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(54) Title: DIGITAL SURVEYS USING AERIAL VEHICLES WITH PHOTOREALISTIC BOUNDARY VIEW

(57) Abstract: A method and an apparatus for surveying a survey area. The method includes determining a flight plan for an unmanned aerial vehicle (UAV) 104 for surveying the survey area and receiving a plurality of first images 200 with partially overlapping regions in a first view, a location data, and a timestamp data for each of the first images 200. The method further includes receiving a second image 302 indicative of a google map in a second view and survey coordinates of the survey area. Further, aligning and stitching the plurality of first images 200 based on the partially overlapping regions to generate a third image 202. Further, generating and superimposing 3D point clouds of the second image 302 and the third image 202 based on the location data and timestamp data to generate a fourth image 502 based on with the survey coordinates, wherein the fourth image 502 comprises visual indications of landmarks, assets, and boundaries of the survey area.

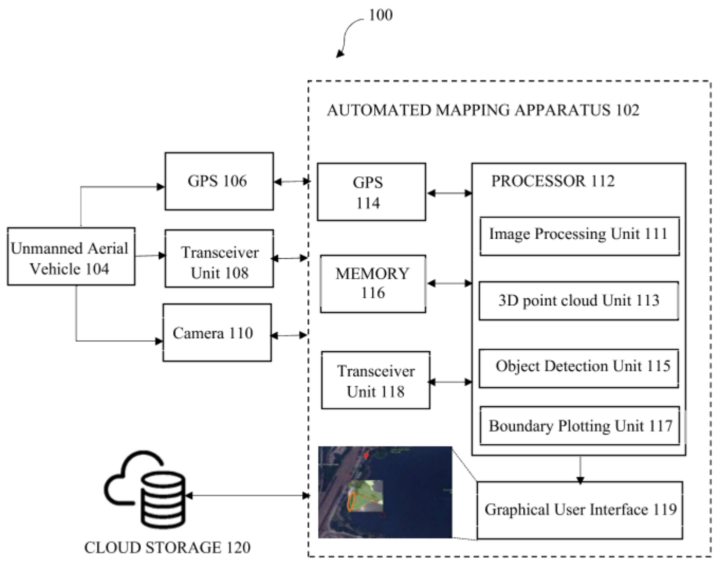

FIG. 1

FORM 2

THE PATENTS ACT 1970
(39 OF 1970)
&
The Patent Rules, 2003

Complete Specification

(See Section 10 and Rule 13)

1. TITLE OF THE INVENTION

DIGITAL SURVEYS USING AERIAL VEHICLES WITH PHOTOREALISTIC BOUNDARY VIEW

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3. PREAMBLE TO THE DESCRIPTION

COMPLETE

The following specification describes the invention and the manner in which it is to be performed

DESCRIPTION

TECHNICAL FIELD

[001] The present disclosure relates generally to digital surveys and more particularly to digital surveys with a photorealistic view of boundaries and assets of a survey area.

BACKGROUND OF INVENTION

[002] The following description includes information that may be useful in understanding the present disclosure. It is not an admission that any of the information provided herein is prior art or relevant to the presently claimed disclosure, or that any publication specifically or implicitly referenced is prior art.

[003] Conventionally, surveying an area may be performed manually by surveyors using surveying instruments such as, for example, theodolite, measuring tape, total station, 3D scanners, GPS (Global Positioning System), RTK (Real-time kinematic positioning) and the like. Most of these instruments may be fixed onto a tripod when in use. The outcome of such surveying using these instruments would be a survey map depicting topography, boundaries with landmarks as reference points, and assets of the survey area. In some examples, the survey map may include different symbols to represent critical assets such as water body, elevation, roads, structures, etc. Typically, such manual surveying may not be feasible when surveying larger survey areas as it requires manual labor in transporting the instruments along with recording the boundaries and landmarks. Further, the ruggedness of the terrain along with weather condition at the survey area may be affect the survey. Furthermore, the survey map may be confusing to read for a common man with limited knowledge on the surveys as the map may not provide a real-time holistic view of the survey area.

[004] Therefore, there exists a need for an automated mapping apparatus that provides a photorealistic view of the survey area with boundaries, landmarks and assets overcoming the limitations of present manual mapping systems.

SUMMARY OF INVENTION

[005] The following presents a simplified summary to provide a basic understanding of some aspects of the disclosed material handling system. This summary is not an extensive overview and is intended to neither identify key or critical elements nor delineate the scope of such elements. Its purpose is to present some concepts of the described features in a simplified form as a prelude to the more detailed description that is presented later.

[006] Various example embodiments described herein relate to an automated mapping apparatus for surveying a survey area. The apparatus includes a processor communicably coupled with a memory, a graphical user interface and a transceiver unit, wherein the processor is configured to: determine a flight plan for an unmanned aerial vehicle for surveying the survey area, wherein the flight plan comprises one of a flight area, a flight path, and a flight duration. The processor is to receive a plurality of first images in a first view using a camera positioned on the unmanned aerial vehicle, wherein one or more of the first images comprises partially overlapping regions. The processor is to receive a location data and a timestamp data of the unmanned aerial vehicle using a global positioning system (GPS) positioned on the unmanned aerial vehicle, wherein the location data and the timestamp data is captured for each of the first images. The processor is to receive a second image indicative of a google map of the flight area in a second view. The processor is to receive a third image indicative of boundaries of the survey area and further to align and stitch the plurality of first images based on the partially overlapping regions to generate a fourth image, wherein the fourth image comprises at least one image of the survey area. The processor is to generate and superimpose 3D point clouds of the second image, the third image and the fourth image based on the location data and timestamp data. The processor is to generate and display a fifth image based on the superimposition of the 3D point clouds, wherein the fifth image comprises visual indications and annotations of landmarks, assets, and boundaries of the survey area.

[007] Various example embodiments described herein relate to the automated mapping apparatus for surveying the survey area, wherein the first view is a Nadir view, and the second view is a satellite view of the survey area.

[008] Various example embodiments described herein relate to the automated mapping apparatus for surveying the survey area, wherein the processor is further configured to: execute a deep learning model for recognizing one or more objects on each of the first images, wherein the one or more objects are indicative of the landmarks and assets within the survey area.

[009] Various example embodiments described herein relate to the automated mapping apparatus for surveying the survey area, wherein the third image is a 2D survey map with survey coordinates of the survey area.

[0010] Various example embodiments described herein relate to the automated mapping apparatus for surveying the survey area, wherein the alignment and stitching of the plurality of first images is performed by georeferencing.

[0011] Various example embodiments described herein relate to the automated mapping apparatus for surveying the survey area, wherein the location data is indicative of the GPS coordinates of the unmanned aerial vehicle relative to the survey area.

[0012] Various example embodiments described herein relate to the automated mapping apparatus for surveying the survey area, wherein the fifth image is a photorealistic view of the survey area with at least a portion of the fourth image and the survey coordinates of the third image superimposed on the second image.

[0013] Various example embodiments described herein relate to a method for surveying a survey area. The method includes determining a flight plan for an unmanned aerial vehicle for surveying the survey area, wherein the flight plan comprises one of a flight area, a flight path, and a flight duration. The method further includes receiving a plurality of first images in a first view using a camera positioned on the unmanned aerial vehicle, wherein one or more of the first images comprises partially overlapping regions. The method further includes receiving a location data and a timestamp data for each of the first images using a global positioning system (GPS) positioned on the unmanned aerial vehicle and receiving a second image indicative of a google map of the flight area in a second view. The method further includes receiving a survey coordinate information of the survey area from one of an external database or input/output (I/O) interfaces; and aligning and stitching the plurality of first images of the survey area based on the partially overlapping regions to generate a third image. The method further includes generating and superimposing 3D point clouds of the second image and the third image based on the location data and timestamp data; and generating and displaying a fourth image based on the superimposition of the 3D point clouds and the survey coordinate information, wherein the fourth image comprises visual indications of landmarks, assets, and marked boundaries of the survey area.

[0014] Various example embodiments described herein relate to the method for surveying the survey area, wherein the fourth image is a photorealistic view of the survey area with at least a portion of the third image and the survey coordinate information superimposed on the second image.

[0015] Various example embodiments described herein relate to the method for surveying the survey area, wherein generating and displaying the fourth image further includes: automatically plotting the boundaries of the survey area in the fourth image based on the survey coordinate information; and annotating the fourth image with the type of landmarks and assets detected in the survey area.

[0016] The above summary is provided merely for purposes of summarizing some example embodiments to provide a basic understanding of some aspects of the disclosure. Accordingly, it will be appreciated that the above-described embodiments are merely examples and should not be construed to narrow the scope or spirit of the disclosure in any way. It will be appreciated that the scope of the disclosure encompasses many potential embodiments in addition to those here summarized, some of which will be further described below.

BRIEF DESCRIPTION OF DRAWINGS

[0017] The embodiments of the disclosure itself, 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 when read in conjunction with the accompanying drawings. One or more embodiments are now described, by way of example only, with reference to the accompanying drawings in which:

[0018] FIG. 1 illustrates a schematic block diagram of an exemplary surveying system comprising automated mapping apparatus, in accordance with an embodiment of the present disclosure.

[0019] FIG. 2 illustrates multiple images of a survey area captured in a first view by an unmanned aerial vehicle with location data, in accordance with an embodiment of the present disclosure.

[0020] FIG. 2A illustrates a stitched image in of the multiple images of FIG. 2 in 3D space, in accordance with an embodiment of the present disclosure.

[0021] FIG. 3 illustrates an image of the survey area in a second view with location data, in accordance with an embodiment of the present disclosure.

[0022] FIG. 4 illustrates a superimposed photorealistic image in which at least a portion of the image of FIG. 2A is superimposed with the image of FIG. 3, in accordance with an embodiment of the present disclosure.

[0023] FIG. 5 illustrate a superimposed photorealistic image comprising visual indications of the boundaries, assets, and landmarks of the survey area, in accordance with an embodiment of the present disclosure.

[0024] FIG. 6 discloses a flowchart of a method for surveying a survey area, in accordance with an embodiment of the present disclosure.

[0025] The figures depict embodiments of the disclosure for purposes of illustration only. One skilled in the art will readily recognize from the following description that alternative embodiments of the structures and methods illustrated herein may be employed without departing from the principles of the disclosure described herein.

DETAILED DESCRIPTION

[0026] Various embodiments of the present invention now will be described more fully hereinafter with reference to the accompanying drawings, in which some, but not all embodiments of the invention are shown. Indeed, the invention may be embodied in many different forms and should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will satisfy applicable legal requirements. The term “or” is used herein in both the alternative and conjunctive sense, unless otherwise indicated. The terms “illustrative,” “example,” and “exemplary” are used to be examples with no indication of quality level. Like numbers refer to like elements throughout.

[0027] The phrases “in an embodiment,” “in one embodiment,” “according to one embodiment,” and the like generally mean that the particular feature, structure, or characteristic following the phrase may be included in at least one embodiment of the present disclosure and may be included in more than one embodiment of the present disclosure (importantly, such phrases do not necessarily refer to the same embodiment).

[0028] The word “exemplary” is used herein to mean “serving as an example, instance, or illustration.” Any implementation described herein as “exemplary” is not necessarily to be construed as preferred or advantageous over other implementations.

[0029] If the specification states a component or feature “can,” “may,” “could,” “should,” “would,” “preferably,” “possibly,” “typically,” “optionally,” “for example,” “often,” or “might” (or other such language) be included or have a characteristic, that particular component or feature is not required to be included or to have the characteristic. Such component or feature may be optionally included in some embodiments, or it may be excluded.

[0030] Conventional survey techniques consumed long man hours for surveying and producing a survey map as the survey had to be done manually using the surveying instruments. In some examples, if the survey area is a dam, mining area, or a shipping port, tough or unexpected terrain may pose issues to the surveyor undertaking the survey. Additionally, long commutes from one location to another location within the survey area may be required.

[0031] In the recent past, as an effort to avoid manual surveying, unmanned aerial vehicles such as drones have been employed for surveying. The drones may fly over the survey area with inbuilt cameras to capture an aerial view of the survey area. However, drone-based surveying may have certain limitations. For example, the drone may provide only the images of the aerial view of the survey area without being aware of the boundaries and the assets within the survey area. Therefore, in order to locate the assets and the boundaries, the surveyor may have to physically label or mark some reference landmarks of visible assets on the land being surveyed, which can be recognized in the images captured by the drone. Thereby, mapping of the boundaries and assets still remain semi-automatic as certain level of human intervention is required for surveying even when the drones are being employed.

[0032] Therefore, there exists a need for an automated mapping apparatus that provides a photorealistic view of the survey area without requiring the ground control points to identify the boundaries, landmarks, and assets.

[0033] Through applied effort, ingenuity, and innovation, many of the above identified problems have been solved by developing solutions that are included in embodiments of the present disclosure, many examples of which are described in detail herein. The present disclosure relates to an automated mapping apparatus for surveying a survey area, which provides a photorealistic view identifying boundaries, landmarks, and assets of the survey area. The survey area may be a land survey area. The photorealistic view is provided without considering the ground control points by correlating location data and timestamp data of plurality of first images captured in a first view and a second image provided in a second view. Further, the photorealistic view provided visual indications and annotations of the landmarks, assets, and boundaries of the survey area by superimposition of the 3D point clouds of the first images, second image and a third image.

[0034] According to an embodiment, the automated mapping apparatus aligns and stitches the plurality of first images based on partially overlapping regions of the first images to generate a fourth image which comprises at least one image of the survey area. The at least one image is superimposed in 3D space with the second image.

[0035] According to an embodiment, the automated mapping apparatus generates and displays the photorealistic view of the survey area on a graphical user interface based on the superimposition of the 3D point clouds of the fourth image, the second image and the third image.

[0036] According to an embodiment, the automated mapping apparatus receives a survey coordinate information of the survey area for automatically plotting the boundaries of the survey area in the photorealistic view based on the survey coordinate information.

[0037] According to an embodiment, the automated mapping apparatus detects the assets and landmarks within or outside the survey area by executing a software algorithm based on a neural network based deep learning model.

[0038] In the following detailed description of exemplary embodiments of the disclosure, specific representative embodiments in which the disclosure may be practiced are described in sufficient detail to enable those skilled in the art to practice the disclosed embodiments. For example, specific details such as specific method orders, structures, elements, and connections have been presented herein. However, it is to be understood that the specific details presented need not be utilized to practice embodiments of the present disclosure. It is also to be understood that other embodiments may be utilized, and that logical, architectural, programmatic, mechanical electrical and other changes may be made without departing from the general scope of the disclosure. The following detailed description is, therefore, not to be taken in a limiting sense, and the scope of the present disclosure is defined by the appended claims and equivalents thereof.

[0039] As used herein, the term “apparatus” encompasses all apparatus, devices, and machines for processing data, including by way of example a programmable processor, a computer, or multiple processors or computers. The apparatus can include, in addition to hardware, code that creates an execution environment for the computer program in question, e.g., code that constitutes processor firmware, a protocol stack, a database management system, an operating system, a cross-platform runtime environment, or a combination of one or more of them. In addition, the apparatus can employ different computing model infrastructures, such as web services, distributed computing, and grid computing infrastructures.

[0040] As used herein, the terms such as “store,” “storage,” “data store,” data storage,” “database,” and substantially any other information storage component relevant to operation and functionality of a component are utilized to refer to “memory components,” entities embodied in a “memory,” or components comprising a memory. It is to be appreciated that memory and/or memory components described herein can be either volatile memory or nonvolatile memory or can include both volatile and nonvolatile memory.

[0041] As used herein, the term “unit” may indicate a controller, microprocessor, and/or custom logic circuit adapted to execute programming code, software, and/or functions implemented in the form of a code that is executable. As used herein, the term “controller” refers to any type of processor, such as a central processing unit (CPU) or processor, microprocessor, or embedded microcontroller. In various embodiments, a “unit” may be implemented mechanically or electronically. For example, the unit may comprise dedicated circuitry or logic that is permanently configured (e.g., as a special-purpose processor, such as a field programmable gate array (FPGA) or an application-specific integrated circuit (ASIC)) to perform certain operations. The unit may also comprise programmable logic or circuitry (e.g., as encompassed within a general-purpose processor or other programmable processor) that is temporarily configured by software to perform certain operations. It will be appreciated that the decision to implement the unit mechanically, in dedicated and permanently configured circuitry, or in temporarily configured circuitry. Accordingly, the term “unit” should be understood to encompass a tangible entity, be that an entity that is physically constructed, permanently configured (e.g., hardwired), or temporarily configured (e.g., programmed) to operate in a certain manner or to perform certain operations described herein. As used herein, “unit” may refer to a hardware module.

[0042] As used herein, the term ‘machine learning model’ or ‘deep learning model’ or ‘ML model’ or ‘DL model’ may be used interchangeably, and these terms shall not be taken in a sense to limit the scope of the present disclosure. Further, the term ‘machine learning model’ or ‘deep learning model’ may refer to a model which is trained or is subject to training by a machine learning processor. In some examples, the machine learning model may be supervised, semi-supervised, unsupervised and reinforcement type machine learning model.

[0043] FIG. 1 illustrates a schematic block diagram of an exemplary surveying system 100 comprising automated mapping apparatus 102, in accordance with an embodiment of the present disclosure.

[0044] Referring initially to FIG. 1, an example of a surveying system 100 with an unmanned aerial vehicle (UAV 104) and the automated mapping apparatus 102 is disclosed. The UAV 104 may include plurality of components to perform operations such as, but not limited to, flight control, speed control, landing/take-off control, path planning, elevation measurement, inertia measurement, surveying, imaging, and the like. However, only a few components may be disclosed for ease of explanation without limiting the scope of the type of drone being employed to perform various functions disclosed in the description. For example, the UAV 104 may be a drone or any aircraft without any human pilot, crew, or passengers on board. According to an embodiment, the UAV 104 may be equipped with a camera 110 and a Global Positioning System (GPS 106) to capture images from various viewpoints and provide navigation over multiple terrains. In some examples, the camera 110 may be capable of capturing photos and videos. In some examples, the camera 110 may a thermal imaging camera 110, near infrared (NIR) camera 110, and like combinations. According to an embodiment, the UAV 104 may be equipped with a first transceiver unit 108 to communicate with a second transceiver unit 118 of a base station. The base station may include the automated mapping apparatus 102. In some examples, the images captured by the camera 110 and the location information captured by the GPS 106 may be communicated to the automated mapping apparatus 102 via the first transceiver unit 108 and the second transceiver unit 118. According to an embodiment, the components of the UAV 104 and the components of the automated mapping apparatus 102 are communicatively coupled with one another via one or more wired or wireless communications media with wide variety of networks and protocol types. According to an embodiment, the automated mapping apparatus 102 may be in communication with an external database (i.e., cloud storage 120) or a remote server. The cloud storage 120 may receive images from the UAV 104 during flight and processed images from the automated mapping apparatus 102. In some examples, the processed images may be rectified, stitched, or superimposed images.

[0045] According to an embodiment, the automated mapping apparatus 102 may be a dedicated personal computer (PC) such as a laptop or desktop with includes a processor 112, memory 116, and a graphical user interface 119. The processor 112 communicably coupled with the memory 116, the graphical user interface 119, and the transceiver unit 118. The dedicated PC may include a path planning, a mapping, and a surveying software to survey the survey area. In some examples, the dedicated PC may include a single software to control all the surveying operations and functions. Such surveying operations and functions may be implemented by various hardware units of the processor 112. According to an embodiment, the processor 112 may include an image processing unit 111, a 3D point cloud unit 113, an object detection unit 115, and a boundary plotting unit 117. Such units 111, 113, 115, 117 may be communicably coupled to each other to execute a dedicated software controlling the operation and functions for path planning, mapping, and surveying.

[0046] In some examples, the processor 112 may be implemented as one or more microprocessor, microcomputers, microcontrollers, digital signal processors, central processing units, state machines, logic circuitries, and/or any devices that manipulate signals based on operational instructions. Among other capabilities, the processor 112 may be configured to fetch and execute computer-readable instructions stored in the memory 116. In some examples, the processor 112 may also operate to support performance of relevant operations in a cloud computing environment or as a software as a service (SaaS). For example, at least some of the operations may be performed in the cloud computing environment, these operations being accessible via a network (e.g., the Internet) and via one or more appropriate interfaces (e.g., application program interfaces (APIs).

[0047] In some examples, the memory 116 may include random access memory (RAM), read-only memory (ROM), electrically erasable programmable read-only memory (EEPROM), FLASH memory, disk storage, magnetic storage devices, or the like. Disk storage, as used herein, includes compact disc (CD), laser disc, optical disc, digital versatile disc (DVD), floppy disk, and Blu-ray Disc™, or other storage devices that store data magnetically or optically with lasers. Combinations of the above types of media are also included within the scope of the terms non-transitory computer-readable and processor readable media. Additionally, any combination of instructions stored on the one or more non-transitory processor readable or computer-readable media may be referred to herein as a computer program product.

[0048] In some examples, the graphical user interface 119 may provide a visual interface on a display, such as a light emitting diode (LED) display, liquid crystal display (LCD), a cathode ray tube (CRT), or any other display suitable for conveying information related to the blood pressure measurement. The display may have a touch-sensitive interface with graphics including icons, text, web sites, animations, videos, electronic images, and any other forms of graphics providing interactive information to the human users. In some examples, the visual interface may include one or more graphical user interface 119s which may be activated and selectively displayed by means of a menu selection, a virtual button, a physical button or at least one predetermined movement on the touch-sensitive interface.

[0049] According to an embodiment, during the surveying operation, the automated mapping apparatus 102 may determine a flight plan for the UAV 104 for surveying the survey area. For example, the survey area may be a shipping port, a land, building construction, dam, etc. For the purpose of ease of explanation, the survey area is considered as a land with a defined boundary, specifically a trace of such boundary as a trace of GPS points are available and the UAV 104 is employed for surveying the land. According to an embodiment, the flight plan for surveying the land comprises one of a flight area, a flight path, and a flight duration. For example, the flight area may include the land to be surveyed and additional area adjacent to the land. In some examples, the flight area may be larger than the survey area such that the UAV 104 may capture the images of the survey area from various viewpoints. For example, the flight path may be a path through which the UAV 104 is instructed to travel such that to avoid potential obstacles. In some examples, the flight path may be dynamically changed by a user using user interfaces of the automated mapping apparatus 102. In some examples, multiple flight paths for the UAV 104 may be provided such that the images are captured from various viewpoints. In some examples, the speed and elevation of the UAV 104 may be predefined or dynamically defined based on the flight path or the images captured by the UAV 104. For example, the flight duration may be based on a square unit, terrain, and images of the survey area. In some examples, the flight duration may be predefined or dynamically defined by the user. For example, when the UAV 104 is surveying the shipping port, the flight duration may be longer since the survey area could be several square miles, whereas the flight duration for surveying a piece of land may be shorter since the survey area could be several square feet. In this regard, the automated mapping apparatus 102 may define the flight plan considering a type of survey area to be surveyed by the UAV 104.

[0050] According to an embodiment, during the surveying operation, the image processing unit 111 of the automated mapping apparatus 102 may receive a plurality of first images 200 in a first view using the camera 110 positioned on the unmanned aerial vehicle. For example, the first view may a Nadir View from the camera 110. For example, FIG. 2 illustrates multiple first images 200 of the land survey area captured in the first view by the unmanned aerial vehicle with location data and timestamp data, in accordance with an embodiment of the present disclosure. The one or more of the first images 200 comprises partially overlapping regions. For example, the UAV 104 may capture images at shorter time intervals without missing on any regions within the land under survey. In this regard, each of the first images 200 may include at least one partially overlapping region of the survey land. According to an embodiment, each of the first images 200 may be captured with the location data and the timestamp data. For example, three-dimensional position coordinates with a first latitude and longitude information may be captured with the first images 200. Such three-dimensional position coordinates may be used along with the GPS 106 data to match and align the first images 200 with a second image 302 (i.e., a google map) without requiring any reference points (i.e., the ground control points). The google map shows the flight area and the survey area in a second view. For example, the second view is a satellite view. The google map may include locations adjacent to the flight area and the survey area. The google map may also include a second latitude and longitude information of the survey area. For example, FIG. 3 illustrates an image of the survey area in a second view with the second latitude and longitude information, in accordance with an embodiment of the present disclosure.

[0051] According to an embodiment, during the surveying operation, the image processing unit 111 of the automated mapping apparatus 102 may align and stitch the plurality of first images 200 based on the partially overlapping regions to generate a third image. In some examples, the alignment and stitching of the plurality of first images 200 may be performed by georeferencing such that the coordinates recorded with the first images 200 may be related to geographic coordinate system. For example, FIG. 2A illustrates the aligned and stitched image of the multiple first images 200 of FIG. 2 in 3D space, in accordance with an embodiment of the present disclosure. According to an embodiment, the 3D point cloud unit 113 of the automated mapping apparatus 102 may generate 3D point clouds of the third image and the second image 302 followed by superimposing 3D point clouds based on the location data and timestamp data. In some examples, the 3D point clouds may be subjected to Point Cloud Segmentation and Detection, Clustering, Filtering and Transformation in a supervised or in an unsupervised manner to superimpose the images (i.e., the third image and the second image 302). In some examples, the first latitude and longitude information may be matched with the second latitude and longitude information to generate the superimposed 3D image. For example, FIG. 4 illustrates a superimposed photorealistic image in which at least a portion of the image of FIG. 2A is superimposed with the image of FIG. 3, in accordance with an embodiment of the present disclosure. The superimposed 3D image may be a fourth image displayed on the graphical user interface 119. In this regard, the fourth image is a photorealistic view of the survey area with at least a portion of the third image and the survey coordinate information superimposed on the second image 302. For example, FIG. 5 illustrates a superimposed photorealistic image comprising visual indications of the boundaries, assets, and landmarks of the survey area, in accordance with an embodiment of the present disclosure. As shown in FIG. 5, the landmark may be a “shipping port” located near the survey area and the asset may be a “tree” located in the survey area.

[0052] According to an embodiment, prior to the surveying operation, the automated mapping apparatus 102 may receive a survey coordinate information of the survey area from one of an external database 120 or input/output (I/O) interfaces. For example, the survey coordinate information of a survey land may be provided as an input from past records of a public survey database. For example, an owner of the survey land may provide the survey coordinate information to the user of the automated mapping apparatus 102. Such information may be fed into the surveying system 100 using the input/output (I/O) interfaces or fetched from the external database 120. According to an embodiment, fourth image 502 may be displayed on the graphical user interface 119 with visual indications of landmarks, assets, and boundaries of the survey area. The fourth image 502 may be generated based on the survey coordinate information and the superimposition of the 3D point clouds. According to an embodiment, the boundary plotting unit 117 of the automated mapping apparatus 102 may automatically plot the boundaries of the survey area in the fourth image 502 based on the survey coordinate information and annotate the fourth image 502 with the type of landmarks and assets detected in the survey area.

[0053] According to an embodiment, during the surveying operation, the automated mapping apparatus 102 may receive a survey coordinate information of the survey area as an additional image (not shown) indicative of boundaries of the survey area. The additional image may be transformed into 3D point clouds and superimposed with the google map (i.e., the second image 302) and the stitched image (i.e., the images 202 from the UAV 104). In this regard, the first images 200 may be from the UAV 104, the second image 302 may be the google map, the third image (not shown) may be a 2D survey map with the survey coordinate information, the fourth image 202 may be the stitched images of the first images 200. Accordingly, the automated mapping apparatus 102 may generate and superimpose 3D point clouds of the second image 302, the third image (not shown) and the fourth image 402 based on the location data and the timestamp data. In this regard, a fifth image 502 may be generated with visual indications and annotations of landmarks, assets, and boundaries of the survey area, which may be a result of the superimposition of the 3D point clouds. The fifth image 502 may be a photorealistic view of the survey area with at least a portion of the fourth image 202 and the survey coordinates of the third image (not shown) superimposed on the second image 302. For example, FIG. 5 illustrates a superimposed photorealistic image 502 comprising visual indications of the boundaries, assets, and landmarks of the survey area, in accordance with an embodiment of the present disclosure.

[0054] According to an embodiment, during the surveying operation, the object detection unit 115 of the automated mapping apparatus 102 may execute a deep learning model for recognizing one or more objects on each of the first images 200. The one or more objects may be indicative of the landmarks and assets within the survey area. In some examples, the deep learning model which employs Region-Based Convolutional Neural Networks (R-CNN) for image classification, object localization, recognition and segmentation may be employed for detecting the landmarks and assets.

[0055] FIG. 6 discloses a flowchart of a method for surveying a survey area, in accordance with an embodiment of the present disclosure. As illustrated in FIG. 6, the method 600 includes one or more blocks illustrating a method for surveying a survey area. The method 600 may be described in the general context of computer executable instructions. Generally, computer executable instructions may include routines, programs, objects, components, data structures, procedures, modules, and functions, which perform specific functions or implement specific abstract data types.

[0056] The order in which the method 600 is described is not intended to be construed as a limitation, and any number of the described method blocks may be combined in any order to implement the method. Additionally, individual blocks may be deleted from the methods without departing from the spirit and scope of the subject matter described.

[0057] According to an embodiment, the automated mapping apparatus may be a dedicated personal computer (PC) such as a laptop or desktop with includes a processor, memory, and a graphical user interface. The processor communicably coupled with the memory, the graphical user interface, and the transceiver unit. The dedicated PC may include a dedicated software to control all the surveying operations and functions, which may be executed by various hardware units of the processor.

[0058] At step 602, the processor may determine a flight plan for an unmanned aerial vehicle for surveying the survey area. The flight plan comprises one of a flight area, a flight path, and a flight duration. For example, the survey area may be a shipping port, a land, building construction, dam, etc. In some examples, multiple flight paths for the UAV may be provided such that the images are captured from various viewpoints

[0059] At step 604, the processor may receive a plurality of first images in a first view using a camera positioned on the unmanned aerial vehicle. The one or more of the first images comprises partially overlapping regions. Such overlapping regions may be required to align the first images in sequence and reconstruct a complete view of the survey area.

[0060] At step 606, the processor may receive a location data and a timestamp data for each of the first images using a global positioning system (GPS) positioned on the unmanned aerial vehicle. At step 608, the processor may receive a second image indicative of a google map of the flight area in a second view. For example, three-dimensional position coordinates with a first latitude and longitude information may be captured with the first images. Similarly, the three-dimensional position coordinates with a second latitude and longitude information may be captured with the second image. Such three-dimensional position coordinates may be used along with the GPS data without requiring any reference points (i.e., the ground control points).

[0061] At step 610, the processor may receive a survey coordinate information of the survey area from one of an external database or input/output (I/O) interfaces. For example, the survey coordinate information of a survey land may be provided as an input from past records of a public survey database. For example, an owner of the survey land may provide the survey coordinate information to the user of the automated mapping apparatus.

[0062] At step 612, the processor may align and stitch the plurality of first images of the survey area based on the partially overlapping regions to generate a third image. In some examples, the alignment and stitching of the plurality of first images may be performed by georeferencing such that the coordinates recorded with the first images may be related to geographic coordinate system.

[0063] At step 614, the processor may generate and superimpose 3D point clouds of the second image and the third image based on the location data and timestamp data. In some examples, the 3D point clouds may be subjected to Point Cloud Segmentation and Detection, Clustering, Filtering and Transformation in a supervised or in an unsupervised manner to superimpose the images (i.e., the third image and the second image).

[0064] At step 616, the processor may generate and display a fourth image based on the superimposition of the 3D point clouds and the survey coordinate information, wherein the fourth image comprises of the photo-realistic stitched aligned image of the surveyed land with visual indications of landmarks, assets, and boundaries of the survey area. Furthermore, the processor may ensure that the photo-realistic view of the surveyed land is limited or confined to the exact boundaries of the survey and does not extend beyond the boundary (i.e., considering the images that the actual drone camera captures may overlap the images of the neighboring land areas with the images of the actual land to be surveyed). Accordingly, the processor may automatically plot the boundaries of the survey area in the fourth image based on the survey coordinate information and annotate the fourth image with the type of landmarks and assets detected in the survey area. According to an embodiment, the processor may execute a deep learning model for recognizing one or more landmarks and assets on each of the 3D point clouds. The fourth image may be a photorealistic view of the survey area with at least a portion of the third image and the survey coordinate information superimposed on the second image.

[0065] It should be noted that the embodiments of the present invention are described by taking the field of unmanned aerial vehicles as an example, but the solution of the present invention is not limited to the field of unmanned aerial vehicles.

[0066] A person skilled in the art can understand that all or part of the steps of implementing the above method embodiments may be completed by using hardware related to the program instructions. The foregoing program may be stored in a computer readable storage medium, and the program is executed when executed. The foregoing storage medium includes read-only memory (ROM), random access memory (RAM), magnetic disk or optical disk, and the like, which can store program codes. Medium.

[0067] As will be appreciated by one skilled in the art, aspects of the present invention may be embodied as a system, method, or computer program product. Accordingly, aspects of the present invention may take the form of an entirely hardware embodiment, an entirely software embodiment (including firmware, resident software, micro-code, etc.) or an embodiment combining software and hardware aspects that may all generally be referred to herein as a “circuit,” “module” or “system.” Furthermore, aspects of the present invention may take the form of a computer program product embodied in one or more computer readable medium(s) having computer readable program code embodied thereon.

[0068] It is to be understood that the software for the computing systems of the present invention embodiments may be implemented in any desired computer language and could be developed by one of ordinary skill in the computer arts based on the functional descriptions contained in the specification and flow charts illustrated in the drawings. By way of example only, the software may be implemented in the C#, C++, Python, Java, or PHP programming languages. Further, any references herein of software performing various functions generally refer to computer systems or processors performing those functions under software control.

[0069] Some embodiments may be described using the expression “coupled” and “connected” along with their derivatives. It should be understood that these terms are not intended as synonyms for each other. For example, some embodiments may be described using the term “connected” to indicate that two or more elements are in direct physical or electrical contact with each other. In another example, some embodiments may be described using the term “coupled” to indicate that two or more elements are in direct physical or electrical contact. The term “coupled,” however, may also mean that two or more elements are not in direct contact with each other, yet still cooperate or interact with each other. The embodiments are not limited in this context.

[0070] The various embodiments described above are provided by way of illustration only and should not be construed to limit the claims attached hereto. Those skilled in the art will readily recognize various modifications and changes that may be made without following the example embodiments and applications illustrated and described herein, and without departing from the true spirit and scope of the following claims.

WE CLAIM:

1. An automated mapping apparatus 102 for surveying a survey area, the apparatus 102 comprises:

a processor 112 communicably coupled with a memory 116, a graphical user interface 117 and a transceiver unit 118, wherein the processor 112 is configured to:

determine a flight plan for an unmanned aerial vehicle 104 for surveying the survey area, wherein the flight plan comprises one of a flight area, a flight path, and a flight duration;

receive a plurality of first images 200 in a first view using a camera 110 positioned on the unmanned aerial vehicle 104, wherein one or more of the first images 200 comprises partially overlapping regions;

receive a location data and a timestamp data of the unmanned aerial vehicle 104 using a global positioning system (GPS) 114 positioned on the unmanned aerial vehicle 104, wherein the location data and the timestamp data is captured for each of the first images 200;

receive a second image 302 indicative of a google map of the flight area in a second view;

receive a third image indicative of boundaries of the survey area;

align and stitch the plurality of first images 200 based on the partially overlapping regions to generate a fourth image 202, wherein the fourth image 202 comprises at least one image of the survey area;

generate and superimpose 3D point clouds of the second image 302, the third image and the fourth image 202 based on the location data and timestamp data; and

generate and display a fifth image 502 based on the superimposition of the 3D point clouds, wherein the fifth image 502 comprises visual indications and annotations of landmarks, assets, and boundaries of the survey area.

2. The automated mapping apparatus of claim 1, wherein the first view is a Nadir view and the second view is a satellite view of the survey area.

3. The automated mapping apparatus of claim 1, wherein the processor 112 is further configured to:

Execute a deep learning model for recognizing one or more objects on each of the first images 200, wherein the one or more objects are indicative of the landmarks and assets within the survey area.

4. The automated mapping apparatus of claim 1, wherein the third image is a 2D survey map with survey coordinates of the survey area.

5. The automated mapping apparatus of claim 1, wherein the alignment and stitching of the plurality of first images 200 is performed by georeferencing.

6. The automated mapping apparatus of claim 1, wherein the location data is indicative of the GPS coordinates of the unmanned aerial vehicle 104 relative to the survey area.

7. The automated mapping apparatus of claim 1, wherein the fifth image 502 is a photorealistic view of the survey area with at least a portion of the fourth image 202 and the survey coordinates of the third image superimposed on the second image 302, and wherein the assets are indicated with their localized GPS coordinates on the photorealistic view.

8. A method for surveying a survey area, comprising:

determining a flight plan for an unmanned aerial vehicle 104 for surveying the survey area, wherein the flight plan comprises one of a flight area, a flight path, and a flight duration;

receiving a plurality of first images 200 in a first view using a camera 110 positioned on the unmanned aerial vehicle 104, wherein one or more of the first images 200 comprises partially overlapping regions;

receiving a location data and a timestamp data for each of the first images 200 using a global positioning system (GPS) 106 positioned on the unmanned aerial vehicle 104,

receiving a second image 302 indicative of a google map of the flight area in a second view;

receiving a survey coordinate information of the survey area from one of an external database 120 or input/output (I/O) interfaces;

aligning and stitching the plurality of first images 200 of the survey area based on the partially overlapping regions to generate a third image 202;

generating and superimposing 3D point clouds of the second image 302 and the third image 202 based on the location data and timestamp data; and generating and displaying a fourth image 502 based on the superimposition of the 3D point clouds and the survey coordinate information, wherein the fourth image 502 comprises visual indications of landmarks, assets, and marked boundaries of the survey area.

9. The method of claim 8, wherein the fourth image is a photorealistic view of the survey area with at least a portion of the third image 202 and the survey coordinate information superimposed on the second image 302.

10. The method of claim 9, wherein generating and displaying the fourth image 502 further comprises:

automatically plotting the boundaries of the survey area in the fourth image 502 based on the survey coordinate information; and

annotating the fourth image 502 with the type of landmarks and assets detected in the survey area by autodetecting the type of landmarks and assets with their GPS coordinates.

Dated this 22nd day of June 2023

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ABSTRACT

DIGITAL SURVEYS USING AERIAL VEHICLES WITH PHOTOREALISTIC BOUNDARY VIEW

A method and an apparatus for surveying a survey area. The method includes determining a flight plan for an unmanned aerial vehicle (UAV) 104 for surveying the survey area and receiving a plurality of first images 200 with partially overlapping regions in a first view, a location data, and a timestamp data for each of the first images 200. The method further includes receiving a second image 302 indicative of a google map in a second view and survey coordinates of the survey area. Further, aligning and stitching the plurality of first images 200 based on the partially overlapping regions to generate a third image 202. Further, generating and superimposing 3D point clouds of the second image 302 and the third image 202 based on the location data and timestamp data to generate a fourth image 502 based on with the survey coordinates, wherein the fourth image 502 comprises visual indications of landmarks, assets, and boundaries of the survey area.

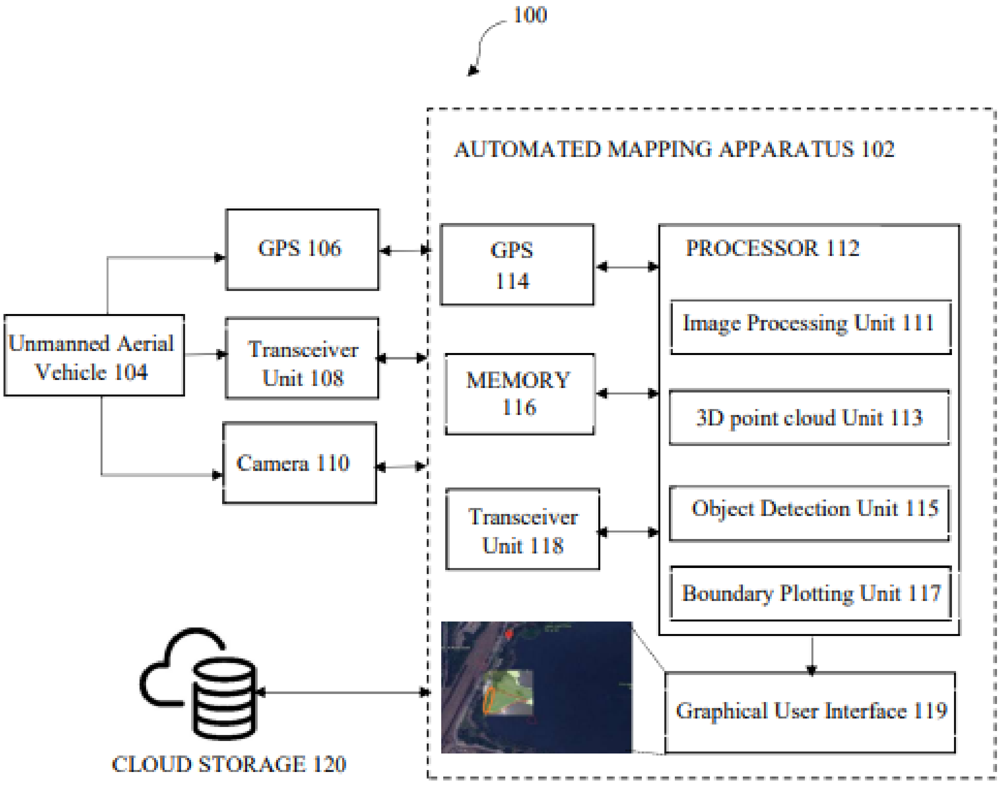

FIG. 1

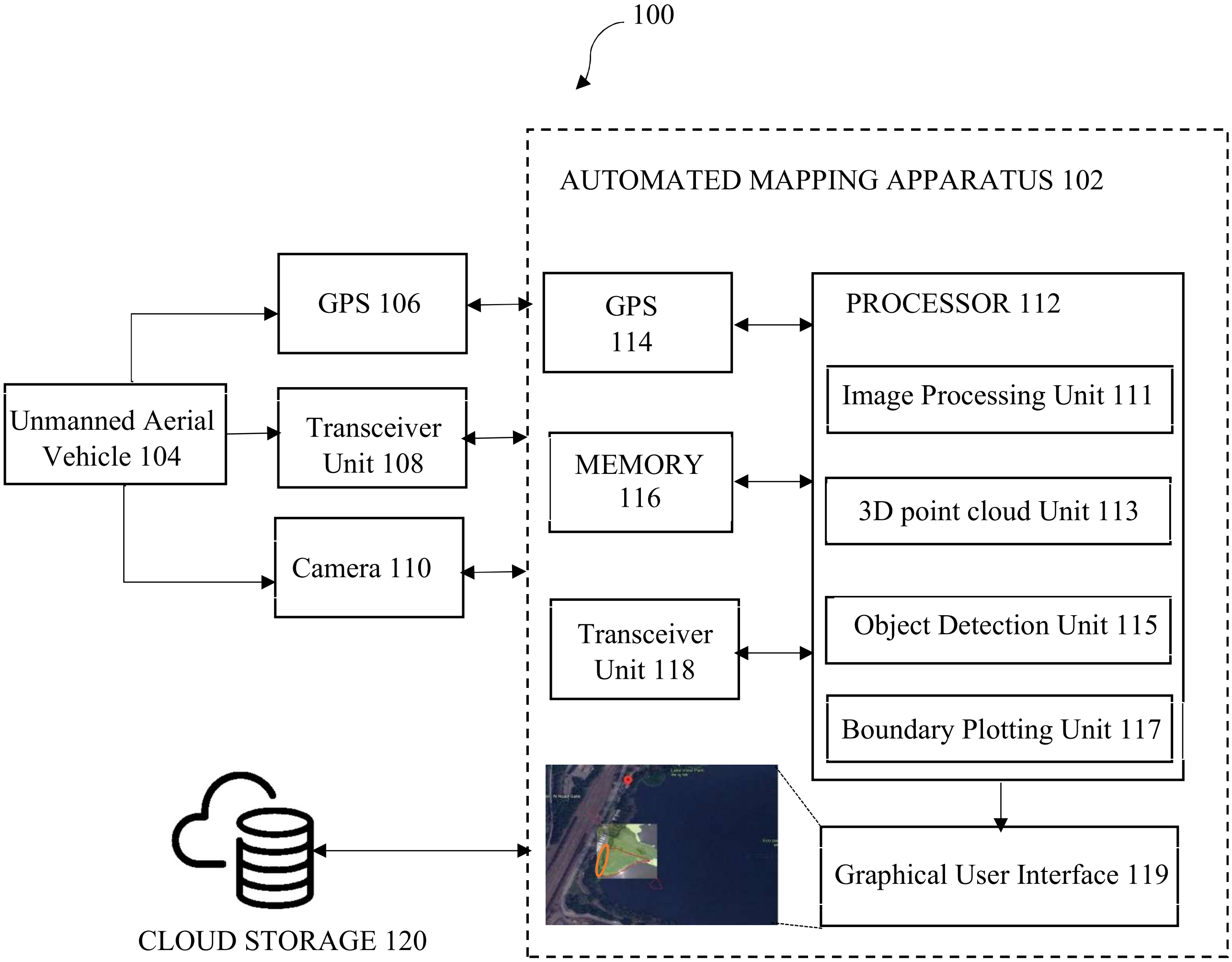

FIG. 1

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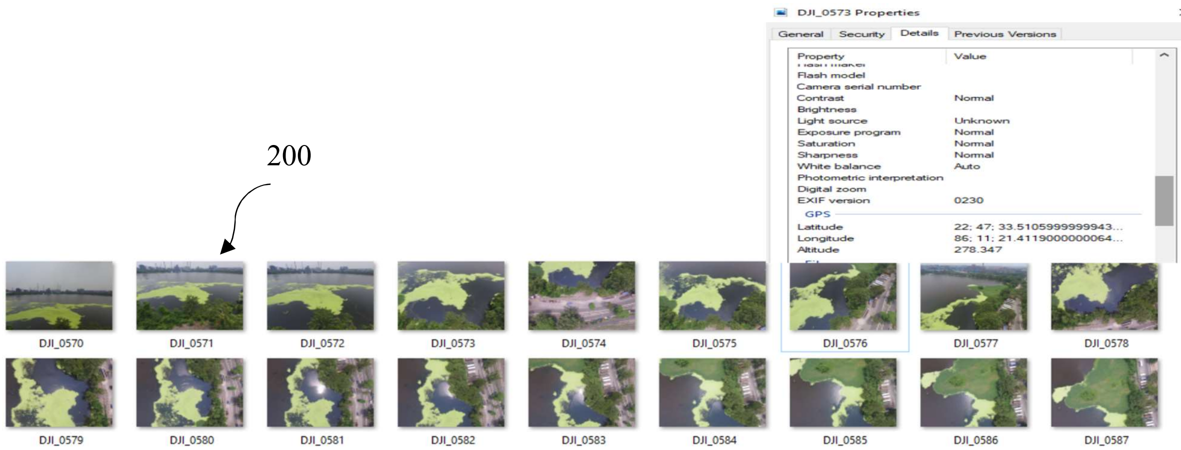
DJI_0573 Properties
General
Security
Details
Previous Versions
Property
Value
Flash model
Camera serial number
Contrast
Normal
Brightness
Light source
Unknown
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Normal
Saturation
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Sharpness
Normal
White balance
Auto
Photometric interpretation
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Longitude
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Altitude
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FIG. 2

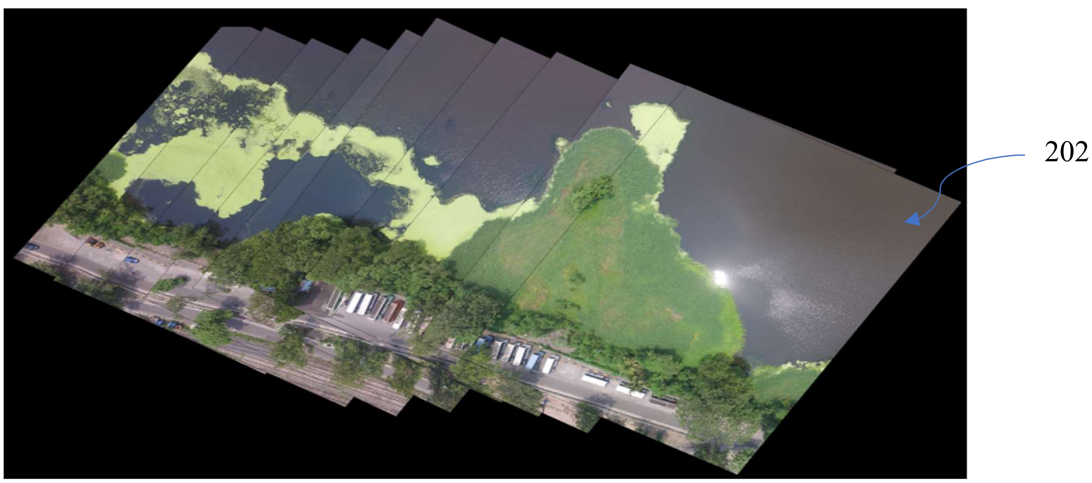
202

FIG. 2A

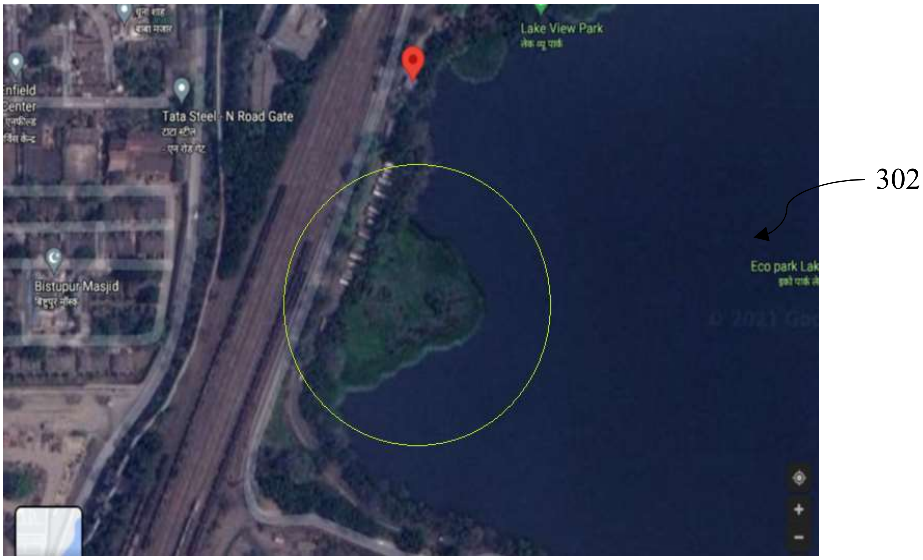

FIG. 3

FIG. 4

FIG. 5

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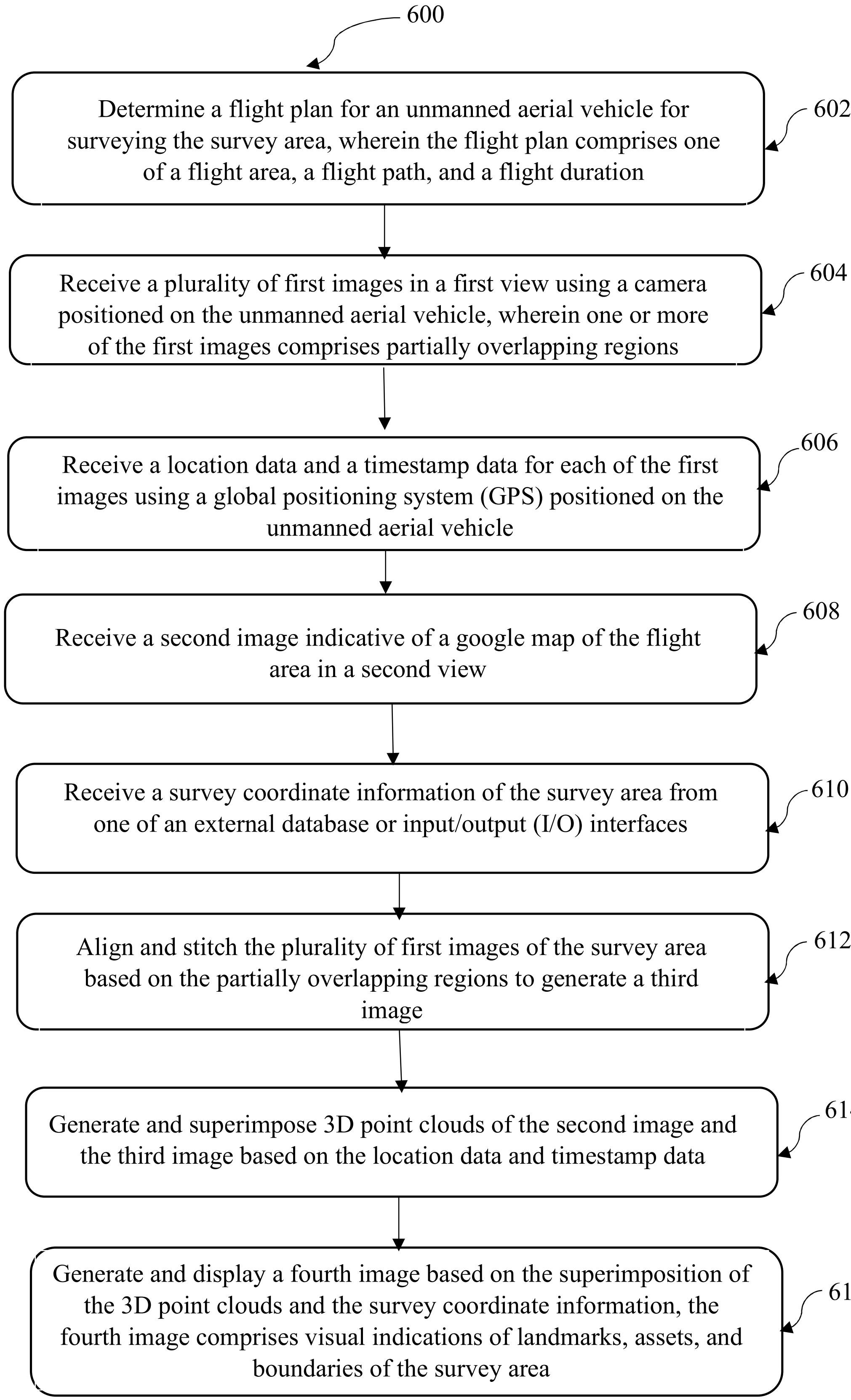

FIG. 6

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