(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
12 April 2012 (12.04.2012)

PCT

(10) International Publication Number
WO 2012/047479 A1

(51) International Patent Classification:
B64F 5/00 (2006.01)

(21) International Application Number:
PCT/US2011/051830

(22) International Filing Date:
15 September 2011 (15.09.2011)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
12/897,158 4 October 2010 (04.10.2010) US

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

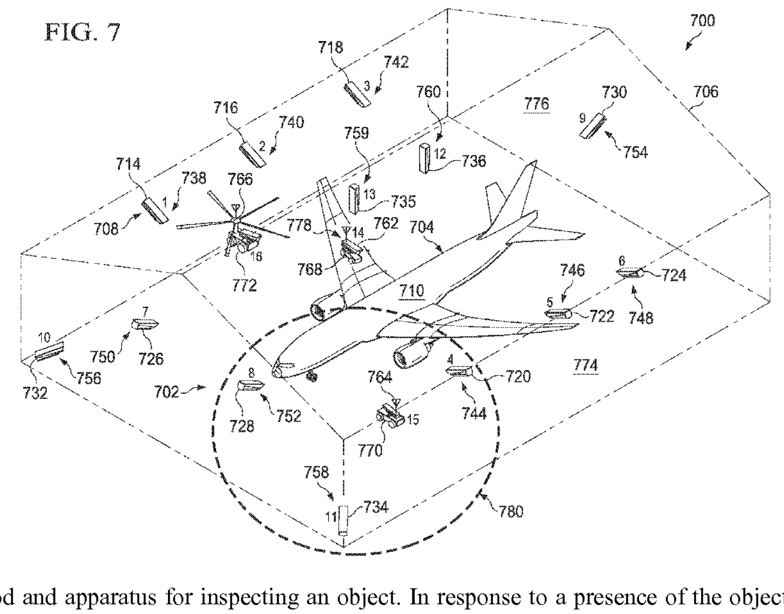
Published:

— *with international search report (Art. 21(3))*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

(54) **Title**: AUTOMATED VISUAL INSPECTION SYSTEM

FIG. 7



(57) **Abstract**: A method and apparatus for inspecting an object. In response to a presence of the object in an inspection area, a volume containing the object is identified. The volume has a plurality of portions. A number of sensor systems is assigned to the plurality of portions of the volume. Each sensor system in the number of sensors systems is assigned to a number of portions in the plurality of portions of the volume based on whether each sensor system is able to generate data with a desired level of quality about a surface of the object in a particular portion in the plurality of portions. Data about the surface of the object is generated using the number of sensor systems assigned to the plurality of portions of the volume. A determination is made as to whether a number of inconsistencies is present on the surface of the object using data.

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AUTOMATED VISUAL INSPECTION SYSTEM

BACKGROUND INFORMATION

1. Field:

[0001] The present disclosure relates generally to inspecting objects and, in particular, to inspecting an aircraft. Still more particularly, the present disclosure relates to a method and apparatus for automatically inspecting an aircraft on the ground.

2. Background:

[0002] Aircraft and parts for aircraft are inspected during different phases of the life of the aircraft. For example, when an aircraft is being assembled, the different parts of the aircraft are inspected during various phases of assembly. Further, during testing and certification of an aircraft, inspections are made to determine whether different parts of the aircraft are performing as expected or desired.

[0003] During use of the aircraft, periodic checks are made after a certain time or usage. For example, a check may be made after about five to about 800 hours or about every three months or about 12 to about 18 months, depending on the type of inspection. The inspection on an aircraft may include a visual inspection of the exterior of an aircraft. In other cases, the inspection may involve removing different parts of the aircraft and inspecting those parts. The inspection may result in maintenance being performed on the aircraft.

[0004] Currently, these inspections are performed by people using instructions that identify parts and inconsistencies that a person should look for. These people are also referred to as maintenance operators. The results of these inspections are written down or entered into a database by the maintenance operator.

[0005] For example, in some inspections, an aircraft may be moved into a hangar. A maintenance operator may walk around the aircraft to determine whether any inconsistencies are present on the surface of the aircraft. These inconsistencies may include, for example, without limitation, a dent, a leak, missing rivets, or some other type of inconsistency.

[0006] This type of inspection requires larger amounts of time than desired. Additionally, the maintenance operators, who perform the inspections, need a level of training and experience that allow for the identification of inconsistencies with a desired level of accuracy. The amount of time, skill, and experience needed for maintenance operators results in a high cost in performing inspections of aircraft.

[0007] Therefore, it would be advantageous to have a method and apparatus that takes into account one or more of the issues discussed above, as well as other possible issues.

SUMMARY

[0008] In one illustrative embodiment, a method is provided for inspecting an object. In response to a presence of the object in an inspection area, a volume that contains the object is identified. The volume has a plurality of portions. A number of sensor systems is assigned to the plurality of portions of the volume. Each sensor system in the number of sensors systems is assigned to a number of portions in the plurality of portions of the volume based on whether each sensor system is able to generate data with a desired level of quality about a surface of the object in a particular portion in the plurality of portions. The data about the surface of the object is generated using the number of sensor systems assigned to the plurality of portions of the volume. A determination is made as to whether a number of inconsistencies is present on the surface of the object using the data.

[0009] In another illustrative embodiment, an apparatus comprises a number of sensor systems located in an inspection area and a computer system in communication with the number of sensor systems. The computer system is configured to identify a volume that contains an object. The volume has a plurality of portions. The computer system is configured to assign the number of sensor systems to the plurality of portions of the volume. Each sensor system in the number of sensors systems is assigned to a number of portions in the plurality of portions of the volume based on whether each sensor system is able to generate data with a desired level of quality about a surface of the object in a particular portion in the plurality of portions. The computer system is configured to generate the data about the surface of the object using the number of sensor systems assigned to the plurality of portions of the volume. The computer system is configured to determine whether a number of inconsistencies is present on the surface of the object.

[0010] The features, functions, and advantages can be achieved independently in various embodiments of the present disclosure or may be combined in yet other embodiments in which further details can be seen with reference to the following description and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The novel features believed characteristic of the illustrative embodiments are set forth in the appended claims. The illustrative embodiments, however, as well as a preferred mode of use, further objectives, and advantages thereof, will best be understood by reference to the following detailed description of an illustrative embodiment of the present disclosure when read in conjunction with the accompanying drawings, wherein:

[0012] **Figure 1** is an illustration of an aircraft manufacturing and service method in accordance with an illustrative embodiment;

[0013] **Figure 2** is an illustration of an aircraft in which an illustrative embodiment may be implemented;

[0014] **Figure 3** is an illustration of an inspection environment in accordance with an illustrative embodiment;

[0015] **Figure 4** is an illustration of a data processing system in accordance with an illustrative embodiment;

[0016] **Figure 5** is an illustration of a sensor system in accordance with an illustrative embodiment;

[0017] **Figure 6** is an illustration of a testing system in accordance with an illustrative embodiment;

[0018] **Figure 7** is an illustration of a perspective view of an inspection environment in accordance with an illustrative embodiment;

[0019] **Figure 8** is an illustration of an enlarged perspective view of a portion of an inspection environment in accordance with an illustrative embodiment;

[0020] **Figure 9** is an illustration of a front view of an inspection environment in accordance with an illustrative embodiment;

[0021] **Figure 10** is an illustration of a top view of a volume in an inspection area in accordance with an illustrative embodiment;

[0022] **Figure 11** is an illustration of a side view of a volume in an inspection area in accordance with an illustrative embodiment;

[0023] **Figure 12** is an illustration of a perspective view of an inspection environment in accordance with an illustrative embodiment; and

[0024] **Figure 13** is an illustration of a flowchart of a process for inspecting an object in accordance with an illustrative embodiment.

DETAILED DESCRIPTION

[0025] Referring more particularly to the drawings, embodiments of the disclosure may be described in the context of aircraft manufacturing and service method **100** as shown in **Figure 1** and aircraft **200** as shown in **Figure 2**. Turning first to **Figure 1**, an illustration of an aircraft manufacturing and service method is depicted in accordance with an illustrative embodiment. During pre-production, aircraft manufacturing and service method **100** may include specification and design **102** of aircraft **200** in **Figure 2** and material procurement **104**.

[0026] During production, component and subassembly manufacturing **106** and system integration **108** of aircraft **200** in **Figure 2** takes place. Thereafter, aircraft **200** in **Figure 2** may go through certification and delivery **110** in order to be placed in service **112**. While in service **112** by a customer, aircraft **200** in **Figure 2** is scheduled for routine maintenance and service **114**, which may include modification, reconfiguration, refurbishment, and other maintenance or service.

[0027] Each of the processes of aircraft manufacturing and service method **100** may be performed or carried out by a system integrator, a third party, and/or an operator. In these examples, the operator may be a customer. For the purposes of this description, a system integrator may include, without limitation, any number of aircraft manufacturers and major-system subcontractors; a third party may include, without limitation, any number of venders, subcontractors, and suppliers; and an operator may be an airline, leasing company, military entity, service organization, and so on.

[0028] With reference now to **Figure 2**, an illustration of an aircraft is depicted in which an illustrative embodiment may be implemented. In this example, aircraft **200** is produced by aircraft manufacturing and service method **100** in **Figure 1** and may include airframe **202** with a plurality of systems **204** and interior **206**. Examples of systems **204** include one or more of propulsion system **208**, electrical system **210**, hydraulic system **212**, and environmental system **214**. Any number of other systems may be included. Although an aerospace example is shown, different illustrative embodiments may be applied to other industries, such as the automotive and/or ship industry.

[0029] Apparatus and methods embodied herein may be employed during at least one of the stages of aircraft manufacturing and service method **100** in **Figure 1**.

As used herein, the phrase “at least one of”, when used with a list of items, means that different combinations of one or more of the listed items may be used and only one of each item in the list may be needed. For example, “at least one of item A, item B, and item C” may include, for example, without limitation, item A or item A and item B. This example also may include item A, item B, and item C or item B and item C.

[0030] In one illustrative example, components or subassemblies produced in component and subassembly manufacturing **106** in **Figure 1** may be fabricated or manufactured in a manner similar to components or subassemblies produced while aircraft **200** is in service **112** in **Figure 1**. As yet another example, a number of apparatus embodiments, method embodiments, or a combination thereof may be utilized during production stages, such as component and subassembly manufacturing **106** and system integration **108** in **Figure 1**. A number, when referring to items, means one or more items. For example, a number of apparatus embodiments may be one or more apparatus embodiments. A number of apparatus embodiments, method embodiments, or a combination thereof may be utilized while aircraft **200** is in service **112** and/or during maintenance and service **114** in **Figure 1**. The use of a number of the different illustrative embodiments may substantially expedite the assembly of and/or reduce the cost of aircraft **200**.

[0031] The different illustrative embodiments recognize and take into account a number of considerations. For example, the different illustrative embodiments recognize and take into account that the inspection of aircraft may not be as consistent as desired. As one illustrative example, different levels of experience and skill in maintenance operators may result in different maintenance operators identifying different inconsistencies on the same aircraft. In other words, one maintenance operator may not see an inconsistency that another maintenance operator may see, depending on the difference in skill and experience.

[0032] Even with the same skill and experience, the different illustrative embodiments also recognize that maintenance operators may miss an inconsistency entirely or make a judgment call that an inconsistency is not present. With the same aircraft, another maintenance operator may determine that the inconsistency is present.

[0033] The different illustrative embodiments recognize and take into account that with maintenance operators performing inspections, it may be difficult to see upper portions of an aircraft, such as the top of an aircraft. As a result, some inconsistencies may not be detected or identified by the maintenance operators. A maintenance operator may be required to climb a ladder or use a lift to see upper portions of an aircraft. The different illustrative embodiments recognize and take into account that this type of process increases the time needed to inspect the aircraft, as well as requires equipment that allows for maintenance operators to see higher portions of the aircraft that cannot be easily seen from the ground.

[0034] Thus, the different illustrative embodiments provide a method and apparatus for inspecting objects, such as aircraft. In response to the presence of an object in an inspection area, a volume is identified that contains the object. This volume has a plurality of portions. A number of sensor systems are assigned to the plurality of portions of the volume. Each sensor system in the number of sensor systems may be assigned to a number of portions in the plurality of portions of the volume.

[0035] This assignment of the number of sensors is based on whether each sensor is able to generate data with a desired level of quality about a surface of the object in a particular portion in the plurality of portions. The data is then generated about the surface of the object using the number of sensor systems assigned to the plurality of portions of the volume. A determination is made as to whether a number of inconsistencies is present on the surface of the object. This information may then be used to perform maintenance operations and/or other operations on the object.

[0036] With reference now to **Figure 3**, an illustration of an inspection environment is depicted in accordance with an illustrative embodiment. In these illustrative examples, inspection environment **300** may be used during different phases of aircraft manufacturing and service method **100** in **Figure 1**.

[0037] Inspection environment **300** in **Figure 3** is used to inspect object **302** for number of inconsistencies **304**. In these illustrative examples, object **302** is aircraft **306**. Aircraft **306** may be implemented using, for example, aircraft **200** in **Figure 2**. In these illustrative examples, number of inconsistencies **304** may include, for example, without limitation, at least one of a dent, a crack, a leak, and/or some other type of inconsistency.

[0038] In these illustrative examples, inspection of aircraft **306** takes place in location **308**. In particular, location **308** may be in hangar **310** in these examples. Location **308** in hangar **310** forms inspection area **312** for inspecting aircraft **306**.

[0039] Number of sensor systems **314** is associated with inspection area **312** in these illustrative examples. In these depicted examples, number of sensor systems **314** may include mobile sensor system **315**. Mobile sensor system **315** is configured to move along ground **311** or in air **313** in inspection area **312** in hangar **310**.

[0040] Number of sensor systems **314** may be placed in locations **317** in hangar **310** such that substantially all of surface **321** of object **302** can be detected by number of sensor systems **314**. In this manner, the different illustrative embodiments provide a capability to inspect all of object **302** more thoroughly as compared to currently used methods. This type of improvement may be especially evident when object **302** takes the form of aircraft **306**.

[0041] Computer system **316**, in these illustrative examples, is in communication with number of sensor systems **314**. Computer system **316** communicates with number of sensor systems **314** through network **318**. Network **318** may include wired communications links, wireless communications links, or a combination of the two.

[0042] In these illustrative examples, computer system **316** comprises number of computers **320**. Number of computers **320** may be in communication with each other through network **318** or a different network, depending on the particular implementation.

[0043] Inspection process **322** runs on one or more of number of computers **320**. In other words, inspection process **322** may be distributed among different computers in number of computers **320**. Further, inspection process **322** may run as program code, hardware, or a combination of the two on number of computers **320**. In these illustrative examples, number of sensor systems **314** generates data **324**, which is sent to inspection process **322**.

[0044] In these illustrative examples, inspection process **322** identifies volume **326** in response to a presence of object **302** in inspection area **312**. This initiation of inspection process **322** may be performed automatically in response to the presence of object **302**. In other illustrative examples, inspection process **322** may begin inspecting object **302** when object **302** is present in inspection area **312** and an input is received to start the inspection. This input may be user input or some other suitable type of input.

[0045] Volume **326** contains object **302**. In other words, object **302** is located inside of volume **326**. Inspection process **322** assigns number of sensor systems **314** to plurality of portions **328** of volume **326**. The assignment of number of sensor systems **314** to plurality of portions **328** is based on each sensor system being capable of generating data **324** with desired level of quality **332** about surface **321** of object **302** in particular portion **336** in plurality of portions **328**.

[0046] In these illustrative examples, data **324** generated by number of sensor systems **314** takes the form of number of images **338**. Number of images **338** may include still images, images for a video, a combination of the two, or some other suitable type of image.

[0047] In these illustrative examples, number of images **338** may be made by number of sensor systems **314** using visual light, infrared light, and/or other suitable types of light. Further, number of images **338** also may be generated by a laser beam directed toward surface **321** of object **302** with data **324** forming measurements about distance to surface **321** to generate images in number of images **338**. Of course, other types of images may be used, depending on the particular implementation.

[0048] In these depicted examples, inspection process **322** compares data **324** with baseline data **340** in database **342**. Baseline data **340** is obtained for object **302** at a time prior to the generation of data **324**. In other words, baseline data **340** is obtained for object **302** at a time prior to inspection of object **302** for number of inconsistencies **304**.

[0049] Baseline data **340** may take the form of number of images **344** generated after object **302** was manufactured. In other examples, number of images **344** may be images of object **302** taken before a current use of object **302**. In still other illustrative examples, baseline data **340** may be generated from a model of object **302**.

[0050] Inspection process **322** determines whether number of inconsistencies **304** is present on surface **321** of object **302** through the comparison of data **324** with baseline data **340**. For example, inspection process **322** may compare data **324** to baseline data **340** to identify number of pixel locations **341** in number of images **338** where data **324** does not match baseline data **340** within a selected threshold. In this manner, number of inconsistencies **304** is identified at number of pixel locations **341** in number of images **338**.

[0051] In these depicted examples, each pixel location in number of pixel locations **341** is defined using an x-y coordinate system for the pixels in image with the pixel location. Inspection process **322** identifies the locations on surface **321** of aircraft **306** that correspond to the locations in number of images **338**. In this manner, inspection process **322** identifies number of locations **348** that correspond to number of pixel locations **341**. Number of locations **348** includes the actual locations on surface **321** of aircraft **306** for number of inconsistencies **304**.

[0052] The comparison between data **324** and baseline data **340** may be made using a number of different techniques. For example, at least one of image segmentation, edge detection, image enhancement, geometric pattern matching, wavelet transformation, graph-based algorithms, and other suitable techniques are used to compare data **324** to baseline data **340**.

[0053] In response to a determination that a number of inconsistencies are present on surface **321** of object **302**, inspection process **322** may identify number of maintenance operations **346** to perform on object **302**. These maintenance operations may include, for example, without limitation, replacements of parts, reworking of parts, additional inspections, and/or other suitable types of maintenance operations.

[0054] For example, inspection process **322** may control testing system **350** to perform additional inspections in number of locations **348** where number of inconsistencies **304** has been identified. In these illustrative examples, testing system **350** may include number of mobile testing systems **354**. Number of mobile testing systems **354** may travel between number of locations **348** to perform additional inspections on number of inconsistencies **304**. In these illustrative examples, number of mobile testing systems **354** performs non-destructive testing **356** at number of locations **348** where number of inconsistencies **304** have been identified.

[0055] In these depicted examples, non-destructive testing **356** includes a number of different types of testing techniques that do not generate more inconsistencies or cause undesired changes to object **302**. For example, non-destructive testing **356** may include at least one of testing using ultrasound signals, magnetic particles, liquid penetration, x-rays, eddy currents, and/or other suitable techniques to perform further inspection of object **302**.

[0056] In this manner, the different illustrative embodiments provide an improved method and apparatus over current inspection systems for identifying inconsistencies in objects, such as aircraft. In these illustrative examples, time and effort may be saved for objects, such as aircraft **306**. In particular, the inspection of object **302** in the form of aircraft **306** may be performed quickly and with more accuracy using number of sensor systems **314** and inspection process **322** than by using human maintenance operators.

[0057] The illustration of inspection environment **300** in **Figure 3** is not meant to imply physical or architectural limitations to a manner in which different illustrative embodiments may be implemented. Other components in addition to and/or in place of the ones illustrated may be used. Some components may be unnecessary in some illustrative embodiments. Also, the blocks are presented to illustrate some functional components. One or more of these blocks may be combined and/or divided into different blocks when implemented in different illustrative embodiments.

[0058] For example, the different illustrative embodiments may be applied to objects other than aircraft **306**. For example, the different illustrative embodiments may be applied to other types of objects, such as, for example, without limitation, a land-based structure, an aquatic-based structure, a space-based structure, and/or some other suitable type of object. More specifically, the different illustrative embodiments may be applied to, for example, without limitation, a submarine, a bus, a personnel carrier, a tank, a train, an automobile, a spacecraft, a space station, a satellite, a surface ship, a power plant, a dam, an engine, a flap, a portion of a fuselage, a manufacturing facility, a building, and/or some other suitable object.

[0059] Additionally, these inspections may be performed at different times in addition to performing maintenance on an aircraft. For example, the different illustrative embodiments may be applied to parts manufactured for aircraft **306** and during testing and certification of aircraft **306**. Additionally, the different illustrative embodiments may be applied to inspecting the interior of an aircraft. For example, number of sensor systems **314** may be present inside of aircraft **306** or located on mobile platforms that move within aircraft **306** to inspect the surface of the interior of aircraft **306**.

[0060] Turning now to **Figure 4**, an illustration of a data processing system is depicted in accordance with an illustrative embodiment. In this illustrative example, data processing system **400** is an example of one implementation for one or more computers in number of computes **320** in computer system **316** in **Figure 3**.

[0061] As depicted, data processing system **400** includes communications fabric **402**, which provides communications between processor unit **404**, memory **406**, persistent storage **408**, communications unit **410**, input/output (I/O) unit **412**, and display **414**. Data processing system **400** is an example of a data processing system that may be used to implement number of computers **320** in computer system **316** in **Figure 3**.

[0062] Processor unit **404** serves to execute instructions for software that may be loaded into memory **406**. Processor unit **404** may be a number of processors, a multi-processor core, or some other type of processor, depending on the particular implementation. A number, as used herein with reference to an item, means one or more items. Further, processor unit **404** may be implemented using a number of heterogeneous processor systems in which a main processor is present with secondary processors on a single chip. As another illustrative example, processor unit **404** may be a symmetric multi-processor system containing multiple processors of the same type.

[0063] Memory **406** and persistent storage **408** are examples of storage devices **416**. A storage device is any piece of hardware that is capable of storing information, such as, for example, without limitation, data, program code in functional form, and/or other suitable information either on a temporary basis and/or a permanent basis. Storage devices **416** may also be referred to as computer readable storage devices in these examples. Memory **406**, in these examples, may be, for example, a random access memory or any other suitable volatile or non-volatile storage device. Persistent storage **408** may take various forms, depending on the particular implementation.

[0064] For example, persistent storage **408** may contain one or more components or devices. For example, persistent storage **408** may be a hard drive, a flash memory, a rewritable optical disk, a rewritable magnetic tape, or some combination of the above. The media used by persistent storage **408** also may be removable. For example, a removable hard drive may be used for persistent storage **408**.

[0065] Communications unit **410**, in these examples, provides for communications with other data processing systems or devices. In these examples, communications unit **410** is a network interface card. Communications unit **410** may provide communications through the use of either or both physical and wireless communications links.

[0066] Input/output unit **412** allows for input and output of data with other devices that may be connected to data processing system **400**. For example, input/output unit **412** may provide a connection for user input through a keyboard, a mouse, and/or some other suitable input device. Further, input/output unit **412** may send output to a printer. Display **414** provides a mechanism to display information to a user.

[0067] Instructions for the operating system, applications, and/or programs may be located in storage devices **416**, which are in communication with processor unit **404** through communications fabric **402**. In these illustrative examples, the instructions are in a functional form on persistent storage **408**. These instructions may be loaded into memory **406** for execution by processor unit **404**. The processes of the different embodiments may be performed by processor unit **404** using computer implemented instructions, which may be located in a memory, such as memory **406**.

[0068] These instructions are referred to as program code, computer usable program code, or computer readable program code that may be read and executed by a processor in processor unit **404**. The program code in the different embodiments may be embodied on different physical or computer readable storage media, such as memory **406** or persistent storage **408**.

[0069] Program code **418** is located in a functional form on computer readable media **420** that is selectively removable and may be loaded onto or transferred to data processing system **400** for execution by processor unit **404**. Program code **418** and computer readable media **420** form computer program product **422** in these examples. In one example, computer readable media **420** may be computer readable storage media **424** or computer readable signal media **426**. Computer readable storage media **424** may include, for example, an optical or magnetic disk that is inserted or placed into a drive or other device that is part of persistent storage **408** for transfer onto a storage device, such as a hard drive, that is part of persistent storage **408**.

[0070] Computer readable storage media **424** also may take the form of a persistent storage, such as a hard drive, a thumb drive, or a flash memory, that is connected to data processing system **400**. In some instances, computer readable storage media **424** may not be removable from data processing system **400**. In these illustrative examples, computer readable storage media **424** is a non-transitory computer readable storage medium.

[0071] Alternatively, program code **418** may be transferred to data processing system **400** using computer readable signal media **426**. Computer readable signal media **426** may be, for example, a propagated data signal containing program code **418**. For example, computer readable signal media **426** may be an electromagnetic signal, an optical signal, and/or any other suitable type of signal. These signals may be transmitted over communications links, such as wireless communications links, optical fiber cable, coaxial cable, a wire, and/or any other suitable type of communications link. In other words, the communications link and/or the connection may be physical or wireless in the illustrative examples.

[0072] In some illustrative embodiments, program code **418** may be downloaded over a network to persistent storage **408** from another device or data processing system through computer readable signal media **426** for use within data processing system **400**. For instance, program code stored in a computer readable storage medium in a server data processing system may be downloaded over a network from the server to data processing system **400**. The data processing system providing program code **418** may be a server computer, a client computer, or some other device capable of storing and transmitting program code **418**.

[0073] The different components illustrated for data processing system **400** are not meant to provide architectural limitations to the manner in which different embodiments may be implemented. The different illustrative embodiments may be implemented in a data processing system including components in addition to or in place of those illustrated for data processing system **400**. Other components shown in **Figure 4** can be varied from the illustrative examples shown.

[0074] The different embodiments may be implemented using any hardware device or system capable of running program code. As one example, the data processing system may include organic components integrated with inorganic components and/or may be comprised entirely of organic components excluding a human being. For example, a storage device may be comprised of an organic semiconductor.

[0075] In another illustrative example, processor unit **404** may take the form of a hardware unit that has circuits that are manufactured or configured for a particular use. This type of hardware may perform operations without needing program code to be loaded into a memory from a storage device to be configured to perform the operations.

[0076] For example, when processor unit **404** takes the form of a hardware unit, processor unit **404** may be a circuit system, an application specific integrated circuit (ASIC), a programmable logic device, or some other suitable type of hardware configured to perform a number of operations. With a programmable logic device, the device is configured to perform the number of operations. The device may be reconfigured at a later time or may be permanently configured to perform the number of operations.

[0077] Examples of programmable logic devices include, for example, a programmable logic array, programmable array logic, a field programmable logic array, a field programmable gate array, and other suitable hardware devices. With this type of implementation, program code **418** may be omitted because the processes for the different embodiments are implemented in a hardware unit.

[0078] In still another illustrative example, processor unit **404** may be implemented using a combination of processors found in computers and hardware units. Processor unit **404** may have a number of hardware units and a number of processors that are configured to run program code **418**. With this depicted example, some of the processes may be implemented in the number of hardware units, while other processes may be implemented in the number of processors.

[0079] As another example, a storage device in data processing system **400** is any hardware apparatus that may store data. Memory **406**, persistent storage **408**, and computer readable media **420** are examples of storage devices in a tangible form.

[0080] In another example, a bus system may be used to implement communications fabric **402** and may be comprised of one or more buses, such as a system bus or an input/output bus. Of course, the bus system may be implemented using any suitable type of architecture that provides for a transfer of data between different components or devices attached to the bus system. Additionally, a communications unit may include one or more devices used to transmit and receive data, such as a modem or a network adapter. Further, a memory may be, for example, memory **406**, or a cache, such as found in an interface and memory controller hub that may be present in communications fabric **402**.

[0081] With reference now to **Figure 5**, an illustration of a sensor system is depicted in accordance with an illustrative embodiment. In this illustrative example, sensor system **500** is an example of a sensor system that may be used to implement a sensor system in number of sensor systems **314** in **Figure 3**.

[0082] As depicted in this example, sensor system **500** comprises number of cameras **502**. Number of cameras **502** is configured to generate data **504** in the form of number of images **506**. Number of images **506** may be, for example, without limitation, at least one of still images **508**, video **510**, and/or other types of suitable images.

[0083] In these illustrative examples, number of cameras **502** may generate number of images **506** for area **512**. Number of cameras **502** may be fixed or may be moveable about number of axes **514**.

[0084] This movement over number of axes **514** is controlled through motor system **516** and controller **518**. Further, the movement about number of axes **514** may be referred to as pan and tilt in these illustrative examples.

[0085] Although number of cameras **502** may be able to generate number of images **506** over area **512**, data **504** may be generated for only portion **520** of area **512**. Portion **520** of area **512** may provide number of images **506** with desired level of quality **522**.

[0086] In these illustrative examples, desired level of quality **522** takes the form of resolution **524**. The resolution of a camera in number of cameras **502** may be measured in pixels and is a measure of a quality of an image. The quality of an image may be based on features, such as, for example, without limitation, sharpness, color intensity, color contrast, distortion, compression, noise, dynamic range, and/or other suitable features. As one illustrative example, as the resolution of an image increases, features, such as the sharpness of an image and the ability to make out objects in an image, also increase.

[0087] With reference now to **Figure 6**, an illustration of a testing system is depicted in accordance with an illustrative embodiment. In this illustrative example, testing system **600** is an example of one implementation for testing system **350** in **Figure 3**.

[0088] In this depicted example, testing system **600** is mobile testing system **602**. As illustrated, mobile testing system **602** comprises platform **604**, propulsion system **606**, controller **608**, and non-destructive testing unit **610**. Platform **604** provides a structure for other components in mobile testing system **602**. Propulsion system **606**, controller **608**, and non-destructive testing unit **610** are associated with platform **604**.

[0089] Propulsion system **606** is configured to move mobile testing system **602**. Propulsion system **606** may move mobile testing system **602** on the ground, in the air, or a combination of the two.

[0090] For example, propulsion system **606** may comprise motor **612** and track system **614**. Motor **612** causes track system **614** to move platform **604** on the ground. In other illustrative examples, propulsion system **606** may comprise motor **616** and blades **618**. Motor **616** is configured to rotate blades **618** to provide a lift in movement of mobile testing system **602**.

[0091] Non-destructive testing unit **610** may comprise at least one of x-ray system **620**, eddy current testing system **622**, ultrasound system **624**, camera system **626**, and/or other suitable types of non-destructive testing systems. In this illustrative example, x-ray systems **620** may be configured to generate images using x-rays. Eddy current testing system **622** may be used to detect inconsistencies in conductive materials through electromagnetic induction. Ultrasound system **624** may be configured to send signals through materials to identify inconsistencies.

[0092] Camera system **626** may have a higher resolution than cameras in number of sensor systems **314** in **Figure 3**. By moving camera system **626** to a location of a detected inconsistency, more detail of the inconsistency may be identified. In this manner, camera system **626** may be used to perform additional inspection of the detected inconsistency.

[0093] Controller **608** may be a data processing system, such as data processing system **400** in **Figure 4**, or a processor unit. Controller **608** is configured to control mobile testing system **602**. For example, controller **608** may control the movement of mobile testing system **602**. Further, controller **608** may control the generation of data by non-destructive testing unit **610**. The movement and data generated by mobile testing system **602** may be controlled through instructions or commands received from inspection process **322** in **Figure 3**.

[0094] With reference now to **Figure 7**, an illustration of a perspective view of an inspection environment is depicted in accordance with an illustrative embodiment. In this illustrative example, inspection environment **700** is an example of one implementation for inspection environment **300** in **Figure 3**.

[0095] As depicted, inspection environment **700** includes inspection area **702** and aircraft **704** in inspection area **702**. Inspection area **702** is in hangar **706** in this illustrative example. As illustrated, sensor systems **708** are located in inspection area **702**. Sensor systems **708** are configured to generate data about surface **710** of aircraft **704**. In some illustrative examples, sensor systems **708** may be configured to generate data about other portions of aircraft **704**, such as inner portions of aircraft **704**. For example, sensor systems **708** may include x-ray systems.

[0096] In this illustrative example, sensor systems **708** include camera systems **714**, **716**, **718**, **720**, **722**, **724**, **726**, **728**, **730**, **732**, **734**, **735**, **736**, **762**, **764**, and **766**. These camera systems may be implemented using, for example, a camera in number of cameras **502** in **Figure 5**. In this illustrative example, these camera systems generate images for surface **710** of aircraft **704**. In particular, these camera systems generate video.

[0097] Camera systems **714**, **716**, **718**, **720**, **722**, **724**, **726**, **728**, **730**, **732**, **734**, **735**, and **736** are in locations in hangar **706** in this depicted example. For example, camera systems **714**, **716**, **718**, **720**, **722**, **724**, **726**, **728**, **730**, **732**, **734**, **735**, and **736** are in locations **738**, **740**, **742**, **744**, **746**, **748**, **750**, **752**, **754**, **756**, **758**, **759**, and **760**, respectively, in hangar **706**. These locations are fixed locations for the camera systems in this depicted example.

[0098] As illustrated, sensor systems **708** also include camera systems **762**, **764**, and **766**. Camera systems **762**, **764**, and **766** are connected to robots **768**, **770**, and **772**, respectively. These robots allow camera systems **762**, **764**, and **766** to move within inspection area **702**.

[0099] For example, robot **768** and robot **770** are configured to move camera system **762** and camera system **764**, respectively, on a surface. This surface may be, for example, ground **774** of hangar **706** or surface **710** of aircraft **704**. For example, robot **768** is in location **778** on the surface of a wing for aircraft **704**.

[00100] In this illustrative example, robot **772** is configured to move camera system **766** in air **776** in hangar **706**. In other words, robot **772** flies such that camera system **766** moves in air **776**. In some illustrative examples, robot **772** may be configured to pick up, carry, and deploy a robot, such as robot **768,** with camera system **762** on surface **710** of aircraft **704**. In this manner, camera systems **762**, **764**, and **766** are capable of moving to different locations within inspection area **702** to generate images for different portions of surface **710** of aircraft **704**.

[00101] The images generated by sensor systems **708** may be sent to a computer system, such as computer system **316** in **Figure 3**, for processing. The images may be used to determine whether inconsistencies are present on surface **710** of aircraft **704**. Portion **780** of inspection environment **700** is illustrated in an enlarged view in **Figure 8** below.

[00102] Turning now to **Figure 8**, an illustration of an enlarged perspective view of a portion of an inspection environment is depicted in accordance with an illustrative embodiment. In this illustrative example, portion **780** of inspection environment **700** from **Figure 7** is depicted.

[00103] As depicted, camera system **720** has field of view **800**. Camera system **728** has field of view **802**. Camera system **734** has field of view **804**. Further, camera system **764** has field of view **806**. The locations of camera systems **720**, **728**, **734**, and **764** allow images to be generated for different portions of surface **710** of aircraft **704**.

[00104] With reference now to **Figure 9**, an illustration of a front view of an inspection environment is depicted in accordance with an illustrative embodiment. In this illustrative example, inspection environment **700** from **Figure 7** is depicted from a front view of inspection area **702** and aircraft **704** in inspection area **702**.

[00105] Turning now to **Figure 10**, an illustration of a top view of a volume in an inspection area is depicted in accordance with an illustrative embodiment. In this illustrative example, volume **1000** is identified within inspection area **702** in inspection environment **700** from **Figure 7**.

[00106] In this illustrative example, volume **1000** comprises plurality of portions **1002**. Plurality of portions **1002** is selected to cover substantially all of surface **710** of aircraft **704**. In other words, aircraft **704** is contained within plurality of portions **1002**.

[00107] As illustrated, each camera system in sensor systems **708** is assigned to a number of portions within plurality of portions **1002**. In this manner, each camera system generates images for surface **710** of aircraft **704** within the field of view of each camera system in the number of portions assigned to each camera system. As one illustrative example, camera system **716** is assigned to portions **1004**, **1006**, **1008**, **1010**, **1012**, **1014**, **1016**, and **1018**.

[00108] Further, in this depicted example, each camera system is assigned to the number of portions in plurality of portions **1002** based on whether each camera system is able to generate images with a desired level of quality of surface **710** of aircraft **704** in a particular portion in plurality of portions **1002**. The quality of the images generated by each camera system may depend on the distance from each camera system from surface **710** of aircraft **704**.

[00109] In this illustrative example, camera system **735** and camera system **736** in **Figure 7** are not shown to provide a clearer view of plurality of portions **1002** in volume **1000**. Camera system **735** in **Figure 7** is assigned to portion **1016** and portion **1022** in plurality of portions **1002** in this depicted example. Further, camera system **736** in **Figure 7** is assigned to portion **1018** and portion **1020**.

[00110] With reference now to **Figure 11**, an illustration of a side view of a volume in an inspection area is depicted in accordance with an illustrative embodiment. In this illustrative example, a side view of volume **1000** in **Figure 10** is depicted. As depicted, only a portion of plurality of portions **1002** from **Figure 10** is depicted.

[00111] With reference now to **Figure 12**, an illustration of a perspective view of an inspection environment is depicted in accordance with an illustrative embodiment. In this illustrative example, inspection environment **700** from **Figure 7** is depicted having rail system **1200**.

[00112] As depicted, rail system **1200** includes rails **1202**, **1204**, **1206**, **1208**, **1210**, **1212**, **1214**, **1216**, **1218**, **1220**, **1222**, and **1224**. Camera systems **714**, **716**, **718**, **720**, **722**, **724**, **726**, **728**, **730**, **732**, and **734** are configured to move in the direction of arrow **1227** along rails **1202**, **1204**, **1206**, **1208**, **1210**, **1212**, **1214**, **1216**, **1218**, **1220**, **1222,** and **1224,** respectively. Camera system **735** and camera system **736** are configured to move in the direction of arrow **1226** along rail **1224**.

[00113] In this manner, the locations of these camera systems may be changed. The locations of the camera systems may be changed to reassign the camera systems to different portions in a volume identified within an inspection area, such as volume **1000** in **Figure 10**. The locations of the camera systems may also be changed to account for the size and/or shape of different aircraft and/or other structures located within inspection area **702** in hangar **706**.

[00114] With reference now to **Figure 13**, an illustration of a flowchart of a process for inspecting an object is depicted in accordance with an illustrative embodiment. The process illustrated in **Figure 13** may be implemented in inspection environment **300** in **Figure 3**.

[00115] The process begins by identifying a volume that contains an object in response to a presence of the object in an inspection area (operation **1300**). The volume has a plurality of portions. The volume may be, for example, volume **1000** with plurality of portions **1002** in **Figure 10**.

[00116] The process then assigns a number of sensor systems to the plurality of portions of the volume (operation **1302**). Each sensor system in the number of sensor systems is assigned to a number of portions in the plurality of portions of the volume based on whether each sensor system is able to generate data with a desired level of quality about a surface of the object in a particular portion in the plurality of portions. In

this illustrative example, the number of sensor systems may be camera systems configured to generate data in the form of still images and/or video.

[00117] Thereafter, the process generates the data about the surface of the object using the number of sensor systems assigned to the plurality of portions of the volume (operation **1304**). The process then determines whether a number of inconsistencies are present on the surface of the object using the data (operation **1306**). Operation **1306** is performed by comparing the data to baseline data, such as baseline data **340** in **Figure 3**, in these examples.

[00118] If a number of inconsistencies are not present on the surface of the object, the process terminates. Otherwise, if a number of inconsistencies are present on the surface of the object, the process identifies a number of maintenance operations to perform on the object (operation **1308**), with the process terminating thereafter.

[00119] The number of maintenance operations may include, for example, reworking the surface of the object, repairing the surface of the object, replacing a part associated with the surface of the object, performing additional inspection of the number of inconsistencies, and/or other suitable operations. In this illustrative example, operation **1308** may also include initiating the number of maintenance operations identified. For example, in operation **1308**, if additional inspection of the number of inconsistencies is identified, the process may send commands to a mobile testing system to send the mobile testing system to the number of inconsistencies.

[00120] The flowchart and block diagrams in the different depicted embodiments illustrate the architecture, functionality, and operation of some possible implementations of apparatus and methods in different illustrative embodiments. In this regard, each block in the flowchart or block diagrams may represent a module, segment, function, and/or a portion of an operation or step. In some alternative implementations, the function or functions noted in the block may occur out of the order noted in the figures. For example, in some cases, two blocks shown in succession may be executed substantially concurrently, or the blocks may sometimes be executed in the reverse order, depending upon the functionality involved. Also, other blocks may be added in addition to the illustrated blocks in a flowchart or block diagram.

[00121] Thus, the different illustrative embodiments provide a method and apparatus for inspecting objects, such as aircraft. In response to the presence of an object in an inspection area, a volume is identified that contains the object. This volume

has a plurality of portions. A number of sensor systems are assigned to the plurality of portions of the volume. Each sensor system in the number of sensor systems may be assigned to a number of portions in the plurality of portions of the volume. This assignment of the number of sensors is based on whether each sensor is able to generate data with a desired level of quality about a surface of the object in a particular portion in the plurality of portions. The data is then generated about the surface of the object using the number of sensor systems assigned to the plurality of portions of the volume. A determination is made as to whether a number of inconsistencies is present on the surface of the object. This information may then be used to perform maintenance operations and/or other operations on the object.

[00122] In this manner, the different illustrative embodiments reduce the time, effort, and/or equipment needed to inspect an object, such as an aircraft. With the use of a number of sensor systems assigned to generate data with a desired quality for particular portions of a volume in an inspection area that contains the object, inspection of the object may be made easier, less time-consuming, more accurate, and/or more consistent as compared to currently available methods of inspection.

[00123] The different illustrative embodiments can take the form of an entirely hardware embodiment, an entirely software embodiment, or an embodiment containing both hardware and software elements. Some embodiments are implemented in software, which includes, but is not limited to, forms, such as, for example, firmware, resident software, and microcode.

[00124] Furthermore, the different embodiments can take the form of a computer program product accessible from a computer usable or computer readable medium providing program code for use by or in connection with a computer or any device or system that executes instructions. For the purposes of this disclosure, a computer usable or computer readable medium can generally be any tangible apparatus that can contain, store, communicate, propagate, or transport the program for use by or in connection with the instruction execution system, apparatus, or device.

[00125] The computer usable or computer readable medium can be, for example, without limitation, an electronic, magnetic, optical, electromagnetic, infrared, or semiconductor system, or a propagation medium. Non-limiting examples of a computer readable medium include a semiconductor or solid state memory, magnetic tape, a removable computer diskette, a random access memory (RAM), a read-only memory

(ROM), a rigid magnetic disk, and an optical disk. Optical disks may include compact disk – read only memory (CD-ROM), compact disk – read/write (CD-R/W), and DVD.

[00126] Further, a computer usable or computer readable medium may contain or store a computer readable or usable program code such that when the computer readable or usable program code is executed on a computer, the execution of this computer readable or usable program code causes the computer to transmit another computer readable or usable program code over a communications link. This communications link may use a medium that is, for example, without limitation, physical or wireless.

[00127] A data processing system suitable for storing and/or executing computer readable or computer usable program code will include one or more processors coupled directly or indirectly to memory elements through a communications fabric, such as a system bus. The memory elements may include local memory employed during actual execution of the program code, bulk storage, and cache memories, which provide temporary storage of at least some computer readable or computer usable program code to reduce the number of times code may be retrieved from bulk storage during execution of the code.

[00128] Input/output or I/O devices can be coupled to the system either directly or through intervening I/O controllers. These devices may include, for example, without limitation, keyboards, touch screen displays, and pointing devices. Different communications adapters may also be coupled to the system to enable the data processing system to become coupled to other data processing systems, remote printers, or storage devices through intervening private or public networks. Non-limiting examples are modems and network adapters and are just a few of the currently available types of communications adapters.

[00129] The description of the different illustrative embodiments has been presented for purposes of illustration and description and is not intended to be exhaustive or limited to the embodiments in the form disclosed. Many modifications and variations will be apparent to those of ordinary skill in the art. Further, different illustrative embodiments may provide different advantages as compared to other illustrative embodiments. The embodiment or embodiments selected are chosen and described in order to best explain the principles of the embodiments, the practical application, and to enable others of ordinary skill in the art to understand the disclosure

for various embodiments with various modifications as are suited to the particular use contemplated.

CLAIMS:

What is claimed is:

1. A method for inspecting an object, the method comprising:

responsive to a presence of the object in an inspection area, identifying a volume that contains the object, wherein the volume has a plurality of portions;

assigning a number of sensor systems to the plurality of portions of the volume, wherein each sensor system in the number of sensors systems is assigned to a number of portions in the plurality of portions of the volume based on whether the each sensor system is able to generate data with a desired level of quality about a surface of the object in a particular portion in the plurality of portions;

generating the data about the surface of the object using the number of sensor systems assigned to the plurality of portions of the volume; and

determining whether a number of inconsistencies is present on the surface of the object using the data.

2. The method of claim 1 further comprising:

responsive to a determination that the number of inconsistencies is present on the surface of the object, identifying a number of maintenance operations to perform on the object.

3. The method of claim 1, wherein the number of sensor systems generate images of the surface of the object and further comprising:

responsive to a determination that the number of inconsistencies is present on the surface of the object, sending a mobile testing system to the number of inconsistencies; and

performing non-destructive testing at a location for each of the number of inconsistencies using the mobile testing system.

4. The method of claim 1 further comprising:

sending the data about the surface of the object to a computer system; and wherein the step of determining whether the number of inconsistencies is present on the surface of the object using the data comprises:

determining, by the computer system, whether the number of inconsistencies is present on the surface of the object using the data.

5. The method of claim 1, wherein the step of determining whether the number of inconsistencies is present on the surface of the object using the data comprises:

comparing the data to baseline data to form a comparison; and

determining whether the number of inconsistencies is present on the surface of the object using the comparison.

6. The method of claim 1 further comprising:

responsive to a determination that the number of inconsistencies is present on the surface of the object, identifying a number of locations on the surface of the object for the number of inconsistencies.

7. The method of claim 5, wherein the baseline data is a number of images of the surface of the object generated by performing at least one of generating the number of images after manufacturing of the object, generating the number of images using a model of the object, and generating the number of images before a current use of the object.

8. The method of claim 1, wherein the number of sensor systems includes a mobile sensor system and further comprising:

moving the mobile sensor system in the inspection area while generating the data about the surface of the object.

9. The method of claim 1 further comprising:

selecting the plurality of portions of the volume such that the data is generated for substantially all of the surface of the object.

10. An apparatus comprising:

a number of sensor systems located in an inspection area; and a computer system in communication with the number of sensor systems and configured to identify a volume that contains an object, wherein the volume has a plurality of portions; assign the number of sensor systems to the plurality of portions of the volume, wherein each sensor system in the number of sensors systems is assigned to a number of portions in the plurality of portions of the volume based on whether the each sensor system is able to generate data with a desired level of quality about a surface of the object in a particular portion in the plurality of portions; generate the data about the surface of the object using the number of sensor systems assigned to the plurality of portions of the volume; and determine whether a number of inconsistencies is present on the surface of the object.

11. The apparatus of claim 10, wherein the computer system is further configured to identify a number of maintenance operations to perform on the object in response to a determination that the number of inconsistencies is present on the surface of the object.

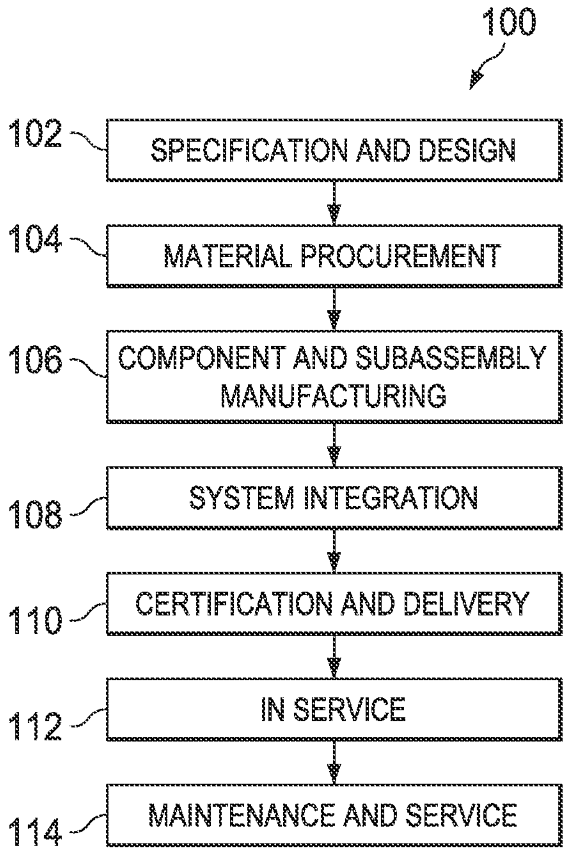
12. The apparatus of claim 10 further comprising:

a mobile testing system, wherein the computer system is further configured to send the mobile testing system to the number of inconsistencies in response to a determination that the number of inconsistencies is present on the surface of the object and wherein the mobile testing system is configured to perform non-destructive testing at a location for each of the number of inconsistencies.

13. The apparatus of claim 12, wherein the computer system is further configured to identify the location for the each of the number of inconsistencies using the data about the surface of the object.

14. The apparatus of claim 10, wherein in being configured to determine whether the number of inconsistencies is present on the surface of the object using the data, the computer system is configured to compare the data to baseline data to form a comparison; and determine whether the number of inconsistencies is present on the surface of the object using the comparison.

15. The apparatus of claim 10, wherein the number of sensor systems includes a mobile sensor system in which the mobile sensor system is configured to move in the inspection area while generating the data about the surface of the object.


100
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SPECIFICATION AND DESIGN
104
MATERIAL PROCUREMENT
106
COMPONENT AND SUBASSEMBLY MANUFACTURING
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SYSTEM INTEGRATION
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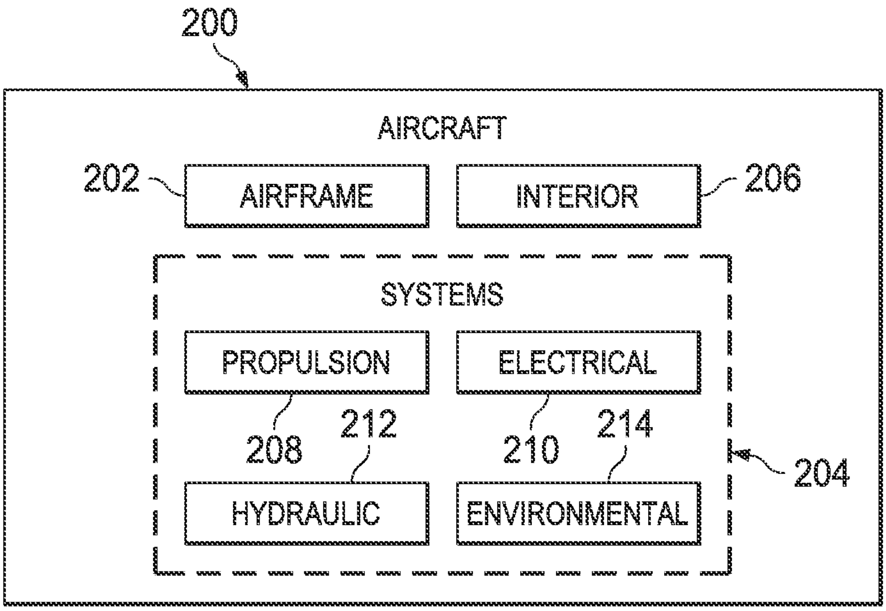
CERTIFICATION AND DELIVERY
112
IN SERVICE
114
MAINTENANCE AND SERVICE

FIG. 1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202
AIRFRAME
INTERIOR
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ELECTRICAL
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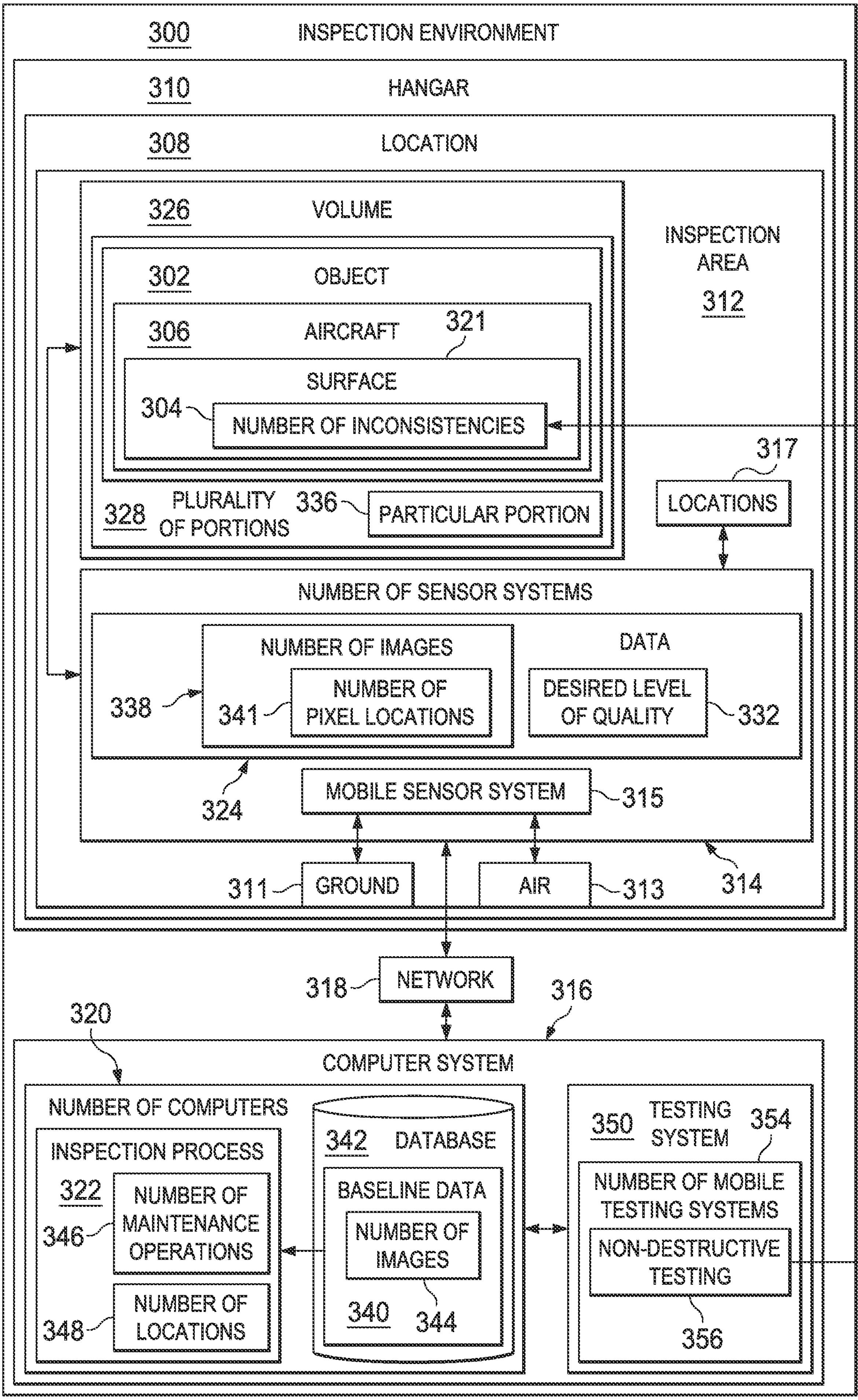
214
204
HYDRAULIC
ENVIRONMENTAL

FIG. 2

FIG. 3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302 OBJECT
306 AIRCRAFT
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SURFACE
304
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INSPECTION AREA 312
317
LOCATIONS
328 PLURALITY OF PORTIONS
336
PARTICULAR PORTION
NUMBER OF SENSOR SYSTEMS
NUMBER OF IMAGES
DATA
338
341
NUMBER OF PIXEL LOCATIONS
DESIRED LEVEL OF QUALITY
332
324
MOBILE SENSOR SYSTEM
315
311
GROUND
AIR
313
314
318
NETWORK
316
320
COMPUTER SYSTEM
NUMBER OF COMPUTERS
INSPECTION PROCESS
322
346
NUMBER OF MAINTENANCE OPERATIONS
348
NUMBER OF LOCATIONS
342 DATABASE
BASELINE DATA
NUMBER OF IMAGES
340
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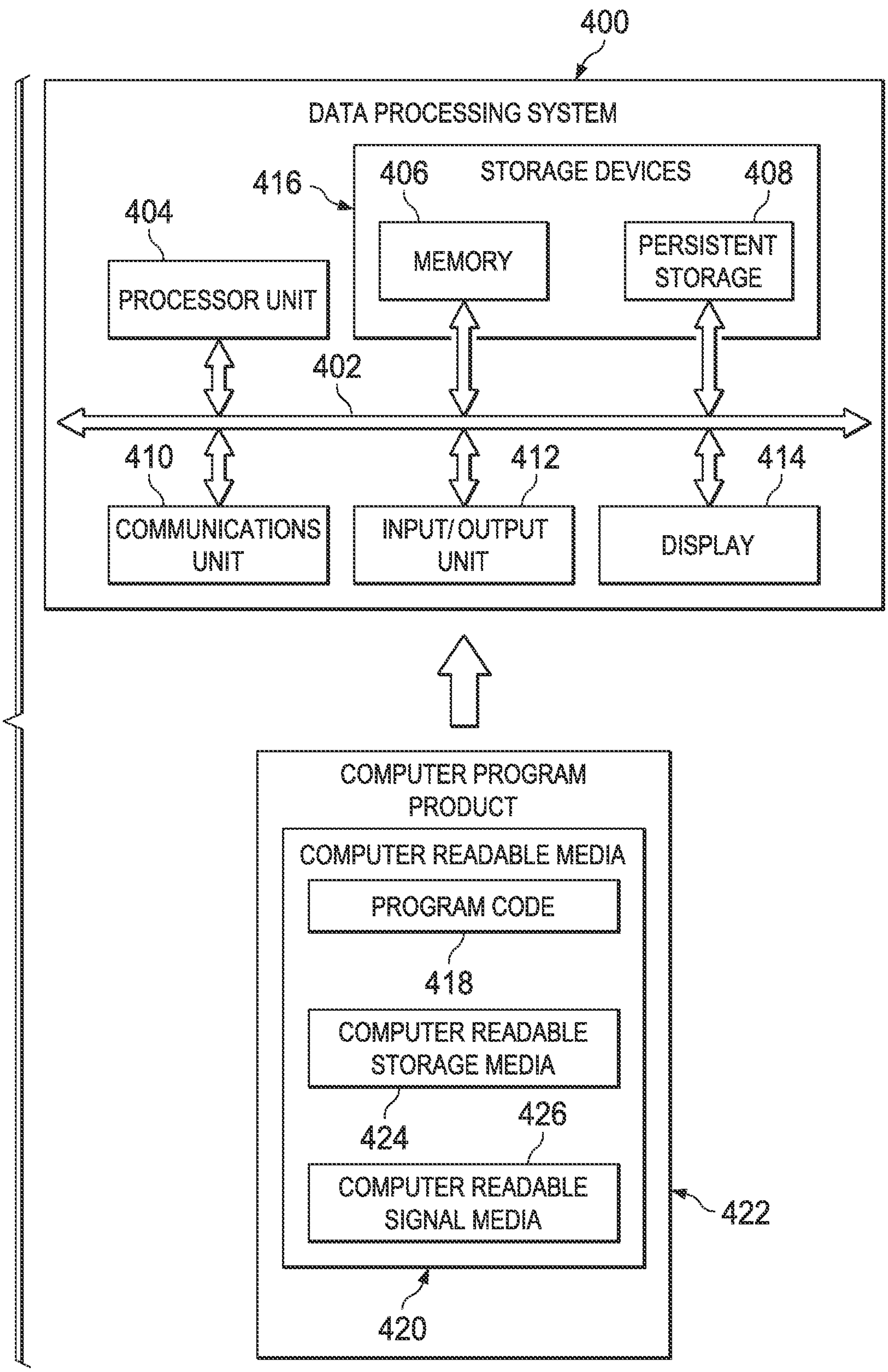
350 TESTING SYSTEM
354
NUMBER OF MOBILE TESTING SYSTEMS
NON-DESTRUCTIVE TESTING
356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416
406
STORAGE DEVICES
408
404
MEMORY
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PROCESSOR UNIT
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410
412
414
COMMUNICATIONS UNIT
INPUT/ OUTPUT UNIT
DISPLAY
COMPUTER PROGRAM PRODUCT
COMPUTER READABLE MEDIA
PROGRAM CODE
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COMPUTER READABLE STORAGE MEDIA
424
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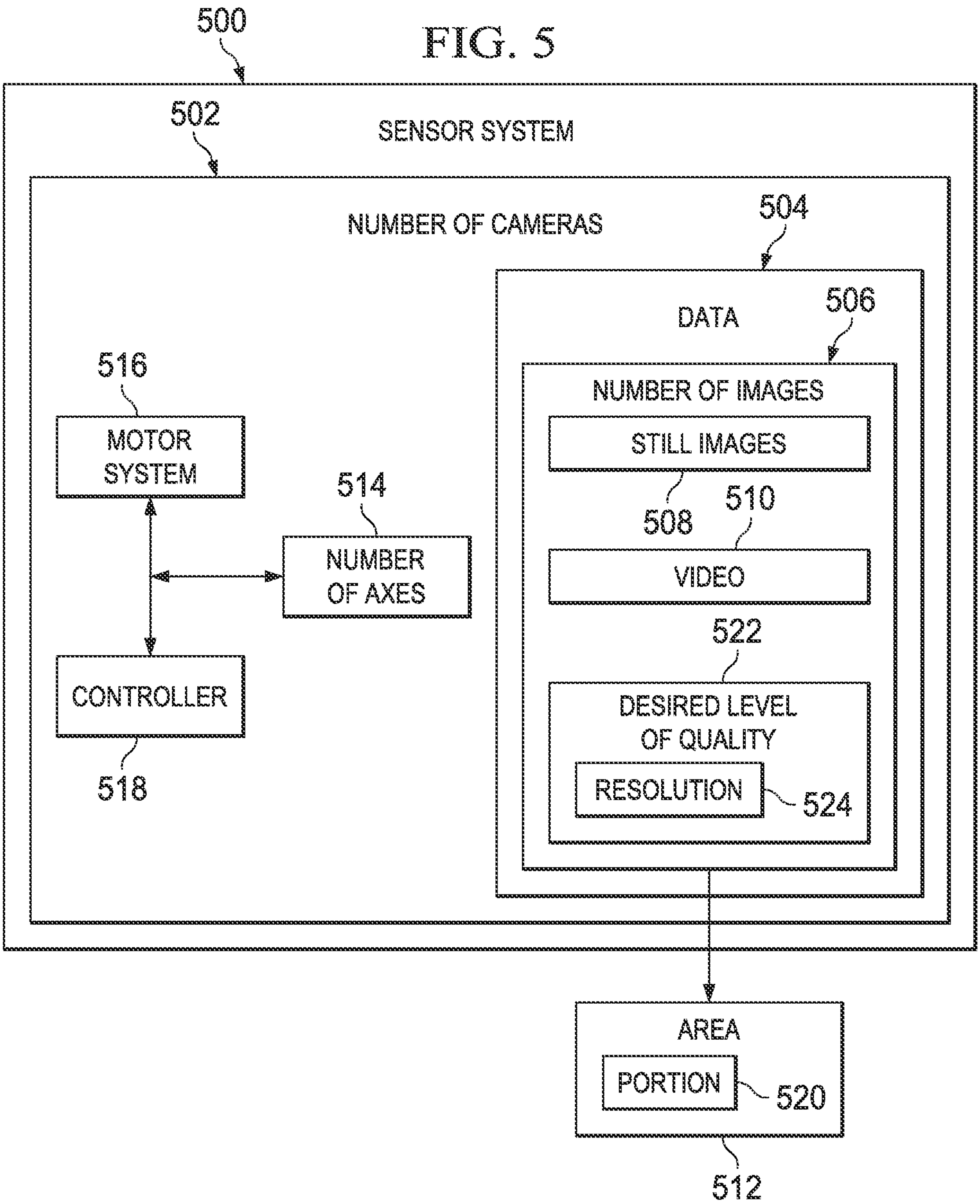
COMPUTER READABLE SIGNAL MEDIA
422
420

FIG. 4

FIG. 5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DATA
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STILL IMAGES
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510
VIDEO
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RESOLUTION
524
516
MOTOR SYSTEM
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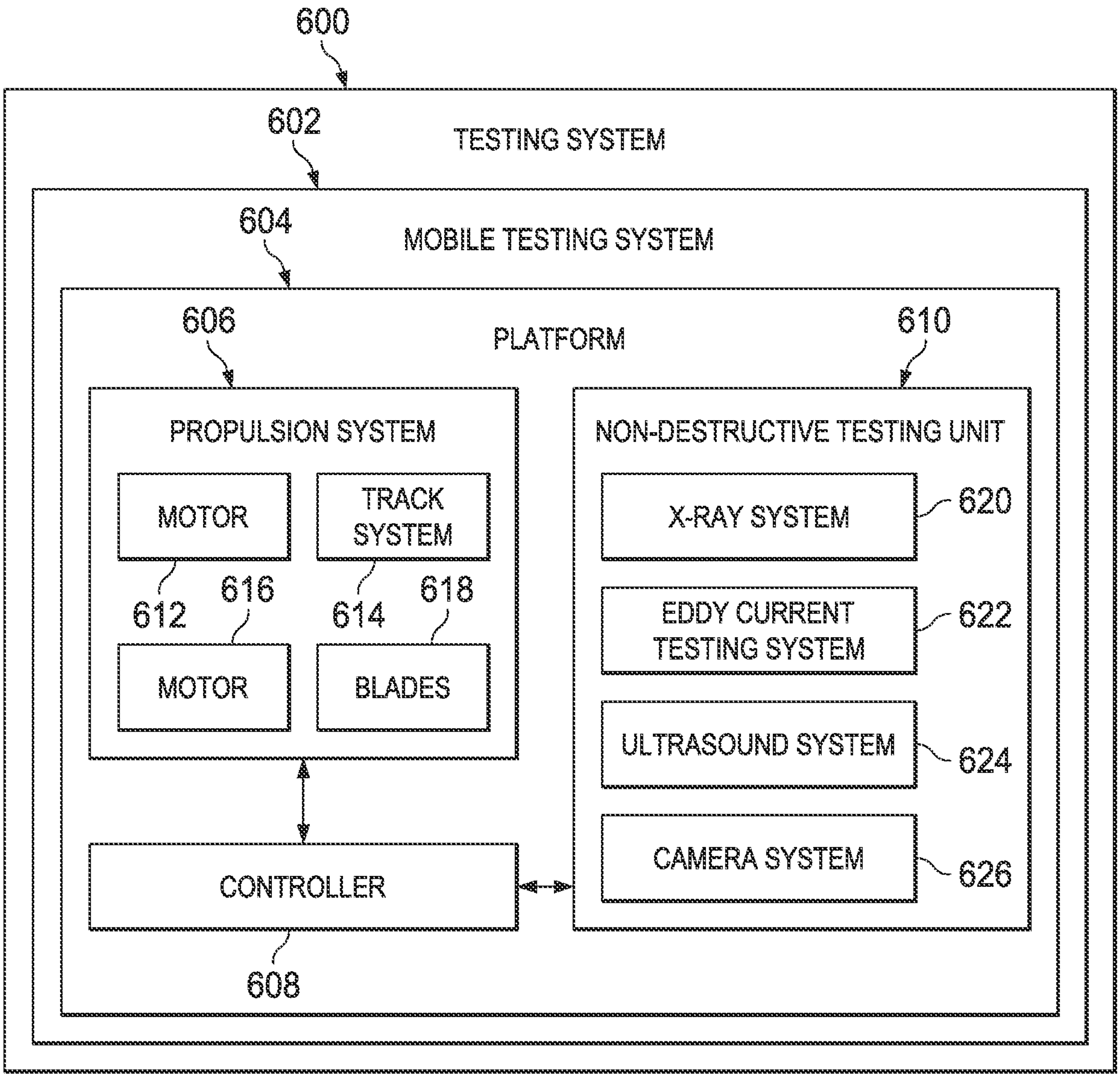
NUMBER OF AXES
CONTROLLER
518
AREA
PORTION
520
512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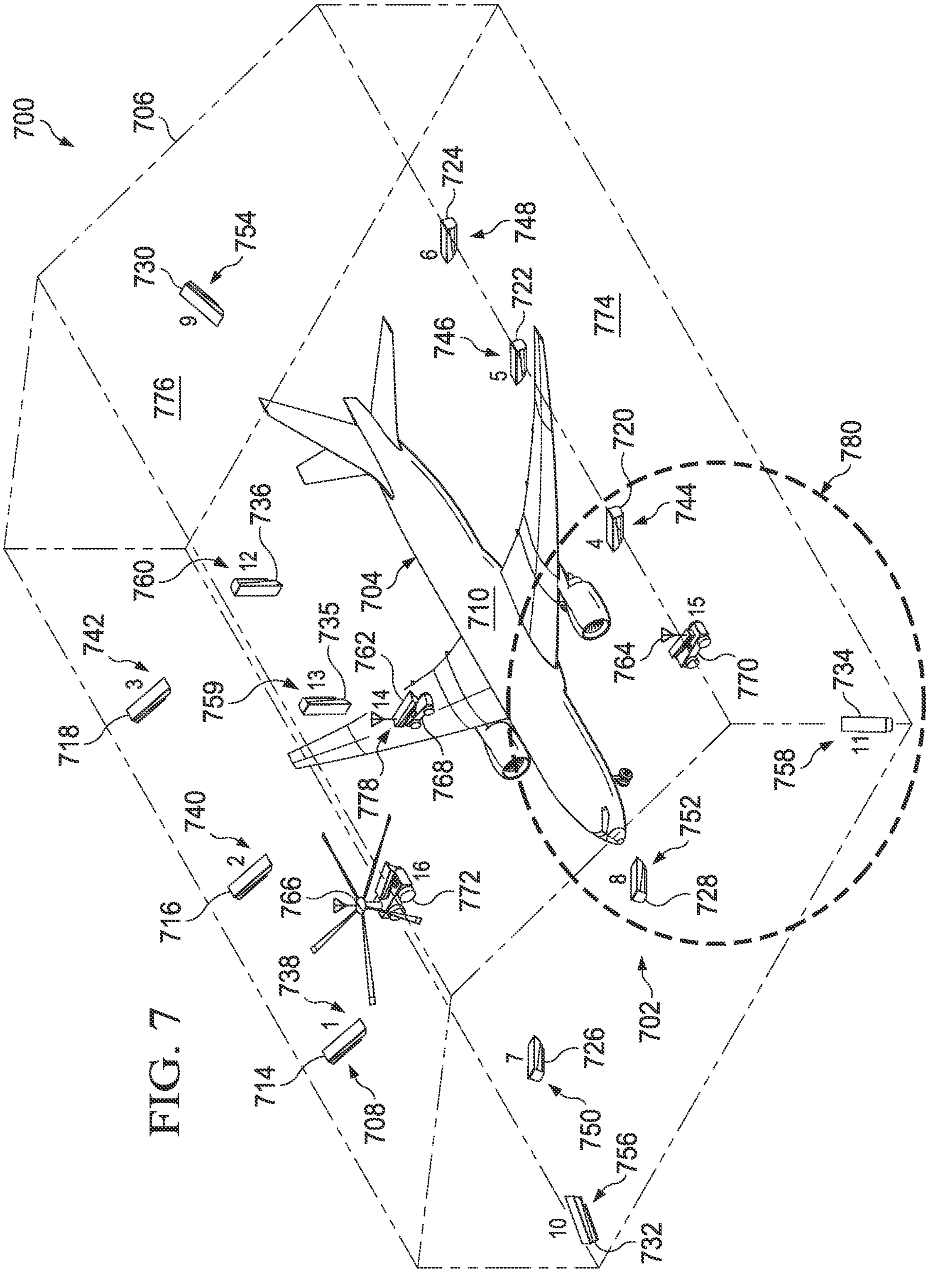
602
TESTING SYSTEM
604
MOBILE TESTING SYSTEM
606
PLATFORM
610
PROPULSION SYSTEM
MOTOR
TRACK SYSTEM
612
616
614
618
MOTOR
BLADES
NON-DESTRUCTIVE TESTING UNIT
X-RAY SYSTEM
620
EDDY CURRENT TESTING SYSTEM
622
ULTRASOUND SYSTEM
624
CAMERA SYSTEM
626
CONTROLLER
608

FIG. 6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3
718
735
13
759
762
14
704
710
764
15
770
734
11
758
740
2
716
778
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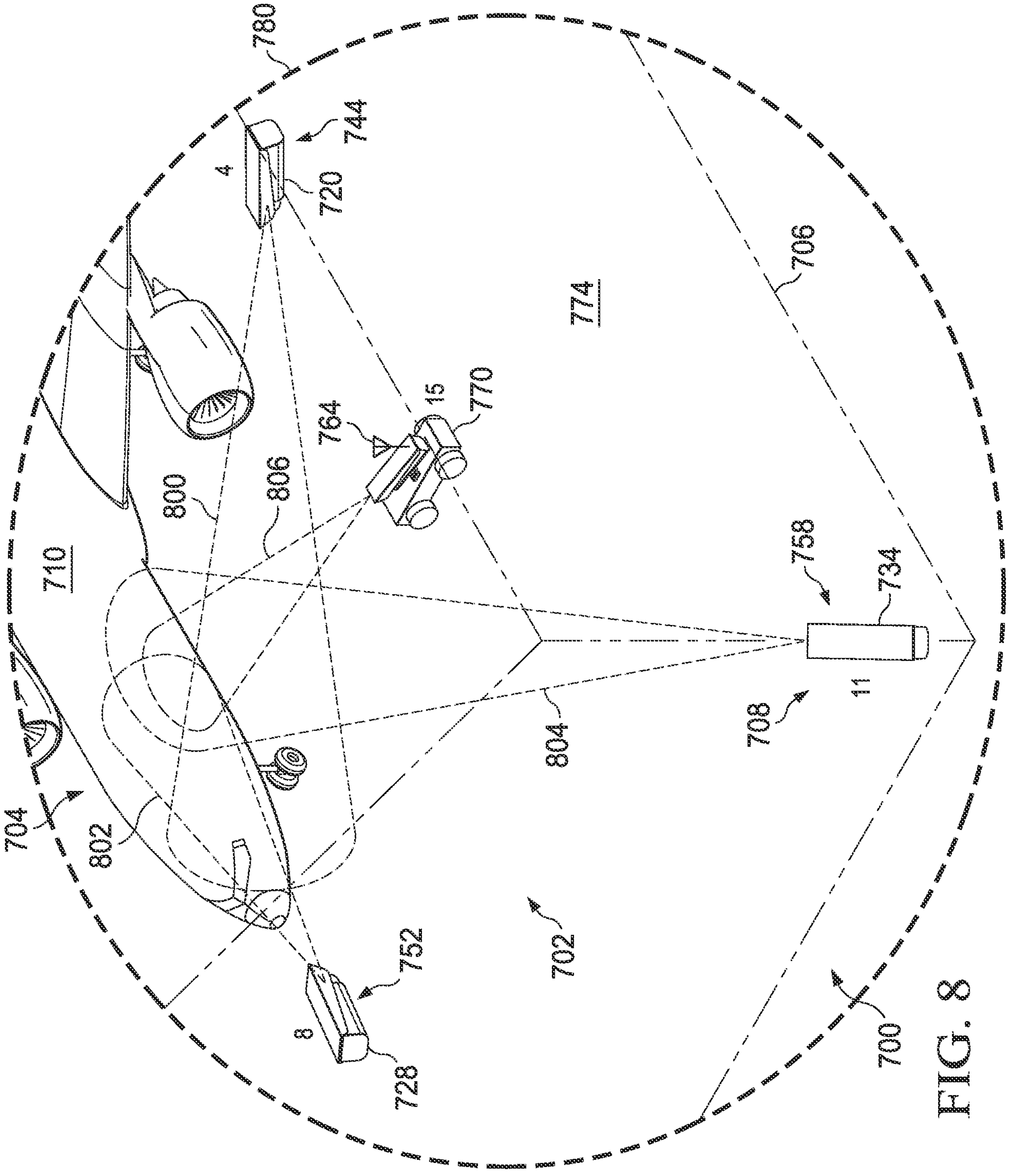
756
10
732

FIG. 7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744
4
720
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710
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806
758
734
704
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804
708
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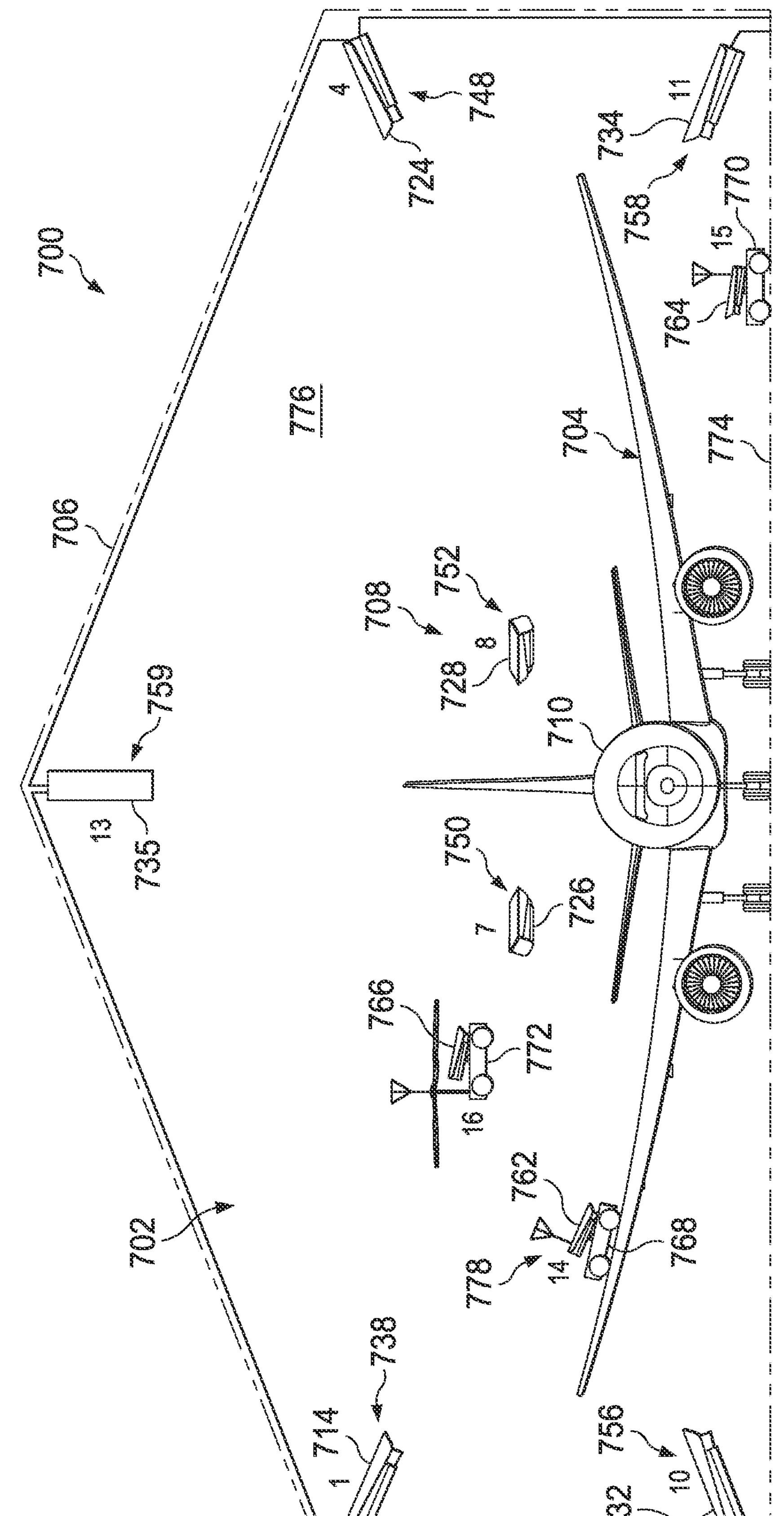
752
702
8
728
700

FIG. 8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759
13
735
710
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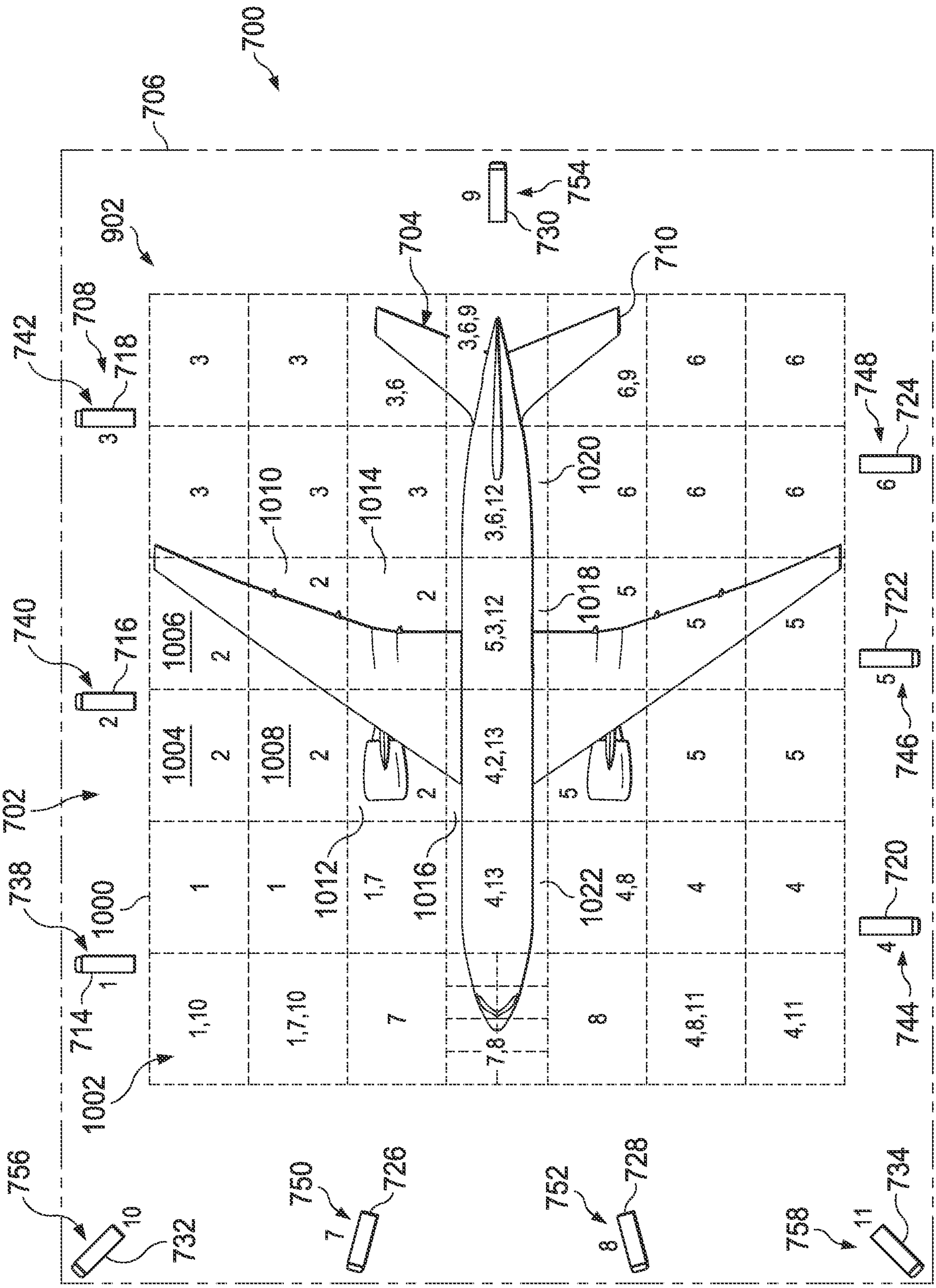
768
738
714
1
756
10
732

FIG. 9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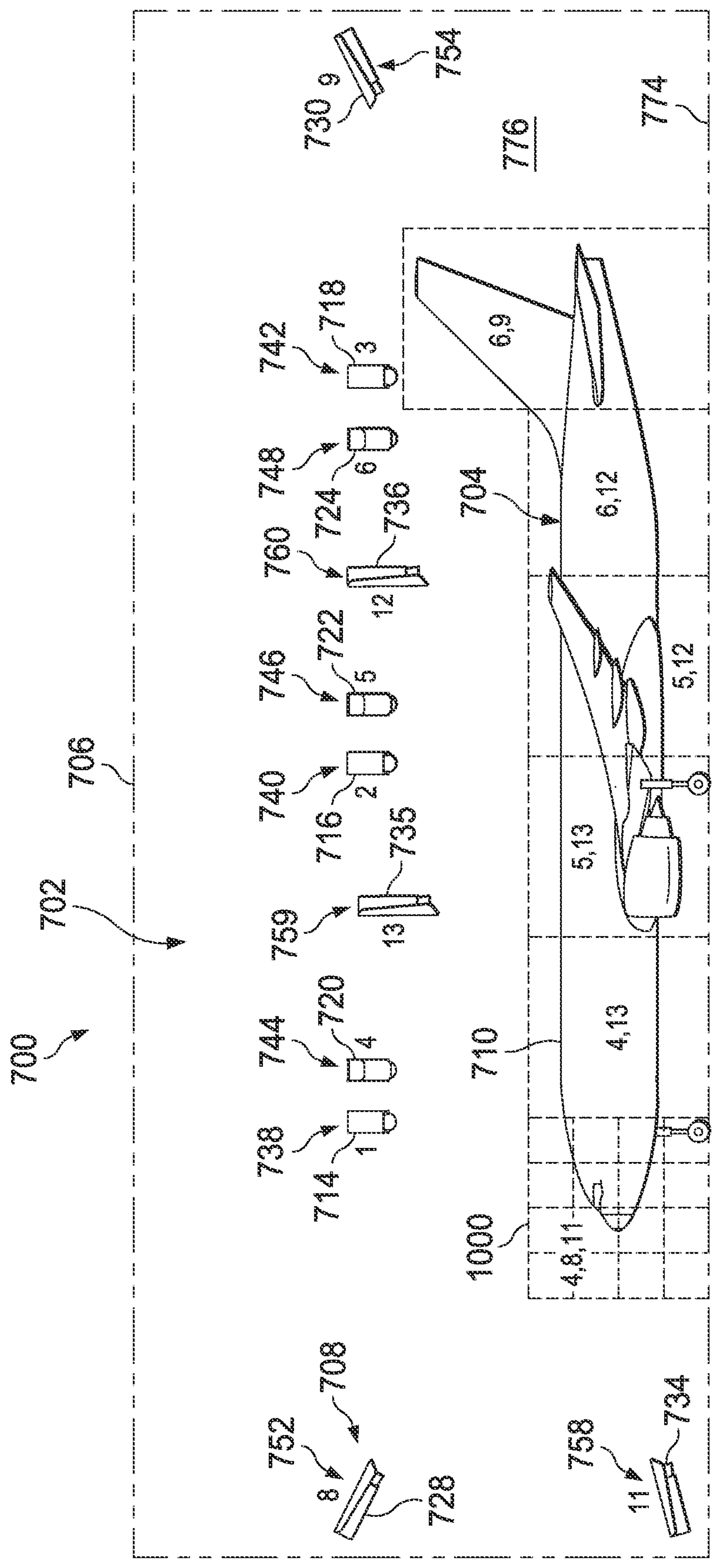
742
744
746
748
750
752
754
756
758
1000
1002
1004
1006
1008
1010
1012
1014
1016
1018
1020
1022

FIG. 10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746
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752
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758
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760
774
776
1000
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6,9
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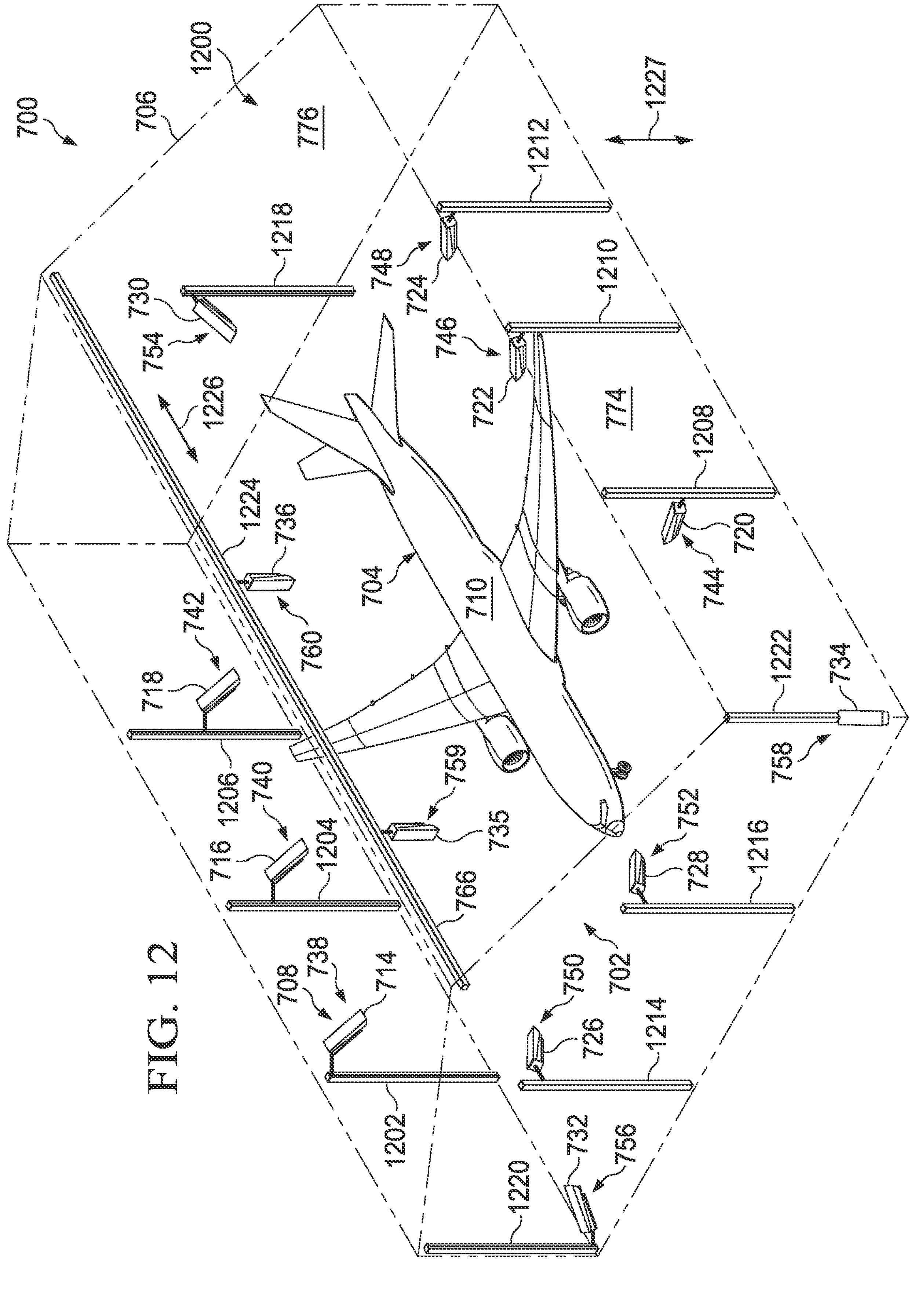
5,13
4,13
4,8,11

FIG. 11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720
744
704
710
742
718
760
1222
734
1206
740
759
758
752
716
1204
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766
1216
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738
714
750
702
726
1214
1202
732
756
1220

FIG. 12

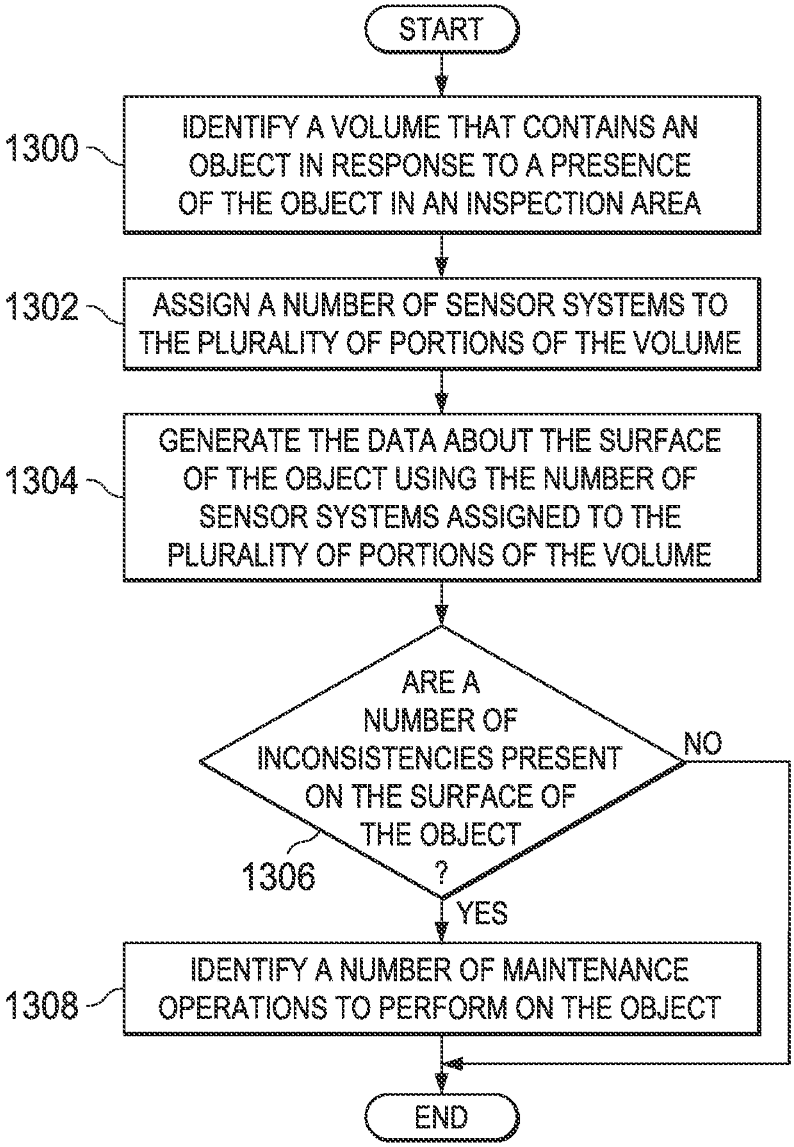
START
1300
IDENTIFY A VOLUME THAT CONTAINS AN OBJECT IN RESPONSE TO A PRESENCE OF THE OBJECT IN AN INSPECTION AREA
1302
ASSIGN A NUMBER OF SENSOR SYSTEMS TO THE PLURALITY OF PORTIONS OF THE VOLUME
1304
GENERATE THE DATA ABOUT THE SURFACE OF THE OBJECT USING THE NUMBER OF SENSOR SYSTEMS ASSIGNED TO THE PLURALITY OF PORTIONS OF THE VOLUME
ARE A NUMBER OF INCONSISTENCIES PRESENT ON THE SURFACE OF THE OBJECT ?
1306
NO
YES
1308
IDENTIFY A NUMBER OF MAINTENANCE OPERATIONS TO PERFORM ON THE OBJECT
END

FIG. 13

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2011/051830

A. CLASSIFICATION OF SUBJECT MATTER
INV. B64F5/00
ADD.

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)
B64F G01N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 918 321 A (KLENK JUERGEN [DE] ET AL) 17 April 1990 (1990-04-17) figure 2 column 3, lines 42-61 column 4, lines 54-58 column 5, lines 41-44 column 6, lines 25-28 column 6, line 54 - column 7, line 42 -----	1,4-10, 13-15
X	EP 1 619 625 A2 (SECURITY PROCESSES LTD [GB]) 25 January 2006 (2006-01-25)	1,4-7,9, 10,13,14
Y	the whole document -----	2,3,11, 12

-/--

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
31 January 2012	07/02/2012

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Cesaro, Ennio

Form PCT/ISA/210 (second sheet) (April 2005)

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	US 2004/073411 A1 (ALSTON MARK S [US] ET AL) 15 April 2004 (2004-04-15) paragraphs [0006], [0010], [0034] - [0037] figure 1	2,3,11, 12 1,10
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A	Priyan Gunatilake ET AL: "Image Understanding Algorithms for Remote Visual Inspection of Aircraft Surfaces", , 21 April 1997 (1997-04-21), XP55017987, Retrieved from the Internet: URL:http://www.cs.cmu.edu/afs/cs/user/mws/OldFiles/ftp/papers/gunatilake_spie97.pdf [retrieved on 2012-01-31] the whole document	1,8,10, 15
A	US 2007/113690 A1 (WILCOX DAVID E [US] ET AL) 24 May 2007 (2007-05-24) abstract figure 10	3,12

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2011/051830

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EP 1619625 A2	25-01-2006	NONE	
US 2004073411 A1	15-04-2004	NONE	
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US 2007113690 A1	24-05-2007	NONE	