

EXHIBIT 1002



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
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P.O. Box 1450
Alexandria, Virginia 22313-1450
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APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/983,657	12/27/2022	11538349	H215046-US	4104

10786 7590 12/07/2022
HONEYWELL/BROOKS
Intellectual Property Services Group
855 S. Mint Street
Charlotte, NC 28202

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 333 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 Patents Stakeholder Experience (OPSE), Stakeholder Support Division (SSD) at (571)-272-4200.

INVENTOR(s) (Please see PAIR WEB site <http://pair.uspto.gov> for additional inventors):

Rajesh V. Poojary, Bangalore, INDIA;
Raghu Seelamonthula, Bangalore, INDIA;
Vinay Sridhara Murthy, Bangalore, INDIA;
Manuj Sharma, Bangalore, INDIA;

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

Honeywell International Inc., Morris Plains, NJ;

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.

IR103 (Rev. 10/09)

PART B - FEE(S) TRANSMITTAL

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

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

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

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

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

10786 7590 09/01/2022
HONEYWELL/BROOKS
Intellectual Property Services Group
855 S. Mint Street
Charlotte, NC 28202

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

Certificate of Mailing or Transmission

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

Alexander Marquardt	(Typed or printed name)
/Alexander Marquardt/	(Signature)
November 29, 2022	(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/983,657	08/03/2020	Rajesh V. Poojary	H215046-US	4104

TITLE OF INVENTION: MULTI-SENSOR DATA FUSION-BASED AIRCRAFT DETECTION, TRACKING, AND DOCKING

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	\$1200	\$0.00	\$0.00	\$1200	12/01/2022

EXAMINER	ART UNIT	CLASS-SUBCLASS
WONG, YUEN H	3667	701-003000

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/AIA/122 or PTO/SB/122) attached.

☐ "Fee Address" indication (or "Fee Address" Indication form PTO/AIA/47 or 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.

1 Brooks, Cameron & Huebsch, PLLC

2 1201 Marquette Ave. S. Ste. 400

3 Minneapolis, MN 55403

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

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

(A) NAME OF ASSIGNEE

Honeywell International Inc.

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

Charlotte, NC, U.S.A.

Please check the appropriate assignee category or categories (will not be printed on the patent): ☐ Individual ☒ Corporation or other private group entity ☐ Government4a. Fees submitted: ☒ Issue Fee ☐ Publication Fee (if required) ☐ Advance Order - # of Copies _____

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

☒ Electronic Payment via EFS-Web ☐ Enclosed check ☐ Non-electronic payment by credit card (Attach form PTO-2038)☐ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. _____

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

☐ Applicant certifying micro entity status. See 37 CFR 1.29☐ Applicant asserting small entity status. See 37 CFR 1.27☐ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.

NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.

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

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

Authorized Signature /Mark R. Berger/Date November 29, 2022Typed or printed name Mark R. BergerRegistration No. 62556

Electronic Patent Application Fee Transmittal				
Application Number:		16983657		
Filing Date:		03-Aug-2020		
Title of Invention:		MULTI-SENSOR DATA FUSION-BASED AIRCRAFT DETECTION, TRACKING, AND DOCKING		
First Named Inventor/Applicant Name:		Rajesh V. Poojary		
Filer:		Mark R. Berger/Alexander Marquardt		
Attorney Docket Number:		H215046-US		
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	1200	1200

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				1200

Electronic Acknowledgement Receipt	
EFS ID:	47102534
Application Number:	16983657
International Application Number:	
Confirmation Number:	4104
Title of Invention:	MULTI-SENSOR DATA FUSION-BASED AIRCRAFT DETECTION, TRACKING, AND DOCKING
First Named Inventor/Applicant Name:	Rajesh V. Poojary
Customer Number:	10786
Filer:	Mark R. Berger/Alexander Marquardt
Filer Authorized By:	Mark R. Berger
Attorney Docket Number:	H215046-US
Receipt Date:	29-NOV-2022
Filing Date:	03-AUG-2020
Time Stamp:	09:52:51
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	EFT
Payment was successfully received in RAM	\$ 1200
RAM confirmation Number	E2022AS053314387
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	Issue Fee Payment (PTO-85B)	01048676.PDF	161584	no	1
			7e0fb7d7a703f4794228ca84c6073d442cd53a86		
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	38291	no	2
			fe6f64551fa8b2fd988a2c4765fc431f39327c64		
Warnings:					
Information:					
Total Files Size (in bytes):			199875		
<p>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.</p> <p><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.</p> <p><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.</p> <p><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.</p>					



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NOTICE OF ALLOWANCE AND FEE(S) DUE

10786 7590 09/01/2022
HONEYWELL/BROOKS
Intellectual Property Services Group
855 S. Mint Street
Charlotte, NC 28202

EXAMINER

WONG, YUEN H

ART UNIT PAPER NUMBER

3667

DATE MAILED: 09/01/2022

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/983,657	08/03/2020	Rajesh V. Poojary	H215046-US	4104

TITLE OF INVENTION: MULTI-SENSOR DATA FUSION-BASED AIRCRAFT DETECTION, TRACKING, AND DOCKING

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	\$1200	\$0.00	\$0.00	\$1200	12/01/2022

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

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

HOW TO REPLY TO THIS NOTICE:

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

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

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

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

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

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

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

PART B - FEE(S) TRANSMITTAL

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

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

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

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

10786 7590 09/01/2022
HONEYWELL/BROOKS
Intellectual Property Services Group
855 S. Mint Street
Charlotte, NC 28202

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Certificate of Mailing or Transmission

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/983,657	08/03/2020	Rajesh V. Poojary	H215046-US	4104

TITLE OF INVENTION: MULTI-SENSOR DATA FUSION-BASED AIRCRAFT DETECTION, TRACKING, AND DOCKING

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	\$1200	\$0.00	\$0.00	\$1200	12/01/2022

EXAMINER	ART UNIT	CLASS-SUBCLASS
WONG, YUEN H	3667	701-003000

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/AIA/122 or PTO/SB/122) attached.
- ☐ "Fee Address" indication (or "Fee Address" Indication form PTO/AIA/47 or 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, 1 _____
- (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. 2 _____
- 3 _____

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

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

(A) NAME OF ASSIGNEE

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

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

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

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

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

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

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

- ☐ Applicant certifying micro entity status. See 37 CFR 1.29
- ☐ Applicant asserting small entity status. See 37 CFR 1.27
- ☐ Applicant changing to regular undiscounted fee status.

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NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.

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

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

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/983,657	08/03/2020	Rajesh V. Poojary	H215046-US	4104
10786 7590 09/01/2022 HONEYWELL/BROOKS Intellectual Property Services Group 855 S. Mint Street Charlotte, NC 28202			EXAMINER WONG, YUEN H	
			ART UNIT 3667	PAPER NUMBER

DATE MAILED: 09/01/2022

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

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

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

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

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

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

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

Privacy Act Statement

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

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

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

Notice of Allowability	Application No. 16/983,657	Applicant(s) Poojary et al.	
	Examiner YUEN WONG	Art Unit 3667	AIA (FITF) Status Yes

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

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

1. ☒ This communication is responsive to 8/3/2020.
☐ 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 1-20 . 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 _____. 3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material _____. 4. ☒ Interview Summary (PTO-413), Paper No./Mail Date. <u>8/25/2022</u> .	5. ☒ Examiner's Amendment/Comment 6. ☒ Examiner's Statement of Reasons for Allowance 7. ☐ Other _____.
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/YUEN WONG/ Primary Examiner, Art Unit 3667	
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The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

EXAMINER'S AMENDMENT

- I. 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.
- II. Authorization for this examiner's amendment was given in a telephone interview with Mark Berger on 25 August 2022.
- III. The application has been amended as follows:
1. (Currently amended) A method for tracking an aircraft, comprising:
 - receiving camera image data of ~~[[an]]~~ the aircraft while the aircraft is approaching ~~or in the~~ a ramp area for parking the aircraft on an airside of an airport;
 - receiving ~~LIDAR/Radar~~ Light Detection And Ranging (LIDAR) or RAdio Detection And Ranging (RADAR) sensor data of ~~[[an]]~~ the aircraft while the aircraft is approaching ~~or in the~~ ramp area;
 - merging the camera image data and the ~~LIDAR/Radar~~ LIDAR/RADAR-sensor data into a merged data set; and
 - wherein the merged data set includes at least one of: data for determining ~~the~~ position and orientation of the aircraft relative to the position and orientation of the ramp area, data for determining speed of the aircraft, data for determining direction of the aircraft, data for determining proximity of the aircraft to a particular object within the

ramp area, and data for forming a three dimensional virtual model of at least a portion of the aircraft from the merged data; and

displaying messages to provide directional and speed guidance to a pilot with the merged data set.

2. (Currently amended) The method of claim 1, ~~wherein the method includes~~ further comprising:

comparing the three dimensional virtual model to one or more aircraft reference models stored in memory of a computing device to find a match between the three dimensional virtual model and one of the aircraft reference models to determine an aircraft type.

3. (Currently amended) The method of claim ~~[[1]]~~ 2, ~~wherein the method includes~~ further comprising:

comparing the determined aircraft type with an aircraft type provided in gate arrival information to determine that the aircraft type that is approaching or in the ramp area is ~~[[the]]~~ a correct aircraft type.

4. (Currently amended) The method of claim 1, ~~wherein the method includes~~ further comprising:

scanning the aircraft with a ~~LIDAR/Radar~~ LIDAR/RADAR sensor with a sweep of the ~~LIDAR/Radar~~ LIDAR/RADAR across the aircraft in at least one of a horizontal or vertical direction or both.

5. (Currently amended) The method of claim 4, ~~wherein the method includes~~ further comprising:

comparing the camera image data and the ~~LIDAR/Radar~~ LIDAR/RADAR sensor data to identify that ~~[[an]]~~ the aircraft is present in both the camera image data and the ~~LIDAR/Radar~~ LIDAR/RADAR sensor data.

6. (Currently amended) The method of claim 1, wherein ~~the~~ a gate arrival information is received from an airport computing system.

7. (Currently amended) The method of claim 1, ~~wherein the method includes~~ further comprising:

comparing the camera image data and the ~~LIDAR/Radar~~ LIDAR/RADAR sensor data to identify that ~~[[an]]~~ the aircraft is present in both the camera image data and the ~~LIDAR/Radar~~ LIDAR/RADAR sensor data before merging the camera image data and the ~~LIDAR/Radar~~ LIDAR/RADAR sensor data.

8. (Original) The method of claim 1, wherein the data for determining proximity of the aircraft to a particular object within the ramp area include data for determining proximity of the aircraft to a stop point.

9. (Original) The method of claim 1, wherein the data for determining proximity of the aircraft to a particular object within the ramp area include data for determining proximity of the aircraft to a piece of equipment on a ramp area tarmac surface.

10. (Currently amended) A method for tracking an aircraft, comprising:

receiving camera image data of ~~[[an]]~~ the aircraft while the aircraft is approaching ~~or in the~~ a ramp area for parking the aircraft on an airside of an airport;

determining a portion of the camera image data associated with the aircraft:

receiving ~~LIDAR/RADAR~~ Light Detection And Ranging (LIDAR) or Radio Detection And Ranging (RADAR) sensor data of ~~[[an]]~~ the aircraft while the aircraft is approaching ~~or in~~ the ramp area;

determining a portion of the ~~LIDAR/Radar~~ LIDAR/RADAR sensor data associated with the aircraft:

merging the camera image data and the ~~LIDAR/Radar~~ LIDAR/RADAR sensor data associated with the aircraft into a merged data set; and

wherein the merged data set includes at least one of: data for determining the position and orientation of the aircraft relative to the position and orientation of the ramp area, data for determining speed of the aircraft, data for determining direction of the aircraft, data for determining proximity of the aircraft to a particular object within the ramp area, and data for forming a three dimensional virtual model of at least a portion of the aircraft from the merged data; and

displaying messages to provide directional and speed guidance to a pilot with the merged data set.

11. (Currently amended) The method of claim 10, ~~wherein the method includes~~ further comprising:

comparing the three dimensional virtual model to one or more aircraft reference models to find a match between the three dimensional virtual model and one of the aircraft reference models to determine an aircraft type.

12. (Original) The method of claim 11, wherein comparing the three dimensional virtual model to one or more aircraft reference models includes comparing at least one of: wing edge to nose end distance;

tail tip height;

number of windows;

position of windows;

size of windows:

number of pilot windows;

position of pilot windows;

number of engines;

engine cowl type;

engine cowl size;

fuselage length;

number of windows in fuselage;

wing span size;

height of the nose from ground;

position of engines; and

nose dimensions.

13. (Currently amended) The method of claim 10, ~~wherein the method includes~~ further comprising:

 sending at least the determined speed and direction to a ramp docking
system controller device.

14. (Currently amended) The method of claim 13, ~~wherein the method includes also~~ further comprising:

 sending at least the determined position and orientation to the ramp docking
system controller device.

15. (Currently amended) The method of claim 10, ~~wherein the method includes~~ further comprising:

 sending at least the determined position and orientation to a ramp docking system controller device.

16. (Currently amended) The method of claim 10, ~~wherein the method includes~~ further comprising:

 sending at least one of the determined speed, direction, position, and orientation to a pilot unit computing device on the aircraft.

17. (Currently amended) The method of claim 10, ~~wherein the method includes~~ further comprising:

 sending at least one of the determined speed, direction, position, and orientation to a passenger computing device on the aircraft.

18. (Currently amended) A system for tracking an aircraft, comprising:

 a camera image sensor for capturing camera image data of ~~[[an]]~~ the aircraft while the aircraft is approaching ~~or in the~~ a ramp area for parking the aircraft on an airside of an airport;

 a computing device having memory associated therewith for receiving the camera image data from the camera image sensor;

 a ~~LIDAR/RADAR~~ Light Detection And Ranging (LIDAR) or RAdio Detection And Ranging (RADAR) sensor for capturing ~~LIDAR/Radar~~ LIDAR/RADAR sensor data of ~~[[an]]~~ the aircraft while the aircraft is approaching ~~or in~~ the ramp area;

the computing device for receiving the ~~LIDAR/Radar~~ LIDAR/RADAR sensor data and merging the camera image data and the ~~LIDAR/Radar~~ LIDAR/RADAR sensor data associated with the aircraft into a merged data set; and

wherein the merged data set includes at least one of: data for determining the position and orientation of the aircraft relative to the position and orientation of the ramp area, data for determining speed of the aircraft, data for determining direction of the aircraft, data for determining proximity of the aircraft to a particular object within the ramp area, and data for forming a three dimensional virtual model of at least a portion of the aircraft from the merged data; and

the computing device for displaying messages to provide directional and speed guidance to a pilot with the merged data set.

19. (Currently amended) The ~~computing device~~ system of claim 18, wherein the ~~LIDAR/Radar~~ LIDAR/RADAR sensor data is analyzed using a point cloud process to correlate points in the ~~LIDAR/Radar~~ LIDAR/RADAR sensor data to points in the camera image data.

20. (Currently amended) The ~~computing device~~ system of claim 18, wherein the computing device analyzes the camera image data to identify that ~~the~~ an aircraft is approaching ~~or in~~ the ramp area.

ALLOWABLE SUBJECT MATTER

IV. Claims 1-20 are pending and allowed. Claims 1-7, 10-11, and 13-20 are currently amended.

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

The closest prior art of Papageorgiou et al. US 2017/0178520 A1 teaches systems and methods for on-ground vehicle collision avoidance utilizing shared vehicle hazard sensor data. In one embodiment, a system comprises: a ground based hazard data aggregation system comprising at least one memory storing a hazard position database; and at least one vehicle-ground communications electronics system coupled to the aggregation system; wherein the aggregation system is communicatively coupled to an onboard ground hazard collision avoidance system of at least a first on-ground subscriber vehicle through a wireless datalink established via the vehicle-ground communications electronics system; wherein the hazard position database stores vehicle collected hazard position data generated by a first on-ground contributing vehicle; and wherein the ground based hazard data aggregation system transmits to the first on-ground subscriber vehicle aggregated hazard position data from the hazard position database, the aggregated hazard position data including the vehicle collected hazard position data generated by the first on-ground contributing vehicle.

In regarding to independent claims 1, 10, and 18, Papageorgiou taken either individually or in combination with other prior art of record fails to teach or render obvious a method and system comprising: receiving camera image data of the aircraft while the aircraft is approaching a ramp area for parking the aircraft on an airside of an airport; receiving Light Detection And Ranging (LIDAR) or RAdio Detection And Ranging (RADAR) sensor data of the aircraft while the aircraft is approaching or in the ramp area; merging the camera image data and the LIDAR/RADAR sensor data into a merged data set; and wherein the merged data set includes at least one of: data for determining the position and orientation of the aircraft relative to the position and

orientation of the ramp area, data for determining speed of the aircraft, data for determining direction of the aircraft, data for determining proximity of the aircraft to a particular object within the ramp area, and data for forming a three dimensional virtual model of at least a portion of the aircraft from the merged data; and displaying messages to provide directional and speed guidance to a pilot with the merged data set.

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."

Inquiry

Any inquiry concerning this communication or earlier communications from the examiner should be directed to YUEN WONG whose telephone number is (313)446-4851. The examiner can normally be reached on M-F 9-5:30.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Faris Almatrahi, can be reached on (313)446-4821. 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

Application/Control Number: 16/983,657
Art Unit: 3667

Page 11

USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

The fax phone numbers for the organization where this application or proceedings is assigned are as follows:

(571)273-8300 (Official Communications: including After Final Communications labeled "Box AF")

(571)273-6705 (Draft Communications)

/YUEN WONG/
Primary Examiner, Art Unit 3667

<i>Examiner-Initiated Interview Summary</i>	Application No. 16/983,657	Applicant(s) Poojary et al.		
	Examiner YUEN WONG	Art Unit 3667	AIA (First Inventor to File) Status Yes	Page 1 of 1

All Participants (applicant, applicants representative, PTO personnel)	Title	Type
YUEN WONG	Primary Examiner	Telephonic
MARK BERGER	Attorney of Record	

Date of Interview: 25 August 2022

Issues Discussed:

35 U.S.C. 101

Examiner suggests, in the interest of compact prosecution, to Applicant amend independent claims 1, 10, and 18 to overcome 101 rejection by adding a display based on [0046]. Applicant indicated willingness to consider the suggestion. No agreement has been reached.

Objections

Examiner suggested to Applicant amend the preamble of claims 19 and 20 from "the computing device" to "The system". Applicant indicated willingness to consider the suggestion. No agreement has been reached.

/YUEN WONG/ Primary Examiner, Art Unit 3667	
<p>Applicant is reminded that a complete written statement as to the substance of the interview must be made of record in the application file. It is the applicants responsibility to provide the written statement, unless the interview was initiated by the Examiner and the Examiner has indicated that a written summary will be provided. See MPEP 713.04</p> <p>Please further see: MPEP 713.04 Title 37 Code of Federal Regulations (CFR) § 1.133 Interviews, paragraph (b) 37 CFR § 1.2 Business to be transacted in writing</p>	

Applicant recordation instructions: It is not necessary for applicant to provide a separate record of the substance of interview.

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

<i>Notice of References Cited</i>	Application/Control No. 16/983,657	Applicant(s)/Patent Under Reexamination Poojary et al.	
	Examiner YUEN WONG	Art Unit 3667	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-20170178520-A1	06-2017	Papageorgiou; George	G08G5/04	1/1
	B					
	C					
	D					
	E					
	F					
	G					
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FOREIGN PATENT DOCUMENTS

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NON-PATENT DOCUMENTS

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	X	

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Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

U.S. Patent and Trademark Office
PTO-892 (Rev. 01-2001)

Notice of References Cited

Part of Paper No. 20220825

Search Notes 	Application/Control No. 16/983,657	Applicant(s)/Patent Under Reexamination Poojary et al.
	Examiner YUEN WONG	Art Unit 3667

CPC - Searched*		
Symbol	Date	Examiner
G08G5/065 or B64D45/00 or G05D1/0202 or G06K9/6289 or G06T7/521 or G06V20/13 or G01S13/874 or G01S2013/9323 or B64F1/002 or G01S7/412 or G01S13/04 or G01S13/08 or G01S13/867 or G01S13/934 or G01S7/417 or G01S13/58 or G01S7/4802 or G01S17/58 or G01S17/66 or G01S17/86 or G01S17/933 or G08G5/0026 or G01S17/42	08/23/2022	/YW/

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

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

	/Y.W./ Examiner: Art Unit 3667
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Search Notes 	Application/Control No. 16/983,657	Applicant(s)/Patent Under Reexamination Poojary et al.
	Examiner YUEN WONG	Art Unit 3667

Search Notes		
Search Notes	Date	Examiner
Inventor Name Search (PE2E & PALM)	08/23/2022	/YW/
PE2E (US PGPUB, USPAT, EPO, JPO, DERWENT, IBM_TDB, USOCR, FPRS)	08/23/2022	/YW/
PE2E - backward/forward search	08/23/2022	/YW/
CPC search - G08G5/065 or B64D45/00 or G05D1/0202 or G06K9/6289 or G06T7/521 or G06V20/13 or G01S13/874 or G01S2013/9323 or B64F1/002 or G01S7/412 or G01S13/04 or G01S13/08 or G01S13/867 or G01S13/934 or G01S7/417 or G01S13/58 or G01S7/4802 or G01S17/58 or G01S17/66 or G01S17/86 or G01S17/933 or G08G5/0026 or G01S17/42 (text search)	08/23/2022	/YW/
EIC 3600 search - aircraft camera image lidar radar	08/23/2022	/YW/

Interference Search			
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	/Y.W./ Examiner.Art Unit 3667
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Issue Classification 	Application/Control No. 16/983,657	Applicant(s)/Patent Under Reexamination Poojary et al.
	Examiner YUEN WONG	Art Unit 3667

CPC						
Symbol					Type	Version
G08G	/	5	/	065	F	2013-01-01
G06T	/	7	/	521	I	2017-01-01
G06V	/	20	/	13	I	2022-01-01
B64D	/	45	/	00	I	2013-01-01
G05D	/	1	/	0202	I	2013-01-01
G06K	/	9	/	6289	I	2013-01-01

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Symbol				Type	Set	Ranking	Version
	/		/				

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	20	
/YUEN WONG/ Primary Examiner, Art Unit 3667 (Primary Examiner)	25 August 2022 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 2

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Part of Paper No.: 20220825

Issue Classification 	Application/Control No. 16/983,657	Applicant(s)/Patent Under Reexamination Poojary et al.
	Examiner YUEN WONG	Art Unit 3667

INTERNATIONAL CLASSIFICATION			
CLAIMED			
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NON-CLAIMED			
/		/	

US ORIGINAL CLASSIFICATION	
CLASS	SUBCLASS

CROSS REFERENCES(S)						
CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)					

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	20	
/YUEN WONG/ Primary Examiner, Art Unit 3667 (Primary Examiner)	25 August 2022 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 2

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Issue Classification 	Application/Control No. 16/983,657	Applicant(s)/Patent Under Reexamination Poojary et al.
	Examiner YUEN WONG	Art Unit 3667

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

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	20	
/YUEN WONG/ Primary Examiner, Art Unit 3667	25 August 2022	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	2

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Doc code: IDS
 Doc description: Information Disclosure Statement (IDS) Filed

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number	16983657
	Filing Date	2020-08-03
	First Named Inventor	Rajesh V. Poojary
	Art Unit	OPAP
	Examiner Name	DOCKET CENTRAL
	Attorney Docket Number	H215046-US

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	1	3680689	EP	A1	2020-07-15	ADB SAFEGATE SWEDEN AB	Original Document	
	2	111427374	CN	A	2020-07-17	LEISHEN INTELLIGENT SYSTEM CO LTD	Original Document & English Abstract	
	3	2001187599	JP	A	2001-07-10	MITSUBISHI ELECTRIC CORP, et al.	Original Document & English Abstract	

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ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /YW/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		16983657
	Filing Date		2020-08-03
	First Named Inventor	Rajesh V. Poojary	
	Art Unit	OPAP	
	Examiner Name	DOCKET CENTRAL	
	Attorney Docket Number	H215046-US	

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<small> ¹ See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. ² Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). ³ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁴ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. ⁵ Applicant is to place a check mark here if English language translation is attached. </small>			

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number	16983657
	Filing Date	2020-08-03
	First Named Inventor	Rajesh V. Poojary
	Art Unit	OPAP
	Examiner Name	DOCKET CENTRAL
	Attorney Docket Number	H215046-US

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☒ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Jeffery L. Cameron/	Date (YYYY-MM-DD)	2022-01-05
Name/Print	Jeffery L. Cameron	Registration Number	43527

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. **DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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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:

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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.
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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.
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Bibliographic Data

Application No: 16/983,657

Foreign Priority claimed: ☐ Yes ☒ No

35 USC 119 (a-d) conditions met: ☐ Yes ☒ No ☐ Met After Allowance

Verified and Acknowledged:

/YUEN WONG/

Examiner's Signature

Initials

Title:

MULTI-SENSOR DATA FUSION-BASED AIRCRAFT
DETECTION, TRACKING, AND DOCKING

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
08/03/2020	701	3667	H215046-US
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APPLICANTS

Honeywell International Inc., Morris Plains, NJ, UNITED STATES

INVENTORS

Rajesh V. Poojary, Bangalore, INDIA

Raghu Seelamonthula, Bangalore, INDIA

Vinay Sridhara Murthy, Bangalore, INDIA

Manuj Sharma, Bangalore, INDIA

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	3	101314566	KR	B1	2013-10-07	ANSE TECHNOLOGIES CO LTD	w/ English abstract	☐

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	1	RENUKA, ET AL. "SMART RAMP INFORMATION DISPLAY SYSTEM", International Journal of Pure and Applied Mathematics, Vol. 119, No. 16, 2018, 6 pages.	
	2	RODRIGUEZ-GARAVITO, ET AL., "Automatic Laser And Camera Extrinsic Calibration for Data Fusion Using Road Plane", IEEE Intelligent Transportation Systems Conference, 2006, 6 pages.	
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	First Named Inventor	Rajesh V. Poojary	
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	Examiner Name		
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CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Mark R. Berger/	Date (YYYY-MM-DD)	2020-08-03
Name/Print	Mark R. Berger	Registration Number	62556

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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ARTICLE

Method for 3-D Scene Reconstruction Using Fused LiDAR and Imagery From a Texel Camera

Bybee, Taylor C ; Budge, Scott E

IEEE transactions on geoscience and remote sensing, 2019, Vol.57 (11), p.8879-8889

«
...), consisting of a LiDAR point cloud and an overlaid image, is valuable in many applications including agriculture, military, surveying, and natural disaster response...
»

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2



BOOK

Field and Service Robotics Results of the 7th International Conference

International Conference on Field and Service Robotics.; International Conference on Field and Service Robotics; Kelly, Alonzo. editor.; Iagnemma, Karl. editor.; Howard, Andrew. editor.

2010

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3



ARTICLE

Tightly-coupled camera/LiDAR integration for point cloud generation from GNSS/INS-assisted UAV mapping systems

Zhou, Tian ; Hasheminasab, Seyyed Meghdad ; Habib, Ayman

ISPRS journal of photogrammetry and remote sensing, 2021, Vol.180 (C), p.336-356

«
... together with cameras and/or LiDAR sensors are being widely used for topographic mapping in a variety of applications such as precision agriculture, coastal monitoring, and archaeological documentation...
»

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BOOK

The history and future of technology : can technology save humanity from extinction?

Ayres, Robert U., author.

2021

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ARTICLE

Geomorphological mapping with a small unmanned aircraft system (sUAS): Feature detection and accuracy assessment of a photogrammetrically-derived digital terrain model

Hugenholtz, Chris H. ; Whitehead, Ken ; Brown, Owen W. ; Barchyn, Thomas E. ; Moorman, Brian J. ; LeClair, Adam ; Riddell, Kevin ; Hamilton, Tayler

Geomorphology (Amsterdam, Netherlands), 2013, Vol.194, p.16-24

Small unmanned aircraft systems (sUAS) are a relatively new type of aerial platform for acquiring high-resolution remote sensing measurements of Earth surface processes and landform...

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ARTICLE

A survey of safe landing zone detection techniques for autonomous unmanned aerial vehicles (UAVs)

Shah Alam, Md ; Oluoch, Jared

Expert systems with applications, 2021, Vol.179, p.115091

Keywords UAV; Zone Detection; Camera Vision; LiDAR; Image Analysis; DEM; Path Planning Highlights...

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ARTICLE

3D Tree Dimensionality Assessment Using Photogrammetry and Small Unmanned Aerial Vehicles

Gatzliolis, Demetrios ; Lienard, Jean F ; Vogs, Andre ; Strigul, Nikolay S ; Chen, Han Y.H.

PloS one, 2015, Vol.10 (9), p.e0137765-e0137765

.... Active remote technologies such as LiDAR operated from airborne platforms provide only partial crown reconstructions...

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ARTICLE

Forest restoration monitoring through digital processing of high resolution images

Reis, Bruna Paolinelli ; Martins, Sebastião Venâncio ; Fernandes Filho, Elpidio Inácio ; Sarcinelli, Tathiane Santi ; Gleriani, José Marinaldo ; Leite, Helio Garcia ; Halassy, Melinda

Ecological engineering, 2019, Vol.127, p.178-186

*[Display omitted] *Methods of forest restoration monitoring using LiDAR and UAV were elaborated...*

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ARTICLE

Using lightweight unmanned aerial vehicles to monitor tropical forest recovery

Zahawi, Rakan A. ; Dandois, Jonathan P. ; Holl, Karen D. ; Nadwodny, Dana ; Reid, J. Leighton ; Ellis, Erle C.

Biological conservation, 2015, Vol.186, p.287-295

*...; Costa Rica; Drone; Ecosynth; Hexacopter; LiDAR; Point cloud model Highlights * We compared*

ground-based to a remote-sensing (Ecosynth) monitoring method... »

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ARTICLE

Impacts of selective logging on Amazon forest canopy structure and biomass with a LIDAR and photogrammetric survey sequence

d'Oliveira, Marcus Vinicio Neves ; Figueiredo, Evandro Orfanó ; de Almeida, Danilo Roberti Alves ; Oliveira, Luis Claudio ; Silva, Carlos Alberto ; Nelson, Bruce Walker ; da Cunha, Renato Mesquita ; de Almeida Papa, Daniel ; Stark, Scott C. ; Valbuena, Ruben

Forest ecology and management, 2021, Vol.500, p.119648

» » » LIDAR-photogrammetry can identify canopy logging damage accurately and estimate AGB... »

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L1	4	"20220036750".pn.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, CA, CH, CN, DD, DE, EA, EP, ES, FR, GB, JP, KR, OA, RU, SU, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/08/23 07:09 PM
L2	0	("2022/0036750").urpn. AND (PGPB USPT USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/08/23 07:14 PM
L3	41	(Artificial Intelligence) More Like: US-20220036750-A1 Text: (EP-3951421-A1 OR US-20200180783-A1 OR GB-2580532-A OR CN-113287035-A OR AU-2019275577-A1 OR JP-2022517325-A OR BR-112021013025-A2 OR CA-3125494-A1 OR US-20220066025-A1 OR EP-3908851-A1 OR WO-2020144264-A1 OR AU-2020206515-A1 OR EP-3680689-A1 OR KR-20210113295-A OR CN-111427374-A OR US-20150293225-A1 OR EP-3751302-A1 OR CN-113853532-A OR CN-101196565-B OR CN-101196565-A).did.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/08/23 07:14 PM
L4	0	POOJARY-RAJESH.in.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/08/23 08:03 PM
L5	11	SEELAMONTHULA-	(US-PGPUB; USPAT;	OR	ON	ON	2022/08/23

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		RAGHU.in.	USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)				08:04 PM
L6	4397	SRIDHARA MURTHY-VINAY.in.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/08/23 08:04 PM
L7	20	SHARMA-MANUJ.in.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/08/23 08:05 PM
L8	69685	honeywell.as.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO,	OR	ON	ON	2022/08/23 08:05 PM

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L9	12	("10255520" 20200180783").PN.	NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB) (US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/08/23 08:09 PM
L10	13354	(ramp terminal apron) AND (aircraft airplane plane) AND camera AND (image picture) AND lidar AND radar AND (merg\$3 fusion combined) AND (position speed direction)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/08/23 10:24 PM
L11	23	(3 5 6 7 8 9) AND 10	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/08/23 10:25 PM
L12	76	(ramp terminal apron) AND (aircraft airplane plane) AND camera	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY,	OR	ON	ON	2022/08/23 11:19 PM

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L13	35	WITH (image picture) WITH lidar WITH radar WITH (merg\$3 fusion combined) AND (position speed direction)	CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/08/23 11:28 PM
L14	1182	(ramp) AND (aircraft airplane) AND camera WITH (image picture) WITH lidar WITH radar WITH (merg\$3 fusion combined) AND (position speed direction)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/08/23 11:29 PM
L15	4	(3 5 6 7 8 9) AND 14	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH,	OR	ON	ON	2022/08/23 11:29 PM

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L17	4	Docking ADJ guidance AND camera AND (image picture) AND lidar AND radar AND (merg\$3 fusion) AND (position speed direction)	TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB) (US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/08/23 11:43 PM
L18	4	Docking ADJ guidance AND camera AND (image picture) AND lidar AND radar AND (merg\$3 fusion)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/08/23 11:44 PM
L19	17	Docking ADJ guidance AND camera AND (image picture) AND lidar AND radar	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/08/23 11:44 PM
L20	37	(Artificial Intelligence) More Like: CN-1103092-C Text:	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA,	OR	ON	ON	2022/08/23 11:46 PM

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L21	13	(CN-1214139-A OR WO-9732291-A1 OR EP-0883873-A1 OR KR-100351343-B1 OR KR-19990087359-A OR US-6282488-B1 OR BR-9707716-A OR CA-2248296-A1 OR EP-0883873-B1 OR PT-883873-E OR ES-2141598-T3 OR KR-20160007090-A OR KR-0154603-B1 OR JP-H08146130-A OR KR-101656280-B1 OR KR-101650905-B1 OR KR-960018616-A OR KR-102315546-B1 OR CN-100474354-C OR CN-101156189-A).did. (Visual ADJ Docking ADJ guidance vdgs) AND camera AND (image picture) AND lidar AND radar	EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB) (US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/08/23 11:49 PM
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PE2E SEARCH - Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
N1	4	(ramp terminal apron).clm. AND (aircraft airplane).clm. AND camera.clm. AND (image picture).clm. AND lidar.clm. AND radar.clm. AND (merg\$3 fusion combined).clm. AND (position speed direction).clm.	(US-PGPUB; USPAT)	OR	ON	ON	2022/08/25 11:01 PM



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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/983,657	08/03/2020	Rajesh V. Poojary	H215046-US

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PUBLICATION NOTICE



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Publication No.US-2022-0036750-A1

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	Filing Date	2020-08-03
	First Named Inventor	Rajesh V. Poojary
	Art Unit	OPAP
	Examiner Name	DOCKET CENTRAL
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	3	2001187599	JP	A	2001-07-10	MITSUBISHI ELECTRIC CORP, et al.	Original Document & English Abstract	

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	Filing Date	2020-08-03
	First Named Inventor	Rajesh V. Poojary
	Art Unit	OPAP
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(12) EUROPEAN PATENT APPLICATION

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(57) The disclosure relates to airport stand arrangement (100,200,300) comprising: a display (130); a radar-based system (110R); and one or more additional systems selected from laser-based systems (110L) and imaging systems (110C), wherein said radar-based system (110R) and said one or more additional systems together form a combined system (110,210,310), wherein the airport stand arrangement (100) is configured, based on output data from said combined system (110), to detect and track (S108,S110) an aircraft (10) within a stand area (20) when said aircraft (10) is approaching a stand within the stand area (20) for parking at a parking position (160) therein, and configured, based on said detection and tracking of the approaching aircraft (10), to provide (S114,S116) pilot maneuvering guidance information on said display (130) for aiding a pilot of the approaching aircraft (10) in maneuvering the aircraft (10) towards said parking position (160).

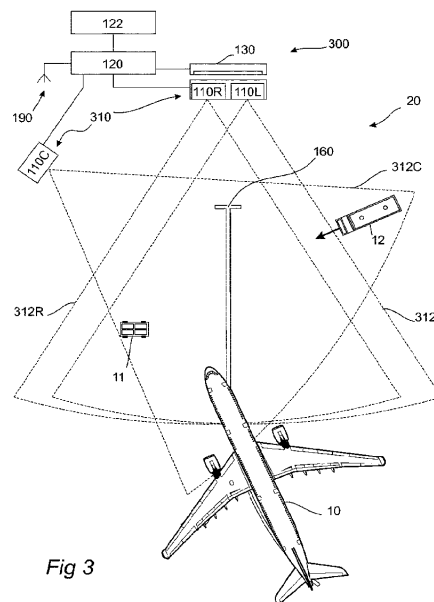


Fig 3

Description**Summary**Field of the invention

[0001] The present invention relates to an airport stand arrangement. More specifically, the disclosure relates to an airport stand arrangement configured to aid a pilot of an approaching aircraft in maneuvering the aircraft towards a parking position at the stand.

Background art

[0002] Safe and reliable docking of aircrafts to stands at airports is today most often achieved by means of aircraft stand arrangements, such as aircraft docking systems, arranged locally at the stands of the airport, wherein each aircraft docking system is configured to aid the pilot, and sometimes also the ground crew, in receiving the aircraft at the stand in a safe and reliable way. Often, such aircraft stand arrangements comprise means for establishing a position of the aircraft as it approaches the stand, said means often being a remote sensing detection system, such as a laser scanning system. Typically, the aircraft stand arrangements known in the art are configured to analyze position data from the aircraft, and potentially also other input parameters, and, based on the parameters, determine pilot maneuvering guidance information on a display of the aircraft stand arrangements for aiding a pilot of the approaching aircraft in maneuvering the aircraft towards a predetermined parking position at the stand.

[0003] A challenge with existing arrangements is that they often rely on optical sensing techniques which are less accurate, or even not applicable, in low visibility weather conditions, such as e.g. rain, fog or snow. Moreover, as at least some remote sensing detection systems rely on measuring and interpreting a backscattered signal from the aircraft, the quality of the signal will depend on the surface characteristics of the aircraft itself. Conventional aircrafts most often comprise exterior surface parts of steel, which provide an efficient backscattering. However, as there is an increasing use of non-metallic composite materials in today's aircrafts for weight reduction, conventional aircraft docking systems may have difficulty in detecting these planes with enough accuracy.

[0004] A further problem is that it is sometimes difficult to detect enough surface of the aircraft for assessing aircraft data, such as position, dimensions, and aircraft type. A specific challenge in this respect is to successfully determine and track the angle of approach of the aircraft with respect to the lead-in line of the stand. Also, spatial resolution may be inadequate for successfully determining the aircraft type.

[0005] Thus, there is a need in the art for an improved aircraft stand arrangement.

[0006] It is an object to mitigate, alleviate or eliminate one or more of the above-identified deficiencies in the art and disadvantages singly or in any combination and solve at least the above-mentioned problem. According to a first aspect there is provided an airport stand arrangement comprising:

a display;
a radar-based system; and
one or more additional systems selected from laser-based systems and imaging systems,
wherein said radar-based system and said one or more additional systems together form a combined system,
wherein the airport stand arrangement is configured, based on output data from said combined system, to detect and track an aircraft within a stand area when said aircraft is approaching a stand within the stand area for parking at a parking position therein, and configured, based on said detection and tracking of the approaching aircraft, to provide pilot maneuvering guidance information on said display for aiding a pilot of the approaching aircraft in maneuvering the aircraft towards said parking position.

[0007] The airport stand arrangement may be advantageous as it allows for combining more than one remote sensing technique to detect and track the aircraft. As each remote sensing technique has its specific strengths and weaknesses, the proposed airport stand arrangement may thus be more versatile in different situations. Specifically, it provides a means for meeting the problems of the prior art systems. For example, the radar-based system provides increased sensitivity in low visibility conditions. Moreover, the radar-based system is less sensitive to the composite materials of modern aircrafts as radar signal backscattering is sufficiently strong from these materials to result in a good signal-to-noise ratio. Imaging systems provide an improved spatial resolution in good weather. Imaging systems also generally provide a higher repetition rate for faster objects, and are less expensive. As will be shown later, a further advantage of the airport stand arrangement is that it allows accurate detection and tracking of other objects present in a stand area.

[0008] The airport stand arrangement may consist of several interconnected units, wherein each unit may be disposed at different positions at, or around the gate area. However, the airport stand arrangement is disposed at the stand area and is not configured to detect and track aircrafts at other parts of the airport, such as e.g. the taxi lines, or the runways. The airport stand arrangement may be an aircraft docking system.

[0009] The radar-based system is a remote sensing detection system based on microwave electromagnetic radiation. Such systems emit continuous or pulsed radar

signals towards a target and capture and detect radar pulses backscattered from the target. The radar system may comprise a radar sensor of semi-conductor type. For example, the radar sensor may be of the kind used within the automotive industry. The radar sensor may operate at 77 kHz.

[0010] The laser-based system is a remote sensing detection system based on optical electromagnetic radiation. Such systems emit continuous or pulsed laser radiation towards a target and capture and detect laser radiation backscattered from the target. The laser-based system may comprise beam deflecting means for providing scanning capabilities. Such beam deflecting means may be e.g. a scanning mirror arrangement.

[0011] The imaging system may comprise a camera sensitive to optical or infrared radiation. The imaging system may be used to capture the emission of natural radiation from the target. However, it is also conceivable that the camera is used to capture radiation emitted from the target as a result from the laser-based system. Such radiation may be scattered or reflected laser radiation, fluorescence, phosphorescence and the like.

[0012] According to some embodiments, said one or more additional systems are selected from laser-based systems only.

[0013] According to some embodiments, said one or more additional systems are selected from imaging systems only.

[0014] According to some embodiments, said one or more additional systems comprise at least one laser-based system and at least one image-based system.

[0015] The airport stand arrangement further comprises control means for controlling, and performing, said detection and tracking. The control means may comprise a separate control unit of the airport stand arrangement, but may alternatively comprise several control units. For example, each system of the combined system may comprise a respective control unit. It is readily realized by the skilled person that many physical embodiments exist within the scope of the claims.

[0016] Each system of the combined system provides a respective coverage at the stand area. Preferably, the respective coverages at least partially overlap each other. It is however conceivable for some embodiments that two or more of said respective coverages do not overlap each other.

[0017] According to some embodiments, the airport stand arrangement is configured to detect and track the approaching aircraft based on combined output data from said radar-based system, on the one hand, and from said one or more additional systems, on the other hand.

[0018] This may be advantageous as it allows for increasing the overall accuracy of the detection and tracking. In some situations, one system of the combined system may be more accurate than another one. The airport stand arrangement may then predominately base its detection and tracking on the output data from the most accurate system. It is also conceivable that different sys-

tems show a varying accuracy or sensitivity at different spatial locations of the stand area, or different spatial positions of the approaching aircraft. Thus, it is conceivable that the detection and tracking is based on output data from the two or more systems in different relative weights dependent on spatial position. It is also conceivable that the two or more systems have partly different areas of coverage at the stand area. In such a case, it may be possible to detect an aircraft with one system as the aircraft enters the stand area, and then automatically shift to another more accurate system when the aircraft has entered the area of coverage of that system.

[0019] According to some embodiments, two or more systems of the combined system are each distanced from each other so as to, at each position in time, detect the approaching aircraft using different collection angles.

[0020] This may be advantageous as it allows for extending the overall coverage of the airport stand arrangement. For example, one system of the combined system may be arranged to detect an approaching aircraft from the side, and another system of the combined system from the front. This may be especially advantageous for providing output data that is more reliable for predicting the angle of the approaching aircraft. At some airport stands, the aircraft has to maneuver along a relatively narrowly curved lead-in line for arriving at the stand. Such stand areas may, preferably, be equipped with an aircraft stand arrangement having such distanced systems of the combined systems.

[0021] The radar-based system may be arranged so as to emit radar radiation in a direction along the lead-in line towards the approaching aircraft. This implies that the radar-based system may be disposed at, or in a vicinity of, the display.

[0022] According to some embodiments, the airport stand arrangement is further configured to determine a visibility based on output data from one or more of said additional systems. Visibility may be determined using the laser-based system. For example, the visibility may be determined based on the ratio between backscattered laser radiation and emitted laser radiation. Visibility may alternatively or additionally be determined using the imaging system. For example, the visibility may be determined by comparing different spatial regions of captured images. Visibility may be based on output data from one system of the combined system, but may alternatively be based on output data from two or more systems of the combined system. For example, a visibility could be determined based on a weighted average of a respective visibility determined by each system of the combined system.

[0023] According to some embodiments, the airport stand arrangement is configured, in response to said visibility being lower than a first visibility threshold, to detect and track the approaching aircraft based on output data from the radar based system.

[0024] This may be advantageous as it allows for reducing the influence of visibility conditions on the accu-

racy and sensitivity of the detection and tracking of the airport stand arrangement. For example, the airport stand arrangement may be configured to detect and track the aircraft based on output data from a laser-based system as a default setting, and, as a visibility is determined to be lower than the first visibility threshold, switch from the laser-based system to the radar-based system so as to, instead, detect and track the aircraft based on output data from the radar-based system.

[0025] According to some embodiments, the airport stand arrangement further comprises wireless transmitting means, and wherein the airport stand arrangement is configured, in response to said visibility being lower than a second visibility threshold, lower than said first visibility threshold, to wirelessly transmit, using the wireless transmitting means, a signal comprising said pilot maneuvering guidance information to the approaching aircraft.

[0026] This may be advantageous as it allows for parking the aircraft at the parking position of the stand even in visibility conditions severe enough for the pilot not being able to view the display. The signal may be received by equipment installed within the aircraft and viewed on a display in the cockpit of the aircraft. The signal may be transmitted using the separate wireless transmitting means. It is, however, also conceivable that the signal is transmitted as a part of the radar signals emitted from the radar-based system.

[0027] According to some embodiments, the airport stand arrangement is further configured:

- to, as a first determination step, determine whether an aircraft is present or not at said parking position based at least on output data from said one or more additional systems; and
- to, in response to a negative determination in said first determination step and as a second determination step, determine whether an aircraft is present or not at said parking position based on output data from said radar-based system;
- to transmit an aircraft-present-signal in response to a positive determination in any of said first and second determination steps; and
- to transmit an aircraft-not-present-signal in response to a negative determination in both of said first and second determination steps.

[0028] The aircraft-present-signal and/or the aircraft-not-present-signal may be transmitted to personnel operating the airport stand arrangement at the stand. Alternatively, the aircraft-present-signal and/or the aircraft-not-present-signal may be transmitted to an external system, such as an airport operational database AODB in communication with the airport stand arrangement.

[0029] This may be advantageous as it allows for determining the occupancy of airport stands automatically, also in bad weather conditions. For example, respective airport stand arrangements of a plurality of stands at an

airport may be connected to a central system, such as an airport operational database AODB. The AODB may query which stands are occupied at a specific time. It is also conceivable that an airport stand arrangement is configured to determine if an aircraft is leaving, or approaching, a stand.

[0030] According to some embodiments, the airport stand arrangement is further configured to determine, as a third determination step, if a passenger bridge is in a predetermined passenger bridge position based on output data from the radar system. In response to a negative determination in the third determination step, the airport stand arrangement may be configured to transmit a passenger-bridge-incorrectly-positioned-signal. In response to a negative determination in the third determination step the airport stand arrangement may be further configured to provide further pilot maneuvering guidance information instructing the pilot to stop the aircraft.

[0031] According to some embodiments, the airport stand arrangement is further configured to detect and track other objects within the stand area. The arrangement may be further configured to detect and track said other objects within the stand area in parallel with said detection and tracking of the approaching aircraft during said maneuvering of the approaching aircraft towards the parking position.

[0032] Other objects may include any objects other than the approaching aircraft. Typically, the other objects belong to the ground support equipment GSE of the airport. Such equipment includes for example luggage train tractors and dollies, food delivery trucks, refuelers and transport buses. Other examples are chocks and aircraft service stairs. However, the other objects are not limited to ground support equipment. Thus, other objects may for example include a further aircraft accidentally entering the stand area, luggage dropped at the stand area, or even persons. Other objects may be stationary, or moving objects.

[0033] According to some embodiments, said arrangement is further configured to predict if the approaching aircraft is on a collision course with any of said other objects, and, in response to a collision course being predicted, to provide further pilot maneuvering guidance information instructing the pilot to stop the aircraft.

[0034] According to some embodiments, said detection and tracking of said other objects is based on output data from the radar-based system, and wherein said detection and tracking of the approaching aircraft is based on output data from said one or more additional systems.

[0035] This may be advantageous as it allows for automatically monitoring the stand area thus reducing the risk of accidents at the stand. Monitoring the stand area is sometimes referred to as an apron check. Typically, the stand area is monitored manually, or by additional surveillance systems not part of an airport stand arrangement. Neither of these solutions provide a possibility of automatically making decisions and informing the pilot thereof. The disclosed airport stand arrangement may

utilize the systems of the combined system to detect and track not only the approaching aircraft, but also other objects within the stand area. The detection and tracking of the other objects may occur independently of the detection and tracking of the approaching aircraft. In other words, the detection and tracking of other objects may occur before the approaching aircraft has entered the stand area, and/or during the process of parking the aircraft at the parking position, and/or during the time when the aircraft is parked at the stand, and/or during the process of the aircraft departing from the parking position at the stand area etc.

[0036] According to a second aspect there is provided a method for detecting and tracking an aircraft within a stand area when said aircraft is approaching a stand within the stand area for parking at a parking position therein, wherein said detection and tracking is based on output data from a radar-based system; and one or more additional systems selected from laser-based systems and imaging systems, the method comprising:

determining a visibility based on output data from one or more of said one or more additional systems, in response to said visibility being lower than a first visibility threshold:

detecting and tracking the approaching aircraft based on output data from said radar based system.

[0037] According to some embodiments the method further comprises:

in response to said visibility being higher than the first visibility threshold:

detecting and tracking the approaching aircraft based on output data from one or more of said one or more additional systems.

[0038] According to some embodiments, the method further comprises:

providing, based on said detection and tracking of the approaching aircraft, pilot maneuvering guidance information on a display for aiding a pilot of the approaching aircraft in maneuvering the aircraft towards said parking position.

[0039] According to some embodiments, the method further comprises:

in response to said visibility being lower than a second visibility threshold, lower than said first visibility threshold: wirelessly transmitting a signal comprising said pilot maneuvering guidance information to the approaching aircraft.

[0040] According to a third aspect there is provided a computer-readable medium comprising computer code instructions which when executed by a device having processing capability are adapted to perform the method according to the second aspect.

[0041] Effects and features of the second and third aspects are largely analogous to those described above in connection with the first aspect. Embodiments mentioned in relation to the first aspect are largely compatible

with the second aspect and third aspects. It is further noted that the inventive concepts relate to all possible combinations of features unless explicitly stated otherwise.

[0042] A further scope of applicability of the present invention will become apparent from the detailed description given below. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since various changes and modifications within the scope of the invention will become apparent to those skilled in the art from this detailed description.

[0043] Hence, it is to be understood that this invention is not limited to the particular component parts of the device described or steps of the methods described as such device and method may vary. It is also to be understood that the terminology used herein is for purpose of describing particular embodiments only, and is not intended to be limiting. It must be noted that, as used in the specification and the appended claim, the articles "a", "an", "the", and "said" are intended to mean that there are one or more of the elements unless the context clearly dictates otherwise. Thus, for example, reference to "a unit" or "the unit" may include several devices, and the like. Furthermore, the words "comprising", "including", "containing" and similar wordings does not exclude other elements or steps.

Brief descriptions of the drawings

[0044] The invention will by way of example be described in more detail with reference to the appended schematic drawings, which shows presently preferred embodiments of the invention.

Figure 1 is a top view of the airport stand arrangement at a stand area according to an embodiment of the present disclosure.

Figure 2 is a top view of the airport stand arrangement at a stand area according to another embodiment of the present disclosure.

Figure 3 is a top view of the airport stand arrangement at a stand area according to yet another embodiment of the present disclosure.

Figure 4 is a flow chart illustrating a functionality of the airport stand arrangement according to embodiments of the present disclosure.

Figure 5 is a flow chart illustrating another functionality of the airport stand arrangement according to embodiments of the present disclosure.

Detailed description

[0045] The present invention will now be described more fully hereinafter with reference to the accompanying drawings, in which currently preferred embodiments of the invention are shown. This invention may, however,

be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided for thoroughness and completeness, and fully convey the scope of the invention to the skilled person.

[0046] Figure 1 shows an airport stand arrangement 100 according to an example embodiment. The airport stand arrangement comprises a radar-based system 110R, and one or more additional systems selected from laser-based systems and imaging systems. As can be seen in Fig. 1, the one or more additional systems are here selected from laser-based systems only. Specifically, the one or more additional systems is here a laser-based system 110L.

[0047] The radar-based system 110R is a remote sensing detection system based on microwave electromagnetic radiation. Such systems emit continuous or pulsed radar signals towards a target and capture and detect radar pulses backscattered from the target. The radar-based system 110R may comprise a radar sensor of semi-conductor type. For example, the radar sensor may be of the kind used within the automotive industry. The radar sensor may operate at 77 kHz. The radar-based system provides output data pertaining to a radar-based system coverage 112R at the stand area 20.

[0048] The laser-based system 110L is a remote sensing detection system based on optical electromagnetic radiation. Such systems emit continuous or pulsed laser radiation towards a target and capture and detect laser radiation backscattered from the target. The laser-based system 110L may comprise beam deflecting means for providing scanning capabilities. Such beam deflecting means may be e.g. a scanning mirror arrangement. The laser-based system 110L provides output data pertaining to a laser-based system coverage 112L at the stand area 20.

[0049] The radar-based system 110R and the one or more additional systems together form a combined system 110. As illustrated in Fig. 1, the combined system 110 is disposed at the display and arranged so as to emit laser radiation and radar radiation in a direction along the lead-in line 162 towards the approaching aircraft 10.

[0050] The airport stand arrangement 100 further comprises a display 130 for providing pilot maneuvering guidance information to a pilot of the approaching aircraft 10. The display 130 is here mounted on the wall of the terminal building at a vertical position where the display 130 is in clear view of the pilot of the approaching aircraft 10.

[0051] The airport stand arrangement 100 further comprises a control unit 120 operatively connected to the combined system 110 and the display 130. The control unit 120 is further operatively connected to a database 122. The database 122 may be an airport operational database AODB comprising flight plans of arriving and departing aircrafts. This way, the control unit 120 may access information pertaining to the type of aircraft which will be approaching the stand area 20. The control unit 120 may also be in direct communication with the ap-

proaching aircraft 10, for example via ADS-B. In such a case, the control unit may receive the type of aircraft directly from the aircraft 10 instead of via the database 122.

[0052] The functionality of the airport stand arrangement 100 will now be described with reference to Fig. 4.

[0053] The airport stand arrangement 100 is configured to determine S102 output data pertaining to an appearance of the stand area 20. Such a determination may be carried out using one or more from the combined systems. However, one preferred functionality of the airport stand arrangement 100 is that the output data is determined S102 using one or more from the additional systems (in the example: the laser-based system S110L). The laser-based system 110L is a remote sensing detection system based on optical electromagnetic radiation. Such systems emit continuous or pulsed laser radiation towards a target and capture and detect laser radiation backscattered from the target. The laser-based system 110L comprises beam deflecting means for providing scanning capabilities. Such beam deflecting means may be e.g. a scanning mirror arrangement.

[0054] The airport stand arrangement 100 is further configured to determine S104 a visibility V based on output data from one or more of said additional systems (in the example: the laser-based system 110L). As is known, fog or precipitation affects visibility mainly in that incident electromagnetic radiation is scattered by the droplets in the atmosphere. During the scattering process, the illuminated droplets reemit some fraction of the incident electromagnetic radiation in all directions. The droplets then act as point sources of the reemitted energy. Some portion of the incident electromagnetic radiation is scattered backwards towards the radiation source, dependent on the relation between the droplet size and the radiation wavelength. The relation between visibility and scattered electromagnetic radiation is widely described in the literature as discussed in more detail for example in patent application WO2007108726A9.

[0055] The airport stand arrangement 100 is configured to compare S106 said visibility with a first visibility threshold V1. If the determined visibility V is found to be lower than a first visibility threshold V1, the airport stand arrangement 100 is configured to detect and track S110 the approaching aircraft 10 based on output data from the radar based system 110R. Thus, if the weather conditions are determined to be severe enough for preventing accurate optical remote sensing using the laser-based system 110R, the radar-based system 110R may instead be used for the detection and tracking of the approaching aircraft 10. Alternatively, if the determined visibility V is found to be higher than the first visibility threshold V1, the airport stand arrangement 100 is configured to detect and track S108 the approaching aircraft 10 based on output data from the one or more additional systems (in the example: the laser-based system 110R).

[0056] Independent on which system is used to provide output data for detection and tracking, the airport stand arrangement 100 performs similar tasks. As specified

above, the airport stand arrangement 100 is configured, based on output data from said combined system 110, to detect and track S108, S110 the aircraft 10 within a stand area 20 when said aircraft 10 is approaching a stand within the stand area 20 for parking at a parking position 160 therein. Said detection and tracking of the aircraft 10 is based on output data from the combined system 110. Thus, the radar-based system 110R and/or the one or more additional systems (in the example: the laser-based system 110L) outputs data pertaining to objects at the stand area 20 to the controller 120. The controller 120 receives said output data and performs a data analysis of it so as to determine tracking data of the aircraft 10, said tracking data including the position of the aircraft 10, the velocity of the aircraft 10 etc. Moreover, the controller 120 may also perform a data analysis of the received output data to determine the dimensions of the aircraft 10. Said dimensions may be compared to dimensions of aircraft models stored locally in the airport stand arrangement, or in the AODB 122, to establish an aircraft type and model of the aircraft 10. Alternatively, or additionally, the aircraft type and model may be determined by other means. For example, if the aircraft 10 is communicating with an airport surveillance system using the ADS-B standard, the airport surveillance system may receive the identity and position of the aircraft 10 transmitted to the airport surveillance system directly from the aircraft using an ADS-B transponder of the aircraft 10. In such a case, the aircraft model may be accessed from the AODB 122 by comparing the received identity of the aircraft with known aircrafts stored within a flight plan of the AODB 122. The aircraft stand arrangement 100 may then receive the aircraft type and/or dimensions of the aircraft type from the AODB 122. The aircraft stand arrangement 100 may then compare the dimensions of the aircraft type with dimensions of the aircraft inferred from an analysis of the output data received from the combined system 110. Thus, the aircraft type determined based on the direct communication with the aircraft using the ADS-B system may be confirmed by the aircraft stand arrangement 100.

[0057] The airport stand arrangement 100 is further configured, based on said detection and tracking of the approaching aircraft 10, to provide pilot maneuvering guidance information for aiding the pilot of the approaching aircraft 10 in maneuvering the aircraft 10 towards the parking position 160. The pilot maneuvering guidance information is determined by the control unit 120 by analyzing the output data received from the combined system 110.

[0058] As illustrated in Fig. 4, the airport stand arrangement 100 may, after having determined the pilot maneuvering guidance information, act differently depending on the determined visibility V. Thus, in a second determination step D113, the visibility V is compared to a second visibility threshold V2, lower than the first visibility threshold V1. If the determined visibility V is found to be lower than the second visibility threshold V2, the airport stand

arrangement 100 is configured to wirelessly transmit S116 a signal comprising said pilot maneuvering guidance information to the approaching aircraft 10. For the purpose, the airport stand arrangement 100 comprises wireless transmitting means 190. The wireless transmitting means 190 is operatively connected to the control unit 120. It is, however, also conceivable that the signal is wirelessly transmitted as a part of the radar signals emitted from the radar-based system 110R. The signal may be received by equipment installed within the aircraft 10 and viewed on a display in the cockpit of the aircraft. This allows for the pilot to maneuver the aircraft 10 to the parking position 160 also without the guidance provided by the display 130 of the arrangement 100. For example, in extreme weather situations, such as heavy smog, the pilot may maneuver the aircraft 10 to the parking position 160 without having to look through the cockpit windows. [0059] The airport stand arrangement 100 is further configured to detect and track the approaching aircraft 10 based on combined output data from said radar-based system 110R, on the one hand, and from the one or more additional systems (in the example: the laser-based system 110L), on the other hand. This functionality allows for increasing the overall sensitivity and accuracy of detection and tracking within the stand area 20. In the example embodiment 100, the laser-based system 110L may provide higher spatial resolution in good weather conditions, whereas the radar system may provide higher sensitivity for specific materials such as composite materials. The airport stand arrangement 100 may therefore in the control unit 120 receive respective output data from the radar-based system 110R and the laser-based system 110L, and analyze said respective output data together. An algorithm may run a pre-processing sub-algorithm to determine corresponding spatial regions of the output data (e.g. pixel-to-pixel matching), analyze each output data within said corresponding regions so as to determine which of the respective output data that contains the most promising data for detecting and tracking in that corresponding region. In case the corresponding region contains data pertaining from the nose of a composite-material bodied aircraft, the output data from the radar-based system may be most promising. In case the corresponding region contains data pertaining from the metallic front body frame of an aircraft, the output data from the laser-based system may be most promising, and so on.

[0060] Figure 2 shows an airport stand arrangement 200 according to another example embodiment. The airport stand arrangement 200 is similar to the airport stand arrangement 100 already described in detail, herein, except from that the one or more additional systems are here selected from imaging systems only. Specifically, the one or more additional systems is here an imaging system 110C. The imaging system 110C comprises a camera sensitive to optical or infrared radiation. The imaging system 110C is used to capture the emission of natural radiation from the target. The imaging system

110C provides output data pertaining to an imaging system coverage 112C at the stand area 20.

[0061] Figure 3 shows an airport stand arrangement 300 according to another example embodiment. The airport stand arrangement 300 is similar to the airport stand arrangement 100 already described in detail, herein, except from that the one or more additional systems comprise laser-based system 110L and image-based system 110C. The airport stand arrangement 300 also differs from the airport stand arrangement 100 in that the imaging system 110C is distanced from the radar-based system 110R and the laser-based system 110L. This allows for the arrangement 300 to, at each position in time, detect the approaching aircraft 10 using different collection angles.

[0062] The airport stand arrangement 300 is further configured to detect and track other objects within the stand area 20. Two other objects are illustrated in Fig. 3, namely a luggage dolly 11, and a food delivery truck 12. As also illustrated in Fig. 3, the luggage dolly 11 is standing still, whereas the food delivery truck 12 is approaching the stand area from the right. This allows for continuously, and automatically, monitoring the stand area 20 for potential objects which may be involved in causing accidents at the stand.

[0063] Typically, the most severe such accidents involve the accidental collision of the approaching aircraft 10 with one or more from said other objects. Thus, it is of interest to detect and track said other objects during the approach of the aircraft 10. The arrangement 300 is thus configured to detect and track the other objects 11,12 within the stand area 20 in parallel with said detection and tracking of the approaching aircraft 10 during the maneuvering of the approaching aircraft 10 towards the parking position 160. This may be achieved in different ways. By way of example, detection and tracking of the aircraft may be based on output data from the laser-based system 110L, whereas the detection and tracking of other objects may be based on output data from the radar-based system 110R. It is however, also conceivable that detection and tracking of the aircraft and of the other objects is based on output data from more than one system of the combined system 310.

[0064] The arrangement 300 is further configured to predict if the approaching aircraft 10 is on a collision course with any of said other objects 11,12, and, in response to a collision course being predicted, to provide further pilot maneuvering guidance information instructing the pilot to stop the aircraft 10. The prediction may be achieved using tools readily available to the skilled person. For example, the evaluation may be performed based on the use of a Kalman filter acting as a time filter to combine measurements (observations) and a model of the dynamics of the detected obstacles. The Kalman filter may be used to combine a set of measurements over time to create the most likely positions or trajectories of the obstacles.

[0065] Figure 5 shows a further functionality of the air-

port stand arrangement 300 of the disclosure. It is of importance for airport overall control to keep track of which gates are available and which are occupied. For this purpose, the airport stand arrangement 300 may use its detection and tracking capability to continuously, or at a request, inform stand personnel and/or airport control of the occupancy status of the stand. Thus, the airport stand arrangement 300 is configured to determine S202 output data pertaining to the stand area 20 using one or more from the additional systems (for example the laser-based system 110L). The airport stand arrangement 300 is then configured to, as a first determination step, determine S204 whether an aircraft is present or not at said parking position based at least on output data from said one or more additional systems (for example the laser-based system 110L). In some situations, for example during good weather conditions, this may be enough. If an aircraft is indeed present within the gate area 20, the aircraft will also be successfully detected by the arrangement 300. However, in some situations, for example during bad weather conditions, characteristics of the aircraft may not be clearly present in the output data of the one or more additional systems. In such a case, the first determination step may result in that the stand is detected to be empty, while it in reality is not - a situation which may result in serious accidents. To mitigate this problem, the airport stand arrangement 300 is further configured to, in response to a negative determination in the first determination step, determine S206 output data pertaining to the stand area 20 using radar-based system 110R, and, as a second determination step, to determine S208 whether an aircraft is present or not at said parking position based on output data from the radar-based system 110R. Thus, in case an aircraft cannot be detected by the one or more additional systems, the radar-based system is used so as to provide a basis for a second opinion in the matter. Finally, the airport stand arrangement 300 is configured to transmit S210 an aircraft-present-signal in response to a positive determination in any of said first and second determination steps, and to transmit S212 an aircraft-not-present-signal in response to a negative determination in both of said first and second determination steps. Thus, in case the first determination step results in a detection of the aircraft in the stand area 20, the second determination step is not needed. It is however conceivable to use both determination steps at all times to further increase the accuracy of determination. For example, combined output data from two or more systems of the combined system may be used, as discussed hereinabove.

[0066] The person skilled in the art realizes that the present invention by no means is limited to the preferred embodiments described above. On the contrary, many modifications and variations are possible within the scope of the appended claims. Additionally, variations to the disclosed embodiments can be understood and effected by the skilled person in practicing the claimed invention, from a study of the drawings, the disclosure, and

the appended claims.

Claims

1. Airport stand arrangement (100,200,300) comprising:
 - a display (130);
 - a radar-based system (110R); and
 - one or more additional systems selected from laser-based systems (110L) and imaging systems (110C),
 - wherein said radar-based system (110R) and said one or more additional systems together form a combined system (110,210,310),
 - wherein the airport stand arrangement (100) is configured, based on output data from said combined system (110), to detect and track (S108,S110) an aircraft (10) within a stand area (20) when said aircraft (10) is approaching a stand within the stand area (20) for parking at a parking position (160) therein, and configured, based on said detection and tracking of the approaching aircraft (10), to provide (S114,S116) pilot maneuvering guidance information on said display (130) for aiding a pilot of the approaching aircraft (10) in maneuvering the aircraft (10) towards said parking position (160).
2. The airport stand arrangement (100) according to claim 1, wherein said one or more additional systems are selected from laser-based systems (110L) only.
3. The airport stand arrangement (200) according to claim 1, wherein said one or more additional systems are selected from imaging systems (110C) only.
4. The airport stand arrangement (300) according to claim 1, wherein said one or more additional systems comprise at least one laser-based system (110L) and at least one image-based system (110C).
5. The airport stand arrangement (100,200,300) according to any one of claims 1 to 4, wherein the airport stand arrangement (110,210,310) is configured to detect and track the approaching aircraft (10) based on combined output data from said radar-based system (110R), on the one hand, and from said one or more additional systems (110L,110C), on the other hand.
6. The airport stand arrangement (300) according to any one of claims 1 to 5, wherein two or more systems of the combined system (310) each are distanced from each other so as to, at each position in time, detect the approaching aircraft (10) using different collection angles.
7. The airport stand arrangement (100,200,300) according to any one of the claims 1 to 6, wherein the airport stand arrangement (100) is further configured to determine a visibility (V) based on output data from one or more of said additional systems (110L,110C), and in response to said visibility (V) being lower than a first visibility threshold (V1), to detect and track the approaching aircraft (10) based on output data from the radar-based system (110R).
8. The airport stand arrangement (100,200,300) according to claim 7, further comprising wireless transmitting means (190), and wherein the airport stand arrangement is configured, in response to said visibility (V) being lower than a second visibility threshold (V2), lower than said first visibility threshold (V1), to wirelessly transmit (S116), using the wireless transmitting means (190), a signal comprising said pilot maneuvering guidance information to the approaching aircraft (10).
9. The airport stand arrangement (100,200,300) according to any one of claims 1 to 8, wherein said airport stand arrangement is further configured:
 - to, as a first determination step, determine (S204) whether an aircraft is present or not at said parking position based at least on output data from said one or more additional systems, and
 - to, in response to a negative determination in said first determination step and as a second determination step, determine (S208) whether an aircraft is present or not at said parking position based on output data from said radar-based system;
 - to transmit (S210) an aircraft-present-signal in response to a positive determination in any of said first and second determination steps; and
 - to transmit (S212) an aircraft-not-present-signal in response to a negative determination in both of said first and second determination steps.
10. The airport stand arrangement (100,200,300) according to any one of claims 1 to 9, wherein said arrangement is further configured to detect and track other objects (11,12) within the stand area (20).
11. The airport stand arrangement (100,200,300) according to claim 10, wherein said arrangement is further configured to detect and track said other objects (11,12) within the stand area (20) in parallel with said detection and tracking of the approaching aircraft (10) during said maneuvering of the approaching aircraft (10) towards the parking position (160).
12. The airport stand arrangement (100,200,300) ac-

according to claim 11, wherein said arrangement is further configured to predict if the approaching aircraft (10) is on a collision course with any of said other objects (11,12), and, in response to a collision course being predicted, to provide further pilot maneuvering guidance information instructing the pilot to stop the aircraft (10).

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13. The airport stand arrangement (100,200,300) according to any one of claims 10 to 12, wherein said detection and tracking of said other objects (11,12) is based on output data from the radar-based system (110R), and wherein said detection and tracking of the approaching aircraft (10) is based on output data from said one or more additional systems (110L,110C).

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14. A method for detecting and tracking an aircraft within a stand area when said aircraft (10) is approaching a stand within the stand area (20) for parking at a parking position (160) therein, wherein said detection and tracking is based on output data from a radar-based system (110R) and output data from one or more additional systems selected from laser-based systems (110L) and imaging systems (110C), the method comprising:

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determining a visibility (V) based on output data from one or more of said one or more additional systems,

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in response to said visibility (V) being lower than a first visibility threshold (V1):

detecting and tracking the approaching aircraft (10) based on output data from said radar-based system (110R).

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15. A computer-readable medium comprising computer code instructions which when executed by a device having processing capability are adapted to perform the method according to claim 14.

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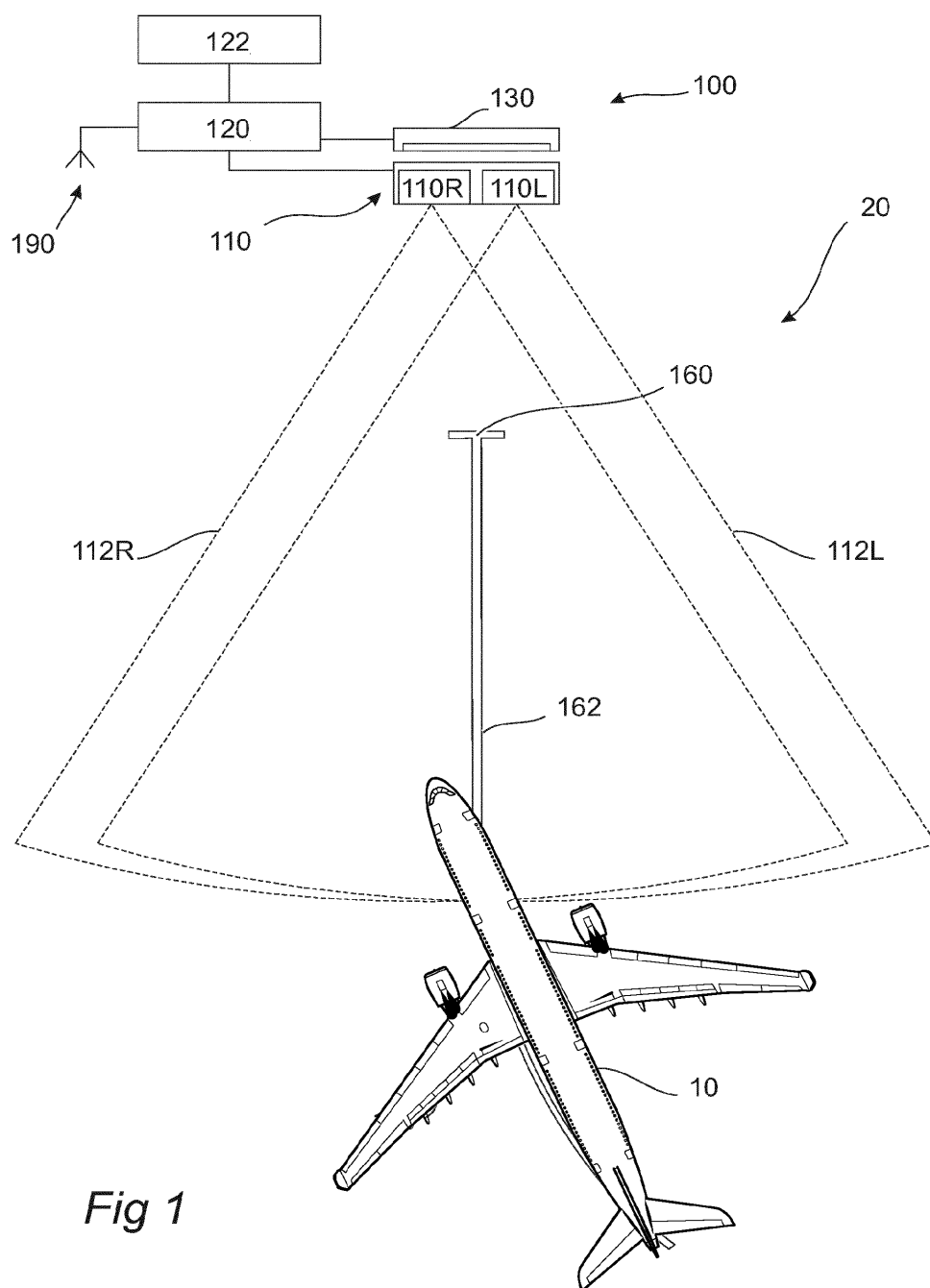
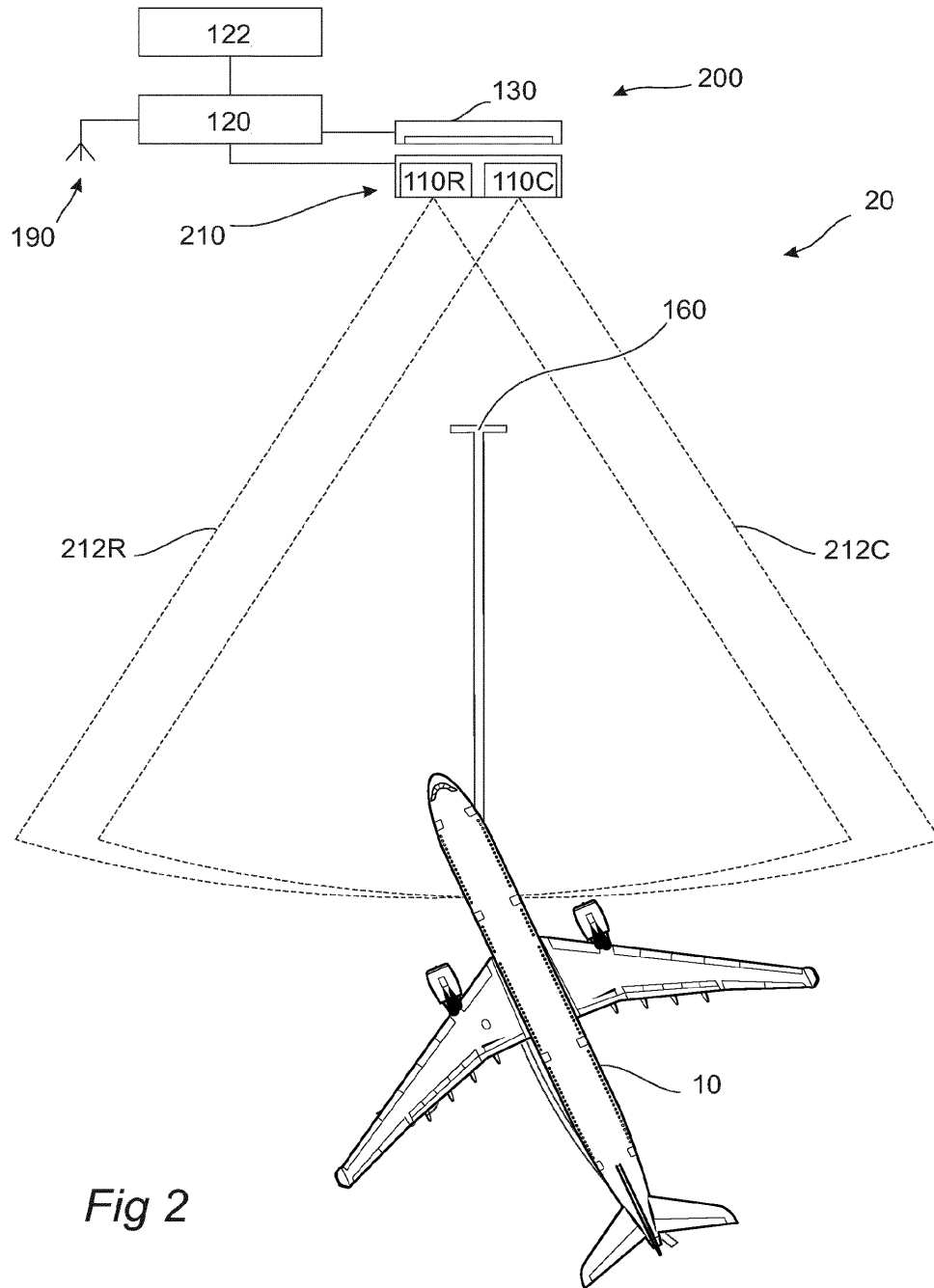
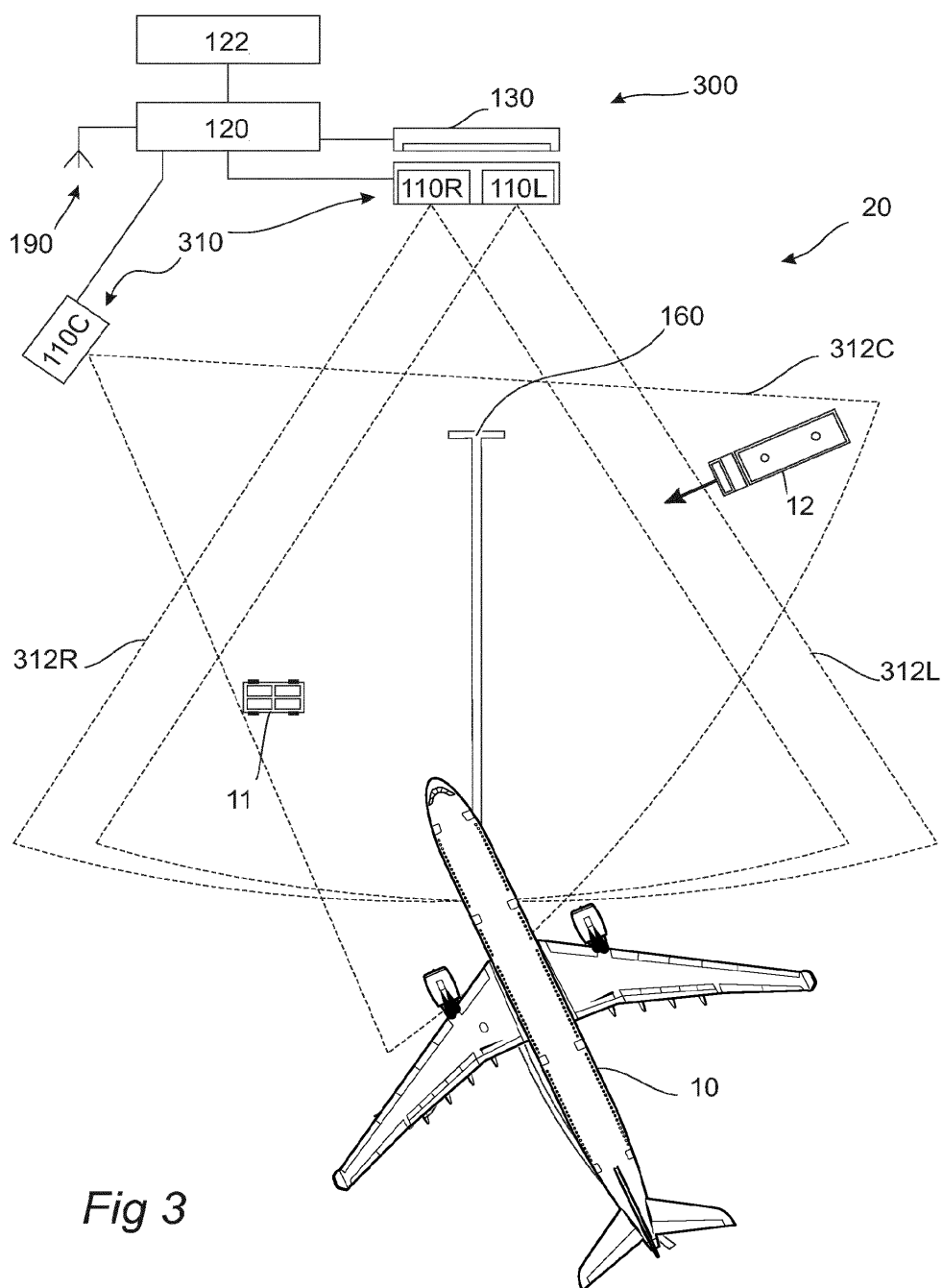
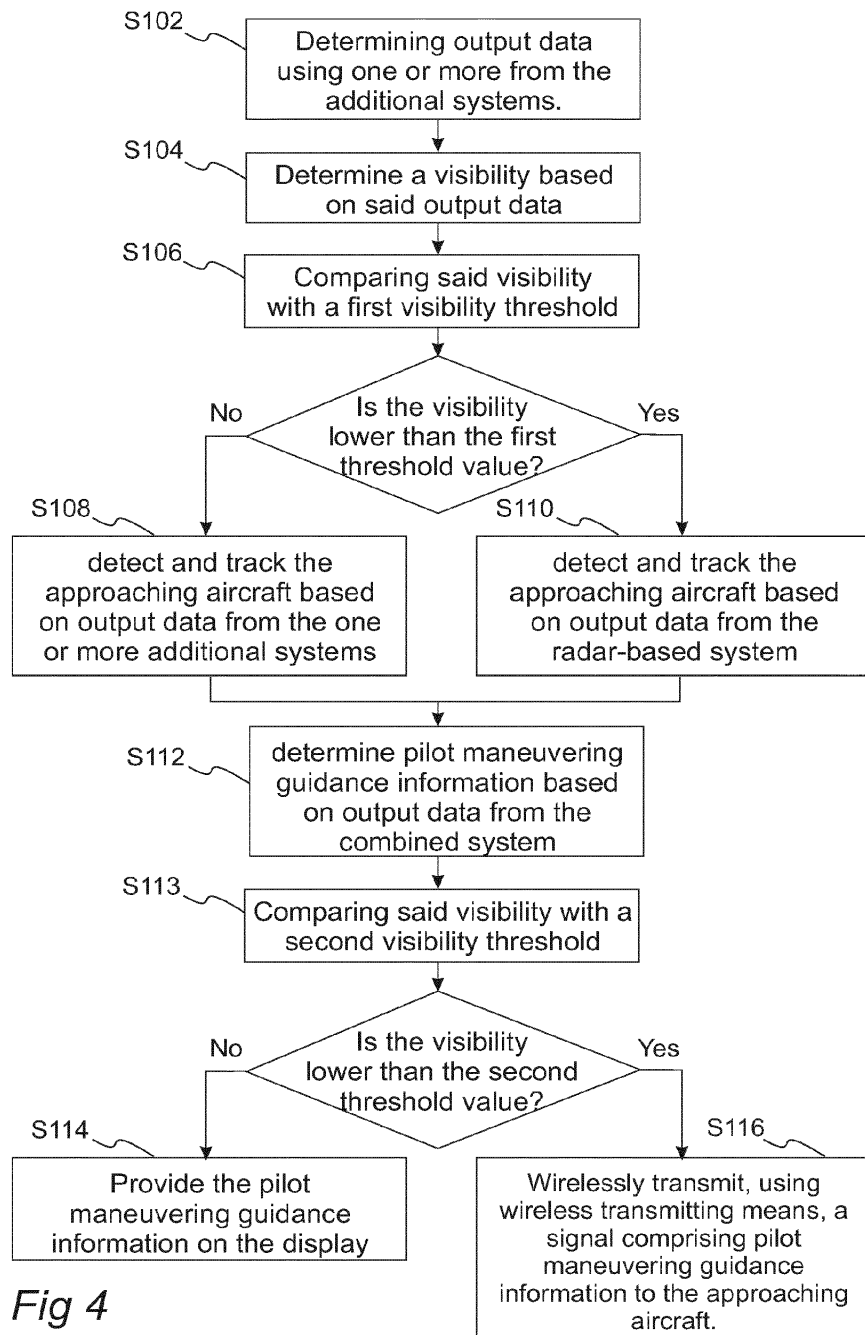
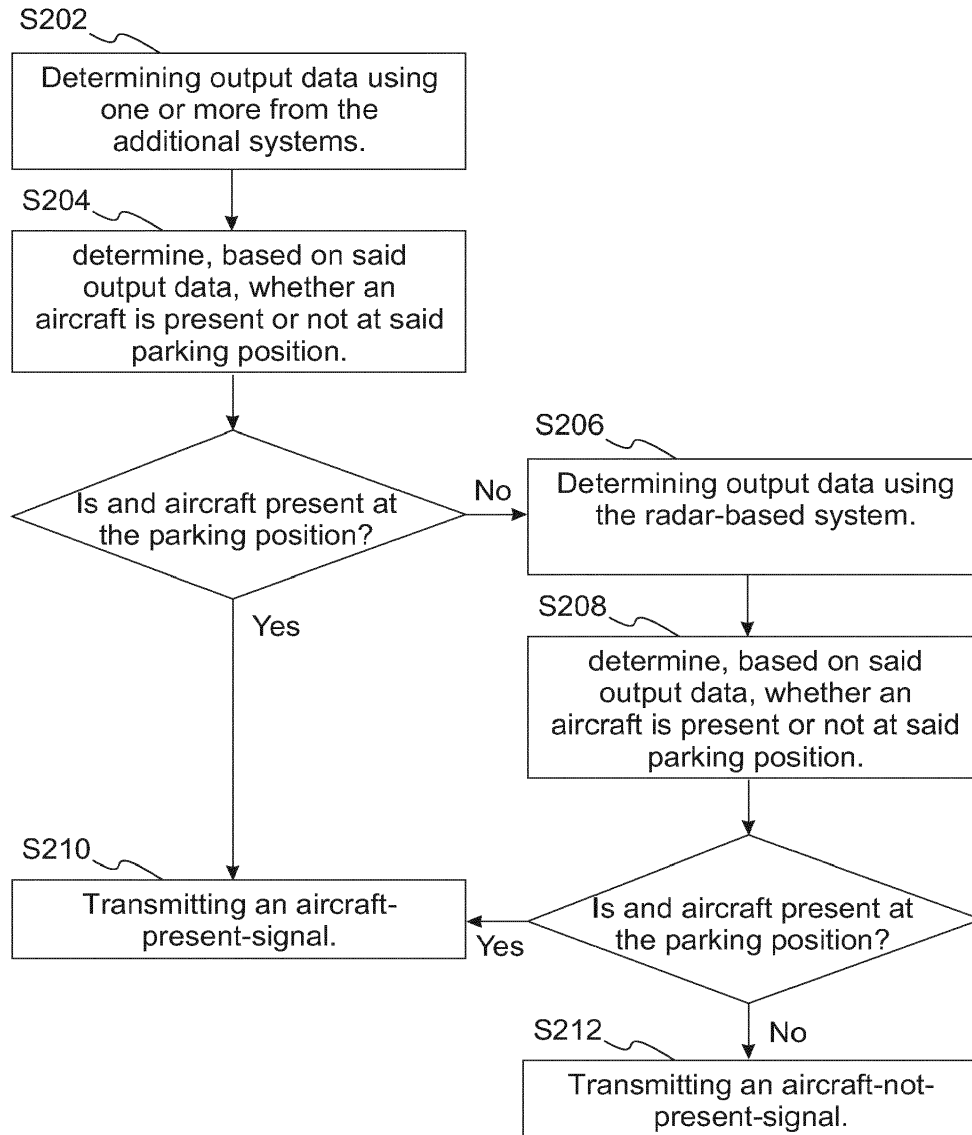


Fig 1





*Fig 4*

*Fig 5*



EUROPEAN SEARCH REPORT

Application Number
EP 19 15 1380

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Place of search Munich		Date of completion of the search 12 June 2019	Examiner Rudolf, Hans
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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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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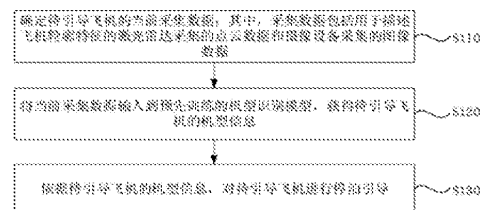
权利要求书2页 说明书11页 附图5页

(54)发明名称

飞机泊位引导方法、装置及设备

(57)摘要

本发明实施例公开了一种飞机泊位引导方法、装置、设备及存储介质。所述方法包括：确定待引导飞机的当前采集数据；其中，所述采集数据包括用于描述飞机轮廓特征的激光雷达采集的点云数据和摄像设备采集的图像数据；将所述当前采集数据输入到预先训练的机型识别模型，获得所述待引导飞机的机型信息；依据所述机型信息，对所述待引导飞机进行停泊引导。采用本申请方案，可采用两个维度的融合数据来实现对飞机机型的融合识别检测，能够提高机型识别检测的可靠性和精确度，而且机型识别模型对大量数据进行训练得到，使得机型识别检测的稳定性比较高。同时，本申请方案可根据机型为待引导飞机匹配合适的泊位引导方式，使得飞机停泊更安全和更有效。



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1. 一种飞机泊位引导方法,其特征在于,包括:

确定待引导飞机的当前采集数据;其中,所述采集数据包括用于描述飞机轮廓特征的激光雷达采集的点云数据和摄像设备采集的图像数据;

将所述当前采集数据输入到预先训练的机型识别模型,获得所述待引导飞机的机型信息;

依据所述机型信息,对所述待引导飞机进行停泊引导。

2. 根据权利要求1所述的方法,其特征在于,确定待引导飞机的当前采集数据,包括:

实时获取所述激光雷达采集到的点云数据;

根据实时采集到的点云数据确定所述待引导飞机的位置信息,并根据所述待引导飞机的位置信息,通过所述摄像设备进行图像数据采集。

3. 根据权利要求2所述的方法,其特征在于,所述激光雷达传感器的扫描视场与所述图像传感器的拍摄视场至少存在部分交叠区域。

4. 根据权利要求1所述的方法,其特征在于,所述机型识别模型的构建操作,包括:

将已获取的各飞机的飞机数据作为训练样本,并对所述训练样本进行样本标注,以添加样本标签;其中,所述飞机数据包括激光雷达采集的点云数据和摄像设备采集的图像数据,所述样本标签用于表示所述训练样本的机型信息;

对样本标注后的所述训练样本进行神经网络模型训练,得到所述机型识别模型。

5. 根据权利要求1所述的方法,其特征在于,依据所述机型信息,对所述待引导飞机进行停泊引导,包括:

依据所述机型信息,确定所述待引导飞机的飞机尺寸信息和泊位引导信息;所述泊位引导信息包括停泊引导线和停泊位置;

依据所述飞机尺寸信息和泊位引导信息,引导所述待引导飞机向泊位区域行进,以在所述停泊位置处停泊。

6. 根据权利要求5所述的方法,其特征在于,在依据所述机型信息,对所述待引导飞机进行停泊引导时,还包括:

根据实时获取的点云数据确定所述待引导飞机的行进位置信息和剩余行进距离信息,用于对停泊引导进行校正;

其中,所述行进位置信息包括所述待引导飞机相对所述停泊引导线的偏离角度和偏离距离;所述剩余行进距离信息包括所述待引导飞机的行进位置相对停泊位置的距离。

7. 根据权利要求1所述的方法,其特征在于,在依据所述机型信息,对所述待引导飞机进行停泊引导时,还包括:

根据所述激光雷达采集的点云数据,确定所述待引导飞机的实时位置信息;

根据所述位置信息和所述机型信息确定动态防护区域的范围;其中,所述动态防护区域的位置随所述待引导飞机的位置动态移动;

根据实时获取的点云数据,确定是否有障碍物进入到所述动态防护区内,并在障碍物进入所述动态防护区时进行告警。

8. 根据权利要求1所述的方法,其特征在于,所述方法还包括:

显示所述待引导飞机的行进信息以及所述机型信息;所述行进信息包括行进轨迹、行进方向和行进位置中的至少一种信息。

9. 一种飞机泊位引导装置,其特征在于,包括:

数据确定模块,用于确定待引导飞机的当前采集数据;其中,所述采集数据包括用于描述飞机轮廓特征的激光雷达采集的点云数据和摄像设备采集的图像数据;

机型识别模块,用于将所述当前采集数据输入到预先训练的机型识别模型,获得所述待引导飞机的机型信息;

停泊引导模块,用于依据所述机型信息,对所述待引导飞机进行停泊引导。

10. 一种飞机泊位引导设备,其特征在于,包括:

至少一个激光雷达;用于采集扫描区域内的点云数据;

至少一个摄像传感器,用于获取目标区域内的图像数据;以及

控制设备,所述控制设备包括存储装置和一个或多个处理器;

存储装置,用于存储一个或多个程序;

当所述一个或多个程序被所述一个或多个处理器执行,使得所述一个或多个处理器实现权利要求1-8中任一所述的飞机泊位引导方法。

飞机泊位引导方法、装置及设备

技术领域

[0001] 本发明实施例涉及飞机自动泊位技术领域,尤其涉及一种飞机泊位引导方法、装置及设备。

背景技术

[0002] 目前,大多数机场事故发生在登机口和停机坪区域,因此需要准确地将飞机引导到安全的停止位置进行停泊。

[0003] 目前,可通过在停机坪区域以及附近区域预先埋设感应线圈来感知飞机的位置,进而实现自动引导飞机停泊。但是,上述方案的可靠性不高和测量精度比较低,且无法为飞机匹配合适的引导方式。因此,需要解决无法在停机坪区域对飞机进行准确引导的问题。

发明内容

[0004] 本发明实施例中提供一种飞机泊位引导方法、装置、设备及存储介质,以实现在各种天气条件下自动对飞机进行准确地泊位引导。

[0005] 第一方面,本发明实施例中提供了一种飞机泊位引导方法,包括:

[0006] 确定待引导飞机的当前采集数据;其中,所述采集数据包括用于描述飞机轮廓特征的激光雷达采集的点云数据和摄像设备采集的图像数据;

[0007] 将所述当前采集数据输入到预先训练的机型识别模型,获得所述待引导飞机的机型信息;

[0008] 依据所述机型信息,对所述待引导飞机进行停泊引导。

[0009] 第二方面,本发明实施例中还提供了一种飞机泊位引导装置,包括:

[0010] 数据确定模块,用于确定待引导飞机的当前采集数据;其中,所述采集数据包括用于描述飞机轮廓特征的激光雷达采集的点云数据和摄像设备采集的图像数据;

[0011] 机型识别模块,用于将所述当前采集数据输入到预先训练的机型识别模型,获得所述待引导飞机的机型信息;

[0012] 停泊引导模块,用于依据所述机型信息,对所述待引导飞机进行停泊引导。

[0013] 第三方面,本发明实施例中还提供了一种飞机泊位引导设备,包括:

[0014] 至少一个激光雷达;用于采集扫描区域内的点云数据;

[0015] 至少一个摄像传感器,用于获取目标区域内的图像数据;以及

[0016] 控制设备,所述控制设备包括存储装置和一个或多个处理器;

[0017] 存储装置,用于存储一个或多个程序;

[0018] 当所述一个或多个程序被所述一个或多个处理器执行,使得所述一个或多个处理器实现如本发明任意实施例中提供的飞机泊位引导方法。

[0019] 第四方面,本发明实施例中还提供了一种计算机可读存储介质,其上存储有计算机程序,该程序被处理器执行时实现如本发明任意实施例中提供的飞机泊位引导方法。

[0020] 本发明实施例中提供了一种飞机泊位引导方法,可确定待引导飞机的当前采集数

据,当前采集数据中可包括用于描述飞机轮廓特征的激光雷达采集的点云数据和摄像设备采集的图像数据的融合,进而可将采集的点云数据和图像数据的融合作为输入,通过预先训练的机型识别模型识别待引导飞机的机型,以便根据待引导飞机的机型来进行飞机停泊引导。采用本申请方案,可采用两个维度的融合数据来实现对飞机机型的融合识别检测,能够提高机型识别检测的可靠性和精确度,而且机型识别模型对大量数据进行训练得到,使得机型识别检测的稳定性比较高。同时,本申请方案可根据机型为待引导飞机匹配合适的泊位引导方式,使得飞机停泊更安全和更有效。

[0021] 上述发明内容仅是本发明技术方案的概述,为了能够更清楚了解本发明的技术手段,而可依照说明书的内容予以实施,并且为了让本发明的上述和其它目的、特征和优点能够更明显易懂,以下特举本发明的具体实施方式。

附图说明

[0022] 通过阅读参照以下附图所作的对非限制性实施例所作的详细描述,本发明的其它特征、目的和优点将会变得更明显。附图仅用于示出优选实施方式的目的,而并不认为是对本发明的限制。而且在整个附图中,用相同的参考符号表示相同的部件。在附图中:

[0023] 图1是本发明实施例中提供的一种飞机泊位引导方法的流程图;

[0024] 图2是本发明实施例中提供的一种飞机泊位引导设备的结构示意图;

[0025] 图3是本发明实施例中提供的另一种飞机泊位引导方法的流程图;

[0026] 图4是本发明实施例中提供的一种飞机停泊引导的显示示意图;

[0027] 图5是本发明实施例中提供的另一种飞机停泊引导的显示示意图;

[0028] 图6是本发明实施例中提供的又一种飞机停泊引导的显示示意图;

[0029] 图7是本发明实施例中提供的又一种飞机停泊引导的显示示意图;

[0030] 图8是本发明实施例中提供的又一种飞机停泊引导的显示示意图;

[0031] 图9是本发明实施例中提供的一种飞机泊位引导装置的结构框图;

[0032] 图10是本发明实施例中提供的一种飞机泊位引导设备的结构示意图。

具体实施方式

[0033] 下面结合附图和实施例对本发明作进一步的详细说明。可以理解的是,此处所描述的具体实施例仅仅用于解释本发明,而非对本发明的限定。另外还需要说明的是,为了便于描述,附图中仅示出了与本发明相关的部分而非全部结构。

[0034] 在更加详细地讨论示例性实施例之前应当提到的是,一些示例性实施例被描述成作为流程图描绘的处理或方法。虽然流程图将各项操作(或步骤)描述成顺序的处理,但是其中的许多操作可以被并行地、并发地或者同时实施。此外,各项操作的顺序可以被重新安排。当其操作完成时所述处理可以被终止,但是还可以具有未包括在附图中的附加步骤。所述处理可以对应于方法、函数、规程、子例程、子程序等等。

[0035] 图1是本发明实施例中提供的一种飞机泊位引导方法的流程图,该方法可适用于对飞机自动停泊引导的情况,该方法可由飞机泊位引导装置来执行,该装置可由软件和/或硬件实现,并集成在任何具有网络通信功能的飞机泊位引导设备上。如图1所示,本申请实施例中的飞机泊位引导方法,可包括以下步骤:

[0036] S110、确定待引导飞机的当前采集数据；其中，采集数据包括用于描述飞机轮廓特征的激光雷达采集的点云数据和摄像设备采集的图像数据。

[0037] 在本实施例中，图2是本发明实施例中提供一种飞机泊位引导设备的结构示意图。参见图2，本申请实施例中的飞机引导设备可包括：激光雷达传感器（当然，也可以直接称之为激光雷达）、图像传感器、数据处理器（图2中未示出）和显示器。通过激光雷达传感器可扫描采集并获取用于描述飞机外表面的轮廓特征的第一类采集数据，这里记为激光雷达采集的点云数据；通过图像传感器也可采集得到用于描述飞机外表面的轮廓特征的第二类采集数据，这里记为图像数据。

[0038] 在本实施例中，在一些特定条件下，尤其是在停机坪区域进行飞机停泊需要处于各种天气条件时，采用单一类型的数据进行飞机机型识别，在一定程度上会限制机型识别的精确度和可靠度。为此，本申请方案，在进行飞机机型识别时，融合了激光雷达传感器采集的激光雷达点云数据和图像传感器采集的图像数据作为机型识别的依据条件。采用上述方式能够融合了激光雷达和图像传感器来共同进行数据采集，这样可使得获得的数据优势互补，从而在依据融合的数据进行飞机机型识别时能够提高识别可靠度和准确度，并且即使激光雷达点云数据或图像数据出现些许偏差，两种类型的采集数据也可互补修正，一定程度上能够保证机型识别的稳定性。

[0039] 在本实施例中，可选地，激光雷达传感器可为多线激光雷达；图像传感器可为摄像头，可采集摄像画面数据。在一个可选示例中，可预先对激光雷达的采集参数和图像传感器的采集参数进行校准，以保证激光雷达传感器采集的激光雷达点云数据和图像传感器采集的图像数据进行有效地融合。

[0040] 在本实施例的一种可选方式中，确定待引导飞机的当前采集数据，可包括以下步骤A1-A2：

[0041] 步骤A1、实时获取用于描述飞机轮廓特征的激光雷达采集到的点云数据。

[0042] 在本实施方式中，飞机进行停泊的过程需要经历多个阶段，每一个阶段可对应执行各自的操作。飞机泊位引导设备可通过激光雷达对扫描区域进行数据采集，可得到采集的激光雷达点云数据，进而通过识别可得到待引导飞机的点云数据。待引导飞机的点云数据可包括每个点的三维坐标和反射强度信息，进而通过上述信息可计算每个点的距离和姿态信息。

[0043] 步骤A2、根据实时采集到的点云数据确定待引导飞机的位置信息，并根据待引导飞机的位置信息，通过摄像设备进行图像数据采集。

[0044] 在本实施方式中，激光雷达可在预设的扫描能力范围内进行扫描，根据激光雷达采集到的点云数据判断是否有待引导飞机，并在探测到待引导飞机后对待引导飞机进行跟踪。这样，就可确定待引导飞机的实时位置信息，控制摄像设备进行图像数据采集，以准确得到包含待引导飞机图像的图像数据。

[0045] 在一个可选示例中，可根据实时采集到的点云数据确定待引导飞机的位置信息，根据待引导飞机的位置信息联动图像传感器进行图像数据获取，以准确采集到能描述飞机轮廓特征的图像数据。具体地，摄像设备联动是指根据激光雷达探测到的待引导飞机的位置，然后调整摄像设备的摄像角度，来实现对待引导飞机的实时图像的获取。

[0046] 在另一可选示例中，可根据实时采集到的点云数据确定待引导飞机的位置信息，

并在检测到待引导飞机进入到图像采集区域时,触发摄像设备进行图像数据采集,以准确采集到能描述飞机轮廓特征的图像数据。具体地,可根据激光雷达采集到的点云数据对待引导飞机进行实时跟踪,并实时检测待引导飞机是否进入图像采集区域;当检测到待引导飞机进入图像采集区域,对待引导飞机进行图像数据采集,通常图像采集区域为摄像设备能够获取到的足够清晰的图像的距离范围,这样可避免重复的进行图像数据采集浪费数据采集资源,也可以确保采集到的图像具有足够的清晰度,进行精准判断。

[0047] 在本实施方式中,可预先采用标定算法对激光雷达与图像传感器进行联合标定,使得融合后激光雷达与图像传感器扫描探测到的待引导飞机统一到同一个坐标系下,这样可便于采集到的点云数据与图像数据能更好地统一到一个坐标系下。在一个可选示例中,除了通过标定算法对激光雷达与图像传感器进行联合标定,还可对激光雷达的扫描视场与图像传感器的拍摄视场的相对位置进行设定,使得激光雷达传感器的扫描视场与图像传感器的拍摄视场至少存在部分交叠区域。

[0048] 示例性地,参见图2,可通过设置将激光雷达传感器与图像传感器上下平齐,且设置激光雷达传感器的扫描视场与图像传感器的拍摄视场的视野方向保持一致。可选地,具体可将激光雷达传感器与图像传感器上下平齐方式按固定位置设置,且设置激光雷达传感器与图像传感器的视野均朝向正前方的待引导飞机。采用上述方式可使得激光雷达传感器与图像传感器采集的目标是相同的。

[0049] 在本实施方式中,此外,激光雷达传感器与图像传感器可进行同步采集数据,即在通过激光雷达传感器采集数据时,可通过图像传感器对待引导飞机所处的数据采集区域的环境进行拍摄,进而可提取得到数据采集区域中待引导飞机的图像数据,这样得到激光雷达点云数据与图像数据能有效地融合使用。

[0050] 采用上述方式,能将激光雷达点云数据和图像数据进行融合使用,这样一来针对飞机机型识别操作可拥有更可靠的识别依据,大幅度提高后续机型识别的可靠度和准确度,由于激光雷达点云数据和图像数据可融合互补,可通过两种数据的融合互补减弱因为任一类型数据出现些许异常带来的识别误差。

[0051] S120、将当前采集数据输入到预先训练的机型识别模型,获得待引导飞机的机型信息。

[0052] 在本实施例中,机型识别模型可用于检测识别出待引导飞机的机型,当电子设备确定待引导飞机的激光雷达点云数据和图像数据后,可将上述激光雷达点云数据和图像数据的融合信息作为机型识别模型的输入参数,进而通过机型识别模型进行融合识别得到待引导飞机的机型信息。采用融合识别的方式进行机型识别不仅可提高机型识别的稳定性,而且可提高机型识别的准确度和可靠度。

[0053] 在本实施例的一种可选方式中,本申请实施例中的机型识别模型的构建操作可包括以下步骤B1-B2:

[0054] 步骤B1、将已获取的各飞机的飞机数据作为训练样本,并对训练样本进行样本标注,以添加样本标签;其中,飞机数据包括激光雷达采集的点云数据和摄像设备采集的图像数据,样本标签用于表示训练样本对应的机型。

[0055] 在本实施方式中,针对不同的机场应用场景,例如,可针对机场内各个飞机所处的不同天气条件,可采用激光雷达传感器和图像传感器,同步采集机场内各类型飞机的激光

雷达点云数据和图像数据。进而,可将上述获取的机场内各类型飞机的激光雷达点云数据和图像数据作为训练样本。此外,还需对包括激光雷达点云数据和图像数据的训练样本进行样本标注,用于对训练样本添加样本标签。通过样本标签可用于表示训练样本所属飞机的机型信息。

[0056] 步骤B2、对样本标注后的训练样本进行神经网络模型训练,得到机型识别模型。

[0057] 在本实施方式中,机型识别模型属于机型深度网络学习模型。在确定训练样本和训练样本的样本标签后,可使用添加样本标签的训练样本对不断地训练神经网络模型,即可得到本实施例的机型识别模型。通过机型识别模型可根据采集到的激光雷达点云数据和图像数据学习出扫描到的待引导飞机的机型。

[0058] 采用上述方式,由于机器识别模型通过对不同机场应用场景下的数据进行训练得到的模型,使得机型识别模型的环境适应性更高,从而保证机型识别模型的识别稳定性,能适应性的在多种天气条件进行机型识别检测,保证在各种天气下均可保持准确的识别操作,降低在复杂天气环境下错误识别机型的风险。

[0059] S130、依据待引导飞机的机型信息,对待引导飞机进行停泊引导。

[0060] 在本实施例中,不同机型的飞机具有不同的飞机停泊引导策略,在确定待引导飞机的机型后,可为待引导飞机选择合适的飞机停泊引导策略,使得电子设备可依据合适的飞机停泊引导策略来对待引导飞机进行安全地停泊引导。

[0061] 本发明实施例中提供了一种飞机泊位引导方法,采用本申请方案,可采用两个维度的融合数据来实现对飞机机型的融合识别检测,能够提高机型识别检测的可靠性和精确度,而且机型识别模型对大量数据进行训练得到,使得机型识别检测的稳定性比较高。同时,本申请方案可根据机型为待引导飞机匹配合适的泊位引导方式,使得飞机停泊更安全更有效,不仅能实现更有效安全地规划引导和降低运营成本,并且在各种天气条件下保持运作,保证飞机停泊引导的稳定性和安全性。

[0062] 在上述实施例的基础上,可选地,在依据待引导飞机的机型信息,对待引导飞机进行停泊引导时,还可包括以下步骤C1-C3:

[0063] 步骤C1、根据激光雷达采集的点云数据,确定待引导飞机的实时位置信息。

[0064] 步骤C2、根据待引导飞机的实时位置信息和机型信息确定动态防护区域的范围;其中,动态防护区域的位置随待引导飞机的位置动态移动。

[0065] 在本实施方式中,在确定待引导飞机的实时位置信息后,可依据确定的机型信息确定出飞机尺寸信息,因此能够以待引导飞机为中心设置一个动态防护区域。动态防护区域的大小至少应该能够确保待引导飞机在停泊过程中具有安全运行区域,以保证待引导飞机能够在安全运行区域中安全运行。由于动态防护区域是以待引导飞机的中心也即其位置来配置的,因此待引导飞机的动态防护区域可跟随待引导飞机的移动而随之移动。

[0066] 步骤C3、根据实时获取的点云数据,确定是否有障碍物进入到动态防护区内,并在障碍物进入动态防护区时进行告警。

[0067] 在本实施例中,在待引导飞机进行自动泊位的过程中,会对实时采集到的点云数据进行监测,根据点云数据确定飞机位置后即可配置相应的动态防护区域,从而对该动态防护区域内的点云进行障碍物识别,在识别到动态防护区域内存在障碍物时,则确定有障碍物进入到动态防护区内。在他的实施例中,也可以先对点云数据进行障碍物识别,然后判

断障碍物的位置是否处于动态防护区内。当待引导飞机在行进过程中确定有障碍物进入该动态防护区后,电子设备可输出告警信息,指示待引导飞机减缓行进速度或者暂停行进,如此可进一步提高飞机自动停泊的安全性。

[0068] 在本实施方式中,可选地,在待引导飞机的停泊过程中,可联动图像传感器对待引导飞机的行进场景进行视频跟拍,并对跟拍视频数据进行存储,以备进行数据调用。摄像头进行飞机运行场景视频跟拍存储,以备调用。在一个可选示例中,可联动图像传感器对待引导飞机的动态防护区所在场景进行联动视频跟拍,以及实时显示和存储待引导飞机的障碍探测所属的3D点云信息和图像信息,以备查验。可选地,图像传感器的联动是指根据激光雷达探测到的待引导飞机的位置,然后调整图像传感器的拍摄角度来实现对待引导飞机的实时图像的获取。

[0069] 图3是本发明实施例中提供的另一种飞机泊位引导方法的流程图,本发明实施例在上述实施例的基础上对前述实施例进行进一步优化,本发明实施例可以与上述一个或者多个实施例中各个可选方案结合。如图3所示,本申请实施例中的飞机泊位引导方法,可包括以下步骤:

[0070] S310、确定待引导飞机的当前采集数据;其中,采集数据包括用于描述飞机轮廓特征的激光雷达采集的点云数据和摄像设备采集的图像数据。

[0071] S320、将当前采集数据输入到预先训练的机型识别模型,获得待引导飞机的机型信息。

[0072] S330、依据待引导飞机的机型信息,确定待引导飞机的飞机尺寸信息和泊位引导信息;其中,泊位引导信息包括停泊引导线和停泊位置。

[0073] 在本实施例中,飞机尺寸信息可包括待引导飞机的飞机长度、飞机宽度和飞机高度等信息。可选地,电子设备可预先确定不同机型的飞机的长度、宽度和高度等信息,并对机型与飞机尺寸信息进行关联存储。泊位引导信息包括停泊引导线和停泊位置。可选地,停泊引导线是飞机停泊的行进轨迹指示线,通过停泊引导线可指示飞机在停泊过程中的行进路径。停泊位置是指在停机坪区域中用于停泊飞机的位置。

[0074] S340、依据飞机尺寸信息和泊位引导信息,引导该待引导飞机向泊位区域行进,用以在停泊位置处停泊。

[0075] 在本实施例中,依据飞机尺寸信息可为待引导飞机设置用于安全行进的动态防护区,避免侵入障碍物对待引导飞机的行进造成影响。同时,可依据泊位引导信息中的停泊引导线指示的行进轨迹,引导该待引导飞机向停机坪区域的泊位区域行进,尤其是引导该待引导飞机向停机坪区域的泊位区域的停泊位置处行进,以使的待引导飞机停泊在规定的停泊位置处。可选地,不同机型或不同尺寸的飞机在停机坪区域可具有不同的停泊位置。采用上述方式,可按照与飞机匹配的停泊引导线来引导飞机进行停泊,降低了飞机停泊错误的风险和增强了飞机停泊的安全性,保证飞机停泊更有规划。

[0076] 在上述实施例的基础上,在引导该待引导飞机向泊位区域行进时,本申请实施例中的飞机泊位引导方法,还可包括以下步骤:

[0077] 通过激光雷达传感器,确定待引导飞机的行进位置信息和剩余行进距离信息,用于对停泊引导进行校正。

[0078] 在本实施例中,可通过激光雷达实时测量待引导飞机的行进位置和剩余行进距

离,这样就可以通过行进位置信息和剩余行进距离信息对待引导飞机的行进操作进行调整。可选地,行进位置信息可包括待引导飞机相对停泊引导线的偏离角度和偏离距离;剩余行进距离信息可包括待引导飞机的行进位置相对停泊位置的距离。

[0079] 在上述实施例的基础上,本申请实施例中的飞机泊位引导方法,还可包括以下步骤:实时显示待引导飞机的行进信息以及机型信息;其中,行进信息包括行进轨迹、行进方向和行进位置中的至少一项。

[0080] 在本实施例中,在对待引导飞机进行停泊引导的过程中,可将待引导飞机的行进信息以及机型信息,在飞机自动泊位引导设备的停泊引导显示器上进行实时显示和更新。图4是本发明实施例中提供的一种飞机停泊引导的显示示意图。参见图4,在确定待引导飞机的机型但未开始引导的过程中,在显示器屏幕的上方可显示出待引导飞机的机型信息,而在显示器屏幕的下方可显示出不断向上移动的箭头,用于指示待引导飞机的停泊引导方向。并且,通过这个移动的箭头,可告知飞行员开始操纵飞机执行停泊引导的滑入操作。

[0081] 在本实施例中,图5是本发明实施例中提供的另一种飞机停泊引导的显示示意图。参见图5,当针对待引导飞机开始进行停泊引导时,可显示器屏幕上显示“T”字形的标志。图6是本发明实施例中提供的又一种飞机停泊引导的显示示意图。参见图6,当电子设备检测到待引导飞机的滑行速度过快时,可在显示器屏幕上显示“SLOW”字样,并提醒飞行员降低滑行速度,防止飞机冲出停机位。

[0082] 在本实施例中,图7是本发明实施例中提供的又一种飞机停泊引导的显示示意图。参见图7,如果检测到待引导飞机偏离了停泊引导线,可在显示屏幕的“T”字标志的左下方或者右下方显示出一个向上的小箭头,提示待引导飞机当前的位置偏离到停泊引导线的中心线的左侧或者右侧。同时,还可在显示屏幕的上方显示一个不断闪耀的光标,光标的方向用于指示待引导飞机需要调整的方向指,例如向右侧或者左侧,提醒飞行员需要向右或者向左调整方位。

[0083] 在本实施例中,图8是本发明实施例中提供的又一种飞机停泊引导的显示示意图。参见图8,当待引导飞机进入距离停泊位置的第一距离之内后,例如距离30米以内后,可在显示屏幕上显示剩余行进距离信息,每接近一米,表征距离的数字会以米为单位不断更新,如30.0m,7.0m等。当待引导飞机进入距离停泊位置的第二距离之内后,例如,距离2米以内后,每接近0.2米,显示屏幕上表征距离的数字会以0.2米单位更新。继续参见图8,当待引导飞机进入距离停泊位置的第三距离之内后,例如,距离16米之内后,在显示屏幕上的“T”字标志的竖线长度也开始随剩余行进距离不变变小而缩短,这个显示不但可形象地表现出待引导飞机距离停泊位置的距离长短,而且还可以看到距离的缩短率,帮助飞行员更好地控制待引导飞机的滑行速度。例如,显示屏幕上的“T”字标志的竖线长度的变化率为每接近0.5米长度会减少一格。

[0084] 在本实施例中,当待引导飞机进入泊位区域的停泊位置后,显示屏幕上开始显示“STOP”字样,同时屏幕中间两侧会方块可进行颜色更改。当待引导飞机正确地停在泊位区域的停泊位置时,显示屏幕上将会显示出“OK”字样,并持续数秒钟;否则,显示屏幕上会显示“TOO FAR”,并通知飞行员对停泊引导的停止位置进行修正。当地面机务人员把起落架放下锁定插销插好,并触发飞机自动泊位引导设备的“CHOCK ON”开关以后,显示屏幕上会同时显示“CHONCK ON”字样,并通知飞行员停泊引导的操作完毕。

[0085] 本发明实施例中提供了一种飞机泊位引导方法,采用本申请方案,可采用两个维度的融合数据来实现对飞机机型的融合识别检测,能够提高机型识别检测的可靠性和精确度,而且机型识别模型对大量数据进行训练得到,使得机型识别检测的稳定性比较高。同时,本申请方案可根据机型为待引导飞机匹配合适的泊位引导方式,使得飞机停泊更安全 and 更有效。

[0086] 图9是本发明实施例中提供的一种飞机泊位引导装置的结构框图,该装置可适用于对飞机进行自动停泊引导的情况,该装置可由软件和/或硬件实现,并集成在任何具有网络通信功能的电子设备上。其中,该电子设备可为飞机自动泊位引导设备等。如图9所示,本申请实施例中的飞机泊位引导装置,具体可包括以下:数据确定模块910、机型识别模块920和停泊引导模块930。其中:

[0087] 数据确定模块910,用于确定待引导飞机的当前采集数据;其中,所述采集数据包括用于描述飞机轮廓特征的激光雷达采集的点云数据和摄像设备采集的图像数据;

[0088] 机型识别模块920,用于将所述当前采集数据输入到预先训练的机型识别模型,获得所述待引导飞机的机型信息;

[0089] 停泊引导模块930,用于依据所述机型信息,对所述待引导飞机进行停泊引导。

[0090] 在上述实施例的基础上,可选地,数据确定模块910包括:

[0091] 点云数据获取单元,用于实时获取所述激光雷达采集到的点云数据;

[0092] 图像数据采集单元,用于根据实时采集到的点云数据确定所述待引导飞机的位置信息,并根据所述待引导飞机的位置信息,通过所述摄像设备进行图像数据采集。

[0093] 在上述实施例的基础上,可选地,图像数据采集单元,包括:

[0094] 根据所述待引导飞机的位置信息,联动所述图像传感器进行图像数据的获取;或者根据所述待引导飞机的位置信息,在检测到所述待引导飞机进入到图像采集区域时,触发所述摄像设备进行图像数据采集。

[0095] 在上述实施例的基础上,可选地,所述激光雷达传感器的扫描视场与所述图像传感器的拍摄视场至少存在部分交叠区域。

[0096] 在上述实施例的基础上,可选地,所述机型识别模型的构建操作包括:

[0097] 将已获取的各飞机的飞机数据作为训练样本,并对所述训练样本进行样本标注,以添加样本标签;其中,所述飞机数据包括激光雷达采集的点云数据和摄像设备采集的图像数据,所述样本标签用于表示所述训练样本的机型信息;

[0098] 对样本标注后的所述训练样本进行神经网络模型训练,得到所述机型识别模型。

[0099] 在上述实施例的基础上,可选地,停泊引导模块930包括:

[0100] 依据所述机型信息,确定所述待引导飞机的飞机尺寸信息和泊位引导信息;所述泊位引导信息包括停泊引导线和停泊位置;

[0101] 依据所述飞机尺寸信息和泊位引导信息,引导所述待引导飞机向泊位区域行进,以在所述停泊位置处停泊。

[0102] 在上述实施例的基础上,可选地,本实施例的飞机泊位引导装置还包括:

[0103] 行进信息确定模块940,用于在依据所述机型信息,对所述待引导飞机进行停泊引导时,根据实时获取的点云数据确定所述待引导飞机的行进位置信息和剩余行进距离信息,用于对停泊引导进行校正;

[0104] 其中,所述行进位置信息包括所述待引导飞机相对所述停泊引导线的偏离角度和偏离距离;所述剩余行进距离信息包括所述待引导飞机的行进位置相对停泊位置的距离。

[0105] 在上述实施例的基础上,可选地,在依据所述机型信息,对所述待引导飞机进行停泊引导时,还包括:

[0106] 根据所述激光雷达采集的点云数据,确定所述待引导飞机的实时位置信息;

[0107] 根据所述位置信息和所述机型信息确定动态防护区域的范围;其中,所述动态防护区域的位置随所述待引导飞机的位置动态移动;

[0108] 根据实时获取的点云数据,确定是否有障碍物进入到所述动态防护区内,并在障碍物进入所述动态防护区时进行告警。

[0109] 在上述实施例的基础上,可选地,本实施例的飞机泊位引导装置还包括:

[0110] 行进信息显示模块950,用于显示所述待引导飞机的行进信息以及所述机型信息;所述行进信息包括行进轨迹、行进方向和行进位置中的至少一种信息。

[0111] 本发明实施例中所提供的飞机泊位引导装置可执行上述本发明任意实施例中所提供的飞机泊位引导方法,具备执行该飞机泊位引导方法相应的功能和有益效果,详细过程参见前述实施例中的飞机泊位引导方法的相关操作。

[0112] 图10是本发明实施例中提供的一种飞机泊位引导设备的结构示意图。如图10所示结构,本发明实施例中提供的飞机泊位引导设备可包括:至少一个激光雷达;用于采集扫描区域内的点云数据;至少一个摄像传感器,用于获取目标区域内的图像数据;以及一个或多个处理器1010和存储装置1020;该飞机泊位引导设备中的处理器1010可以是一个或多个,图10中以一个处理器1010为例;存储装置1020用于存储一个或多个程序;所述一个或多个程序被所述一个或多个处理器1010执行,使得所述一个或多个处理器1010实现如本发明实施例中任一项所述的飞机泊位引导方法。

[0113] 该飞机泊位引导设备还可以包括:输入装置1030和输出装置1040。

[0114] 该飞机泊位引导设备中的处理器1010、存储装置1020、输入装置1030和输出装置1040可以通过总线或其他方式连接,图10中以通过总线连接为例。

[0115] 该飞机泊位引导设备中的存储装置1020作为一种计算机可读存储介质,可用于存储一个或多个程序,所述程序可以是软件程序、计算机可执行程序以及模块,如本发明实施例中所提供的飞机泊位引导方法对应的程序指令/模块。处理器1010通过运行存储在存储装置1020中的软件程序、指令以及模块,从而执行飞机泊位引导设备的各种功能应用以及数据处理,即实现上述方法实施例中的飞机泊位引导方法。

[0116] 存储装置1020可包括存储程序区和存储数据区,其中,存储程序区可存储操作系统、至少一个功能所需的应用程序;存储数据区可存储根据飞机泊位引导设备的使用所创建的数据等。此外,存储装置1020可以包括高速随机存取存储器,还可以包括非易失性存储器,例如至少一个磁盘存储器件、闪存器件、或其他非易失性固态存储器件。在一些实例中,存储装置1020可进一步包括相对于处理器1010远程设置的存储器,这些远程存储器可以通过网络连接至设备。上述网络的实例包括但不限于互联网、企业内部网、局域网、移动通信网及其组合。

[0117] 输入装置1030可用于接收输入的数字或字符信息,以及产生与飞机泊位引导设备的用户设置以及功能控制有关的键信号输入。输出装置1040可包括显示屏等显示设备。

[0118] 并且,当上述飞机泊位引导设备所包括一个或者多个程序被所述一个或者多个处理器1010执行时,程序进行如下操作:

[0119] 确定待引导飞机的当前采集数据;其中,所述采集数据包括用于描述飞机轮廓特征的激光雷达采集的点云数据和摄像设备采集的图像数据;

[0120] 将所述当前采集数据输入到预先训练的机型识别模型,获得所述待引导飞机的机型信息;

[0121] 依据所述机型信息,对所述待引导飞机进行停泊引导。

[0122] 当然,本领域技术人员可以理解,当上述飞机泊位引导设备所包括一个或者多个程序被所述一个或者多个处理器1010执行时,程序还可以进行本发明任意实施例中所提供的飞机泊位引导方法中的相关操作。

[0123] 本发明实施例中提供了一种计算机可读介质,其上存储有计算机程序,该程序被处理器执行时用于执行飞机泊位引导方法,该方法包括:

[0124] 确定待引导飞机的当前采集数据;其中,所述采集数据包括用于描述飞机轮廓特征的激光雷达采集的点云数据和摄像设备采集的图像数据;

[0125] 将所述当前采集数据输入到预先训练的机型识别模型,获得所述待引导飞机的机型信息;

[0126] 依据所述机型信息,对所述待引导飞机进行停泊引导。

[0127] 可选的,该程序被处理器执行时还可以用于执行本发明任意实施例中所提供的飞机泊位引导方法。

[0128] 本发明实施例的计算机存储介质,可以采用一个或多个计算机可读的介质的任意组合。计算机可读介质可以是计算机可读信号介质或者计算机可读存储介质。计算机可读存储介质例如可以是——但不限于——电、磁、光、电磁、红外线、或半导体的系统、装置或器件,或者任意以上的组合。计算机可读存储介质的更具体的例子(非穷举的列表)包括:具有一个或多个导线的电连接、便携式计算机磁盘、硬盘、随机存取存储器(Random Access Memory, RAM)、只读存储器(Read Only Memory, ROM)、可擦式可编程只读存储器(Erasable Programmable Read Only Memory, EPROM)、闪存、光纤、便携式CD-ROM、光存储器件、磁存储器件、或者上述的任意合适的组合。计算机可读存储介质可以是任何包含或存储程序的有形介质,该程序可以被指令执行系统、装置或者器件使用或者与其结合使用。

[0129] 计算机可读的信号介质可以包括在基带中或者作为载波一部分传播的数据信号,其中承载了计算机可读的程序代码。这种传播的数据信号可以采用多种形式,包括但不限于:电磁信号、光信号或上述的任意合适的组合。计算机可读的信号介质还可以是计算机可读存储介质以外的任何计算机可读介质,该计算机可读介质可以发送、传播或者传输用于由指令执行系统、装置或者器件使用或者与其结合使用的程序。

[0130] 计算机可读介质上包含的程序代码可以用任何适当的介质传输,包括但不限于:无线、电线、光缆、无线电频率(RadioFrequency, RF)等等,或者上述的任意合适的组合。

[0131] 可以以一种或多种程序设计语言或其组合来编写用于执行本发明操作的计算机程序代码,所述程序设计语言包括面向对象的程序设计语言—诸如Java、Smalltalk、C++,还包括常规的过程式程序设计语言—诸如“C”语言或类似的设计语言。程序代码可以完全地在用户计算机上执行、部分地在用户计算机上执行、作为一个独立的软件包执行、部

分在用户计算机上部分在远程计算机上执行、或者完全在远程计算机或服务器上执行。在涉及远程计算机的情形中，远程计算机可以通过任意种类的网络——包括局域网 (LAN) 或广域网 (WAN) ——连接到用户计算机，或者，可以连接到外部计算机 (例如利用因特网服务提供商来通过因特网连接)。

[0132] 在本说明书的描述中，参考术语“一个实施例”、“一些实施例”、“示例”、“具体示例”、或“一些示例”等的描述意指结合该实施例或示例描述的具体特征、结构、材料或者特点包含于本发明的至少一个实施例或示例中。在本说明书中，对上述术语的示意性表述不一定指的是相同的实施例或示例。而且，描述的具体特征、结构、材料或者特点可以在任何一个或多个实施例或示例中以合适的方式结合。

[0133] 注意，上述仅为本发明的较佳实施例及所运用技术原理。本领域技术人员会理解，本发明不限于这里所述的特定实施例，对本领域技术人员来说能够进行各种明显的变化、重新调整和替代而不会脱离本发明的保护范围。因此，虽然通过以上实施例对本发明进行了较为详细的说明，但是本发明不仅仅限于以上实施例，在不脱离本发明构思的情况下，还可以包括更多其他等效实施例，而本发明的范围由所附的权利要求范围决定。

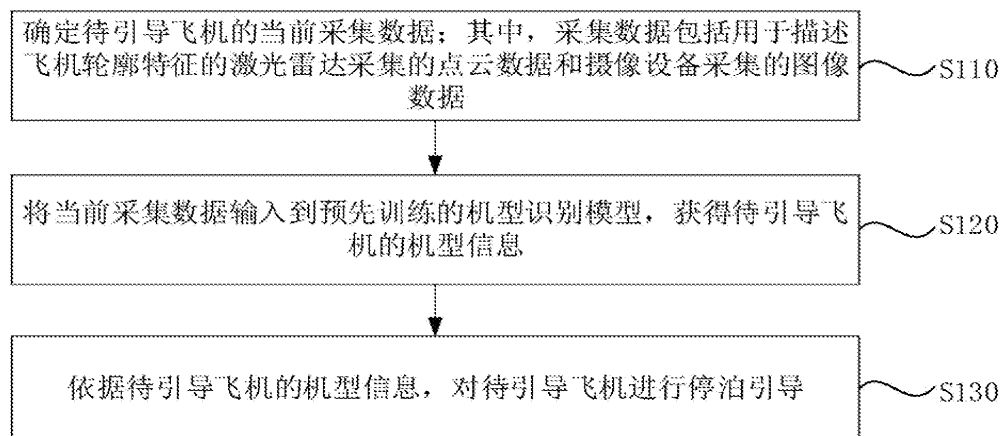


图1

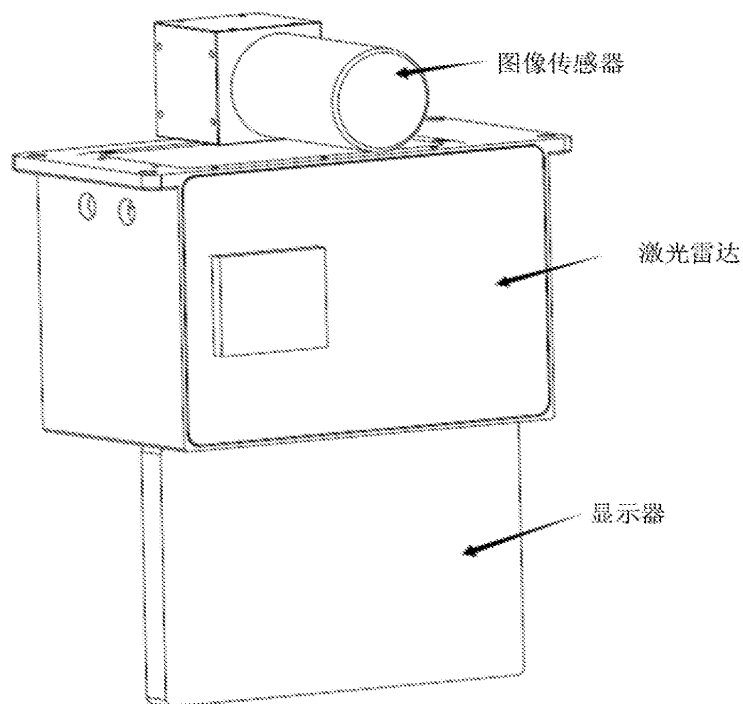


图2

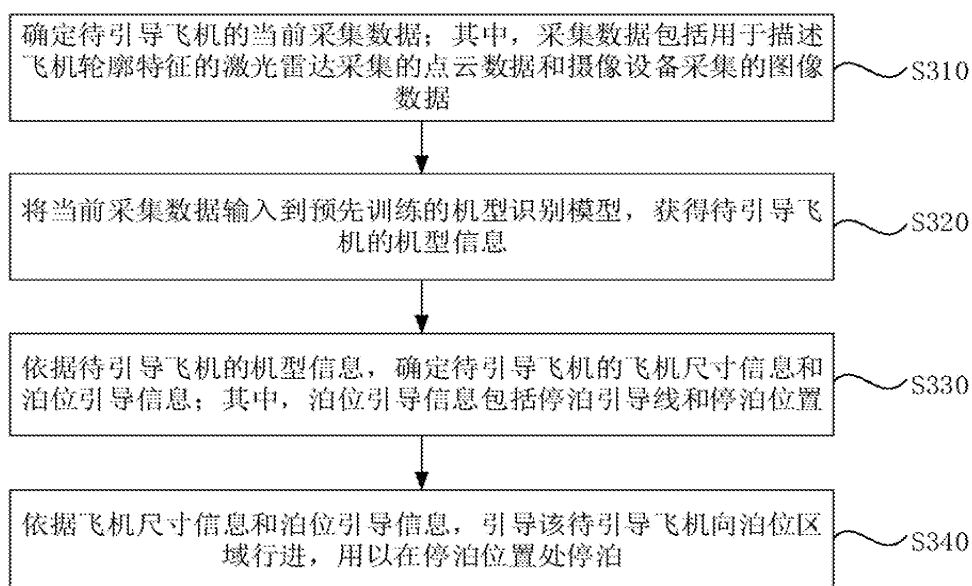


图3

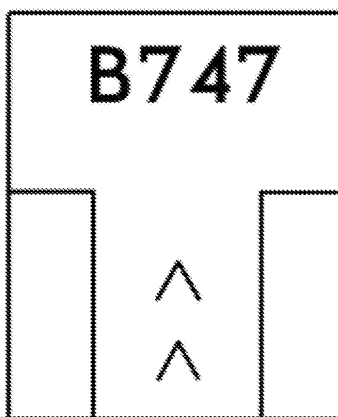


图4

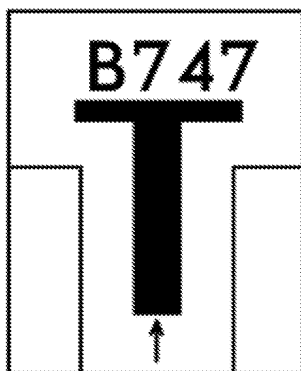


图5

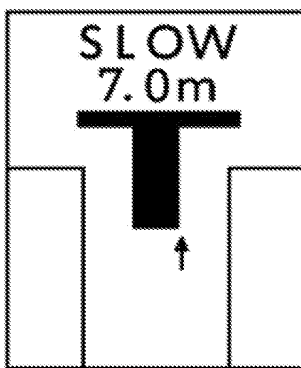


图6

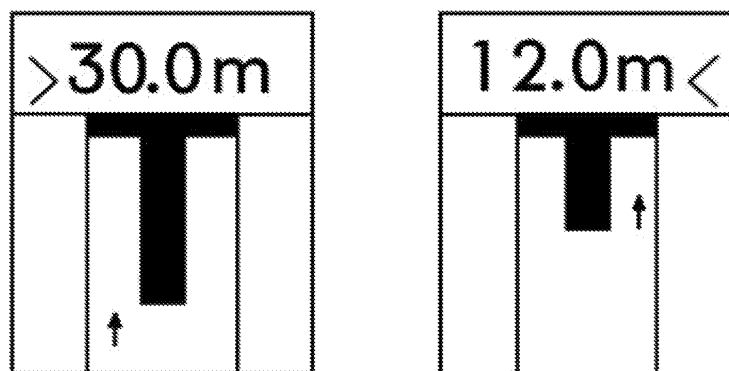


图7

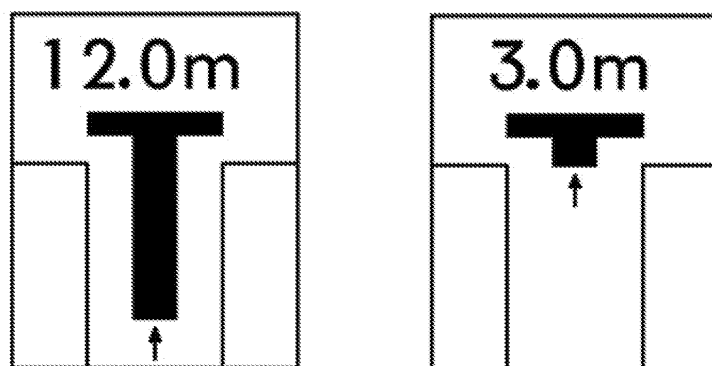


图8

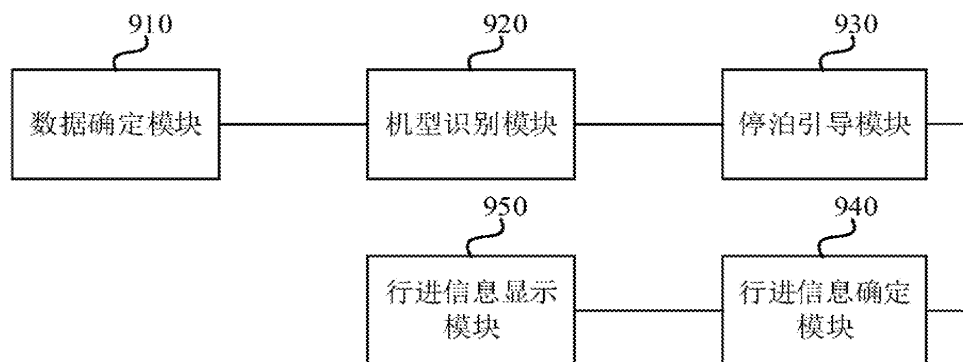


图9

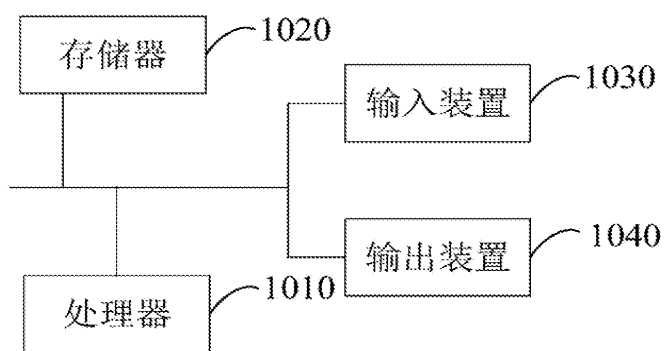


图10



Espacenet

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Aircraft berth guiding method, device and equipment

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Abstract of CN111427374 (A)

The embodiment of the invention discloses an aircraft berth guiding method, device and equipment and a storage medium. The method comprises the following steps: determining current acquired data of a-to-be-guided aircraft, wherein the acquired data comprises point cloud data acquired by a laser radar and image data acquired by camera equipment, and the point cloud data is used for describing airplane contour characteristics; inputting the current acquired data into a pre-trained airplane type identification model to obtain airplane type information of the airplane to be guided; and according to the aircraft type information, parking guidance is carried out on the aircraft to be guided. By adopting the scheme of the invention, fusion identification detection of the aircraft type can be realized by adopting the fusion data of two dimensions, the reliability and accuracy of aircraft type identification detection can be improved, and the aircraft type identification model is obtained by training a large amount of data, so that the stability of aircraft type identification detection is higher. Meanwhile, according to the scheme, an appropriate berth guiding mode can be matched for the aircraft to be guided according to the airplane type, and therefore the airplane can be parked more safely and effectively.

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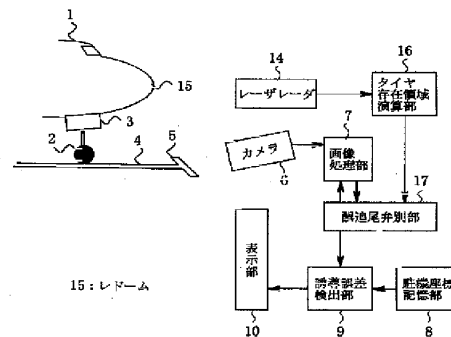
弁理士 宮田 金雄 (外1名)

(54) 【発明の名称】 駐機位置表示装置

(57) 【要約】

【課題】 この発明は、雨天や夜間などの環境の悪条件が重なった場合でも、信頼性の高い誘導が可能な駐機位置表示装置を提供することを目的としている。

【解決手段】 カメラ6と、カメラ6の映像を処理する画像処理部7と、レーザレーダ14と、レーザレーダ14の反射光からタイヤの存在領域を求めるタイヤ存在領域演算部16と、タイヤ存在領域演算部16で得られた存在領域と画像処理部7で求められたタイヤ候補との比較によってタイヤ位置を求め、このタイヤ位置と駐機位置との差異を算出する誘導誤差検出部9と、誘導誤差検出部9で得られた差異を表示する表示部10とを設けたものである。



【特許請求の範囲】

【請求項1】 パイロットに対して駐機位置に対する方位ずれ情報および残距離情報を提供することによってエプロンを走行する航空機を停止すべき駐機位置へ誘導する駐機位置表示装置において、前記航空機を撮像して映像信号を出力するカメラと、この映像信号を画像処理してタイヤの存在位置の候補を検出する画像処理部と、前記航空機における特定の位置を検出する位置検出手段と、この位置検出手段で検出された特定の位置に基づいて航空機のタイヤが存在する領域を算出するタイヤ存在領域演算部と、前記画像処理部で検出されたタイヤ存在位置の候補と前記タイヤ存在領域演算部で検出されたタイヤの存在領域との比較に基づいてタイヤ位置を検出し、この検出されたタイヤ位置と前記航空機の駐機位置との差異を検出する誘導誤差検出部と、前記誘導誤差検出部で検出された差異をパイロットに表示する表示部とを備えた駐機位置表示装置。

【請求項2】 前記位置検出手段は、航空機のレドーム位置を検出するレーザレーダを備えたことを特徴とする請求項1記載の駐機位置表示装置。

【請求項3】 前記誘導誤差検出部は、前記タイヤ存在領域演算部で検出されたタイヤの存在領域に前記画像処理部で検出されたタイヤの存在位置の候補を有していないときに、前記タイヤの存在領域内の画像からタイヤの存在位置を検出する手段を備えたことを特徴とする請求項1記載の駐機位置表示装置。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】この発明は空港において航空機の駐機位置近傍におけるビル壁面などに設置され、エプロンを走行する航空機を駐機位置まで誘導する駐機位置表示装置に関するものである。

【0002】

【従来の技術】図3に従来の駐機位置表示装置の構成図を示す。図において1は定められた駐機位置に自機を停止させるためにエプロンを走行してスポットに進入する航空機、2は航空機のノーズギアのタイヤ、3は航空機下面のノーズギア格納庫の扉、4は航空機走行方向に沿って路面にマーキングしてある走行中心表示線、5は航空機進入方向に直交して路面にマーキングしてある停止位置表示線、6は航空機1のノーズギア近傍を撮像するように進入する航空機に対向してターミナルビルの壁面に設置したカメラ、7はノーズギアのタイヤの存在が予想されるタイヤ候補の位置を検出する画像処理部、8は最終的に航空機1を誘導すべき駐機位置の座標データを保持する駐機座標記憶部、9は現在のタイヤ座標と駐機位置の座標との差異を求める誘導誤差検出部、10はこの結果の残距離と左右ずれ情報をパイロットに提示する表示部である。

【0003】ここで駐機位置表示装置の概要について説

明する。航空機1は着陸した後、エプロンを走行し、あらかじめ指定してあったスポットに向かう。そのスポットには風雨や寒暖から乗客を保護するボーディングブリッジがあり、このボーディングブリッジは専属の操作員によって操縦される。しかしボーディングブリッジの片側は空港ビルに固定されているために前後左右の方向に自由自在に移動できるわけではない。このため、駐機位置に対して航空機1の位置が大きすぎて停止してしまった機体の場合、操作員はボーディングブリッジの他方の側について進行と後退を何度も繰り返す、その度に左右操舵を実施して少しずつ航空機のドアに接近して行く。このため上記誤差が大きい場合では航空機ドアとのドッキングに時間がかかったり、最悪の場合は機体との間に若干の隙間を生じてしまう場合があった。一般的に速やかでしかも安全にボーディングブリッジを航空機とドッキングさせるためには、航空機は定められた駐機位置に対して、500mm以内の誤差に停止させることが必要だといわれている。このため、空港ではマーシャラや駐機位置表示装置によって駐機位置と航空機のタイヤ位置との誤差情報をパイロットに提供し、上記誤差をできる限り少なくするようにしている。パイロットはこれらの提供された情報に従って、自分の機体の左右偏差と残距離とを認識しながら定められた駐機位置に航空機を操縦して行くこととなる。

【0004】次に図3を用いて従来の駐機位置表示装置の動作例について説明する。スポットに進入してくる航空機1に対向して、やや上方に設置されたカメラ6は航空機1におけるノーズギアのタイヤ2の近傍を撮像し、その映像信号は画像処理部7へ伝送される。画像処理部7では、カメラ6で取得された航空機のいない状態での背景画像と新たに取得された画像との差分画像を抽出する処理（背景差分処理）や、背景差分処理後の二値化処理などを行い、タイヤ2を背景のコンクリートの画像と区別して認識し、この認識されたタイヤに関して、左右方向は2本のタイヤの中心を、また残距離方向はタイヤが路面と接している点をタイヤ位置の座標として算出する。一方、航空機1のタイヤ2を誘導すべき駐機位置の座標は予め算出してあり、駐機座標記憶部8に記録されている。ここで誘導誤差検出部9は、タイヤ位置座標と駐機位置座標との両者の差を、常に誤差情報として計算している。この結果、たとえば左右方向は左に0.2m、残距離方向は15mなどと計算された誤差情報を、表示部10を通じて航空機1のパイロットにリアルタイムに提供する。パイロットはこの表示部10の表示を見て、航空機1を予め定められている駐機位置に一致するように操縦して航空機1を停止させる。カメラ6によって撮像されるカメラ出力画像例を図4に示す。また、この画像を画像処理した例を図5に示す。図5において、11はカメラ6の出力画像を処理した結果検出したタイヤ候補を示す枠であり、そして12は左右方向が認識された2本のタイヤ

の中心、また残距離方向が認識されたタイヤと路面とが接地している点（タイヤ位置）を示す十字カーソルである。なお、この図では説明のためにタイヤ候補を示す枠11はタイヤと重ならないようにやや広く、また十字カーソル12と重なる部分の枠11は切り欠いて図示してある。また、参考として航空機1の全体像も示してある。図5に示すように、この例ではタイヤ候補を示す枠11は正しく2本のタイヤを囲い込んでいる。また十字カーソル12に関しても、左右方向は2本のタイヤの中心で、残距離方向はタイヤが路面と接している位置を正しく示している。

【0005】

【発明が解決しようとする課題】ここで通常撮像される映像では、路面は灰色のコンクリートであり、一方タイヤ2は黒いゴムである。よって映像では灰色の背景の中に黒いタイヤ2が存在することになる。このため、例えば図4の映像に背景差分処理を行って走行中心表示線4や停止位置表示線5などの像を除去した後、全画面に白黒の2値化処理を施すと、タイヤ2に相当する部分では横方向に白から黒への変化のエッジが上下に直線的な塊りを有する矩形形状の像が生成される。この特徴を利用して、全画面の内、左右方向の画素の明るさの変化を生じるエッジ部分が上下方向に直線的な塊りを有する部分を検出することによって、タイヤ2を認識することができる。

【0006】ところが、例えば夜間に雨の降る状況下では、路面は暗く撮像され、またタイヤ2は黒く撮像される。すなわち背景となる路面とタイヤ2との差異が著しく少なくなり、全画面について二値化処理等を施す場合に、タイヤ2を明確に検出できる二値化の閾値が自動的に設定されないことがあった。この状況下では、図4のようにノーズギアの格納庫の扉3が下方にほぼ垂直に開いていると、上述のタイヤ2と非常に良く似通った白黒のエッジを生じる。ここで問題となるのは、実際のタイヤ2と路面との左右方向における画素の明るさの変化よりも、開いたノーズギア格納庫の扉3と路面の方が明確な変化を有してしまうことである。この場合、図6に示すように、雨でぬれた暗い路面では扉3をタイヤと誤認識する恐れがあった。すなわち、図6のように誤ったタイヤ候補を示す枠13は上方向にずれ、ノーズギアの格納庫の扉3を捕らえてしまう。ここで画像処理部7における残距離の計算は、タイヤ2の座標が図の上方向に存在する場合は残距離がまだ遠いと計算してしまい、一方、図の下方向に存在する場合には残距離が近い計算となる。このため、図6では、例えばすでに停止線をオーバーランしてしまっているにも関わらず、残距離がまだ遠いと誤認識してしまい、さらに勢い良く前進しても良い旨の誤った表示をしてしまう。この表示に従うと停止位置を大きくオーバーランしてしまい、翼端をボーディングブリッジにぶついたり、地上作業員の避難場所にまで達し

て地上作業員に接触したり、地上の車両や地上からの電源や空気供給設備用ステップなどにノーズギアをぶつけて破損したりすると言った問題を引き起こすような誤追尾と誤表示を行なう恐れがあった。

【0007】この発明はかかる問題を解決するためになされたものであり、夜間に雨の降るような悪状況下であっても航空機のタイヤ位置を誤りなく検出し、航空機を誘導すべき駐機位置とタイヤ位置との正確な誤差情報をパイロットに提供する駐機位置表示装置を得るものである。

【0008】

【課題を解決するための手段】第1の発明による駐機位置表示装置は、パイロットに対して駐機位置に対する方位ずれ情報および残距離情報を提供することによってエプロンを走行する航空機を停止すべき駐機位置へ誘導する駐機位置表示装置において、前記航空機を撮像して映像信号を出力するカメラと、この映像信号を画像処理してタイヤの存在位置の候補を検出する画像処理部と、前記航空機における特定の位置を検出する位置検出手段と、この位置検出手段で検出された特定の位置に基づいて航空機のタイヤが存在する領域を算出するタイヤ存在領域演算部と、前記画像処理部で検出されたタイヤ存在位置の候補と前記タイヤ存在領域演算部で検出されたタイヤの存在領域との比較に基づいてタイヤ位置を検出し、この検出されたタイヤ位置と前記航空機の駐機位置との差異を検出する誘導誤差検出部と、前記誘導誤差検出部で検出された差異をパイロットに表示する表示部とを備えたものである。

【0009】また、第2の発明による駐機位置表示装置は、前記位置検出手段として、航空機のレドーム位置を検出するレーザレーダを備えたものである。

【0010】また、第3の発明による駐機位置表示装置は、前記誘導誤差検出部として、前記タイヤ存在領域演算部で検出されたタイヤの存在領域に前記画像処理部で検出されたタイヤの存在位置の候補を有していないときに、前記タイヤの存在領域内の画像からタイヤの存在位置を検出する手段を備えたものである。

【0011】

【発明の実施の形態】実施の形態1．図1はこの発明の実施の形態1を示した構成図であり、図において14はレーザ光を出射し物体からの反射光を受光するレーザレーダ、15は航空機先端のレドーム、16はタイヤ存在領域演算部、そして17は誤追尾弁別部であり、1から10までは上述の従来装置と同じである。

【0012】次に動作について説明する。レーザレーダ14はエプロン上の物体までの距離と、反射波の受光レベルの情報を得ることができるものである。図1でレーザレーダ14は航空機先端のレドーム15に対向して、例えばターミナルビルの壁面に設置してある。航空機1がスロットに進入して来ていない場合は、エプロン上に障害

物はなく、このためレーザレーダ14のレーザ光を反射する物体は無い。レーザ光の反射物としては、わずかに地上整備員の反射テープを縫い付けた安全ベストや、地上電源や地上設備からのフレッシュエア供給用のダクトや、停止した航空機にアクセスするためのタラップ程度はあるにせよ、航空機1のレドーム15の面積と比べると微々たるものであり、その大きさやレーザ光の反射強度、または物体の塊の大きさによって、容易に航空機との識別が可能である。航空機1がスポットに進入した場合、レーザレーダ14は反射波の受光レベルが所定値以上となることから航空機のレドーム15に相当する物体の存在を検知し、この検知された物体の周辺における、レーザレーダ14の検出距離がもっとも小さい部分、即ちもっとも近い位置がレドームの先端であると認識する。

【0013】ここで、航空機の種類によって、レドーム先端とノーズギアとの高さや距離は定まっており、レーザレーダ14によってレドーム先端の位置が分かれば、ノーズギアの位置も判明する。したがって、レーザレーダ14によって航空機1のノーズギアの概略位置とそのタイヤ位置が推定できることとなる。ただし、レーザレーダ14はノーズギアのタイヤ2がどのあたりの領域に存在するというのを安定して検出することができる半面、距離データの精度は数十センチと低い。一方、カメラ6を用いた画像処理によるノーズギアのタイヤ2の検出誤差は、数センチメートルと高精度であるものの、上述した雨の夜のように特定の悪い環境条件が重なると、例えば残距離方向での大きな誤差を生じることがある。

【0014】このため、この実施の形態ではこの2種類のセンシング手法を組み合わせて用いることによってそれぞれの短所を補う。すなわち、レーザレーダ14はスポットに進入する航空機1のレドーム15の先端を検出し、レーザレーダ14の基準位置（例えばターミナルビルの壁面）からレドーム15の先端までの距離を出力する。ここで、タイヤ存在領域演算部16は、あらかじめ内部の記憶回路において航空機の機種に対応付けられたレドーム15の先端とノーズギア間の距離及び高さの情報を記憶している。タイヤ存在領域演算部16は、あらかじめ判明している航空機の機種に基づいて内部の記憶回路に有する情報を参照し、この機種に対応するレドーム15とノーズギア間の距離と高さを認識した後、この認識された距離及び高さやレーザレーダ14で得られたレドーム15までの距離とから、予め設定された換算表や換算式に基づいてレーザレーダ14の基準位置からノーズギアまでの距離を求める。次にタイヤ存在領域演算部16は、既知であるレーザレーダ14の基準位置からカメラ6までの距離（この例では、カメラ6とレーザレーダ14を同一の壁面に設けてあるので0となる）と、既知であるカメラ6の設置高さ及びその視野方向と、求められたレーザレーダ14の基準位置からノーズギアまでの距離などに基づき、予め設定された換算表や換算式

を用いてカメラ6で撮像された画像内の座標に換算した場合に、どの座標を中心にしてどの範囲まで画像処理を実施すればノーズギアのタイヤ2を捕らえることができるかを予測し、この予測されたタイヤを捕らえるべき領域（以下タイヤ存在領域とする）の中心位置の座標、及びこの領域の境界位置を計算する。一方、並行して、航空機1におけるノーズギアのタイヤ2の位置は従来通りカメラ6で撮像し、これにより従来通りのエッジ検出によるタイヤ認識を実施し、この結果が誤追尾弁別部17に入力される。これと同時に画像処理と異なる手法、即ち上述のタイヤ存在領域演算部16の出力も、誤追尾弁別部17に入力される。ここで、正常に追尾が実行されている通常の状態であれば画像処理部7が出力するタイヤ位置の座標と、タイヤ存在領域演算部16で予測されたタイヤ存在領域の中心位置の座標とは概ね一致する。この両者が概ね一致した場合は、異なるセンシング手法によるタイヤ位置の計算結果が一致したことに相当し、この状態でのタイヤ追尾の信頼性は高く、画像処理部7の出力するタイヤ位置の座標と予め駐機座標記憶部8に記憶された駐機位置座標との差を誘導誤差検出部9で計算し、誤差情報を表示部10に出力することによって航空機を正しく誘導する。航空機1のパイロットは表示部10の表示情報に従って航空機1を操縦し、左右方向を走行中心表示線4に合致させ、また残距離方向を定められた停止位置表示線5に合致させて航空機1を停止させる。

【0015】一方、画像処理部7からのタイヤ位置座標とタイヤ存在領域演算部16からのタイヤ存在領域の中心位置座標が異なった場合（座標間の位置ずれが所定以上となった場合）、誤追尾弁別部17は追尾が異常になったことを認識する。誤追尾弁別部17はこの認識に応じて、タイヤ存在領域演算部16で得られたタイヤ存在領域内のみについて再度画像処理を実施するように、画像処理部7に指令する。例えば図2のように画像全体を処理してタイヤ候補を検出した場合に、ノーズギア格納庫の扉3のほうに左右方向のエッジが強く、画像処理部3で画像処理した結果のタイヤ候補の座標も上方に外れる。しかし、タイヤ存在領域演算部16が図2に点線で示すようなタイヤ存在領域18を予測し、誤追尾弁別部17の指令に応じて画像処理部7がこの存在領域18内のみで再度画像処理することにより、路面の濡れた暗い夜間であっても路面との中の黒いタイヤとの間に、微少ながらもエッジの差異が顕在化するので、真のタイヤを認識することが可能となる。

【0016】なお、一般にレーザレーダ14は進入してくる航空機1のパイロットに対向して設置されるため、パイロットが目を受けても影響がないような低いレベルの強度を有するレーザ光しか出射できず、遠距離における航空機の認識性能は画像にくらべて低くなる（すなわち、遠方では反射光の受光レベルが常に所定値以下となる）。このため、航空機が遠方に位置してレーザレーダ

14における反射光の受光レベルがどの方向でも所定値以下となる場合は、航空機1のタイヤの追尾を画像処理部7のみで行い、その後航空機が接近して反射光の受光レベルが所定値以上となる領域の存在が検知された場合は、環境の悪条件によって生じるノイズが格納庫の扉3の誤認識を避けるために、上述のようにタイヤ存在領域演算部16からのタイヤ存在領域18について画像処理部7でタイヤの検出を行うことによって、この近距離での精密なタイヤ追尾を行う。

【0017】また、上述では説明が煩雑となることをさけるため、レーザレーダ14による情報を距離情報のみとしたが、レーザレーダ14によって得られる航空機1のレドーム15の位置情報として、残距離方向の情報の他に方位方向の情報も得られる。したがって、図1に示すレーザレーダ14によってレドーム先端における方位方向の情報を取得し、その結果に基づいてタイヤ存在領域演算部16ではタイヤ存在領域18における方位方向の位置を予測する。誤追尾弁別部17では、タイヤ存在領域演算部16からのタイヤ存在領域18の方位方向と画像処理部7からのタイヤ候補の方位方向とを比較して、カメラ6の画像処理結果に方位方向の偏差が生じたことを検知する。この検知に応じて、タイヤ存在領域演算部16から得られるタイヤ存在領域18内で画像処理部7によるタイヤの検出を行ってタイヤ位置を検出する。これを用いることによって、何らかの悪条件によってカメラ6の画像処理結果に方位方向の偏差を生じた場合でも、画像処理部7からの検出結果の異常を検知し、精度良くタイヤ位置を検出することが可能となる。

【0018】さらに、ここで用いるレーザレーダ14としては、ペンシルビームを用いてアジマスとエレベーション方向に走査するもの、あるいは空間的にエレベーション方向が扇型となるレーザビームをアジマス方向のみに走査するものなどを用いる。後者の場合は光学系が簡素化し、またポリゴンミラーの駆動を行う必要がないことから、低いコストで長期動作時の高信頼性を確保でき、また1走査あたりの時間を短くできることから高いデータレートを実現できる。

【0019】また、ここでは説明し易さのために駐機座標記憶部8は1種類の航空機の機種に対応する座標の情報を記憶することとしたが、もちろん複数の駐機位置を記憶しても良い。この場合、切替えスイッチによって複数の機種を切り替えることとし、この切替え操作はそのスポットに次に進入する機種をあらかじめ知らされている地上作業員が実施すれば良い。さらに、例えばこの駐機座標記憶部8と例えば地上走行を管制するランプコントロールとをネットワークで接続しても良い。これによってランプコントロールからの遠隔操作によって機種の切替えが集中管理することが実現できる。また、タイヤ存在領域演算部16についても、駐機座標記憶部8と同様、ランプコントロールからの遠隔操作などによって航

空機の機種を切替えるものであってもよい。この場合タイヤ存在領域演算部16は、内部の記憶回路からその機種に対応する機種情報（例えばレドーム15の先端とノーズギアとの距離と高さ）を得ることができる。

【0020】この実施の形態では、誤追尾弁別部17によりタイヤ存在領域演算部16で得られた正しいと思われるタイヤ存在位置の座標近傍について、画像処理部7で再度タイヤ検出のための画像処理を実施する例について説明したが、他の例として、例えば受信性能を改善して遠距離まで航空機のレドーム15を認識できるレーザレーダ14を用いることにより、航空機の進入の初期段階からレーザレーダ14が示すタイヤ存在領域18のみを画像処理するような処理を行っても良い。また、レーザレーダ14による航空機のレドーム15の位置検出に関しては、レーザレーダ以外の他の位置検出手段として、例えばマイクロ波やミリ波レーダによって航空機における特定の位置を検出するものを用いても良い。この場合、タイヤ存在領域演算部16ではこの検出位置に基づいてタイヤ存在領域18を予測する。

【0021】

【発明の効果】この発明によれば、夜間の降雨時などのように画像による路面とタイヤの識別が困難な環境下であっても、信頼性の高い誘導が可能な駐機位置表示装置を提供できる。

【図面の簡単な説明】

【図1】 この発明の実施の形態1を示す構成図。

【図2】 この発明による追尾中の画像例を示す図。

【図3】 従来のこの種の装置を示す構成図。

【図4】 カメラ出力の画像例を示す図。

【図5】 正常にタイヤを追尾している画像処理結果の例を示す図。

【図6】 誤ってタイヤを追尾している画像処理結果の例を示す図。

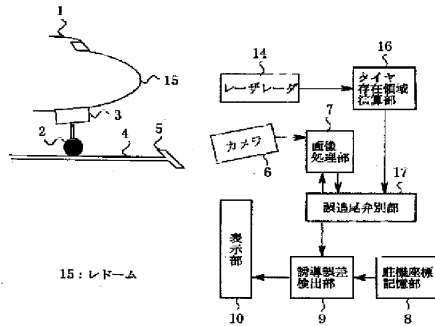
【符号の説明】

- 1 航空機
- 2 タイヤ
- 3 扉
- 4 走行中心表示線
- 5 停止位置表示線
- 6 カメラ
- 7 画像処理部
- 8 駐機座標記憶部
- 9 誘導誤差検出部
- 10 表示部
- 11 タイヤ候補を示す枠
- 12 十字カーソル
- 13 誤ったタイヤ候補を示す枠
- 14 レーザレーダ
- 15 レドーム
- 16 タイヤ存在領域演算部

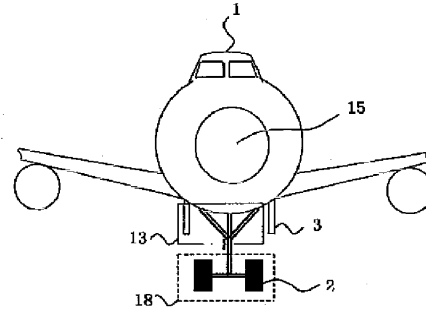
17 誤追尾弁別部

18 タイヤ存在領域

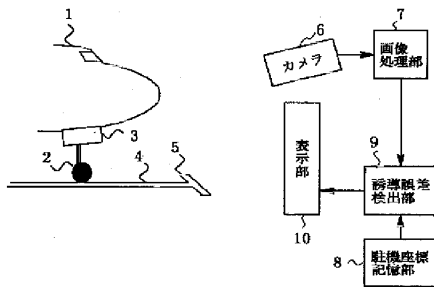
【図1】



【図2】

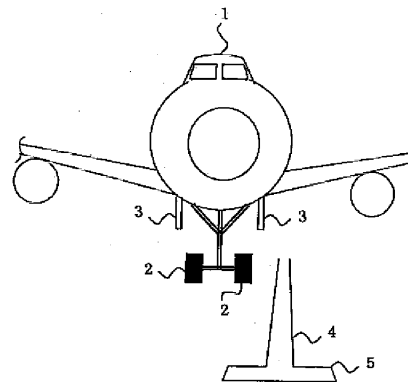


【図3】

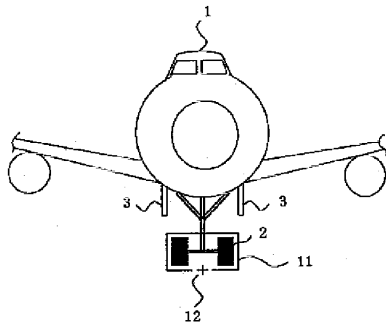


18 : タイヤ存在領域

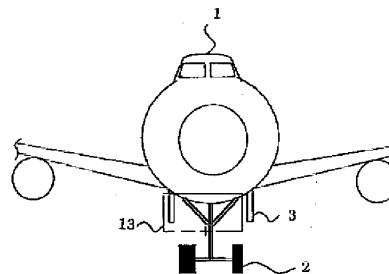
【図4】



【図5】



【図6】





Espacenet

Bibliographic data: JP2001187599 (A) — 2001-07-10

AIRCRAFT PARKING POSITION DISPLAY DEVICE

Inventor(s): HOZUMI YUJI; SUGASAWA TOSHIHIRO ± (HOZUMI YUJI ; SUGASAWA TOSHIHIRO)

Applicant(s): MITSUBISHI ELECTRIC CORP; NEW TOKYO INTERNAT AIRPORT AUT ± (MITSUBISHI ELECTRIC CORP, ; NEW TOKYO INTERNATIONAL AIRPORT AUTHORITY)

Classification: - international: *B64F1/22*; (IPC1-7): B64F1/22
- cooperative:

Application number: JP19990374276 19991228

Priority number(s): JP19990374276 19991228

Also published as: JP4071412 (B2)

Abstract of JP2001187599 (A)

PROBLEM TO BE SOLVED: To provide an aircraft parking position display device permitting guidance of high reliability even under unfavorable conditions such as rain at night. **SOLUTION:** This aircraft parking position display device is provided with a camera 6; an image processing part 7 for processing the image of the camera 6; a laser radar 14; a tire existing area computing part 16 obtaining the existing area of a tire from the reflected light of the laser radar 14; a guidance error detecting part 9 obtaining a tire position by comparing an existing area obtained by the tire existing area computing part 16, with a tire candidate obtained by the image processing part 7, and computing the difference between the tire position and an aircraft parking position; and a display part 10 displaying the difference obtained by the guidance error detecting part 9.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875						Application or Docket Number 16/983,657		
APPLICATION AS FILED - PART I <div style="display: flex; justify-content: space-around; font-size: small;"> (Column 1) (Column 2) </div>								
FOR	NUMBER FILED	NUMBER EXTRA	SMALL ENTITY		OR	OTHER THAN SMALL ENTITY		
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	RATE(\$)	FEE(\$)		RATE(\$)	FEE(\$)	
SEARCH FEE (37 CFR 1.16(k), (l), or (m))	N/A	N/A	N/A			N/A	300	
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	660	
TOTAL CLAIMS (37 CFR 1.16(i))	20	minus 20 = *				N/A	760	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	3	minus 3 = *			OR	x 100 =	0.00	
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$310 (\$155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).					x 460 =	0.00	
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00	
			TOTAL			TOTAL	1720	
* If the difference in column 1 is less than zero, enter "0" in column 2.								
APPLICATION AS AMENDED - PART II <div style="display: flex; justify-content: space-around; font-size: x-small;"> (Column 1) (Column 2) (Column 3) </div>								
AMENDMENT A		CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE(\$)	ADDITIONAL FEE(\$)	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						TOTAL ADD'L FEE	
AMENDMENT B		CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE(\$)	ADDITIONAL FEE(\$)	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						TOTAL ADD'L FEE	
* If the entry in column 1 is less than the entry in column 2, write "0" in column 3. ** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20". *** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3". The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.								



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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY. DOCKET NO.	TOT CLAIMS	IND CLAIMS
16/983,657	08/03/2020	3646	1720	H215046-US	20	3

CONFIRMATION NO. 4104
FILING RECEIPT



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10786
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Date Mailed: 08/11/2020

Receipt is acknowledged of this non-provisional utility 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 FIRST INVENTOR, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection.

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Inventor(s)

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Applicant(s)

Honeywell International Inc., Morris Plains, NJ;

Power of Attorney: The patent practitioners associated with Customer Number 10786

Domestic Applications for which benefit is claimed - None.

A proper domestic benefit claim must be provided in an Application Data Sheet in order to constitute a claim for domestic benefit. See 37 CFR 1.76 and 1.78.

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see <http://www.uspto.gov> for more information.) - None.

Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

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

If Required, Foreign Filing License Granted: 08/10/2020

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 16/983,657**

Projected Publication Date: 02/03/2022

Non-Publication Request: No

Early Publication Request: No
Title

MULTI-SENSOR DATA FUSION-BASED AIRCRAFT DETECTION, TRACKING, AND DOCKING

Preliminary Class

342

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

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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.

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page 2 of 4

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	Filing Date	
	First Named Inventor	Rajesh V. Poojary
	Art Unit	
	Examiner Name	
	Attorney Docket Number	H215046-US

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	1	2015005534	WO	A1	2015-01-15	ANSE TECHNOLOGIES CO LTD	w/ English abstract	
	2	108932875	CN	A	2018-12-04	Chenlong Aircraft Jingmen Co Ltd		×
	3	101314566	KR	B1	2013-10-07	ANSE TECHNOLOGIES CO LTD	w/ English abstract	☐

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		
	Filing Date		
	First Named Inventor	Rajesh V. Poojary	
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	1	RENUKA, ET AL. "SMART RAMP INFORMATION DISPLAY SYSTEM", International Journal of Pure and Applied Mathematics, Vol. 119, No. 16, 2018, 6 pages.	
	2	RODRIGUEZ-GARAVITO, ET AL., "Automatic Laser And Camera Extrinsic Calibration for Data Fusion Using Road Plane", IEEE Intelligent Transportation Systems Conference, 2006, 6 pages.	
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number		
	Filing Date		
	First Named Inventor	Rajesh V. Poojary	
	Art Unit		
	Examiner Name		
	Attorney Docket Number	H215046-US	

CERTIFICATION STATEMENT											
<p>Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):</p> <p>That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).</p> <p>OR</p> <p>That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).</p> <p>☐</p> <p>See attached certification statement.</p> <p>The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.</p> <p>☒ A certification statement is not submitted herewith.</p> <p style="text-align: center;">SIGNATURE</p> <p>A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.</p> <table border="1" style="width: 100%;"> <tr> <td>Signature</td> <td>/Mark R. Berger/</td> <td>Date (YYYY-MM-DD)</td> <td>2020-08-03</td> </tr> <tr> <td>Name/Print</td> <td>Mark R. Berger</td> <td>Registration Number</td> <td>62556</td> </tr> </table> <p>This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.</p>				Signature	/Mark R. Berger/	Date (YYYY-MM-DD)	2020-08-03	Name/Print	Mark R. Berger	Registration Number	62556
Signature	/Mark R. Berger/	Date (YYYY-MM-DD)	2020-08-03								
Name/Print	Mark R. Berger	Registration Number	62556								

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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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Bibliographic data: WO2015005534 (A1) — 2015-01-15

HYBRID VISUAL INTERVAL INDUCING DEVICE

Inventor(s): LEE KI CHANG [KR] ± (LEE, KI CHANG)

Applicant(s): ANSE TECHNOLOGIES CO LTD [KR]; INCHEON INTERNAT
AIRPORT CORP [KR] ± (ANSE TECHNOLOGIES CO., LTD, ;
INCHEON INTERNATIONAL AIRPORT CORPORATION)

Classification: - international: G06T1/00; G06T5/00
- cooperative: G06T7/30 (EP); G06T2207/10004 (EP);
G06T2207/10028 (EP)

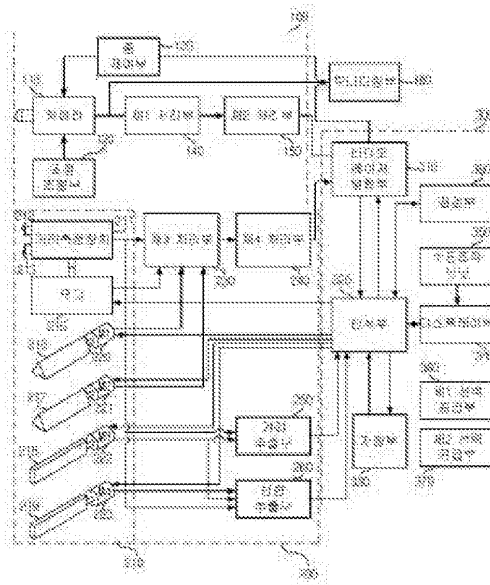
Application number: WO2013KR09314 20131018 Global Dossier

Priority number(s): KR20130079884 20130708

Also published as: KR20150006279 (A)

Abstract of WO2015005534 (A1)

The present invention relates to an interval inducing device and includes a first extracting unit extracting airplane image data from an image signal captured by a camera, a second extracting unit extracting airplane scan data from a signal scanned with a 3D laser scanner, and a control unit generating airplane location data obtained by aggregating the airplane image data with the airplane scan data and thus providing a distance to an interval target location and a direction to induce an interval. Accordingly, the hybrid visual interval inducing device has an effect in that it is possible to determine the type of an airplane quickly and accurately by combining the advantage of a camera-based inducing method with that of a laser-based inducing method.



- 110 ... Camera
- 120 ... Focusing unit
- 130 ... Zoom control unit
- 140 ... First processing unit
- 150 ... Second processing unit
- 160 ... Monitoring unit
- 211 ... Distance measuring device
- 215 ... Motor
- 230 ... Third processing unit
- 240 ... Fourth processing unit
- 250 ... Distance extracting unit
- 260 ... Direction extracting unit
- 310 ... Video and laser aggregating unit
- 320 ... Recognizing unit
- 330 ... Storage unit
- 340 ... Display unit
- 350 ... Manual operation unit
- 360 ... First power supply unit
- 370 ... Second power supply unit
- 380 ... Inspection unit

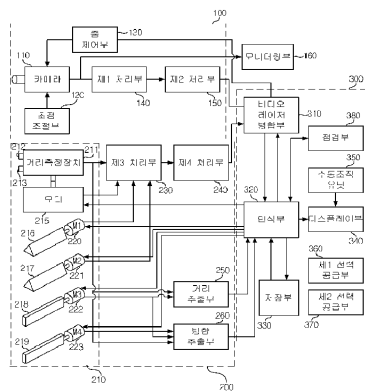


- (51) 국제특허분류: **G06T 1/00** (2006.01) **G06T 5/00** (2006.01)
- (21) 국제출원번호: PCT/KR2013/009314
- (22) 국제출원일: 2013년 10월 18일 (18.10.2013)
- (25) 출원언어: 한국어
- (26) 공개언어: 한국어
- (30) 우선권정보: 10-2013-0079884 2013년 7월 8일 (08.07.2013) KR
- (71) 출원인: (주)안세기술 (ANSE TECHNOLOGIES CO., LTD.) [KR/KR]; 152-740 서울시 구로구 디지털로 26길 5, 에이스하이엔드타워 701호 (구로동), Seoul (KR). 인천국제공항공사 (INCHEON INTERNATIONAL AIRPORT CORPORATION) [KR/KR]; 400-700 인천시 중구 공항로 424번길 47 (운서동), Incheon (KR).
- (72) 발명자: 이기창 (LEE, Ki Chang); 412-820 경기도 고양시 덕양구 토당로 168, 2층 202호 (토당동, 동아3빌딩), Gyeonggi-do (KR).
- (74) 대리인: 진천웅 (JIN, Cheon Woong) 등; 135-855 서울특별시 강남구 도곡동 423-5 덕영빌딩 4층, Seoul (KR).
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- (84) 지정국 (별도의 표시가 없는 한, 가능한 모든 종류의 국내 권리의 보호를 위하여): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), 유라시아 (AM, AZ, BY, KG, KZ, RU, TJ, TM), 유럽 (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR),

[다음 쪽 계속]

(54) Title: HYBRID VISUAL INTERVAL INDUCING DEVICE

(54) 발명의 명칭 : 하이브리드 비주얼 주기 유도 장치



110 ... Camera
120 ... Focusing unit
130 ... Zoom control unit
140 ... First processing unit
150 ... Second processing unit
160 ... Monitoring unit
210 ... Distance measuring device
215 ... Motor
230 ... Third processing unit
240 ... Fourth processing unit
250 ... Distance extracting unit
260 ... Direction extracting unit
270 ... Video and laser aggregating unit
310 ... Recognizing unit
320 ... Storage unit
330 ... Display unit
340 ... Manual operation unit
350 ... First power supply unit
360 ... Second power supply unit
370 ... Inspection unit

(57) Abstract: The present invention relates to an interval inducing device and includes a first extracting unit extracting airplane image data from an image signal captured by a camera, a second extracting unit extracting airplane scan data from a signal scanned with a 3D laser scanner, and a control unit generating airplane location data obtained by aggregating the airplane image data with the airplane scan data and thus providing a distance to an interval target location and a direction to induce an interval. Accordingly, the hybrid visual interval inducing device has an effect in that it is possible to determine the type of an airplane quickly and accurately by combining the advantage of a camera-based inducing method with that of a laser-based inducing method.

(57) 요약서: 본 발명은 주기 유도 장치에 관한 것으로, 카메라로 촬영한 영상 신호로부터 항공기 이미지 데이터를 추출하는 제 1 추출부, 3차원 레이저 스캐너로 스캔한 신호로부터 항공기 스캔 데이터를 추출하는 제 2 추출부 및 항공기 이미지 데이터와 항공기 스캔 데이터를 병합한 항공기 위치 데이터를 생성하여 주기 목표 위치와의 거리 및 방향을 제공하여 주기를 유도하는 제어부를 포함하여 카메라를 이용한 유도 방식과 레이저를 이용한 유도방식의 장점을 결합하여 빠르고 정확하게 항공기의 종류를 판별할 수 있다는 효과가 있는 하이브리드 비주얼 주기 유도 장치에 관한 것이다.



OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

공개:

— 국제조사보고서와 함께 (조약 제 21 조(3))

명세서

발명의 명칭: 하이브리드 비주얼 주기 유도 장치

기술분야

- [1] 본 발명은 하이브리드 비주얼 주기 유도 장치에 관한 것이다.
[2]

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- [5] 이 때 조종사는 정해진 탑승구에 탑승교 접현 위치까지 항공기를 이동시키는데 이를 보조하기 위해서 종래에는 항공기 유도사(Mashaller)가 4인 1조로 항공기를 정해진 위치까지 유도하였다. 항공기 유도사는 양손에 패들(Paddle, 유도판)을 들고 수신호로 항공기를 정해진 위치까지 유도한다. 그러나 항공기가 워낙 커서 혼자서 항공기 진입로를 다 볼 수 없기 때문에 이들은 4인 1조로 일을 하는데, 날개 쪽 좌우에 워그 가이드뱀을 1명씩 배치하고 한 명은 앞바퀴가 멈추어야 하는 라인 옆에, 그리고 항공기 유도사는 항공기 전면에 있는 유도대(臺) 위에 서서 유도한다.
- [6] 조종실에서는 정지선이 보이지 않기 때문에 이들은 끝까지 기장과 눈을 맞추면서 선회, 직진, 서행, 정지 등의 신호를 보내서 노랑색 정지선에 정확하게 앞바퀴가 정렬하도록 한다. 그러나 항공기 유도사를 활용한 주기 유도 시스템은 항공기 유도사의 안전, 인건비 소요, 정확성, 심야근무자 확보곤란 및 인력수급의 어려움으로 인해 점차 그 수가 줄어들고 있다.
- [7] 이에 직접 항공기 유도사가 항공기를 유도하는 것이 아닌 디스플레이 장치를 활용하여 항공기를 유도하는 시각 주기 유도 시스템(VDGS : Visual Docking Guidance System)이 도입되었다. 그 중에서도 카메라를 이용한 시각 주기 유도 시스템은 항공기의 영상 이미지를 획득하고 그로부터 항공기의 윤곽선을 추출하여 항공기의 기종과 형상을 판별하며, 항공기 위치를 유도하는 방식으로 동작한다.
- [8] 그러나 카메라를 이용하여 유도하는 방식은 안개나 눈, 비 등이 심한 악천후에 획득되는 영상이 열악하고, 야간의 영상획득을 위하여 조명이 필수적으로 요구되며, 판별오류가 발생하는 단점이 있다.

대체용지 (규칙 제26조)

- [9] 최근에는 이러한 단점을 보완하기 위하여 단일 포인트로 강력한 광 에너지를 집중하여 송출하고 이를 이용하여 항공기를 스캔하는 레이저 스캔 방식이 많이 사용되고 있다. 레이저 빔을 이용하여 영상 이미지를 획득하는 개선된 시각 주기 유도 시스템(A-VDGS : Advanced-VDGS) 장치는 점 광원인 레이저 빔(Laser Beam)을 사용하므로 영상 이미지를 획득하기 위해서는 수많은 화소(Point Cloud)를 형성할 수 있도록 수직 및 수평축으로 주사(Scanning)하여야 한다. 또한 해상도가 높은 영상을 얻기 위해서는 더 많은 화소의 고속 스캔이 요구되어 한 프레임의 영상을 얻는데 더 많은 시간이 소요된다. 따라서 기존 방식으로는 일정 수의 특징적인 부위의 위치정보만을 토대로 항공기를 판별하고 추적 및 유도할 수밖에 없어 정확한 판별과 추적 및 유도에 한계가 있었다.

[10]

발명의 상세한 설명 기술적 과제

- [11] 본 발명은 상기한 바와 같은 문제점을 해결하기 위하여 제안된 것으로, 카메라를 이용한 방식과 레이저 스캐너를 이용한 방식을 결합한 하이브리드 비주얼 주기 유도 장치에 관한 것이다.

[12]

과제 해결 수단

- [13] 상기와 같은 기술적 과제를 해결하기 위해, 본 발명의 하이브리드 비주얼 주기 유도 장치는 카메라로 촬영한 영상 신호로부터 항공기 이미지 데이터를 추출하는 제1 추출부, 3차원 레이저 스캐너로 스캔한 신호로부터 항공기 스캔 데이터를 추출하는 제2 추출부 및 상기 항공기 이미지 데이터와 상기 항공기 스캔 데이터를 병합한 항공기 위치 데이터를 생성하여 주기 목표 위치와의 거리 및 방향을 제공하여 주기를 유도하는 제어부를 포함한다.
- [14] 본 발명의 일 실시 예에 따른 상기 제1 추출부는, 비디오 영상을 촬영하는 카메라, 상기 카메라로 촬영한 비디오 영상을 디지털 이미지로 변환하고, 변환된 상기 디지털 이미지로부터 항공기 데이터를 얻기 위해 영상처리 작업을 수행하는 제1 처리부 및 상기 제1 처리부의 출력으로부터 에지(Edge)를 추출하고, 항공기를 제외한 배경 이미지나 불필요한 영상부분을 마스킹(Masking) 처리하는 제2 처리부를 포함하는 것이 바람직하다.
- [15] 본 발명의 일 실시 예에 따른 상기 제1 추출부는, 상기 카메라를 이용하여 항공기 주기장 상태를 모니터링하는 모니터링부를 더 포함하는 것이 바람직하다.
- [16] 본 발명의 일 실시 예에 따른 상기 제1 추출부는 상기 카메라로 촬영한 비디오 영상에 대해서 오토 포커싱(Auto Focusing)을 수행하는 초점 조절부를 더 포함하는 것이 바람직하다.
- [17] 본 발명의 일 실시 예에 따른 상기 제1 추출부는, 상기 카메라로 촬영한 비디오

영상의 특정 영역을 확대하거나 전체 영역을 축소하는 줌 제어부를 더 포함하는 것이 바람직하다.

- [18] 본 발명의 일 실시 예에 따른 상기 제2 추출부는, 3차원 레이저 스캐너를 이용하여 항공기 스캔 이미지를 추출하고, 항공기의 거리 정보를 측정하는 레이저 스캐너부를 포함하고, 상기 레이저 스캐너부는 레이저 빔을 송출하는 송출부와 송출된 레이저 빔의 반사파를 수신하는 수신부를 구비하고 송출된 레이저 빔과 수신된 반사파의 도달 시간 이용하여 항공기와의 거리 정보를 측정하는 거리 측정부, 상기 거리 측정부를 회전시키는 모터 및 상기 송출부에서 레이저 빔을 송출되는 방향과 다른 방향으로 굴절시키기 위한 하나 이상의 굴절부를 포함하고, 상기 모터는 레이저 거리 측정 장치와 동일한 회전축에서 회전하는 것이 바람직하다.
- [19] 본 발명의 일 실시 예에 따른 상기 굴절부는, 상기 항공기의 상체를 스캔하기 위한 제1 삼각 미러, 상기 항공기의 하체를 스캔하기 위한 제2 삼각 미러, 상기 항공기의 코(Nose)부분을 스캔하기 위한 제1 평면 미러 및 상기 항공기의 꼬리(Tail)부분을 스캔하기 위한 제2 평면 미러로 구성된 것이 바람직하다.
- [20] 본 발명의 일 실시 예에 따른 상기 제2 추출부는, 상기 레이저 스캐너부로부터 항공기 스캔 이미지와 항공기의 거리정보를 수신하여 불필요한 부분을 제거하는 제3 처리부를 더 포함하는 것이 바람직하다.
- [21] 본 발명의 일 실시 예에 따른 상기 제2 추출부는, 상기 제3 처리부로부터 불필요한 부분이 제거된 항공기 스캔 이미지와 항공기의 거리정보를 이용하여 항공기의 에지 정보를 추출하고 상기 거리정보를 결합하여 항공기 스캔 데이터를 추출하는 제4 처리부를 더 포함하는 것이 바람직하다.
- [22] 본 발명의 일 실시 예에 따른 상기 제어부는, 상기 제1 추출부에서 추출한 항공기 이미지 데이터와 상기 제2 추출부에서 추출한 항공기 스캔 데이터를 병합하여 항공기의 이미지 데이터인 항공기 템플릿과 항공기의 규격정보를 포함하는 항공기 데이터 프로파일을 작성하는 비디오 레이저 병합부, 공항 전산 시스템과 네트워크를 통해 연결되고, 항공기의 스케줄과 항공기 기종에 관한 항공기 정보를 저장하는 저장부 및 상기 항공기 템플릿 및 항공기 데이터 프로파일과 상기 저장부에 저장된 항공기 정보를 비교하여 주기 대상 항공기를 인식하는 인식부로 구성된 것이 바람직하다.
- [23] 본 발명의 일 실시 예에 따른 상기 제어부는, 상기 인식부의 항공기 인식 결과에 따른 정보를 이용하여 항공기 조종사에게 주기 유도를 위한 정보를 디스플레이하는 디스플레이부를 더 포함하는 것이 바람직하다.
- [24] 본 발명의 일 실시 예에 따른 상기 제어부는, 교류 상용 전원을 직류로 변환하여 상기 하이브리드 비주얼 주기 유도 장치에 필요한 전력을 공급하는 제1 전력공급부 및 교류 상용전원이 정전인 경우 직류전압을 직접 공급하는 제2 전력 공급부를 더 포함하는 것이 바람직하다.
- [25] 본 발명의 일 실시 예에 따른 상기 제어부는, 상기 하이브리드 비주얼 주기 유도

장치를 점검하는 점검부를 더 포함하고, 상기 점검부는 상기 하이브리드 비주얼 주기 유도 장치의 기준값 정보를 저장하고 시스템 점검시 저장된 상기 기준값 정보와 측정값 정보를 비교하여 시스템의 이상 유무를 판단하는 것이 바람직하다.

- [26] 본 발명의 일 실시 예에 따른 상기 기준값 정보는, 상기 하이브리드 비주얼 주기 유도 장치와 가장 가까운 정지선과 중심진행선의 교차점을 기준점으로 하고, 상기 하이브리드 비주얼 주기 유도 장치와 상기 기준점까지의 거리인 거리정보, 상기 기준점과 수직면상의 각도 차이인 수직각 정보 및 상기 기준점과 수평면상의 각도 차이인 수평각 정보를 포함하는 것이 바람직하다.
- [27] 본 발명의 일 실시 예에 따른 상기 제2 추출부는, 3차원 레이저 스캐너를 이용하여 항공기 스캔 이미지를 추출하고, 항공기의 거리 정보를 측정하는 레이저 스캐너부를 포함하고, 상기 레이저 스캐너부는 레이저 빔을 송출하는 송출부와 송출된 레이저 빔의 반사파를 수신하는 수신부를 구비하고 송출된 레이저 빔과 수신된 반사파의 도달 시간을 이용하여 항공기와의 거리 정보를 측정하는 거리 측정부, 상기 레이저 거리 측정 장치로부터 송출된 상기 레이저 빔을 송출된 방향과 수직한 방향으로 굴절시키기 위한 회전 거울, 상기 회전거울에 의해 굴절된 레이저 빔을 회전거울에 의해 굴절된 방향과 수직한 방향으로 굴절시키기 위한 하나 이상의 굴절부 및 상기 회전거울과 동일한 회전축에서 회전하는 구동부로 구성된 것이 바람직하다.
- [28] 본 발명의 일 실시 예에 따른 상기 굴절부는, 상기 항공기의 상체를 스캔하기 위한 제1 삼각 미러, 상기 항공기의 하체를 스캔하기 위한 제2 삼각 미러, 상기 항공기의 코(Nose)부분을 스캔하기 위한 제1 평면 미러 및 상기 항공기의 꼬리(Tail)부분을 스캔하기 위한 제2 평면 미러로 구성된 것이 바람직하다.
- [29] 본 발명의 일 실시 예에 따른 상기 제어부는, 항공기 정면도와 평면도 데이터인 이미지 템플릿 및 항공기의 특징부분의 규격과 각도 데이터인 데이터 프로파일이 저장된 저장부를 포함하고, 상기 항공기 이미지 데이터와 상기 이미지 템플릿을 비교하는 단계와 상기 항공기 스캔 데이터와 상기 데이터 프로파일을 비교하는 단계를 거쳐 항공기를 판별하는 것이 바람직하다.

[30]

발명의 효과

- [31] 상기와 같은 본 발명은 비디오 카메라를 이용한 유도 방식과 레이저 스캐너를 이용한 유도방식의 장점을 결합하여 빠르고 정확하게 항공기의 종류를 판별할 수 있다는 효과가 있다.
- [32] 또한 본 발명은 레이저 방식을 이용하여 열악한 기상상황에서도 정확하고 정밀한 주기 유도할 수 있다는 효과가 있다.
- [33] 또한 본 발명은 이미지 템플릿과 데이터 프로파일의 이중의 매칭 시스템을 이용하여 정확성과 신뢰도를 향상시키는 효과가 있다.

[34] 또한 본 발명은 하이브리드 비주얼 주기 유도 장치의 교정을 수행하여 장비의 오류를 방지하는 효과가 있다.

[35] 또한 본 발명은 비디오 영상이 악천후 등에 의해 작동이 불가능한 경우에는 레이저 스캐너에 의한 데이터를 사용하고, 레이저 스캐너가 작동이 불가능한 경우에는 비디오 영상을 사용하여 어느 한 방식이 작동하지 않는 경우 나머지 방식에 의해 보완이 가능한 효과가 있다.

[36]

도면의 간단한 설명

[37] 도 1은 본 발명의 일 실시 예에 따른 하이브리드 비주얼 주기 유도 장치의 구성을 간략하게 나타낸 블록도이다.

[38] 도 2는 본 발명의 일 실시 예에 따른 하이브리드 비주얼 주기 유도 장치의 제1 추출부의 구성을 나타낸 블록도이다.

[39] 도 3은 본 발명의 일 실시 예에 따른 하이브리드 비주얼 주기 유도 장치의 레이저 스캐너부(210)의 일 실시 예를 나타낸 것이다.

[40] 도 4는 본 발명의 일 실시 예에 따른 하이브리드 비주얼 주기 유도 장치의 레이저 스캐너부(210)의 또 다른 일 실시 예를 나타낸 것이다.

[41] 도 5는 본 발명의 일 실시 예에 따른 하이브리드 비주얼 주기 유도 장치의 제2 추출부의 구성을 나타낸 블록도이다.

[42] 도 6은 본 발명의 일 실시 예에 따른 하이브리드 비주얼 주기 유도 장치의 제어부(300)의 구성을 나타낸 것이다.

[43] 도 7은 각 항공기 제조사에서 제공하는 항공기들의 규격을 비교한 예를 나타낸 것이다.

[44] 도 8은 카메라(110) 및 거리 측정부(211)에 의해 획득한 최종 항공기의 정면도를 나타낸 것이다.

[45] 도 9는 카메라(110) 및 거리 측정부(211)에 의해 획득한 항공기 이미지의 평면도이다.

[46] 도 10 및 11은 본 하이브리드 비주얼 주기 유도 장치의 교정 기능을 설명하기 위한 것이다.

[47] 도 12는 본 발명의 일 실시 예에 따른 하이브리드 비주얼 주기 유도 장치의 전체적인 구성도를 나타낸 것이다.

[48] 도 13은 본 발명의 일 실시 예에 따른 하이브리드 비주얼 주기 유도 장치의 동작방법을 나타낸 순서도이다.

[49]

발명의 실시를 위한 최선의 형태

[50] 본 발명의 실시를 위한 최선의 형태는 도 1에 도시된 하이브리드 비주얼 주기 유도 장치이다.

[51] 도 1에 따르면 본 발명의 하이브리드 비주얼 주기 유도 장치는 카메라를

이용하여 항공기 이미지를 추출하는 제1 추출부(100), 3차원 레이저 스캐너를 이용하여 항공기 스캔 데이터를 추출하는 제2 추출부(200) 및 항공기 이미지와 항공기 스캔 데이터를 이용하여 지정된 주기 위치까지의 거리와 방향 데이터를 제공하는 제어부(300)를 포함할 수 있다.

[52] 제1 추출부(100)는 카메라를 이용하여 항공기 이미지를 촬영하고, 항공기 이미지로부터 항공기의 에지(Edge)를 추출하고 배경 이미지나 불필요한 부분을 제거한 항공기 이미지를 추출할 수 있다.

[53] 제2 추출부(200)는 3차원 고속 레이저 스캐너를 이용하여 항공기까지의 거리나 방향 정보를 포함하는 항공기 스캔 데이터를 추출할 수 있다.

[54] 제어부(300)는 제1 추출부 및 제2 추출부의 출력을 이용하여 항공기의 기종을 판별하고, 항공기까지의 거리나 방향 정보를 항공기 파일럿에게 제공할 수 있다.

[55]

발명의 실시를 위한 형태

[56] 본 발명은 다양한 변경을 가할 수 있고 여러 가지 실시 예를 가질 수 있는바, 특정 실시 예들을 도면에 예시하고 상세하게 설명하고자 한다. 그러나 이는 본 발명을 특정한 실시 형태에 대해 한정하려는 것이 아니며, 본 발명의 사상 및 기술범위에 포함되는 모든 변경, 균등물 내지 대체물을 포함하는 것으로 이해되어야 한다.

[57] 이하, 첨부된 도면을 참조하여 본 발명에 따른 바람직한 일 실시 예를 상세히 설명한다.

[58] 도 2는 본 발명의 일 실시 예에 따른 하이브리드 비주얼 주기 유도 장치의 제1 추출부(100)의 구성을 나타낸 블록도이다.

[59] 도 2에 따르면, 본 발명의 제1 추출부(100)는 카메라(110), 초점 조절부(120), 줌 제어부(130), 제1 처리부(140) 및 제2 처리부(150)를 포함할 수 있다.

[60] 카메라(110)는 본 발명의 하이브리드 비주얼 주기 유도 장치의 전방을 촬영한 결과를 전기적 신호로 변환하는 장치이다. 카메라(110)는 CCD(Charge-Coupled Device) 카메라, CMOS(Complementary Metal Oxide Semiconductor) 카메라뿐만 아니라, 다양한 카메라가 사용될 수 있으며 특정 종류의 카메라에 한정되지 않는다.

[61] 초점 조절부(120)는 카메라(110)의 초점을 최적의 상태로 유지할 수 있도록, 카메라의 상태에 따라 자동으로 초점을 조절할 수 있다. 또한 초점 조절부(120)는 카메라(110)로 촬영한 이미지에 대해서 오토 포커싱(Auto Focusing) 기능을 수행할 수 있다.

[62] 줌 제어부(130)는 카메라(110) 촬영시 특정 영역을 확대하거나 축소하는 부분으로, 상술한 초점 조절부(120)와 줌 제어부(130)의 입력신호를 받아 카메라(110)는 최적의 이미지를 촬영할 수 있다.

[63] 제1 처리부(140)는 카메라(110)가 촬영한 이미지의 전기적 신호를 수신하여

- 적절한 해상도를 갖는 디지털 이미지로 변환할 수 있다. 또한, 제1 처리부(140)는 변환한 디지털 이미지 신호에 대해서 다양한 이미지 처리를 할 수 있다.
- [64] 즉, 제1 처리부(140)는 카메라(110)가 촬영한 이미지를 디지털 이미지로 변환하고, 변환된 항공기 디지털 이미지로부터 필요한 각종 데이터를 획득하기 위해 대수연산, 논리연산, 명암대비 확장 또는 변환, 히스토그램 평활화(Histogram Equalization), 샤프닝(Sharpening)등의 영상처리 작업을 수행할 수 있다. 제1 처리부(140)는 다양한 영상처리 작업을 수행하고 영상 처리가 완료된 이미지를 제2 처리부(150)로 전송할 수 있다.
- [65] 제2 처리부(150)는 항공기의 기종을 판별하거나 항공기의 추적을 위해서 전송받은 이미지 신호에 Roberts, Prewitt, Sobel, Frei-Chen등의 1차 미분 연산자나, 라플라시안(Laplacian), 가우시안 라플라시안(LOG : Laplacian of Gaussian), 가우시안 차(DOG : Difference of Gaussian) 연산자 등의 2차 미분 연산자를 사용할 수 있다. 제2 처리부(150)는 상술한 1차 또는 2차 미분연산자를 사용하여 이미지 신호로부터 항공기 에지(Edge)를 추출하고, 항공기 이미지를 제외한 배경 이미지나 불필요한 영상부분을 마스킹(Masking) 처리할 수 있다. 항공기의 에지(Edge)를 추출하고 배경 이미지나 불필요한 영상부분을 마스킹 처리한 항공기 이미지 데이터는 제어부(300)내 비디오/레이저 병합부(310)로 전송될 수 있다.
- [66] 본 발명의 일 실시 예에 따른 하이브리드 비주얼 주기 유도 장치는 모니터링부(160)를 더 포함할 수 있다.
- [67] 모니터링부(160)는 카메라(110)에서 획득한 영상 이미지를 이용하여 항공기 주기장 상태를 모니터링하고 공항의 중앙감시반에서 장비 운용자나 관리자들은 모니터링부(160)를 이용하여 영상을 감시하거나 저장할 수 있다.
- [68] 또한 모니터링부(160)는 필요한 이미지 검색을 위해서 카메라(110)를 이용할 수 있다.
- [69] 도 3은 본 발명의 일 실시 예에 따른 하이브리드 비주얼 주기 유도 장치의 레이저 스캐너부(210)의 일 실시 예를 나타낸 것이다.
- [70] 도 3에 따르면 본 발명의 레이저 스캐너부(210)는 거리 측정부(211), 회전 원판(214), 모터(215), 삼각 미러(216, 217), 평면 미러(218, 219) 및 미러 회전모터(220, 221, 222, 223)를 포함할 수 있다.
- [71] 거리 측정부(211)는 레이저 빔을 발생시켜 송출하고, 항공기로부터 반사된 레이저 빔을 수신하는 전자회로를 포함할 수 있다.
- [72] 거리 측정부(211)는 내부에 레이저 송신용 레이저 다이오드(212)(LD : Laser Diode)와 레이저 수신용 포토 다이오드(213)(PD: Photo Diode) 또는 아발란체 포토 다이오드(APD: Avalanche Photo Diode)를 포함할 수 있다. 또한, 레이저 다이오드와 포토다이오드 외에도 이들을 레이저 송신 펄스와 반사파 수신 펄스의 시각 차이를 측정하고 그로부터 반사점의 거리를 계산하는 전자회로 및 소프트웨어를 포함할 수 있다.

- [73] 회전 원판(214)은 거리 측정부(211)를 고정하는 수단일 수 있다.
- [74] 또한 모터(215)는 회전 원판(214)을 회전시키는 동력을 제공하며, 스텝핑 모터(Stepping motor) 또는 서보 모터(Servo motor)가 사용될 수 있으나, 어느 하나에 한정되는 것은 아니다. 모터(215)에 의해서 거리 측정부(211)는 360도 방향으로 회전을 하며 스캐닝을 실시한다.
- [75] 레이저 스캐너부(210)의 거리 측정부(211)의 외부에 네 방향에 걸쳐 미러(216, 217, 218, 219)들이 위치할 수 있다. 미러(216, 217, 218, 219)들은 레이저 다이오드(212)에서 발생한 레이저 빔을 90도 각도로 굴절시켜 수평방향으로 송신하고, 레이저 광을 수신할 때도 입사하는 방향으로부터 수평방향으로 들어온 반사와 신호를 90도 각도로 굴절시켜 거리 측정부(211)의 수광소자인 포토 다이오드(213) 또는 아발란체 포토 다이오드 쪽으로 입사시킨다.
- [76] 본 발명의 일 실시 예에 따른 하이브리드 비주얼 주기 유도 장치에 사용되는 레이저 스캐너부(210)의 경우 평면 미러(218, 219)와 삼각 미러(216, 217)의 두 가지 종류의 미러가 사용될 수 있으나, 그 구성 방법에 따라 다양한 형태와 숫자의 미러가 사용될 수 있다.
- [77] 거리 측정부(211)는 한 번 회전 하는 동안에 네 개의 미러(216, 217, 218, 219)들을 이용하여 각기 다른 네 지점으로 레이저 빔을 송수신함으로써 여러 지점의 거리와 방향을 동시에 측정할 수 있다.
- [78] 제1 삼각 미러(216)는 항공기의 윗 부분(상체) 스캔에 사용되고, 제2 삼각 미러(217)는 항공기의 아랫부분(하체) 스캔에 사용될 수 있다.
- [79] 또 제1 평면 미러(218)는 항공기의 코(Nose) 부분을 향하도록 구성되어 항공기의 감지(Detection), 추적(Tracking) 및 거리(Distance)측정을 할 수 있다.
- [80] 제2 평면 미러(219)는 항공기의 꼬리(Tail)부분의 거리 측정과 제1 평면 미러와 함께 항공기 방향(Azimuth)을 측정할 수 있다.
- [81] 미러 회전모터(220, 221, 222, 223)는 각 미러에 연결되고, 미러를 회전시키며 각각 독립하여 작동할 수 있다.
- [82] 도 4는 본 발명의 일 실시 예에 따른 하이브리드 비주얼 주기 유도 장치의 레이저 스캐너부(210)의 또 다른 일 실시 예를 나타낸 것이다.
- [83] 도 4에 따르면, 본 발명의 하이브리드 비주얼 주기 유도 장치에 사용되는 레이저 스캐너부(21)는 도 3의 경우와 같이 거리 측정부(211) 자체를 회전시킬 수도 있지만, 도 4와 같이 회전 미러(214')를 구비하고, 회전 미러를 회전시키는 회전 미러 모터(215')를 이용하여 고정된 거리 측정부(211)로부터 송출된 레이저 빔을 전방으로 굴절시켜 전송하고 반사파를 수신함으로써 보다 효율적이고 안정된 구조를 구현할 수 있다..
- [84] 도 4와 같은 구성에 따르면, 본 발명의 일 실시 예에 따른 하이브리드 비주얼 주기 유도 장치의 레이저 스캐너부(210)는 레이저 거리 측정부(211)를 직접 회전시키지 않기 때문에 보다 높은 내구도를 갖는 하이브리드 비주얼 주기 유도 장치를 구현할 수 있다.

- [85] 도 5는 본 발명의 일 실시 예에 따른 하이브리드 비주얼 주기 유도 장치의 제2 추출부의 구성을 나타낸 블록도이다.
- [86] 도 5에 따르면, 본 발명의 제2 추출부는 레이저 스캐너부(210), 제3 처리부(230), 제4 처리부(240), 거리 추출부(250) 및 방향 추출부(260)를 포함할 수 있다.
- [87] 레이저 스캐너부(210)는 3차원 레이저 스캐너로 그 형태가 다양하게 구성될 수 있으며, 특정 3차원 레이저 스캐너에 한정되지 않는다. 다만, 본 발명에서 사용되는 3차원 레이저 스캐너의 일 실시 형태는 상술한 도 4 및 도 5에 대한 설명과 동일하므로 이하 상세한 설명은 생략한다. 레이저 스캐너부(210)는 3차원 레이저 스캐너를 통해 스캔하고자 하는 목표물을 3차원으로 스캔할 수 있다. 본 발명에서는 하이브리드 비주얼 주기 유도 장치로부터 항공기의 특정 지점까지의 거리 및 방향 정보를 추출할 수 있다.
- [88] 제3 처리부(230)는 레이저 스캐너부(210)의 거리 측정부(211), 모터(215), 제1 삼각 미러(216), 제2 삼각 미러(217) 및 제1, 2 삼각 미러를 회전시키는 미러 회전모터(220, 221)로부터 항공기의 윗부분 및 아랫부분의 거리 정보를 수신할 수 있다. 제3 처리부는 항공기의 윗부분 및 아랫부분의 거리 정보를 수신하고 불필요한 데이터를 제거하여 항공기 스캔 이미지로 변환할 수 있다. 또한 제3 처리부(230)는 거리 측정부(211)로부터 거리정보 측정 데이터를 수신하고, 모터(215)로부터 회전각 위치 데이터를 수신하여 각 위치에 따른 거리 정보를 토대로 불필요한 데이터를 제거하는 등 정확한 영상을 얻기 위한 작업을 수행할 수 있다. 제3 처리부(230)는 위 기술한 동작 외에도 정확한 항공기 위치 데이터를 얻기 위해 다양한 작업을 수행할 수 있다.
- [89] 제4 처리부(240)는 제3 처리부(230)의 거리정보 변화 함수의 출력을 미분하여 항공기의 에지(Edge)를 취득할 수 있다. 구체적으로 모터(215)와 미러 회전모터(220, 221, 222, 223)의 위치정보, 레이저 빔의 송출시각 및 각 반사파 도착시간 등의 정보를 바탕으로 각각의 이미지 및 측정 거리정보를 결합하여 최종 이미지와 데이터 정보를 저장한다. 그리하여 제3 처리부(230)의 출력을 바탕으로 최종 항공기 스캔 이미지와 거리 및 위치 데이터를 포함한 항공기 스캔 데이터를 비디오/레이저 병합부(310)로 전송할 수 있다.
- [90] 거리 추출부(250)와 방향 추출부(260)는 레이저 스캐너부(210)의 평면 미러(218, 219) 및 이들을 회전시키는 미러 회전모터(222, 223)로부터 수신한 데이터를 바탕으로 본 발명의 하이브리드 비주얼 주기 유도 장치로부터 항공기까지의 거리와 항공기의 방향을 추출할 수 있다.
- [91] 구체적으로, 제1 평면 미러(218)는 항공기의 코(Nose) 부분을 향하도록 구성되어 항공기의 감지(Detection), 추적(Tracking) 및 거리(Distance)측정을 할 수 있다.
- [92] 또한 제2 평면 미러(219)는 항공기의 꼬리(Tail)부분의 거리 측정과 제1 평면 미러와 함께 항공기 방향(Azimuth)을 측정할 수 있다.
- [93] 거리 추출부(250)는 제1 평면 미러(218)와 미러 회전모터(222)에 의해

계속적으로 항공기의 코끝 위치를 추적하여 항공기의 거리(Distance)를 실시간으로 측정할 수 있다. 측정된 거리 정보는 항공기의 정지지점으로부터 잔여거리를 실시간으로 계산하는데 사용될 수 있다. 계산된 잔여거리는 제어부(300)를 통해 항공기 조종사에게 제공될 수 있다.

- [94] 방향 추출부(34)는 제2 평면 미러(219)과 미러 회전모터(223)에 의해 계속적으로 항공기 코끝의 위치와 꼬리의 위치를 조합하여 항공기의 방향(Azimuth)을 실시간으로 특정하고, 중심선으로부터 항공기의 주행방향의 얼마나 차이가 나는지를 실시간으로 계산하여 항공기 조종사에게 제어부(300)를 통해 제공할 수 있다.
- [95] 도 6은 본 발명의 일 실시 예에 따른 하이브리드 비주얼 주기 유도 장치의 제어부(300)의 구성을 나타낸 것이다.
- [96] 도 6에 따르면 본 발명의 하이브리드 비주얼 주기 유도 장치의 제어부(300)는 비디오 레이저 병합부(310), 인식부(320), 저장부(330), 파일럿 디스플레이부(340), 수동조작유닛(350), 제1 전력공급부(360), 제2 예비 전력 공급부(370) 및 점검부(380)로 구성될 수 있다.
- [97] 비디오 레이저 병합부(310)는 제2 처리부(150)를 통해 처리된 항공기 이미지 데이터와 제4 처리부(240)를 통해 처리된 항공기 스캔 데이터를 병합할 수 있다. 구체적으로 비디오 레이저 병합부(310)의 항공기 이미지와 레이저 스캔 데이터 중 최종 항공기 스캔 이미지를 병합하여 최종 이미지를 완성하고 그에 따른 항공기의 특정 부분의 위치 데이터에 대한 프로파일(Profile)을 작성할 수 있다.
- [98] 항공기 특정부분의 위치 데이터는 기체 장(Body Length), 날개 폭(Wing Span), 코 높이(Nosal Height) 및 날개 각(Wing Angle)등의 데이터를 포함하며 그외 각 주요 부위의 길이나 각도 등의 데이터 프로파일을 별도의 텍스트 데이터 레코드의 형태로 저장될 수 있다.
- [99] 인식부(320)는 본 발명의 일 실시 예에 따른 하이브리드 비주얼 주기 유도 장치의 종합적인 제어 및 최종 처리 시스템 프로세서이다.
- [100] 인식부(320)는 비디오 레이저 병합부(310)로부터 얻은 최종 이미지 및 데이터를 기준으로 본 발명의 하이브리드 비주얼 주기 유도 장치의 목적인 항공기 기종 판별 및 주기 유도를 위한 종합적인 제어와 데이터 처리를 할 수 있다.
- [101] 즉, 인식부(320)는 비디오 레이저 병합부(310)로부터 얻은 최종 이미지로부터 저장부(330)에 저장된 항공기 이미지 템플릿 중 매칭되는 템플릿을 찾아내고, 동시에 기체 장(Body Length), 날개 폭(Wing Span), 코 높이(Nosal Height) 및 날개 각(Wing Angle)등 항공기 주요 부위의 길이나 각도 등의 프로파일을 저장부(330)에 미리 저장된 항공기 제작사의 각 기종별 데이터와 비교하여 완전히 정합 되는 기종을 판별할 수 있다.
- [102] 인식부(320)는 항공기의 기종을 판별한 뒤, 주기 유도를 위하여 목표지점과의 거리 및 방향 정보를 디스플레이부(340)에 표시하여 항공기 조종사가 이를

- 기초로 정해진 목표지점에 정확히 주기할 수 있다.
- [103] 인식부(320)는 이미지 템플릿과 데이터 프로파일을 비교하는 이중 매칭을 확인함으로써 판별 오류를 최소화하기 때문에 기존의 시각 주기 유도 시스템(VDGS)보다 정확성과 신뢰도를 크게 향상시킬 수 있다.
- [104] 수동조작유닛(350)은 본 발명의 하이브리드 비주얼 주기 유도 장치에 에러가 발생하거나 비상정지(Emergency Stop)가 발생한 경우 수동모드(Manual Mode)로 디스플레이부(340)에 필요한 정보를 디스플레이 할 수 있다.
- [105] 즉 하이브리드 비주얼 주기 유도 장치의 고장이나 작동이 어려운 상황에서 기본적인 주기를 위한 정보를 수동모드로 항공기 조종사를 위해 디스플레이부(340)에 표시할 수도 있다.
- [106] 제1 전력 공급부(360)는 본 발명의 하이브리드 비주얼 주기 유도 장치에 교류(AC)전압을 직류 24V로 변환하여 전원을 공급할 수 있다.
- [107] 또한 본 발명의 하이브리드 비주얼 주기 유도 장치는 교류 상용전원이 정전인 경우를 대비하여 직류전압을 직접 공급하는 제2 전력 공급부(370)를 더 포함할 수 있다.
- [108] 점검부(380)는 본 발명의 하이브리드 비주얼 주기 유도 장치의 이상 유무를 점검하고 교정(Calibration)할 수 있다. 점검부(380)의 동작에 대해서는 도 10 및 11에서 상세히 설명한다.
- [109] 도 7은 각 항공기 제조사에서 제공하는 항공기들의 규격을 비교한 예를 나타낸 것이다.
- [110] 도 7에 따르면, 휴즈(Hughes)사의 H-4 Spruce Goose, Myria AN-255, Airbus사의 A-380-800 및 보잉(Boeing)사의 B-747-8 모델의 각 규격을 비교한 것을 볼 수 있다.
- [111] 각각의 항공기는 날개 길이, 날개 각도, 기체 길이 및 코끝 높이 등이 상이하여 이들 요소들을 비교하여 각 항공기의 기종을 판별할 수 있다.
- [112] 도 7에 나타난 항공기는 일부 예시에 불과하며, 본 발명의 일 실시 예에 따른 하이브리드 비주얼 주기 유도 장치가 판별 가능한 항공기를 도시한 것이 아니다.
- [113] 도 8은 카메라(110) 및 거리 측정부(211)에 의해 획득한 최종 항공기의 평면도를 나타낸 것이다.
- [114] 도 8에 따르면, T(10)는 최원점인 항공기의 꼬리지점이고, N(20)은 항공기의 최근점인 코끝이다. L(30)과 R(40)은 각각 항공기의 최좌점 및 최우점이다. 또한 항공기의 날개각을 구하기 위해 W1(50) 및 W2(60)의 거리 및 위치각 정보를 획득하는데 이는 좌우 날개의 시작지점이다.
- [115] 비디오 영상이나 레이저 스캔에 따른 평면도는 명확하게 표현되지 않을 수 있으나, 항공기 높이와 본 발명의 하이브리드 비주얼 주기 유도 장치의 높이가 비슷하므로 주요 특징지점의 위치만 확인되면 항공기 기종 판별이 가능하다.
- [116] 도 9는 카메라(110) 및 거리 측정부(211)에 의해 획득한 항공기 이미지의 평면도이다.

- [117] 도 9에 따르면 최원점(10)과 최근점(20)을 연결한 중심선과 최좌점(30) 및 최측날개 시작지점(50)을 연결한 선이 이루는 각을 항공기 날개각(70)이라 한다.
- [118] 도 10 및 11은 본 하이브리드 비주얼 주기 유도 장치의 교정 기능을 설명하기 위한 것이다.
- [119] 도 11은 도 10을 위에서 바라본 평면도를 도시한 것이다.
- [120] 도 10에 따르면 본 발명의 하이브리드 비주얼 주기 유도 장치의 교정(Calibration) 기능은 주기적, 비주기적, 일 1회, 월 1회 등 횟수나 주기를 임의로 지정할 수 있다.
- [121] 하이브리드 비주얼 주기 유도 장치의 교정기능은 제어부(300)내 점검부(380)에서 수행될 수 있다. 본 발명의 하이브리드 비주얼 주기 유도 장치(700)는 다양한 위치에 설치될 수 있다. 도 10에서는 설명이 용이하도록 지지 수단(720)에 의해 고정된 것으로 되어 있으나, 이에 한정하는 것은 아니다.
- [122] 하이브리드 비주얼 주기 유도 장치의 교정방법은 다음과 같다. 항공기 유도로(taxiway)는 항공기의 주기 유도가 실시되는 도로를 의미한다. 항공기 유도로는 중심진행선(Centerline)(740)이 있고, 항공기의 정지 위치에는 다수의 정지선(Stopline)(730)이 존재한다. 항공기 기종에 따라 정지선의 위치가 각각 상이할 수 있다.
- [123] 본 발명의 하이브리드 비주얼 주기 유도 장치의 교정을 위해 기준이 되는 지점인 기준점(Reference Point)은 하이브리드 비주얼 주기 유도 장치에 가장 인접한 정지선인 인접정지선(731)과 중심진행선(740)의 교차점일 수 있다.
- [124] 본 발명의 하이브리드 비주얼 주기 유도 장치(700)로부터 기준점까지의 거리인 거리정보d(71)와 장치로부터 기준점(Reference Point)으로 투사되는 레이저 빔 경로의 수직 면에서의 각도를 나타내는 수직각정보 ϕ (72) 및 장치의 설치방향과 중심진행선(740)의 수평면에서의 각도를 나타내는 수평각정보 θ (73)를 사전에 측정하여 기준값으로 설정할 수 있다.
- [125] 따라서 본 발명의 하이브리드 비주얼 주기 유도 장치의 교정시 미리 설정된 거리정보d(71), 수직각정보 ϕ (72) 및 수평각정보 θ (73)의 기준값과 측정값을 비교하여, 오차범위 밖에 있는 경우, 자체 교정(Self Calibration)을 실시하여 본 발명의 하이브리드 비주얼 주기 유도 장치의 정확도를 높일 수 있다.
- [126] 도 12는 본 발명의 일 실시 예에 따른 하이브리드 비주얼 주기 유도 장치의 전체적인 구성도를 나타낸 것이다.
- [127] 도 12에 따르면 본 발명의 하이브리드 비주얼 주기 유도 장치의 전체적인 구성은 카메라(110)를 이용한 제1 추출부(100)와 3차원 레이저 스캐너부(210)를 이용한 제2 추출부(200) 그리고 제1 및 제2 추출부의 출력을 병합하여 주기를 유도하는 방식으로 동작하며, 그 구체적인 내용은 앞서 설명한 바와 동일하므로 생략한다.
- [128] 도 13은 본 발명의 일 실시 예에 따른 하이브리드 비주얼 주기 유도 장치의 동작방법을 나타낸 순서도이다.

- [129] 도 13에 따르면 먼저, 항공기의 착륙 일정 시간 전 하이브리드 비주얼 주기 유도 장치가 동작을 개시할 수 있다.
- [130] 하이브리드 비주얼 주기 유도 장치는 항공기의 도래가 예상되는 지점으로 레이저 빔을 발사하여 반사파의 수신 여부를 점검할 수 있다(S10). 이를 대기 모드라고 할 수 있고, 항공기가 감지되지 않으면, 계속 대기 모드에 있다가, 항공기가 감지되고 난 뒤 미리 설정해 놓은 시간 또는 거리에 항공기가 이르게 되면, 비디오 영상을 획득하고(S20), 획득된 영상으로부터 에지(Edge)를 검출할 수 있다(S21).
- [131] 비디오 영상은 카메라에 투시된 영상에서 한 프레임(Frame)의 영상을 포착(Catch)하는 방식으로 획득할 수 있다. 그와 동시에 항공기에 대한 레이저 이미지를 스캔하게 된다(S30). 레이저 이미지 스캔을 위해 레이저 스캐너부(210)의 제1 삼각 미러(216) 및 제2 삼각 미러(217)를 사용하여 레이저 이미지를 스캔하고, 스캔 이미지로부터 휘도 및 거리 값의 미분 값을 이용해서 에지 검출(Edge Detection) 및 에지 향상(Edge Enhancement)등의 처리를 할 수 있다(S31).
- [132] 비디오 영상과 레이저 스캔 이미지의 에지 검출이 끝나면 두 이미지를 하나로 병합하고(S40), 최종 에지를 추출하고, 이를 명암대비 확장 등의 기법으로 향상시킨다.
- [133] 그 뒤 항공기 몸체 등 필요하고 관심 있는 영상 이미지만 추출하고 나머지 불필요한 이미지를 마스킹(Masking)한다(S41).
- [134] 최종 이미지가 완성되면 저장부(330)내의 항공기 템플릿 데이터(S43)로부터 완성된 항공기 이미지 템플릿과 가장 일치하는 항공기 이미지 템플릿을 검색한 뒤, 그 차이가 미리 설정된 오차범위 내에 있는지를 판별한다(S44).
- [135] 오차범위 내에 해당하면, 항공기 트래킹(Tracking) 모드로 진입하지만, 그렇지 않은 경우에는 비디오 이미지 및 레이저 이미지를 다시 추출할 수 있다.
- [136] 한편, 레이저 스캔 이미지로부터 거리 정보 데이터를 추출할 수 있다.
- [137] 거리 정보 데이터는 최원점(The Farthest Point), 최근점(The Nearest Point), 최좌점(The Leftmost Point) 및 최우점(The Rightmost Point)에 대한 거리 및 각도 데이터를 포함한다(S32). 거리 정보 데이터를 이용하여 항공기의 기체 장(Body Length), 날개 폭(Wing Span), 코 높이(Nosal Height) 및 날개 각(Wing Angle)등의 값을 계산하고(S33), 그 결과를 텍스트 프로파일 레코드 형태로 항공기 프로파일을 작성한다(S34).
- [138] 또한 저장부(330)내에 항공기 프로파일 데이터(S36)로부터 해당 항공기 프로파일 데이터와 가장 유사한 프로파일을 추출하고 오차범위 내에 해당하는지를 비교한다(S35,S37). 비교한 결과 오차범위 내라면 트래킹 단계(S50)로 진입하지만, 그렇지 못한 경우에는 비디오 이미지 및 레이저 스캔 이미지를 다시 획득한다. 이 경우 불일치의 주 원인이 되는 항공기 진입속도를 낮추기 위해 항공기 조종사에게 천천히를 의미하는 "SLOW"를 출력할 수

있다(S38).

- [139] 일반적으로 공항에서는 공항 네트워크(S51)를 통해 운항정보관리시스템(FIMS : Flight Information Management System), 게이트 운영 시스템(GOS : Gate Operating System)등 공항 전산 시스템이 존재 하는데(S52), 항공기가 트래킹 모드로 진입하게 되면, 비디오와 레이저로부터 획득한 데이터가 운항정보상의 예정된 기종명과 상호 일치하는지 판단한다(S53).
- [140] 만일 공항내 운항정보관리시스템에 입력된 항공기 정보와 본 발명의 하이브리드 비주얼 주기 유도 장치가 검출한 항공기 정보가 불일치 하는 경우 운항 규정상 항공기 조종사에게 긴급정지(Emergency Stop)을 의미하는 "E.STOP"를 조종사에게 출력할 수 있다. 이 경우 동시에 자동모드에서 수동모드로 전환된다(S55).
- [141] 위와 같은 공항 전산 시스템은 공항 네트워크에 통신 인터페이스를 사용하여 접속할 수 있다.
- [142] 계획된 운항정보와 본 발명의 하이브리드 비주얼 주기 유도 장치가 판별한 항공기 정보가 일치하는 경우 항공기 모델 즉 기종명을 확정하고, 디스플레이부(340)를 통해 항공기 모델명을 예를 들어 "B-747-400"과 같이 기종명과 형명을 표시해주고 주기단계에 진입한다(S56,57,60)
- [143] 주기단계부터는 항공기를 계속 추적하면서 주행로의 중심선으로부터의 이격방향과 항공기 진입속도를 실시간으로 측정하여 정지지점까지의 거리, 주행로 중심선으로부터의 이격방향 및 항공기 진입속도의 항목들에 대해서 디스플레이부(340)를 통해 표시할 수 있다(S61).
- [144] 정지지점에서 0.1미터 이내가 되면 주기단계를 종료하고 항공기 조종사에게 정지를 의미하는 "STOP"를 출력할 수 있다(S62,63,64).
- [145] 만일 항공기 조종사가 정지 조작을 늦게 행하여 항공기가 정지지점으로부터 0.1미터 이상 초과하면 항공기 조종사에게 "TOO FAR"를 출력할 수 있다(S65,66).
- [146] 이상에서 본 발명에 따른 실시 예들이 설명되었으나, 이는 예시적인 것에 불과하며, 당해 분야에서 통상적 지식을 가진 자라면 이로부터 다양한 변형 및 균등한 범위의 실시예가 가능하다는 점을 이해할 것이다. 따라서, 본 발명의 진정한 기술적 보호 범위는 다음의 특허청구범위에 의해서 정해져야 할 것이다.

청구범위

- [청구항 1] 카메라로 촬영한 영상 신호로부터 항공기 이미지 데이터를 추출하는 제1 추출부;
3차원 레이저 스캐너로 스캔한 신호로부터 항공기 스캔 데이터를 추출하는 제2 추출부; 및
상기 항공기 이미지 데이터와 상기 항공기 스캔 데이터를 병합한 항공기 위치 데이터를 생성하여 주기 목표 위치와의 거리 및 방향을 제공하여 주기를 유도하는 제어부를 포함하는 하이브리드 비주얼 주기 유도 장치.
- [청구항 2] 제1항에 있어서, 상기 제1 추출부는,
비디오 영상을 촬영하는 카메라;
상기 카메라로 촬영한 비디오 영상을 디지털 이미지로 변환하고, 변환된 상기 디지털 이미지로부터 항공기 데이터를 얻기 위한 영상처리 작업을 수행하는 제1 처리부; 및
상기 제1 처리부의 출력으로부터 에지(Edge)를 추출하고, 항공기를 제외한 배경 이미지나 불필요한 영상부분을 마스킹(Masking) 처리하는 제2 처리부를 포함하는 하이브리드 비주얼 주기 유도 장치.
- [청구항 3] 제2항에 있어서, 상기 제1 추출부는,
상기 카메라를 이용하여 항공기 주기장 상태를 모니터링하는 모니터링부를 더 포함하는 하이브리드 비주얼 주기 유도 장치.
- [청구항 4] 제2항 내지 제3항 중 어느 한 항에 있어서, 상기 제1 추출부는,
상기 카메라로 촬영한 비디오 영상에 대해서 오토 포커싱(Auto Focusing)을 수행하는 초점 조절부를 더 포함하는 하이브리드 비주얼 주기 유도 장치.
- [청구항 5] 제 2항 내지 3항 중 어느 한 항에 있어서, 상기 제1 추출부는,
상기 카메라로 촬영한 비디오 영상의 특정 영역을 확대하거나 전체 영역을 축소하는 줌 제어부를 더 포함하는 하이브리드 비주얼 주기 유도 장치.
- [청구항 6] 제 1항에 있어서, 상기 제2 추출부는,
3차원 레이저 스캐너를 이용하여 항공기 스캔 이미지를 추출하고, 항공기의 거리 정보를 측정하는 레이저 스캐너부를 포함하고,
상기 레이저 스캐너부는,
레이저 빔을 송출하는 송출부와 송출된 레이저 빔의 반사파를 수신하는 수신부를 구비하고 송출된 레이저 빔과 수신된 반사파의 도달 시간 이용하여 항공기와의 거리 정보를 측정하는 거리 측정부;

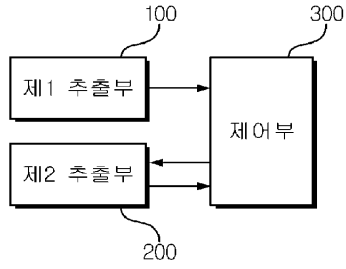
- 상기 거리 측정부를 회전시키는 모터;및
 상기 송출부에서 레이저 빔을 송출되는 방향과 다른 방향으로
 굴절시키기 위한 하나 이상의 굴절부를 포함하고,
 상기 모터는 레이저 거리 측정 장치와 동일한 회전축에서
 회전하는 하이브리드 비주얼 주기 유도 장치.
- [청구항 7] 제 6항에 있어서 상기 굴절부는,
 상기 항공기의 상체를 스캔하기 위한 제1 삼각 미러;
 상기 항공기의 하체를 스캔하기 위한 제2 삼각 미러;
 상기 항공기의 코(Nose)부분을 스캔하기 위한 제1 평면 미러;및
 상기 항공기의 꼬리(Tail)부분을 스캔하기 위한 제2 평면 미러로
 구성된 하이브리드 비주얼 주기 유도 장치.
- [청구항 8] 제 6항에 있어서 상기 제2 추출부는,
 상기 레이저 스캐너로부터 항공기 스캔 이미지와 항공기의
 거리정보를 수신하여 항공기 이외의 부분을 제거하는 제3
 처리부를 더 포함하는 하이브리드 비주얼 주기 유도 장치.
- [청구항 9] 제 8항에 있어서 상기 제2 추출부는,
 상기 제3 처리부로부터 불필요한 부분이 제거된 항공기 스캔
 이미지와 항공기의 거리정보를 이용하여 항공기의 에지 정보를
 추출하고 상기 거리정보를 결합하여 항공기 스캔 데이터를
 추출하는 제4 처리부를 더 포함하는 하이브리드 비주얼 주기 유도
 장치.
- [청구항 10] 제 1항에 있어서, 상기 제어부는,
 상기 제1 추출부에서 추출한 항공기 이미지 데이터와 상기 제2
 추출부에서 추출한 항공기 스캔 데이터를 병합하여 항공기의
 윤곽선 데이터인 항공기 템플릿과 항공기의 주요 규격정보를
 포함하는 항공기 데이터 프로파일을 작성하는 비디오 레이저
 병합부;
 공항 전산 시스템과 네트워크를 통해 연결되고, 항공기의
 스케줄과 항공기 기종에 관한 항공기 정보를 저장하는 저장부;및
 상기 항공기 템플릿 및 항공기 데이터 프로파일과 상기 저장부에
 저장된 항공기 스케줄 및 항공기 정보를 비교하여 주기 대상
 항공기를 인식하는 인식부로 구성된 하이브리드 비주얼 주기 유도
 장치.
- [청구항 11] 제 10항에 있어서, 상기 제어부는,
 상기 인식부의 항공기 인식 결과에 따른 결과로부터 항공기
 조종사에게 주기 위치와의 거리 및 방향 정보를 디스플레이하는
 디스플레이부를 더 포함하는 하이브리드 비주얼 주기유도 장치.
- [청구항 12] 제 1항에 있어서, 상기 제어부는,

- 교류 상용 전원을 직류로 변환하여 상기 하이브리드 비주열 주기 유도 장치에 필요한 전력을 공급하는 제1 전력공급부 및 교류 상용전원이 정전인 경우 직류전압을 직접 공급하는 제2 전력 공급부를 더 포함하는 하이브리드 비주열 주기 유도 장치.
- [청구항 13] 제 1항에 있어서, 상기 제어부는, 상기 하이브리드 비주열 주기 유도 장치를 점검하는 점검부를 더 포함하고, 상기 점검부는 상기 하이브리드 비주열 주기 유도 장치의 기준값 정보를 저장하고 시스템 점검시 저장된 상기 기준값 정보와 측정값 정보를 비교하여 시스템의 이상 유무를 판단하는 하이브리드 비주열 주기 유도 장치.
- [청구항 14] 제 13항에 있어서, 상기 기준값 정보는, 상기 하이브리드 비주열 주기 유도 장치와 가장 가까운 정지선과 중심진행선의 교차점을 기준점으로 하고, 상기 하이브리드 비주열 주기 유도 장치와 상기 기준점까지의 거리인 거리정보; 상기 기준점과 수직면상의 각도 차이인 수직각 정보; 및 상기 기준점과 수평면상의 각도 차이인 수평각 정보를 포함하는 하이브리드 비주열 주기 유도 장치.
- [청구항 15] 제 1항에 있어서 상기 제2 추출부는, 3차원 레이저 스캐너를 이용하여 항공기 스캔 이미지를 추출하고, 항공기의 거리 정보를 측정하는 레이저 스캐너부를 포함하고, 상기 레이저 스캐너부는 레이저 빔을 송출하는 송출부와 송출된 레이저 빔의 반사파를 수신하는 수신부를 구비하고 송출된 레이저 빔과 수신된 반사파의 도달 시간을 이용하여 항공기와의 거리 정보를 측정하는 거리 측정부; 상기 레이저 거리 측정 장치로부터 송출된 상기 레이저 빔을 송출된 방향과 수직한 방향으로 굴절시키기 위한 회전 거울; 상기 회전거울에 의해 굴절된 레이저 빔을 회전거울에 의해 굴절된 방향과 수직한 방향으로 굴절시키기 위한 하나 이상의 굴절부; 및 상기 회전거울과 동일한 회전축에서 회전하는 구동부로 구성된 하이브리드 비주열 주기 유도 장치.
- [청구항 16] 제 15항에 있어서 상기 굴절부는, 상기 항공기의 상체를 스캔하기 위한 제1 삼각 미러; 상기 항공기의 하체를 스캔하기 위한 제2 삼각 미러; 상기 항공기의 코(Nose)부분을 스캔하기 위한 제1 평면 미러; 및 상기 항공기의 꼬리(Tail)부분을 스캔하기 위한 제2 평면 미러로 구성된 하이브리드 비주열 주기 유도 장치.

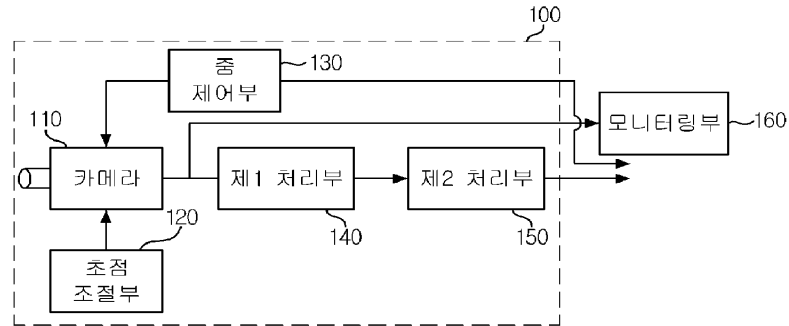
[청구항 17]

제 1항에 있어서, 상기 제어부는,
항공기 정면도와 평면도 데이터인 이미지 템플릿 및 항공기의
특정부분의 규격과 각도 데이터인 데이터 프로파일이 저장된
저장부를 포함하고,
상기 항공기 이미지 데이터와 상기 이미지 템플릿을 비교하는
단계와 상기 항공기 스캔 데이터와 상기 데이터 프로파일을
비교하는 단계를 거쳐 항공기를 판별하는 하이브리드 비주얼 주기
유도 장치.

[Fig. 1]

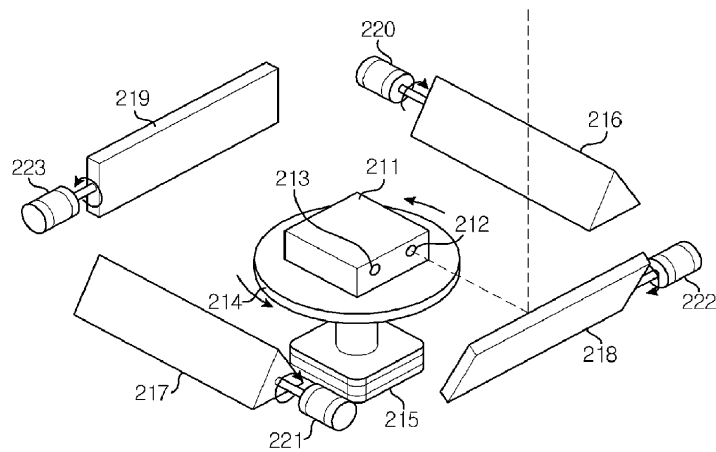


[Fig. 2]

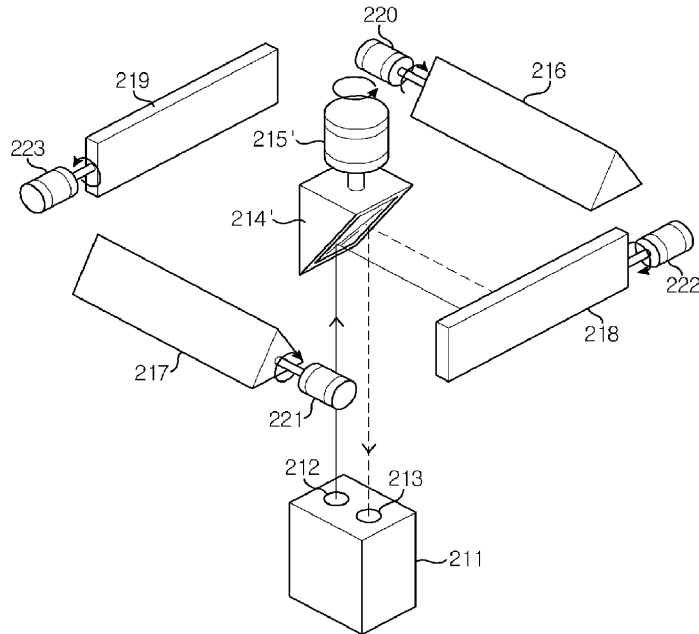


[Fig. 3]

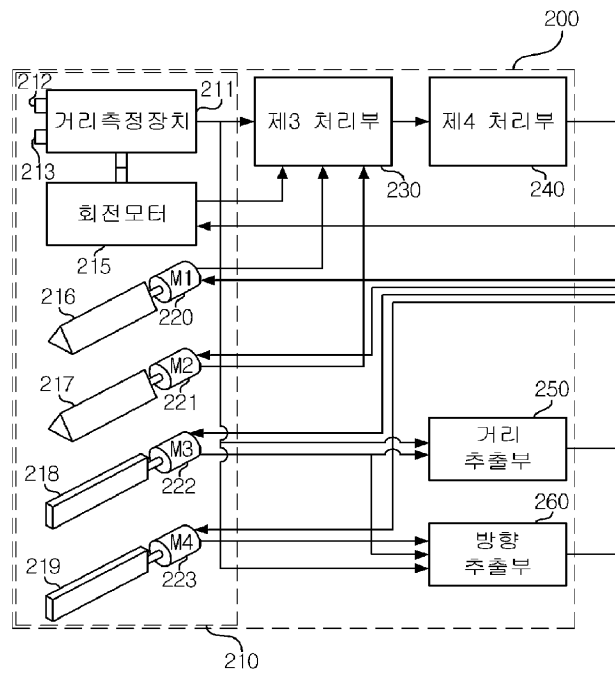
210



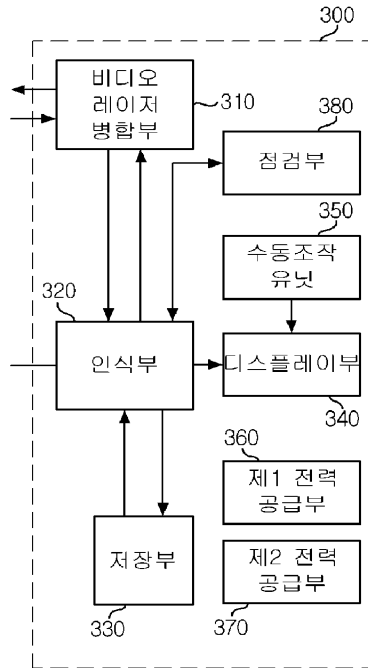
[Fig. 4]



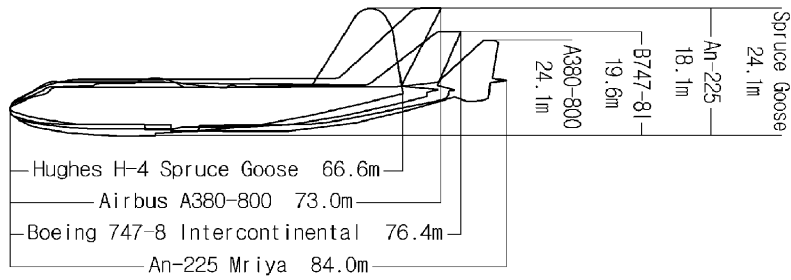
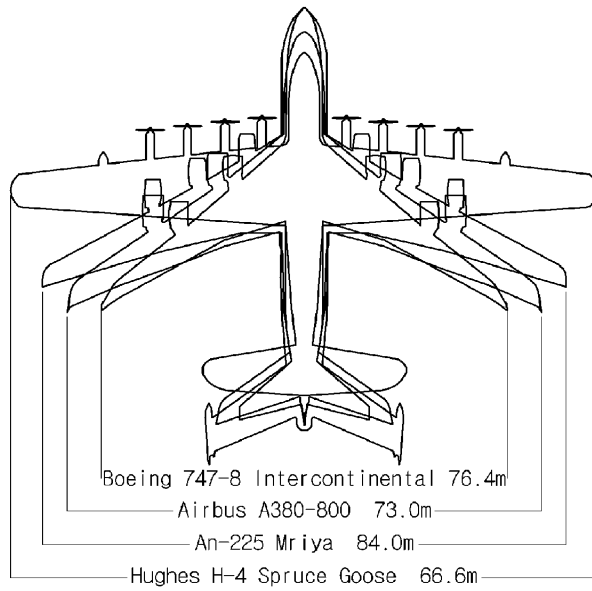
[Fig. 5]



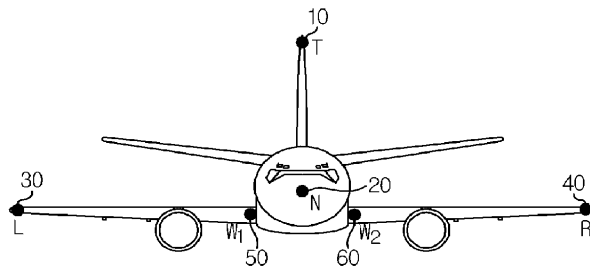
[Fig. 6]



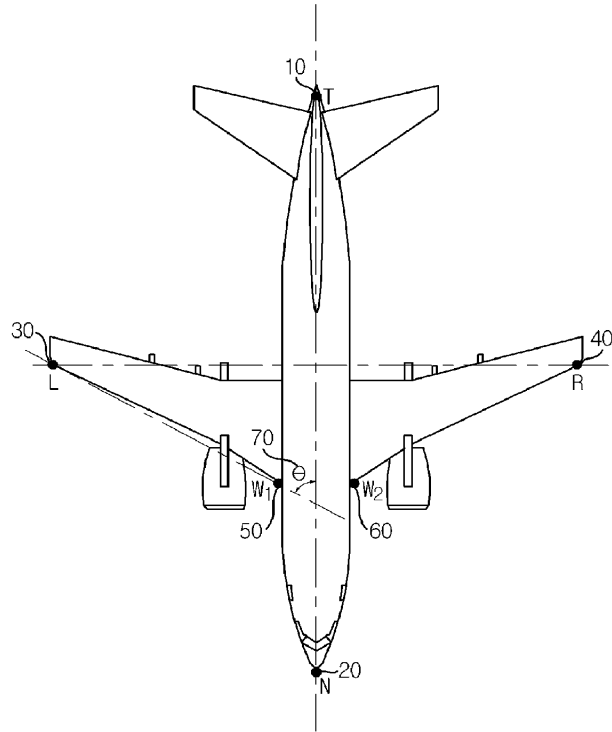
[Fig. 7]



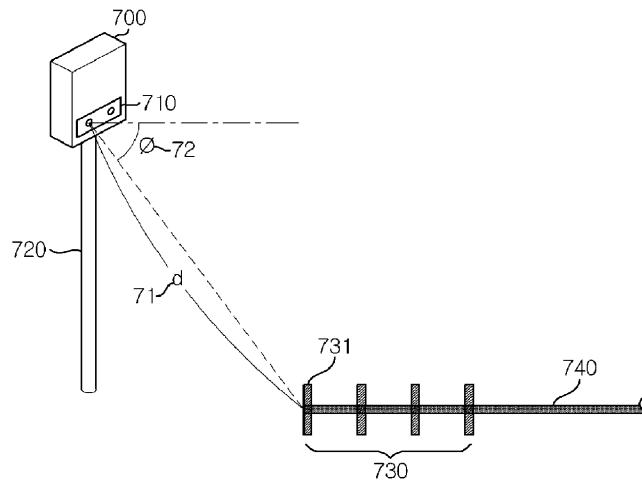
[Fig. 8]



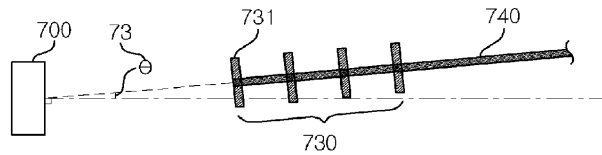
[Fig. 9]



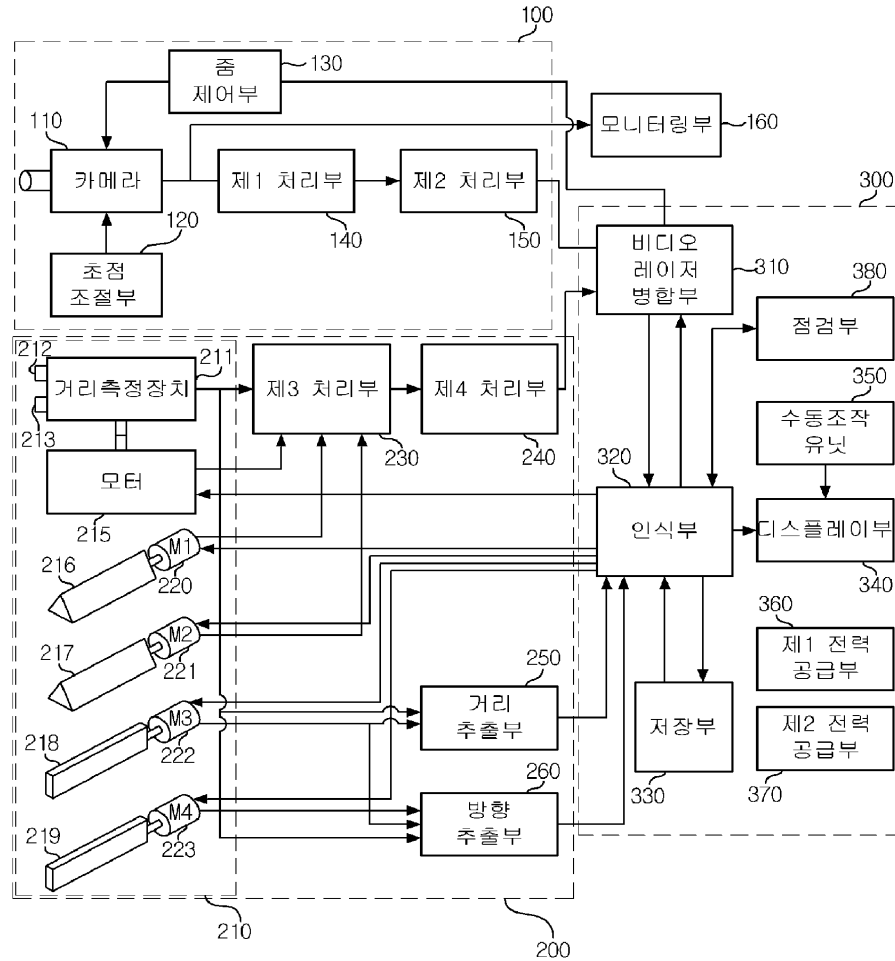
[Fig. 10]



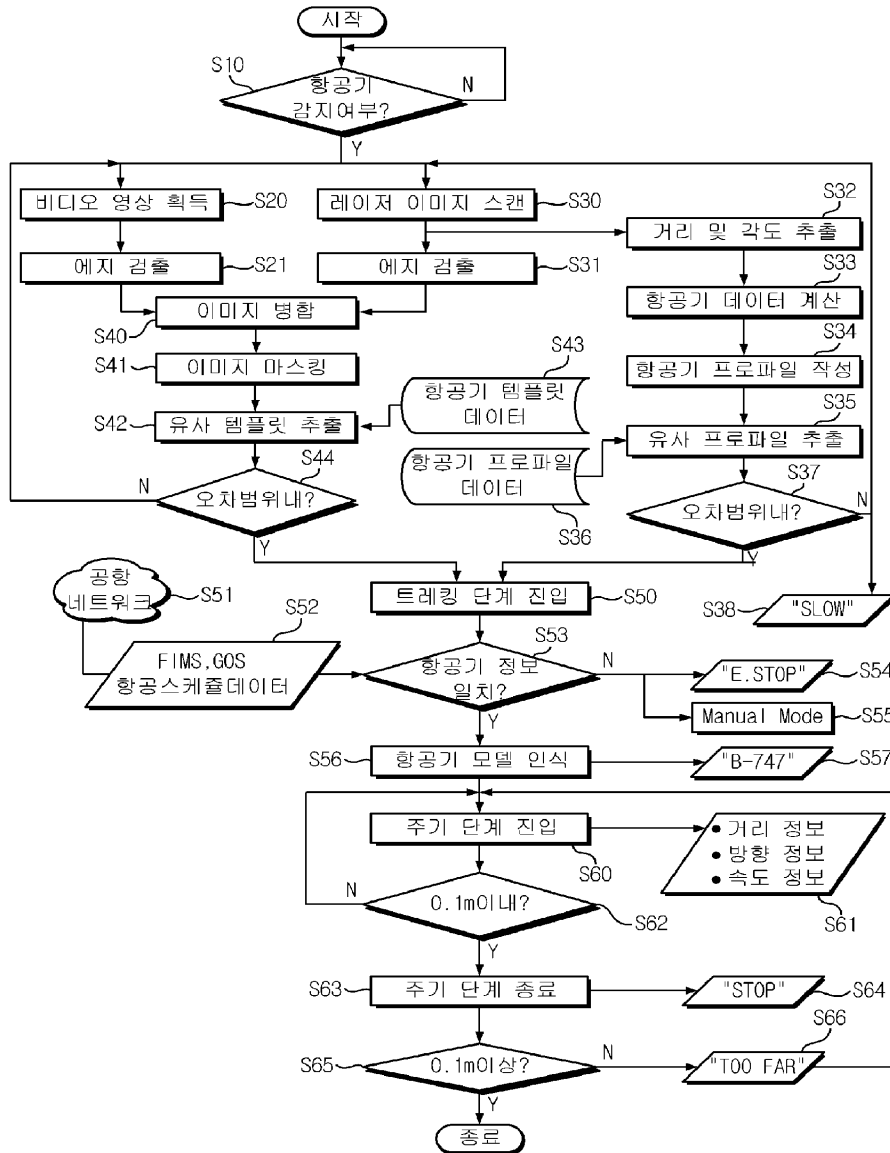
[Fig. 11]



[Fig. 12]



[Fig. 13]



INTERNATIONAL SEARCH REPORT

International application No.

PCT/KR2013/009314

A. CLASSIFICATION OF SUBJECT MATTER G06T 1/00(2006.01)i, G06T 5/00(2006.01)i According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) G06T 1/00; B64F 1/22; H04N 7/18; H04N 5/225; G06F 17/00; G08B 21/00; G01C 3/08; G01S 17/10; G06T 5/00 Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Korean Utility models and applications for Utility models: IPC as above Japanese Utility models and applications for Utility models: IPC as above Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) eKOMPASS (KIPO internal) & Keywords: air craft, inducement, cycle, camera, laser, scan, refraction, examination, distance, contour.		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6100964 A (CREMIERS, Michel De) 08 August 2000 See column 4, lines 30-34, 43-52; figures 3-4; and claim 1.	1
Y		12
A		2-11,13-17
Y	KR 10-0512770 B1 (BIKYUNG SYSTEM CO., LTD) 06 September 2005 See pages 2-3; figure 2; and claim 1.	12
A	JP 2001-187599 A (MITSUBISHI ELECTRIC CORP. et al.) 10 July 2001 See abstract; paragraphs 11-14; figure 1; and claims 1-2.	1-17
A	US 2012-0075461 A1 (YU, Qifeng et al.) 29 March 2012 See paragraphs 49-51; figures 1-3; and claim 1.	1-17
A	JP 2006-287650 A (MITSUBISHI HEAVY IND., LTD.) 19 October 2006 See paragraphs 36-42; figure 1; and claims 1, 2, 9.	1-17
☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 27 MARCH 2014 (27.03.2014)		Date of mailing of the international search report 31 MARCH 2014 (31.03.2014)
Name and mailing address of the ISA/KR  Korean Intellectual Property Office Government Complex-Daejeon, 189 Seonsa-ro, Daejeon 302-701, Republic of Korea Facsimile No. 82-42-472-7140		Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/KR2013/009314

Patent document cited in search report	Publication date	Patent family member	Publication date
US 06100964 A	08/08/2000	DE 69818340 D1 EP 0880122 A1 EP 0880122 B1 FR 2763727 A1 FR 2763727 B1 US 5306619 A	30/10/2003 25/11/1998 24/09/2003 27/11/1998 13/08/1999 26/04/1994
KR 10-0512770 B1	06/09/2005	KR 10-2005-0045112 A	17/05/2005
JP 2001-187599 A	10/07/2001	JP 04071412 B2	02/04/2008
US 2012-0075461 A1	29/03/2012	EP 2413096 A1 WO 2010-108301 A1	01/02/2012 30/09/2010
JP 2006-287650 A	19/10/2006	NONE	

Form PCT/ISA/210 (patent family annex) (July 2009)

A. 발명이 속하는 기술분류(국제특허분류(IPC)) G06T 1/00(2006.01)i, G06T 5/00(2006.01)i		
B. 조사된 분야 조사된 최소문헌(국제특허분류를 기재) G06T 1/00; B64F 1/22; H04N 7/18; H04N 5/225; G06F 17/00; G08B 21/00; G01C 3/08; G01S 17/10; G06T 5/00 조사된 기술분야에 속하는 최소문헌 이외의 문헌 한국등록실용신안공보 및 한국공개실용신안공보: 조사된 최소문헌란에 기재된 IPC 일본등록실용신안공보 및 일본공개실용신안공보: 조사된 최소문헌란에 기재된 IPC 국제조사에 이용된 전산 데이터베이스(데이터베이스의 명칭 및 검색어(해당하는 경우)) eKOMPASS(특허청 내부 검색시스템) & 키워드: 항공기, 유도, 주기, 카메라, 레이저, 스캔, 굴절, 점검, 거리, 운곽.		
C. 관련 문헌		
카테고리*	인용문헌명 및 관련 구절(해당하는 경우)의 기재	관련 청구항
X	US 6100964 A (MICHEL DE CREMIERS) 2000.08.08 컬럼 4, 라인 30-34, 43-52; 도면 3-4; 및 청구항 1 참조.	1
Y		12
A		2-11, 13-17
Y	KR 10-0512770 B1 (비경시스템주식회사) 2005.09.06 페이지 2-3; 도면 2; 및 청구항 1 참조.	12
A	JP 2001-187599 A (MITSUBISHI ELECTRIC CORP. 외 1) 2001.07.10 요약; 단락 11-14; 도면 1; 및 청구항 1-2 참조.	1-17
A	US 2012-0075461 A1 (QIFENG YU 외 5명) 2012.03.29 단락 49-51; 도면 1-3; 및 청구항 1 참조.	1-17
A	JP 2006-287650 A (MITSUBISHI HEAVY IND., LTD.) 2006.10.19 단락 36-42; 도면 1; 및 청구항 1, 2, 9 참조.	1-17
☐ 추가 문헌이 C(계속)에 기재되어 있습니다. ☒ 대응특허에 관한 별지를 참조하십시오.		
* 인용된 문헌의 특별 카테고리: “A” 특별히 관련이 없는 것으로 보이는 일반적인 기술수준을 정의한 문헌 “E” 국제출원일보다 빠른 출원일 또는 우선일을 가지나 국제출원일 이후에 공개된 선출원 또는 특허 문헌 “L” 우선권 주장에 의문을 제기하는 문헌 또는 다른 인용문헌의 공개일 또는 다른 특별한 이유(이유를 명시)를 밝히기 위하여 인용된 문헌 “O” 구두 개시, 사용, 전시 또는 기타 수단을 언급하고 있는 문헌 “P” 우선일 이후에 공개되었으나 국제출원일 이전에 공개된 문헌 “T” 국제출원일 또는 우선일 후에 공개된 문헌으로, 출원과 상충하지 않으며 발명의 기초가 되는 원리나 이론을 이해하기 위해 인용된 문헌 “X” 특별한 관련이 있는 문헌. 해당 문헌 하나만으로 청구된 발명의 신규성 또는 진보성이 없는 것으로 본다. “Y” 특별한 관련이 있는 문헌. 해당 문헌이 하나 이상의 다른 문헌과 조합하는 경우로 그 조합이 당업자에게 자명한 경우 청구된 발명은 진보성이 없는 것으로 본다. “&” 동일한 대응특허문헌에 속하는 문헌		
국제조사의 실제 완료일 2014년 03월 27일 (27.03.2014)		국제조사보고서 발송일 2014년 03월 31일 (31.03.2014)
ISA/KR의 명칭 및 우편주소  대한민국 특허청 (302-701) 대전광역시 서구 청사로 189, 4동 (둔산동, 정부대전청사) 팩스 번호 +82-42-472-7140		심사관 황윤구 전화번호 +82-42-481-5715 

서식 PCT/ISA/210 (두 번째 용지) (2009년 7월)

국제조사보고서에서 인용된 특허문헌	공개일	대응특허문헌	공개일
US 06100964 A	2000/08/08	DE 69818340 D1 EP 0880122 A1 EP 0880122 B1 FR 2763727 A1 FR 2763727 B1 US 5306619 A	2003/10/30 1998/11/25 2003/09/24 1998/11/27 1999/08/13 1994/04/26
KR 10-0512770 B1	2005/09/06	KR 10-2005-0045112 A	2005/05/17
JP 2001-187599 A	2001/07/10	JP 04071412 B2	2008/04/02
US 2012-0075461 A1	2012/03/29	EP 2413096 A1 WO 2010-108301 A1	2012/02/01 2010/09/30
JP 2006-287650 A	2006/10/19	없음	

서식 PCT/ISA/210 (대응특허 추가용지) (2009년 7월)



Espacenet

Bibliographic data: KR101314566 (B1) — 2013-10-07

**SYSTEM AND METHOD FOR DISCRIMINATION OF AN AIRCRAFT MODEL AND
DOCKING GUIDE OF AN AIRCRAFT**

Inventor(s): LEE YOUNG AN [KR]; LEE KI CHANG [KR] ± (LEE, YOUNG AN, ;
LEE, KI CHANG)

Applicant(s): ANSE TECHNOLOGIES CO LTD [KR] ± (ANSE TECHNOLOGIES
CO., LTD)

Classification: - **international:** G01S17/06; G01S17/88; G08G5/06
- **cooperative:** G01S17/89 (KR); G08G5/025 (KR); G08G5/06 (KR)

**Application
number:** KR20120095937 20120830 Global Dossier

**Priority
number(s):** KR20120095937 20120830

Abstract of KR101314566 (B1)

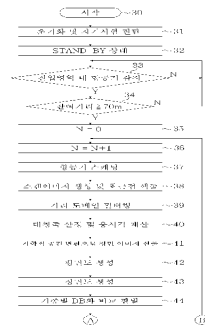
PURPOSE: An aircraft model discrimination and docking guidance system and a method thereof automatically discriminate the model of an aircraft by applying 3D modeling digital image information processing technology based on a 3D laser scanner. **CONSTITUTION:** A 3D laser scanner device includes a laser transceiver and a data acquisition and distance measurement device generating data on a distance to an object and images. A model data memory (5) stores specifications and features by model of an aircraft. A data analysis determination algorithm processing device (4) generates a plane view and a front view of the object as the information on the object generated from the 3D laser scanner device and determines the model of the object by comparing the information stored in the model data memory. A character display device (6) indicates docking information generated in the data analysis determination algorithm processing device to an aircraft pilot. [Reference numerals] (1) Laser transmission and reception device; (10) Image display device; (2) Data acquisition and distance measurement device; (3) 2-D scanning mechanism; (4) Data analysis determination algorithm processing device; (5) Model data memory; (6) Text display device; (7) Manual operation control panel; (8) External system communication access interface; (9) Image camera and additional device

	(19) 대한민국특허청(KR)	(45) 공고일자	2013년10월07일
	(12) 등록특허공보(B1)	(11) 등록번호	20-1314566
		(24) 등록일자	2013년09월27일
(51) 국제특허분류(Int. Cl.)	G08G 5/06 (2006.01) G01S 17/06 (2006.01)	(73) 특허권자	(주)안세기솔
	G01S 17/88 (2006.01)	(주)안세기솔	서울특별시 구로구 디지털로26길 5, 에이스하이엔드타워 701호 (구로동)
(21) 출원번호	10-2012-0095937	(72) 발명자	이용안
(22) 출원일자	2012년08월30일	이용안	서울특별시 동작구 여의대방로 22, 1동 306호 (신대방동, 우성아파트)
	심사청구일자 2013년01월11일	이기창	경기도 고양시 덕양구 토당로 168, 2층 202호 (토당동, 동아3빌딩)
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(57) 2 9/16

본 발명에 의하면, 저속 이동 중에 있는 항공기를 레이저로 순간 스캐닝 하여 임의의 응시각도에서의 3 차원 운 집(Point Cloud) 이미지 데이터를 포착, 생성하고, 이를 3-D modeling의 기하학적인 공간변화 기법을 사용하여 항공기의 평면도 및 정면도 이미지를 추출하고, 이 이미지를 사선에 수집하여 기종 데이터 메모리에 저장되어 놓 는 기존 항공기 기종별 이미지 정보와 비교, 검색하여 합치되는 기종을 찾아냄으로서, 항공기의 기종을 실시간으 로 즉시 식별해 낼 수 있는 혁신적인 시스템을 구성할 수 있다.

Figure 3a



특허청구의 범위

청구항 1

레이저 빔을 송출하고 대상물에 의해 반사되는 상기 레이저 빔을 수신하는 레이저 송수신장치와, 상기 레이저 빔의 송수신시간으로써 대상물까지의 거리 및 영상데이터를 생성하는 데이터 획득 및 거리측정장치를 포함하는 3 차원 레이저 스캐너 장치;

항공기의 기종별 규격 및 특징이 저장되어 있는 기종 데이터메모리;

상기 3 차원 레이저 스캐너 장치 및 기종 데이터메모리와 통신하며, 상기 3 차원 레이저 스캐너 장치로부터 생성된 대상물에 대한 정보로써 대상물의 평면도 및 정면도를 생성하고, 상기 기종 데이터메모리에 저장된 정보와 비교하여 대상물의 기종을 판정하는 데이터 분석판정 알고리즘 처리장치; 및

상기 데이터 분석판정 알고리즘 처리장치와 통신하며, 항공기 조종사에게 상기 데이터 분석판정 알고리즘 처리장치에서 생성된 주기정보를 표시하여 제공하기 위한 조종사 안내표시용 문자디스플레이장치;를 포함하는 항공기 기종판별 및 주기유도시스템.

청구항 2

제1항에 있어서,

상기 데이터 분석판정 알고리즘 처리장치와 통신하며, 진입하는 항공기의 실물 이미지를 촬영하여 상기 데이터 분석판정 알고리즘 처리장치에 송신하는 영상 카메라; 및

상기 데이터 분석판정 알고리즘 처리장치와 통신하며, 상기 데이터 분석판정 알고리즘 처리장치에서 상기 영상 카메라로써 촬영된 항공기의 실물 이미지로부터 처리된 영상 이미지를 항공기 조종사에게 제공하기 위한 조종사 안내표시용 영상 디스플레이장치;를 더 포함하는 것을 특징으로 하는 항공기 기종판별 및 주기유도시스템.

청구항 3

제2항에 있어서,

상기 데이터 분석판정 알고리즘 처리장치와 통신하며, 비상시 또는 필요시에 수동적으로 조작자가 상기 문자디스플레이장치 또는 영상디스플레이장치를 통해 항공기 조종사에게 지시할 수 있는 수동조작 제어패널을 더 포함하는 것을 특징으로 하는 항공기 기종판별 및 주기유도시스템.

청구항 4

제1항에 있어서,

상기 데이터 분석판정 알고리즘 처리장치와 통신하며, 공항 내의 작동정보시스템과 접속하여 공항의 종합정보를 수신받거나, 상기 데이터 분석판정 알고리즘 처리장치에서 운영 상태 및 생성된 결과를 상기 작동정보시스템으로 송출할 수 있는 외부시스템 통신접속 인터페이스를 더 포함하는 것을 특징으로 하는 항공기 기종판별 및 주기유도시스템.

청구항 5

제1항에 있어서,

상기 레이저 송수신장치는 이동 중에 있는 항공기를 레이저 빔으로써 순간 스캐닝하여 임의의 응시각도에서의 3 차원 윤집(point cloud) 이미지 데이터를 포착, 생성하고;

상기 데이터 분석판정 알고리즘 처리장치는 상기 포착, 생성된 데이터를 3 차원 모델링 기하학적 공간변환기법을 사용하여 평면도 및 정면도 이미지로서 추출하여, 상기 기종 데이터메모리에 저장되어 있는 기존 항공기의 기종별 정보와 비교하여 합치되는 기종을 찾아내는 것을 특징으로 하는 항공기 기종판별 및 주기유도시스템.

청구항 6

레이저 송수신장치와 데이터 획득 및 거리측정장치를 포함하는 3 차원 레이저 스캐너 장치, 기종 데이터메모리, 조종사 안내표시용 디스플레이장치, 및 데이터 분석판정 알고리즘 처리장치를 포함하는 항공기 기종판별 및 주기유도시스템의 제어방법에 있어서,

프로그램 수행 전 상기 데이터 분석판정 알고리즘 처리장치의 하드웨어와 소프트웨어 시스템에 대하여 초기화를 수행하고 자기 진단과 자기 시험을 행하는 제1 단계;

이 후, 상기 레이저 송수신장치는 활주로를 경유하여 착륙한 항공기가 배정된 탑승구로 진입할 때, 탑승구로부터 70m 내지 100m의 거리 내에서 항공기의 진입이 예상되는 특정방향을 지향하여 주기적으로 레이저를 발사하고 수신신호를 확인하는 동작을 지속 수행하는 제2 단계;

이 후, 항공기의 진입이 감지되면, 상기 항공기가 탑승구로부터 50m 거리 안으로 진입하기 전에, 상기 3 차원 레이저 스캐너 장치에 의해 항공기의 정보를 검출하고, 검출된 항공기의 정보와 상기 기종 데이터메모리에 저장되어 있는 기종별 정보를 가지고 상기 데이터 분석판정 알고리즘 처리장치에서 항공기의 기종을 판별하는 제3 단계;

이 후, 상기 데이터 분석판정 알고리즘 처리장치에서 판별된 항공기 기종에 따른 항공기 정지지점을 판단하고, 진입하고 있는 항공기의 정지지점인 탑승구까지의 잔여거리를 상기 디스플레이장치에 표시하는 제4 단계;

이 후, 상기 항공기가 탑승구로부터 25 m 내에 진입하면, 상기 3 차원 레이저 스캐너 장치에 의해 지속적으로 검출되는 항공기의 정보로써 상기 데이터 분석판정 알고리즘 처리장치에서 중앙유도선에 대한 항공기의 좌우편차 정보를 검출하고, 상기 검출된 좌우편차 정보를 상기 디스플레이장치에 제공하는 제5 단계; 및

이 후, 상기 항공기가 탑승구로부터 0.1m 내에 진입하면, 상기 디스플레이장치에 정지신호를 제공하는 제6 단계;를 포함하는 항공기 기종판별 및 주기유도시스템의 제어방법.

청구항 7

제6항에 있어서,

상기 제4 단계에서는 상기 항공기의 정지지점인 탑승구까지의 잔여거리를 1m 단위로 상기 디스플레이장치에 제공하다가, 잔여거리가 3m가 남은 때부터는 0.2m 단위로 잔여거리를 상기 디스플레이장치에 제공하는 것을 특징으로 하는 항공기 기종판별 및 주기유도시스템의 제어방법.

청구항 8

제6항에 있어서,

상기 제3 단계는,

상기 데이터 분석판정 알고리즘 처리장치에서 상기 3 차원 레이저 스캐너 장치에 의해 검출된 임의의 응시각도에서의 3 차원 윤집 이미지 데이터로부터 거리 필터링 기술을 이용하여 항공기의 이미지 정보를 추출하는 것을 특징으로 하는 항공기 기종판별 및 주기유도시스템의 제어방법.

청구항 9

제8항에 있어서,

상기 데이터 분석판정 알고리즘 처리장치는 항공기의 코에 해당하는 최근점과 항공기의 수직 뒷날개에 해당하는 최원점의 정보를 바탕으로 수직 및 수평면상의 대칭축을 찾아내서 응시각도를 계산하는 것을 특징으로 하는 항공기 기종판별 및 주기유도시스템의 제어방법.

청구항 10

제9항에 있어서,

상기 데이터 분석판정 알고리즘 처리장치는 상기 응시각도가 0이 되도록 상기 3 차원 레이저 스캐너 장치에 의해 검출된 3 차원 윤곽 이미지 데이터에 3 차원 기하학적 공간변환을 행하여, 항공기 이미지의 정확한 평면도 및 정면도를 생성하는 것을 특징으로 하는 항공기 기종판별 및 주기유도시스템의 제어방법.

청구항 11

제10항에 있어서,

상기 데이터 분석판정 알고리즘 처리장치는, 상기 기종 데이터메모리에 있는 기종별 데이터와 비교, 검색하여 생성된 평면도 및 정면도가 합치하는 기종명을 찾아내어 항공기를 판별하는 것을 특징으로 하는 항공기 기종판별 및 주기유도시스템의 제어방법.

발명내용

기술분야

[0001] 본 발명은 3 차원의 레이저 스캐너를 이용한 항공기 기종판별 및 주기유도 시스템 및 방법에 관한 것으로, 더욱 상세하게는 공항에 항공기가 착륙하여 탑승교각이 설치된 해당 탑승구 장소로 주행하여 진입하는 경우에, 시각 주기유도시스템(VDGS: Visual Docking Guidance System)에서 거리정보를 획득하는 3 차원의 레이저 스캐너를 기반으로 하여 3-D 모델링 디지털 영상정보처리기술을 적용함으로써, 자동적으로 항공기의 기종을 판별하고 기종별로 정해진 주기장소에 진입 및 주기를 유도하는 항공기 기종판별 및 주기유도 시스템 및 방법에 관한 것이다.

배경기술

[0002] 종래에는 국제 및 국내공항의 활주로에서 착륙한 항공기를 정확한 위치에 주기하도록 유도하기 위하여, 항공기 유도원(마샬러: marshaller)이 항공기의 이, 착륙 때마다 수동 신호에 의하여 항공기를 유도하였다. 즉 항공기 유도원이 깃발을 사용한 수신호를 통하여 항공기 조종사에게 항공기의 진행방향과 속도, 정지위치 등을 지시하면서 항공기를 주기장소까지 유도하였다.

[0003] 그러나, 이러한 수동적인 유도방법은 게이트가 많은 대형 공항에서 수많은 항공기가 이, 착륙하는 경우에, 특정한 계류장에서 문제나 장애가 발생하는 경우 공항지휘본부에서 이에 대한 통보나 신속한 파악 및 조치가 어려웠으며, 항공기 회사에서 항공기 유도용역 서비스를 제공하는 용역회사에 상당액의 인건비를 지불해야 하기 때문에 비경제적일 뿐만 아니라, 이른 새벽이나 심야에 이, 착륙하는 경우에 인력확보에도 어려움이 많았다.

또한, 수동유도에 따른 과실이나 오류, 유도원의 부재 등으로 인한 항공기 지연 등으로 인하여 종종 항공사에 대한 승객의 항의 등 민원이 발생하였다.

[0004] 이러한 불편을 해결하기 위하여, 영상(Video) 카메라와 이미지 처리장치를 사용한 전자식 항공기 시각주기유도시스템(VDGS)이 개발되어 무인자동방식으로 사용되게 되었다.

이러한 시각주기유도시스템의 하나로 특허로 등록된 대한민국 특허 제10-346556호(발명의 명칭: 항공기 주기위치 지시시스템)는 CCD(Charge-Coupled Device) 카메라, 영상표시부, 영상처리부 및 표시부로 구성되고, 항공기 계류장에서 CCD 카메라로 계류장으로 진입하는 항공기의 2차원 영상을 획득하여 항공기의 윤곽선이 추출되게 영상을 처리한 후 항공기의 종류, 거리, 측방편위 등의 계산결과를 디스플레이하는 항공기 시각주기유도시스템이

다.

[0005] 상기 항공기 주기위치 지시시스템은 CCD 카메라를 사용하여 항공기의 화상을 얻은 후 영상처리과정을 통하여 얻은 항공기의 이미지를 이용해 구축해 놓은 항공기 데이터베이스(DB)를 활용하여 거리 및 각도 변화 처리를 수행한 시뮬레이션 결과와 획득된 실화상을 비교하여 일치하는 데이터를 찾아내어 기종을 판별하고 항공기의 현재의 거리 및 각도 등을 삼각법(Triangulation)을 이용하여 산정하며 항공기를 주기위치에 정확히 유도하는 방식이다.

이와 같이 영상 카메라와 이미지 처리장치를 사용하는 종래의 시각주기유도시스템은 영상 카메라를 사용해 획득한 영상 이미지 패턴과 기준 이미지 패턴의 데이터를 비교하기 때문에, 안개가 심하게 끼었거나, 극심한 우천, 우박 등의 악천후 및 역광 등과 같은 환경적 요인에 의하여 정확한 이미지 추출이 어려운 경우에는 판별이 잘 되지 않게 되는 문제점과, 거리정보를 실시간으로 직접 얻을 수 없는 것들의 한계점과 판정오류가 자주 발생하는 등의 문제점과 취약점을 가지고 있었다.

[0006] 삭제

발명의 내용

해결하려는 과제

[0007] 본 발명은 앞에 설명한 제래방식의 문제점들을 해결하기 위해 개량된 주기유도시스템을 발명한 것으로, 종래의 영상(Video) 이미지 처리방식을 사용하지 않고 비가시(invisible) 파장의 레이저 빔을 대상물 방향으로 수직과 수평으로 스캔하면서 발사하여 대상물에서 되돌아오는 광 반사파의 비행거리(time-of-flight)를 측정하여 대상점의 거리정보를 계산해 내는 3 차원 레이저 스캐너 장치와, 디지털 영상정보처리기술을 적용하여 항공기의 입의 시점방향에서의 3 차원 이미지를 획득하고, 3 차원 모델링(3-D modeling) 좌표변환기법에 의하여 그 이미지의 응시각도(viewing angle)를 변환하여 항공기의 기준이 되는 평면도 및 정면도 이미지를 추출해 내서 이 정보를 이미 저장되어 있는 기종별 항공기 규격 데이터베이스(DB) 메모리의 이미지 데이터와 비교하여 항공기의 기종을 판별하고, 주기장소로 중앙선을 따라 유도하여 정지선 상에 정확히 주기시키기 위한 시스템을 제공하고자 함에 그 목적이 있다.

[0008] 또한, 본 발명의 다른 목적은, 이렇게 레이저 방식에 의함으로 종래의 영상 카메라 방식에서 문제가 되던 악천후 등에서의 작동률을 높일 뿐만 아니라 오류율을 감소시키며 야간에라도 조명이 불필요하게 하는 탁월한 장점을 갖게 하는 3 차원 레이저 스캐너 및 영상정보처리기술을 이용한 항공기 기종판별 및 주기유도시스템인 것이다.

과제의 해결 수단

[0009] 상기 목적을 달성하기 위하여 본 발명은, 레이저 빔을 송출하고 대상물에 의해 반사되는 상기 레이저 빔을 수신하는 레이저 송수신장치와, 상기 레이저 빔 송수신시간으로써 대상물까지의 거리 및 영상데이터를 생성하는 데이터 획득 및 거리측정장치를 포함하는 3 차원 레이저 스캐너 장치와, 항공기의 기종별 규격 및 특징이 저장되어 있는 기종 데이터메모리와, 상기 3 차원 레이저 스캐너 장치 및 기종 데이터메모리와 통신하며, 상기 3 차원 레이저 스캐너 장치로부터 생성된 대상물에 대한 정보로써 대상물의 평면도 및 정면도를 생성하고, 상기 기종 데이터메모리에 저장된 정보와 비교하여 대상물의 기종을 판정하는 데이터 분석판정 알고리즘 처리장치와, 상기 데이터 분석판정 알고리즘 처리장치와 통신하며, 항공기 조종사에게 상기 데이터 분석판정 알고리즘 처리장치에서 생성된 주기정보를 표시하여 제공하기 위한 조종사 안내표시용 문자디스플레이장치를 포함하는 항공기 기종판별 및 주기유도시스템을 제공한다.

바람직하게, 상기 데이터 분석판정 알고리즘 처리장치와 통신하며, 진입하는 항공기의 실물 이미지를 촬영하여 상기 데이터 분석판정 알고리즘 처리장치에 송신하는 영상 카메라와, 상기 데이터 분석판정 알고리즘 처리장치와 통신하며, 상기 데이터 분석판정 알고리즘 처리장치에서 상기 영상 카메라로써 촬영된 항공기의 실물 이미지로부터 처리된 영상 이미지를 항공기 조종사에게 제공하기 위한 조종사 안내표시용 영상 디스플레이장치를 더

포함하는 것을 특징으로 한다.

바람직하게, 상기 데이터 분석판정 알고리즘 처리장치와 통신하며, 비상시 또는 필요시에 수동적으로 조작자가 상기 문자디스플레이장치 또는 영상디스플레이장치를 통해 항공기 조종사에게 지시할 수 있는 수동조작 제어패널을 더 포함하는 것을 특징으로 한다.

바람직하게, 상기 데이터 분석판정 알고리즘 처리장치와 통신하며, 공항 내의 작동정보시스템과 접속하여 공항의 종합정보를 수신받거나, 상기 데이터 분석판정 알고리즘 처리장치에서 운영 상태 및 생성된 결과를 상기 작동정보시스템으로 송출할 수 있는 외부시스템 통신접속 인터페이스를 더 포함하는 것을 특징으로 한다.

바람직하게, 상기 레이저 송수신장치는 이동 중에 있는 항공기를 레이저 빔으로써 순간 스캐닝하여 임의의 응시각도에서의 3 차원 운집(point cloud) 이미지 데이터를 포착, 생성하고;

상기 데이터 분석판정 알고리즘 처리장치는 상기 포착, 생성된 데이터를 3 차원 모델링 기하학적 공간변환기법을 사용하여 평면도 및 정면도 이미지로서 추출하여, 상기 기종 데이터메모리에 저장되어 있는 기존 항공기의 기종별 정보와 비교하여 합치되는 기종을 찾아내는 것을 특징으로 한다.

한편 본 발명은 레이저 송수신장치와 데이터 획득 및 거리측정장치를 포함하는 3 차원 레이저 스캐너 장치, 기종 데이터메모리, 조종사 안내표시용 디스플레이장치, 및 데이터 분석판정 알고리즘 처리장치를 포함하는 항공기 기종판별 및 주기유도시스템에 있어서, 프로그램을 수행 전 상기 데이터 분석판정 알고리즘 처리장치의 하드웨어와 소프트웨어 시스템에 대하여 초기화를 수행하고 자기 진단과 자기 시험을 행하는 제1 단계와, 이 후, 상기 레이저 송수신부는 활주로를 경유하여 착륙한 항공기가 배정된 탑승구로 진입할 때, 탑승구로부터 70m 내지 100m의 거리 내에서 항공기의 진입이 예상되는 특정방향을 지향하여 주기적으로 레이저를 발사하고 수신신호를 확인하는 동작을 지속 수행하는 제2 단계와, 이 후, 항공기의 진입이 감지되면, 상기 항공기가 탑승구로부터 50m 거리 안으로 진입하기 전에, 상기 3 차원 레이저 스캐너 장치에 의해 항공기의 정보를 검출하고, 검출된 항공기의 정보와 상기 기종 데이터메모리에 저장되어 있는 기종별 정보를 가지고 상기 데이터 분석판정 알고리즘 처리장치에서 항공기의 기종을 판별하는 제3 단계와, 이 후, 상기 데이터 분석판정 알고리즘 처리장치에서 판별된 항공기 기종에 따른 항공기 정지지점을 판단하고, 진입하고 있는 항공기의 정지지점인 탑승구까지의 잔여거리를 상기 디스플레이장치에 표시하는 제4 단계와, 이 후, 상기 항공기가 탑승구로부터 25 m 내에 진입하면, 상기 3 차원 레이저 스캐너 장치에 의해 지속적으로 검출되는 항공기의 정보로써 상기 데이터 분석판정 알고리즘 처리장치에서 중앙유도선에 대한 항공기의 좌우편차 정보를 검출하고, 상기 검출된 좌우편차 정보를 상기 디스플레이부에 제공하는 제5 단계와, 이 후, 상기 항공기가 탑승구로부터 0.1m 내에 진입하면, 상기 디스플레이부에 정지신호를 제공하는 제6 단계;를 포함하는 항공기 기종판별 및 주기유도시스템의 제어방법을 제공한다.

바람직하게, 상기 제4 단계에서는 상기 항공기의 정지지점인 탑승구까지의 잔여거리를 1m 단위로 상기 디스플레이부에 제공하다가, 잔여거리가 3m가 남은 때부터는 0.2m 단위로 잔여거리를 상기 디스플레이부에 제공하는 것을 특징으로 한다.

바람직하게, 상기 제3 단계는 상기 데이터 분석판정 알고리즘처리장치에서 상기 3 차원 레이저 스캐너 장치에 의해 검출된 임의의 응시각도에서의 3 차원 운집 이미지 데이터로부터 거리 필터링 기술을 이용하여 항공기의 이미지 정보를 추출하는 것을 특징으로 한다.

바람직하게, 상기 데이터 분석판정 알고리즘처리장치는 항공기의 코에 해당하는 최근점과 항공기의 수직 뒷날개에 해당하는 최원점의 정보를 바탕으로 수직 및 수평면상의 대칭축을 찾아내서 응시각도를 계산하는 것을 특징으로 한다.

바람직하게, 상기 데이터 분석판정 알고리즘처리장치는 상기 응시각도가 0이 되도록 상기 3 차원 레이저 스캐너 장치에 의해 검출된 3 차원 운집 이미지 데이터에 3 차원 기하학적 공간변환을 행하여, 항공기 이미지의 정확한 평면도 및 정면도를 생성하는 것을 특징으로 한다.

바람직하게, 상기 데이터분석판정 알고리즘처리장치는, 상기 기종 데이터메모리에 있는 기종별 데이터와 비교, 검색하여 생성된 평면도 및 정면도가 합치하는 기종명을 찾아내어 항공기를 판별하는 것을 특징으로 한다.

[0010] 삭제

[0011] 삭제

발명의 효과

- [0012] 본 발명에 의하면, 저속 이동 중에 있는 항공기를 레이저로 순간 스캐닝 하여 임의의 응시각도에서의 3 차원 운집(Point Cloud) 이미지 데이터를 포착, 생성하고, 이를 3-D modeling의 기하학적인 공간변환 기법을 사용하여 항공기의 평면도 및 정면도 이미지를 추출하고, 이 이미지를 사전에 수집하여 기종 데이터 메모리에 저장되어 있는 기존 항공기 기종별 이미지 정보와 비교, 검색하여 합치되는 기종을 찾아냄으로서, 항공기의 기종을 실시간으로 즉시 식별해 낼 수 있는 혁신적인 시스템을 구성할 수 있다는 효과가 있다.
- [0013] 또한, 본 발명은 3 차원 레이저 스캐너와 디지털 영상정보 처리기술, 3 차원 좌표변환기법에 의하여 측정하기 때문에, 종래의 영상 카메라 방식 또는 일부 특징점만으로 기종판별을 행하던 방식에서 문제가 되던 작동율을 높이고 어떠한 악천후에도 강력(robust)하며 측정오차도 적어 오류율이 낮게 되며 주야를 막론하고 조명이 없이도 동작이 가능한 장점이 있다.

도면의 간단한 설명

- [0014] 도 1은 본 발명의 실시예에 따른 항공기 기종판별 및 주기유도 시스템을 간략하게 도시한 전체 블록도.
- 도 2 는 도 1에서의 레이저 빔 펄스 발생, 송수신, 수평/수직 스캐닝 및 레인지(ranging) 기능을 수행하기 위한 수직/수평 스텝 모터 등을 갖춘 메커니즘을 포함하는 3 차원 레이저 스캔 및 TOF(Time-of-Flight) 측정부분의 하드웨어 상세 구성도
- 도 3 a), b)는 본 발명 장치의 하드웨어를 사용하여 항공기의 진입감지, 기종판별 및 주기유도를 행하기 위한 종합적인 소프트웨어 알고리즘의 한 구성 예를 간략하게 보여주는 순서도
- 도 4 는 본 발명에서 항공기 기종을 판별하고자 할 때 진입한 항공기를 3 차원 레이저 스캔 장치를 이용하여 스캔한 원본 이미지 도면을 3-D 모델링의 기하학적 좌표변환기법으로 수평 응시각과 수직 응시각을 변환하여 항공기의 평면 이미지(top-view)와 정면 이미지(front view)를 생성하는 방법을 보여주는 이미지 변환 원리도

발명을 실시하기 위한 구체적인 내용

- [0015] 이하, 본 발명의 바람직한 실시예는 첨부된 도면을 참조하여 상세하게 설명한다.
- 특별한 정의가 없는 한 본 명세서의 모든 용어는 당업자가 이해하는 용어의 일반적인 의미와 동일하고, 만약 본 명세서에서 사용된 용어가 당해 용어의 일반적인 의미와 충돌하는 경우에는 본 명세서에 사용된 정의에 따른다.
- 다만, 이하에 기술될 발명은 본 발명의 실시예를 설명하기 위한 것일 뿐 본 발명의 권리범위를 한정하기 위한 것을 아니며, 명세서 전반에 걸쳐서 동일하게 사용된 참조번호들은 동일한 구성요소들을 나타낸다.
- 먼저, 항공기의 레이저 방식 VDGS 장치에서 접현(입항)하는 항공기의 종류와 기종을 식별하는 데 있어, 짧은 시간 내에 실시간으로 항공기의 기종정보를 정확하게 식별하여 당해 기종 항공기에 해당되는 정지선의 위치정보를 불러내고, 이를 기준으로 항공기 조종사에게 정지선까지의 잔여거리 정보를 알려주게 되며, 또한 공항 관리부서의 항공관제시스템 등에 제공함으로써 해당 항공기 기종에 적합하게 탑승교각의 입구 위치와 높이 등을 적절하게 제어할 수 있게 된다.
- [0016] 이러한 기능을 신속 및 정확하게 제공하기 위해서는 접현하는 항공기의 기종을 어떠한 기후 조건에서나 주야의 구분 없이 항상 신속하고 정확하게 판별하는 것이 가장 중요하다.
- 이를 위하여 본 발명의 알고리즘에서는 판별오류를 최소화하기 위하여 레이저 스캐닝에 의하여 항공기의 물리적인 규격 중에서 기종 상호 변별력이 있는 몇 개 부분의 특정부위 규격을 측정하는 것이 아니라, 측정 대상물인 이동체의 이미지 패턴 전체를 추출하고, 이를 수평면 상의 평면도 이미지와 수직면 상의 정면도 이미지로 변환하여 등록되어 메모리에 저장되어 있는 항공기 기종별 데이터 이미지와 합치여부를 확인하여 판정을 함으로서 거의 100%에 가까운 판독율을 갖는 신뢰성 있는 시스템이 되도록 한다.
- [0017] 본 발명의 항공기 기종판별 및 주기유도 시스템 및 방법은 바로 이러한 항공기 기종 판별 알고리즘으로서의 시

시스템장치를 개발하는 데에 목적이 있다.

[0018] 이하, 본 발명의 바람직한 실시예를 예시도면에 의거하여 상세히 설명한다.

[0019] 도 1은 본 발명의 일실시예에 따른 항공기 기종판별 및 주기유도 시스템을 간략하게 도시한 전체 블록도이다.

[0020] 삭제

[0021] 도 1을 참조하면, 레이저 송수신장치(1), 데이터 획득 및 거리측정장치(2), 2D 스캐닝 메커니즘(3), 데이터 분석판정 알고리즘 처리장치(4), 기종 데이터메모리(5), 문자디스플레이장치(6), 수동조작 제어패널(7), 외부시스템 통신접속 인터페이스(8), 영상 카메라 및 부수장치(9) 및 영상디스플레이장치(10)를 포함한다.

상기 레이저 송수신장치(1)는 레이저 빔을 송출하고 대상물에 의해 반사되는 상기 레이저 빔을 수신하며, 상기 데이터 획득 및 거리측정장치(2)는 레이저 빔 송수신시간을 이용하여 대상물까지의 거리 및 영상데이터를 생성하는데, 이들은 3 차원 레이저 스캐너 장치를 구성한다.

획득된 정보로부터 데이터를 분석, 계산, 처리, 변환 및 판정을 하는 컴퓨터 시스템인 상기 데이터 분석판정 알고리즘 처리장치(4)에는 상기 3 차원 레이저 스캐너 장치와 2D 스캐닝 메커니즘(3)이 각각 연결된다.

또한, 상기 데이터 분석판정 알고리즘 처리장치(4)에는 항공기 조종사에게 각종 주기정보를 표시하여 제공하기 위한 문자디스플레이 장치(6), 탑승교 등의 위치에 설치된 수동조작 제어패널(7), 외부시스템 통신접속 인터페이스(8), 각종 현장 비디오 영상을 얻기 위한 복수의 영상 카메라와 부수 저장장치 등(9) 및 이를 디스플레이하기 위한 영상 디스플레이장치(10)가 각각 연결되도록 구성되어 있다.

[0022] 도 1은 하드웨어 구성도로서 실체를 가진 부분으로 구성되어 있지만, 실제로 업무를 처리하는 핵심기능은 상기 데이터 분석판정 알고리즘 처리장치(4)에 도시되어있지 아니한 소프트웨어 알고리즘에 있다.

상기 소프트웨어 알고리즘은 이를테면 획득된 3 차원의 데이터를 분석, 필터링 및 이미지 생성, 이미지의 3-D 모델링에 의한 응시각도 변환과 평면도 및 정면도 이미지의 추출 및 기종비교 판정 등의 3 차원 디지털 영상정보처리를 수행하는 컴퓨터 처리 시스템이라 할 수 있다.

즉, 본 발명은 3 차원 레이저 스캐너 장치(1, 2)와 2차원 스캐닝 메커니즘(3)에서 레이저 펄스 빔을 발사하여 대상물에 부딪히 반사되어 오는 신호를 수신하여 레이저의 비행시간(TOF)을 측정하여 거리정보를 계산해서 3 차원 정보를 가진 대상물의 이미지를 얻어서 필요한 처리를 하는 것이다.

도 1을 보다 상세히 설명하면, 상기 레이저 송수신장치(1)는 레이저 빔을 송출하기 위한 레이저 다이오드와 그 집속 렌즈(collimating lens)가 포함되고, 대상물에 반사되어 돌아오는 레이저 광선을 수신하여 전기신호로 변환해 주는 수광소자(Photo Transistor, Avalanche Photo Diode 등)와 그 부수회로가 포함되어 있다.

상기 데이터 획득 및 거리측정장치(2)는 상기 레이저 송수신장치(1)의 수광소자에서 얻은 아날로그 수신신호 펄스와 송출 펄스 신호와의 시간차를 측정하여 거리정보로 환산하고, 환산된 아날로그 데이터를 ADC 회로에 의하여 디지털 신호로 변환하여 영상데이터 처리를 하는 프로세서인 데이터 분석 판정 알고리즘 처리장치(4)로 보낸다.

한편, 상기 2 차원 스캐닝 메커니즘(3)은 상기 레이저 송수신장치(1)에서 발생된 레이저, 예컨대 비가시광 근적외선인 905nm의 파장을 가진 클래스(Class) 1 레이저 빔을 수직 및 수평 방향의 두 개의 정밀한 스텝 모터와 미러를 사용해 수직/수평으로 스캔하여 정면으로 발사할 수 있게 함으로써 전면에 존재하는 대상물을 감지하고 거리를 측정할 수 있게 하는 기계적인 부분과, 이를 구동하는 스텝핑 모터와, 그 드라이버 회로 등을 포함한다.

따라서 상기 레이저 송수신장치(1)와 2차원 스캐닝 메커니즘(3)은 상호 기계적으로 결합되어 있고, 여기에 데이터 획득 및 거리측정장치(2)가 전기적으로 연결되어 있어서 전체가 하나의 3 차원 레이저 스캐너(3-D laser scanner) 및 거리측정장치(range finder)인 것이다.

이 부분을 보다 상세하게 도시한 그림이 도 2이다.

상기 데이터 분석판정 알고리즘 처리장치(4)는 상기 3 차원 레이저 스캐너장치(1 내지 3)에 있는 스텝모터와 레이저 발생장치를 실제로 제어하고 조정하며, 수신된 레이저빔 반사 신호를 수신하여 데이터를 저장하고 분석하며, 기종식별을 위한 판정을 하는 알고리즘을 포함하는 핵심부분으로, 판정 결과를 조종사 안내표시용 디스플레이

- 이 장치에 출력하고, 외부 시스템과의 데이터 교환을 관리한다.
- [0023] 삭제
- [0024] 삭제
- [0025] 즉, 파장 900nm 부근의 비가시(invisible) 레이저 빔을 대상물 방향으로 수직과 수평으로 발사하여 대상물에서 되돌아오는 반사파의 TOF를 측정하여 대상점의 거리정보를 계산해 내는 3 차원 레이저 스캐너 장치와, 디지털 영상정보처리기술을 적용하여 항공기의 임의 시점방향에서의 3 차원 이미지를 획득하고, 3-D 모델링 좌표변환기법에 의하여 그 이미지의 응시각도(viewing angle)를 변환하여 항공기의 기준이 되는 평면도 및 정면도 이미지를 추출, 생성해 내서, 이 정보를 이미 저장되어 있는 기종별 항공기 규격 데이터베이스 (DB)메모리의 이미지 데이터와 비교하여 항공기의 기종을 판별하고 계속하여 주기장소로 중앙선을 따라 유도하여 정지선 상에 정확히 주기시키기 위한 처리를 행하는 핵심부분이다.
- [0026] 상기 기종 데이터 메모리(5)는 각종 항공기의 규격과 특징들에 대한 요소들을 사전에 저장하여 데이터 분석판정 알고리즘 처리장치(4)가 기종인식 판정을 하는데 참고자료를 제공하는 기억장치로 필요에 따라 내용을 삭제, 추가 프로그램할 수 있다.
- [0027] 상기 문자디스플레이 장치(6)는 데이터 분석판정 알고리즘 처리장치(4)에서 처리한 결과를 문자 또는 기호로써 항공기 조종사에게 시각적으로 표시하여 지시할 수 있는 표시장치인 것이다.
- [0028] 상기 수동조작 제어패널(7)은 비상시 또는 필요시에 무인자동조작 대신 수동적으로 조작자가 버튼조작에 의하여 디스플레이를 통해 항공기 조종사에게 지시할 수 있는 조작장치인 것이다.
- [0029] 상기 외부시스템 통신접속 인터페이스(8)는 공항 내의 종합항공관제시스템, 항공기운항정보관리시스템 등과 본 발명장치를 접속함으로써, 공항의 종합정보를 입수하거나 본 발명장치에서의 결과 및 운영상태를 공항의 작동정보시스템으로 송출할 수 있는 통신 인터페이스 장치인 것이다.
- [0030] 상기 영상 카메라(9)는 산업용 정밀급 비디오 영상 카메라로 진입하는 항공기의 실물 이미지를 촬영하여 데이터 분석판정 알고리즘 처리장치(4)의 동작제어를 거쳐 영상 이미지를 영상 디스플레이장치(10)로 보내어 1차적으로는 항공기 조종사 등이 시각적으로 항공기의 진입상태를 간편하게 감시할 수 있게 하고, 기타 웹 네트워크를 통하여 송출하여 원격 감시나 저장 등이 가능하도록 하는 장치로서, 비디오 영상을 표시하는 일반적인 LED, LCD 또는 PDP 등의 비디오 디스플레이 장치이다.
- [0031] 이상 설명한 바와 같이 본 발명은 저속 이동 중에 있는 항공기를 레이저로 순간 스캐닝하여 임의의 응시각도에서의 3 차원 운집(point cloud) 이미지 데이터를 포착, 생성하고 이를 기하학적인 공간변환 기법을 사용하여 평면도 및 정면도 이미지를 추출하고 이 이미지를 메모리에 저장되어 있는 기존 항공기 기종별 이미지 정보와 비교, 검색하여 합치되는 기종을 찾아냄으로, 항공기의 기종을 실시간으로 즉시 식별해 낼 수 있는 혁신적인 항공기 기종판별 및 주기유도시스템을 구성할 수 있다.
- [0032] 도 1의 레이저 송수신장치(1)는 도 2에서 레이저 다이오드 및 수광소자(11)와 집속렌즈(collimating lens)(12)로 구성되는 부분인데, 레이저 다이오드 및 수광소자(11)에는 레이저 광 신호를 발사하는 레이저 다이오드(laser diode)와 광수신용 소자로서 구성된다. 광수신용 소자에는 보통 일반용 광 트랜지스터(photo transistor)나 APD(Avalanche Photo Diode)를 사용한다. 2-D 스캐닝 메커니즘(3)은 레이저 송수신장치(1)를 기계적으로 통째로 부착하거나 메커니즘의 구조를 간략하게 하기 위하여 레이저 송수신장치(1)에서 발사되거나 입사되어 오는 레이저 광선 빔(beam)을 각각 수평(x축) 및 수직(y축)으로 반사시켜주는 수평 미러(15)와 수직 미러(16)에 의하여 각기 90도 각도로 꺾여 줌으로서 레이저 빔의 방향이 이에 직각인 z축으로 향하게 한다. 수평축(x축) 스텝퍼 모터(13)와 수직축(y축) 스텝퍼 모터(14)는 각각 정밀급의 스텝퍼 모터(stepper motor)로서 각각의 축에 부착되어 있는 미러를 미세각 단위로 회전시켜 줌으로서 x-y축의 2차원 스캐닝을 행한다.

- [0033] 수직축 제어신호 인덱서(19)는 본 장비의 제어용 컴퓨터에서 들어오는 디지털 제어신호를 받아서 스텝퍼 모터를 적절하게 제어할 수 있도록 인덱스(index)하는 신호로 변환시켜주고 인터페이스 시켜주는 역할을 한다. 수직모터 드라이버(20)는 수직축 제어신호 인덱서(19)로부터 받은 신호를 사용하여 수직 스텝퍼 모터(14)가 정확한 회전을 할 수 있도록 필요한 전류가 흐르도록 구동하는 회로이다. 수평축 제어신호 인덱서(17)와 수평 모터 드라이버(18)도 이와 동일한 기능으로 수평 스텝퍼 모터(13)를 제어하고 구동한다.
- [0034] 레이저 수신신호 증폭처리부(23)은 레이저 다이오드 및 수광소자(11) 내에 있는 레이저 빔 수광소자에서 수신한 레이저 수신 신호파형의 레벨을 증폭하고 문턱레벨제어에 의한 잡음제거, 표본화 윈도우 제어 등의 처리를 행한 다음 이산 출력신호를 TOF 측정부(24)로 보낸다. TOF 측정부(24)는 레이저 송신펄스 제어신호부(22)에서 발사한 레이저 송신 펄스의 발사시각과 레이저 수신 신호증폭처리부에서 수신된 레이저 수신 펄스의 시각 차이를 측정하여 이를 2로 나누어 빛의 속도를 곱해주는 연산처리를 하여 레이저 펄스가 목적물에서 반사되어 온 거리를 계산해 내어 측정결과 데이터를 제어용 컴퓨터로 출력한다. 레이저 송신펄스 제어신호부(22)는 레이저 다이오드 및 수광소자(11) 내에 있는 레이저 광 송신용 레이저 다이오드를 필요한 시점에서 점화시키거나 차단하는 제어를 행한다. 클럭신호 발생부(21)은 레이저 거리측정 처리과정의 기준이 되는 정확한 클럭펄스(clock pulse) 신호를 만들어 레이저 송신펄스 제어신호부(22), 레이저 수신신호 증폭처리부(23) 및 TOF 측정부(24)에 공급한다. 클럭신호발생부(21)는 자체적으로 클럭 펄스를 생성하는 대신 제어용 컴퓨터의 메인 클럭신호를 변환하여 적절한 클럭주기를 만들기 때문에 제어용 컴퓨터의 각종 명령어 인스트럭션(instruction) 수행과 동기를 갖게 한다.
- 도 3 은 본 발명 장치의 하드웨어를 사용하여 항공기의 감지, 기종판별 및 주기유도를 행하기 위한 종합적인 소프트웨어 알고리즘의 한 구성 예를 간략하게 보여주는 절차도이다.
- 도 3을 참조하여 각 단계별로 간략히 설명을 하면 다음과 같다.
- [0035] 삭제
- [0036] 삭제
- [0037] 시작 단계(30)는 본 장치의 컴퓨터 하드웨어가 동작을 시작하여 운영체제를 가동하고 본 장치의 메인 프로그램을 시작하는 단계이다. 초기화 및 자기시험 진단단계(31)는 본 장치가 거리측정 및 이미지 추출을 하기 전에 각종 메모리의 갱신 등 초기화(initialization) 절차를 수행하고 거리측정 및 수직/수평 각도 상의 오차나 오류를 없애기 위하여 자기시험(self test) 및 자기 진단 루틴(self-diagnostic routine)을 행하는 단계이다(S31).
- 이 후, 자기 시험 및 진단 결과 수직 및 수평 모터의 작동각도 범위 내에서의 동작이나 레이저 빔의 발사와 수신작동 등이 이상이 없는 경우에 시스템은 system ready 신호를 출력하게 되고 단계(32)의 대기 모드(stand-by mode)로 돌입하게 된다(S32).
- [0038] 대기 모드에서는 레이저 송신신부가 70m 이상의 거리에서 항공기의 진입이 예상되는 특정방향을 지향하고 주기적으로 레이저를 발사하고 수신신호를 확인하는 동작을 자동적으로 지속 수행하는 루프(loop) 동작을 한다(S33).
- 항공기가 진입하면 이를 감지하고 aircraft detected 메시지를 출력하는 감지모드(detection mode)로 돌입한다.
- 이 후, 항공기가 감지되었을 경우 만일 감지 거리가 70m 이상이라면 이미지를 생성하기에 좀 멀기 때문에 감지작업을 재 반복하고 70 m 이내에 도달한 경우에는 다음 단계(35)에서 변수 N을 0으로 설정한다. 이 변수는 항공기 기종판별 오류 발생시 3회까지 반복하기 위한 변수이다(S34, S35).
- [0039] 이 후, $N = N + 1$ 로 메모리 내의 변수 N을 1만큼 증가시키고 단계(37)에서는 본 장치에 있는 X축 및 Y축 2차원의 레이저 스캐너가 정치가 전방에 있는 항공기를 스캐닝한다(S37).
- 이 후, 상기 단계 S37에서 획득한 운집(point cloud) 데이터 중에서 잡음이나 배경 이미지 등을 제거하고, 이동체 이미지를 생성하고, 그 중 최근점(the nearest point)의 각도와 거리를 산출한다(S38). 여기서, 상기 최근점은 항공기가 진입하는 것이므로 항공기의 코끝이 될 것이다.
- [0040] 이 후, 거리 도메인 필터링(distance domain filtering) 처리 기법을 사용하여 위에서 내려다 본 이미지 중에서 항공기 몸체 주위 거리보다 일정 양만큼 낮은 지면 반사 신호나 좌우 날개끝 보다 더 가장자리에 존재할 수 있

- 는 승객용교각(PBB) 또는 차량 등 주기장 주변의 부수시설물의 이미지 등 불필요한 데이터를 제거한다(S39).
- 이 후, 필터를 거쳐서 최종적으로 추출된 이동체(항공기) 이미지 중에서 항공기의 기체가 좌우대칭이라는 특성을 가지므로 이를 이용해 대칭축을 찾아내고 따라서 응시각도를 계산해 낸다(S40).
- [0041] 삭제
- [0042] 이 후, 레이저 스캐닝에 의하여 획득된 X축 좌표, Y축 좌표 및 측정된 거리정보(Z)의 3 차원 데이터와 함께 메모리에 저장된 각 point cloud들의 데이터를 사용하여 3-D modeling 처리에 의하여 기하학적 좌표변환 영상처리 과정을 수행하여 수평 응시각을 0도로 회전한다(S41).
- [0043] 이 후, 상기 단계 S41에서 얻은 결과 이미지를 다시 수직 응시각도를 +90도로 회전시켜 항공기의 평면도 이미지를 생성해 낸다(S42). 또 단계(43)에서는 계속하여 수직 응시각도를 0도로 변환하여 항공기의 평면도 이미지를 얻어낸다(S43).
- [0044] 이 후, 위 단계에서 얻어낸 항공기의 평면도와 평면도를 기종별 데이터 메모리(5)에 저장되어 있는 항공기 정보에서 최적으로 일치하는 기종명을 검색하여 결정한다(S44). 이 때, 주요 부위의 거리 등을 비교하되 적절한 허용오차를 부여하여 오차 값 이내로 합치되는 경우를 찾는다.
- [0045] 이 후, GOS(Gate Operating System), FIMS(Flight Information Management System) 등 공항에서 항공기 운행 관리에 사용하는 시스템으로부터 온라인으로 취득해 온 기종정보를 본 시스템에서 판별한 기종명과 비교하여 일치여부를 확인한다(S45).
- 만일, 두 정보가 불일치하는 경우에는 단계(48)를 경유하여 다시 단계(36)로 올라가서 변수 N을 하나 증가시키고 동일한 기종판별 절차를 반복한다. 최대 3회까지 반복하여도 기종명이 불일치하는 경우에는 단계(48)에서 단계(49)로 빠져나가 ID Failed 라는 메시지를 송출하고 항공기를 정지시키거나 단계(50)에서 본 시스템을 Auto Mode 대신에 Manual Mode로 전환시켜 수동으로 주기과정을 진행한다.
- [0046] 기종판별 결과와 공항운영시스템의 통보기종명이 일치하는 경우에는 단계(46)로 진행되며 Aircraft Verified 라는 메시지와 함께 판별된 기종명을 문자 디스플레이 표시하고 동시에 외부 시스템 통신접속 인터페이스(8)을 통하여 관련 시스템에 데이터를 출력한다(S46).
- [0047] 이 후부터는, 기종판별 단계를 끝내고 주기유도 단계에 들어가기 위하여 해당기종에 적용되는 정지선 위치정보를 불러온다(S47).
- 이 후, 정지선 정보와 현재의 항공기 최근거리 정보를 비교하여 잔여거리를 계산하고, 이 값을 1 m 단위로 문자 디스플레이에 출력한다(S51).
- 이 후, 잔여거리가 25 m가 될 때까지 잔여거리 계산을 계속하며, 25 m 이내가 되는 경우부터는 잔여거리 계산과 병행하여 중앙유도선에 대한 항공기의 좌우편차 정보를 추출하여 표시출력 함으로서 조종사에게 정확한 주기위치를 안내하고 유도한다(S52, S53, S54).
- [0048] 이 후, 항공기의 진입속도를 측정하여 문자디스플레이 장치(6)에 숫자로 표시하며 동시에 최종 정지점까지의 거리 접근비율을 동시에 바코드 형태로 도시하여 항공기 조종사가 진행속도를 체감하도록 한다(S55).
- [0049] 이 후, 잔여거리가 3 m 이내가 되는 시점을 판별하고 그 이후부터는 잔여거리 정보를 0.2 m 단위로 계산하여 문자디스플레이 장치(6)에 출력함으로써 정밀한 주기를 유도한다(S56, S57, S58).
- 이 후, 잔여거리가 0.1 m 인 시점과 지점을 찾아내고, 이 지점에서는 즉시 조종사가 항공기를 정지하도록, 단계(60)에서 STOP 메시지를 문자디스플레이 장치(6)에 표시한다. 여기서 0.1 m는 항공기의 관성을 위해 설정한 수치이고 STOP 메시지를 보고 항공기를 정지시키면 거의 0 m 지점에 도달할 것이다(S59, S60).
- [0050] 만일 항공기가 정지선으로부터 0.1 m 이상 앞으로 나가게 되는 경우에는 이를 감지해 단계(62)에서 TOO FAR 메시지가 문자 디스플레이에 표시된다(S61, S62).
- [0051] 도 4는 2차원 레이저 스캐너와 측정된 거리 정보에 의하여 획득한 3 차원의 이미지 데이터를 영상처리하여 얻은 항공기의 3-D 모델링 정보를 이용하여 기종판별을 위한 항공기 평면도와 평면도를 생성하는 과정을 보여주는 3 차원 영상처리 원리도이다.

- 먼저 부재번호 100은 레이저 스캐너에 의하여 생성된 3 차원의 스캔 이미지 원본이다. 이는 항공기가 활주로(runway)로부터 유도로(taxiway)로 진입하여 배정된 최종 탑승구(gate)에 주기하기 위하여 주행하다가 정지선 앞 약 70~100 m 정도 위치에서 항공기가 감지되고 약 50~70 m 정도의 거리에서 스캔이 시작되어 획득된 이미지로서 유도로의 형태에 따라 항공기 이미지가 정면이 아닌 임의의 응시각도를 가질 수 있음을 나타낸다.
- [0052] 따라서, 이 임의의 각도의 이미지에서 대칭축을 구하여 수직 및 수평면에서의 응시각도를 계산하고 1차적으로 수평각을 회전하여 0도로 변환함으로써 부재번호 101과 같이 수평각 0도가 되는 이미지로 변환한다.
- [0053] 다음, 2 차적으로 부재번호 101의 이미지를 수직 응시각도를 변환하는 3 차원 모델링 기하학적 좌표변환을 행하여 수직 응시각도를 +90도와 0도로 하면 각각 부재번호 102 및 103과 같은 평면도와 정면도를 생성할 수 있게 된다.
- 따라서 이 두 가지 도면을 이용하여 기종별 메모리 저장장치에 들어있는 정보와 비교하여 합치되는 기종을 판별할 수 있게 되는 것이다.
- [0054] 도 1 내지 도 2 에 도시된 본 발명은, 예컨대 파장 905 nm 대의 비가시형 레이저 빔을 생성하고 레이저 필스를 송수신하여 전면에 존재하는 대상을 감지하고 거리를 측정하는 레이저 거리 측정장치(laser range finder)와, 이 레이저 빔을 X(수평)축 및 Y(수직)축으로 2차원의 스캐닝을 하는 소위 정밀급의 팬-틸트 메커니즘(pan-tilt mechanism) 또는 2개의 수직/수평 미러 회전 스텝퍼모터(mirror rotation stepper motor)를 사용하는 레이저 스캐너 및 측정장치를 이용할 수 있다.
- [0055] 그리고, 상기 스텝퍼모터와 레이저 발생장치를 제어하고 조정하고, 수신된 레이저빔 반사신호를 수신하여 데이터를 저장하고 분석하며, 기종식별을 위한 판정을 하는 알고리즘을 포함하는 판정결과를 조종사 안내표시용 디스플레이 장치에 출력하고 외부 시스템과의 데이터 교환을 관리하는 데이터 분석판정 알고리즘 처리장치가 설치된다.
- [0056] 각종 항공기의 규격과 특징들에 대한 요소들을 사전에 메모리 장치에 저장하여 데이터 분석판정 알고리즘 처리장치가 기종인식 판정을 하는데 기준자료를 제공하는 기억장치로서 필요에 따라 내용을 삭제, 추가 프로그램하는 기종 데이터 메모리를 연결하여 사용할 수 있다.
- [0057] 상기 데이터 분석판정 알고리즘 처리장치에서 처리한 결과를 문자 또는 기호로써 항공기 조종사에게 시각적으로 표시하는 문자디스플레이 장치와; 비상 또는 필요시에 무인자동조작 대신 수동적으로 조작자가 버튼조작에 의하여 디스플레이를 통해 항공기 조종사에게 지시하는 수동조작 제어패널을 각각 연결한다.
- [0058] 상기 데이터 분석판정 알고리즘 처리장치에는 공항 내의 종합운영시스템과 접속함으로써 공항종합정보를 입수하거나 알고리즘 처리장치에서의 결과 및 운영상태를 공항 정보장치로 송출하는 외부시스템 통신접속 인터페이스와; 비디오 영상 카메라로 진입하는 항공기의 실물 이미지를 촬영하여 데이터 분석판정 알고리즘 처리장치의 제어를 거쳐 영상 이미지를 영상 디스플레이장치로 보내어 항공기 조종사 등이 시각적으로 항공기의 진입상태를 간편하게 감시하는 영상 카메라로 구성된 것이 설치된다.
- 요컨대, 도 2 는 도 1에 도시된 레이저 송수신장치(1)와 데이터 획득 및 거리측정장치(2) 및 2차원 스캐닝 메커니즘(3)의 상호 종속적으로 연관된 레이저 프론트엔드(front-end) 부분의 동작을 보다 구체적으로 설명하기 위하여 구성을 더 상세하게 도시한 도면이다.
- [0059] 삭제
- [0060] 도 4 는 본 발명에서 항공기 기종을 판별하고자 할 때 먼저 진입하는 항공기를 레이저 스캐너장치를 이용하여 스캔하고, 이 이미지에서 이동체인 항공기 이미지를 추출하고 임의의 방향에서 스캐닝된 항공기 이미지에서 좌우 대칭축을 찾아내고 3-D 모델링 기법으로 수평 응시각도(viewing angle)를 0도로 만들고 수직 응시각도 0도와 +90도로 만들어 항공기의 정면도와 평면도 이미지를 3 차원 기하학적 좌표변환 기술에 의하여 생성하는 과정을 보여주고 있다.
- [0061] 본 발명의 항공기 기종판별 및 주기유도시스템이 데이터 분석판정 알고리즘 처리장치에서 프로그램 수행을 시작

- 하여 각종 초기화를 행하고 업무를 수행하기 전에 하드웨어와 소프트웨어 시스템에 대하여 자기진단과 시험을 행한다.
- [0062] 상기 데이터 분석판정 알고리즘 처리장치에서는 초기화 및 자기시험단계에 이어 항공기를 감지하는 단계인 바, 이는 활주로를 경유하여 착륙한 항공기가 배정된 탑승구로 진입할 때에 탑승구로부터 50~100 미터 거리에서 항공기의 진입을 감지하는 단계이다.
- [0063] 그리고, 레이저 송수신장치(1)의 데이터 획득 및 거리측정장치(2)와 2차원(D) 스캐닝 메커니즘(3)에 의해 약 70 m의 지점으로부터 레이저 스캐너가 스캐닝을 시작하여 약 50 m 이전에 항공기의 기종을 판별하는 단계이다.(도 4 참조).
- [0064] 약 50 m의 지점으로부터 레이저 스캐너가 판별된 항공기의 정지지점을 불러와서 정지지점까지의 잔여거리 정보를 계산해서 디스플레이하는 단계이고, 약 25 m의 지점으로부터 레이저 스캐너가 획득한 이미지 자료를 사용하여 좌우편차 정보를 제공하는 단계이다.
- [0065] 약 15 m의 지점으로부터는 레이저 스캐너가 좌우편차 정보를 제공하면서 더욱 정밀하게 잔여거리를 제공(1 m 단위로 하다가, 3 m 이내부터는 0.2 m 단위로 잔여거리 제공) 하다가 정지지점에서 정지신호를 제공하고, 항공기의 주기가 종료되었다는 신호를 송출하는 단계 등으로 구분하여 작동을 하게 한다.
- [0066] 특히, 상기 데이터 분석판정 알고리즘처리장치는 항공기를 스캐닝한 다음에는 획득된 3 차원 공간상의 수많은 운집 데이터로부터 거리 도메인 필터링(distance domain filtering) 기술을 사용하여 이동체의 이미지만을 추출하고, 항공기의 코에 해당하는 최근점(the nearest point)과 최원점(the farthest points)의 정보를 바탕으로 수직 및 수평면 상의 대칭축(symmetrical axis)을 찾아내서 응시각도를 계산한다. 여기서, 최원점은 항공기가 접근하는 것이므로, 항공기의 수직 뒷날개가 될 수 있다.
- [0067] 이 응시각도가 0 이 되도록 3 차원 운집 이미지 데이터의 3 차원 기하학적 공간변환을 행하여 당해 항공기 이미지의 정확한 평면도 및 정면도를 생성할 수 있다.
- [0068] 다음 데이터분석판정 알고리즘처리장치에서는, 항공기 데이터베이스에 들어 있는 기종별 데이터와 비교, 검색하여 도 4에 도시된 생성 평면도 및 정면도가 합치하는 기종명을 찾아내어 항공기를 판별하고, 이후에 각종 제어 및 유도를 행하는 단계로 구성된 것이다.
- [0069] 지금까지의 이러한 프로그램 처리 흐름도는 본 발명 장치의 제반 기능을 처리하기 위한 하나의 예를 도시한 것일 뿐이고, 각 처리의 순서를 바꾸거나 형태를 달리하여 동일한 기능을 수행하도록 변화시킬 수 있는 소지가 있다.
- [0070] 따라서 본 발명은 이러한 포괄적인 흐름 절차를 포함한 알고리즘을 제안하는 것으로 권리범위가 정해져야 하는 것이다.

부호의 설명

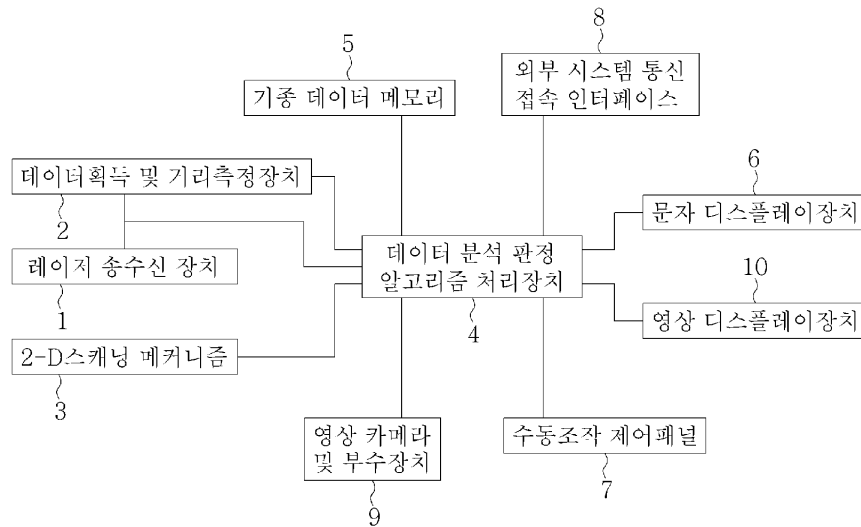
- [0071] 1 : 레이저 송수신장치
 2 : 데이터획득 및 거리측정장치
 3 : 2-D(차원) 스캐닝 메커니즘
 4 : 데이터 분석판정 알고리즘 처리장치
 5 : 기종 데이터 메모리
 6 : 문자디스플레이장치
 7 : 수동조작 제어패널
 8 : 외부시스템 통신접속 인터페이스

9 : 영상카메라

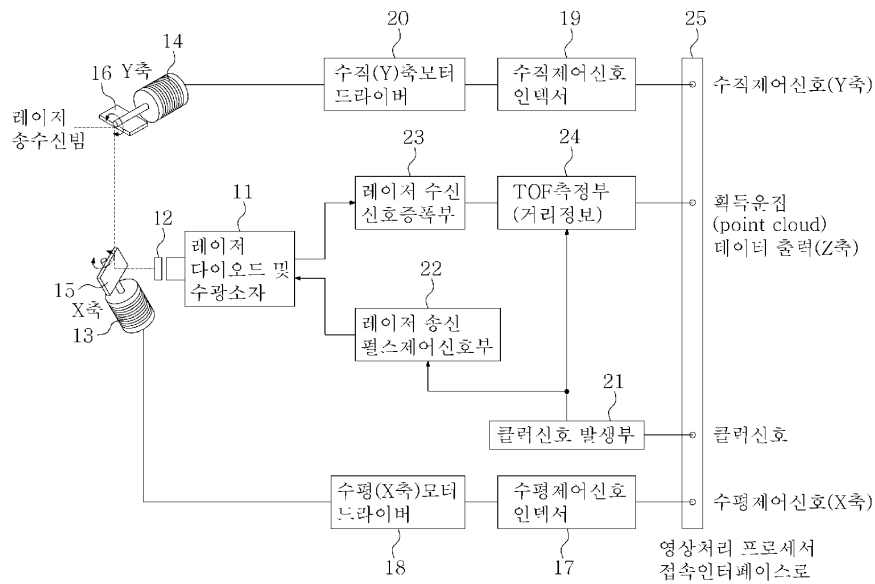
10 : 영상디스플레이장치

도면

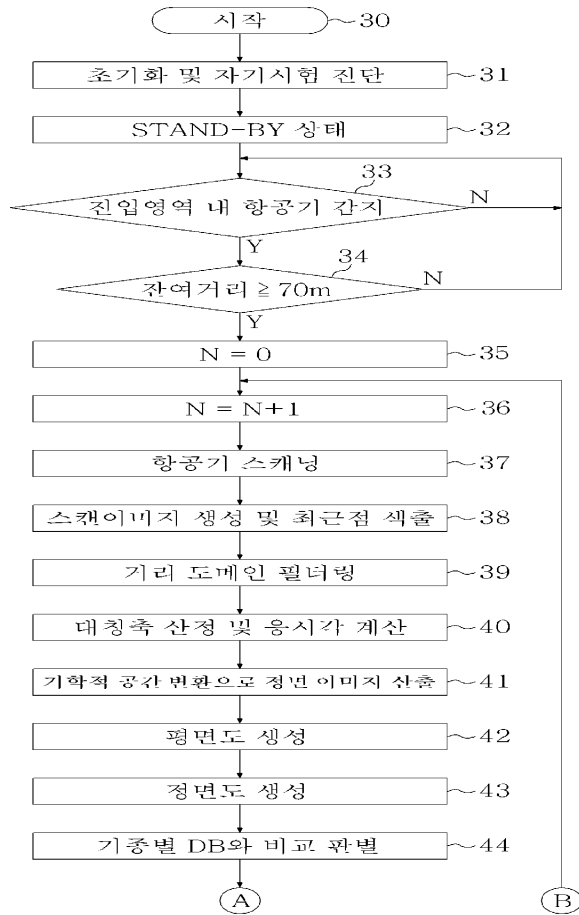
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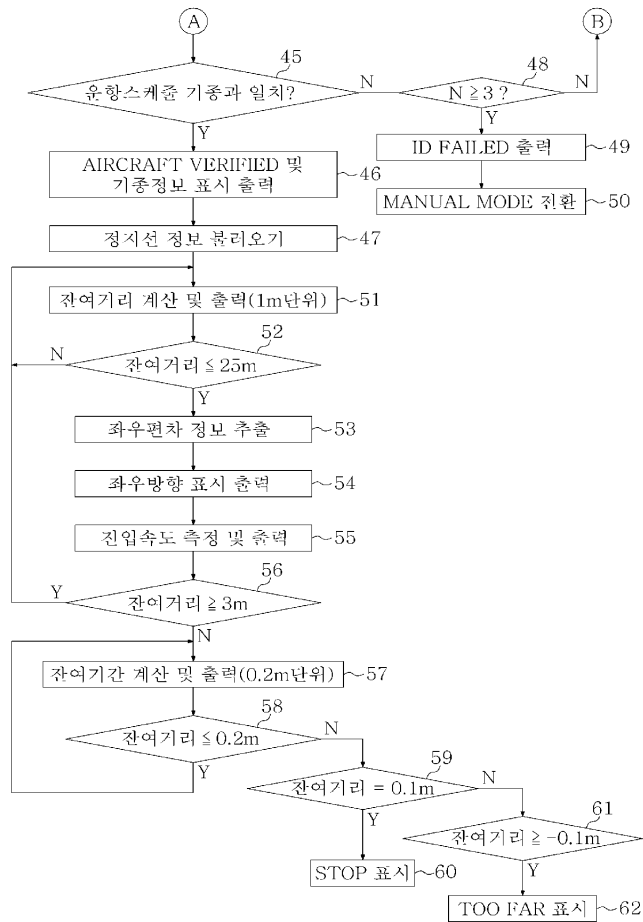
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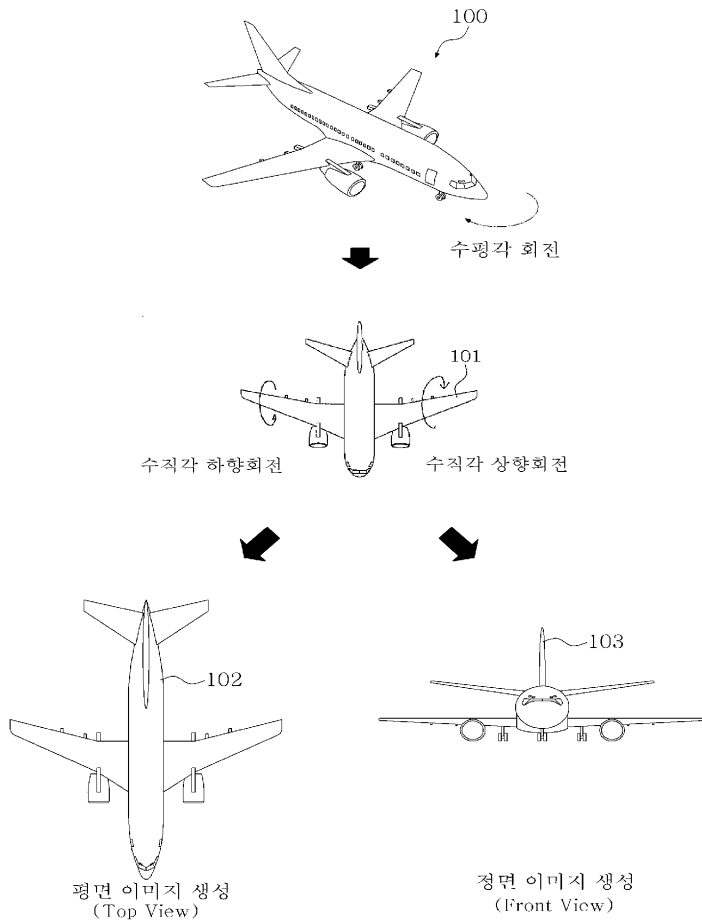
도면 3a



도면 36



도면 4





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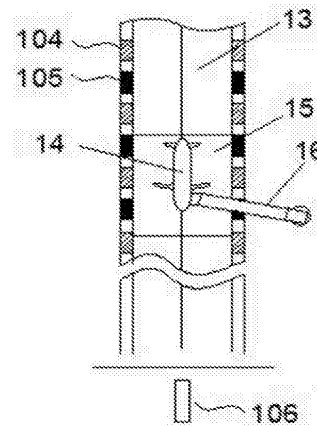
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(54)发明名称

一种安全性能高的飞机泊位智能指示系统

(57)摘要

本发明公开了一种安全性能高的飞机泊位智能指示系统,包括信息采集单元、泊位运算主控模块、廊桥自动控制模块、无线通信模块、远程控制中心、信息收发模块、信息处理及控制模块、红外信号接收模块、飞机定位模块、智能语音提示模块、实时红外图像显示模块、数据储存模块和检测信息显示模块,所述信息采集单元包括视频采集模块、泊机位红外投影模块、红外图像采集模块、激光测距传感模块、测速模块、中轴定位感应模块、廊桥定位模块、第一红外信号发射模块和第二红外信号发射模块。本发明安全性能高,能够有效提高了飞机泊位精度,具备有提示功能、同时具备实时数据比对功能,可远程控制飞机泊位,满足快速、准确、高效的泊位引导需求。



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1. 一种安全性能高的飞机泊位智能指示系统, 其特征在于: 包括信息采集单元(1)、泊位运算主控模块(2)、廊桥自动控制模块(3)、无线通信模块(4)、远程控制中心(5)、信息收发模块(6)、信息处理及控制模块(7)、红外信号接收模块(8)、飞机定位模块(9)、智能语音提示模块(10)、实时红外图像显示模块(11)、数据储存模块(12)和检测信息显示模块(17), 所述信息采集单元(1)包括视频采集模块(101)、泊机位红外投影模块(102)、红外图像采集模块(103)、激光测距传感模块(104)、测速模块(105)、中轴定位感应模块(106)、廊桥定位模块(107)、第一红外信号发射模块(108)和第二红外信号发射模块(109), 其中, 所述视频采集模块(101)与泊位运算主控模块(2)连接, 用于对运行在飞机泊位牵引通道(13)上的飞机(14)影像跟踪和运行轨迹的捕捉, 所述泊机位红外投影模块(102)与泊位运算主控模块(2)连接, 用于对飞机泊位牵引通道上的泊机位(15)进行红外投影, 所述红外图像采集模块(103)与泊位运算主控模块(2)连接, 用于对泊机位(15)上的红外投影图像及飞机(14)影像和运行轨迹进行实时捕捉, 所述激光测距传感模块(104)和测速模块(105)分别与泊位运算主控模块(2)连接, 用于对飞机(14)与飞机泊位牵引通道(13)两侧间距和飞机(14)运行速度进行实时检测, 所述中轴定位感应模块(106)与泊位运算主控模块(2)连接, 用于指示飞机(14)沿飞机泊位牵引通道(13)的中线直线运行, 所述廊桥定位模块(107)与泊位运算主控模块(2)连接, 用于廊桥(16)与飞机(14)登机口的高度差检测, 所述第一红外信号发射模块(108)和第二红外信号发射模块(109)分别与泊位运算主控模块(2)连接, 用于飞机(14)登机口的定位检测, 所述廊桥自动控制模块(3)与泊位运算主控模块(2)连接, 用于控制廊桥(16)运行至与飞机(14)登机口对应位置, 所述泊位运算主控模块(2)通过无线通信模块(4)与远程控制中心(5)连接, 用于实现远程控制, 所述泊位运算主控模块(2)通过信息收发模块(6)与信息处理及控制模块(7)连接, 所述红外信号接收模块(8)与信息处理及控制模块(7)连接, 用于接收第一红外信号发射模块(108)和第二红外信号发射模块(109)的红外信号, 所述飞机定位模块(9)用于飞机(14)实时定位, 所述智能语音提示模块(10)与信息处理及控制模块(7)连接, 用于语音提示飞行员飞机(14)运行线路偏离飞机泊位牵引通道(13)的中线, 所述实时红外图像显示模块(11)与信息处理及控制模块(7)连接, 用于实时显示通过接收来自红外图像采集模块(103)采集的红外投影信息, 所述数据储存模块(12)与信息处理及控制模块(7)连接, 用于储存各项检测数据、计算结果以及供信息处理及控制模块(7)提取标准数据, 并通过检测信息显示模块(17)进行显示, 同时与实时检测数据进行比对, 所述检测信息显示模块(17)与信息处理及控制模块(7)连接, 用于显示各项数据、检测信息及计算结果, 便于飞行员进行运行轨迹的调整。

2. 如权利要求1所述的一种安全性能高的飞机泊位智能指示系统, 其特征在于: 所述视频采集模块(101)采用视频摄像机, 通过影像跟踪技术捕捉飞机(14)运行轨迹。

3. 如权利要求1所述的一种安全性能高的飞机泊位智能指示系统, 其特征在于: 所述泊机位红外投影模块(102)采用红外投影仪, 对泊机位(15)进行区域红外投影, 所述飞机(14)的机体外壳采用不反光但反射红外光源的特殊材料, 通过红外图像采集模块(103)对飞机(14)的运行轨迹进行捕捉。

4. 如权利要求1所述的一种安全性能高的飞机泊位智能指示系统, 其特征在于: 所述激光测距传感模块(104)采用激光传感器, 所述测速模块(105)采用测速传感器, 激光传感器与测速传感器设置有多个, 且对应设置于飞机泊位牵引通道(13)的两侧, 位于两侧的激光

传感器和测速传感器交替设置。

5. 如权利要求1所述的一种安全性能高的飞机泊位智能指示系统,其特征在于:所述中轴定位感应模块(106)采用第一卫星定位天线,第一卫星定位天线安装在飞机泊位牵引通道(13)的中线轴向端部且位于飞机(14)起飞线的外端,用于检测飞机(14)运行时机体与中线的角度。

6. 如权利要求1所述的一种安全性能高的飞机泊位智能指示系统,其特征在于:所述第一红外信号发射模块(108)和第二红外信号发射模块(109)分别采用第一红外发射器和第二红外发射器,所述廊桥(16)包括前段(1601)、中段(1602)和后段(1603),第一红外发射器对应设置于中段(1602)的侧部,第二红外发射器对应设置于前段(1601)的顶端,所述红外信号接收模块(8)采用与第一红外发射器和第二红外发射器型号匹配的红外接收器,红外接收器设置于飞机(14)登机口的上端,红外接收器、第一红外发射器和第二红外发射器的高度相同,所述廊桥定位模块(107)采用第二卫星定位天线,对应安装于前段(1601)顶端且位于第二红外发射器的一侧,用于实时检测前段(1601)与飞机(14)登机口的高度差。

7. 如权利要求6所述的一种安全性能高的飞机泊位智能指示系统,其特征在于:所述廊桥(16)处于初始状态时,中段(1602)轴向与飞机泊位牵引通道(13)的轴向之间呈锐角设置,第一红外发射器安装于中段(1602)靠近飞机(14)的侧部,且第一红外发射器发射的红外线信号方向与飞机泊位牵引通道(13)的轴向呈垂直设置。

8. 如权利要求1所述的一种安全性能高的飞机泊位智能指示系统,其特征在于:所述检测信息显示模块(17)采用触摸显示屏,便于飞行员进行人机交互。

一种安全性能高的飞机泊位智能指示系统

技术领域

[0001] 本发明涉及飞机泊位指示系统技术领域，具体为一种安全性能高的飞机泊位智能指示系统。

背景技术

[0002] 飞机泊位自动指示系统能够为飞机在停机坪安全、高效停泊提供准确和规范的引导，指引飞行员以最优程序停泊飞机。飞机泊位过程是航班运行中的一个组成部分，使用辅助设备提高航班运行的效率 and 安全性也是机场现代化建设的一个组成部分。

[0003] 但传统的飞机泊位指示系统主要采用视频测量图像识别方法和触发式线圈感应检测方法，视频测量图像识别方法是通过视频摄像机影像跟踪技术捕捉飞机运行轨迹，但受天气与光线的影响较大，存在较大的误差和一定的错误概率，存在安全隐患；触发式线圈感应检测方法是通过埋在地面下的感应线圈来确定飞机位置，存在易损坏，精度低，安全性能低的缺点；现急需一种安全性能高，具有提示功能，具有多次数据对比功能，可远程控制飞机进行泊位，满足快速、准确、高效的泊位引导需求的飞机泊位智能指示系统。

[0004] 所以，本发明将提供一种安全性能高的飞机泊位智能指示系统，来解决上述问题。

发明内容

[0005] 针对现有技术的不足，本发明提供了一种安全性能高的飞机泊位智能指示系统，解决了飞机泊位指示系统安全性能低、指示精度不高以及效率低，不能满足快速、准确、高效的泊位引导需求的问题。

[0006] 为实现上述目的，本发明通过以下技术方案予以实现：一种安全性能高的飞机泊位智能指示系统，包括信息采集单元、泊位运算主控模块、廊桥自动控制模块、无线通信模块、远程控制中心、信息收发模块、信息处理及控制模块、红外信号接收模块、飞机定位模块、智能语音提示模块、实时红外图像显示模块、数据储存模块和检测信息显示模块，所述信息采集单元包括视频采集模块、泊机位红外投影模块、红外图像采集模块、激光测距传感模块、测速模块、中轴定位感应模块、廊桥定位模块、第一红外信号发射模块和第二红外信号发射模块，其中，所述视频采集模块与泊位运算主控模块连接，用于对运行在飞机泊位牵引通道上的飞机影像跟踪和运行轨迹的捕捉，所述泊机位红外投影模块与泊位运算主控模块连接，用于对飞机泊位牵引通道上的泊机位进行红外投影，所述红外图像采集模块与泊位运算主控模块连接，用于对泊机位上的红外投影图像及飞机影像和运行轨迹进行实时捕捉，所述激光测距传感模块和测速模块分别与泊位运算主控模块连接，用于对飞机与飞机泊位牵引通道两侧间距和飞机运行速度进行实时检测，所述中轴定位感应模块与泊位运算主控模块连接，用于指示飞机沿飞机泊位牵引通道的中线直线运行，所述廊桥定位模块与泊位运算主控模块连接，用于廊桥与飞机登机口的高度差检测，所述第一红外信号发射模块和第二红外信号发射模块分别与泊位运算主控模块连接，用于飞机登机口的定位检测，所述廊桥自动控制模块与泊位运算主控模块连接，用于控制廊桥运行至与飞机登机口对应

位置,所述泊位运算主控模块通过无线通信模块与远程控制中心连接,用于实现远程控制,所述泊位运算主控模块通过信息收发模块与信息处理及控制模块连接,所述红外信号接收模块与信息处理及控制模块连接,用于接收第一红外信号发射模块和第二红外信号发射模块的红外信号,所述飞机定位模块用于飞机实时定位,所述智能语音提示模块与信息处理及控制模块连接,用于语音提示飞行员飞机运行线路偏离飞机泊位牵引通道的中线,所述实时红外图像显示模块与信息处理及控制模块连接,用于实时显示通过接收来自红外图像采集模块采集的红外投影信息,所述数据储存模块与信息处理及控制模块连接,用于储存各项检测数据、计算结果以及供信息处理及控制模块提取标准数据,并通过检测信息显示模块进行显示,同时与实时检测数据进行比对,所述检测信息显示模块与信息处理及控制模块连接,用于显示各项数据、检测信息及计算结果,便于飞行员进行运行轨迹的调整。

[0007] 进一步的,所述视频采集模块采用视频摄像机,通过影像跟踪技术捕捉飞机运行轨迹。

[0008] 进一步的,所述泊机位红外投影模块采用红外投影仪,对泊机位进行区域红外投影,所述飞机的机体外壳采用不反光但反射红外光源的特殊材料,通过红外图像采集模块对飞机的运行轨迹进行捕捉。

[0009] 进一步的,所述激光测距传感模块采用激光传感器,所述测速模块采用测速传感器,激光传感器与测速传感器设置有多,且对应设置于飞机泊位牵引通道的两侧,位于两侧的激光传感器和测速传感器交替设置。

[0010] 进一步的,所述中轴定位感应模块采用第一卫星定位天线,第一卫星定位天线安装在飞机泊位牵引通道的中线轴向端部且位于飞机起飞线的外端,用于检测飞机运行时机体与中线的角度。

[0011] 进一步的,所述第一红外信号发射模块和第二红外信号发射模块分别采用第一红外发射器和第二红外发射器,所述廊桥包括前段、中段和后段,第一红外发射器对应设置于中段的侧部,第二红外发射器对应设置于前段的顶端,所述红外信号接收模块采用与第一红外发射器和第二红外发射器型号匹配的红外接收器,红外接收器设置于飞机登机口的上端,红外接收器、第一红外发射器和第二红外发射器的高度相同,所述廊桥定位模块采用第二卫星定位天线,对应安装于前段顶端且位于第二红外发射器的一侧,用于实时检测前段与飞机登机口的高度差。

[0012] 进一步的,所述廊桥处于初始状态时,中段轴向与飞机泊位牵引通道的轴向之间呈锐角设置,第一红外发射器安装于中段靠近飞机的侧部,且第一红外发射器发射的红外信号方向与飞机泊位牵引通道的轴向呈垂直设置。

[0013] 进一步的,所述检测信息显示模块采用触摸显示屏,便于飞行员进行人机交互。

[0014] 与现有技术相比,该发明的有益之处为:

[0015] 1. 该安全性能高的飞机泊位智能指示系统,通过信息采集单元中视频采集模块以及泊机位红外投影模块和红外图像采集模块配合设置,通过双影像跟踪和运行轨迹捕捉的方式实现飞机识别及位置检测,有效减小检测误差,提高了泊位精度,安全性高。

[0016] 2. 该安全性能高的飞机泊位智能指示系统,通过信息采集单元中激光测距传感模块、测速模块、中轴定位感应模块、廊桥定位模块、第一红外信号发射模块和第二红外信号发射模块的配合设置,能够辅助牵引飞机在飞机泊位牵引通道上直线行驶,为飞机提供快

速、准确、高效的泊位引导,进一步提高了泊位精度的同时,配合廊桥自动控制模块,能够实现廊桥的自动化对接,工作效率高。

[0017] 3.该安全性能高的飞机泊位智能指示系统,通过泊位运算主控模块、信息收发模块、信息处理及控制模块、数据储存模块和检测信息显示模块的配合设置,通过泊位运算主控模块将采集的检测数据及运算结果通过信息收发模块发送给信息处理及控制模块,通过检测信息显示模块进行数据显示,同时显示通过数据储存模块回送的标准数据信息,通过实时比对检测数据和标准数据,便于飞行员进行飞行轨迹调整,实现精准泊位。

[0018] 4.该安全性能高的飞机泊位智能指示系统,通过泊位运算主控模块、无线通信模块、远程控制中心、信息处理及控制模块和智能语音提示模块的配合设置,能够智能提示飞行员进行泊位调整,同时实现飞机泊位的远程控制。

附图说明

[0019] 图1为本发明中飞机泊位牵引通道的简易示意图;

[0020] 图2为本发明中泊机位红外投影简易说明图;

[0021] 图3为发明中信息采集单元与泊位运算主控模块的原理框图;

[0022] 图4为本发明中泊位运算主控模块与信息处理及控制模块的原理框图;

[0023] 图5为本发明中信息处理及控制模块与各模块的原理框图;

[0024] 图6为本发明中飞机与廊桥在对接与没有对接两种情况下的简易关系说明图。

[0025] 图中:1、信息采集单元;101、视频采集模块;102、泊机位红外投影模块;103、红外图像采集模块;104、激光测距传感模块;105、测速模块;106、中轴定位感应模块;107、廊桥定位模块;108、第一红外信号发射模块;109、第二红外信号发射模块;2、泊位运算主控模块;3、廊桥自动控制模块;4、无线通信模块;5、远程控制中心;6、信息收发模块;7、信息处理及控制模块;8、红外信号接收模块;9、飞机定位模块;10、智能语音提示模块;11、实时红外图像显示模块;12、数据储存模块;13、飞机泊位牵引通道;14、飞机;15、泊机位;16、廊桥;1601、前段;1602、中段;1603、后段;17、检测信息显示模块。

具体实施方式

[0026] 下面将结合本发明实施例中的附图,对本发明实施例中的技术方案进行清楚、完整地描述,显然,所描述的实施例仅仅是本发明一部分实施例,而不是全部的实施例。基于本发明中的实施例,本领域普通技术人员在没有做出创造性劳动前提下所获得的所有其他实施例,都属于本发明保护的范围。

[0027] 如图1-6所示,本发明提供一种技术方案:一种安全性能高的飞机泊位智能指示系统,包括信息采集单元1、泊位运算主控模块2、廊桥自动控制模块3、无线通信模块4、远程控制中心5、信息收发模块6、信息处理及控制模块7、红外信号接收模块8、飞机定位模块9、智能语音提示模块10、实时红外图像显示模块11、数据储存模块12和检测信息显示模块17,信息采集单元1包括视频采集模块101、泊机位红外投影模块102、红外图像采集模块103、激光测距传感模块104、测速模块105、中轴定位感应模块106、廊桥定位模块107、第一红外信号发射模块108和第二红外信号发射模块109,其中,视频采集模块101与泊位运算主控模块2连接,用于对运行在飞机泊位牵引通道13上的飞机14影像跟踪和运行轨迹的捕捉,泊机位

红外投影模块102与泊位运算主控模块2连接,用于对飞机泊位牵引通道上的泊机位15进行红外投影,红外图像采集模块103与泊位运算主控模块2连接,用于对泊机位15上的红外投影图像及飞机14影像和运行轨迹进行实时捕捉,激光测距传感模块104和测速模块105分别与泊位运算主控模块2连接,用于对飞机14与飞机泊位牵引通道13两侧间距和飞机14运行速度进行实时检测,中轴定位感应模块106与泊位运算主控模块2连接,用于指示飞机14沿飞机泊位牵引通道13的中线直线运行,廊桥定位模块107与泊位运算主控模块2连接,用于廊桥16与飞机14登机口的高度差检测,第一红外信号发射模块108和第二红外信号发射模块109分别与泊位运算主控模块2连接,用于飞机14登机口的定位检测,廊桥自动控制模块3与泊位运算主控模块2连接,用于控制廊桥16运行至与飞机14登机口对应位置,泊位运算主控模块2通过无线通信模块4与远程控制中心5连接,用于实现远程控制,泊位运算主控模块2通过信息收发模块6与信息处理及控制模块7连接,红外信号接收模块8与信息处理及控制模块7连接,用于接收第一红外信号发射模块108和第二红外信号发射模块109的红外信号,飞机定位模块9用于飞机14实时定位,智能语音提示模块10与信息处理及控制模块7连接,用于语音提示飞行员飞机14运行线路偏离飞机泊位牵引通道13的中线,实时红外图像显示模块11与信息处理及控制模块7连接,用于实时显示通过接收来自红外图像采集模块103采集的红外投影信息,数据储存模块12与信息处理及控制模块7连接,用于储存各项检测数据、计算结果以及供信息处理及控制模块7提取标准数据,并通过检测信息显示模块17进行显示,同时与实时检测数据进行比对,检测信息显示模块17与信息处理及控制模块7连接,用于显示各项数据、检测信息及计算结果,便于飞行员进行运行轨迹的调整。

[0028] 具体来说,视频采集模块101采用视频摄像机,通过影像跟踪技术捕捉飞机14运行轨迹。

[0029] 具体来说,泊机位红外投影模块102采用红外投影仪,对泊机位15进行区域红外投影,飞机14的机体外壳采用不反光但反射红外光源的特殊材料,通过红外图像采集模块103对飞机14的运行轨迹进行捕捉。

[0030] 具体来说,激光测距传感模块104采用激光传感器,测速模块105采用测速传感器,激光传感器与测速传感器设置有多个,且对应设置于飞机泊位牵引通道13的两侧,位于两侧的激光传感器和测速传感器交替设置。

[0031] 具体来说,中轴定位感应模块106采用第一卫星定位天线,第一卫星定位天线安装在飞机泊位牵引通道13的中线轴向端部且位于飞机14起飞线的外端,用于检测飞机14运行时机体与中线的角度。

[0032] 具体来说,第一红外信号发射模块108和第二红外信号发射模块109分别采用第一红外发射器和第二红外发射器,廊桥16包括前段1601、中段1602和后段1603,第一红外发射器对应设置于中段1602的侧部,第二红外发射器对应设置于前段1601的顶端,红外信号接收模块8采用与第一红外发射器和第二红外发射器型号匹配的红外接收器,红外接收器设置于飞机14登机口的上端,红外接收器、第一红外发射器和第二红外发射器的高度相同,廊桥定位模块107采用第二卫星定位天线,对应安装于前段1601顶端且位于第二红外发射器的一侧,用于实时检测前段1601与飞机14登机口的高度差。

[0033] 具体来说,廊桥16处于初始状态时,中段1602轴向与飞机泊位牵引通道13的轴向之间呈锐角设置,第一红外发射器安装于中段1602靠近飞机14的侧部,且第一红外发射器

发射的红外线信号方向与飞机泊位牵引通道13的轴向呈垂直设置。

[0034] 具体来说,检测信息显示模块17采用触摸显示屏,便于飞行员进行人机交互。

[0035] 使用时,通过信息采集单元1中视频采集模块101以及泊机位红外投影模块102和红外图像采集模块103的配合设置,通过双影像跟踪和运行轨迹捕捉的方式实现飞机14识别及位置检测;通过信息采集单元1中激光测距传感模块104、测速模块105、中轴定位感应模块106、廊桥定位模块107、第一红外信号发射模块108和第二红外信号发射模块109的配合设置,能够辅助牵引飞机14在飞机泊位牵引通道13上直线行驶,为飞机提供快速、准确、高效的泊位引导;通过泊位运算主控模块2、信息收发模块6、信息处理及控制模块7、数据储存模块12和检测信息显示模块17的配合设置,通过泊位运算主控模块2将采集的检测数据及运算结果通过信息收发模块6发送给信息处理及控制模块7,通过检测信息显示模块17进行数据显示,同时显示通过数据储存模块12回送的标准数据信息,通过实时比对检测数据和标准数据,便于飞行员进行飞行轨迹调整,实现精准泊位;通过泊位运算主控模块2、无线通信模块4、远程控制中心5、信息处理及控制模块7和智能语音提示模块10的配合设置,能够智能提示飞行员进行泊位调整,同时实现飞机14泊位的远程控制。

[0036] 综上所述,本发明安全性能高,能够有效提高了飞机14泊位精度,具备有提示功能、同时具备实时数据比对功能,可远程控制飞机14泊位,满足快速、准确、高效的泊位引导需求。

[0037] 需要说明的是,在本文中,诸如第一和第二等之类的关系术语仅仅用来将一个实体或者操作与另一个实体或操作区分开来,而不一定要求或者暗示这些实体或操作之间存在任何这种实际的关系或者顺序。而且,术语“包括”、“包含”或者其任何其他变体意在涵盖非排他性的包含,从而使得包括一系列要素的过程、方法、物品或者设备不仅包括那些要素,而且还包括没有明确列出的其他要素,或者是还包括为这种过程、方法、物品或者设备所固有的要素。在没有更多限制的情况下,由语句“包括一个……”限定的要素,并不排除在包括所述要素的过程、方法、物品或者设备中还存在另外的相同要素。

[0038] 尽管已经示出和描述了本发明的实施例,对于本领域的普通技术人员而言,可以理解在不脱离本发明的原理和精神的情况下可以对这些实施例进行多种变化、修改、替换和变型,本发明的范围由所附权利要求及其等同物限定,需要说明的是,该文中出现的电器元件均与外界的主控器及220V市电连接,并且主控器可为计算机等起到控制的常规已知设备。

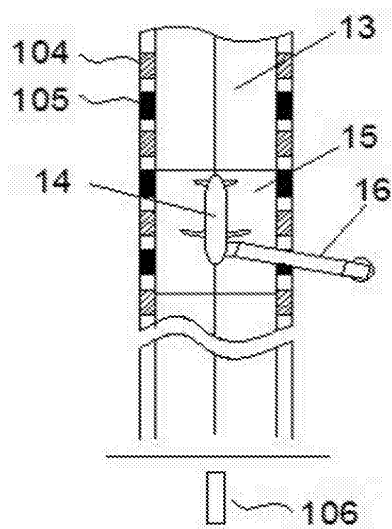


图1

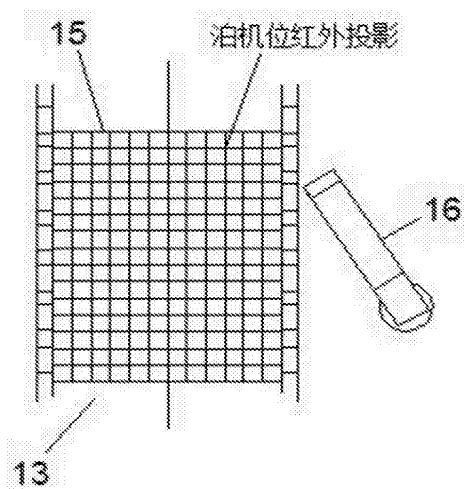


图2

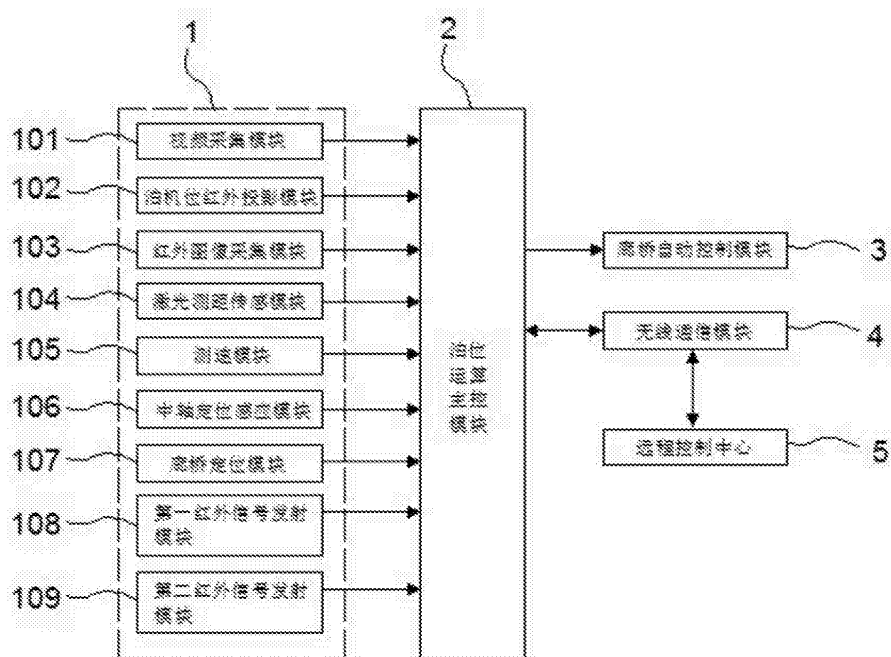


图3

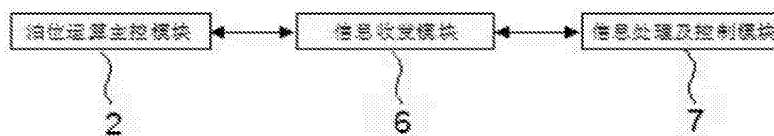


图4

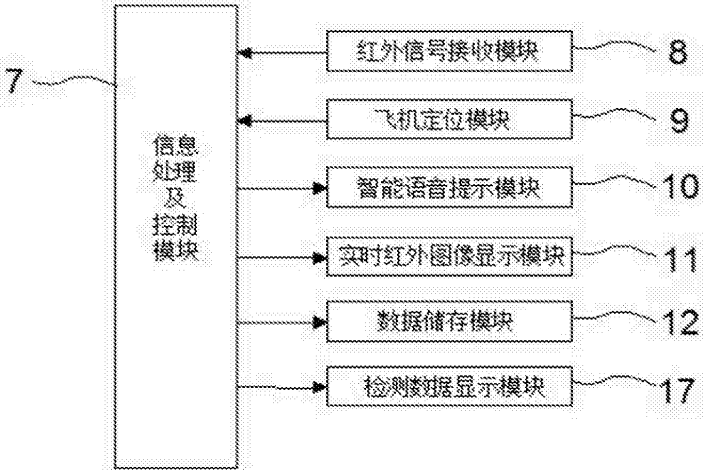


图5

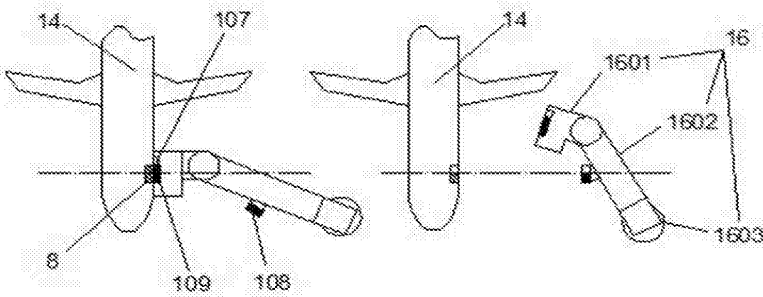


图6

Notice

This translation is machine-generated. It cannot be guaranteed that it is intelligible, accurate, complete, reliable or fit for specific purposes. Critical decisions, such as commercially relevant or financial decisions, should not be based on machine-translation output.

DESCRIPTION CN108932875A

Abstract The invention discloses an aircraft berth intelligent indication system with high safety performance, which includes an information acquisition unit, a berth calculation main control module, a bridge automatic control module, a wireless communication module, a remote control center, an information transceiver module, information processing and control Module, infrared signal receiving module, aircraft positioning module, intelligent voice prompt module, real-time infrared image display module, data storage module and detection information display module. The information acquisition unit includes a video acquisition module, a parking space infrared projection module, and an infrared image Acquisition module, laser distance measurement sensor module, speed measurement module, central axis positioning sensor module, bridge positioning module, first infrared signal emission module and second infrared signal emission module. The invention has high safety performance, can effectively improve the accuracy of the aircraft berth, has a prompt function, and has a real-time data comparison function, can remotely control the aircraft berth, and meets the needs of fast, accurate and efficient berth guidance.

Intelligent aircraft berth indicating system with high safety performance

Technical field

The invention relates to the technical field of aircraft berth indication systems, in particular to an aircraft berth intelligent indication system with high safety performance.

Background technique

The aircraft berth automatic indication system can provide accurate and standardized guidance for safe and efficient parking of aircraft on the apron, and guide pilots to park the aircraft in the optimal procedure. The aircraft berth process is an integral part of flight operations, and the use of auxiliary equipment to improve flight operation efficiency and safety is also an integral part of airport modernization.

However, traditional aircraft berth indication systems mainly use video measurement image recognition methods and trigger coil induction detection methods. Video measurement image recognition methods use video camera image tracking technology to capture aircraft trajectories, but they are greatly affected by weather and light. Large errors and a certain probability of error, there are hidden safety hazards; the trigger coil induction detection method is to determine the position of the aircraft through the induction coil buried under the ground, which has the shortcomings of easy damage, low accuracy and low safety performance; it is urgently needed. An intelligent aircraft berth indication system with high safety performance, prompt function, multiple data comparison functions, remote control of aircraft for berth, and fast, accurate and efficient berth guidance requirements.

Therefore, the present invention will provide an aircraft berth intelligent indication system with high safety performance to solve the above-mentioned problems.

Summary of the invention

In view of the shortcomings of the prior art, the present invention provides an intelligent aircraft berth indication system with high safety performance, which solves the problem of low safety performance, low indication accuracy and low efficiency of the aircraft berth indication system, which cannot satisfy fast, accurate and efficient berths The problem of guiding demand.

In order to achieve the above objectives, the present invention is achieved through the following technical solutions: an intelligent aircraft berth indication system with high safety performance, including an information collection unit, a berth calculation main control module, a bridge automatic control module, a wireless communication module, and a remote control center, information transceiver module, information processing and control module, infrared signal receiving module, aircraft positioning module, intelligent voice prompt module, real-time infrared image display module, data storage module and detection information display module, the information acquisition unit includes a video acquisition module, Parking space infrared projection module, infrared image acquisition module, laser ranging sensor module, speed measurement module, central axis positioning sensor module, bridge positioning module, first infrared signal transmitting module and second infrared signal transmitting module, among which, The video acquisition module is connected with the berth calculation main control module, and is used to track and capture the trajectory of the aircraft running on the aircraft berth towing channel. The berth infrared projection module is connected to the berth calculation main control module for Perform infrared projection on the parking space on the aircraft berth towing channel. The infrared image acquisition module is connected to the berth calculation main control module for real-time capture of the infrared projection image on the parking space and the aircraft image and running track. The laser distance measurement sensor module and the speed measurement module are respectively connected to the berth calculation main control module for real-time detection of the distance between the aircraft and the aircraft berth towing channel and the aircraft operating speed. The central axis positioning sensor module is connected to the berth calculation main control module. The control module is connected to instruct the aircraft to move straight along the center line of the aircraft berth towing channel. The bridge positioning module is connected to the berth calculation main control module for detecting the height difference between the bridge and the aircraft boarding gate. The infrared signal transmitting module and the second infrared signal transmitting module are respectively connected to the berth calculation main control module for the positioning detection of the aircraft boarding gate, and the bridge automatic control module is connected to the berth calculation main control module and is used to control the bridge Running to the position corresponding to the boarding gate of the aircraft, the berth calculation main control module is connected to the remote control center through a wireless communication module for remote control, and the berth calculation main control module is connected to the information processing and control module through the information transceiver module The infrared signal receiving module is connected to the information processing and control module, and is used to receive infrared signals from the first infrared signal transmitting module and the second infrared signal transmitting module. The aircraft positioning module is used for aircraft real-time positioning, and the intelligent The voice prompt module is connected to the information processing and control module, and is used for voice prompting the pilot that the aircraft operation line deviates from the center line of the aircraft berth towing channel. The real-time infrared image display module is connected to the information processing and control module for real-time display through receiving infrared The infrared projection information collected by the image acquisition module, the data storage module is connected to the information processing and control module, and is used to store various detection data, calculation results, and for the information processing and control module to extract standard data, which is performed through the detection information display module Display, and compare with real-time detection data. The detection information display module is connected with the information processing and control module to display various data, detection information and calculation results. Therefore, it is convenient for the pilot to adjust the running trajectory.

Further, the video acquisition module adopts a video camera, and captures the trajectory of the aircraft through image tracking technology.

Further, the parking space infrared projection module adopts an infrared projector to perform regional infrared projection on the parking space, and the aircraft body shell adopts a special material that does not reflect light but reflects the infrared light source. Run the track to capture.

Further, the laser ranging sensor module adopts a laser sensor, and the speed measuring module adopts a speed sensor. There are multiple laser sensors and speed sensors, and they are correspondingly arranged on both sides of the aircraft berth towing channel. The sensor and the speed sensor are set alternately.

Further, the central axis positioning sensing module adopts a first satellite positioning antenna. The first satellite positioning antenna is installed at the axial end of the centerline of the aircraft berth towing channel and is located at the outer end of the aircraft take-off line, and is used to detect the body of the aircraft during operation. The angle to the centerline.

Further, the first infrared signal transmitting module and the second infrared signal transmitting module respectively adopt a first infrared transmitter and a second infrared transmitter. The bridge includes a front section, a middle section and a rear section, and the first infrared transmitter corresponds to Set on the side of the middle section, the second infrared transmitter is correspondingly set on the top of the front section, the infrared signal receiving module adopts an infrared receiver matching the models of the first infrared transmitter and the second infrared transmitter, and the infrared receiver is set at At the upper end of the aircraft boarding gate, the height of the infrared receiver, the first infrared transmitter and the second infrared transmitter are the same. The bridge positioning module adopts the second satellite positioning antenna, which is correspondingly installed at

the top of the front section and located at the second infrared transmitter. The side of the device is used to detect the height difference between the front section and the aircraft gate in real time.

Further, when the bridge is in the initial state, the axial direction of the middle section and the axial direction of the aircraft berth towing channel are arranged at an acute angle, the first infrared transmitter is installed on the side of the middle section close to the aircraft, and the first infrared transmitter emits. The direction of the infrared signal is perpendicular to the axis of the aircraft berth towing channel.

Further, the detection information display module adopts a touch screen, which is convenient for pilots to perform man-machine interaction.

Compared with the prior art, the advantages of this invention are:

1.

The intelligent aircraft parking indicator system with high safety performance is set through the video acquisition module in the information acquisition unit, the parking space infrared projection module and the infrared image acquisition module to achieve aircraft recognition and position detection through dual image tracking and running track capture. , Effectively reduce the detection error, improve the berth accuracy and high safety.

2.

The intelligent aircraft berth indication system with high safety performance uses the laser ranging sensor module, speed measurement module, central axis positioning sensor module, bridge positioning module, first infrared signal emission module and second infrared signal emission module in the information acquisition unit. The coordinated setting can assist the towing aircraft to drive straight on the aircraft berth towing channel, provide fast, accurate and efficient berth guidance for the aircraft, further improve the berth accuracy, and cooperate with the automatic control module of the bridge to realize the automation of the bridge Docking, high work efficiency.

3.

The intelligent aircraft berth indication system with high safety performance, through the berth calculation main control module, information transceiver module, information processing and control module, data storage module and detection information display module, through the coordinated setting of the berth calculation main control module to collect the detection. The data and calculation results are sent to the information processing and control module through the information transceiver module, and the data is displayed through the detection information display module. At the same time, the standard data information sent back through the data storage module is displayed. Through real-time comparison of the detection data and standard data, it is convenient for the pilot to perform Flight trajectory adjustment to achieve precise berths.

4.

The intelligent aircraft berth indication system with high safety performance can intelligently prompt the pilot to adjust the berth through the cooperation of the berth calculation main control module, wireless communication module, remote control center, information processing and control module, and intelligent voice prompt module. Remote control of aircraft berth.

Description of the drawings

Figure 1 is a simplified schematic diagram of the aircraft berth towing channel in the present invention;

Figure 2 is a simplified illustration of infrared projection of parking spaces in the present invention;

Figure 3 is a schematic block diagram of the information acquisition unit and berth operation main control module in the invention;

4 is a block diagram of the principle of the berth operation main control module and the information processing and control module in the present invention;

Figure 5 is a functional block diagram of the information processing and control module and each module in the present invention;

Fig. 6 is a simplified diagram illustrating the relationship between the aircraft and the bridge in the present invention when they are docked or not.

In the figure: 1. Information acquisition unit; 101, video acquisition module; 102, parking space infrared projection module; 103, infrared image acquisition module; 104, laser ranging sensor module; 105, speed measurement module; 106, central axis positioning Sensing module; 107, corridor positioning module; 108, first infrared signal transmitter module; 109, second infrared signal transmitter module; 2. berth operation main control module; 3. bridge automatic control module; 4. wireless communication module; 5. Remote control center; 6. Information transceiver module; 7. Information processing and control module; 8. Infrared signal receiving module; 9. Aircraft positioning module; 10. Intelligent voice prompt module; 11. Real-time infrared image display module; 12. Data storage module; 13, aircraft berth towing channel; 14, aircraft; 15, berth; 16, bridge; 1601, front section; 1602, middle section; 1603, rear section; 17, detection information display module.

detailed description

The technical solutions in the embodiments of the present invention will be clearly and completely described below in conjunction with the accompanying drawings in the embodiments of the present invention. Obviously, the described embodiments are only a part of the embodiments of the present invention, rather than all the embodiments.

Based on the embodiments of the present invention, all other embodiments obtained by those of ordinary skill in the art without creative work shall fall within the protection scope of the present invention.

As shown in Figures 1-6, the present invention provides a technical solution: an intelligent aircraft berth indication system with high safety performance, including an information collection unit 1, a berth calculation main control module 2, an automatic bridge control module 3, and wireless communication Module 4, remote control center 5, information transceiver module 6, information processing and control module 7, infrared signal receiving module 8, aircraft positioning module 9, intelligent voice prompt module 10, real-time infrared image display module 11, data storage module 12 and detection information display module 17, information acquisition unit 1 includes video acquisition module 101, parking space infrared projection module 102, infrared image acquisition module 103, laser ranging sensor module 104, speed measurement module 105, central axis positioning sensor module 106, and bridge The positioning module 107, the first infrared signal transmitting module 108 and the second infrared signal transmitting module 109, wherein the video acquisition module 101 is connected to the berth arithmetic main control module 2 and is used to image the aircraft 14 running on the aircraft berth towing channel 13 For tracking and capturing of operating trajectories, the parking space infrared projection module 102 is connected to the berth calculation main control module 2 for infrared projection of the parking space 15 on the aircraft berth towing channel, and the infrared image acquisition module 103 is connected to the berth calculation main control Module 2 is connected for real-time capture of the infrared projection image on the parking space 15 and the aircraft 14 image and running trajectory. The laser ranging sensor module 104 and the speed measurement module 105 are respectively connected to the berth computing main control module 2 for Perform real-time detection of the distance between the aircraft 14 and the aircraft berth towing channel 13 and the operating speed of the aircraft 14. The central axis positioning sensing module 106 is connected to the berth calculation main control module 2 and is used to instruct the aircraft 14 along the center line of the aircraft berth towing channel 13 In operation, the bridge positioning module 107 is connected to the berth calculation main control module 2 for detecting the height difference between the bridge 16 and the boarding gate of the aircraft 14. The first infrared signal transmitting module 108 and the second infrared signal transmitting module 109 are respectively connected to the berth The calculation main control module 2 is connected for the positioning detection of the boarding gate of the aircraft 14, and the bridge automatic control module 3 is connected with the berth calculation main control module 2 to control the operation of the bridge 16 to the position corresponding to the boarding gate of the aircraft 14. The berth calculation main control module 2 is connected to the remote control center 5 through the wireless communication module 4 for remote control. The berth calculation main control module 2 is connected to the information processing and control module 7 through the information transceiver module 6, and the infrared signal receiving module 8 is connected to The information processing and control module 7 is connected to receive infrared signals from the first infrared signal transmitting module 108 and the second infrared signal transmitting module 109. The aircraft positioning module 9 is used for real-time positioning of the aircraft 14, and the intelligent voice prompt module 10 is connected to the information processing and The control module 7 is connected to voice prompt the pilot that the operating line of the aircraft 14 deviates from the center line of the aircraft berth towing channel 13, and the real-time infrared image display module 11 is connected to the information processing and control module 7 for real-time display by receiving from the infrared image acquisition module 103 Collected infrared projection information, data storage module 12 and information processing and control module 7 connection, used to store various test data, calculation results and for the information processing and control module 7 to extract standard data, and display it through the test information display module 17, and compare it with real-time test data. The test information display module 17 and The information processing and control module 7 is connected to display various data, detection information and calculation results, which is convenient for the pilot to adjust the running track.

Specifically, the video capture module 101 uses a video camera to capture the trajectory of the aircraft 14 through image tracking technology.

Specifically, the parking space infrared projection module 102 uses an infrared projector to perform regional infrared projection on the parking space 15. The aircraft body shell uses a special material that does not reflect light but reflects the infrared light source. 14 to capture the running track.

Specifically, the laser ranging sensor module 104 adopts a laser sensor, and the speed measuring module 105 adopts a speed sensor. There are multiple laser sensors and speed sensors, and they are correspondingly arranged on both sides of the aircraft berth towing channel 13. The sensor and the speed sensor are set alternately.

Specifically, the central axis positioning sensor module 106 adopts a first satellite positioning antenna, which is installed at the axial end of the center line of the aircraft berth towing channel 13 and located at the outer end of the take-off line of the aircraft 14 for detecting the aircraft 14 The angle between the body and the centerline during operation.

Specifically, the first infrared signal transmitting module 108 and the second infrared signal transmitting module 109 respectively adopt a first infrared transmitter and a second infrared transmitter. The bridge 16 includes a front section 1601, a middle section 1602, and a rear section 1603. The transmitter is correspondingly arranged on the side of the middle section 1602, and the second infrared transmitter is correspondingly arranged on the top of the front section 1601. The infrared signal receiving module 8 adopts an infrared receiver that matches the models of the first infrared transmitter and the second infrared transmitter. The receiver is arranged at the upper end of the boarding gate of the aircraft 14. The infrared receiver, the first infrared transmitter and the second infrared transmitter are at the same height. The bridge positioning module 107 uses a second satellite positioning antenna, which is correspondingly installed on the top of the front section 1601 and Located on the side of the second infrared transmitter, it is used to detect the height difference between the front section 1601 and the boarding gate of the aircraft 14 in real time.

Specifically, when the bridge 16 is in the initial state, the axial direction of the middle section 1602 and the axial direction of the aircraft berth towing channel 13 are arranged at an acute angle. The first infrared transmitter is installed on the side of the middle section 1602 close to the aircraft 14, and The direction of the infrared signal emitted by the infrared transmitter is perpendicular to the axis of the aircraft berth towing channel 13.

Specifically, the detection information display module 17 adopts a touch screen to facilitate the pilot's human-computer interaction.

When in use, through the coordinated setting of the video acquisition module 101, the parking space infrared projection module 102 and the infrared image acquisition module 103 in the information acquisition unit 1, the aircraft 14 identification and position detection are realized through dual image tracking and running track capture; The laser distance measurement sensor module 104, the speed measurement module 105, the central axis positioning sensor module 106, the bridge positioning module 107, the first infrared signal transmitter module 108 and the second infrared signal transmitter module 109 in the information collection unit 1 can be configured in cooperation The auxiliary towing aircraft 14 travels in a straight line on the aircraft berth towing channel 13, providing fast, accurate and efficient berth guidance for the aircraft; through the berth calculation main control module 2, the information transceiver module 6, the information processing and control module 7, and the data storage module 12 In conjunction with the detection information display module 17, the collected detection data and calculation results are sent to the information processing and control module 7 through the information transceiver module 6 through the berth calculation main control module 2, and the detection information display module 17 performs data display. Display the standard data information sent back through the data storage module 12, and compare the detection data with the standard data in real time, which is convenient for pilots to adjust the flight trajectory and achieve precise berth; through the berth calculation main control module 2, wireless communication module 4, remote control center 5 , The coordinated arrangement of the information processing and control module 7 and the intelligent voice prompt module 10 can intelligently prompt the pilot to adjust the berth, and at the same time realize the remote control of the aircraft 14 berth.

In summary, the present invention has high safety performance, can effectively improve the accuracy of the aircraft's 14 berths, has a prompt function, and has a real-time data comparison function. It can remotely control the aircraft's 14 berths and meet the needs of fast, accurate and efficient berth guidance. .

It should be noted that in this article, relational terms such as first and second are only used to distinguish one entity or operation from another entity or operation, and do not necessarily require or imply one of these entities or operations. There is any such actual relationship or order between.

Moreover, the terms "including", "including" or any other variation thereof are intended to cover non-exclusive inclusion, so that a process, method, article, or device that includes a series of elements includes not only those elements, but also those that are not explicitly listed Other elements of, or also include elements inherent to this process, method, article or equipment.

If there are no more restrictions, the element defined by the sentence "including a..." does not exclude the existence of other same elements in the process, method, article, or equipment including the element.

Although the embodiments of the present invention have been shown and described, those of ordinary skill in the art can understand that various changes, modifications, and substitutions can be made to these embodiments without departing from the principle and spirit of the present invention. And variants, the scope of the present invention is defined by the appended claims and their equivalents. It should be noted that the electrical components appearing in the text are all connected to the external main controller and 220V mains, and the main controller can be a computer Wait for the conventional known equipment to control.

Electronic Patent Application Fee Transmittal				
Application Number:				
Filing Date:				
Title of Invention:		MULTI-SENSOR DATA FUSION-BASED AIRCRAFT DETECTION, TRACKING, AND DOCKING		
First Named Inventor/Applicant Name:		Rajesh V. Poojary		
Filer:		Mark R. Berger/Rory Kluever		
Attorney Docket Number:		H215046-US		
Filed as Large Entity				
Filing Fees for Utility under 35 USC 111(a)				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
UTILITY APPLICATION FILING	1011	1	300	300
UTILITY SEARCH FEE	1111	1	660	660
UTILITY EXAMINATION FEE	1311	1	760	760
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Post-Allowance-and-Post-Issuance:				
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Miscellaneous:				
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Information:					
2		00804926.PDF	141216	yes	27
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	Multipart Description/PDF files in .zip description				
	Document Description		Start	End	
	Specification		1	22	
	Claims		23	26	
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3	Drawings-only black and white line drawings	00804062.PDF	400885	no	7
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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	H215046-US
		Application Number	
Title of Invention	MULTI-SENSOR DATA FUSION-BASED AIRCRAFT DETECTION, TRACKING, AND DOCKING		
<p>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.</p> <p>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.</p>			

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.)
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Inventor Information:

Inventor 1 Remove				
Legal Name				
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Address 2	P.O. Box 377			
City	Morris Plains	State/Province	NJ	
Postal Code	07950	Country ⁱ	US	
Inventor 3 Remove				
Legal Name				

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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	H215046-US
		Application Number	
Title of Invention	MULTI-SENSOR DATA FUSION-BASED AIRCRAFT DETECTION, TRACKING, AND DOCKING		

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Inventor	4	<input type="button" value="Remove"/>
Legal Name		

Prefix	Given Name	Middle Name	Family Name	Suffix
	Manuj		Sharma	
Residence Information (Select One) US Residency ☒ Non US Residency Active US Military Service				
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Mailing Address of Inventor:

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Address 2	P.O. Box 377			
City	Morris Plains	State/Province	NJ	
Postal Code	07950	Country ⁱ	US	

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the Add button.			<input type="button" value="Add"/>
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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	10786		
Email Address	berger@bipl.net	<input type="button" value="Add Email"/>	<input type="button" value="Remove Email"/>
Email Address	kluever@bipl.net	<input type="button" value="Add Email"/>	<input type="button" value="Remove Email"/>

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	H215046-US
		Application Number	
Title of Invention	MULTI-SENSOR DATA FUSION-BASED AIRCRAFT DETECTION, TRACKING, AND DOCKING		

Application Information:

Title of the Invention	MULTI-SENSOR DATA FUSION-BASED AIRCRAFT DETECTION, TRACKING, AND DOCKING		
Attorney Docket Number	H215046-US	Small Entity Status Claimed	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	7	Suggested Figure for Publication (if any)	

Filing By Reference:

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

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

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

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)
☐ Request Not to Publish. I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application has not and will not be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32). Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.			
Please Select One:	☒ Customer Number	US Patent Practitioner	☐ Limited Recognition (37 CFR 11.9)
Customer Number	10786		

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	H215046-US
		Application Number	
Title of Invention	MULTI-SENSOR DATA FUSION-BASED AIRCRAFT DETECTION, TRACKING, AND DOCKING		

Domestic Benefit/National Stage Information:

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

Prior Application Status	<input type="text"/>	<input type="button" value="Remove"/>	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<input type="text"/>	<input type="text"/>		
Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the Add button.			<input type="button" value="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. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)ⁱ the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Application Number	Country ⁱ	Filing Date (YYYY-MM-DD)	<input type="button" value="Remove"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>	Access Code ^j (if applicable)
Additional Foreign Priority Data may be generated within this form by selecting the Add button.			<input type="button" value="Add"/>

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

<p>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.</p> <p>☐ 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.</p>
--

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	H215046-US
		Application Number	
Title of Invention	MULTI-SENSOR DATA FUSION-BASED AIRCRAFT DETECTION, TRACKING, AND DOCKING		

Authorization or Opt-Out of Authorization to Permit Access:

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

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

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

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

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

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

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

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

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

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

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	H215046-US
		Application Number	
Title of Invention	MULTI-SENSOR DATA FUSION-BASED AIRCRAFT DETECTION, TRACKING, AND DOCKING		

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		<input type="button" value="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.			
		<input type="button" value="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:			
<div></div>			
Name of the Deceased or Legally Incapacitated Inventor: <div></div>			
If the Applicant is an Organization check here. ☒			
Organization Name	Honeywell International Inc.		
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Country	US	Postal Code	07950
Phone Number		Fax Number	
Email Address			
Additional Applicant Data may be generated within this form by selecting the Add button. <input type="button" value="Add"/>			

Assignee Information including Non-Applicant Assignee Information:

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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	H215046-US
		Application Number	
Title of Invention	MULTI-SENSOR DATA FUSION-BASED AIRCRAFT DETECTION, TRACKING, AND DOCKING		

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.				
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If the Assignee or Non-Applicant Assignee is an Organization check here. ☐				
Prefix	Given Name	Middle Name	Family Name	Suffix
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Mailing Address Information For Assignee including Non-Applicant Assignee:				
Address 1		<input type="text"/>		
Address 2		<input type="text"/>		
City	<input type="text"/>	State/Province	<input type="text"/>	
Country ⁱ	<input type="text"/>	Postal Code	<input type="text"/>	
Phone Number	<input type="text"/>	Fax Number	<input type="text"/>	
Email Address	<input type="text"/>			
Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button. <input type="button" value="Add"/>				

Signature:

<input type="button" value="Remove"/>					
NOTE: This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). However, if this Application Data Sheet is submitted with the INITIAL filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).					
This Application Data Sheet must be signed by a patent practitioner if one or more of the applicants is a juristic entity (e.g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, all joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of all joint inventor-applicants.					
See 37 CFR 1.4(d) for the manner of making signatures and certifications.					
Signature	/Mark R. Berger/		Date (YYYY-MM-DD)	2020-08-03	
First Name	Mark R.	Last Name	Berger	Registration Number	62,556
Additional Signature may be generated within this form by selecting the Add button. <input type="button" value="Add"/>					

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	H215046-US
		Application Number	
Title of Invention	MULTI-SENSOR DATA FUSION-BASED AIRCRAFT DETECTION, TRACKING, AND DOCKING		

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

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

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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.
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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.
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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.
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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.

MULTI-SENSOR DATA FUSION-BASED AIRCRAFT DETECTION, TRACKING, AND DOCKING

Technical Field

5 The present disclosure relates to detection, tracking, and docking aircraft in a taxiway, apron, or ramp area of an airport.

Background

10 Airport gates on the airside of an airport are characterized as parking spaces that are designed to enable the parking of aircraft of different dimensions (e.g., based on wingspan, fuselage length) and, in many situations, access to a ramp to allow for the ingress and egress of passengers and crew to the aircraft. These spaces, called ramp areas or parking stands, are size-constrained, particularly when there are fixed
15 obstacles (e.g., stand furniture) in close proximity to an aircraft when it is being parked. Hazards associated with aircraft maneuvering and parking, therefore, make the accuracy of aircraft position on-stand more critical.

 Aircraft pilots (self-powered) or tug drivers (aircraft is being towed) pull aircraft into gates with visual guidance provided by a marshal and wing-
20 watchers to safely park the aircraft in a gate area (e.g., where the area is in contact with the gate or remote therefrom). A marshal aligns the nose wheel with a guidance line and designates when to stop the aircraft at the designated stop position. Wing-watchers stop movement of any ground vehicles in proximity to the aircraft and ensure clearance of wingtips from
25 any obstacles.

 Manual approaches to these repetitive tasks have long been error prone and consistency in visual guidance to pilots from different parts of the world has been problematic. Accordingly, there has been movement toward using automated systems for some of these tasks or to assist in the

guidance of the aircraft have seen the need for an automated system. Such systems are generally referred to as – Docking Guidance Systems (DGS).

Early approaches to DGS leveraged mirrors but posed significant limitations and distracted the pilot. Subsequent approaches to DGS

5 leveraged intrusive technologies like induction loops, again with significant limitations.

Regulatory requirements too evolved and as technologies became more capable, DGS system evolved from being Visual Docking Guidance Systems (VDGS) to Advanced Visual Docking Guidance Systems (A-
10 VDGS). This included for providing active azimuth guidance with deviation calculated by the system. Further various aircraft models (types/sub-types) got introduced to meet the demand for air travel and airports equally adopted more complicated gate designs, like Multiple Aircraft Ramp Stands (MARS).

15 Today, airports also use systems that relay information to the pilots for managing aircraft movement in areas further away from the ramp area and use lasers to track an aircraft's movement on the ground. However, conventional laser/LIDAR systems have issues with: a curved approach of an aircraft to a ramp area, long range detection of the aircraft as it
20 approaches, dark colored aircraft detection, and thick snow/foggy/heavy rain conditions or conditions with precipitation. Also, they do not generate images for use by the system, so there are no image archives for incident analysis, among other issues.

Other airports use camera systems that relay information to the pilots
25 for managing aircraft movement in areas close to the ramp area and use cameras to track the aircraft's movement. Camera systems airports currently use may have issues with accuracy of docking due to accuracy of distance measurements, and they have precise calibration requirements which can make the system difficult to set up and be relied upon for
30 accurate measurements. Camera systems also may not require frequent

calibrations and monitoring of the systems, and can have no redundancy if the camera system malfunctions or cameras are obscured for some reason, among other potential issues.

Because of the above issues, airports using these systems face failed dockings where the aircraft is too far forward or back from the ramp, not parallel with or aligned with the lead-in line or not positioned on the lead-in line, which may cause the delays and additional adjustments by the pilot and ground crew to make the aircraft and ramp line up despite improper positioning of the aircraft. This can be particularly problematic in multiple taxiway systems, where precision is even more important. These current technologies also both still continue to fall short on the ability to meet the critical requirements of today's airports, which can include: having a long scan range of, for example, more than 150m; being operationally flexible and adaptable; being auto-calibration able, allowing for detection and tracking of aircraft, vehicles, people, etc.; providing aircraft type and/or sub-type identification; providing accurate and repeatable guidance; improved safety through apron mapping, wing tip clearance, obstacle detection, FOD, etc.; improved surveillance by being an extension to surveillance sensors that cover gate areas; all weather capable; and low maintenance.

Brief Description of the Drawings

Figure 1 illustrates a number of aircraft ramp area arrangements that can be used in accordance with one or more embodiments of the present disclosure.

Figure 2 illustrates an imaging and LIDAR/Radar sensing arrangement in accordance with one or more embodiments of the present disclosure.

Figure 3 illustrates a flow diagram of a system showing some components of the system and some functions of the system in accordance with one or more embodiments of the present disclosure.

Figure 4 illustrates a two dimensional display of a three dimensional (3D) model of an aircraft and sample point cloud data set in accordance with one or more embodiments of the present disclosure.

Figure 5 illustrates a computing device for use in accomplishing ramp area aircraft movement functions in accordance with one or more
5 embodiments of the present disclosure.

Figure 6 illustrates a memory location in a computing device of a docking system in accordance with one or more embodiments of the present disclosure.

10 Figure 7 illustrates a method for detection, tracking, and docking aircraft in a taxiway or ramp area of an airport in accordance with one or more embodiments of the present disclosure.

Detailed Description

15 Based on the increased capacity over airspace and passenger throughput, most larger airports are seeing an increasing number of aircraft movements per day. With limited infrastructure, it can be difficult for the airports to manage the increased demand and capacity. The embodiments of the present disclosure overcome the above challenges, by improving
20 ground operations to reduce aircraft turnaround time. The embodiments also can potentially optimize the amount of the time required for the aircraft to be to complete the turnaround process, among other benefits.

Benefits of the concepts proposed herein are important to an airport because of several factors. For example, some factors include: the safety of
25 the aircraft and ground operators during the ramp operations from docking to pushback; early detection of aircraft via the docking system's long range capabilities to meet ripple taxiway lines; precise and/or accurate docking so that there is no significant time taken for connecting a ramp or the need for tow vehicles to adjust the docking; obstacle detection prior to docking; and

pre-positioning of the ramp area equipment before the docking to reduce
turnaround times. Further, the solutions herein can be beneficial in aircraft
detection at all times during the day and night, in all weather conditions, in
all lighting conditions, and for all aircraft types and subtypes with all colors,
5 unlike prior systems.

In the following detailed description, reference is made to the
accompanying drawings that form a part hereof. The drawings show, by
way of illustration, how one or more embodiments of the disclosure may be
practiced.

10 These embodiments are described in sufficient detail to enable those
of ordinary skill in the art to practice one or more embodiments of this
disclosure. It is to be understood that other embodiments may be utilized
and that process, computerized, and/or structural changes may be made
without departing from the scope of the present disclosure.

15 As will be appreciated, elements shown in the various embodiments
herein can be added, exchanged, combined, and/or eliminated so as to
provide a number of additional embodiments of the present disclosure. The
proportion and the relative scale of the elements provided in the figures are
intended to illustrate the embodiments of the present disclosure and should
20 not be taken in a limiting sense.

The figures herein follow a numbering convention in which the first
digit or digits correspond to the drawing figure number and the remaining
digits identify an element or component in the drawing. Similar elements or
components between different figures may be identified by the use of similar
25 digits. For example, 116 may reference element “16” in Figure 1, and a
similar element may be referenced as 216 in Figure 2.

As used herein, “a” or “a number of” something can refer to one or
more such things. For example, “a number of 3D models” can refer to one
or more 3D models. Further, as used herein, the term “docking system” is
30 used by itself to refer to the broad system that controls the docking process.

The “docking system” includes a central docking system component and a ramp docking system component that each provide different functions within the overall docking system, as will be discussed in more detail below.

Figure 1 illustrates a number of aircraft ramp area arrangements that
5 can be used in accordance with one or more embodiments of the present disclosure. In Figure 1, the three arrangements at the top illustrate a number of embodiments using one sensor array (i.e., a combination of at least one camera image sensor and at least one laser/radar sensor, described herein as a LIDAR/Radar sensor, but embodiments are not so
10 limited) with aircraft 101 located in ramp areas 100. The bottom three arrangements show embodiments having multiple sensor arrays, as will be discussed in more detail below.

Each arrangement has several common elements. For example, all of the arrangements include a ramp area wherein at least a portion of the
15 ramp area is within the field of view 104 of at least one sensor of a sensor array 102. Although described herein as a “ramp area”, the ramp area as used herein merely means a parking space for an aircraft located on the airside apron of a gate at an airport and although described herein using the term “ramp”, the space may sometimes be in a location where passengers
20 and crew access the aircraft via stairs from the tarmac and a ramp is not used. The embodiments of the present disclosure may be used in such arrangements as well.

Each arrangement also includes at least one aircraft 101 in the ramp area and wherein at least a portion of the aircraft is within the field of view of
25 the image sensor of sensor array 102. In some of the arrangements, a large aircraft arrangement is superimposed over a small aircraft arrangement to show the versatility of these ramp area configurations.

The arrangements also all show at least one lead-in line 106 that indicates to the pilot the correct path to follow to position the aircraft in the
30 correct position and orientation with the ramp area. These lead-in lines can

be painted on the tarmac and/or can be virtual lines provided on a display viewed by the pilot on a pilot unit computing device. In arrangements where the ramp area is used with multiple aircraft types, such as the large and small arrangements shown, lead-in lines can be provided for each aircraft and the pilot will need guidance to know which lead-in line to follow based on their type of aircraft.

With respect to the single sensor array embodiments, the embodiment on the top left shows an aircraft 101 moving into a ramp area within the field of view 104 of sensor array 102 having a camera image sensor and a LIDAR/Radar sensor (together represented at 112). Although most of the lead-in paths are indicated as straight into the ramp area, but at different positions within the field of view. The top left arrangement illustrates that the aircraft has altered its path (the curvature shown represents the mid-course adjustment) to align itself with the correct lead-in line. It is the concepts disclosed herein that allow for such precise adjustment during movement of the aircraft.

The arrangements on the bottom provide several multiple sensor embodiments. As can be discerned by the illustration, using multiple sensor arrays 102, can allow for more precise movements and can allow for aircraft docking scenarios the are not straight, such as those shown on the bottom of the illustration (straight arrangements shown on top).

For example, in the bottom left arrangement, two sensor arrays are provided in a single location (e.g., one device with multiple arrays or multiple arrays in close proximity to each other). In this example, the two sensors have a different field of view, with one having a wide field of view (dashed line 107 nearly parallel to the surface of the array) and the other sensor having a narrower field of view 104.

In this manner, the arrays collect different information from their positions that can aid in determining the six dimensional information discussed below and can be helpful in providing data for creating the 3D

model discussed herein. The information can be particularly beneficial where the fields of view overlap as those areas then have data from two sources and at different positions, which can be very helpful with respect to 3D modeling and in determining position, orientation, and movement.

5 The bottom middle arrangement, has two sensor arrays spaced apart from each other. In this embodiment, one sensor array 102-1 has one camera image sensor with a field of view 104-1 and one LIDAR or Radar sensor. The second sensor array 102-2 includes multiple camera image sensors each having a different field of view (104-2 and 104-3). As with the
10 bottom left arrangement, the arrays collect different information from their respective positions that can aid in determining the six dimensional information discussed below and can be helpful in providing data for creating the 3D model discussed herein.

 The bottom right arrangement has two arrays spaced apart from each
15 other, but the arrays each have one camera image sensor and one LIDAR/Radar sensor. As can be seen in this arrangement, there are a lot of overlapping fields of view (104-1 and 104-2) between the two arrays. As with the other bottom arrangements, the arrays collect different information from their respective positions that can aid in determining the six
20 dimensional information discussed below and can be helpful in providing data for creating the 3D model discussed herein. It should be noted that the bottom arrangements also allow for a larger field of view area than the top arrangements due to the spacing of the sensors or type of sensors used.

 As discussed above, in order to achieve these benefits, the
25 embodiments of the present disclosure include all camera image, laser and radar sensors. For example, the camera sensor capability can provide the detection of the aircraft from the longer distances, such as from the ramp area stand entry lead-in lines and the LIDAR/Radar can provide the clear guidance to the aircraft to perform the precise docking. The data from
30 multiple systems are collected and merged via a data fusion process

described herein which provides a rich data set to track and provide guidance to the aircraft, from entry into the ramp area to docking.

As shown in Figure 1, areas of the aircraft such as the fuselage 103, the tail 111, the wings 113, and the engines 115 can be in the field of view of the camera image sensor 104 (e.g., illustrated in the top right arrangement).
5 As discussed below, characteristics of these aircraft features and characteristics of other features can be used to identify the aircraft's type and/or subtype using the processes discussed herein.

Figure 2 illustrates an imaging and LIDAR/Radar sensing
10 arrangement in accordance with one or more embodiments of the present disclosure. Figure 2 provides a closer, side perspective of a ramp area within an airport 200 according to an embodiment of the present disclosure. In the embodiment, the camera image sensor 222 and LIDAR/Radar sensor 220 form sensor array 202. This view also illustrates that the field of view
15 224 has a vertical spread in addition to the horizontal spread generally illustrated in Figure 1 with respect to the field of view 104.

This data is helpful in creating the 3D model of the aircraft which is used to identify the type and/or subtype of the aircraft, among other uses. Also, as shown in Figure 2, characteristics of the aircraft 201, such as shape
20 of the fuselage 230, number, shape, and position of passenger windows 228 and pilot windows 226 can be ascertained from the data captured by the camera image sensor 222 depending on the angle of approach of the aircraft to the sensor 222.

Further, the data captured can also indicate positioning of the wheel
25 234 to the stop point 233 (at stop bar in Figure 2). Additionally, the LIDAR/Radar sensor can gauge the distance d to the aircraft to determine whether the aircraft is nearing the stop point 233.

Figure 3 illustrates a flow diagram of a system showing some components of the system and some functions of the system in accordance
30 with one or more embodiments of the present disclosure. Figure 3 shows a

central docking system controller 340 of the docking system connected to a number of other devices and systems from which the central docking system controller 340 receives data and/or sends data.

For instance, components including the LIDAR/Radar sensor 342, the ADS-B system 344, the imaging sensor 346, and the airport computing system 361 are examples of components that send data to the central docking system controller 340. The ramp docking system controller 362 and pilot unit display 364 are examples of components that receive information from the central docking system controller 340.

As discussed herein, a LIDAR/Radar system includes computing device executable instructions and data to operate the LIDAR/Radar sensor 342, capture LIDAR/Radar sensor data, and send the data to the central docking system controller 340 for processing. These functions can be carried out in one or more devices and some of these functions may be provided by the central docking system controller 340.

The LIDAR/Radar system provides its data as a plurality of LIDAR/Radar data points, referred to herein as a LIDAR/Radar point cloud (illustrated at 468 of Figure 4), that are collected as the LIDAR/Radar scans over surfaces of the aircraft. The LIDAR/Radar data can also include distance information 352, indicating, for example, the distance of the front surface of the fuselage of the aircraft to the LIDAR/Radar sensor.

Although LIDAR/Radar sensing is discussed primarily herein, it should be noted that other light/radio based detection and ranging methodologies may be used to provide the functions of the LIDAR/Radar system described herein. Suitable LIDAR/Radar sensing methodologies include those that scan the aircraft with a LIDAR/Radar sensor by sweeping the laser/radio signals across the aircraft in at least one of a horizontal or vertical direction or both. One suitable laser sensing system is a light detection and ranging (LIDAR) system and a suitable radio signal scanning system is Radio Detection and Ranging (RADAR).

As discussed herein, a camera image system includes computing device executable instructions and data to operate the camera image sensor 346, capture image sensor data, and send the data to the central docking system controller 340 for processing. These functions can also be carried out in one or more devices and some of these functions may be provided by the central docking system controller 340. The camera image system provides its data as image data captured from the imaging sensor and can be data representing frames of video data or one or more still images, for example, taken in a sequence.

In embodiments of the present disclosure, an image processing system is used to create an initial aircraft 3D model (these functions are shown at 354 and 356 of Figure 3) and LIDAR/Radar point cloud analytics (these functions are shown at 348 and 350 of Figure 3), utilized by a LIDAR/Radar module (shown at 671 of Figure 6), provide the point cloud for the aircraft that is nearing the ramp area. In some embodiments, the embodiment includes machine learning/deep learning capabilities wherein both of the data outputs get fused by the data fusion module to derive the hybrid accurate aircraft model and/or type and/or subtype detection.

In some embodiments, the LIDAR/Radar point cloud creation, image processing 3D model creation, and data fusion can be real-time processes, depending on the computing and networking speed of the docking system, which derives the speed and position of the aircraft. This will provide the input to the central docking system controller to provide the clear information to use in pilot unit display messages that can be used to provide directional and/or speed guidance to the pilot.

The docking systems of the present disclosure aircraft detection methodology analyze not only the outline shape of a 3D model of an aircraft composed from camera image data, but characteristic shape feature parameters of an aircraft including, for example: the number, position, and/or shape of pilot and/or passenger windows; engine location; engine

cover size; number of engines; wing span; wing edge to nose end distance; wing shape; fuselage size and/or shape; tail size and/or shape; tail tip height; nose dimensions; and/or other features. The docking system will also collect data for some similar parameters from the LIDAR/Radar system.

- 5 Then, based on the data from both data sets, the docking system will determine the position and orientation of the aircraft, its speed, and/or its distance to a stop point where the aircraft is the correct distance from the gate in the ramp area.

- Several embodiments are discussed herein. For example, one
- 10 method embodiment includes receiving camera image data of an aircraft while the aircraft is approaching or in the ramp area, receiving LIDAR/Radar sensor data of an aircraft while the aircraft is approaching or in the ramp area, merging the camera image data and the LIDAR/Radar sensor data into a merged data set, and wherein the merged data set includes at least
- 15 one of: data for determining the position of the aircraft relative to the position of the ramp area, data for determining the orientation of the aircraft relative to the orientation of the ramp area, data for determining speed of the aircraft, data for determining direction of the aircraft, data for determining proximity of the aircraft to a particular object within the ramp area, and data
- 20 for forming a three dimensional virtual model of at least a portion of the aircraft from the merged data.

- In some embodiments, in order to identify a probable aircraft type, the docking system can use LIDAR/Radar data and machine learning and image data (at 354 of Figure 3) to determine aircraft 3D model, then merging
- 25 the data together using data fusion module 358. This merged data can be used to provide a determination of aircraft type and determination of speed and distance 360. For example, the docking system can compare a three dimensional virtual model to one or more aircraft reference models stored in memory of a computing device to find a match between the three
- 30 dimensional virtual model and one of the aircraft reference models to determine an aircraft type.

In some embodiments, the docking system does not need to find an exact match to a reference model, but can use a statistical probability algorithm to consider how closely the approaching aircraft matches a reference aircraft based on the data's closeness to matching a characteristic of an aircraft (e.g., pilot window position, shape, orientation, nose shape, tail tip height, etc.). As discussed herein, the docking system can receive aircraft type data from the airport's computing system. The docking system can then compare the determined aircraft type with an aircraft type provided in gate arrival information (e.g. from the airport computing system) to determine that the aircraft type that is approaching or in the ramp area is the correct aircraft type.

If the docking system confirms that the correct type of aircraft is entering the ramp area, the docking system can forward guidance information to be displayed by a pilot unit computing system 364 on the aircraft and ramp docking system controller 362 to assist the pilot in positioning and orienting the aircraft correctly with respect to the ramp area and any objects in the ramp area.

If the aircraft is going to the wrong ramp area, the docking system can send information to the pilot indicating that they are going to wrong ramp area. In some embodiments, the docking system can instruct the pilot to stop talking so that they can receive important information.

Through use of this data, embodiments of the present disclosure can, for example, provide ramp area object detection and the presence of foreign objects in the ramp area. For example, the docking system can locate objects in the ramp area and monitor proximity of the aircraft to a particular object within the ramp area including using data for determining proximity of the aircraft to a piece of equipment on a ramp area tarmac surface or near a stop point. Further, some embodiments can be utilized with several ramp area layouts including: single funnel w/single lead-inline, multiple lead-in lines with single funnel where the lead-in lines are converging, and two

funnels jointly connected, as illustrated in Figure 1, and these areas can be monitored for aircraft and objects as discussed herein.

Embodiments can also identify a region of interest of a ramp area. For example, an area of interest can be the area that the aircraft will occupy when positioned correctly or a path through the ramp area through which the aircraft will traverse to arrive at the stop point. This can be helpful to identify objects that will need to be moved before or as the aircraft approaches the ramp area.

The docking system can also validate the 3D model based on comparisons with the other models stored and already identified as certain aircraft models to identify which type of aircraft is coming into the ramp area and compare that information with aircraft arrival information to ensure the correct type of aircraft is coming into the ramp area. In some embodiments, the 3D model database and the comparison functionality can be expanded and precisioned based on the use of machine learning. With more models and a higher success rate of positive identifications, the docking system can more accurately identify that the approaching aircraft is of the correct aircraft type and may be able to make the identification more quickly, allowing for an incorrect aircraft to be notified and guided to change course before it enters the ramp area.

One suitable camera system includes: at least one sensor (e.g. single camera or dual camera sensor models), an image processor, and memory. The docking system collects data from one or more frames of image data captured by the image sensor. One suitable system collects image data at, for example, 30 frames per second. As discussed herein, this image data can be used to create a 3D model of the aircraft.

The camera can, for example, include mono or multi-mode sensors, such as high definition camera sensors that can capture the field of view of the apron, including most or all of the ramp area and, potentially, some area

outside the ramp area where an aircraft will taxi through to get to the ramp area.

To accomplish this, the camera can, for example, use a camera based pose detection algorithm that uses 3D models of aircraft and image contours to estimate six dimensions (6D) of pose (i.e., x, y, z, roll, pitch, and yaw) of the aircraft to perform a vision pose estimation process.

This 6D of pose estimation can be accomplished by, for example, orienting the projection of the 3D model within an image plane by using a calibrated camera (wherein the image plane is defined as part of the calibration process and wherein the image plane is associated with a real world plane of the ramp area) and then comparing the projection with image contours of the aircraft (from the camera image data). From this data, the six dimensions of the aircraft in the image can be determined.

Additionally, once the camera image data and data have been collected, a data fusion process can occur, where qualities of each data set can be used together to identify the 6D elements. One process for accomplishing data fusion can be to: receive data to be used to form a 3D point cloud from the sensor, calculate a transformation between the coordinates of the system and a vision coordinate system of the camera image system (representative of a real world coordination system of the ramp area), determine an estimated pose of the 3D model from the vision pose estimation process described above. This transformation can be accomplished, for example, by having the sensor data analyzed using a point cloud process to correlate points in the sensor data to points in the camera image data.

This pose can also be determined from any other sensor type, such as from an automatic dependent service – broadcast (ADS-B). An ADS-B system is an in air communications system that broadcasts position, velocity, and other parameters and can be used with embodiments herein to improve aircraft tracking, especially just prior to and entering the camera field of view.

The process also can include: registering point cloud data generated out of the 3D model and 3D point cloud data from the sensor, through an iterated point cloud algorithm (ICP). This registration between the two point cloud data sets can create a final improved pose which is the fusion of both point clouds. As used herein, the process of point cloud analytics refers to registering the points on the point cloud, formed from the image sensor data, to positionally similar data points received from the sensor. This can be accomplished, for example, by mapping both data sets to a virtual space having a common coordinate system.

This improved pose can, for example, be used to find the kinematics of the approaching aircraft using an estimation algorithm (e.g., velocity, acceleration, etc.). The improved pose from the fusion process and the 3D model can also be used to mask out an area occupied by aircraft (e.g., define an aircraft shaped space). In some embodiments, using this mask process, the docking system can search for potential obstacles in the masked area and find places to move them that are located in the non-masked part of the ramp area, using the camera image data. Simply stated, to accomplish this, the docking system identifies objects that are not the aircraft and spaces that are not the masked area.

The docking system can also utilize airport gate information in its analysis. For example, once an airport gate has been assigned by the airport computing system, that information is forwarded to the central docking system. This data includes gate arrival information such as, for example, an aircraft type scheduled to arrive at the gate.

As discussed herein, the docking system can receive information about an incoming flight from the airport computing system 361. For example, the data received from the airport computing system can include an aircraft type - 832N, among other information relevant to docking. For example, a database in the airport computing system can communicate with a central aircraft docking control system at the airport and to the docking system at the particular ramp area where the aircraft is attempting to dock.

The central docking system has a set of aircraft templates stored in memory. The central docking system uses the 832N aircraft type to identify which template represents the type of aircraft arriving at the ramp area and provides that information to the docking system at the ramp area.

5 In some embodiments, the docking system will search the area it can sense for that aircraft type until it comes into the area. Once an aircraft is sensed, the docking system then checks to see if it is the correct type of aircraft. In some embodiments, camera image data and LIDAR/Radar sensor data can be compared to identify whether an aircraft is present in
10 both the camera image data and the LIDAR/Radar sensor data. This can, for example, be done before merging the camera image data and the LIDAR/Radar sensor data. In this way, computing resources won't be wasted on analysis of objects that are not aircraft.

A suitable guidance range for such systems is that the LIDAR/Radar
15 sensing range of the docking system should allow for sensing to at least the last 25 meters from the stop point. The guidance module of the central docking system can, for example, provide the remaining distance and the horizontal deviation with respect to the center line of the path (e.g., lead-in line) that the aircraft is supposed to follow. This can provide the pilot with
20 directions regarding how to get the aircraft to the correct location. In some embodiments, the guidance system can indicate to the pilot when to brake in order to stop on the stop point.

The docking system can also provide and monitor maximum speeds for approaching a gate. These speed thresholds can be set and monitored
25 and instructions can be passed to the pilot to slow down. For example, in some embodiments, the determined speed, position, orientation, and/or direction can be sent to a ramp docking system controller device in the ramp docking system and then passed to the pilot unit computing device. After docking at the stop point, the use of chocks can be identified and
30 communicated to the pilot via the central docking system controller, so the pilot knows that they should not try to move the aircraft.

In some embodiments, this information can also be sent to a passenger computing device on the aircraft, so passengers can see when they arrive in the ramp area. This may be beneficial at larger airports where the aircraft may taxi for a long period.

5 In addition to providing a very robust data set and offering significant additional analysis functionalities, embodiments of the present disclosure also provide redundancy if either the LIDAR/Radar or imaging system are not functioning. This can be highly beneficial in allowing the airport gate to continue to function even if one of the two systems is not operating.

10 Figure 4 illustrates a two dimensional display of a three dimensional (3D) model of an aircraft and sample point cloud data set in accordance with one or more embodiments of the present disclosure. Figure 4 illustrates the differences between the point cloud data 468 and the 3D model data 470 as illustrated in a virtual 3D space. As can be understood from this
15 comparison, the two data sets are very distinctly different and each has its beneficial uses, as discussed herein.

Figure 5 illustrates a computing device for use in accomplishing ramp area aircraft movement functions in accordance with one or more
embodiments of the present disclosure. Computing device 543 is a typical
20 computing device that can be used as the airport computing system, as the central docking system controller 340, as the ramp docking system controller 362, and/or as the pilot unit 364, as described in Figure 3. In the system illustrated in Figure 5, the system 541 includes a computing device 543 having a number of components coupled thereto. The computing
25 device 543 includes a processor 545 and memory 547. The memory 547 can include various types of information including data 555 and instructions 551 executable by the processor 545, discussed herein.

Memory and/or the processor may be located on the computing device 543 or off the device, in some embodiments. The system can
30 include a network interface 553. Such an interface can allow for processing on another locally networked computing or other device or devices on other

networks. For example, the network interface can include a computing device having Internet access for allowing access to the airport computing system or to access other computing resources to access flight information.

As illustrated in the embodiment of Figure 5, a system can include one or more input and/or output interfaces 557. Such interfaces can be used to connect the computing device with one or more input or output devices. These devices can be used to receive or access data that can be used to accomplish the functions described herein.

For example, in the embodiment illustrated in Figure 5, the system 541 can include connectivity to a camera image device 559 (sensing device), a LIDAR/Radar sensing device 561, an input device 563 (e.g., a keyboard, mouse, touch screen, etc.), a display device 565 (e.g., a monitor) and/or one or more other input devices. The input/output interface 557 can receive data, storable in the data storage device (e.g., memory 547), for example, representing the sensor data or aircraft type information discussed herein, among other information.

The processor 545 can be configured to execute instructions stored in memory to execute functions of the docking system and/or provide the functionalities described herein, and can provide those details to a display 565 (e.g., on a graphical user interface (GUI) running on the processor 545 and visible on the display 545).

Such connectivity can allow for the input and/or output of data and/or instructions among other types of information. Although some embodiments may be distributed among various computing devices within one or more networks, such systems as illustrated in Figure 5 can be beneficial in allowing for the query, analysis, and/or display of information discussed herein.

Figure 6 illustrates a memory location in a computing device of a docking system in accordance with one or more embodiments of the present disclosure. Memory 647 includes executable instructions 651 that can be grouped into modules based on the functionality the grouped instructions

provide. The main functionality modules used by the docking system are: a docking module 670, a LIDAR/Radar module 671, a camera image module 672, a data fusion module 673, and a guidance module 674.

5 Data 655 is also stored in memory that is used with each of the executable instruction modules to accomplish that module's specific functions. Accordingly, memory includes a docking datastore 680, a LIDAR/Radar datastore 681, a camera image datastore 682, a data fusion datastore 683, and a guidance datastore 684. This data can include items such as sensor data, aircraft type data, data for configuring 3D virtual
10 spaces to be presented on a display, a library of models of aircraft already identified, and other such data useful to accomplish the functions discussed herein.

Figure 7 illustrates a method for detection, tracking, and docking aircraft in a taxiway or ramp area of an airport in accordance with one or
15 more embodiments of the present disclosure. In the method of Figure 7, the method recites: receiving camera image data of an aircraft while the aircraft is approaching or in the ramp area, at block 790. The method also includes: receiving LIDAR/Radar sensor data of an aircraft while the aircraft is approaching or in the ramp area, at block 792.

20 At block 794, the method merges the camera image data and the LIDAR/Radar sensor data into a merged data set. The merged data set includes, at block 796, at least one of: data for determining the position and orientation of the aircraft relative to the position and orientation of the ramp area, data for determining speed of the aircraft, data for determining
25 direction of the aircraft, data for determining proximity of the aircraft to a particular object within the ramp area, and data for forming a three dimensional virtual model of at least a portion of the aircraft from the merged data. Such a method can provide a robust, merged data set that can provide many benefits over prior systems, as discussed herein.

Although specific embodiments have been illustrated and described herein, those of ordinary skill in the art will appreciate that any arrangement calculated to achieve the same techniques can be substituted for the specific embodiments shown. This disclosure is intended to cover any and
5 all adaptations or variations of various embodiments of the disclosure.

It is to be understood that the above description has been made in an illustrative fashion and not a restrictive one. Combination of the above embodiments, and other embodiments not specifically described herein, will be apparent to those of skill in the art upon reviewing the above description.

10 The scope of the various embodiments of the disclosure includes any other applications in which the above structures and methods are used. Therefore, the scope of various embodiments of the disclosure should be determined with reference to the appended claims, along with the full range of equivalents to which such claims are entitled.

15 In the foregoing Detailed Description, various features are grouped together in example embodiments illustrated in the figures for the purpose of streamlining the disclosure. This method of disclosure is not to be interpreted as reflecting an intention that the embodiments of the disclosure require more features than are expressly recited in each claim.

20 Rather, as the following claims reflect, inventive subject matter lies in less than all features of a single disclosed embodiment. Thus, the following claims are hereby incorporated into the Detailed Description, with each claim standing on its own as a separate embodiment.

Claims

What is claimed:

1. A method for tracking an aircraft, comprising:
 - receiving camera image data of an aircraft while the aircraft is approaching or in the ramp area;
 - receiving LIDAR/Radar sensor data of an aircraft while the aircraft is approaching or in the ramp area;
 - merging the camera image data and the LIDAR/Radar sensor data into a merged data set; and
 - wherein the merged data set includes at least one of: data for determining the position and orientation of the aircraft relative to the position and orientation of the ramp area, data for determining speed of the aircraft, data for determining direction of the aircraft, data for determining proximity of the aircraft to a particular object within the ramp area, and data for forming a three dimensional virtual model of at least a portion of the aircraft from the merged data.
2. The method of claim 1, wherein the method includes:
 - comparing the three dimensional virtual model to one or more aircraft reference models stored in memory of a computing device to find a match between the three dimensional virtual model and one of the aircraft reference models to determine an aircraft type.
3. The method of claim 1, wherein the method includes:
 - comparing the determined aircraft type with an aircraft type provided in gate arrival information to determine that the aircraft type that is approaching or in the ramp area is the correct aircraft type.
4. The method of claim 1, wherein the method includes:

scanning the aircraft with a LIDAR/Radar sensor with a sweep of the LIDAR/Radar across the aircraft in at least one of a horizontal or vertical direction or both.

5. The method of claim 4, wherein the method includes:
comparing the camera image data and the LIDAR/Radar sensor data to identify that an aircraft is present in both the camera image data and the LIDAR/Radar sensor data.
6. The method of claim 1, wherein the gate arrival information is received from an airport computing system.
7. The method of claim 1, wherein the method includes:
comparing the camera image data and the LIDAR/Radar sensor data to identify that an aircraft is present in both the camera image data and the LIDAR/Radar sensor data before merging the camera image data and the LIDAR/Radar sensor data.
8. The method of claim 1, wherein the data for determining proximity of the aircraft to a particular object within the ramp area include data for determining proximity of the aircraft to a stop point.
9. The method of claim 1, wherein the data for determining proximity of the aircraft to a particular object within the ramp area include data for determining proximity of the aircraft to a piece of equipment on a ramp area tarmac surface.
10. A method for tracking an aircraft, comprising:
receiving camera image data of an aircraft while the aircraft is approaching or in the ramp area;

determining a portion of the camera image associated with the aircraft;

receiving LIDAR/Radar sensor data of an aircraft while the aircraft is approaching or in the ramp area;

determining a portion of the LIDAR/Radar sensor data associated with the aircraft;

merging the camera image data and the LIDAR/Radar sensor data associated with the aircraft into a merged data set; and

wherein the merged data set includes at least one of: data for determining the position and orientation of the aircraft relative to the position and orientation of the ramp area, data for determining speed of the aircraft, data for determining direction of the aircraft, data for determining proximity of the aircraft to a particular object within the ramp area, and data for forming a three dimensional virtual model of at least a portion of the aircraft from the merged data.

11. The method of claim 10, wherein the method includes:

comparing the three dimensional virtual model to one or more aircraft reference models to find a match between the three dimensional virtual model and one of the aircraft reference models to determine an aircraft type.

12. The method of claim 11, wherein comparing the three dimensional virtual model to one or more aircraft reference models includes comparing at least one of:

wing edge to nose end distance;

tail tip height;

number of windows;

position of windows;

size of windows;

number of pilot windows;

position of pilot windows;

number of engines;
engine cowl type;
engine cowl size;
fuselage length;
number of windows in fuselage;
wing span size;
height of the nose from ground;
position of engines; and
nose dimensions.

13. The method of claim 10, wherein the method includes sending at least the determined speed and direction to a ramp docking system controller device.

14. The method of claim 13, wherein the method includes also sending at least the determined position and orientation to the ramp docking system controller device.

15. The method of claim 10, wherein the method includes sending at least the determined position and orientation to a ramp docking system controller device.

16. The method of claim 10, wherein the method includes sending at least one of the determined speed, direction, position, and orientation to a pilot unit computing device on the aircraft.

17. The method of claim 10, wherein the method includes sending at least one of the determined speed, direction, position, and orientation to a passenger computing device on the aircraft.

18. A system tracking an aircraft, comprising:

a camera image sensor for capturing camera image data of an aircraft while the aircraft is approaching or in the ramp area;

a computing device having memory associated therewith for receiving the camera image data from the camera image sensor;

a LIDAR/Radar sensor for capturing LIDAR/Radar sensor data of an aircraft while the aircraft is approaching or in the ramp area;

the computing device for receiving the LIDAR/Radar sensor data and merging the camera image data and the LIDAR/Radar sensor data associated with the aircraft into a merged data set; and

wherein the merged data set includes at least one of: data for determining the position and orientation of the aircraft relative to the position and orientation of the ramp area, data for determining speed of the aircraft, data for determining direction of the aircraft, data for determining proximity of the aircraft to a particular object within the ramp area, and data for forming a three dimensional virtual model of at least a portion of the aircraft from the merged data.

19. The computing device of claim 18, wherein the LIDAR/Radar sensor data is analyzed using a point cloud process to correlate points in the LIDAR/Radar sensor data to points in the camera image data.

20. The computing device of claim 18, wherein the computing device analyzes the camera image data to identify that an aircraft is approaching or in the ramp area.

Abstract of the Disclosure

Tracking aircraft in and near a ramp area is described herein. One method includes receiving camera image data of an aircraft while the aircraft is approaching or in the ramp area, receiving LIDAR/Radar sensor data of an aircraft while the aircraft is approaching or in the ramp area, merging the camera image data and the LIDAR/Radar sensor data into a merged data set, and wherein the merged data set includes at least one of: data for determining the position and orientation of the aircraft relative to the position and orientation of the ramp area, data for determining speed of the aircraft, data for determining direction of the aircraft, data for determining proximity of the aircraft to a particular object within the ramp area, and data for forming a three dimensional virtual model of at least a portion of the aircraft from the merged data.

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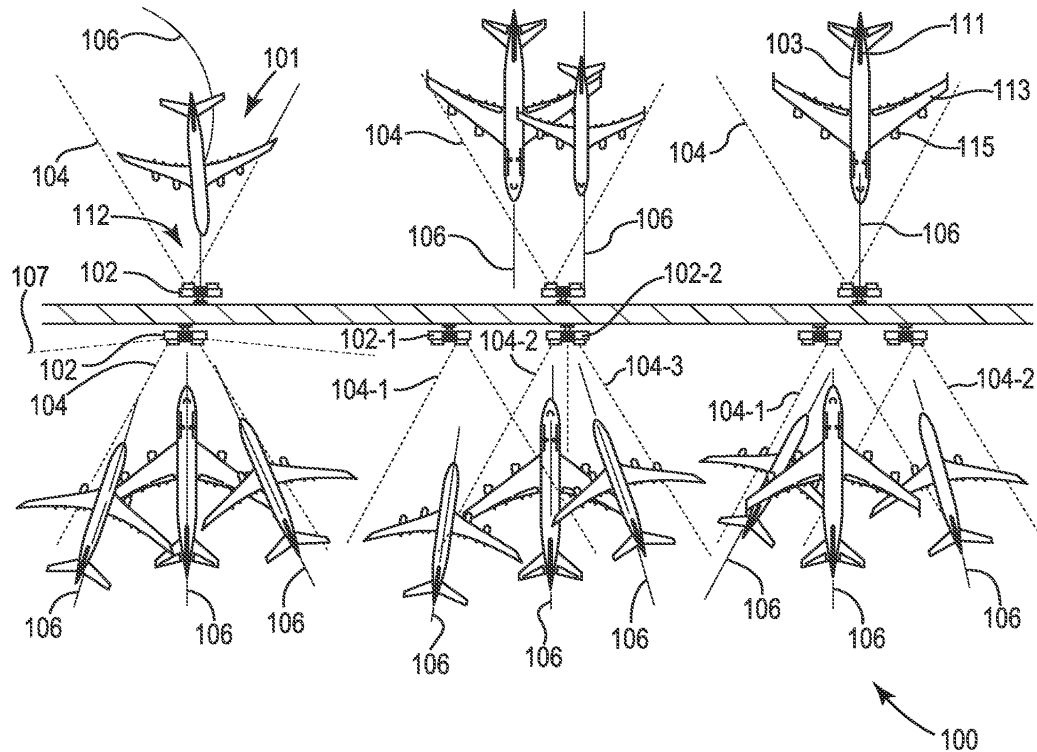


FIG. 1

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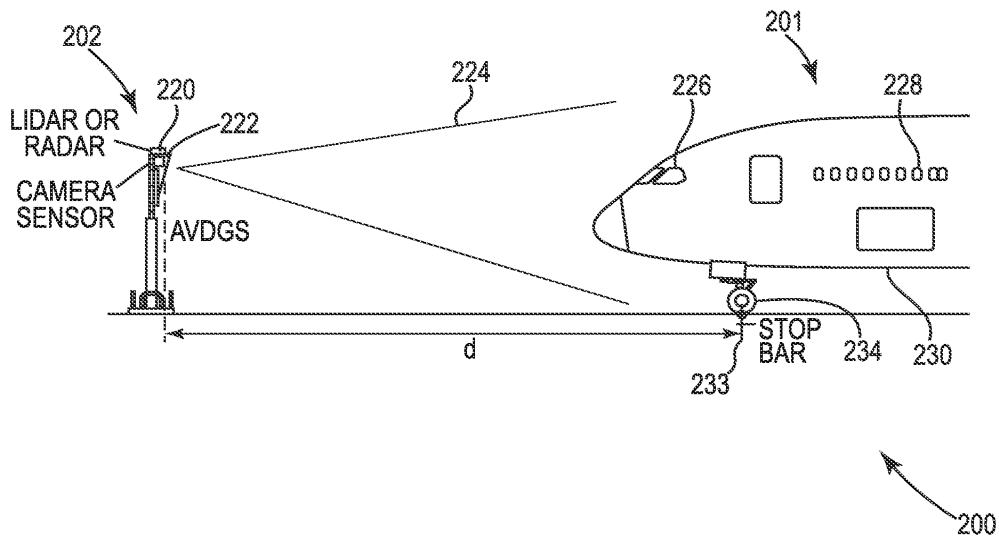


FIG. 2

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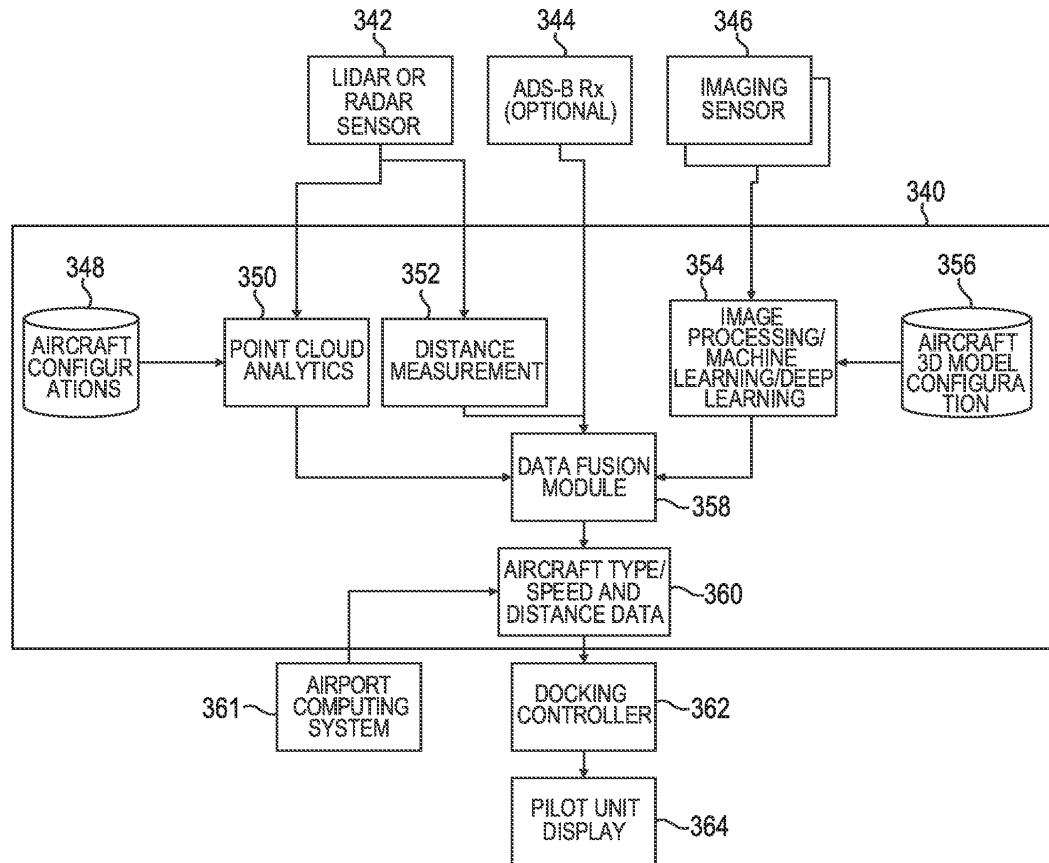


FIG. 3

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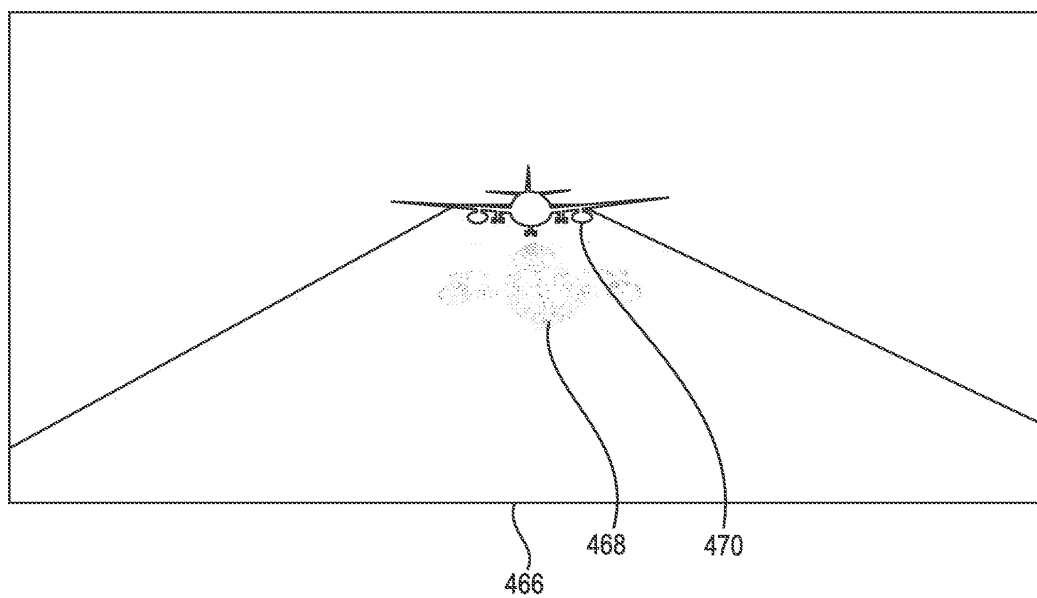


FIG. 4

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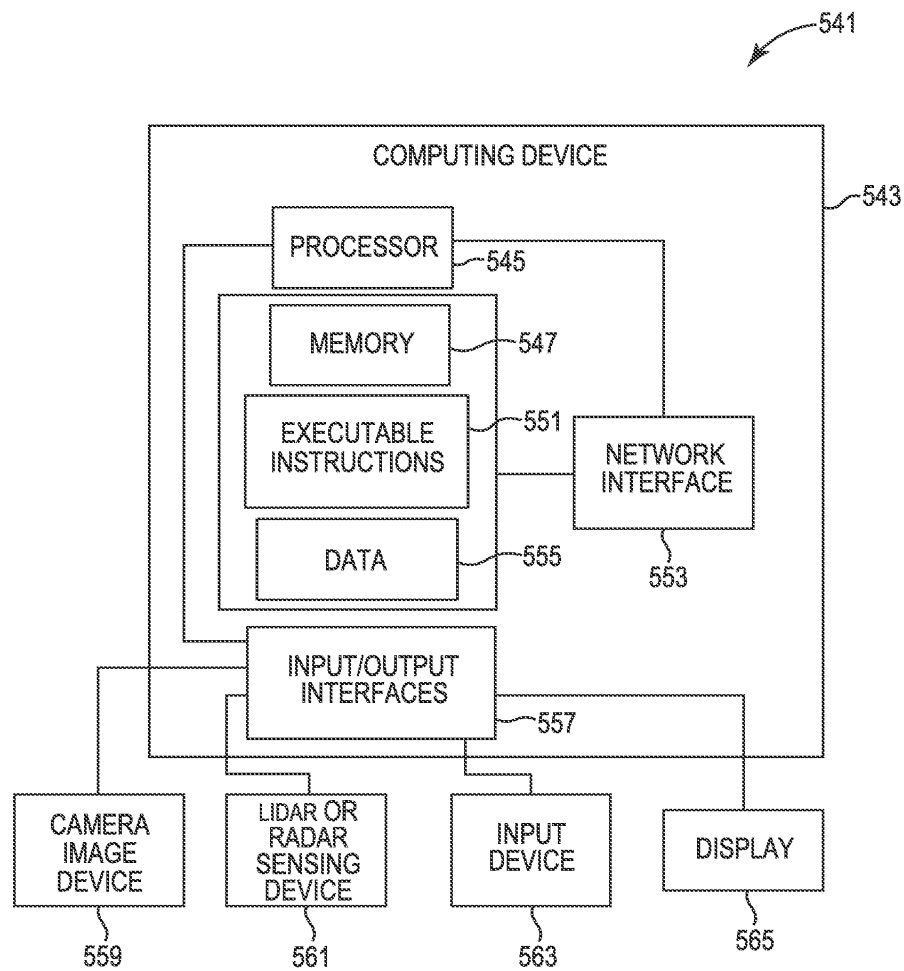


FIG. 5

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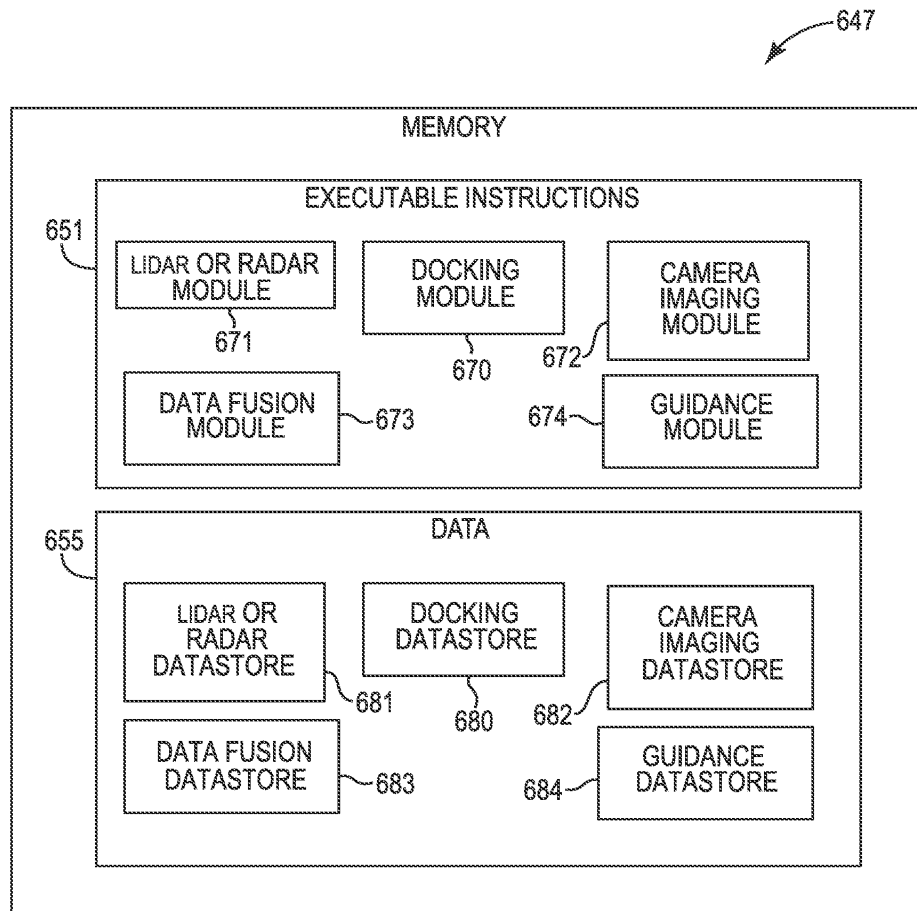


FIG. 6

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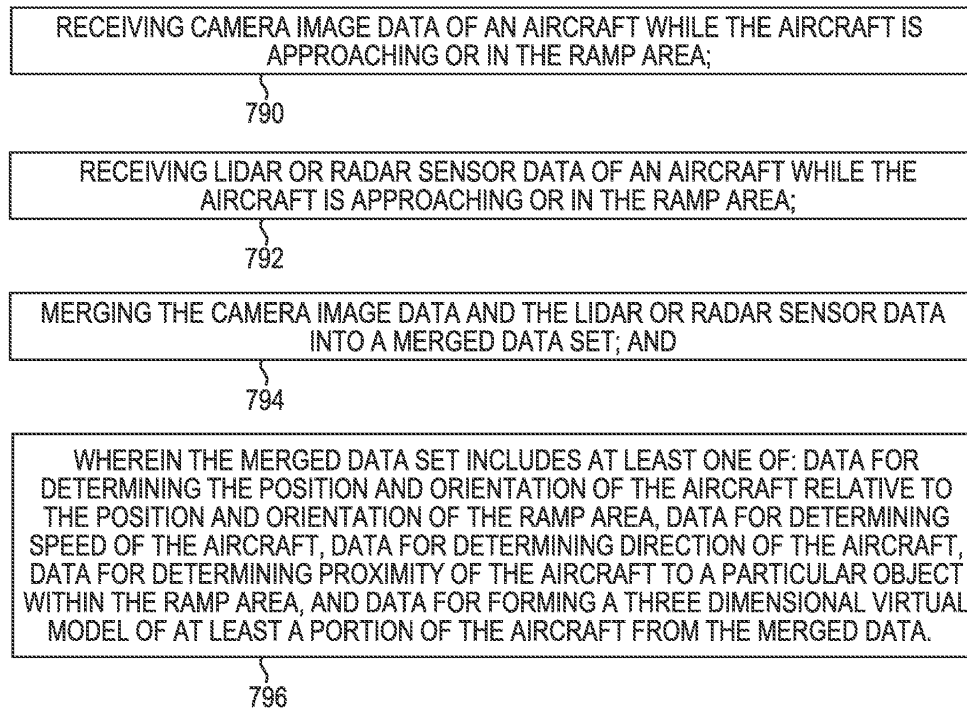


FIG. 7

TRANSMITTAL FOR POWER OF ATTORNEY TO ONE OR MORE REGISTERED PRACTITIONERS

NOTE: This form is to be submitted with the Power of Attorney by Applicant form (PTO/AIA/82B) to identify the application to which the Power of Attorney is directed, in accordance with 37 CFR 1.5, unless the application number and filing date are identified in the Power of Attorney by Applicant form. If neither form PTO/AIA/82A nor form PTO/AIA82B identifies the application to which the Power of Attorney is directed, the Power of Attorney will not be recognized in the application.

Application Number	Not yet assigned
Filing Date	Herewith
First Named Inventor	Rajesh V. Poojary
Title	MULTI-SENSOR DATA FUSION-BASED AIRCRAFT DETECTION, TRACKING, AND DOCKING
Art Unit	Not yet assigned
Examiner Name	Not yet assigned
Attorney Docket Number	H215046-US

SIGNATURE of Applicant or Patent Practitioner

Signature	/Mark R. Berger/	Date (Optional)	2020-08-03
Name	Mark R. Berger	Registration Number	62556
Title (if Applicant is a juristic entity)	Patent Attorney		
Applicant Name (if Applicant is a juristic entity)	Honeywell International Inc.		

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. If more than one applicant, use multiple forms.



*Total of 2 forms are submitted.

This collection of information is required by 37 CFR 1.131, 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.

POWER OF ATTORNEY BY APPLICANT

I hereby revoke all previous powers of attorney given in the application identified in either the attached transmittal letter or the boxes below.

Application Number	Filing Date

(Note: The boxes above may be left blank if information is provided on form PTO/AIA/82A.)

☒ I hereby appoint the Patent 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 identified above:

10786

OR

☐ I hereby appoint Practitioner(s) named in the attached list (form PTO/AIA/82C) 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 patent application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above. (Note: Complete form PTO/AIA/82C.)

Please recognize or change the correspondence address for the application identified in the attached transmittal letter or the boxes above 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		

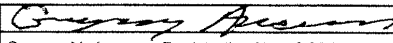
I am the Applicant (if the Applicant is a juristic entity, list the Applicant name in the box):

--

- ☐ Inventor or Joint Inventor (title not required below)
- ☐ Legal Representative of a Deceased or Legally Incapacitated Inventor (title not required below)
- ☒ Assignee or Person to Whom the Inventor is Under an Obligation to Assign (provide signer's title if applicant is a juristic entity)
- ☐ 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) (provide signer's title if applicant is a juristic entity)

SIGNATURE of Applicant for Patent

The undersigned (whose title is supplied below) is authorized to act on behalf of the applicant (e.g., where the applicant is a juristic entity).

Signature		Date (Optional)	8-22-14
Name	Gregory M. Ansems, Registration No. 42,264		
Title	Intellectual Property General Counsel, Honeywell International 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. If more than one applicant, use multiple forms.

☒ Total of 2 forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.132, and 1.133. 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.

AUTHORIZATION OR RESCISSION OF AUTHORIZATION TO PERMIT ACCESS TO APPLICATION-AS-FILED BY PARTICIPATING OFFICES	
Send completed form to: Commissioner for Patents P.O. Box 1450, Alexandria, VA 22313-1450	
Application Number (if known):	Filing Date:
First Named Inventor: Rajesh V. Poojary	Attorney Docket Number: H215046-US
Title (Required) MULTI-SENSOR DATA FUSION-BASED AIRCRAFT DETECTION, TRACKING, AND	
<p>Check either box 1 or 2 below, but not both:</p> <p>1. ☒ By checking this box, the undersigned hereby grants the USPTO authority to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization (WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h)(1).</p> <p>2. ☐ By checking this box, the undersigned hereby rescinds the previous authority granted to the USPTO to provide the EPO, JPO, KIPO, SIPO, WIPO or any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement access to the documents and information identified in paragraph 1 above.</p> <p>This rescission of the previous authorization will not be effective unless and until an appropriate USPTO official recognizes and acts on the rescission.</p> <p>However, once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.</p>	
NOTE: This form must be signed by an authorized party in accordance with 37 CFR 1.14(c). Please see 37 CFR 1.4(d) for the form of the signature. If necessary, submit multiple forms for more than one signature, see below.*	
Signature /Mark R. Berger/	Date 2020-08-03
Name (Print/Typed) Mark R. Berger	Practitioner Registration Number (if applicable) 62556
Name of Assignee (if applicable) Honeywell International Inc.	Title (if applicable) Patent Attorney
☒ *Total of <u>1</u> forms are submitted.	

This collection of information is required by 37 CFR 1.14(h). 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: 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.

AUTHORIZATION OR RESCISSION OF AUTHORIZATION TO PERMIT ACCESS TO SEARCH RESULTS BY THE EUROPEAN PATENT OFFICE (EPO)	
Send completed form to: Commissioner for Patents P.O. Box 1450, Alexandria, VA 22313-1450	
Application Number (if known):	Filing Date:
First Named Inventor: Rajesh V. Poojary	Attorney Docket Number: H215046-US
Title (Required) MULTI-SENSOR DATA FUSION-BASED AIRCRAFT DETECTION, TRACKING, AND	
<p>Check either box 1 or 2 below, but not both:</p> <p>1. ☒ By checking this box, the undersigned hereby grants the USPTO authority to provide the EPO access to the bibliographic data and search results from the instant patent application when a European patent application claiming priority to the instant application is filed. See 37 CFR 1.14(h)(2).</p> <p>The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.</p> <p>2. ☐ By checking this box, the undersigned hereby rescinds the previous authority granted to the USPTO to transmit to the EPO any search results from the instant patent application.</p> <p>This rescission of the previous authorization will not be effective unless and until an appropriate USPTO official recognizes and acts on the rescission.</p> <p>However, once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.</p>	

NOTE: This form must be signed by an authorized party in accordance with 37 CFR 1.14(c). Please see 37 CFR 1.4(d) for the form of the signature. If necessary, submit multiple forms for more than one signature, see below.*	
Signature /Mark R. Berger/	Date 2020-08-03
Name (Print/Typed) Mark R. Berger	Practitioner Registration Number (If applicable) 62556
Name of Assignee (if applicable) Honeywell International Inc.	Title (if applicable) Patent Attorney
☒ *Total of <u>1</u> forms are submitted.	

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.
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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.

**DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION
USING AN APPLICATION DATA SHEET (37 CFR 1.76)
(Based on PTO/AIA/01)**

Title of Invention: MULTI-SENSOR DATA FUSION-BASED AIRCRAFT DETECTION, TRACKING, AND DOCKING

As the below named inventor(s), I hereby declare that:

This declaration is directed to:

 X the attached application, or
 United States application or PCT international application number _____
filed on _____.

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

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

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

I have reviewed and understand the contents of the application, including the claims, and am aware of the duty to disclose to the Office all information known to me to be material to patentability as defined in 37 CFR 1.56.

LEGAL NAME OF INVENTOR

Inventor: Rajesh V. Poojary Date: 01/08/2020

Signature: *Raj*

**DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION
USING AN APPLICATION DATA SHEET (37 CFR 1.76)
(Based on PTO/AIA/01)**

Title of Invention: MULTI-SENSOR DATA FUSION-BASED AIRCRAFT DETECTION, TRACKING, AND DOCKING

As the below named inventor(s), I hereby declare that:

This declaration is directed to:

X the attached application, or
____ United States application or PCT international application number _____
filed on _____.

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

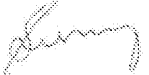
I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

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

I have reviewed and understand the contents of the application, including the claims, and am aware of the duty to disclose to the Office all information known to me to be material to patentability as defined in 37 CFR 1.56.

LEGAL NAME OF INVENTOR

Inventor: Vinay Sridhara Murthy Date: 01/08/2020

Signature: 

Honeywell Docket No. H215046-US

**DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION
USING AN APPLICATION DATA SHEET (37 CFR 1.76)
(Based on PTO/AIA/01)**

Title of Invention: MULTI-SENSOR DATA FUSION-BASED AIRCRAFT DETECTION, TRACKING, AND DOCKING

As the below named inventor(s), I hereby declare that:

This declaration is directed to:

☒ the attached application, or

☐ United States application or PCT international application number _____
filed on _____.

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

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I have reviewed and understand the contents of the application, including the claims, and am aware of the duty to disclose to the Office all information known to me to be material to patentability as defined in 37 CFR 1.56.

LEGAL NAME OF INVENTOR

Inventor: Manuj Sharma Date: 01/08/2020

Signature: MJS