 8, below.

[0044] Figures 2A-2B illustrate aerial images of a building at a particular address. In the illustrated example, the aerial images are represented as stylized line drawings for clarity of explanation. As noted above, such aerial images may be acquired in various ways. In one embodiment, an aircraft, such as an airplane or helicopter is utilized to take photographs while flying over one or more properties. Such aircraft may be manned or unmanned. In another embodiment, a ground-based vehicle, such as a car or truck, is utilized to take photographs (*e.g.*, "street view" photographs) while

driving past one or more properties. In such an embodiment, a camera may be mounted on a boom or other elevating member, such that images of building roofs may be obtained. In another embodiment, photographs may be taken from a fixed position, such as a tall building, hilltop, tower, etc.

[0045] In particular, Figure 2A shows a top plan (top-down) aerial image 210 of a building 200. The roof of the building 200 includes multiple planar roof sections 200a-200d. Figure 2A also shows a second aerial image 211 providing a perspective (oblique) view of the building 200. The roof sections 200a and 200c are also visible in image 211.

[0046] Figure 2B shows a top-down, wide angle image 212 of the building 200. The image 212 includes details of the surrounding areas 220 of the building 220. Information about the surrounding areas 220 of the building 220 are in some embodiments used to determine additional cost factors related to a roof estimate. For example, the cleanup of, or access to, a worksite at building 220 may be complicated by various factors, including a substantial amount of landscaping; steeply sloped building sites; proximity to environmentally sensitive areas; etc. In such cases, the roof estimation system may automatically increase a cost factor in a corresponding roof estimate report.

[0047] In some embodiments, an aerial image has corresponding meta-information. Such meta-information may include details about the type of camera used (*e.g.*, focal length, exposure, etc.), the position of the camera (*e.g.*, GPS coordinates of the aircraft at the time the image was captured), the orientation of the camera (*e.g.*, the angle of the camera), the time and/or date the image was captured, etc.

[0048] Figures 3A-3F illustrate individual pages of an example roof estimate report generated by an example embodiment of a roof estimation system. As discussed with respect to Figure 1, a roof estimate report is generated by the roof estimation system based on one or more aerial images of a building. The roof estimate report may be based on a computer model (*e.g.*, a 3D model) of the roof, and includes one or more views of the model. In this example, the various views of the model are presented as

annotated line drawings, which provide information about the roof, such as the roof section areas, roof section edge lengths, roof section pitches, etc. The roof estimate report may be in an electronic format (*e.g.*, a PDF file) and/or paper format (*e.g.*, a printed report). In some embodiments, the roof estimate report may be in a format that may be consumed by a computer-aided design program.

[0049] Figure 3A shows a cover page 301 of the report and includes the address 301a of a building 301c and an overhead aerial image 301b of the building 301c.

[0050] Figure 3B shows a second page 302 of the report and includes two wide perspective (oblique) views 302a and 302b of the building 301c at the address with the surrounding areas more clearly shown.

[0051] Figure 3C shows a third page 303 of the report and includes a line drawing 303a of the building roof showing ridge lines 303b and 303c, and a compass indicator 303d. In addition, a building roof having valleys would result in a line drawing including one or more valley lines. The ridge and/or valley lines may be called out in particular colors. For example, ridge lines 303b and 303c may be illustrated in red, while valley lines may be illustrated in blue. The line drawing 303a is also annotated with the dimensions of the planar sections of the building roof. In this case, the dimensions are the lengths of the edges of the planar roof sections.

[0052] Fig 3D shows a fourth page 304 of the report and includes a line drawing 304a of the building roof showing the pitch of each roof section along with a compass indicator. The pitch in this example is given in inches, and it represents the number of vertical inches that the labeled planar roof section drops over 12 inches of horizontal run. The slope can be easily calculated from such a representation using basic trigonometry. The use of a numerical value of inches of rise per foot of run is a well known measure of slope in the roofing industry. A roof builder typically uses this information to assist in the repair and/or construction of a roof. Of course, other measures and/or units of slope may be utilized as well, including percent grade, angle in degrees, etc.

[0053] Figure 3E shows a fifth page 305 of the report and includes a line drawing 305a of the building roof showing the square footage of each roof section along with the total square foot area value. Of course, other units of area may be used as well, such as square meters or the number of "squares" of roofing material required for covering each roof section.

[0054] Figure 3F shows a fifth page 306 of the report and includes a line drawing 306a of the building roof where notes or comments may be written. The line drawing 306a includes a label for each roof section (shown here as "A", "B", "C"), such that comments may be conveniently related to specific roof sections.

[0055] In other embodiments, more or less information may be provided, or the illustrated information may be arranged in different ways. For example, the report may be provided in electronic form, such as a PDF file or a computer aided design software format. In some embodiments, the report may be "active" or editable, such that the user of the report may make changes to the report, based on on-site observations.

2. Roof Estimation System User Interface

[0056] Figures 4A-4F, 5A-5D, 6A-6D, and 7A-7C describe an example interactive user interface provided by one embodiment of the roof estimation system. As noted, the RES 100 described with reference to Figure 1 includes a user interface engine 104 that is configured to provide access to one or more functions of the RES 100, including image registration (described with respect to Figures 4A-4F), roof pitch determination (described with respect to Figures 5A-5D), roof model construction (described with reference to Figures 6A-6D), and roof model review (described with respect to Figures 7A-7C).

A. Image Registration

[0057] Figures 4A-4F are screen displays illustrating image registration and image lean correction in an example embodiment. In particular, Figure 4A shows a user

interface screen 400 that is utilized by an operator to generate a three dimensional model of a roof of a building. The user interface screen 400 shows a roof modeling project in an initial state, after the operator has specified an address of a building and after images of the building have been obtained and loaded into the roof estimation system.

[0058] The user interface screen 400 includes a control panel 401 and five images 402-406 of a building roof 407. The control panel 401 includes user selectable controls (*e.g.*, buttons, check boxes, menus, etc.) for various roof modeling tasks, such as setting reference points for the images, setting the vertical (Z) axis for the images, switching between different images, saving the model, and the like. Each of the images 402-406 provides a different view of the building roof 407. In particular, images 402-406 respectively provide substantially top-down, south, north, west, and east views of the building roof 407. Each image 402-406 includes four marker controls (also called "reference points" or "registration markers") that are used by the operator to set reference points in the image for purposes of image registration. The registration markers will be described further with respect to an enlargement of image portion 408 described with respect to Figures 4B-4C, below.

[0059] Figures 4B-4C show an enlarged view of image portion 408 during the process of image registration for image 402, which provides a top-down view of the building roof 407. As shown in Figure 4B, image portion 408 includes the building roof 407 and registration markers 410-413. The markers 410-413 are interactive user interface controls that can be directly manipulated (*e.g.*, moved, rotated, etc.) by the operator in order to specify points to use for purposes of image registration. In particular, image registration includes determining a transformation between each of one or more images and a uniform 3D reference grid. The uniform 3D reference grid is used as a coordinate system for a 3D model of the roof. By registering multiple images to the reference grid, an operator may indicate a roof feature on an image (such as a roof edge), which may then be translated from the coordinate system of the image to the

coordinate system of the reference grid, for purposes of including of the indicated feature in the 3D model.

[0060] Marker 410 is an origin marker control, and includes arms 410a-410c. Arms 410a and 410b are horizontal arms that are utilized to specify the X and Y axes (*e.g.*, the horizontal plane) of the reference grid. Arm 410c is a vertical arm that may be utilized to specify the Z axis (*e.g.*, the vertical axis) of the reference grid. The use of the vertical arm to specify the Z axis will be further described with respect to Figure 4E, below.

[0061] Typically, markers 410-413 are color coded, such that they may be distinguished from one another. For example, marker 411-413 may be respectively colored red, blue, and green. Origin marker 410 has a different appearance than markers 411-413, so may be of any color. In other embodiments, markers 411-413 may be distinguished in other ways, such as by utilizing different sized dashed lines, different line thicknesses, etc. In still other embodiments, markers are not distinguished any way from each other, such as by being of uniform shape, color, etc.

[0062] Figure 4C shows image portion 408 with markers 410-413 after they have been placed by an operator. Typically, registration markers are placed at four spatially distributed corners of the roof. As shown in Figure 4C, the operator has placed markers 410-413 at four different corners of the building roof 407. In particular, the operator first placed the origin marker 410 at the lower left corner of the building roof 407, and has adjusted (*e.g.*, rotated) the arms 410a and 410b to align with the major horizontal axes of the roof. By adjusting the arms 410a and 410b of the origin marker 410, the rotational orientation of markers 411-413 is automatically adjusted by the roof estimation system. Next, the operator places markers 411-413 on some other corners of the roof. In general, the operator can place registration marker over any roof feature, but roof corners are typically utilized because they are more easily identified by the operator. After the operator is satisfied with the placement of markers 410-413, the operator typically registers a next image of the building roof 407, as will be described next.

[0063] Figures 4D-4F illustrate image registration for image 404, which provides a north view of the building roof 407. In particular, Figure 4D shows the user interface screen 400 described with reference to Figure 4A. Here, image 402 has been minimized, while image 404 has been enlarged so that the operator may register that image by placing markers on image 404, as will be described below with respect to an enlarged view of image portion 418.

[0064] Figure 4E shows an enlarged view of image portion 418 during the process of image registration for image 404. Image portion 418 includes the building roof 407 and registration markers 420-423. Markers 420-423 respectively correspond to markers 410-413 described above. In particular, marker 420 is an origin marker control that includes arms 420a-420c. Arms 420a and 420b are horizontal arms that are utilized to specify the X and Y axes of the reference grid. Arm 420c is a vertical arm that may be utilized to specify the Z axis of the reference grid.

[0065] In the example of Figure 4E, the operator has moved each of markers 420-423 to a corner of the roof 407. Note that the markers 420-423 are moved to roof corners that correspond to those selected by the operator with markers 410-413, as described with reference to Figure 4C. In particular, origin marker 420 has been moved to the corner of the roof 407 selected with origin marker 410 in image 408; marker 421 has been moved to the corner selected with marker 411 in image 408; marker 422 has been moved to the corner selected with marker 412 in image 408; and marker 423 has been moved to the corner selected with marker 413 in image 408. In addition, markers 420-423 have been rotated, by operator rotation of the origin marker 420, to align with the major axes of the roof 407.

[0066] As noted, the operator can utilize the origin marker 420 to specify the vertical axis of the reference grid. In particular, the operator can adjust (*e.g.*, by dragging with a mouse or other pointing device) arm 420c of marker 420 to specify the vertical (Z) axis of the image. In some cases, aerial images may include some amount of lean, due to the orientation of the aircraft during image capture. For example, pitch, yaw, or roll of an aircraft during the course of image capture may result in images that are

misaligned with respect to the vertical axis of the building and its roof. Typically, an operator may adjust arm 420c to line up with a feature of a building or roof that is known to be substantially vertical, such as a wall of a house or a chimney. Then, based on the angle of arm 420c with respect to the vertical axis of the image, the roof estimation system can determine a correction between the reference grid and the image.

[0067] Figure 4F shows an enlarged view of image portion 418 after registration of image 404. Once the operator has placed and adjusted markers 420-423, the operator may direct (*e.g.*, by clicking a button) the roof estimation system to register the image to the reference grid, based on the positions and orientations of markers 420-423. Once the roof estimation system registers the image, it provides the operator with feedback so that the operator may determine the correctness or accuracy of the registration.

[0068] In the example of Figure 4F, the operator has directed the roof estimation system to register image 404, and the roof estimation system has updated image portion 418 with registration indicators 430-433. Registration indicators 430-433 provide the operator with feedback so that the operator may judge the accuracy of the registration of image 404.

[0069] Registration indicator 430 is an origin registration indicator that includes two arms 430a-430b and three reference grid indicators 430c-430e, shown as dashed lines. The reference grid indicators 430c-430e show the vertical axis (430c) and the two horizontal axes (430d and 430e) of the reference grid determined based on the placement and orientation of the markers 420-423. Arms 430a and 430b correspond to the placement of arms 420a-420c of origin marker 420. If the arms 430a and 430b do not substantially align with the corresponding reference grid indicators 430e and 430d, then the determined reference grid is out of alignment with the specified axes of the house. Typically, an operator will return to the view of Figure 4E to make adjustments to origin marker, such as adjusting one or more of the vertical or horizontal axes, in order to refine the registration of the image. Although the arms

430a-430b and the reference grid indicators 430c-430e are here illustrated as solid and dashed lines, in other embodiments they may be color coded. For example, arms 430a-430b may be red, while reference grid indicators 430c-430e may be blue.

[0070] Registration indicators 431-433 provide the operator with information regarding the accuracy of the placement of markers 421-423. In particular, each registration indicator 431-433 includes a solid crosshairs and a reference indicator, shown for example as a dashed line 432a. The crosshair of a registration indicator corresponds to the placement of a marker. For example, the crosshairs of registration indicator 431 corresponds to the placement of marker 421 in Figure 4E. If the reference indicator intersects the center (or substantially near the center) of the crosshairs of a registration indicator, then the operator knows that the placement of the corresponding marker is accurate. On the other hand, if the reference indicator does not intersect the center of the crosshairs of a registration indicator, then the operator knows that the placement of the corresponding marker is inaccurate. Typically, such an inaccuracy arises when the placement of markers in the top view of the roof does not agree with (correspond to) the placement of corresponding markers in another view of the roof. In such cases, the operator can return to the view of Figure 4C or 4E to adjust the position of one or more markers.

[0071] After registering image 404, the operator will proceed to register additional images of the building roof 407 utilizing a process similar to that described above. In this example, the operator will register images 403, 405, and 406. Although the operator is here described as registering a total of five images, in other cases more or fewer images may be registered.

B. Roof Model Construction

[0072] Figures 5A-5D and 6A-6C generally illustrate aspects of the process of roof model generation based on multiple registered images. In particular, these figures illustrate the construction of a roof model by an operator. Model generation/construction may include identification of roof features shown in various

images of the roof, such as edges, planar sections, vertexes, and the like, as well as determination of roof pitch and other dimensional attributes of the roof. Each identified roof feature is incorporated by the roof estimation system into a 3D model of the roof, based on a translation between an image in which the feature is identified and the reference grid, as determined by the process described with reference to Figures 4A-4F, above.

[0073] Figures 5A-5D are screen displays illustrating pitch determination in an example embodiment. In particular, Figure 5A shows the user interface screen 400 after images 402-406 have been registered. In this example, the operator is using a pitch determination control (also called a "pitch determination marker" or "pitch determination tool") to specify the pitch of a planar roof section of the building roof 407 visible in image 406. The pitch determination control will be further described in Figure 5B, below, with respect to an enlargement of image portion 508.

[0074] Figure 5B shows an enlarged view of image portion 508 during the process of pitch determination for image 406, which provides an east perspective view of the building roof 407. As shown in Figure 5B, the image portion 508 includes the building roof 407 and a pitch determination marker 510 (also called a "protractor tool"). The pitch determination marker 510 is an interactive user interface control that can be directly manipulated by the operator in order to specify the pitch of a section of the building roof 407.

[0075] The pitch determination marker 510 includes arms 510a-510d. Arms 510a-510c are axes, which are automatically aligned, based on the registration of image 406, with the major (X, Y, and Z) axes of the building roof. Arm 510d is a "protractor" arm that is adjustable by the operator to specify roof pitch.

[0076] The marker 510 is typically first moved by the operator to a convenient location on the building roof 407, usually corner of a planar section of the roof 407. Next, the operator adjusts arm 510d so that is substantially aligns with the sloped edge of the planar roof section. Then, the roof estimation system determines the pitch of the roof

section, based on the configuration of the marker 510 with respect to the image and the reference grid.

[0077] After specifying the pitch of a planar roof section, the operator will typically specify other information about the planar roof section, such as its outline, as will be described with reference to Figures 6A-6D. Note that as the operator provides additional information about the geometry of the roof 407, the roof estimation system may automatically determine the pitch and/or other features of at least some of the other planar roof sections, based on the provided geometric information and/or assumptions about roof symmetry or other standard architectural practices.

[0078] Figure 5C shows a second type of pitch determination marker being used in the context of image 403 which provides a south perspective view of the building roof 407. The illustrated pitch determination marker may be used in addition to, or instead of, the pitch determination marker 510 described with respect to Figures 5A-5B, above. In particular, Figure 5C shows a pitch determination marker 520 (also called an "envelope tool") that includes surfaces 520a and 520b. The pitch determination marker 520 is an interactive user interface control that can be directly manipulated by the operator in order to specify the pitch of a section of the building roof 407. In particular, the pitch determination marker 520 may be moved and/or adjusted so that it appears to lie substantially atop two adjacent planar sections of roof 407.

[0079] Figure 5D shows the pitch determination marker 520 after the operator has used it to specify the pitch of two sections of roof 407. Here, the operator has moved the marker 520 to a position in which the spine of the marker 520 is substantially aligned with the ridge line of roof 407. Then, the operator has adjusted the angle of the surfaces 520a and 520b so that they appear to lie substantially atop corresponding sections of roof 407. Then, the roof estimation system determines the pitch of the roof sections, based on the configuration of the marker 520 with respect to the image and the reference grid. Also illustrated are pitch indicators 521 and 522. Pitch indicator 521 corresponds to the measured pitch of surface 520a, and pitch indicator 522 corresponds to the measured pitch of surface 520b. As the operator

adjusts the angle of surfaces 520a and/or 520b, the corresponding pitch indicators 521-522 are automatically updated to reflect the determined pitch. In this example, the pitch of both surfaces is given as 4 inches of rise per foot of run.

[0080] The envelope pitch determination marker 520 may be adjusted in other ways, to specify pitches for types of roofs other than the gabled roof shown in image 403. For example, when measuring pitch of roof sections that form a roof hip, point 520c may be manipulated by the operator, such as by dragging it to the left or right, to adjust the shape of the surfaces 520a and 520b, so that the surfaces align with the edges formed by the intersection of the sections that form the roof hip.

[0081] Figures 6A-6D are screen displays illustrating model construction and concurrent display of operator specified roof features in an example embodiment. In particular, Figures 6A-6D illustrate the construction of a three dimensional wire frame model of a building roof, based on the specification of roof features by an operator. In addition, Figures 6A-6D illustrate the concurrent display of operator specified roof features in multiple views of a building roof.

[0082] Figure 6A shows the user interface screen 400 after images 402-406 have been registered, and after roof pitches have been determined. In this example, the operator is specifying sections of roof 407, visible in image 406, that are to be added to a 3D wire frame model of the roof 407 maintained by the roof estimation system. The specification of roof sections will be further described with reference to enlarged portion 608 of image 406 in Figure 6B, below. In addition, as the operator specifies roof sections in image 406, the roof estimation system concurrently displays the specified roof sections in each of the other images 402-405. The concurrent display of operator specified roof features will be further described with reference to enlarged portion 609 of image 402 in Figure 6C, below.

[0083] Figure 6B is an enlarged view of image portion 608 during the process of wire frame model construction in the context of image 406, which provides an east perspective view of the building roof 407. As shown in Figure 6B, the image portion 608 includes the building roof 407, drawing tool 610, and wire frame 611. The

drawing tool 610 (also called a “drawing marker” or a “drawing control”) is an interactive user interface control that can be directly manipulated by the operator in order to specify roof features, such as edges, ridges, valleys, corners, etc. In the illustrated embodiment, the operator uses the drawing tool 610 to trace or outline planar sections of the roof 407, leading to the generation of wire frame 611. The drawing tool 610 may be used to establish a series of connected line segments that result in a closed polygon representing a planar roof section. As the operator specifies a planar roof section in this manner, the roof estimation system determines, based on the image and the reference grid, the geometry of the planar roof section, and includes (adds) the specified planar roof section in a 3D model that corresponds to roof 407.

[0084] Figure 6C is an enlarged view of image portion 609 illustrating the concurrent display of operator specified roof features, in the context of image 402, which provides a top plan view of the building roof 407. As the operator specifies roof sections as described with respect to Figure 6B, the roof estimation system concurrently displays the specified roof features in one or more of the other images displayed by the user interface screen 400. More specifically, image portion 609 includes building roof 407 and wire frame 612. Wire frame 612 corresponds to wire frame 611 constructed by the operator with reference to Figure 6B, except that wire frame 612 is automatically displayed as a projection from the 3D model into the top-down view of image 402. Changes that the operator makes to wire frame 611 are concurrently displayed by the roof estimation system as wire frame 612 in image portion 609. For example, if a new planar roof section is added by the operator to wire frame 611, the new planar roof section is automatically displayed in wire frame 612. By concurrently displaying operator identified features in multiple views of building roof 407, the operator obtains feedback regarding the correctness and/or accuracy of the 3D model or other aspects of the model generation process, such as image registration and pitch determination.

[0085] Generally, the roof estimation system can be configured to concurrently display any operator-identified features, such as corners, ridges, valleys, planar sections, and the like, in multiple views of a building.

[0086] Furthermore, the concurrently displayed wire frame 612 is an interactive user interface element, in that the operator can make changes to the wire frame 612, which are then concurrently displayed in wire frame 611. Wire frames similar to those described above are also projected by the roof estimation system into images 403, 404, and 405 displayed by the user interface screen 400. In this manner, the operator can switch between various images of the building roof 407, making refinements to the 3D model by adjusting the wire frame in whichever image is more convenient and/or provides a more suitable perspective/view of the model.

[0087] Figure 6D shows the user interface screen 400 during construction of a 3D model of the building roof 407. In particular, the user interface 400 includes a shaded wire frame 613 representation of the 3D model constructed as described above. In this view, the operator can review the wire frame 613 in isolation from any images to determine whether the wire frame 613 accurately represents the building roof 407. The wire frame 613 is an interactive user interface component, in that it can be directly manipulated (*e.g.*, moved, rotated, resized, etc.). In some embodiments, manipulating the wire frame 613, such as by changing its shape, results in corresponding changes in the underlying 3D model.

C. Roof Model Review

[0088] Figures 7A-7C are screen displays illustrating roof model review in an example embodiment. In particular, Figures 7A-7C illustrate various techniques to facilitate the review of a roof model by an operator. Reviewing the roof model may include reviewing roof section pitches (*e.g.*, to determine whether they conform to the building roof and/or standard construction practices), reviewing the shape and/or location of the roof model (*e.g.*, to determine whether it substantially conforms to the building roof), etc.

[0089] Figure 7A shows the user interface screen 400 after the operator has constructed a model of the roof 407 using one or more of the images 402-406. In this example, a wire frame has been projected onto (superimposed upon) image 402 and annotated with roof section pitches, as will be described further with respect to enlarged portion 708 of image 402 in Figure 7B, below.

[0090] Figure 7B is an enlarged view of image portion 708 during the process of roof model review in the context of image 402, which provides a substantially top plan view of the building roof 407. As shown in Figure 7B, the image portion 708 includes a wire frame 710 and labels 711a-711c that indicate pitches of corresponding sections of roof 407. The wire frame 710 and the illustrated pitches are determined by the roof estimation system based on the pitch determination described with respect to Figures 5A-5D, above, and the operator's specification of the wire frame model described with respect to Figures 6A-6D, above.

[0091] The wire frame 710 includes multiple vertexes connected by line segments. Each vertex includes a handle, such as handle 710a. The handles may be directly manipulated (individually or in groups) by the operator to make adjustments/modifications to the wire frame 710. For example, when an operator drags handle 710a to a new location, the ends of the two line segments connected to handle 710a will also move to the new location.

[0092] Figure 7C is an alternative view of the 3D model of roof 407 during the process of roof model review. In Figure 7C, the user interface screen 400 includes a wire frame 720 representation of the 3D model of the roof 407. The wire frame 720 consists of multiple line segments corresponding to edges of planar roof sections. Each line segment is annotated with a label, such as label 723, indicating the determined length of the corresponding roof section edge. Furthermore, some of the line segments indicate that they correspond to a particular roof feature. For example, line segments 721 and 722 may be colored (*e.g.*, red) so as to indicate that they correspond to roof ridges. Other line segments may be differently colored (*e.g.*, blue) so as to indicate a correspondence to roof valleys or other features. In addition, the

wire frame 720 may be directly manipulated by the operator in order to make adjustments to the underlying model of the roof 407. For example, the operator could increase or decrease the length of line segment 721, resulting in a change in the corresponding feature of the 3D model of roof 407.

[0093] Note that although the operator is shown, in Figures 5-7 above, operating upon a total of five images, in other cases, fewer images may be used. For example, in some cases fewer images may be available, or some images may provide obstructed views of the building roof, such as due to tree cover, neighboring buildings, etc.

3. Implementation Techniques

[0094] Figure 8 is an example block diagram of a computing system for practicing embodiments of a roof estimation system. Figure 8 shows a computing system 800 that may be utilized to implement a Roof Estimation System ("RES") 810. One or more general purpose or special purpose computing systems may be used to implement the RES 810. More specifically, the computing system 800 may comprise one or more distinct computing systems present at distributed locations. In addition, each block shown may represent one or more such blocks as appropriate to a specific embodiment or may be combined with other blocks. Moreover, the various blocks of the RES 810 may physically reside on one or more machines, which use standard inter-process communication mechanisms (*e.g.*, TCP/IP) to communicate with each other. Further, the RES 810 may be implemented in software, hardware, firmware, or in some combination to achieve the capabilities described herein.

[0095] In the embodiment shown, computing system 800 comprises a computer memory ("memory") 801, a display 802, one or more Central Processing Units ("CPU") 803, Input/Output devices 804 (*e.g.*, keyboard, mouse, joystick, track pad, CRT or LCD display, and the like), other computer-readable media 805, and network connections 806. The RES 810 is shown residing in memory 801. In other embodiments, some portion of the contents, some of, or all of the components of the RES 810 may be stored on and/or transmitted over the other computer-readable

media 805. The components of the RES 810 preferably execute on one or more CPUs 803 and generate roof estimate reports, as described herein. Other code or programs 830 (*e.g.*, a Web server, a database management system, and the like) and potentially other data repositories, such as data repository 820, also reside in the memory 801, and preferably execute on one or more CPUs 803. Not all of the components in Figure 8 are required for each implementation. For example, some embodiments embedded in other software do not provide means for user input, for display, for a customer computing system, or other components.

[0096] In a typical embodiment, the RES 810 includes an image acquisition engine 811, a roof modeling engine 812, a report generation engine 813, an interface engine 814, and a roof estimation system data repository 816. Other and/or different modules may be implemented. In addition, the RES 810 interacts via a network 850 with an image source computing system 855, an operator computing system 865, and/or a customer computing system 860.

[0097] The image acquisition engine 811 performs at least some of the functions of the image acquisition engine 101 described with reference to Figure 1. In particular, the image acquisition engine 811 interacts with the image source computing system 855 to obtain one or more images of a building, and stores those images in the RES data repository 816 for processing by other components of the RES 810. In some embodiments, the image acquisition engine 811 may act as an image cache manager, such that it preferentially provides images to other components of the RES 810 from the RES data repository 816, while obtaining images from the image source computing system 855 when they are not already present in the RES data repository 816. In other embodiments, images may be obtained in an "on demand" manner, such that they are provided, either by the image acquisition engine 811 or the image source computing system 855, directly to modules of the RES 810 and/or the operator computing system 865, without intervening storage in the RES data repository 816.

[0098] The roof modeling engine 812 performs at least some of the functions of the roof modeling engine 102 described with reference to Figure 1. In particular, the roof

modeling engine 812 generates a model based on one or more images of a building that are obtained from the RES data repository 816 or directly from the image source computing system 855. As noted, model generation may be performed semi-automatically, based on at least some inputs received from the computing system 865. In addition, at least some aspects of the model generation may be performed automatically, based on image processing and/or image understanding techniques. After the roof modeling engine 812 generates a model, it stores the generated model in the RES data repository 816 for further processing by other components of the RES 810.

[0099] The report generation engine 813 performs at least some of the functions of the report generation engine 103 described with reference to Figure 1. In particular, the report generation engine 813 generates roof reports based on models stored in the RES data repository 816. Generating a roof report may include preparing one or more views of a given 3D model of a roof, annotating those views with indications of various characteristics of the model, such as dimensions of sections or other features (*e.g.*, ridges, valleys, etc.) of the roof, slopes of sections of the roof, areas of sections of the roof, etc. In some embodiments, the report generation engine 813 facilitates transmission of roof measurement information that may or may not be incorporated into a roof estimate report. For example, the roof generation engine 813 may transmit roof measurement information based on, or derived from, models stored in the RES data repository 816. Such roof measurement information may be provided to, for example, third-party systems that generate roof estimate reports based on the provided information.

[00100] The interface engine 814 provides a view and a controller that facilitate user interaction with the RES 810 and its various components. For example, the interface engine 814 implements a user interface engine 104 described with reference to Figure 1. Thus, the interface engine 814 provides an interactive graphical user interface that can be used by a human user operating the operator computing system 865 to interact with, for example, the roof modeling engine 812, to perform functions related

to the generation of models, such as point registration, feature indication, pitch estimation, etc. In other embodiments, the interface engine 814 provides access directly to a customer operating the customer computing system 860, such that the customer may place an order for a roof estimate report for an indicated building location. In at least some embodiments, access to the functionality of the interface engine 814 is provided via a Web server, possibly executing as one of the other programs 830.

[00101] In some embodiments, the interface engine 814 provides programmatic access to one or more functions of the RES 810. For example, the interface engine 814 provides a programmatic interface (*e.g.*, as a Web service, static or dynamic library, etc.) to one or more roof estimation functions of the RES 810 that may be invoked by one of the other programs 830 or some other module. In this manner, the interface engine 814 facilitates the development of third-party software, such as user interfaces, plug-ins, adapters (*e.g.*, for integrating functions of the RES 810 into desktop applications, Web-based applications, embedded applications, etc.), and the like. In addition, the interface engine 814 may be in at least some embodiments invoked or otherwise accessed via remote entities, such as the operator computing system 865, the image source computing system 855, and/or the customer computing system 860, to access various roof estimation functionality of the RES 810.

[00102] The RES data repository 816 stores information related the roof estimation functions performed by the RES 810. Such information may include image data 105, model data 106, and/or report data 107 described with reference to Figure 1. In addition, the RES data repository 816 may include information about customers, operators, or other individuals or entities associated with the RES 810.

[00103] In an example embodiment, components/modules of the RES 810 are implemented using standard programming techniques. For example, the RES 810 may be implemented as a "native" executable running on the CPU 803, along with one or more static or dynamic libraries. In other embodiments, the RES 810 is implemented as instructions processed by virtual machine that executes as one of the

other programs 830. In general, a range of programming languages known in the art may be employed for implementing such example embodiments, including representative implementations of various programming language paradigms, including but not limited to, object-oriented (*e.g.*, Java, C++, C#, Matlab, Visual Basic.NET, Smalltalk, and the like), functional (*e.g.*, ML, Lisp, Scheme, and the like), procedural (*e.g.*, C, Pascal, Ada, Modula, and the like), scripting (*e.g.*, Perl, Ruby, Python, JavaScript, VBScript, and the like), declarative (*e.g.*, SQL, Prolog, and the like).

[00104] The embodiments described above may also use well-known synchronous or asynchronous client-server computing techniques. However, the various components may be implemented using more monolithic programming techniques as well, for example, as an executable running on a single CPU computer system, or alternatively decomposed using a variety of structuring techniques known in the art, including but not limited to, multiprogramming, multithreading, client-server, or peer-to-peer, running on one or more computer systems each having one or more CPUs. Some embodiments execute concurrently and asynchronously, and communicate using message passing techniques. Equivalent synchronous embodiments are also supported by an RES implementation. Also, other functions could be implemented and/or performed by each component/module, and in different orders, and by different components/modules, yet still achieve the functions of the RES.

[00105] In addition, programming interfaces to the data stored as part of the RES 810, such as in the RES data repository 816, can be available by standard mechanisms such as through C, C++, C#, and Java APIs; libraries for accessing files, databases, or other data repositories; through scripting languages such as XML; or through Web servers, FTP servers, or other types of servers providing access to stored data. For example, the RES data repository 816 may be implemented as one or more database systems, file systems, memory buffers, or any other technique for storing such information, or any combination of the above, including implementations using distributed computing techniques.

[00106] Also, the example RES 810 can be implemented in a distributed environment comprising multiple, even heterogeneous, computer systems and networks. For example, in one embodiment, the image acquisition engine 811, the roof modeling engine 812, the report generation engine 813, the interface engine 814, and the data repository 816 are all located in physically different computer systems. In another embodiment, various modules of the RES 810 are hosted each on a separate server machine and are remotely located from the tables which are stored in the data repository 816. Also, one or more of the modules may themselves be distributed, pooled or otherwise grouped, such as for load balancing, reliability or security reasons. Different configurations and locations of programs and data are contemplated for use with techniques of described herein. A variety of distributed computing techniques are appropriate for implementing the components of the illustrated embodiments in a distributed manner including but not limited to TCP/IP sockets, RPC, RMI, HTTP, Web Services (XML-RPC, JAX-RPC, SOAP, and the like).

[00107] Furthermore, in some embodiments, some or all of the components of the RES are implemented or provided in other manners, such as at least partially in firmware and/or hardware, including, but not limited to one or more application-specific integrated circuits (ASICs), standard integrated circuits, controllers (*e.g.*, by executing appropriate instructions, and including microcontrollers and/or embedded controllers), field-programmable gate arrays (FPGAs), complex programmable logic devices (CPLDs), and the like Some or all of the system components and/or data structures may also be stored (*e.g.*, as software instructions or structured data) on a computer-readable medium, such as a hard disk, a memory, a network, or a portable media article to be read by an appropriate drive or via an appropriate connection. The system components and data structures may also be stored as data signals (*e.g.*, by being encoded as part of a carrier wave or included as part of an analog or digital propagated signal) on a variety of computer-readable transmission mediums, which are then transmitted, including across wireless-based and wired/cable-based mediums, and may take a variety of forms (*e.g.*, as part of a single or multiplexed

analog signal, or as multiple discrete digital packets or frames). Such computer program products may also take other forms in other embodiments. Accordingly, embodiments of this disclosure may be practiced with other computer system configurations.

[00108] Figure 9 is an example flow diagram of an image registration routine provided by an example embodiment. The illustrated routine 900 may be provided by, for example, execution of the roof estimation system 810 described with respect to Figure 8. The illustrated routine 900 facilitates image registration based upon operator indicated registration points and/or image lean corrections.

[00109] More specifically, the routine begins in step 901, where it displays, on a user interface screen, an aerial image of a building having a roof. As part of the user interface screen, the routine also displays user interface controls such as markers that may be used by an operator for purposes of image registration and/or lean correction, as described with reference to Figure 4A, above.

[00110] In step 902, the routine receives, via one or more registration markers, indications of one or more points on the aerial image. The registration markers are manipulated by the operator to specify points on the aerial image, as described with reference to Figures 4A-4E. Typically, the points are visually identifiable features, such as corners of the roof of the building. For example, if the roof has four corners (*e.g.*, a northwest, southwest, northeast, and southwest corner) the operator may place one registration marker on each of the four corners as shown in the aerial image. Then, the positions (*e.g.*, coordinates on the aerial image) of the markers are transmitted to the routine for use in registering the aerial image, as described below.

[00111] In step 903, the routine receives, via a lean correction marker, an indication of the vertical axis of the building roof. In at least some cases, the aerial image of the building is out of alignment with respect to the vertical axis of the building. This may be caused, for example, by pitch, roll, and/or yaw experienced by the aircraft during the process of photographing the building. To correct for such misalignment, the lean correction marker is manipulated by the operator to indicate a vertical axis of the

building. Typically, the operator aligns the lean correction marker with known, substantially vertical feature of the building, such as a chimney, wall corner, etc., as described with reference to Figure 4E, above. After the operator has aligned the lean correction marker, the position (*e.g.*, angle of the marker, coordinates of the endpoints of the marker, etc.) of the lean correction marker is transmitted to the routine for use in registering the aerial image, as described below.

[00112] Particular benefits may be obtained from lean correction performed in the context of an overhead, or "top down," view. An "overhead lean" occurs when the camera is not directly overhead with respect to the building when the photo is taken. In some cases, leans in excess of 5 degrees have been observed in "top down" photos. Furthermore, unlike oblique, perspective views, a top-down lean is typically less likely to include a convenient visual marker that provides sufficient angle to assess the lean direction and magnitude, such as the edge of the building or a tall chimney. An overhead lean affects the perceived location of the roof lines in a top down view. This effect is amplified as the pitch of the roof increases and/or as the vertical separation between disconnected roof sections increases. Without lean correction, superimposing a wire frame over the visible ridgelines (and other features of a building that reside at different elevations) may produce asymmetries in otherwise symmetric structures. Further, an absence of lean correction may introduce errors in pitch estimation, as the wire frame may not appear consistent between top and oblique view points. More specifically, without top view lean correction, the positions for the roof lines in an otherwise correct (*i.e.*, accurate with respect to the actual geometry of the roof) wire frame will typically not line up on the visible roof lines in the overhead reference photo. This often leads the user (or software) to either introduce errors by incorrectly drawing the wire frame to the image lines or perform a subjective determination of where and how to shift the wire frame lines off the image lines to produce a correct model. Top view lean correction allows the roof estimation system to trace to, or substantially to, the actual roof lines seen in the top image while still producing an accurate wire frame model.

[00113] Image misalignment may be specified in other ways. For example, in other embodiments, the operator may instead rotate the image to a position in which the building appears to be in a substantially vertical position. Then, the angle of rotation of the image may be transmitted to the routine for use in registering the aerial image.

[00114] In step 904, the routine registers, based on the received indications of the points and/or the received indication of the vertical axis, the aerial image to a reference grid. Registering the image to a reference grid may include determining a transformation between the reference grid and the image, based on the indicated points and/or the indicated vertical axis. Determining such a transformation may be based on other information as well, such as meta-information associated with the aerial image. In some embodiments, the aerial image has corresponding meta-information that includes image capture conditions, such as camera type, focal length, time of day, camera position (*e.g.*, latitude, longitude, and/or elevation), etc.

[00115] In step 905, the routine determines whether there are additional aerial images to be registered, and if so, returns to step 901, else proceeds to step 906. During execution of the loop of steps 901-905, the operator typically indicates, for each registration marker, the same feature (*e.g.*, corner) of the roof as shown in each of multiple images, such that the routine can register the multiple images to a single, uniform reference grid. Upon completion of the registration process, the routine has determined a uniform coordinate system for the multiple aerial images, for use during other phases of model construction, such as pitch determination or feature identification.

[00116] In step 906, the routine generates a three-dimensional model based at least in part on the aerial image(s) and the reference grid. As discussed above with reference to Figures 5A-5D and 6A-6D, model generation includes identification of roof features shown in various images of the roof, such as edges, planar sections, vertexes, and the like, as well as determination of roof pitch and other dimensional attributes of the roof. In other embodiments, the routine performs other functions with the registered images, such as storing them for later use (*e.g.*, by an automated model generation

module), transmitting them to another computing (*e.g.*, for use in a third-party design application), etc. After step 906, the routine ends.

[00117] Note that in at least some embodiments, aspects of the routine 900 may be performed in an automated manner. For example, operations discussed above as being performed by an operator, such as the determination of the location of image registration points of step 902 and/or the indication of lean of step 903, may be performed by automated image processing techniques.

[00118] Figure 10 is an example flow diagram of a pitch determination routine provided by an example embodiment. The illustrated routine 1000 may be provided by, for example, execution of the roof estimation system 810 described with respect to Figure 8. The illustrated routine 1000 facilitates the determination of the pitch of a section of a roof, by displaying a pitch determination marker and modifying a 3D model of a roof based on an indication of roof pitch received via the pitch determination marker.

[00119] More specifically, the routine begins at step 1001 where it displays an aerial image of a building having a roof comprising a plurality of planar roof sections that each have a corresponding pitch. The aerial image is displayed in the context of a user interface screen, such as is described with reference to Figures 4A-6C, above. The aerial images may be received from, for example, the image source computing system 855 and/or from the RES data repository 816 described with reference to Figure 8. As discussed above, aerial images may be originally created by cameras mounted on airplanes, balloons, satellites, etc. In some embodiments, images obtained from ground-based platforms (*e.g.*, vehicle-mounted cameras) may be used instead or in addition.

[00120] In step 1002, the routine displays a pitch determination marker operable to indicate pitch of a planar roof section. The pitch determination marker may be, for example, a pitch determination marker 510 ("protractor tool") or 520 ("envelope tool"), such as are respectively described with respect to Figures 5B and 5C, above. The routine displays the pitch determination marker by, for example, presenting it on a user interface screen displayed on a computer monitor or other display device. The

pitch determination marker is a direct manipulation user interface control, in that an operator may manipulate it (*e.g.*, adjust an angle, change its shape, alter its position, etc.) in order to indicate pitch of a planar roof section. Additional details regarding pitch determination controls are provided with respect to Figures 5A-5D, above.

[00121] In step 1003, the routine receives, via the displayed pitch determination marker, an indication of the pitch of one of the plurality of planar roof sections of the roof of the building. Receiving an indication of the pitch includes receiving an indication (*e.g.*, via an event, callback, etc.) that the marker has been manipulated by the operator, and then determining an angle based on the shape and/or position of the marker. In some embodiments, such an indication may be received on an event driven basis, such as every time the marker is manipulated in some manner. In other embodiments, the routine may poll the marker from time to time to determine its current state. In addition, the operator may explicitly indicate that the current state of the marker is to be transmitted to the routine, such as by pressing a button or other indication.

[00122] In step 1004, the routine modifies a three-dimensional model of the roof based on the received indication of the pitch of the one planar roof section. Modifying the 3D model of the roof includes associating the indicated pitch with a portion of the model corresponding to the one planar roof section. For example, the 3D model may include one or more data structures representing planar roof sections, and the indicated pitch may be included as part of the data structure representing the one planar roof section. In some embodiments, the 3D model may not at this point include representations of the planar roof sections, such as because the operator has not yet specified them. In such a case, the routine may store the indicated pitch in association with the location and orientation at which the pitch was specified by the operator, as determined from the aerial image. Then, at a later time, when the operator specifies a roof section that has the same orientation as the stored pitch and that includes or is near the stored location, the roof estimation system can store the indicated pitch in association with the specified roof section.

[00123] After step 1004, the routine ends. In other embodiments, the routine may instead return to step 1001, to determine the pitch for another planar roof section (of the same or different roof).

[00124] Figure 11 is an example flow diagram of concurrent feature display routine provided by an example embodiment. The illustrated routine 1100 may be provided by, for example, execution of the roof estimation system 810 described with respect to Figure 8. The illustrated routine 1100 concurrently displays operator indicated features in multiple aerial images of a building roof.

[00125] More specifically, the routine begins in step 1101, where it displays a first and a second aerial image of a building having a roof, each of the aerial images providing a different view of the roof of the building. The aerial images are displayed in the context of a user interface screen, such as is described with reference to Figures 6A-6C, above.

[00126] In step 1102, the routine receives an indication of a feature of the building shown in the first aerial image. The indication is typically received via a user interface control, such as a drawing tool or marker, upon its manipulation by an operator. For example, the operator may manipulate a drawing tool in order to specify one or more features of the building roof, such as a corner on the roof, an edge of the roof, an outline of a section of the roof, etc. In one embodiment, the operator utilizes a drawing tool to indicate roof section corner points and roof section edges connecting those corner points. Additional details regarding feature indication are provided with respect to Figures 6A-6C, above.

[00127] In step 1103, the routine modifies a three-dimensional model of the roof based on the received indication of the feature of the building. Modifying the 3D model may include adding or updating the indicated feature to a wire frame model of the roof. For example, if the indicated feature is a roof section corner point, the corner point will be added to the 3D model, along with the location (*e.g.*, the X, Y, and Z position of the point) of the point. The location of the point is automatically determined based on a translation of the position of the point in the image to a point in the uniform reference

grid associated with the image. If the indicated feature is a roof section edge, the edge will be added to the 3D model, such as by associating the edge with two points corresponding to the end points of the edge. Higher-level features can also be indicated. For example, a planar roof section may be indicated by "closing" a sequence of two or more connected line segments, to create a closed polygon that represents the outline or perimeter of the planar roof section.

[00128] In step 1104, the routine concurrently displays a projection of the feature from the modified three-dimensional model onto the first and second aerial images. In one embodiment, displaying the feature from the modified three-dimensional model includes projecting the three-dimensional model onto both the first and second aerial images. For example, if the first image (for which the indicated feature was received) provides a west view of the building, and the second image provides an east view of the building, the routine will concurrently display a projection of the indicated feature from the 3D model onto both the first and second images. The projection of the indicated feature into the second image is based at least in part on a translation from the position of the feature in the reference grid to a position in the second image. In addition, the concurrent display onto two or more images occurs at substantially the same time (within a short time interval, at times that are substantially coincident) as the indication of the feature of the building in step 1102, giving the operator the illusion that as they are indicating a feature in the first image, the feature is being simultaneously projected into the second image.

[00129] After step 1104, the routine ends. In other embodiments, the routine may instead return to step 1101, to perform an interactive loop of steps 1101-1104with the operator, so that the routine can concurrently display multiple features as they are indicated by the operator. Note that in such an embodiment, each iteration of the loop of steps 1101-1104 may be performed at near real-time speeds, so as to provide a fluid, interactive model generation experience for the operator enabling the operator to drag, draw, or otherwise indicate/manipulate features in a first image and view the results of their work concurrently projected into a second image.

[00130] All of the above 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, including but not limited to U.S. Provisional Patent Application No. 61/197,904, entitled "USER INTERFACE SYSTEMS AND METHODS FOR ROOF ESTIMATION," filed October 31, 2008, are incorporated herein by reference, in their entireties.

[00131] From the foregoing it will be appreciated that, although specific embodiments have been described herein for purposes of illustration, various modifications may be made without deviating from the spirit and scope of the present disclosure. For example, the methods, systems, and techniques for generating and providing roof estimate reports discussed herein are applicable to other architectures other than the illustrated architecture or a particular roof estimation system implementation. Also, the methods and systems discussed herein are applicable to differing network protocols, communication media (optical, wireless, cable, etc.) and devices (such as wireless handsets, electronic organizers, personal digital assistants, portable email machines, game machines, pagers, navigation devices such as GPS receivers, etc.). Further, the methods and systems discussed herein may be utilized by and/or applied to other contexts or purposes, such as by or for solar panel installers, roof gutter installers, awning companies, HVAC contractors, general contractors, and/or insurance companies.

CLAIMS

1. A computer-implemented method in a roof estimate report system including at least one processor and a memory coupled to the at least one processor, the method comprising:

displaying, by the at least one processor of the roof estimate report system, a plurality of aerial images of a roof at the same time on a single display, each of the aerial images providing a different view, taken from a different angle of the same roof;

displaying, by the at least one processor of the roof estimate report system, respective line drawings representing features of the roof, the respective line drawings overlying a first and a second aerial image of the plurality of aerial images of the roof on the single display, the line drawing overlying the first aerial image of the roof having features in common with the line drawing overlying the second aerial image of the roof;

in response to user input, changing, by the at least one processor of the roof estimate report system, the line drawing representing a feature of the roof that overlies the first aerial image of the roof;

correlating, by the at least one processor of the roof estimate report system, a location of the feature on the roof represented by the line drawing that has been changed to a location of a corresponding feature represented by the line drawing overlying the second aerial image; and

based on the correlation, changing, by the at least one processor of the roof estimate report system, the corresponding feature in the line drawing overlying the second aerial image according to the change of the line drawing representing the feature of the roof that overlies the first aerial image.

2. The method of claim 1 further comprising, before the displaying the respective line drawings, modifying a three-dimensional model of the roof based on a received indication of a roof feature by adding a planar roof section to the three-dimensional model.

3. The method of claim 2 wherein the indicated roof feature is at least one of: a point on the roof, a section of the roof, a ridgeline of the roof, a valley of the roof, a rake edge of the roof, an eave of the roof, a hip ridge of the roof, an edge of a section of the roof, and a corner of a section of the roof.

4. The method of claim 1 wherein the displaying the respective line drawings comprises:

displaying the respective line drawing overlying the first aerial image at a first time; and

displaying the respective the line drawing overlying the second aerial image at a second time that is substantially coincident to the first time.

5. The method of claim 1 further comprising receiving an indication of one of the features of the roof at a first time, and wherein the displaying the respective line drawings occurs at a second time that is substantially coincident to the first time.

6. The method of claim 1 wherein the displaying the respective line drawings includes initiating display of a line on the first and second image.

7. The method of claim 1 wherein the first image provides a substantially top plan view of the roof of the building, and wherein the second image provides a perspective view of the roof of the building.

8. The method of claim 1 wherein the first image provides a first perspective view of the roof of the building and the second image provides a second perspective view of the roof of the building.

9. The method of claim 1 further comprising:

transmitting roof measurement information based at least in part on the change of the line drawing representing a feature of the roof that overlies the first aerial image of the roof.

10. The method of claim 1 further comprising:

displaying a marker operable to specify a point on an image;

receiving, via the marker, an indication of a point on the first aerial image; and

registering, based on the received indication of the point, the aerial image to a reference grid corresponding to a three-dimensional model of the roof.

11. The method of claim 1 further comprising:

displaying a lean correction marker operable to indicate a vertical axis of an aerial image;

receiving, via the lean correction marker, an indication of a vertical axis of the first aerial image; and

registering, based on the received indication of the vertical axis, the first aerial image to a reference grid corresponding to a three-dimensional model of the roof.

12. A computing system for generating a roof estimate report, the computing system comprising:

a memory;

at least one processor coupled to the memory; and

a roof estimation module that is stored on the memory and that is configured, when executed by at least one processor of the computing system for generating the roof estimate report, to:

substantially concurrently display a projection of a roof feature onto first and second aerial images as a line drawing of the roof feature;

overlay the line drawing of the roof feature on corresponding locations of the feature on the first and second aerial images; and

in response to user input causing modification of the line drawing overlaid on the first aerial image, make corresponding changes to the line drawing overlaid on the second aerial image.

13. The computing system of claim 12 wherein the roof estimation module includes an interactive roof modeling user interface.

14. The computing system of claim 12 wherein the computing system is a desktop computer and the roof estimation module is part of an interactive roof modeling program executing on the computing system.

15. The computing system of claim 12 wherein the roof estimation module is part of a network accessible roof modeling program executing on the computing system.

16. A non-transitory computer-readable storage medium, having computer executable instructions stored thereon that, when executed by at least one computer processor, cause the at least one processor to enable a computing system to generate a roof estimate report for a building having a roof, by performing a method comprising:

substantially concurrently displaying a projection of a roof feature as a line drawing of the feature onto a first aerial image of the roof that provides a first view of the roof of the building and onto a second aerial image that provides a second view of the roof of the building;

overlaying the line drawing on corresponding locations of the feature on the first and second aerial images; and

in response to user input causing modification of the line drawing overlaid on the first aerial image, making corresponding changes to the line drawing overlaid on the second aerial image.

17. The non-transitory computer-readable storage medium of claim 16 wherein the method further comprises modifying a three-dimensional model of the roof by adding a planar roof section to the three-dimensional model.

18. The non-transitory computer-readable storage medium of claim 16 wherein the method further comprises receiving an indication of the feature of the building by receiving position information of the feature in the first aerial image, and wherein substantially concurrently displaying the projection of the feature includes:

translating the received position information into position information of the feature in a three-dimensional model; and

translating the position information of the feature in the three-dimensional model into position information of the feature in the second aerial image.

19. The non-transitory computer-readable storage medium of claim 16 wherein displaying the projection of the feature comprises:

displaying the feature in the first aerial image at a first time; and

displaying the feature in the second aerial image at a second time that is within two seconds of the first time.

20. The non-transitory computer-readable storage medium of claim 16 wherein displaying the projection of the feature includes displaying the projection of the feature substantially concurrently with receiving an indication of the feature of the building.

21. The non-transitory computer-readable storage medium of claim 16 wherein displaying the projection of the feature includes displaying the projection of the feature at substantially the same time as receiving an indication of the feature of the building.

22. The non-transitory computer-readable storage medium of claim 16 wherein the method is performed iteratively, and the method further comprising:

providing an operator with an interactive model generation experience.

23. The non-transitory computer-readable storage medium of claim 16 wherein displaying the projection of the feature includes initiating display of a line on the first and second image.

24. The non-transitory computer-readable storage medium of claim 16 wherein the first image provides a perspective view of the roof of the building, and wherein the second image provides a substantially top plan view of the roof of the building.

25. The non-transitory computer-readable storage medium of claim 16 wherein the method further comprises:

modifying a three dimensional model of the roof based at least on the modification of the line drawing overlaid on the first aerial image; and

generating a roof estimate report based at least in part on the modified three-dimensional model.

26. A computer-implemented method in a roof estimate report system including a computer system and a memory coupled to the computer system, the method comprising:

displaying, by the computer system of the roof estimate report system, a first aerial image of a roof on a single display;

displaying, by the computer system of the roof estimate report system, a second aerial image of the same roof on the same single display, the second aerial image providing a different view than the first aerial image, taken from a different angle of the same roof;

displaying, by the computer system of the roof estimate report system, a first line drawing representing features of the roof overlaid on the first aerial image of the roof;

displaying, by the computer system of the roof estimate report system, a second line drawing representing features of the roof overlaid on the second aerial image of the roof, the second line drawings having features in common with and that correspond to features in the first line drawing;

in response to user input, changing, a line in the first line drawing representing a feature of the roof that overlies the first aerial image of the roof;

changing, by the computer system of the roof estimate report system, a line in the second line drawing that corresponds to the same feature in the first line drawing that was changed by the user, the change in the second line drawing being made by the computer system in response to the change that was made by the user in the first line drawing.

27. The method of claim 26 wherein the roof feature is at least one of: a ridgeline of the roof, a valley of the roof, a rake edge of the roof, an eave of the roof, a hip ridge of the roof, and an edge of a section of the roof.

28. The method of claim 26 wherein the step of displaying, by the computer system of the roof estimate report system, a second line drawing representing features of the roof overlaid on the second aerial image of the roof comprises:

displaying the second line drawing after the first line drawing has been displayed.

29. The method of claim 26 wherein the step of changing, by the computer system of the roof estimate report system, a feature in the second line drawing overlying the second aerial image comprises:

changing the second line drawing at a time that is substantially concurrent to the time the changes are being made by the user in the first line drawing.

30. The method of claim 26 further comprising:

displaying the second line drawing overlying the second aerial image on the same display concurrently with displaying the first line drawing overlying the first aerial image of the roof on the same, single display.

31. The method of claim 26 further comprising:

displaying the second line drawing overlying the second aerial image on the same display at a later time, after the displaying of the first line drawing overlying the first aerial image of the roof on the display.

32. The method of claim 26 wherein the first image provides a substantially top plan view of the roof of the building, and the second image provides an oblique view of the roof of the building.

33. The method of claim 26 wherein the first image provides a first oblique view from a first compass bearing of the roof of the building, and the second image provides a second oblique view from a second compass bearing of the roof of the building.

34. The method of claim 26 further comprising:

displaying roof measurement information on the same display concurrently with the first line drawing being displayed.

35. The method of claim 34 wherein the step of displaying roof measurement information on the same display concurrently with the first line drawing being displayed comprises:

displaying the roof measurement information in a location that overlays the line drawing itself.

36. The method of claim 26 further comprising:

displaying a wire frame model of the roof in isolation from any images of the roof on the same display.

37. The method of claim 26 further comprising:

modifying a wire frame model of the roof based on input received from a user; and

making, by the computer system of the roof estimate report system, corresponding changes in a 3D model of the roof based on the changes made by the user to the wire frame model.

ABSTRACT OF THE DISCLOSURE

User interface systems and methods for roof estimation are described. Example embodiments include a roof estimation system that provides a user interface configured to facilitate roof model generation based on one or more aerial images of a building roof. In one embodiment, roof model generation includes image registration, image lean correction, roof section pitch determination, wire frame model construction, and/or roof model review. The described user interface provides user interface controls that may be manipulated by an operator to perform at least some of the functions of roof model generation. The user interface is further configured to concurrently display roof features onto multiple images of a roof. This abstract is provided to comply with rules requiring an abstract, and it is submitted with the intention that it will not be used to interpret or limit the scope or meaning of the claims.

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Signature	/Jeremiah J. Baunach/	Date (Optional)	August 1, 2014
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