

COMBINED DECLARATION AND ASSIGNMENT FOR PATENT APPLICATIONSTitle of Invention: **SYSTEMS AND METHODS FOR ROBOTIC MAPPING**

As a below named inventor (hereinafter designated as the undersigned), I hereby declare that:

This declaration is directed to the application attached hereto. If the application is not attached hereto, the application is as identified by the attorney docket number as set forth above and/or the following:

U.S. Application Serial No.: 15/340,807; or

PCT International Application No.: _____

Filed on: November 1, 2016

The above-identified application was made or authorized to be made by me. I believe that I am the original inventor or an original joint inventor of a claimed invention in the application. I have reviewed and understand the contents of the above-identified application, including the claims. I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations § 1.56.

WHEREAS, **BRAIN CORPORATION**, with its principal place of business at 9401 Waples Street, Suite 100, San Diego, CA 92121, its heirs, successors, legal representatives and assigns (hereinafter designated as the Assignee) is desirous of acquiring the entire right, title and interest in and to said invention and in and to any Letters Patent(s) that may be granted therefor in the United States of America and in any foreign countries.

NOW, THEREFORE, for good and valuable consideration, the receipt and sufficiency of which is hereby acknowledged, the undersigned has sold, assigned and transferred, and by these presents does (do) sell, assign and transfer unto said Assignee the full and exclusive right to the said invention in the United States of America, its territories, dependencies and possessions and the entire right, title and interest in and to any and all Letters Patent(s) which may be granted therefor in the United States of America, its territories, dependencies and possessions, and if the box above is designated, in any and all foreign countries; and to any and all divisions, reissues, re-examinations, continuations, conversions and extensions thereof, and provisional applications to which priority is claimed therefrom, for the full term or terms for which the same may be granted.

The undersigned agrees to execute all papers necessary in connection with this application and any continuing, divisional, conversion, re-exam, provisional, or reissue applications thereof and also to execute separate assignments in connection with such applications as the Assignee may deem necessary or expedient.

The undersigned agrees to execute all papers necessary in connection with any interference which may be declared concerning this application or continuation, division, conversion, re-exam, provisional, or reissue thereof or Letters Patent(s) or reissue patent issued thereon and to cooperate with the Assignee in every way possible in obtaining and producing evidence and proceeding with such interference.

The undersigned agrees to execute all papers and documents and to perform any act which may be necessary in connection with claims or provisions of the International Convention for the Protection of Industrial Property or similar agreements.

GAZDZINSKI & ASSOCIATES, PC

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COMBINED DECLARATION AND ASSIGNMENT FOR PATENT APPLICATIONS

The undersigned agrees to perform all affirmative acts which may be necessary to obtain a grant of (a) valid United States of America patent(s) or a grant of (a) valid United States of America and any foreign patent(s) to the Assignee and to vest all rights therein hereby conveyed to said Assignee as fully and entirely as the same would have been held by the undersigned if this Assignment and sale had not been made.

The undersigned hereby authorizes and requests the Patent and Trademark Office Officials in the United States of America and in any foreign countries to issue any and all Letters Patent(s) resulting from said application or any continuing, divisional conversion or reissue applications thereof to the said Assignee, as Assignee of the entire interest, and hereby covenants that he has the full right to convey the entire interest herein assigned, and that he has not executed, and will not execute, any agreement in conflict herewith.

The undersigned hereby grants the law firm of GAZDZINSKI & ASSOCIATES, PC, Customer No. **132059**, the power to insert any further identification which may be necessary or desirable in order to comply with the rules of the U.S. Patent and Trademark Office.

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

Executed by the undersigned on the date opposite the undersigned name.

LEGAL NAME OF INVENTOR

Inventor's Name: **JALBERT ROMBOUTS**

Date: April 13th, 2017

Signature: _____

An application data sheet (PTO/AIA/14 or equivalent), including naming the entire inventive entity, must accompany this form. Use a separate form for each inventor; or check the box below and complete the attached page(s) to list additional inventors.

☒ Additional inventors are being named on the 1 supplemental sheet(s) attached hereto.

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Date: _____

Signature: _____

LEGAL NAME OF JOINT INVENTOR, IF ANY

Inventor's Name: **JEAN-BAPTISTE PASSOT**

Date: 4-10-2017

Signature: _____

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Inventor's Name: **ANDREW SMITH**

Date: 4-10-2017

Signature: _____

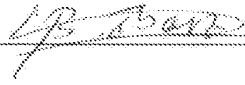
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Date: 4/4/2017

Signature: 

LEGAL NAME OF JOINT INVENTOR, IF ANY

Inventor's Name: **JEAN-BAPTISTE PASSOT**

Date: _____

Signature: _____

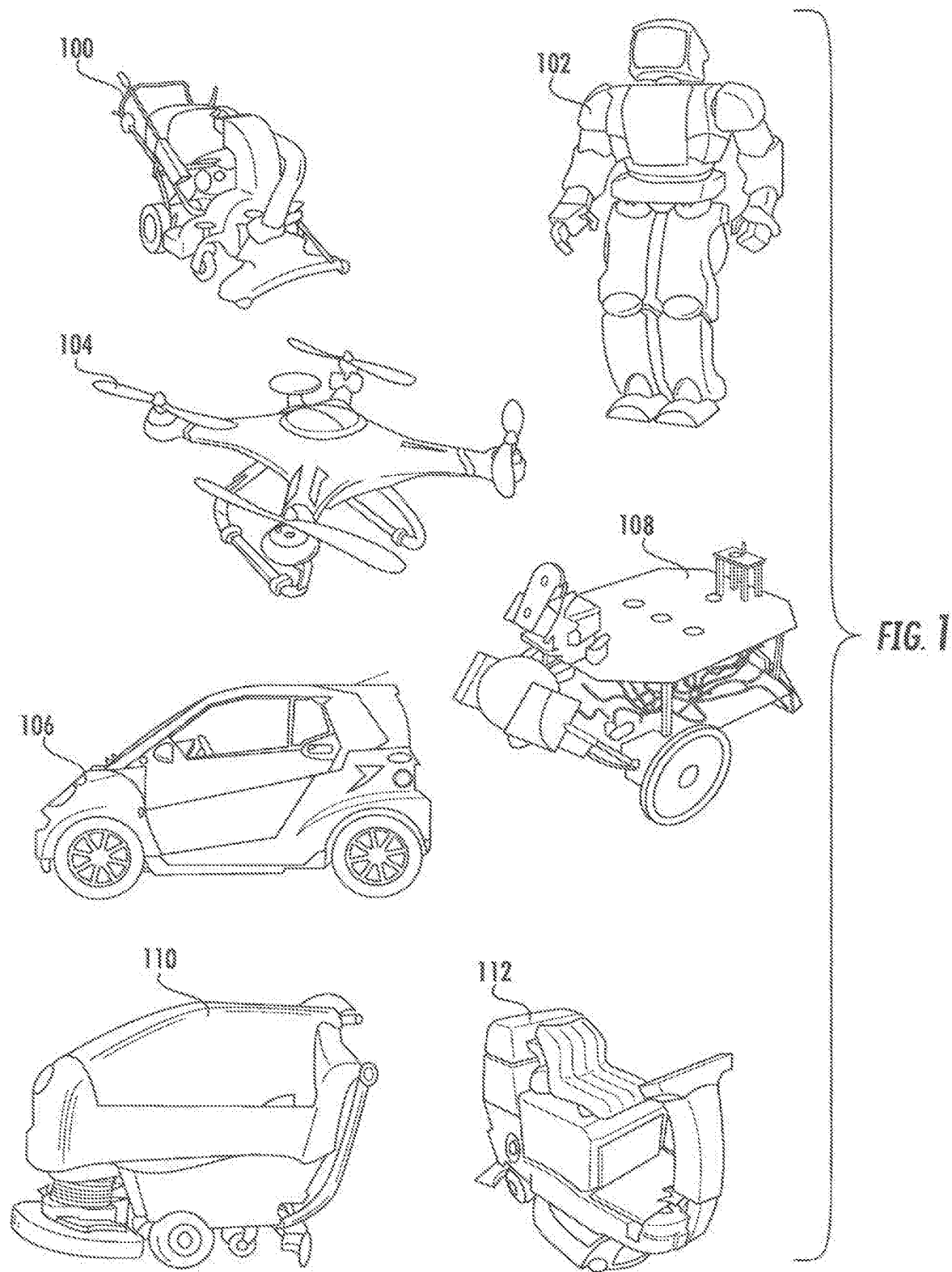
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Inventor's Name: **ANDREW SMITH**

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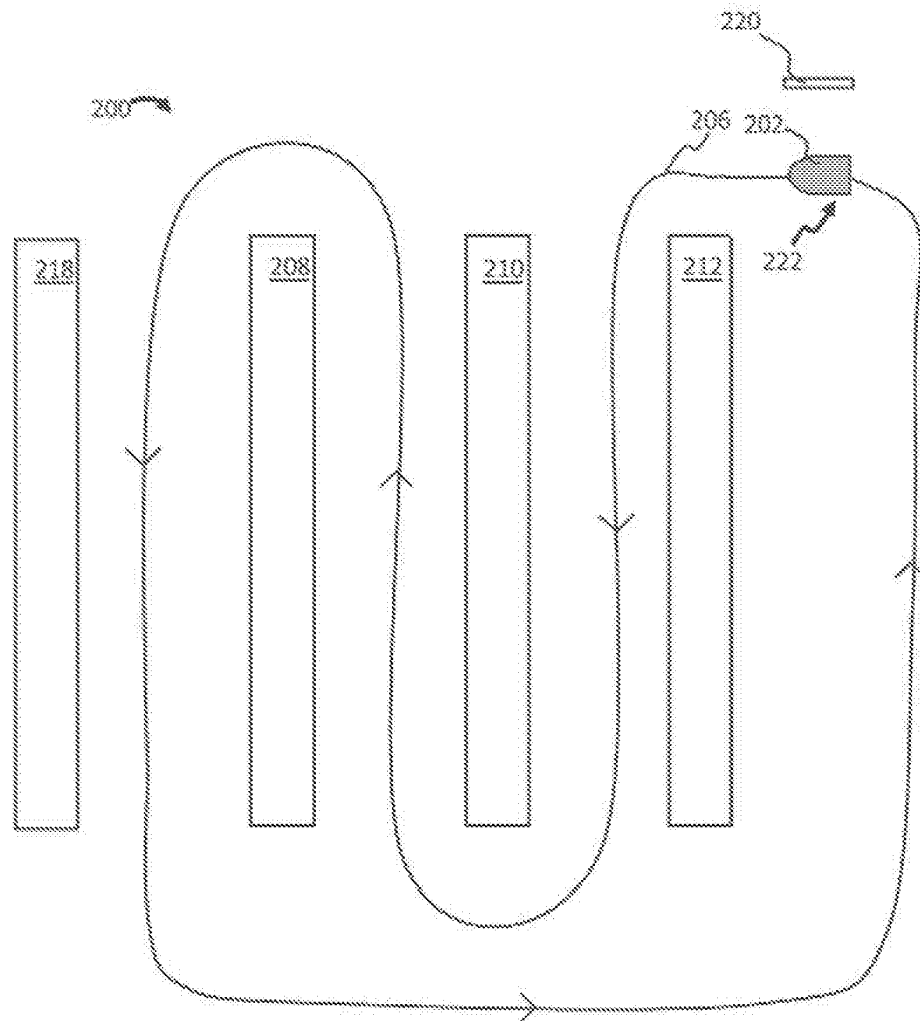


FIG. 2

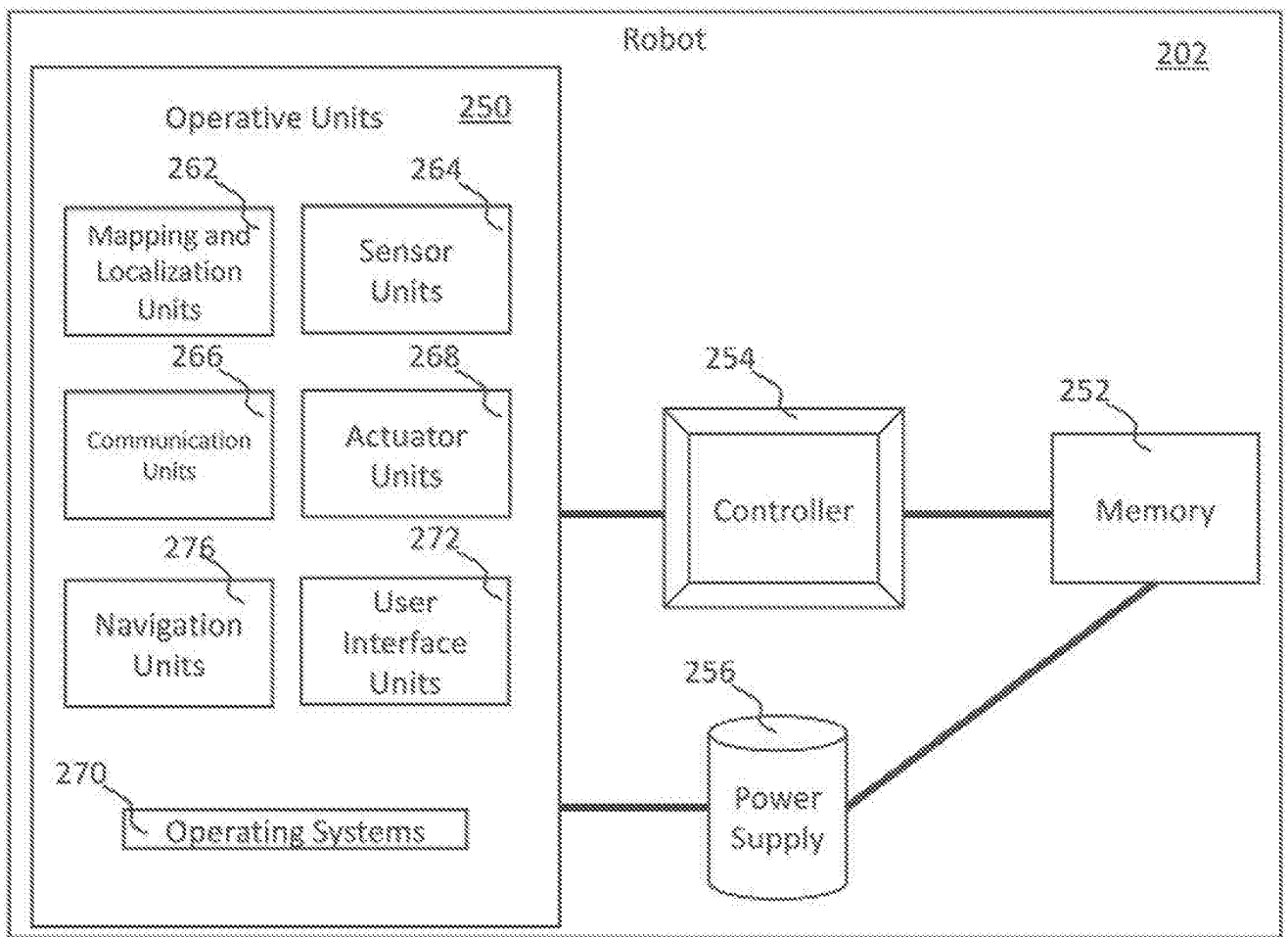


FIG. 3

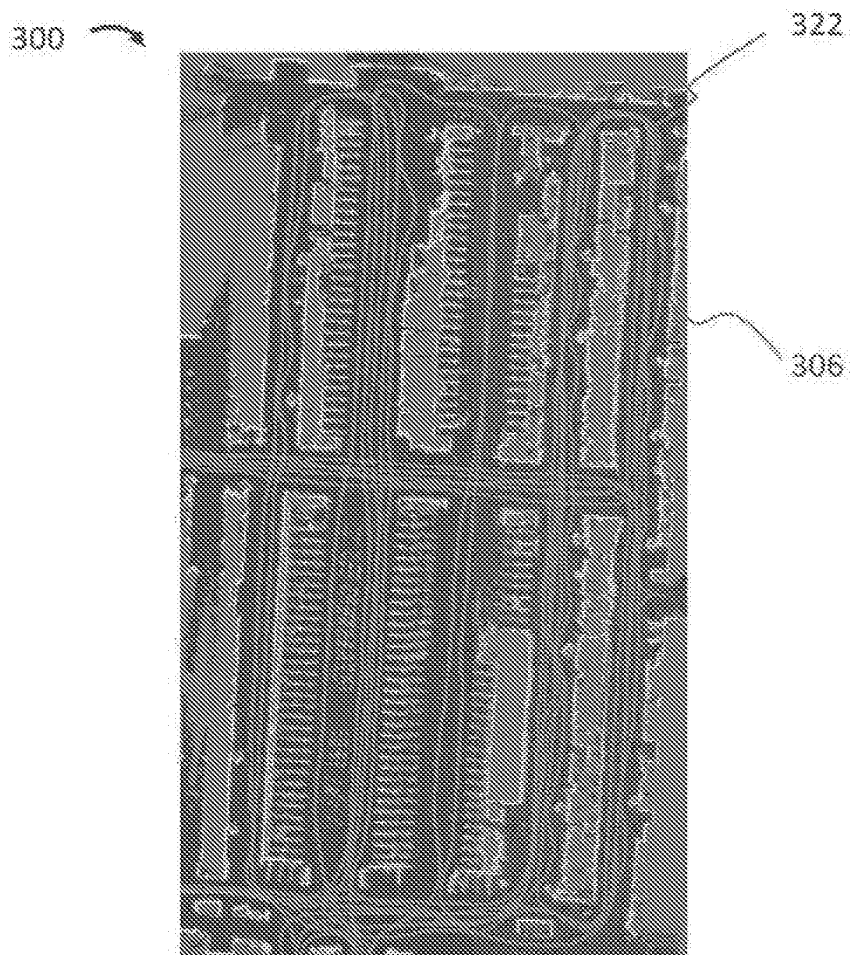


FIG. 4A

400

406

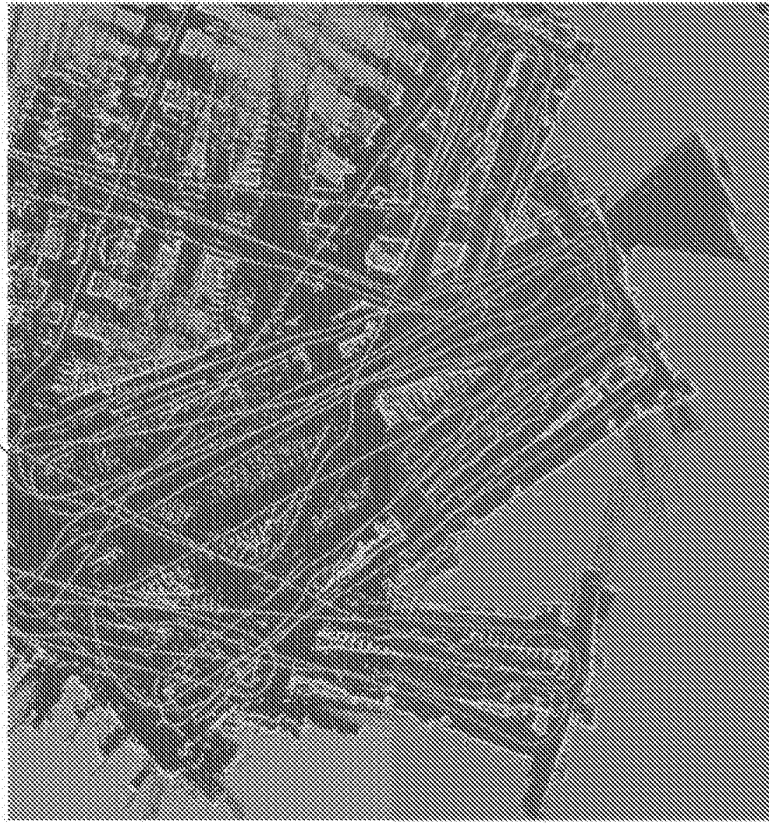


FIG. 48

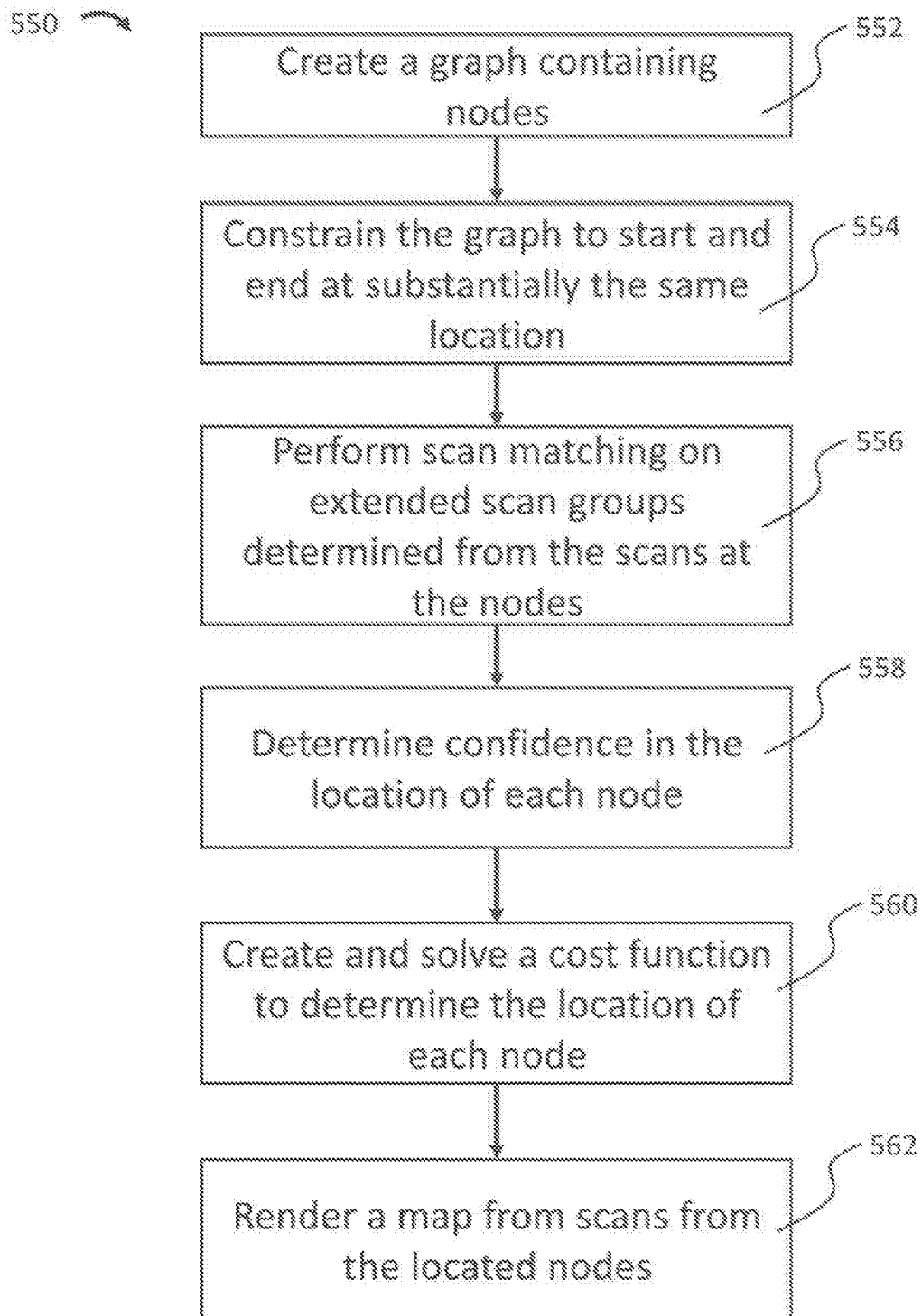


FIG. 5

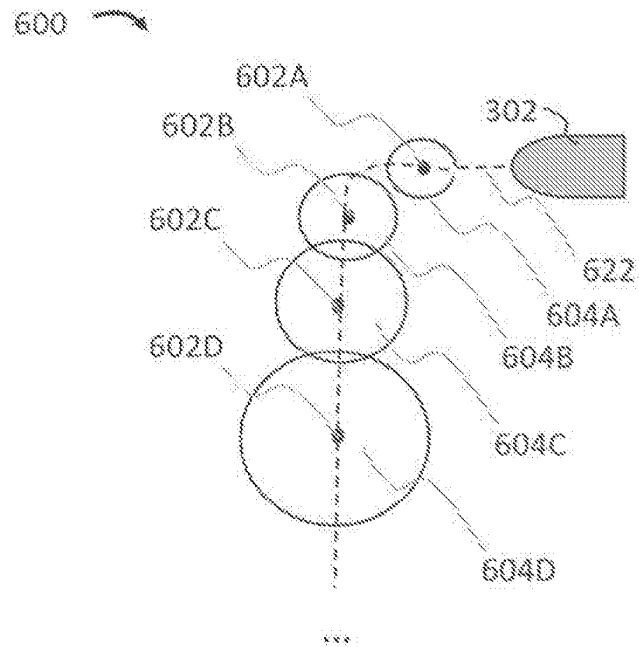


FIG. 6A

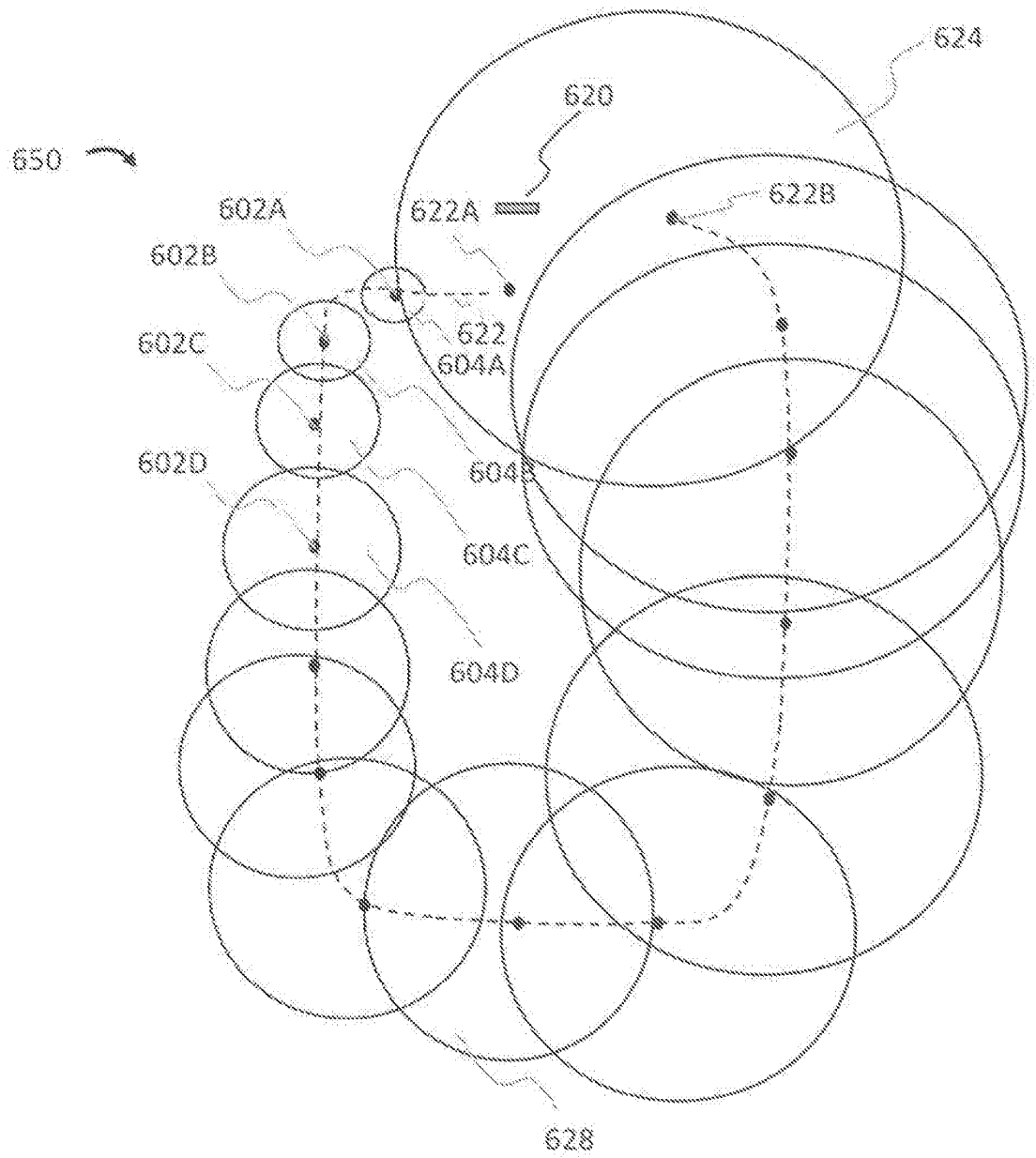


FIG. 6B

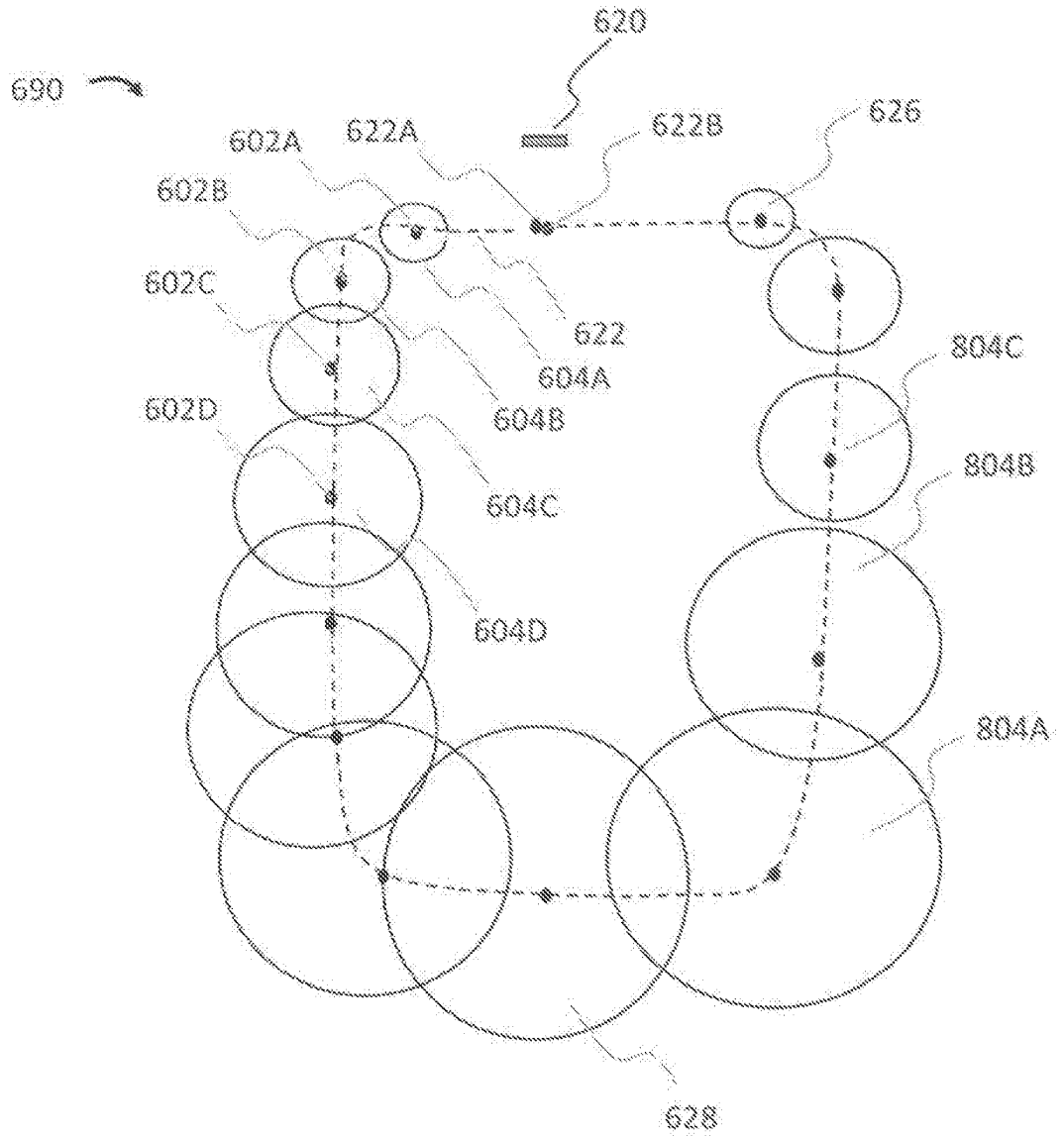


FIG. 6C

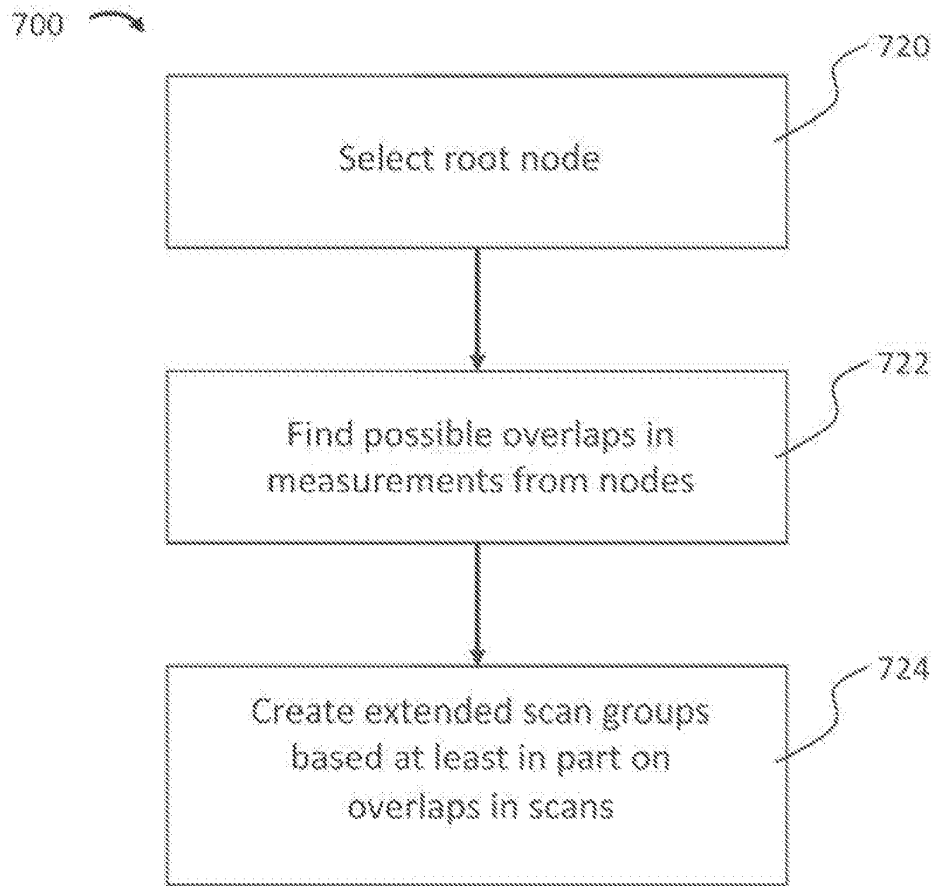


FIG. 7A

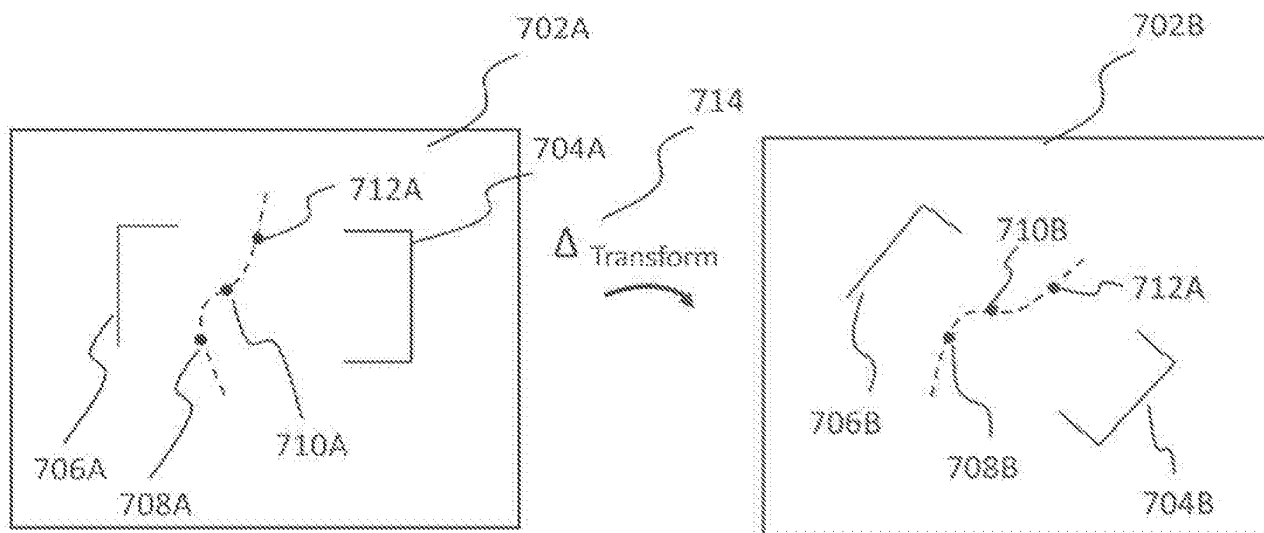


FIG. 7B

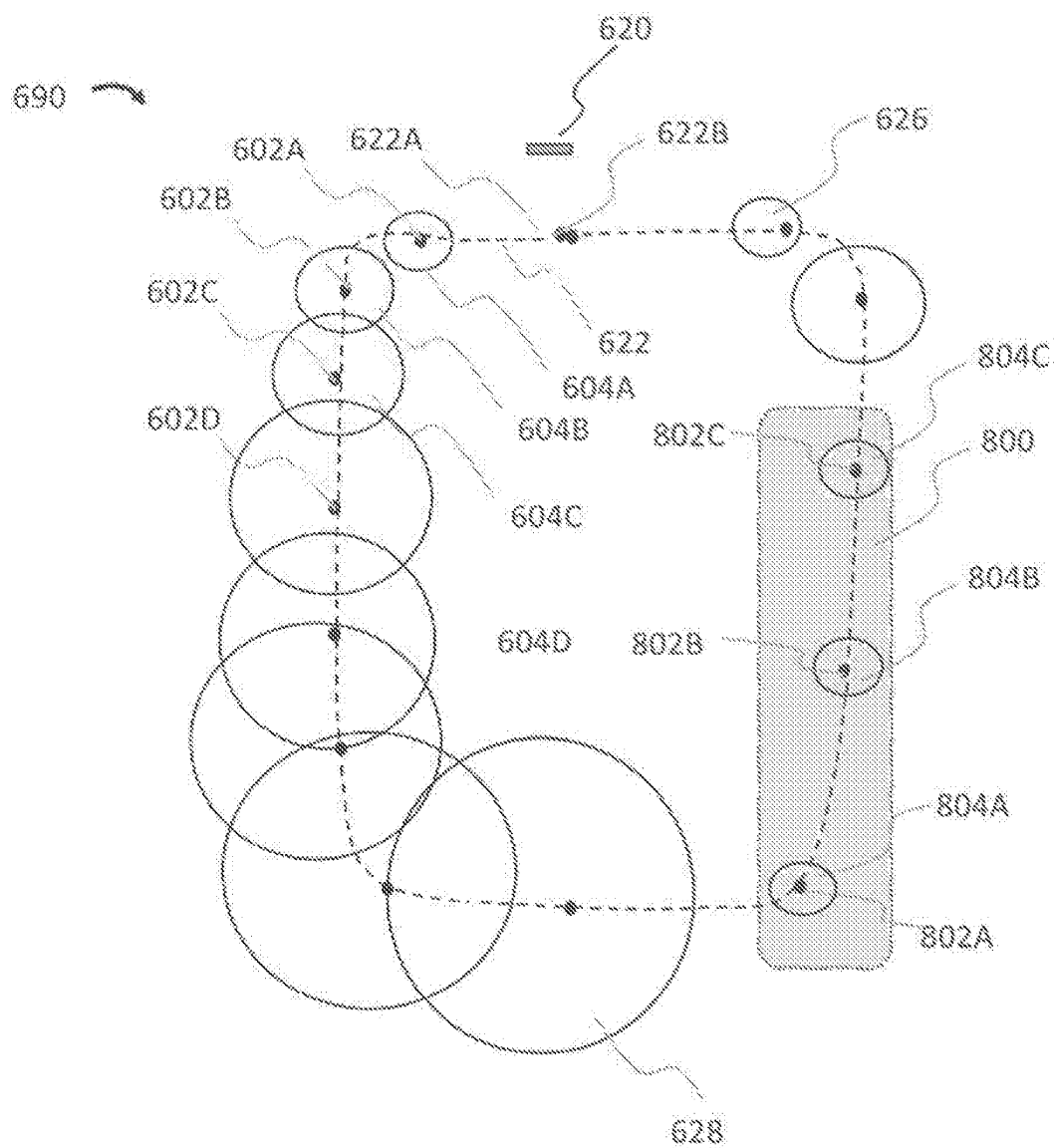


FIG. 8

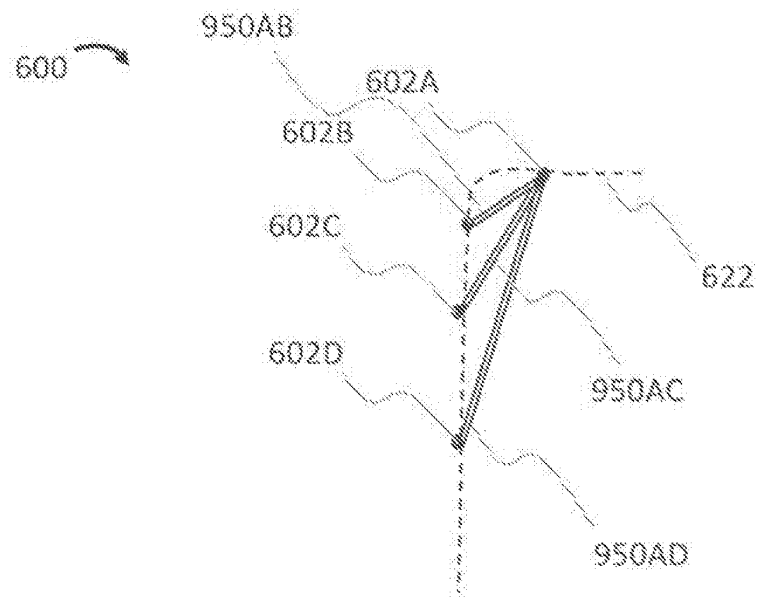


FIG. 9

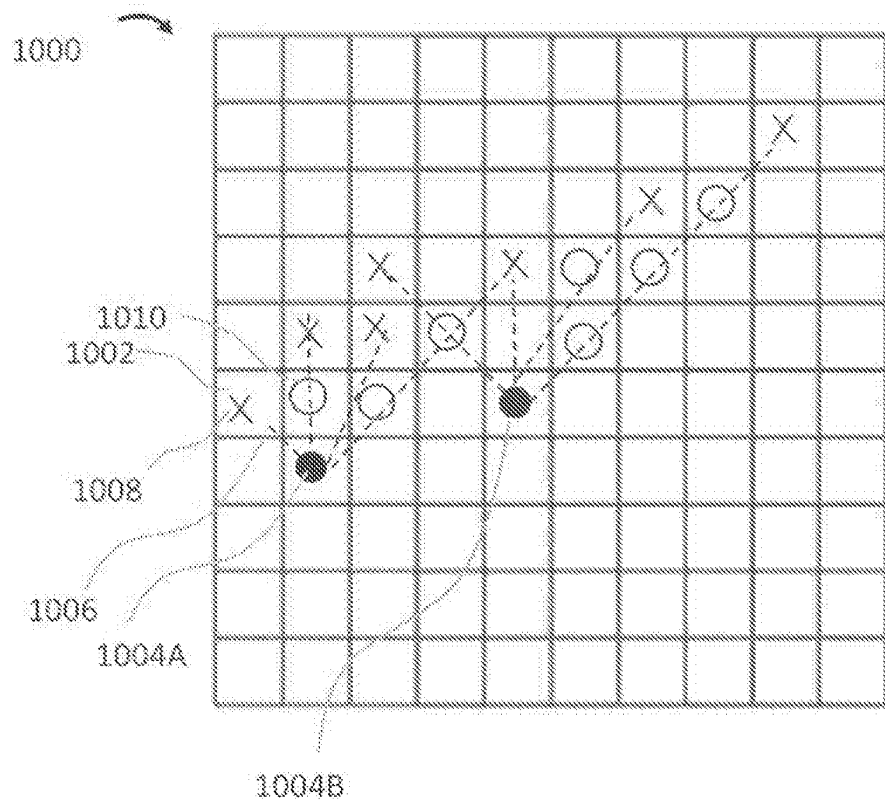


FIG. 10

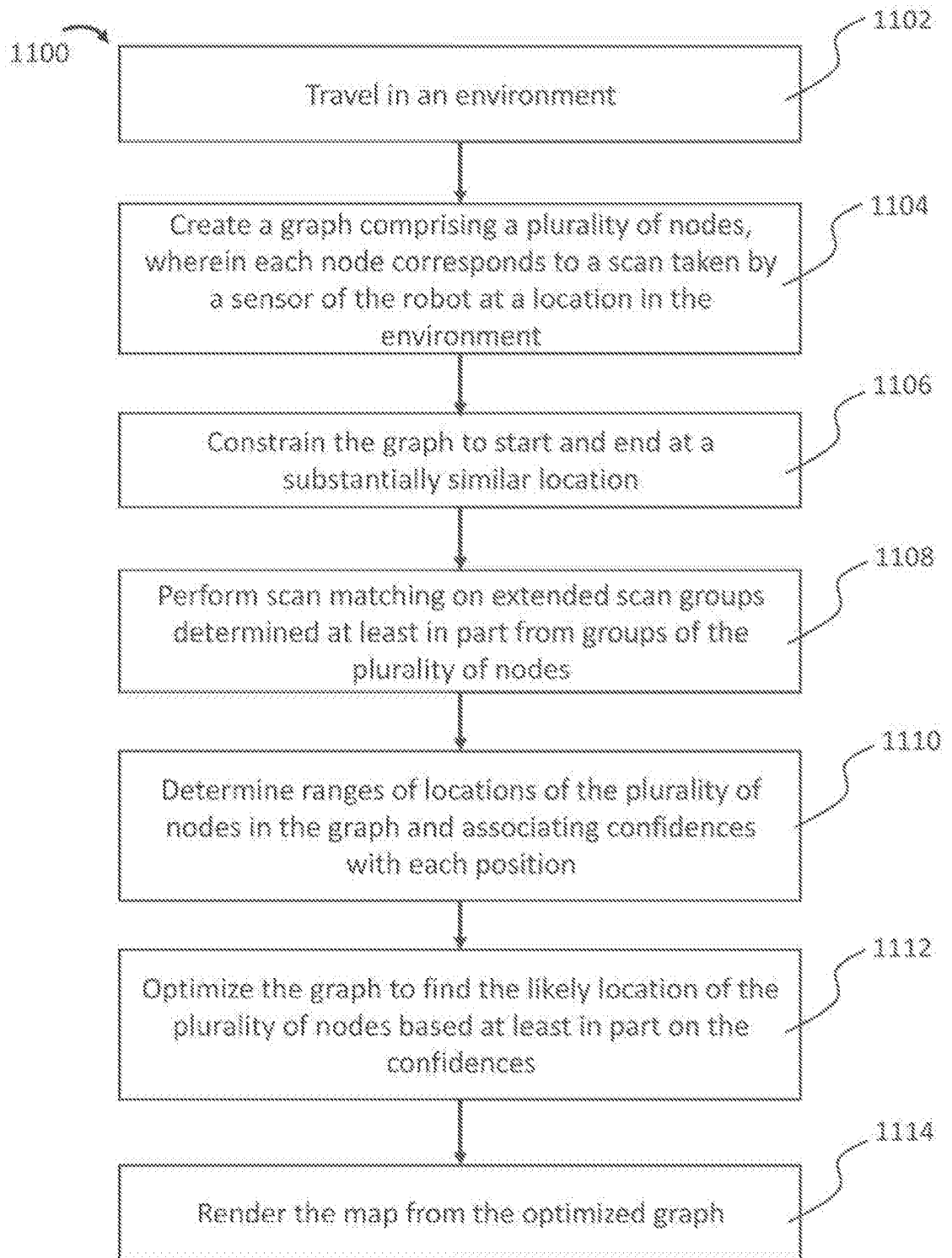


FIG. 11

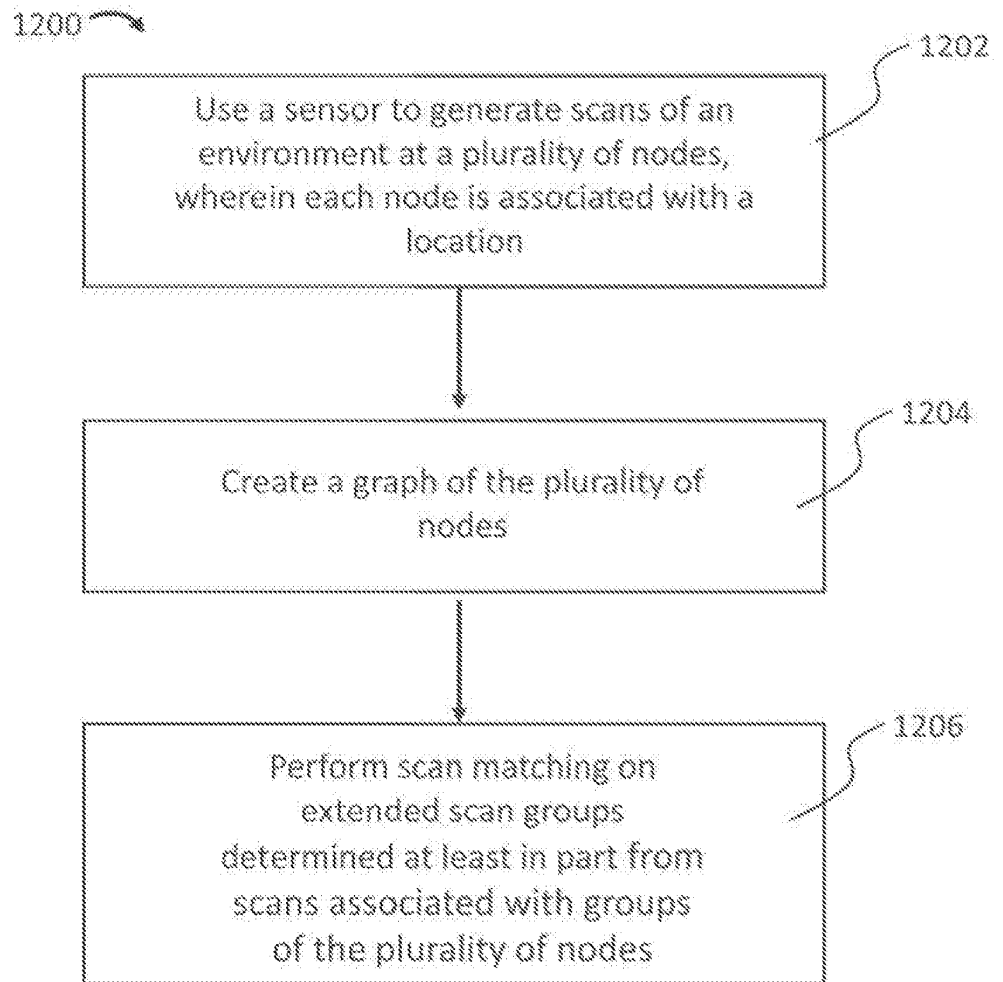


FIG. 12

SYSTEMS AND METHODS FOR ROBOTIC MAPPINGAbstract of the Disclosure

Systems and methods for robotic mapping are disclosed. In some exemplary implementations, a robot can travel in an environment. From travelling in the environment, the robot can create a graph comprising a plurality of nodes, wherein each node corresponds to a scan taken by a sensor of the robot at a location in the environment. In some exemplary implementations, the robot can generate a map of the environment from the graph. In some cases, to facilitate map generation, the robot can constrain the graph to start and end at a substantially similar location. The robot can also perform scan matching on extended scan groups, determined from identifying overlap between scans, to further determine the location of features in a map.

WHAT IS CLAIMED IS:

1. A method of generating a map by a robot, comprising:
traveling, by the robot, in an environment;
creating a graph comprising a plurality of nodes, wherein each node corresponds to a scan taken by a sensor of the robot at a location in the environment;
constraining the graph to start and end at a substantially similar location;
performing scan matching on extended scan groups determined at least in part from groups of the plurality of nodes;
associating a range of possible locations with each of the plurality of nodes based at least in part on the scan matching;
determining confidences associated with each range of possible locations;
optimizing the graph to find a likely location of the plurality of nodes based at least in part on the associated confidences; and
generating the map from the optimized graph.
2. The method of Claim 1, wherein the generation of the map comprises ray tracing with the scans taken by the sensor, the scans associated with the plurality of nodes.
3. The method of Claim 1, wherein optimizing the graph comprises:
generating a cost function based at least in part on: (1) relative locations of each of the plurality of nodes, and (2) the confidences associated with each of the plurality of nodes; and
solving the cost function for a minimum.
4. The method of Claim 1, wherein constraining the graph to start and end at the substantially similar location further comprises constraining the graph to start and end in view of a home locator.
5. The method of Claim 1, wherein the traveling, by the robot, in the environment further comprises navigating under user control.
6. The method of Claim 1, wherein the associated confidences further comprise using a probability distribution indicative at least in part of a probability that a given node is in a given location.
7. The method of Claim 1, wherein the extended scan groups determined at least in part from groups of the plurality of nodes, further comprises:

- selecting a root node as a reference location;
 - finding possible overlaps in measurements of distinct features in scans taken at other nodes; and
 - grouping the other nodes into extended scan groups based at least in part on overlapping distinct features of the scans at those respective other nodes.
8. A robot, comprising:
- a sensor configured to take scans of an environment at a plurality of nodes, wherein each node is associated with a location; and
 - a mapping and localization unit configured to:
 - create a graph of the nodes based at least in part on the taken scans;
 - determine extended scan groups based at least in part on groups of the plurality of nodes; and
 - perform scan matching on the extended scan groups.
9. The robot of Claim 8, wherein the mapping and localization unit is further configured to constrain the graph to start and end at a substantially similar location.
10. The robot of Claim 8, wherein the mapping and localization unit is further configured to determine confidences associated with the location of each node.
11. The robot of Claim 10, wherein the mapping and localization unit is further configured to generate a cost function based at least in part on the confidences and locations of each node, wherein the mapping and localization unit determines the location of each node in the graph based on solving the cost function for a minimum.
12. The robot of Claim 8, further comprising a processor that is further configured to render a map from the graph, the map rendered based at least in part on ray tracings of the scans.
13. The robot of Claim 8, further comprising an actuator configured to move the robot between locations.
14. The robot of Claim 8, further comprising a user interface configured for user control of the robot.
15. The robot of Claim 8, further comprising a navigation unit configured to navigate the robot autonomously.
16. A non-transitory computer-readable storage apparatus having a plurality of

instructions stored thereon, the instructions being executable by a processing apparatus to operate a robot, the instructions configured to, when executed by the processing apparatus, cause the processing apparatus to:

- cause a sensor to generate scans of an environment at a plurality of nodes, wherein each node of the plurality is associated with a location;

- create a graph of the plurality of nodes based on the generated scans;

- determine extended scan groups based at least in part from scans associated with groups of the plurality of nodes; and

- perform scan matching on the extended scan groups.

17. The non-transitory computer-readable storage apparatus of Claim 16, further comprising one or more instructions, when executed by the processing apparatus, that further cause the processing apparatus to constrain the graph to start and end at a substantially similar location.

18. The non-transitory computer-readable storage apparatus of Claim 16, wherein each extended scan group comprises three or more scans.

19. The non-transitory computer-readable storage apparatus of Claim 16, further comprising one or more instructions, when executed by the processing apparatus, that further cause the processing apparatus to determine a cost function based at least in part on confidences associated with the location of each node.

20. The non-transitory computer-readable storage apparatus of Claim 19, further comprising one or more instructions, when executed by the processing apparatus, that further cause the processing apparatus to generate a map based at least in part on minimizing the cost function.

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Background**Technological Field**

[0002] The present application relates generally to robotics, and more specifically to systems and methods for robotic mapping.

Background

[0003] In some cases, robots map an environment. These maps enable the robot to navigate autonomously. As the robot maps its environment, it relies on its senses (e.g., using sensors) to detect features of the environment and remember those features for later reference. However, mapping can be a slow and difficult process due to, among other things, environmental noise, sensor noise and inaccuracy, ambiguities in the environment (e.g., substantially similar features), sensor drift, and other issues.

[0004] Inaccuracies in mapping can cause a robot to get lost during navigation or become unable to navigate an environment at all. In some cases, mapping issues can cause a robot to collide with objects or people in an environment, or fail to accomplish the objective the robot was tasked to do. As a result, there is need in the art to develop systems and methods that can correct for inaccuracies in mapping and generate a map that represents the environment and/or the route traveled by the robot.

[0005] As a further challenge, it is often desirable for robots to be affordable, lightweight, and as small as possible. Accordingly, it is desirable for systems and methods to be computationally efficient and capable of running on low cost (e.g., possibly less accurate) hardware, including sensors and processors.

Summary

[0006] The foregoing needs are satisfied by the present disclosure, which provides for, *inter alia*, apparatus and methods for mapping in autonomous navigation. Example implementations described herein have innovative features, no single one of which is indispensable or solely responsible for their desirable attributes. Without limiting the scope of the claims, some of the advantageous features will now be summarized.

[0007] In a first aspect, a method of generating a map by a robot is disclosed. In one exemplary implementation, the method includes: traveling, by the robot in an environment; creating a graph comprising a plurality of nodes, wherein each node corresponds to a scan taken by a sensor of the robot at a location in the environment; constraining the graph to start and end at a substantially similar location; performing scan matching on extended scan groups determined at least in part from groups of the plurality of nodes; associating a range of possible locations with each of the plurality of nodes based at least in part on the scan matching; determining confidences associated with each range of possible locations; optimizing the graph to find the likely location of the plurality of nodes based at least in part on the confidences; and rendering the map from the optimized graph.

[0008] In one variant, the generation of the map comprises ray tracing with the scans taken by the sensor, the scans associated with the plurality of nodes. In another variant, optimizing the graph comprises: generating a cost function based at least in part on: (1) relative locations of each of the plurality of nodes and (2) the confidences associated with each of the plurality of nodes, and solving the cost function for a minimum.

[0009] In another variant, constraining the graph to start and end at the substantially similar location further comprises constraining the graph to start and end in view of a home locator. In another variant, traveling in an environment comprises navigating under user control.

[0010] In another variant, the associated confidences further comprise using a probability distribution indicative at least in part of a probability that a given node is in a given location.

[0011] In another variant, the extended scan groups determined at least in part from groups of the plurality of nodes further comprise: selecting a root node as a reference location, finding possible overlaps in measurements of distinct features in scans taken at

other nodes, and grouping the other nodes into extended scan groups based at least in part on overlapping distinct features of the scans at those respective other nodes.

[0012] In a second aspect, a robot is disclosed. In one exemplary implementation, the robot includes: a sensor configured to take scans of an environment at nodes, wherein each node is associated with a location; and a mapping and localization unit configured to: create a graph of the nodes based at least in part on the taken scans, determine extended scan groups based at least in part on groups of the plurality of nodes, and perform scan matching on the extended scan groups.

[0013] In one variant, the mapping and localization unit is further configured to constrain the graph to start and end at a substantially similar location. In another variant, the mapping and localization unit is further configured to determine confidences associated with the location of each node.

[0014] In another variant, the mapping and localization unit is further configured to generate a cost function based at least in part on the confidences and locations of each node, wherein the mapping and localization unit determines the location of each node in the graph based on solving the cost function for a minimum.

[0015] In another variant, the processor is further configured to render a map from the graph, the map rendered based at least in part on ray tracings of the scans.

[0016] In another variant, the robot further includes an actuator configured to move the robot between locations. In another variant, the robot further includes a user interface configured for user control of the robot.

[0017] In another variant, the robot further includes a navigation unit configured to navigate the robot autonomously.

In a third aspect, a non-transitory computer-readable storage apparatus is disclosed. In one embodiment, the non-transitory computer-readable storage apparatus has a plurality of instructions stored thereon, the instructions being executable by a processing apparatus to operate a robot. The instructions are configured to, when executed by the processing apparatus, cause a sensor to generate scans of an environment at a plurality of nodes, wherein each node of the plurality is associated with a location; create a graph of the plurality of nodes based on the generated scans; determine extended scan groups based at least in part from scans associated with groups of the plurality of nodes; and perform scan matching on

the extended scan groups.

[0018] In one variant, the instructions further cause the processing apparatus to constrain the graph to start and end at a substantially similar location.

[0019] In another variant, each extended scan group comprises three or more scans.

[0020] In another variant, the instructions further cause the processing apparatus to determine a cost function based at least in part on confidences of the location of each node.

[0021] In another variant, the instructions further cause the processing apparatus to generate a map based at least in part on minimizing the cost function.

[0022] These and other objects, features, and characteristics of the present disclosure, as well as the methods of operation and functions of the related elements of structure and the combination of parts and economies of manufacture, will become more apparent upon consideration of the following description and the appended claims with reference to the accompanying drawings, all of which form a part of this specification, wherein like reference numerals designate corresponding parts in the various figures. It is to be expressly understood, however, that the drawings are for the purpose of illustration and description only and are not intended as a definition of the limits of the disclosure. As used in the specification and in the claims, the singular form of "a", "an", and "the" include plural referents unless the context clearly dictates otherwise.

Brief Description of the Drawings

[0023] The disclosed aspects will hereinafter be described in conjunction with the appended drawings, provided to illustrate and not to limit the disclosed aspects, wherein like designations denote like elements.

[0024] FIG. 1 illustrates various side elevation views of exemplary body forms for a robot in accordance with principles of the present disclosure.

[0025] FIG. 2 is a diagram of an overhead view of a robot as an operator demonstrated a path in accordance with some implementations of this disclosure.

[0026] FIG. 3 illustrates a functional block diagram of an example robot in some implementations.

[0027] FIG. 4A is a top view map and route generated by a robot as it travels in an environment in accordance with some implementations of this disclosure.

[0028] FIG. 4B is a map that does not accurately reflect the surrounding and traveled route of a robot in accordance with some implementations of this disclosure.

[0029] FIG. 5 is a process flow diagram of an exemplary method for creating a map in accordance with some implementations of the present disclosure.

[0030] FIG. 6A is a top view of a diagram comprising discretized measurements of a robot along a route in a graph in accordance to some implementations of the present disclosure.

[0031] FIG. 6B is a top view of a diagram of a graph, which includes a continuation of the route illustrated in FIG. 6A in accordance with some implementations of this disclosure.

[0032] FIG. 6C illustrates a constraint for the graph from FIG. 6B in accordance with some implementations of the present disclosure, wherein the starting and ending locations are at the same and/or substantially the same location.

[0033] FIG. 7A is a process flow diagram of an exemplary method for creating an extended scan group in accordance with some implementations of this disclosure.

[0034] FIG. 7B is a conceptual diagram of a scan matching transformation in accordance with some implementations of the present disclosure.

[0035] FIG. 8 illustrates an example result of a scan matching of an extended scan group on the graph illustrated in FIG. 6C in accordance with some implementations of the present disclosure.

[0036] FIG. 9 illustrates springs to/from a node from the graph illustrated in FIG. 6A in accordance with some implementations of the present disclosure.

[0037] FIG. 10 is a diagram of the pixels of a map being constructed from scans in accordance to some implementations of this disclosure.

[0038] FIG. 11 is a process flow diagram of an exemplary method for generating a map by a robot in accordance with some implementations of the present disclosure.

[0039] FIG. 12 is a process flow diagram of an exemplary method for operating a robot in accordance with some implementations of the present disclosure.

[0040] All Figures disclosed herein are © Copyright 2016 Brain Corporation. All rights reserved.

Detailed Description

[0041] Various aspects of the novel systems, apparatuses, and methods disclosed herein are described more fully hereinafter with reference to the accompanying drawings. This disclosure can, however, be embodied in many different forms and should not be construed as limited to any specific structure or function presented throughout this disclosure. Rather, these aspects are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the disclosure to those skilled in the art. Based on the teachings herein, one skilled in the art should appreciate that the scope of the disclosure is intended to cover any aspect of the novel systems, apparatuses, and methods disclosed herein, whether implemented independently of, or combined with, any other aspect of the disclosure. For example, an apparatus can be implemented or a method can be practiced using any number of the aspects set forth herein. In addition, the scope of the disclosure is intended to cover such an apparatus or method that is practiced using other structure, functionality, or structure and functionality in addition to or other than the various aspects of the disclosure set forth herein. It should be understood that any aspect disclosed herein can be implemented by one or more elements of a claim.

[0042] Although particular aspects are described herein, many variations and permutations of these aspects fall within the scope of the disclosure. Although some benefits and advantages of the preferred aspects are mentioned, the scope of the disclosure is not intended to be limited to particular benefits, uses, and/or objectives. The detailed description and drawings are merely illustrative of the disclosure rather than limiting, the scope of the disclosure being defined by the appended claims and equivalents thereof.

[0043] The present disclosure provides for improved systems and methods for robotic mapping. As used herein, a robot can include mechanical or virtual entities configured to carry out complex series of actions automatically. In some cases, robots can be machines that are guided by computer programs or electronic circuitry. In some cases, robots can include electro-mechanical components that are configured for navigation, where the robot can move from one location to another. Such navigating robots can include autonomous cars, floor cleaners, rovers, drones, carts, and the like.

[0044] As referred to herein, floor cleaners can include floor cleaners that are manually controlled (e.g., driven or remote control) and/or autonomous (e.g., using little to

no user control). For example, floor cleaners can include floor scrubbers that a janitor, custodian, or other person operates and/or robotic floor scrubbers that autonomously navigate and/or clean an environment. Similarly, floor cleaners can also include vacuums, steamers, buffers, mop, polishers, sweepers, burnishers, etc.

[0045] A person having ordinary skill in the art would appreciate that a robot, as referred to herein, can have a number of different appearances/forms. FIG. 1 illustrates various side elevation views of exemplary body forms for a robot in accordance with principles of the present disclosure. These are non-limiting examples meant to further illustrate the variety of body forms, but not to restrict robots described herein to any particular body form. For example, body form 100 illustrates an example where the robot is a stand-up shop vacuum. Body form 102 illustrates an example where the robot is a humanoid robot having an appearance substantially similar to a human body. Body form 104 illustrates an example where the robot is a drone having propellers. Body form 106 illustrates an example where the robot has a vehicle shape having wheels and a passenger cabin. Body form 108 illustrates an example where the robot is a rover.

[0046] Body form 110 can be an example where the robot is a motorized floor scrubber. Body form 112 can be a motorized floor scrubber having a seat, pedals, and a steering wheel, where a user can drive body form 112 like a vehicle as body form 112 cleans, however, body form 112 can also operate autonomously. Other body forms are further contemplated, including industrial machines that can be robotized, such as forklifts, tugs, boats, planes, etc.

[0047] Detailed descriptions of the various implementations and variants of the system and methods of the disclosure are now provided. While many examples discussed herein are in the context of robotic floor cleaners, it will be appreciated that the described systems and methods contained herein can be used in other robots. Myriad other example implementations or uses for the technology described herein would be readily envisaged by those having ordinary skill in the art, given the contents of the present disclosure.

[0048] Advantageously, the systems and methods of this disclosure at least: (i) provide for accurate route and/or environment mapping by a robot; (ii) provide computational efficiency which can reduce consumption of processing power, energy, and/or other resources in navigating robots; and (iii) allow use of lower-cost hardware in

construction of robots. Other advantages are readily discernable by one having ordinary skill given the contents of the present disclosure.

[0049] For example, many current robots that can autonomously navigate are programmed to navigate routes and/or paths to goals. In order to navigate these routes and/or paths, these robots can create maps, which can sometimes be referred to as a global solution in that the maps identify one or more portions of the environment beyond what a robot can directly observe with its sensors at a point in time. These robots generate maps, and their relationship to the environment along routes, using localized detection in a small area around the robot (e.g., in the order of a few meters), where the robot can determine obstacles and/or other features detected by its sensors. When navigating autonomously, robots can then utilize both the global solution and localized detection of objects to avoid collisions and/or reach its goal.

[0050] By way of illustration, a robot (e.g., a floor cleaner, autonomous vehicle, or other robot) can be programmed by demonstration. In the example of a floor cleaner, an operator can control the robot along a desired route in a desired environment. Accordingly, the robot can generate a map, documenting its location (e.g., place on the global map and/or pose relative to features of the environment) while the operator controls it. The robot can generate the map using odometry and its sensors (e.g., scans by a Light Detecting and Ranging ("LIDAR") sensor and/or any other sensor that is described in this disclosure). Subsequently, the robot can navigate the route autonomously, e.g., with little to no operator control.

[0051] A challenge for the robot in this illustration is constructing an accurate map that the robot can utilize to autonomously navigate the route after demonstration. The demonstration process can include complex sets of movements and actions (e.g., turning, stopping, parking, turning on and off blinkers and other signals, lifting and dropping brushes, turning off and on water flow, turning off and on vacuums, etc.) associated with particular poses and/or trajectories, as well as identification of objects. During the demonstration, the robot's mapping may not be perfectly accurate (e.g., subject to drift, noise, and/or error), and the robot may need to determine how the map should have appeared to accurately reflect the true state of the environment.

[0052] FIG. 2 is a diagram of an overhead view of robot 202 as an operator demonstrated a path in accordance with some implementations of this disclosure. In this way, FIG. 2 can illustrate the path robot 202 actually travels in an environment 200 while it is mapping. Robot 202 can be any robot described in this disclosure. By way of illustration, robot 202 can be a robotic floor cleaner, such as a robotic floor scrubber, vacuums, steamers, buffers, mop, polishers, sweepers, burnishers, and the like. Environment 200 can be the space in which robot 202 navigates. In the example of a robotic floor cleaner, environment 200 can be a space having floors desired to be cleaned. For example, environment 200 can be a store, warehouse, office building, home, storage facility, etc. One or more of objects 208, 210, 212, 218 can be shelves, displays, objects, items, people, animals, or any other entity or thing that may be on the floor or otherwise impede the ability of robot 202 to navigate through environment 200. As such, route 206 can be the cleaning path traveled by robot 202. Route 206 can follow a path that weaves between objects 208, 210, 212, and 218 as illustrated in example route 206. For example, where objects 208, 210, 212, and 218 are shelves in a store, robot 202 can go along the aisles of the store and clean the floors of the aisles. However, other routes are also contemplated, such as, without limitation, weaving back and forth along open floor areas and/or any cleaning path a user could use to clean the floor (e.g., if the user is manually operating a floor cleaner). Accordingly, route 206 is meant merely as illustrative examples and can appear differently as illustrated. Also, as illustrated, one example of environment 200 is shown, however, it should be appreciated that environment 200 can take on any number of forms and arrangements (e.g., of any size, configuration, and/or layout of a room and/or building) and is not limited by the example illustrations of this disclosure.

[0053] In route 206, robot 202 can begin at the initial location 222, which can be the starting point/location of robot 202. In some cases, home locator 220 can be positioned near, substantially near, and/or at the initial location 222. For example, home locator 220 can be positioned adjacent to initial location 222, or be within the range of at least one sensor of robot 202 such that a sensor of robot 202 can detect home locator 220 from initial location 222. The operator can then demonstrate route 206 to robot 202 until robot 202 reaches an end location, where the operator can stop operating robot 202. The end location can be designated by a user and/or determined by robot 202. In some cases, the end location can be the location in route 206 after which robot 202 has cleaned the desired area of a floor. As

previously described, route 206 can be a closed loop or an open loop. By way of illustrative example, an end location can be a location for storage for robot 202, such as a temporary parking spot, storage room/closet, and the like. In some cases, the end location can be the point where a user training and/or programming tasks for robot 202. In some cases, the end location can be the same and/or substantially similar as initial location 222. For example, robot 202 can detect a return to a position that is the same and/or substantially similar to initial location 222 by detecting home locator 220.

[0054] In the context of floor cleaners (e.g., floor scrubbers, vacuum cleaners, etc.), robot 202 may or may not clean at every point along route 206. By way of illustration, where robot 202 is a robotic floor scrubber, the cleaning system (e.g., water flow, cleaning brushes, etc.) of robot 202 may only be operating in some portions of route 206 and not others. For example, robot 202 may associate certain actions (e.g., turning, turning on/off water, spraying water, turning on/off vacuums, moving vacuum hose positions, gesticulating an arm, raising/lowering a lift, moving a sensor, turning on/off a sensor, etc.) with particular positions and/or trajectories (e.g., while moving in a certain direction or in a particular sequence along route 206) along the demonstrated route. In the context of floor cleaners, such association may be desirable when only some areas of the floor are to be cleaned but not others and/or in some trajectories. In such cases, robot 202 can turn on a cleaning system in areas where a user demonstrated for robot 202 to clean, and turn off the cleaning system otherwise.

[0055] FIG. 3 illustrates a functional block diagram of example robot 202 in some implementations. As illustrated, robot 202 includes controller 254, memory 252, power supply 256, and operative units 250, each of which can be operatively and/or communicatively coupled to each other and each other's components and/or subcomponents. Controller 254 controls the various operations performed by robot 202. Although a specific implementation is illustrated in FIG. 3, the architecture may be varied in certain implementations as would be readily apparent to one of ordinary skill given the contents of the present disclosure.

[0056] Controller 254 can include one or more processors (e.g., microprocessors) and other peripherals. As used herein, the terms processor, microprocessor, and digital processor can include any type of digital processing devices such as, without limitation, digital signal

processors ("DSPs"), reduced instruction set computers ("RISC"), general-purpose ("CISC") processors, microprocessors, gate arrays (e.g., field programmable gate arrays ("FPGAs")), programmable logic device ("PLDs"), reconfigurable computer fabrics ("RCFs"), array processors, secure microprocessors, and application-specific integrated circuits ("ASICs"). Such digital processors may be contained on a single unitary integrated circuit die, or distributed across multiple components.

[0057] Controller 254 can be operatively and/or communicatively coupled to memory 252. Memory 252 can include any type of integrated circuit or other storage device adapted for storing digital data including, without limitation, read-only memory ("ROM"), random access memory ("RAM"), non-volatile random access memory ("NVRAM"), programmable read-only memory ("PROM"), electrically erasable programmable read-only memory ("EEPROM"), dynamic random-access memory ("DRAM"), Mobile DRAM, synchronous DRAM ("SDRAM"), double data rate SDRAM ("DDR/2 SDRAM"), extended data output RAM ("EDO"), fast page mode ("FPM") RAM, reduced latency DRAM ("RLDRAM"), static RAM ("SRAM"), flash memory (e.g., NAND/NOR), memristor memory, pseudostatic RAM ("PSRAM"), etc. Memory 252 can provide instructions and data to controller 254. For example, memory 252 can be a non-transitory, computer-readable storage medium having a plurality of instructions stored thereon, the instructions being executable by a processing apparatus (e.g., controller 254) to operate robot 202. In some cases, the instructions can be configured to, when executed by the processing apparatus, cause the processing apparatus to perform the various methods, features, and/or functionality described in this disclosure. Accordingly, controller 254 can perform logical and arithmetic operations based on program instructions stored within memory 252.

[0058] Operative units 250 can be coupled to controller 254, or any other controller, to perform the various operations described in this disclosure. One or more, or none, of the modules in operative units 250 can be included in some implementations. Throughout this disclosure, reference may be made to various controllers and/or processors. In some implementations, a single controller (e.g., controller 254) can serve as the various controllers and/or processors described. In other implementations, different controllers and/or processors can be used, such as controllers and/or processors used particularly for, and/or as part of, one or more of operative units 250. Controller 254 can send and/or receive signals, such as power

signals, control signals, sensor signals, interrogatory signals, status signals, data signals, electrical signals and/or any other desirable signals, including discrete and analog signals to operative units 250. Controller 254 can coordinate and/or manage operative units 250, and/or set timings (e.g., synchronously or asynchronously), turn on/off, control power budgets, receive/send network instructions and/or updates, update firmware, send interrogatory signals, receive and/or send statuses, and/or perform any operations for running features of robot 202.

[0059] Operative units 250 can include various units that perform functions for robot 202. For example, units of operative units 250 can include mapping and localization units 262, sensor units 264, actuator units 268, communication units 266, navigation units 276, and user interface units 272. Operative units 250 can also comprise other units that provide the various functionality of robot 202. In some cases, the units of operative units 250 can be instantiated in software or hardware and/or both software and hardware. For example, in some cases, units of operative units 250 can comprise computer-implemented instructions executed by a controller. In some cases, units of operative units 250 can comprise hardcoded logic. In some cases, units of operative units 250 can comprise both computer-implemented instructions executed by a controller and hardcoded logic. Where operative units 250 are implemented at least in part in software, operative units 250 can include units/modules of code configured to provide one or more functionalities.

[0060] In some implementations, sensor units 264 can comprise systems that can detect characteristics within and/or around robot 202. Sensor units 264 can include sensors that are internal to robot 202 or external, and/or have components that are partially internal and/or partially external. Sensors unit 314 can include exteroceptive sensors such as sonar, LIDAR, radar, lasers, video cameras, infrared cameras, 3D sensors, 3D cameras, and/or any other sensor known in the art. Sensor units 264 can also include proprioceptive sensors, such as accelerometers, inertial measurement units, odometers, gyroscopes, speedometers, and/or the like. In some implementations, sensor units 264 can collect raw measurements (e.g., currents, voltages, resistances gate logic, etc.) and/or transformed measurements (e.g., distances, angles, detected points in obstacles, etc.).

[0061] In some implementations, mapping and localization units 262 can include systems and methods that can computationally construct and update maps (e.g., maps 300,

and 400 as will be described with reference to FIGS. 4A and 4B, and/or any other map created by robot 202) of an environment and/or routes as robot 202 navigates the environment. By way of illustrative example, mapping and localization units 262 can map environment 200 and localize robot 202 (e.g., find the position and/or pose) in map 300 at one or more points in time. At the same time, mapping and localization units 262 can record a demonstrated route in map 300 (e.g., mapped route 306).

[0062] Mapping and localization units 262 can also receive sensor data from sensor units 264 to localize robot 202 in a map. In some implementations, mapping and localization units 262 can include localization systems and methods that allow robot 202 to localize itself in the coordinates of a map. As will be described further in this disclosure, mapping and localization units 262 can also process measurements taken by robot 202, such as by generating a graph and/or map.

[0063] In some implementations, communication units 266 can include one or more receivers, transmitters, and/or transceivers. Communication units 266 can be configured to send/receive a transmission protocol, such as BLUETOOTH®, ZIGBEE®, Wi-Fi, induction wireless data transmission, radio frequencies, radio transmission, radio-frequency identification ("RFID"), near-field communication ("NFC"), infrared, network interfaces, cellular technologies such as 3G (3GPP/3GPP2), high-speed downlink packet access ("HSDPA"), high-speed uplink packet access ("HSUPA"), time division multiple access ("TDMA"), code division multiple access ("CDMA") (e.g., IS-95A, wideband code division multiple access ("WCDMA"), etc.), frequency hopping spread spectrum ("FHSS"), direct sequence spread spectrum ("DSSS"), global system for mobile communication ("GSM"), Personal Area Network ("PAN") (e.g., PAN/802.15), worldwide interoperability for microwave access ("WiMAX"), 802.20, long term evolution ("LTE") (e.g., LTE/LTE-A), time division LTE ("TD-LTE"), global system for mobile communication ("GSM"), narrowband/frequency-division multiple access ("FDMA"), orthogonal frequency-division multiplexing ("OFDM"), analog cellular, cellular digital packet data ("CDPD"), satellite systems, millimeter wave or microwave systems, acoustic, infrared (e.g., infrared data association ("IrDA")), and/or any other form of wireless data transmission.

[0064] As used herein, network interfaces can include any signal, data, or software interface with a component, network, or process including, without limitation, those of the

FireWire (e.g., FW400, FW800, FWS800T, FWS1600, FWS3200, etc.), universal serial bus (“USB”) (e.g., USB 1.X, USB 2.0, USB 3.0, USB Type-C, etc.), Ethernet (e.g., 10/100, 10/100/1000 (Gigabit Ethernet), 10-Gig-E, etc.), multimedia over coax alliance technology (“MoCA”), Coaxsys (e.g., TVNET™), radio frequency tuner (e.g., in-band or OOB, cable modem, etc.), Wi-Fi (802.11), WiMAX (e.g., WiMAX (802.16)), PAN (e.g., PAN/802.15), cellular (e.g., 3G, LTE/LTE-A/TD-LTE/TD-LTE, GSM, etc.), IrDA families, etc. As used herein, Wi-Fi can include one or more of IEEE-Std. 802.11, variants of IEEE-Std. 802.11, standards related to IEEE-Std. 802.11 (e.g., 802.11 a/b/g/n/ac/ad/af/ah/ai/aj/aq/ax/ay), and/or other wireless standards.

[0065] Communication units 266 can also be configured to send/receive a transmission protocol over wired connections, such as any cable that has a signal line and ground. For example, such cables can include Ethernet cables, coaxial cables, Universal Serial Bus (“USB”), FireWire, and/or any connection known in the art. Such protocols can be used by communication units 266 to communicate to external systems, such as computers, smart phones, tablets, data capture systems, mobile telecommunications networks, clouds, servers, or the like. Communication units 266 can be configured to send and receive signals comprising of numbers, letters, alphanumeric characters, and/or symbols. In some cases, signals can be encrypted, using algorithms such as 128-bit or 256-bit keys and/or other encryption algorithms complying with standards such as the Advanced Encryption Standard (“AES”), RSA, Data Encryption Standard (“DES”), Triple DES, and the like. Communication units 266 can be configured to send and receive statuses, commands, and other data/information. For example, communication units 266 can communicate with a user controller to allow the user to control robot 202. Communication units 266 can communicate with a server/network in order to allow robot 202 to send data, statuses, commands, and other communications to the server. The server can also be communicatively coupled to computer(s) and/or device(s) that can be used to monitor and/or control robot 202 remotely. Communication units 266 can also receive updates (e.g., firmware or data updates), data, statuses, commands, and other communications from a server for robot 202 and/or its operative units 250.

[0066] In some implementations, one or more of operative units 250 may be instantiated remotely from robot 202. For example, mapping and localization units 262, may

be located in a cloud and/or connected to robot 202 through communication units 266. Connections can be direct and/or through a server and/or network. Accordingly, implementations of the functionality of this disclosure should also be understood to include remote interactions where data can be transferred using communication units 266, and one or more portions of processes can be completed remotely.

[0067] In some implementations, actuator units 268 can include actuators such as electric motors, gas motors, driven magnet systems, solenoid/ratchet systems, piezoelectric systems (e.g., inchworm motors), magnetostrictive elements, gesticulation, and/or any way of driving an actuator known in the art. By way of illustration, such actuators can actuate wheels or other displacement enabling drivers (e.g., mechanical legs, jet engines, propellers, hydraulics, etc.). For example, actuator units 268 can allow robot 202 to move and/or navigate through environment 200 and/or any other environment. In some cases, actuator units 268 can include actuators configured for actions and/or action-specific tasks, such as mobilizing brushes for floor cleaning, moving (e.g., moving up, down, left, right, forward, back) squeegees, turning on/off water, spraying water, turning on/off vacuums, moving vacuum hose positions, gesticulating an arm, raising/lowering a lift, turning a camera and/or any sensor of sensor units 264, and/or any movement desired for robot 202 to perform an action.

[0068] In some implementations, user interface units 272 can be configured to enable a user (e.g., user 604 or any other user) to interact with robot 202. For example, user interface units 272 can include touch panels, buttons, keypads/keyboards, ports (e.g., USB, Digital Visual Interface ("DVI"), Display Port, E-Sata, Firewire, PS/2, Serial, video graphics array ("VGA"), Small Computer System Interface ("SCSI"), audioport, High-Definition Multimedia Interface ("HDMI"), Personal Computer Memory Card International Association ("PCMCIA") ports, memory card ports (e.g., SD and miniSD), and/or ports for computer-readable media), mice, rollerballs, consoles, vibrators, audio transducers, and/or any interface for a user to input and/or receive data and/or commands, whether coupled wirelessly or through wires (including, without limitation, any of the wireless or wired connections described in this disclosure, such as with reference to communication units 266). User interface units 272 can include a display, such as, without limitation, Liquid Crystal Display ("LCDs"), Light-emitting Diode ("LED") displays, LED LCD displays, In-Plane Switching

("IPSS"), cathode ray tubes, plasma displays, High Definition ("HD") panels, 4K displays, retina displays, organic LED displays, touchscreens, surfaces, canvases, and/or any displays, televisions, monitors, panels, screens, and/or devices known in the art for visual presentation. In some implementations, user interface units 272 can be positioned on the body of robot 202. In some implementations, user interface units 272 can be positioned away from the body of robot 202, but can be communicatively coupled to robot 202 (e.g., via communication units 266) directly or indirectly (e.g., through a network or a cloud).

[0069] In some implementations, navigation units 276 can include components and/or software configured to provide directional instructions for robot 202 to navigate. Navigation units 276 can process maps and localization information generated by mapping and localization units 262, sensor data from sensor units 264, and/or other operative units 250. For example, navigation units 276 can receive map 300 from mapping and localization units 262. Navigation units 276 can also receive localization information from mapping and localization units 262, which can be indicative at least in part of the location of robot 202 within map 300, including route 306. Navigation units 276 can also receive sensor data from sensor units 264 which can be indicative at least in part of objects around robot 202. Using one or more of the map, location, and sensor data, navigation units 276 can instruct robot 202 where to navigate (e.g., go forward, left, right, back, and/or any other direction).

[0070] Navigation units 276 can also implement actions and/or action-specific tasks, such as mobilizing brushes for floor cleaning, moving (e.g., moving up, down, left, right, forward, back) squeegees, turning on/off water, spraying water, turning on/off vacuums, moving vacuum hose positions, gesticulating an arm, raising/lowering a lift, turning a camera and/or any sensor of sensor units 264, and/or any action taken by robot 202. In some cases, such actions and/or action-specific tasks can be indicated in a map and be executed by actuator units 268.

[0071] In some implementations, power supply 256 can include one or more batteries, including, without limitation, lithium, lithium ion, nickel-cadmium, nickel-metal hydride, nickel-hydrogen, carbon-zinc, silver-oxide, zinc-carbon, zinc-air, mercury oxide, alkaline, or any other type of battery known in the art. Certain batteries can be rechargeable, such as wirelessly (e.g., by a resonant circuit and/or a resonant tank circuit) and/or by plugging into an external power source. Power supply 256 can also be any supplier of

energy, including wall sockets and electronic devices that convert solar, wind, water, nuclear, hydrogen, gasoline, natural gas, fossil fuels, mechanical energy, steam, and/or any power source into electricity.

[0072] In some implementations, operating system 270 can be configured to manage memory 252, controller 254, power supply 256, modules in operative units 250, and/or any software, hardware and/or features of robot 202. For example, and without limitation, operating system 270 can include device drivers to manage hardware resources for robot 202.

[0073] As previously mentioned, any of the aforementioned components of robot 202 can be instantiated in software and/or hardware. For example, a unit/module can be a piece of hardware and/or a piece of code run on a computer.

[0074] FIG. 4A is a top view map 300 and route 306 generated by robot 202 as it travels in environment 200 in accordance with some implementations of this disclosure. In some implementations, the generation of map 300 can be performed by mapping and localization units 262. Map 300 can comprise pixels, wherein each pixel corresponds to a mapped area of environment 200. The number of pixels in map 300 can be determined based on the resolution of map 300. Map 300 can be substantially similar in layout as environment 200, where each pixel in map 300 can approximate a location in environment 200. Robot 202 can appear on map 300 as robot indicator 302. Each pixel can represent an area, which can be uniform or non-uniform. For example, a pixel could represent one area unit, a nxm or nxn area unit, or a non-uniform unit of area.

[0075] The mapping can be performed by imposing data obtained at least in part by sensor units 264 into a two-dimensional ("2D"), three-dimensional ("3D"), and/or four-dimensional ("4D") map representative at least in part of environment 200. For example, map 300 can include depictions representative at least in part of obstacles and/or objects detected by robot 202. Map 300 can also record demonstrated routes, such as routes robot 202 learned while under user control. For example, mapped route 322 can include coordinates (e.g., x and y in a 2D map and x, y, and z in a 3D map) based at least in part on the relative position, orientation, and/or pose of robot 202 (e.g., including one or more of location, displacement, and orientation) to a reference, such as initialization location 222. For example, pose can have (x, y, theta) coordinates. As used herein, the term position has its ordinary and customary meaning. For example, in some cases, position can include a location

in terms of displacement, coordinates, etc. of an object, robot 202, etc. In some cases, position can also include an orientation of an object, robot 202, etc. Accordingly, in some cases, the terms position and pose may be used interchangeably to include one or more of location, displacement, and orientation. Map 300, created through the demonstration process, can record part of and/or substantially the whole of the environment that robot 202 sensed in one or more demonstrations/trainings. For this reason, some may call map 300 a global map. In some cases, map 300 can be static in that after a demonstration/training, map 300 may not be substantially updated. In some implementations, map 300 and mapped route 306 can also be generated separately (e.g., by a user using a computer) and uploaded onto robot 202.

[0076] In some implementations, pixels (and/or voxels in 3D) of map 300 can have one or more states, where the pixel state is indicative at least in part of a characteristic of the position/location in environment 200 represented by that pixel. For example, pixels of map 300 can be binary, where a first pixel state (e.g., pixel value) is indicative at least in part of a clear (e.g., navigable) location, and a second pixel state is indicative at least in part of a blocked (e.g., not navigable) location. By way of illustration, a pixel value of zero (0) can be indicative at least in part of a clear location and a pixel value of one (1) can be indicative at least in part of a blocked location.

[0077] In some implementations, instead of or in addition to the aforementioned binary states, pixels of map 300 can have other pixels states such as one or more of: a pixel state indicative at least in part of an unknown location (e.g., a position/location with no information); a pixel state indicative at least in part of a position/location that should not be traveled to; a pixel state indicative at least in part of being part of a navigable route; a pixel state indicative at least in part of an area in which robot 202 has traveled; a pixel state indicative at least in part of an area to which robot 202 has not traveled; a pixel state indicative at least in part of an object; a pixel state indicative at least in part of standing water; and/or any other categorization of a position/location on map 300. In some implementations, a pixel state, and/or data associated with a pixel, can be indicative at least in part of actions and/or action-specific tasks, such as mobilizing brushes for floor cleaning, moving (e.g., moving up, down, left, right, forward, back) squeegees, turning on/off water, spraying water, turning on/off vacuums, moving vacuum hose positions, gesticulating an arm, raising/lowering a lift, turning a camera and/or any sensor of sensor units 264, and/or

any other action by robot 202.

[0078] Pixels of map 300 can also store more than a single value or pixel state. For example, each pixel of map 300 can store a plurality of values such as values stored in a vector and/or matrix. These values can include values indicative at least in part of the position/pose (e.g., including location and/or orientation) of robot 202 when the position is measured at a point (e.g., pixel) along route 306. These values can also include whether robot 202 should clean or not clean a position/location, and/or other actions/action-specific tasks that should be taken by robot 202.

[0079] Robot 202 can travel along a route (e.g., 206 pictured in FIG. 2), which can be reflected in map 300 as route 306. At each location robot 202 travels along the route, robot 202 can determine its position and/or orientation, in some cases relative to an initialization location (e.g., initialization location 222), home locator (e.g., home locator 220), and/or another reference point. These mapping and localization functions can be performed by mapping and localization units 262. The initialization location can be represented on map 300 as mapped position 322. In some cases, mapped position 322 can be determined relative to a home locator (which in some implementations can also be a pinpoint on map 300 and/or otherwise represented therein).

[0080] For example, robot 202 can measure or approximate its distance from initialization location 204 (or another reference point) using odometry, where it uses proprioceptive sensors of sensor units 264 (e.g., wheel encoders (e.g., rotary encoders), visual odometry, Inertial Measurement Units ("IMUs") (including accelerometers, magnetometers, angular rate sensors), and the like), to track the movements of robot 202 since starting at initialization location 202. By way of illustrative example, one or more of the proprioceptive sensors can be wheel encoders that measure and/or estimate distance based on the revolution of the wheels of robot 202. As another illustrative example, visual odometers can be used to measure or estimate the distance travelled and/or orientation of robot 202 through sequential images taken by a camera. The visual odometers can construct an optical flow field (e.g., using Lucas-Kanade methods or other methods) and/or estimate camera motion, such as by using Kalman filters or projection. As another non-limiting example, IMUs can be used to measure and/or estimate the position and/or orientation of robot 202.

[0081] Robot 202 can record route 306 in map 300, as robot indicator 302 (e.g., as seen in FIG. 6A and elsewhere) progresses along map 300 in a substantially similar way as robot 202 navigates through environment 200. Advantageously, in some implementations map 300 and route 306 can be created together, wherein robot 202 maps the environment 200 and records route 306 at substantially similar times. Accordingly, in some implementations, map 300 and route 306 can be paired together wherein each recorded route is stored only with a particular map.

[0082] Each location that is part of route 206 can correspond to a pixel on route 306 in map 300, where the pixel state of route 306 indicates the pixel is part of a navigable route. As robot 202 travels, robot 202 can also measure robot's 202 position and/or orientation relative to objects using one or more sensors units 264. These measures can be taken at discrete times and/or locations, represented as nodes. Robot 202 can also take scans using one or more of sensor units 264 to detect its environment. In this way, robot 202 can detect and/or measure the position and/or orientation of robot 202 relative to objects, such as shelves or walls.

[0083] In the case where robot 202 detects objects, robot 202 can use sensors units 264 to detect and/or measure the position and/or orientation of those objects in a plurality of directions relative to robot 202. At the same time, robot 202 can use sensors units 264 to estimate robot's 202 position and/or orientation. As robot 202 moves in the environment, different objects can come within the range of sensors of sensor units 264. For example, sensors can be positioned on front side of robot 202 and can have a predetermined range. For example, robot 202 can detect objects at a front side up to the predetermined range. Similarly, other sensors can each have ranges and detect objects within those ranges. These sensors can be positioned on the front, back, left side, right, side, bottom, top, and/or any combination of the foregoing.

[0084] In some cases, sensors units 264 may not sense certain areas. For example, an object can impede the availability of robot 202 to sense an area, or the area may appear in a blind spot (e.g., place not covered by the measuring range of the sensors).

[0085] The environment mapped in map 300 is a larger set than that illustrated in FIG. 2 as environment 200. Route 306 includes traversals of the aisles and other movements, including horizontally illustrated traversals through paths between aisles. As illustrated in

map 300, robot 202 can clean a floor while traversing the aisles, driving over each aisle a plurality of times.

[0086] In some cases, FIG. 4A can be a completed top view map 300 in accordance with some implementations of this disclosure. Robot 202 can begin and end at mapped position 322. The completed map 300 of FIG. 4A illustrates a completed, accurate map. However, it is not straight-forward to create a map substantially similar to the ground truth simply by plotting data collected by sensor units 264 on a map. Sensors of sensor units 264 have noise, measurement drift, etc. As a result, sensors of sensor units 264 may not always unambiguously identify features in the environment. Sensors of sensor units 264 may also not always unambiguously identify the position and/or pose of robot 202.

[0087] Because identification by sensor units 264 may not be unambiguous, robot 202 can probabilistically determine its position and/or the position of features of the environment 200. As robot 202 moves through environment 200 while mapping, it can record sensor data from sensor units 264 as well as internal robot commands (e.g., move forward, left, right, back, rotate, etc.). The sensor data from sensor units 264 can also be compared to itself or other data, such as through scan matching to determine the relative positions. As a result, robot 202 (e.g., using mapping and localization units 262) can build a posterior probability distribution function of a map given at least sensor data, scan matching, and the internal robot commands. Other factors may also be considered.

[0088] Because of the ambiguity in measurements, robot 202 can generate maps that do not reflect its surrounding and traveled routes if not corrected. FIG. 4B is a map 400 that does not accurately reflect the surrounding and traveled route of robot 202 in accordance with some implementations of this disclosure. Because of noise, sensor drift, and other factors, map 400 appears distorted. As a result, route 406 appears to go all over the place. The mapped environment around route 406 appears to spread out and overlap upon itself, with features that do not reflect the ground truth. By comparison, map 400 can be corrected into map 300, where map 400 is actually a map of the same environment and route as map 300; however, map 400 is distorted and map 300 more accurately reflects reality. As can be observed, environment actually comprises a series of aisles (e.g., appearing as columns).

[0089] FIG. 5 is a process flow diagram of an exemplary method 550 for creating a map in accordance with some implementations of the present disclosure. For example, block

552 includes creating a graph containing nodes. Block 554 includes constraining the graph to start and end at substantially the same location. Block 556 includes performing scan matching on extended scan groups determined from the scans at the nodes. Block 558 includes determining confidence in the location of each node. Block 560 includes creating and solving a cost function to determine the location of each node. Block 562 includes rendering a map from the scans from the located nodes. This process flow diagram is provided for illustrative purposes only. In some cases, one or more blocks can be omitted in the process. Moreover, as described in this disclosure, various other blocks may be added and/or or used in the alternative.

[0090] The creating a graph containing nodes of block 522 of FIG. 5 can be performed, in some cases, by mapping and localization unit 262 and/or controller 254 as robot 202 travels in an environment. By way of further illustration, FIG. 6A is a top view of a diagram comprising discretized measurements of robot 202 (illustrated in FIG. 2) along route 622 in graph 600 in accordance to some implementations of the present disclosure. Route 622 is used for illustrative purposes. In some cases, route 622 can be representative of a route and/or trajectory connecting nodes determined by robot 202, which is illustrated in the graph space of graph 600 as robot indicator 302, from the discrete nodes 602A – 602D. Accordingly, as illustrated in figures herein, routes are drawn for ease of reference, however, systems and methods described herein may be applied prior to and/or after routes are determined.

[0091] As robot 202 navigates along the route represented by route 622 illustrated in graph 600, it can take measurements at nodes 602A – 602D (again illustrated in the map space of graph 600), such as by using sensor units 264. A person having ordinary skill the art would appreciate that there can be a plurality of nodes, the number of which can be determined based at least in part on the resolution of sensors of sensor units 264, the speed of robot 202 (e.g., represented by robot indicator 302), the noise and/or error of the sensors of sensor units 264, predetermined tuning of robot 202 (e.g., setting node distance or time between establishing nodes), etc. FIG. 6A only illustrates one example configuration of example route 622. For example, the distance between nodes can be set as a predefined parameter in standard units (e.g., millimeters, centimeters, meters, inches, feet, etc.) or relative units (clicks, pixels, lengths, etc.). The distance can be determined based on the

resolution desired, which can be dependent on considerations of desired accuracy, storage size, noise, etc. For example, fewer nodes can take up less storage space, but provide less information than more nodes. The gathering of information from nodes 602A – 602D, and the one or more systems and methods used for mapping, can be performed by mapping and localization units 262 and/or controller 254.

[0092] Each of nodes 602A – 602D can represent positions of measurements (e.g., scans) by robot 202. Each of nodes 602A – 602D can be associated with a pose (e.g., including measurements such as (x, y, θ) of robot 202). The pose of robot 202 can be relative to a location and/or orientation (e.g., initialization location 222 and/or home locator 220) and/or features of environment 200. The pose can be determined from data obtained by laser scans, LIDAR, odometry, and/or any other sensor of sensor units 264. Moreover, in some cases, nodes can be positioned on substantially similar spots, such as, for example, when robot 202 passes by the same location a plurality of times.

[0093] Each of edges between nodes 602A – 602D can have an associated probabilistic function and/or probabilistic distribution, illustrated for each of nodes 602A – 602D as ranges 604A – 604D, respectively. In some cases, ranges 604A – 604D can be computed using a posterior probability distribution. In some cases, ranges 604A – 604D can be derived from the mean computed position plus the covariance. In some cases, the probability distribution can be computed using a Bayesian framework, where the uncertainties of the nodes can be stored in one or more data structures, such as matrices (e.g., covariance matrices). A person having ordinary skill in the art would appreciate that ranges 604A – 604D can also be computed using other statistical methods, such as the cross-variance, variance, chi-square distribution, and/or any other statistical methods used in, for example, Simultaneous Localization and Mapping (“SLAM”) and/or other techniques for determining pose known in the art. In some cases, ranges 604A – 604D can be representative, at least in part, of areas around each node 602A – 602D, wherein the actual location of robot 202 relative to graph 600 (e.g., illustrated as robot indicator 302) can be within the areas. For example, instead of node 602B being located as illustrated, node 602B can actually be located anywhere within range 604B, and with different poses, including positions and/or orientations, within range 604B. In some cases, each position within any one of ranges 604A–604D can have associated probabilities, wherein some positions are more

likely than other. In some cases, due to compounding noise, sensor drift, and other factors, subsequent ones of ranges 604A – 604D can become larger as seen from the position of robot indicator 302 as illustrated, representing more uncertainty of the positioning of nodes 602A – 602D. However, some factors, such as the identification of distinct features, scan matching, calibration, external identification, etc., can actually reduce the size of one or more ranges 604A – 604D as compared to preceding ones of ranges 604A – 604D.

[0094] FIG. 6B is a top view of a diagram of graph 650, which includes a continuation of route 622 of FIG. 6A in accordance with some implementations of this disclosure. As illustrated, robot 202 can begin, as represented on graph 650, at node 602A. Node 602A can be positioned relative to indicator 620, which can be the mapped/graphed position of a home locator. As described with reference to FIG. 6, robot 202 can map nodes 602A – 602D. However, one challenge that can occur is that errors can accumulate as robot continues on route 622. For example, ranges can continue to expand throughout as viewed from the location of node 622A (whose position may be determined relative to a home locator, such as indicator 620). By way of illustration, range 628 can be larger than range 604D, and range 624, associated with node 622B, can be even larger. Accordingly, with the larger ranges, there can be more ambiguity in the locations of those nodes. As a result, optimizing graph 650 using conventional SLAM and/or any other algorithm can be computationally expensive and/or inaccurate. The computation, time, and processing costs can be high in trying to find the optimization.

[0095] In some implementation, the constraining of the graph to start and end at substantially the same location of block 554 of FIG. 5 can be performed by mapping and localization unit 262 and/or controller 254. FIG. 6C illustrates a constraint for graph 690 from FIG. 6B in accordance with some implementations of the present disclosure, wherein the starting and ending locations are at the same and/or substantially the same location. Graph 690 illustrates the nodes from graph 650, where nodes 622A and 622B are now constrained to be in substantially the same location. In some implementations nodes 622A and 622B can be in the same and/or substantially the same location in order to constrain graph 690, and the nodes therein, to graphs that start and end at the same and/or substantially similar location. In some cases, graphs that end at the same and/or substantially the same can be determined by detection of a home locator as illustrated by indicator 620. In these cases,

where robot 202 detects the same home locator (e.g., represented by indicator 620 on graph 690) at the beginning and/or end of route 622, such detection can be indicative at least in part that nodes 622A and 622B are in the same and/or substantially the same location.

[0096] In some implementations, substantially similar can be predetermined, such as based on one or more thresholds relating to x-distances, y-distances, z-distances, angles, etc. For example, there can be distance and/or angle thresholds, such as those based on standard units (e.g., inches, meters, degrees, and/or other standard units) or relative units (e.g., clicks, pixels, lengths, etc.). The threshold can be determined based at least in part on the resolution of sensors of sensor units 264, noise from sensors of sensor units 264, sensor drift from sensors of sensor units 264, acceptable errors in graphing/mapping, empirical evidence of performance, view of a reference feature (e.g., home locator and/or other objects) and/or other factors.

[0097] Advantageously, this constraint can reduce ambiguity. Working from the known (and/or assumed) positions of nodes 622A and 622B, which are the start and end positions respectively, error propagation can then be taken in both directions. Accordingly, by way of illustration, range 626 is markedly reduced from the analogous node form FIG. 6B, and the largest range is elsewhere, such as range 628. Noticeably, this reduction of ambiguity of node locations can further reduce computation, time, and processing costs in optimizing graph 690 as compared to graph 650. Ranges 804A, 804B, and 804C will be discussed in further detail with reference to FIG. 8.

[0098] In some cases, confidence in a location can be determined through other methods, such as scan matching. By way of illustration, robot 202 can use scan matching, which can include registering a plurality of scans (e.g., laser scans) from sets of nodes to determine their relative positions. In some cases, scan matching can be used to determine the rigid-body transformation (e.g., using translations and/or rotations) that aligns best a scan and a graph/map, a scan and a scan, and/or a graph/map and a graph/map.

[0099] By way of illustration, a robot sensing an environment from two nodes, x_0 and x_1 , can obtain LIDAR scans z_0 and z_1 . These LIDAR scans can capture a scan of the environment. For example, provided some parts of the environment are visible from both x_0 and x_1 , scan matching can be used to find a rigid transform that will project the points z_1 so

that they align with z_0 . Scan matching, in some forms, has been used in mapping algorithms such as SLAM and others.

[00100] In some cases, the performing of scan matching on extended scan groups determined from the scans at the nodes of block 556 can be performed by mapping and localization unit 262 and/or controller 254. FIG. 7A is a process flow diagram of an exemplary method 700 for creating an extended scan group in accordance with some implementations of this disclosure. Block 720 includes selecting a root node. The root node can include a node from which other nodes are viewed (e.g., the position, distances, poses, angles, etc. and/or certainty relative to the root node). Block 722 includes finding possible overlaps in measurements from nodes. Overlaps of measurements from nodes can include overlaps where scans have features in common and/or are in close proximity. For example, overlap can include scans from nodes that have captured the same feature. By way of illustration, as robot 202 navigates, it can use sensor units 264 to take measurements in its environment. In some cases, such measurements can be done using a scan LIDAR. Accordingly, the scan LIDAR can take measurements of an object within its range as robot 202 navigates. Based on the proximity of the nodes where robot 202 takes scans, individual scans can capture the same object, but at different points in time and/or space (e.g., a first scan can include an object as robot 202 approaches it, a second scan can include the object as robot 202 is near it, a third scan can include the object as robot 202 passes it, a fourth scan can include the object as robot 202 moves further away, etc.). In this way, these overlapping measurements can capture different aspects of a same feature in an environment. Moreover, these measurements can also be substantially proximate in time and/or space. For example, proximity can include nodes that are sequentially next to each other, or within a predetermined number of nodes. Proximity can also include times that are within a predetermined threshold time, such as threshold times determined based at least in part on sensor resolution, capture times, the speed of robot 202, etc.

[00101] Block 724 includes creating groups of nodes based at least in part on overlaps to form extended scan groups. Each extended scan group can include a predetermined number of nodes, such as 2, 3, 4, 5, or more nodes. The number of nodes can be chosen based at least in part on the desired accuracy of scan matching, the data size of each scan, computational resources, etc. In many cases, three nodes can be used to balance the amount

of information provided by having more scans and the complexity of performing the scan matching.

[00102] In some cases, not every node may be in a group. Finding groups can further include only grouping nodes that include and/or are proximal to distinct features. Distinct features can include features that can be distinctive and/or identifiable. For example, hallways with nearly identical walls throughout may not include distinct features. By way of illustration, distinct features can include objects, obstacles, fixtures, and/or any aspect that can make a location distinguishable from at least some other locations. Advantageously, where only groups with distinct features are used, robot 202 can further reduce consumption of system resources by focusing on scan matches that will provide useful and/or less ambiguous information. Advantageously, reliance on the distinct features can reduce false positives.

[00103] In some cases, the same nodes may be used in multiple extended scan groups. In some cases, different extended scan groups can include the same nodes. However, in some cases, each node can be restricted to only being in one extended scan group. Accordingly, determining whether a node belongs in a particular group depends on one or more factors, included in various implementations. The relative weights of each of these factors as implemented can be adjusted between implementations based at least in part on the environment, distinct features (and/or lack thereof), empirical performance measures, etc. A first factor can include the amount of a distinct feature captured in a scan from a node. For example, if more measurements of a distinct feature are captured in a scan from a node, that scan from that node would be more likely to be included in an extended scan group with similarly more measurements of a distinct feature instead of other scans from other nodes that had fewer measures of the distinct feature. A second factor can include proximity to other nodes. Nodes that are in proximity to each other would be more likely to be included together in an extended scan group. Proximity can be based at least in part on distance and/or angle thresholds, determined based at least in part on sensor resolution, density of nodes (e.g., how many nodes are in a space, where proximity may be defined as closer in the situation where there are more nodes in a given space as compared to when there are fewer nodes in a given space), empirical results, etc. A third factor can include the presence of other distinct features within a scan. For example, a scan at a node can have measurements of

a plurality of distinct features. In order to optimize matches, having more extended scan groups can be favorable. Accordingly, where more scans are desired to complete extended scan groups, having scans with multiple distinct features assigned to sets of scans that would otherwise be too few to create an extended scan group would be preferable. In such a situation, robot 202 can be calibrated so it is more likely that more extended scan groups are produced. On the other hand, in other cases, having larger extended scan groups could be advantageous for the speed of computation. A fourth factor can include the size of the extended scan groups. As aforementioned, each extended scan group can be a predetermined sized. Accordingly, determining whether a particular scan from a node belongs with other scans from nodes is dependent on the size of the extended scan groups.

[00104] In some cases, recursive and/or iterative grouping algorithms can be used to match scans into extended scan groups. In some cases, based on one or more performance criteria, each set of extended scan groups can be evaluated. The performance criteria can be based on one or more of the above factors. In some cases, algorithms, such as the minimal cut, graph theory, and/or other grouping algorithms can be implemented to divide the nodes of a graph, and associated scans, into extended scan groups.

[00105] Once groups have been identified, a scan matcher (e.g., as part of mapping and localization units 262) can be used to determine locations and/or orientations of scans. FIG. 7B is a conceptual diagram of a scan matching transformation in accordance with some implementations of the present disclosure. In some cases, a plurality of nodes can be used in a scan matcher, forming an extended scan group. The extended scan group can be compared to other extended scan groups to determine relative translations (and as a result, locations) and/or rotations. Advantageously, the extended scan groups can provide more context (e.g., information, data, etc.) and/or improve one or more of: the speed of graph/map optimization, the accuracy of graphs/maps relative to the ground truth, and the computational and other resource costs of optimization. If a larger scan group has been matched to a location, robot 202 can have relatively high confidence in the location of the nodes involved in the scan matching. In some cases, such as the matching of an extended scan group to previous scans, the confidence can at least match that of the previous scan. In some cases, there can be greater confidence if the extended scan groups and the previous scans were recorded by robot 202 having substantially similar locations and/or orientations. Moreover, in some cases,

known information can be included, wherein the location of features in a graph are known a priori. Accordingly, such information can further increase confidence.

[00106] Scan matching can identify locations based at least in part on overlap of an extended scan group to another extended scan group. Overlap can be determined by algorithms known in the art, such as correlation, iterative comparisons, area of intersection, associations (e.g., point-to-point, point-to-feature, feature-to-feature, etc.), regression algorithms, closest point algorithms (e.g., Iterative Closest Point ("ICP")), nearest neighbor searching algorithms, and others.

[00107] By way of illustration, frame 702A illustrates nodes 708A, 710A, and 712A, as well as detected features 704A and 706A based on scans at nodes 708A, 710A, and 712A. Transform function 714 illustrates a rigid body transform, which can perform scan matching of frame 702A. Transform function 714 can perform translational and/or rotational movements of scans/nodes in frame 702A. As a result, frame 702B illustrates translated and rotated versions as nodes 708A, 710A, and 712A as nodes 708B, 710B, and 712, as well as translated and rotated versions of detected features 704A and 706A as detected features 704B and 706B. In some implementations, transform function 714 may not be a rigid body transform, wherein the relative positions of one or more of nodes 708A, 710A, and 712A and/or detected features 704A and 704B can change relative to one another.

[00108] In some cases, determining the confidence in the location of each node under block 558 of FIG. 5 can be performed by mapping and localization unit 262 and/or controller 254. FIG. 8 illustrates an example result of a scan matching of an extended scan group on the graph illustrated in FIG. 6C in accordance with some implementations of the present disclosure. Extended scan group 800 includes nodes 802A, 802B, and 802C. Because the scan matcher identified the positioning of nodes 802A, 802B, and 802C, their positions are determined with increased confidence. As a result, ranges 804A, 804B, and 804C may narrow, reflecting greater confidence. Accordingly, robot 202 can determine confidence based at least in part on scan matching, the propagation of errors (e.g., as reflected by ranges 602A, 602B, 602C, 602D, 626, and/or 628, and/or other ranges computed by robot 202), and/or other factors.

[00109] With the confidences determined, creating and solving a cost function to determine the location of each node under block 560 of FIG. 5 can be performed by mapping

and localization unit 262 and/or controller 254. In some cases, one or more nodes of a graph can have conceptual springs (e.g., connections) that characterize the spatial relationship between the nodes and the confidence in that relationship (e.g., in a covariance and/or other statistical categorization). The confidence can be based at least in part on the ranges illustrated in FIGS. 6A–6C and 8.

[00110] FIG. 9 illustrates springs to/from node 602A from graph 600 from FIG. 6A in accordance with some implementations of the present disclosure. As illustrated node 602A is connected to a plurality of nodes, including nodes 602B, 602C, and 602D by springs 650AB, 650AC, and 650AD. Node 602A can also be connected to any and/or all of the other nodes in the respective graph 600. However, in some cases, not all nodes of a map may be connected. Optionally, some nodes may be disconnected to prevent and/or mitigate the generation of unrealistic maps. For example, in some implementations, nodes can be selectively disconnected based at least in part on errors, exceeding a predetermined threshold uncertainty, being less than a predetermined threshold uncertainty, and/or any other predetermined constraints and/or restrictions.

[00111] Each of springs 950AB, 950AC, and 950AD can comprise one or more of: (1) a relative location between node 602A and the corresponding node at the other end (e.g., node 602D for spring 950AD, node 602C for spring 950AC, and node 602B for spring 950AB) and/or (2) a confidence of the relative positioning.

[00112] By way of illustration, the relative location can comprise a plurality of relative descriptions. In two-dimensions (e.g., such as those taken by a 2D scan), the relative location can comprise a horizontal direction, vertical direction, and/or an angle, such as in the form one or more of Δx , Δy , and $\Delta \theta$. Other ways of representing relative location are also contemplated, such as those with different coordinate systems and/or dimensions. For example, in three dimensions, relative location can be described in one or more of Δx , Δy , Δz , $\Delta \theta$, Δr , $\Delta \phi$, $\Delta \varphi$, etc. A person having ordinary skill in the art would appreciate that there are many ways to describe relative position and/or orientation in two, three, four, and/or any dimension. The confidence can be represented as a covariance matrix. By way of illustration, the covariance matrix can comprise the covariances between the elements of the location of the nodes (e.g., between node 602A and node 602D for spring 650AD, between node 602A and node 602C for spring 650AC, and between node 602A and node 602B for spring

650AB). In some implementations, confidence can also be represented with other statistical indicia known in the art, such as variances, sample variances, correlations, etc. The confidence can be dependent in part on ranges, such as ranges calculated with respect to FIGS. 6A–6C and 8.

[00113] In some cases, the springs can define a cost function, wherein optimizing a graph includes minimizing the potential energy of the system defined by the springs. In this way, finding the optimal map can also be described as minimizing the cost function and/or finding substantially the maximum likelihood position of each node (e.g., based on the probability distributions). Solving the cost function can utilize least-squares regression methods, non-linear least squares optimization, perturbation theory, weighted-least squares methods, Kalman Filters, and/or any other methods known in the art for solving the cost function. Substantially similar to physical springs, the equilibrium configuration is one where the net force on each node is equal to substantially zero and/or a local minimum. The springs can be represented as weights and/or orientations.

[00114] Once the position of the nodes in the graph (e.g., graph 600, 650, and/or 690, and/or any graph generated by robot 202), robot 202 can construct a map (e.g., map 300, 500A, and/or 500B, and/or any map generated by robot 202), such as by processing the graph with mapping and localization units 262.

[00115] The rendering of a map from scans from the located nodes of block 562 of FIG. 5 can be performed by mapping and localization unit 262 and/or controller 254. For example, FIG. 10 is a diagram of the pixels of a map being constructed from scans in accordance to some implementations of this disclosure. By way of illustration, matrix 1000 comprises cells that correspond to locations on a map. In some cases, each cell can correspond to a pixel. Nodes 1004A and 1004B in cells in matrix 1000, indicative at least in part of the relative location of Nodes 1004A and 1004B. The locations can be based on standard units from a reference point and/or coordinate system (e.g., centimeters, meters, and/or any other standard measurement) and/or relative units (e.g., pixels, clicks, and/or any other relative measurement). Nodes 1004A and 1004B are provided for illustrative purposes. The positioning, number, and/or spacing of nodes can be dependent on the scans taken by robot 202 as it traversed an environment.

[00116] Each scan can provide information indicative at least in part of the relative

location of objects around robot 202 at the nodes. In some cases, scans (e.g., scans from a scan LIDAR) can provide measurements to objects. For example, in some cases, ray tracing can be used, wherein the location of objects along rays extending from robot 202 across space can be used to identify the locations and/or orientations of objects. In matrix 1000, dotted lines such as line 1006 are indicative at least in part of rays. When an object is detected along a ray, the cell, such as cell 1002, can be marked. For visual illustration, mark 1008 is an "X" indicative at least in part that an object has been detected at the location corresponding to cell 1002.

[00117] In contrast, where a ray passes through a location with no object, the corresponding cell can be marked with an "O", such as illustrated with mark 1010. The cells corresponding to locations that rays have not passed through can have no mark. Other designations are contemplated. A person having ordinary skill in the art would appreciate that cells can be marked in any way desired. Additionally, more information can be associated with each cell, such as by associating each cell to another data structure and/or using a data structure with more dimensions. For example, additional information such as the location of the route by robot 202, performance of actions and/or action-specific tasks, characteristics of an environment (e.g., water, carpet, reflective, and/or any other description), prohibited areas, and/or others can also be associated with one or more cells. Such additional information can be derived from scans (e.g., from sensors of sensor units 264) and/or derived separately and inserted into the map. Such additional information can be added in at this stage and/or later after map construction.

[00118] Accordingly, through the plurality of ray tracings that can be observed from scans, the location of objects seen by robot 202 at various nodes can be mapped. Together, the accumulation of scans from nodes can create the map. In some cases, there can be overlap between scans at nodes. In some cases, such overlapping scans can agree on the positioning of objects. However, in some cases, overlapping scans can disagree and provide conflicting information. In some cases, these can be due in errors in measurements and/or moving objects. Accordingly, probabilities can be assigned to an identified cell. In some cases, the probability can be computed as the number of scans that detected an object (or in some cases, the scans that did not detect an object) divided by the total number of scans. In this way Other statistics can be used as well, such as weighted averages, statistical tests, variances,

and/or any other statistical method that reflects the uncertainty of conflicting information. In some cases, based on a predetermined statistical threshold, the presence and/or absence of objects can be determined in the map. For example, if the predetermined statistical threshold is met (either exceeded or not exceeded depending on how it is set), the location of the object will be filled in the generated map (e.g., maps 300, 500A, or 500B, and/or any other map generated by robot 202). By way of illustration, where the predetermined statistical threshold is a percentage, if the percentage of scans that identify an object in a location exceeds a predetermined percentage (e.g., 60, 70, 80, 90, and/or any other percentage based on the certainty desired), then the location will be identified as corresponding to an object in the map. As another illustration, in the case of identifying the absence of an object, if the percentage of scans that identify no object in a location exceeds a predetermined percentage (e.g., 60, 70, 80, 90, and/or any other percentage), then the location will be identified as no corresponding to an object (e.g., an empty space) in the map. A similar statistical analysis can be used in identifying any of the other/additional information described in this disclosure. A person having ordinary skill in the art would appreciate that the predetermined statistical thresholds can be defined in a number of ways, either in the positive (e.g., the presence of an object and/or characteristic) and/or the negative (e.g., the absence of an object and/or characteristic). Advantageously, taking a statistical approach can filter out moving objects, which may only appear in some scans but not others.

[00119] In some implementations, additionally process can be performed on a map and/or graph. For example, in some cases, pixel states can be indicative at least in part of whether robot 202 can navigate through an area. In some cases, certain locations may not have been adequately observed during demonstration, objects in the environment may have moved, and/or there can be uncertainty in measurements. Using user interface units 272, a user can edit a map and/or graph in order to add additional information. For example, a user can edit a map to identify areas in which robot 202 can traverse and/or areas in which robot 202 cannot traverse.

[00120] Robot 202 can learn from the users input. For example, robot 202 can store in memory 252 a library comprising one or more of: (i) original maps and/or graphs, (ii) maps and/or graphs with user input, (iii) other maps and/or graphs. In some cases, the library can be can contain approximately 1, 5, 10, 100, 1000, 10,000, 100,000, 1,000,000, 10,000,000, or

any number of maps and/or graphs. In some implementations, the library can be stored in a network (e.g., cloud, server, etc.) and may not be saved within memory 252. The library can be used (e.g., based on machine learning algorithms) to train robot 202 to determine one or more associations between original maps/graphs and maps/graphs with user input. In this way, robot 202 can learn what changes have been made due to user input in the library and make substantially similar changes when it comes across substantially similar scenarios.

[00121] In some implementations, robot 202 can also made changes to existing graphs and/or maps during subsequent navigations in an environment. For example, robot 202 can collect additional data and/or scans in a new graph and/or map and use that additional data and/or scans to supplement an existing graph and/or map.

[00122] By way of illustration, robot 202 can, in a first period of time, generate a first graph and/or map beginning at a first home locator and traveling along a first route. At a later, second period of time, robot 202 can travel along a substantially similar path to the first route beginning at the first home locator and generating a second graph and/or map thereto, except collecting data (e.g., scans) that was not collected in the first period of time. Advantageously, where robot 202 started at the first home locator in the first period and the second period of time, robot 202 can use its localization to tie scans together from the first graph and/or map and the second graph and/or map. In this way, robot 202 can add additional coverage to the first graph and/or map that was measured in the second graph and/or map, and/or vice versa.

[00123] In some implementations, where different home locators are used as beginning points for the first graph and/or map and the second graph and/or map, robot 202 can transform them into a common coordinate system in order to more easily combine scans from each.

[00124] FIG. 11 is a process flow diagram of an exemplary method 1100 for generating a map by a robot in accordance with some implementations of the present disclosure. Block 1102 includes traveling, by the robot, in an environment. Block 1104 includes creating a graph comprising a plurality of nodes, wherein each node corresponds to a scan taken by a sensor of the robot at a location in the environment. Block 1106 includes constraining the graph to start and end at a substantially similar location. Block 1108 includes performing scan matching on extended scan groups determined at least in part from

groups of the plurality of nodes. Block 1110 includes associating a range of possible locations with each of the plurality of nodes based at least in part on the scan matching. Block 1112 includes determining confidences associated with each range of possible locations. Block 1114 includes optimizing the graph to find the likely location of the plurality of nodes based at least in part on the confidences. Block 1116 includes generating the map from the optimized graph.

[00125] FIG. 12 is a process flow diagram of an exemplary method 1200 for operating a robot in accordance with some implementations of the present disclosure. Block 1202 includes causing a sensor to generate scans of an environment at a plurality of nodes, wherein each node of the plurality is associated with a location. Block 1204 includes creating a graph of the plurality of nodes based on the generated scans. Block 1206 includes determining extended scan groups based at least in part from scans associated with groups of the plurality of nodes. Block 1208 includes performing scan matching on the extended scan groups.

[00126] As used herein, computer and/or computing device can include, but are not limited to, personal computers ("PCs") and minicomputers, whether desktop, laptop, or otherwise, mainframe computers, workstations, servers, personal digital assistants ("PDAs"), handheld computers, embedded computers, programmable logic devices, personal communicators, tablet computers, mobile devices, portable navigation aids, J2ME equipped devices, cellular telephones, smart phones, personal integrated communication or entertainment devices, and/or any other device capable of executing a set of instructions and processing an incoming data signal.

[00127] As used herein, computer program and/or software can include any sequence or human or machine cognizable steps which perform a function. Such computer program and/or software may be rendered in any programming language or environment including, for example, C/C++, C#, Fortran, COBOL, MATLAB™, PASCAL, Python, assembly language, markup languages (e.g., HTML, SGML, XML, VoXML), and the like, as well as object-oriented environments such as the Common Object Request Broker Architecture ("CORBA"), JAVA™ (including J2ME, Java Beans, etc.), Binary Runtime Environment (e.g., BREW), and the like.

[00128] As used herein, connection, link, transmission channel, delay line, and/or wireless can include a causal link between any two or more entities (whether physical or

logical/virtual)), which enables information exchange between the entities.

[00129] It will be recognized that while certain aspects of the disclosure are described in terms of a specific sequence of steps of a method, these descriptions are only illustrative of the broader methods of the disclosure, and may be modified as required by the particular application. Certain steps may be rendered unnecessary or optional under certain circumstances. Additionally, certain steps or functionality may be added to the disclosed implementations, or the order of performance of two or more steps permuted. All such variations are considered to be encompassed within the disclosure disclosed and claimed herein.

[00130] While the above detailed description has shown, described, and pointed out novel features of the disclosure as applied to various implementations, it will be understood that various omissions, substitutions, and changes in the form and details of the device or process illustrated may be made by those skilled in the art without departing from the disclosure. The foregoing description is of the best mode presently contemplated of carrying out the disclosure. This description is in no way meant to be limiting, but rather should be taken as illustrative of the general principles of the disclosure. The scope of the disclosure should be determined with reference to the claims.

[00131] While the disclosure has been illustrated and described in detail in the drawings and foregoing description, such illustration and description are to be considered illustrative or exemplary and not restrictive. The disclosure is not limited to the disclosed embodiments. Variations to the disclosed embodiments can be understood and effected by those skilled in the art in practicing the claimed disclosure, from a study of the drawings, the disclosure and the appended claims.

[00132] It should be noted that the use of particular terminology when describing certain features or aspects of the disclosure should not be taken to imply that the terminology is being re-defined herein to be restricted to include any specific characteristics of the features or aspects of the disclosure with which that terminology is associated. Terms and phrases used in this application, and variations thereof, especially in the appended claims, unless otherwise expressly stated, should be construed as open ended as opposed to limiting. As examples of the foregoing, the term "including" should be read to mean "including, without limitation," "including but not limited to," or the like; the term "comprising" as used

herein is synonymous with “including,” “containing,” or “characterized by,” and is inclusive or open-ended and does not exclude additional, unrecited elements or method steps; the term “having” should be interpreted as “having at least;” the term “such as” should be interpreted as “such as, without limitation;” the term “includes” should be interpreted as “includes but is not limited to;” the term “example” is used to provide exemplary instances of the item in discussion, not an exhaustive or limiting list thereof, and should be interpreted as “example, but without limitation;” adjectives such as “known,” “normal,” “standard,” and terms of similar meaning should not be construed as limiting the item described to a given time period or to an item available as of a given time, but instead should be read to encompass known, normal, or standard technologies that may be available or known now or at any time in the future; and use of terms like “preferably,” “preferred,” “desired,” or “desirable,” and words of similar meaning should not be understood as implying that certain features are critical, essential, or even important to the structure or function of the present disclosure, but instead as merely intended to highlight alternative or additional features that may or may not be utilized in a particular embodiment. Likewise, a group of items linked with the conjunction “and” should not be read as requiring that each and every one of those items be present in the grouping, but rather should be read as “and/or” unless expressly stated otherwise. Similarly, a group of items linked with the conjunction “or” should not be read as requiring mutual exclusivity among that group, but rather should be read as “and/or” unless expressly stated otherwise. The terms “about” or “approximate” and the like are synonymous and are used to indicate that the value modified by the term has an understood range associated with it, where the range can be $\pm 20\%$, $\pm 15\%$, $\pm 10\%$, $\pm 5\%$, or $\pm 1\%$. The term “substantially” is used to indicate that a result (e.g., measurement value) is close to a targeted value, where close can mean, for example, the result is within 80% of the value, within 90% of the value, within 95% of the value, or within 99% of the value. Also, as used herein “defined” or “determined” can include “predefined” or “predetermined” and/or otherwise determined values, conditions, thresholds, measurements, and the like.

Electronic Acknowledgement Receipt	
EFS ID:	35450149
Application Number:	16356160
International Application Number:	
Confirmation Number:	4530
Title of Invention:	SYSTEMS AND METHODS FOR ROBOTIC MAPPING
First Named Inventor/Applicant Name:	Jaldert Rombouts
Customer Number:	26418
Filer:	Sidharth Kapoor/Cody Nye
Filer Authorized By:	Sidharth Kapoor
Attorney Docket Number:	P23291US01
Receipt Date:	18-MAR-2019
Filing Date:	
Time Stamp:	13:31:04
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment		no			
File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Application Data Sheet	P23291US01_-_2019-03-18_-_ADS.PDF	1256399	no	9
			c73293dcc6fcdf43037c5f2ecd5785c88fbc930		
Warnings:					

Information:					
2	Preliminary Amendment	P23291US01_-_2019-03-18_-_Preliminary_Amendment.PDF	496079 <div>477cbc92353164f1cf611cf9f01b72c919efdbf5</div>	no	3
Warnings:					
Information:					
3	Oath or Declaration filed	P23291US01_-_2019-03-18_-_Declarations.PDF	229252 <div>94cb63d3e512f052c42ef1d2bfc43b56ca69e9ae</div>	no	4
Warnings:					
Information:					
4		P23291US01_-_2019-03-18_-_Specification_and_Drawings.pdf	17466183 <div>f7fc80dccef1571912c84d793a9a58c764baa15f</div>	yes	57
	Multipart Description/PDF files in .zip description				
	Document Description		Start	End	
	Drawings-only black and white line drawings		42	57	
	Abstract		41	41	
	Claims		38	40	
	Specification		1	37	
Warnings:					
Information:					
Total Files Size (in bytes):			19447913		

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

New Applications Under 35 U.S.C. 111

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

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

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

New International Application Filed with the USPTO as a Receiving Office

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

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	P23291US01
		Application Number	
Title of Invention	SYSTEMS AND METHODS FOR ROBOTIC MAPPING		
The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76. This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.			

Secrecy Order 37 CFR 5.2:

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

Inventor Information:

Inventor	1				Remove	
Legal Name						
Prefix	Given Name	Middle Name	Family Name	Suffix		
	Jaldert		Rombouts			
Residence Information (Select One) • US Residency Non US Residency Active US Military Service						
City	San Diego	State/Province	CA	Country of Residence ⁱ	US	
Mailing Address of Inventor:						
Address 1	8006 Regents Rd. #204					
Address 2						
City	San Diego	State/Province	CA			
Postal Code	92122	Country ⁱ	US			
Inventor	2				Remove	
Legal Name						
Prefix	Given Name	Middle Name	Family Name	Suffix		
	Borja	Ibarz	Gabardos			
Residence Information (Select One) ○ US Residency • Non US Residency Active US Military Service						
City	London	Country of Residence ⁱ	GB			
Mailing Address of Inventor:						
Address 1	Flat 40, Tavistock Court					
Address 2	Tavistock Square					
City	London	State/Province				
Postal Code	WC1H 9HG	Country ⁱ	GB			
Inventor	3				Remove	
Legal Name						
Prefix	Given Name	Middle Name	Family Name	Suffix		
	Jean-Baptiste		Passot			

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	P23291US01
		Application Number	
Title of Invention	SYSTEMS AND METHODS FOR ROBOTIC MAPPING		

Residence Information (Select One) ☒ US Residency ☐ Non US Residency ☐ Active US Military Service			
City	Solana Beach	State/Province	CA Country of Residence US

Mailing Address of Inventor:

Address 1	930 Via Mil Cumbres, Unit #172		
Address 2			
City	Solana Beach	State/Province	CA
Postal Code	92075	Country i	US
Inventor	4	<input type="button" value="Remove"/>	

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Andrew		Smith	

Residence Information (Select One) ☒ US Residency ☐ Non US Residency ☐ Active US Military Service			
City	San Diego	State/Province	CA Country of Residence US

Mailing Address of Inventor:

Address 1	9360 Galvin Ave.		
Address 2			
City	San Diego	State/Province	CA
Postal Code	92126	Country i	US

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

Correspondence Information:

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

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

Customer Number	26418		
Email Address	ptoipinbox@reedsmith.com	<input type="button" value="Add Email"/>	<input type="button" value="Remove Email"/>

Application Information:

Title of the Invention	SYSTEMS AND METHODS FOR ROBOTIC MAPPING		
Attorney Docket Number	P23291US01	Small Entity Status Claimed ☒	
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	16	Suggested Figure for Publication (if any)	

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	P23291US01
		Application Number	
Title of Invention	SYSTEMS AND METHODS FOR ROBOTIC MAPPING		

Filing By Reference:

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

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

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

Publication Information:

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

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

Representative Information:

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

Please Select One:	☒ Customer Number	US Patent Practitioner	☐ Limited Recognition (37 CFR 11.9)
Customer Number	26418		

Domestic Benefit/National Stage Information:

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

When referring to the current application, please leave the "Application Number" field blank.

Prior Application Status	Pending	Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
	Continuation of	15340807	2016-11-01
Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the Add button.			Add

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	P23291US01
		Application Number	
Title of Invention	SYSTEMS AND METHODS FOR ROBOTIC MAPPING		

Foreign Priority Information:

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

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

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

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

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.

NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	P23291US01
		Application Number	
Title of Invention	SYSTEMS AND METHODS FOR ROBOTIC MAPPING		

Authorization or Opt-Out of Authorization to Permit Access:

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

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

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

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

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

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

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

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

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

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

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	P23291US01
		Application Number	
Title of Invention	SYSTEMS AND METHODS FOR ROBOTIC MAPPING		

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.			
Applicant	1		Remove
<p>If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.</p>			
		Clear	
☒ Assignee	Legal Representative under 35 U.S.C. 117		Joint Inventor
Person to whom the inventor is obligated to assign.		Person who shows sufficient proprietary interest	
If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:			
<div style="border: 1px solid black; height: 20px; width: 100%;"></div>			
Name of the Deceased or Legally Incapacitated Inventor: <div style="border: 1px solid black; height: 20px; width: 100%;"></div>			
If the Applicant is an Organization check here. ☒			
Organization Name	BRAIN CORPORATION		
Mailing Address Information For Applicant:			
Address 1	9401 Waples Street		
Address 2	Suite 100		
City	San Diego	State/Province	CA
Country	US	Postal Code	92121
Phone Number		Fax Number	
Email Address			
Additional Applicant Data may be generated within this form by selecting the Add button.			Add

Assignee Information including Non-Applicant Assignee Information:

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

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	P23291US01
		Application Number	
Title of Invention	SYSTEMS AND METHODS FOR ROBOTIC MAPPING		

Assignee	1			
Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.				
				<input type="button" value="Remove"/>
If the Assignee or Non-Applicant Assignee is an Organization check here. ☐				
Prefix	Given Name	Middle Name	Family Name	Suffix
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Mailing Address Information For Assignee including Non-Applicant Assignee:				
Address 1	<input type="text"/>			
Address 2	<input type="text"/>			
City	<input type="text"/>	State/Province	<input type="text"/>	
Country ⁱ	<input type="text"/>	Postal Code	<input type="text"/>	
Phone Number	<input type="text"/>	Fax Number	<input type="text"/>	
Email Address	<input type="text"/>			
Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button.				<input type="button" value="Add"/>

Signature:

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

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

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

Signature	/Sidharth Kapoor/		Date (YYYY-MM-DD)	2019-03-18
First Name	Sidharth	Last Name	Kapoor	Registration Number
				68159
Additional Signature may be generated within this form by selecting the Add button.				<input type="button" value="Add"/>

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	P23291US01
		Application Number	
Title of Invention	SYSTEMS AND METHODS FOR ROBOTIC MAPPING		

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

Privacy Act Statement

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

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

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

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Jaldert Rombouts et al. Attorney Docket No. P23291US01

Serial No.: Not Yet Assigned

Filed: Herewith

For: SYSTEMS AND METHODS FOR ROBOTIC MAPPING

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

FIRST PRELIMINARY AMENDMENT

Prior to examination of the above application, please enter this Preliminary Amendment.

Amendments to the Specification are on page 2;

Remarks are on page 3.

AMENDMENTS TO THE SPECIFICATION

Please add the following paragraph immediately after the title of the invention in the specification:

Cross-reference and Related Applications

This application is a continuation of U.S. Patent Application Serial No. 15/340,807, filed November 1, 2016, and is incorporated herein by reference in its entirety.

REMARKS

With entry of the foregoing amendment, the specification has been amended to add the priority information. No new matter is added by this amendment.

Date: March 18, 2019

Respectfully submitted,

REED SMITH LLP

/Sidharth Kapoor/

Sidharth Kapoor

Reg. No. 68,159

skapoor@reedsmith.com

Customer Number 26418

Reed Smith LLP

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875						Application or Docket Number 16/356,160				
APPLICATION AS FILED - PART I										
(Column 1)		(Column 2)		SMALL ENTITY		OR OTHER THAN SMALL ENTITY				
FOR	NUMBER FILED	NUMBER EXTRA	RATE(\$)	FEE(\$)		RATE(\$)	FEE(\$)			
BASIC FEE <small>(37 CFR 1.16(a), (b), or (c))</small>	N/A	N/A	N/A	75		N/A				
SEARCH FEE <small>(37 CFR 1.16(k), (l), or (m))</small>	N/A	N/A	N/A	330		N/A				
EXAMINATION FEE <small>(37 CFR 1.16(o), (p), or (q))</small>	N/A	N/A	N/A	380		N/A				
TOTAL CLAIMS <small>(37 CFR 1.16(j))</small>	20	minus 20 = *	x 50 =	0.00	OR					
INDEPENDENT CLAIMS <small>(37 CFR 1.16(h))</small>	3	minus 3 = *	x 230 =	0.00						
APPLICATION SIZE FEE <small>(37 CFR 1.16(s))</small>	If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$310 (\$155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			0.00						
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				0.00						
			TOTAL	785		TOTAL				
* If the difference in column 1 is less than zero, enter "0" in column 2.										
APPLICATION AS AMENDED - PART II										
(Column 1)		(Column 2)		(Column 3)		SMALL ENTITY		OR OTHER THAN SMALL ENTITY		
AMENDMENT A		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE(\$)	ADDITIONAL FEE(\$)		RATE(\$)	ADDITIONAL FEE(\$)
	Total <small>(37 CFR 1.16(i))</small>	*	Minus	**	=	x	=	OR	x	=
	Independent <small>(37 CFR 1.16(h))</small>	*	Minus	***	=	x	=	OR	x	=
	Application Size Fee (37 CFR 1.16(s))							OR		
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	
AMENDMENT B		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE(\$)	ADDITIONAL FEE(\$)		RATE(\$)	ADDITIONAL FEE(\$)
	Total <small>(37 CFR 1.16(i))</small>	*	Minus	**	=	x	=	OR	x	=
	Independent <small>(37 CFR 1.16(h))</small>	*	Minus	***	=	x	=	OR	x	=
	Application Size Fee (37 CFR 1.16(s))							OR		
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	
* If the entry in column 1 is less than the entry in column 2, write "0" in column 3. ** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20". *** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3". The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.										



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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY DOCKET NO	TOT CLAIMS	IND CLAIMS
16/356,160	03/18/2019		0.00	P23291US01	20	3

CONFIRMATION NO. 4530

FILING RECEIPT



26418
REED SMITH LLP
P.O. BOX 488 (NYC)
PITTSBURGH, PA 15230-0488

Date Mailed: 04/04/2019

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

Inventor(s)

Jaldert Rombouts, San Diego, CA;
Borja Ibarz Gabardos, London, UNITED KINGDOM;
Jean-Baptiste Passot, Solana Beach, CA;
Andrew Smith, San Diego, CA;

Applicant(s)

BRAIN CORPORATION, San Diego, CA;

Power of Attorney: None

Domestic Priority data as claimed by applicant

This application is a CON of 15/340,807 11/01/2016

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

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

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

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

If Required, Foreign Filing License Granted: 04/03/2019

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 16/356,160**

Projected Publication Date: To Be Determined - pending completion of Missing Parts

Non-Publication Request: No

Early Publication Request: No

**** SMALL ENTITY ****

Title

SYSTEMS AND METHODS FOR ROBOTIC MAPPING

Preliminary Class

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

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

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

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

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

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

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

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Title 37, Code of Federal Regulations, 5.11 & 5.15

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NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

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Alexandria, Virginia 22313-1450
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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/356,160	03/18/2019	Jaldert Rombouts	P23291US01

CONFIRMATION NO. 4530

FORMALITIES LETTER



OC000000107097463

26418
REED SMITH LLP
P.O. BOX 488 (NYC)
PITTSBURGH, PA 15230-0488

Date Mailed: 04/04/2019

NOTICE TO FILE MISSING PARTS OF NONPROVISIONAL APPLICATION

FILED UNDER 37 CFR 1.53(b)

Filing Date Granted

Items Required To Avoid Abandonment:

An application number and filing date have been accorded to this application. The item(s) indicated below, however, are missing. Applicant is given **TWO MONTHS** from the date of this Notice within which to file all required items below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

- The statutory basic filing fee is missing.
- The application search fee must be submitted.
- The application examination fee must be submitted.
- Surcharge as set forth in 37 CFR 1.16(f) must be submitted.

The surcharge is due for any one of:

- late submission of the basic filing fee, search fee, or examination fee,
- late submission of inventor's oath or declaration,
- filing an application that does not contain at least one claim on filing, or
- submission of an application filed by reference to a previously filed application.

SUMMARY OF FEES DUE:

The fee(s) required within **TWO MONTHS** from the date of this Notice to avoid abandonment is/are itemized below. Small entity discount is in effect. If applicant is qualified for micro entity status, an acceptable Certification of Micro Entity Status must be submitted to establish micro entity status. (See 37 CFR 1.29 and forms PTO/SB/15A and 15B.)

- \$ **75** basic filing fee.
- \$ **80** surcharge.
- \$ **330** search fee.
- \$ **380** examination fee.
- \$(**0**) previous unapplied payment amount.
- \$ **865** TOTAL FEE BALANCE DUE.

Replies must be received in the USPTO within the set time period or must include a proper Certificate of Mailing or Transmission under 37 CFR 1.8 with a mailing or transmission date within the set time period. For more information and a suggested format, see Form PTO/SB/92 and MPEP 512.

Replies should be mailed to:

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

/fhadera/

TRANSMITTAL FOR POWER OF ATTORNEY TO ONE OR MORE REGISTERED PRACTITIONERS

NOTE: This form is to be submitted with the Power of Attorney by Applicant form (PTO/AIA/82B) to identify the application to which the Power of Attorney is directed, in accordance with 37 CFR 1.5, unless the application number and filing date are identified in the Power of Attorney by Applicant form. If neither form PTO/AIA/82A nor form PTO/AIA/82B identifies the application to which the Power of Attorney is directed, the Power of Attorney will not be recognized in the application.

Application Number	16/356,160
Filing Date	3-18-2019
First Named Inventor	Jaldert Rombouts
Title	SYSTEMS AND METHODS FOR ROBOTIC MAPPING
Art Unit	
Examiner Name	
Attorney Docket Number	P23291US01

SIGNATURE of Applicant or Patent Practitioner

Signature	/Sidharth Kapoor/	Date (Optional)	05/03/2019
Name	Sidharth Kapoor	Registration Number	68159
Title (if Applicant is a juristic entity)			
Applicant Name (if Applicant is a juristic entity)			

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. If more than one applicant, use multiple forms.



*Total of 1 forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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

POWER OF ATTORNEY BY APPLICANT

I hereby revoke all previous powers of attorney given in the application identified in either the attached transmittal letter or the boxes below.

Application Number	Filing Date

(Note: The boxes above may be left blank if information is provided on form PTO/AIA/82A.)

- ☒ I hereby appoint the Patent Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above: 26418
- OR
- ☐ I hereby appoint Practitioner(s) named in the attached list (form PTO/AIA/82C) as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the patent application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above. (Note: Complete form PTO/AIA/82C.)

Please recognize or change the correspondence address for the application identified in the attached transmittal letter or the boxes above to:

- ☒ The address associated with the above-mentioned Customer Number

OR

- ☐ The address associated with Customer Number:

OR

- ☐ Firm or
Individual Name

Address

City

State

Zip

Country

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Email

I am the Applicant (if the Applicant is a juristic entity, list the Applicant name in the box):

Brain Corp

- ☐ Inventor or Joint Inventor (title not required below)
- ☐ Legal Representative of a Deceased or Legally Incapacitated Inventor (title not required below)
- ☒ Assignee or Person to Whom the Inventor is Under an Obligation to Assign (provide signer's title if applicant is a juristic entity)
- ☐ Person Who Otherwise Shows Sufficient Proprietary Interest (e.g., a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document) (provide signer's title if applicant is a juristic entity)

SIGNATURE of Applicant for Patent

The undersigned (whose title is supplied below) is authorized to act on behalf of the applicant (e.g., where the applicant is a juristic entity).

Signature

Date (Optional)

Name

Andy Ng

Title

General Counsel

NOTE: Signature - This form must be signed by the applicant in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. If more than one applicant, use multiple forms.

- ☒ Total of 1 forms are submitted.

This collection of information is required by 37 CFR 1.151, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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Electronic Patent Application Fee Transmittal				
Application Number:		16356160		
Filing Date:		18-Mar-2019		
Title of Invention:		SYSTEMS AND METHODS FOR ROBOTIC MAPPING		
First Named Inventor/Applicant Name:		Jaldert Rombouts		
Filer:		Sidharth Kapoor/Cody Nye		
Attorney Docket Number:		P23291US01		
Filed as Small Entity				
Filing Fees for Utility under 35 USC 111(a)				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
UTILITY FILING FEE (ELECTRONIC FILING)	4011	1	75	75
UTILITY SEARCH FEE	2111	1	330	330
UTILITY EXAMINATION FEE	2311	1	380	380
Pages:				
Claims:				
Miscellaneous-Filing:				
LATE FILING FEE FOR OATH OR DECLARATION	2051	1	80	80
Petition:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				865

Electronic Acknowledgement Receipt	
EFS ID:	35913074
Application Number:	16356160
International Application Number:	
Confirmation Number:	4530
Title of Invention:	SYSTEMS AND METHODS FOR ROBOTIC MAPPING
First Named Inventor/Applicant Name:	Jaldert Rombouts
Customer Number:	26418
Filer:	Sidharth Kapoor/Cody Nye
Filer Authorized By:	Sidharth Kapoor
Attorney Docket Number:	P23291US01
Receipt Date:	03-MAY-2019
Filing Date:	18-MAR-2019
Time Stamp:	14:32:03
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	\$865
RAM confirmation Number	050619INTEFSW14322501
Deposit Account	
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Applicant Response to Pre-Exam Formalities Notice	P23291US01_-_2019-05-03_-_Response_to_Missing_Parts.PDF	459615	no	1
			a6b22ef2a6258a21266a7afe477704c1987be9c		
Warnings:					
Information:					
2	Preliminary Amendment	P23291US01_-_2019-05-03_-_Preliminary_Amendment.PDF	499764	no	5
			2bf1ced1e5b07a20eb36a3c17b83e2dc54bd501		
Warnings:					
Information:					
3	Power of Attorney	P23291US01_-_2019-05-03_-_POA.PDF	1041111	no	2
			aa6cc395997e30ffb3c7bde9aa9f607e5edcd41		
Warnings:					
Information:					
4	Fee Worksheet (SB06)	fee-info.pdf	37259	no	2
			a11277370ea2b1e9d53120024fde0e74a921d9fd		
Warnings:					
Information:					
Total Files Size (in bytes):			2037749		

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

New Applications Under 35 U.S.C. 111

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

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

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

New International Application Filed with the USPTO as a Receiving Office

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

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Jaldert Rombouts et al. Attorney Docket No. P23291US01

Serial No.: 16/356,160

Filed: March 18, 2019

For: SYSTEMS AND METHODS FOR ROBOTIC MAPPING

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

SECOND PRELIMINARY AMENDMENT

Prior to examination of the above application, please enter this Preliminary Amendment.

Amendments to the Claims are on page 2; and

Remarks are on page 5.

AMENDMENTS TO THE CLAIMS

Claims 1-20 Cancelled

21. (New) A system for traveling a robot along a route, comprising:
- a memory having computer readable instructions stored thereon; and
- at least one processor configured to execute the computer readable instructions to,
- collect data by at least one sensor coupled to the robot as the robot travels along the route in an environment,
- generate a map of the environment and a virtual route on the map in real-time and concurrently with the collection of the data as the robot travels along the route in the environment, the map corresponding to a virtual representation of the environment, the map including information directed to location and position of the robot along the route in the environment, and
- associate actions undertaken by the robot during traveling along the route with the location and position of the robot on virtual route on the map.

22. (New) The system of claim 21, wherein the map is either a two-dimensional or three-dimensional representation of the environment, the map includes information directed to location and position of the robot along the route in the environment and obstacles detected by the at least one sensor in the environment.

23. (New) The system of claim 21, wherein the at least one processor is further configured to execute the computer readable instructions to,

estimate distance traveled by the robot along the route based on revolution of wheels on the robot.

24. (New) The system of claim 21, wherein the at least one processor is further configured to execute the computer readable instructions to,
estimate distance traveled by the robot along the route based on sequential images captured by the at least one sensor.

25. (New) The system of claim 21, wherein the least one processor is further configured to execute the computer readable instructions to,
determine the robot has returned to a start position based on detecting a home locator in the environment.

26. (New) The system of claim 21, wherein the least one processor is further configured to execute the computer readable instructions to,
limit uncertainty of positioning of a plurality of nodes along the route traveled by the robot based on constraining start and end positions of the robot at a same point.

27. (New) The system of claim 26, wherein each node of the plurality of nodes include an associated probabilistic distribution which correspond to surrounding region around each node of the plurality of nodes.

28. (New) A method for traveling a robot along a route, comprising:

collecting data by at least one sensor coupled to the robot as the robot travels along the route in an environment;

generating a map of the environment and a virtual route on the map in real-time and concurrently with the collection of the data as the robot travels along the route in the environment, the map corresponding to a virtual representation of the environment, the map including information directed to location and position of the robot along the route in the environment; and

associating actions undertaken by the robot during traveling along the route with the location and position of the robot on virtual route on the map.

29. (New) A non-transitory computer readable medium having computer readable instructions stored thereon that when executed by at least one processor configure the at least one processor to,

collect data by at least one sensor coupled to the robot as the robot travels along the route in an environment;

generate a map of the environment and a virtual route on the map in real-time and concurrently with the collection of the data as the robot travels along the route in the environment, the map corresponding to a virtual representation of the environment, the map including information directed to location and position of the robot along the route in the environment; and

associate actions undertaken by the robot during traveling along the route with the location and position of the robot on virtual route on the map.

REMARKS

With entry of the foregoing amendment, Claims 1-20 are cancelled and claims 21-29 are added. No new matter is added by this amendment.

Date: May 3, 2019

Respectfully submitted,

REED SMITH LLP

/Sidharth Kapoor/

Sidharth Kapoor

Reg. No. 68,159

skapoor@reedsmith.com

Customer Number 26418

Reed Smith LLP

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Jaldert Rombouts et al.

Confirmation No. 4530

Serial No. 16/356,160

Filing Date: March 18, 2019

Attorney Docket No.: P23291US01

**SYSTEMS AND METHODS FOR
ROBOTIC MAPPING**

**RESPONSE TO NOTICE TO FILE MISSING PARTS OF NONPROVISIONAL
APPLICATION**

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

Dear Sir:

This is in response to the Notice To File Missing Parts Of Non-Provisional Application mailed by the U.S. Patent Office on April 4, 2019. This paper is being timely filed by June 4, 2019.

Applicant submits herewith the fees totaling \$865.00.

Date: May 3, 2019

Respectfully submitted,

/Sidarth Kapoor /
Sidarth Kapoor
Registration No. 68,159
REED SMITH LLP
136 Main Street
Suite 250
Princeton, NJ 08540
T – 609-524-2077
Attorney for Applicant

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875						Application or Docket Number 16/356,160				
APPLICATION AS FILED - PART I										
(Column 1)		(Column 2)		SMALL ENTITY		OR OTHER THAN SMALL ENTITY				
FOR	NUMBER FILED	NUMBER EXTRA	RATE(\$)	FEE(\$)		RATE(\$)	FEE(\$)			
BASIC FEE <small>(37 CFR 1.16(a), (b), or (c))</small>	N/A	N/A	N/A	75		N/A				
SEARCH FEE <small>(37 CFR 1.16(k), (l), or (m))</small>	N/A	N/A	N/A	330		N/A				
EXAMINATION FEE <small>(37 CFR 1.16(o), (p), or (q))</small>	N/A	N/A	N/A	380		N/A				
TOTAL CLAIMS <small>(37 CFR 1.16(j))</small>	20	minus 20 = *	x 50 =	0.00	OR					
INDEPENDENT CLAIMS <small>(37 CFR 1.16(h))</small>	3	minus 3 = *	x 230 =	0.00						
APPLICATION SIZE FEE <small>(37 CFR 1.16(s))</small>	If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$310 (\$155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			0.00						
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				0.00						
			TOTAL	785		TOTAL				
* If the difference in column 1 is less than zero, enter "0" in column 2.										
APPLICATION AS AMENDED - PART II										
(Column 1)		(Column 2)		(Column 3)		SMALL ENTITY		OR OTHER THAN SMALL ENTITY		
AMENDMENT A		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE(\$)	ADDITIONAL FEE(\$)		RATE(\$)	ADDITIONAL FEE(\$)
	Total <small>(37 CFR 1.16(i))</small>	*	Minus	**	=	x	=	OR	x	=
	Independent <small>(37 CFR 1.16(h))</small>	*	Minus	***	=	x	=	OR	x	=
	Application Size Fee (37 CFR 1.16(s))							OR		
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	
AMENDMENT B		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE(\$)	ADDITIONAL FEE(\$)		RATE(\$)	ADDITIONAL FEE(\$)
	Total <small>(37 CFR 1.16(i))</small>	*	Minus	**	=	x	=	OR	x	=
	Independent <small>(37 CFR 1.16(h))</small>	*	Minus	***	=	x	=	OR	x	=
	Application Size Fee (37 CFR 1.16(s))							OR		
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	
* If the entry in column 1 is less than the entry in column 2, write "0" in column 3. ** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20". *** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3". The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.										



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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY DOCKET NO	TOT CLAIMS	IND CLAIMS
16/356,160	03/18/2019		865	P23291US01	20	3

CONFIRMATION NO. 4530

UPDATED FILING RECEIPT



26418
REED SMITH LLP
P.O. BOX 488 (NYC)
PITTSBURGH, PA 15230-0488

Date Mailed: 05/08/2019

Receipt is acknowledged of this non-provisional utility patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF FIRST INVENTOR, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection.

Please verify the accuracy of the data presented on this receipt. If an error is noted on this Filing Receipt, please submit a written request for a corrected Filing Receipt, including a properly marked-up ADS showing the changes with strike-through for deletions and underlining for additions. If you received a "Notice to File Missing Parts" or other Notice requiring a response for this application, please submit any request for correction to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections provided that the request is grantable.

Inventor(s)

Jaldert Rombouts, San Diego, CA;
Borja Ibarz Gabardos, London, UNITED KINGDOM;
Jean-Baptiste Passot, Solana Beach, CA;
Andrew Smith, San Diego, CA;

Applicant(s)

BRAIN CORPORATION, San Diego, CA;

Power of Attorney: None

Domestic Priority data as claimed by applicant

This application is a CON of 15/340,807 11/01/2016 PAT 10274325

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

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

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

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

If Required, Foreign Filing License Granted: 04/03/2019

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 16/356,160**

Projected Publication Date: 08/15/2019

Non-Publication Request: No

Early Publication Request: No

**** SMALL ENTITY ****

Title

SYSTEMS AND METHODS FOR ROBOTIC MAPPING

Preliminary Class

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

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

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

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

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

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

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, <http://www.stopfakes.gov>. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific

page 2 of 4

countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

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Title 37, Code of Federal Regulations, 5.11 & 5.15

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/356,160	03/18/2019	Jaldert Rombouts	P23291US01

CONFIRMATION NO. 4530

PUBLICATION NOTICE



OC000000110427058

26418
REED SMITH LLP
P.O. BOX 488 (NYC)
PITTSBURGH, PA 15230-0488

Title:SYSTEMS AND METHODS FOR ROBOTIC MAPPING

Publication No.US-2019-0249998-A1

Publication Date:08/15/2019

NOTICE OF PUBLICATION OF APPLICATION

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

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

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

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

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



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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/356,160	03/18/2019	Jaldert Rombouts	P23291US01	4530
26418	7590	09/27/2019	EXAMINER	
REED SMITH LLP			MOYER, DALE S	
P.O. BOX 488 (NYC)				
PITTSBURGH, PA 15230-0488				
			ART UNIT	PAPER NUMBER
			3664	
			NOTIFICATION DATE	DELIVERY MODE
			09/27/2019	ELECTRONIC

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

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

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

nycipdocketing@reedsmith.com
ptoipinbox@reedsmith.com

DETAILED ACTION

Notice of Pre-AIA or AIA Status

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

Status of the Application

This non-final office action is in response to Applicant's preliminary amendment received by the Office on 03 May 2019. Claims 1-29 have been presented in the application, of which, claims 1-20 are cancelled and claims 21-29 are new. Accordingly, pending claims 21-29 are addressed herein.

Claim Rejections - 35 USC § 101

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

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

Claims 21-27 are rejected under 35 U.S.C. 101 because the claimed invention is directed to non-statutory subject matter. The claim(s) does/do not fall within at least one of the four categories of patent eligible subject matter because the claims are directed to software *per se*. Note that Applicant's specification discloses that "any of the aforementioned components of robot 202 can be instantiated in software and/or hardware" (paragraph 0073). Accordingly, the broadest reasonable interpretation of the "at least one processor" recited in claim 21 includes the at least one processor being instantiated in software. As such, the scope of claim 21 includes software *per se*.

Claim Rejections - 35 USC § 112

The following is a quotation of the first paragraph of 35 U.S.C. 112(a):

(a) IN GENERAL.—The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same, and shall set forth the best mode contemplated by the inventor or joint inventor of carrying out the invention.

The following is a quotation of the first paragraph of pre-AIA 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same, and shall set forth the best mode contemplated by the inventor of carrying out his invention.

Claims 21-29 are rejected under 35 U.S.C. 112(a) or 35 U.S.C. 112 (pre-AIA), first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor or a joint inventor, or for pre-AIA the inventor(s), at the time the application was filed, had possession of the claimed invention.

Claims 21-27 recite at least one processor configured to “generate a map of the environment and a virtual route on the map in real-time and concurrently with the collection of data as the robot travels along the route in the environment, the map corresponding to a virtual representation of the environment, the map including information directed to location and position of the robot along the route in the environment, and associate actions undertaken by the robot during traveling along the route with the location and position of the robot on virtual route on the map” on lines 6-12 of claim 21. Applicant has not pointed out where the new claims are supported, nor does there appear to be a written description of the claim limitation requiring ‘generating... a virtual route on the map in real-time...’ and ‘the map corresponding to a virtual representation of the environment’ and ‘associate actions undertaken by the robot during traveling along the route with the location and position of the robot on virtual route on the map’ in the application as filed. See MPEP 2163.04.

Claim 28 recites “generating a map of the environment and a virtual route on the map in real-time and concurrently with the collection of the data as the robot travels along the route in the environment, the map corresponding to a virtual representation of the environment, the map including information directed to location and position of the robot along the route in the environment; and associating actions undertaken by the robot during traveling along the route with the location and

position of the robot on virtual route on the map” on lines 4-10 of claim 28. Applicant has not pointed out where the new claims are supported, nor does there appear to be a written description of the claim limitation requiring ‘generating ... a virtual route on the map in real-time...’ and ‘the map corresponding to a virtual representation of the environment’ and ‘associating actions undertaken by the robot during traveling along the route with the location and position of the robot on virtual route on the map’ in the application as filed. See MPEP 2163.04.

Claim 29 recites at least one processor configured to “generate a map of the environment and a virtual route on the map in real-time and concurrently with the collection of the data as the robot travels along the route in the environment, the map corresponding to a virtual representation of the environment, the map including information directed to location and position of the robot along the route in the environment; and associate actions undertaken by the robot during traveling along the route with the location and position of the robot on virtual route on the map” in lines 6-12 of claim 29. Applicant has not pointed out where the new claims are supported, nor does there appear to be a written description of the claim limitation requiring ‘generate ... a virtual route on the map in real-time’ and ‘the map corresponding to a virtual representation of the environment’ and ‘associate actions undertaken by the robot during traveling along the route with the location and position of the robot on virtual route on the map’ in the application as filed. See MPEP 2163.04.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(a)(1) the claimed invention was patented, described in a printed publication, or in public use, on sale or otherwise available to the public before the effective filing date of the claimed invention.

Claim(s) 21, 23 and 25-29 is/are rejected under 35 U.S.C. 102(a)(1) as being anticipated by Kwak et al. (US 2017/0102709 A1).

Regarding claims 21 and 28-29, Kwak et al. disclose a system for traveling a robot along a route, comprising: a memory (Fig. 6, element 115, 180) having computer readable instructions stored thereon (paragraph 0131-0132, 0145, 0148-0149); and at least one processor (Fig. 6, element 110, 111) configured to execute the computer readable instructions (paragraph 0144-0145,) to, collect data (Fig. 9, step S610) by at least one sensor (Fig. 6, element 130-131, 140-145, 150-153, 190-193) coupled to the robot as the robot travels (via Fig. 6, element 160) along the route (driving path / driving trajectory) in an environment (cleaning zone/region; paragraph 0060, 0068-0071, 0089-0094, 0111, 0153, 0159-0160, 0214), generate (Fig. 9, element S620) a map of the environment (Fig. 10) and a virtual route (Fig. 10, loop $l_1, l_2, l_3, l_4, l_5, l_6, l_7, l_8, l_9, l_{11}$) on the map in real-time and concurrently with the collection of the data (Fig. 9, steps S610-S630) as the robot travels along the route in the environment, the map corresponding to a virtual representation of the environment (*i.e.*, map is a virtual representation of the environment and is stored on storage 180), the map including information directed to location (initial position information $[0, 0, 0^\circ]$) and position (first position information $[x, y, \theta^\circ]$) of the robot along the route in the environment (paragraph 0006, 0057, 0060, 0091-0092, 0131, 0154-0155, 0208, 0212-0219), and associate actions (drive forward, drive backward, rotate clockwise, rotate counter clockwise; via sensor information from Fig. 6, element 150-153) undertaken by the robot during traveling along the route with the location and position of the robot on [the] virtual route on the map (paragraph 0060, 0089-0095, 0118-0119, 0131, 0153).

Regarding claim 23, Kwak et al. disclose the system as applied to claim 21 above, wherein the at least on processor is further configured to execute the computer readable instructions to, estimate distance traveled (displacement) by the robot (Fig. 6, element 100) along the route based on revolution (via Fig. 6, element 150, 153) of wheels (Fig. 6, element 163) on the robot (paragraph 0060, 0095, 0108-0111, 0121).

Regarding claim 25, Kwak et al. disclose the system as applied to claim 21 above, wherein the at least one processor is further configured to execute the computer readable instructions to, determine the robot has returned (Fig. 11, step S1030 is YES, step S1040) to a start position (Fig. 10, element I_1 (0, 0, 0°)) based on detecting a home locator (via Fig. 6, element 190, 191, 193) in the environment (loop closure; paragraph 0230-0234, 0240-0242, 0286, 0315-0316).

Regarding claim 26, Kwak et al. disclose the system as applied to claim 21 above, wherein the at least one processor is further configured to execute the computer readable instructions to, limit uncertainty (minimize) of position of a plurality of nodes (Fig. 10B, elements I2, I3, I4, I5, I6, I7, I8, I9) along the route traveled by the robot based on constraining start and end positions (Fig. 10, element I_1 (0, 0, 0°)) of the robot at the same point (loop closure; paragraphs 0219-0262, 0286 and 0315-0316).

Regarding claim 27, Kwak et al. disclose the system as applied to claim 26 above, wherein each node of the plurality of nodes include an associated probabilistic distribution which correspond to surrounding region around each node of the plurality of nodes (paragraph 0295-0300).

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103 which forms the basis for all obviousness rejections set forth in this Office action:

A patent for a claimed invention may not be obtained, notwithstanding that the claimed invention is not identically disclosed as set forth in section 102, if the differences between the claimed invention and the prior art are such that the claimed invention as a whole would have been obvious before the effective filing date of the claimed invention to a person having ordinary skill in the art to which the claimed invention pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 22 and 24 is/are rejected under 35 U.S.C. 103 as being unpatentable over Kwak et al. (US 2017/0102709 A1) as applied to claim 21 above, and further in view of Shin et al. (US 2012/0219207 A1).

Regarding claim 22, Kwak et al. teach the system as applied to claim 21 above, wherein the map is either a two-dimensional or three-dimensional representation of the environment (Fig. 10 is shown as a 2D map), the map includes information directed to location (initial position information [0, 0, 0°]) and

position (first position information $[x, y, \theta^\circ]$) of the robot along the route in the environment (paragraph 0212-0213). While Kwak et al. teach detecting obstacles in the environment using obstacle detector 140 (paragraph 0060), Kwak et al. are silent regarding the map including the obstacles that are detected by obstacle detector 140.

Shin et al. teach a technique for mapping obstacles detected by an obstacle sensor (Fig. 1, element 110; paragraph 0046). It would have been obvious to a person having ordinary skill in the art prior to Applicant's effective filing date to apply the well-known technique taught by Shin et al. to the prior art system taught by Kwak et al. That is, it would have been obvious to configure the prior art system taught by Kwak et al. to map obstacles in the environment using obstacle detector 140 according to the technique taught by Shin et al. Application of the well-known technique taught by Shin et al. to the prior art system taught by Kwak et al. would have been obvious because such application would have been well within the level of skill of the person having ordinary skill in the art and because such application would have yielded predictable results. The predictable results including the map having information directed to obstacles detected by the at least one sensor in the environment.

Regarding claim 24, Kwak et al. teach the system as applied to claim 21 above, wherein the at least one processor is further configured to execute the computer readable instructions to, estimate distance traveled by the robot (Fig. 6, element 100) along the route [...] by the at least one sensor (Fig. 6, element 130, 131, paragraph 0060, 0068-0071, 0153, 0157, 0214). Kwak et al. are silent regarding the estimated distance traveled by the robot along the route being based on "sequential images" captured by at least one sensor 140.

Shin et al. teach technique for estimating distance traveled by a robot along a route based on sequential images captured by an image sensor (Fig. 2, element 110) and an image variation calculating unit (Fig. 2, element 250; paragraphs 0041-0057). It would have been obvious to a person having ordinary skill in the art, prior to Applicant's effective filing date to apply the well-known technique

taught by Shin et al. to the prior art system taught by Kwak et al. That is, it would have been obvious to configure the prior art system taught by Shin et al. to estimate the traveling distance by applying the well-known technique taught by Shin et al. Application of the well-known technique taught by Shin et al. to the prior art system taught by Kwak et al. would have been obvious because such application would have been well within the level of skill of the person having ordinary skill in the art and because such application would have yielded predictable results. The predictable results including estimating distance traveled by the robot along the route based on sequential images captured by the at least one sensor.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to DALE MOYER whose telephone number is (571)270-7821. The examiner can normally be reached on Monday-Friday 8am-5pm.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at <http://www.uspto.gov/interviewpractice>.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Khoi H Tran can be reached on 571-272-6919. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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

Application/Control Number: 16/356,160
Art Unit: 3664

Page 9

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

/Dale Moyer/
Primary Examiner, Art Unit 3664

<i>Notice of References Cited</i>	Application/Control No. 16/356,160		Applicant(s)/Patent Under Reexamination Rombouts et al.	
	Examiner DALE MOYER		Art Unit 3664	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-20170102709-A1	04-2017	KWAK; No San	A47L11/4011	1/1
*	B	US-20140129027-A1	05-2014	Schnittman; Mark	G05D1/0219	700/253
*	C	US-20120219207-A1	08-2012	Shin; Kyung Chul	B25J9/162	382/153
*	D	US-20160271795-A1	09-2016	Vicenti; Jasper	B25J9/163	1/1
*	E	US-20180038697-A1	02-2018	Li; Beichen	G01C21/206	1/1
*	F	US-20130216098-A1	08-2013	Hasegawa; Osamu	G05D1/0274	382/103
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FOREIGN PATENT DOCUMENTS

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

NON-PATENT DOCUMENTS

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

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

<i>Index of Claims</i> 	Application/Control No. 16/356,160	Applicant(s)/Patent Under Reexamination Rombouts et al.
	Examiner DALE MOYER	Art Unit 3664

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

CLAIMS									
☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47									
CLAIM		DATE							
Final	Original	09/23/2019							
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<i>Search Notes</i> 	Application/Control No. 16/356,160	Applicant(s)/Patent Under Reexamination Rombouts et al.
	Examiner DALE MOYER	Art Unit 3664

CPC - Searched*		
Symbol	Date	Examiner
G05D1/0225	09/21/2019	DM
G05D1/0272	09/21/2019	DM
G05D1/0274	09/21/2019	DM
G05D1/0246	09/21/2019	DM
G05D1/0234	09/21/2019	DM
G05D2201/0215	09/21/2019	DM
G05D2201/0207	09/21/2019	DM
G05D2201/0203	09/21/2019	DM
A47L9/2873	09/21/2019	DM
A47L2201/02	09/21/2019	DM
B25J9/0003	09/21/2019	DM
B25J9/0005	09/21/2019	DM
Y10S901/01	09/21/2019	DM

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

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

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<i>Search Notes</i> 	Application/Control No. 16/356,160	Applicant(s)/Patent Under Reexamination Rombouts et al.
	Examiner DALE MOYER	Art Unit 3664

Search Notes		
Search Notes	Date	Examiner
considered prosecution history of parent 15/340807	09/21/2019	DM
inventor name search	09/21/2019	DM
assignee search	09/21/2019	DM
ip.com search	09/21/2019	DM
see attached EAST Search History Report	09/21/2019	DM

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

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EAST Search History

EAST Search History (Prior Art)

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S14	806	irobot.as.	US-PGPUB; USPAT; USOCR	OR	ON	2019/09/21 13:02
S15	883	(G05D2201/0215).CPC.	US-PGPUB; USPAT; USOCR	OR	ON	2019/09/21 13:03
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S18	11	(G05D2201/0215).CPC. AND (smartphone OR telephone) AND (display\$4 WITH map WITH (position OR location))	US-PGPUB; USPAT; USOCR	OR	ON	2019/09/21 13:05
S19	16	(G05D2201/0215).CPC. AND ((smartphone OR telephone OR (mobile NEAR terminal))) AND (display\$4 WITH map WITH (position OR location))	US-PGPUB; USPAT; USOCR	OR	ON	2019/09/21 13:07
S20	7	(US-20190045992-\$ or US-20190212730-\$ or US-20180263451-\$ or US-20180098200-\$ or US-20170277196-\$ or US-20160135655-\$).did. or (US-10303179-\$).did.	US-PGPUB; USPAT	OR	ON	2019/09/21 13:08
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S22	56	((G05D1/0044 AND G05D2201/0203).CPC.)	US-PGPUB; USPAT	OR	ON	2019/09/21 13:09
S23	2356	((G05D1/0044 OR G05D1/0016 OR G05D1/0038).CPC.)	US-PGPUB; USPAT	OR	ON	2019/09/21 13:10
S26	2056	((G05D2201/0215 OR G05D2201/0203).CPC.)	US-PGPUB; USPAT	OR	ON	2019/09/21 13:10
S27	264	S23 AND S26	US-PGPUB; USPAT	OR	ON	2019/09/21 13:11
S28	121	((display\$4 OR screen) WITH map) AND S27	US-PGPUB; USPAT	OR	ON	2019/09/21 13:11
S29	32	((display\$4 OR screen) WITH map) SAME ((present OR current) NEAR3 (position OR location)).bi. AND S27	US-PGPUB; USPAT	OR	ON	2019/09/21 13:16
S30	3	S2 S8	US-PGPUB;	OR	ON	2019/09/21

			USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			14:41
S31	3	S30 AND virtual	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 14:42
S32	3	S30 AND (((3D OR (three OR "3") ADJ (D OR dimension\$2)) OR "3"\$1D))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 14:45
S33	1	S30 AND (realtime OR real\$1time OR (real ADJ time))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 14:46
S34	1	S30 AND concurrent\$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 14:47
S35	3	S30 AND (obstacle WITH map)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 14:48
S36	3	S30 AND (images)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 14:49
S37	3	S30 AND (home locator)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 14:49
S38	3	S30 AND (home NEAR locator)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	OR	ON	2019/09/21 14:49

			IBM_TDB			
S39	3	S30 AND (uncertainty)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 14:50
S40	3	S30 AND constrain\$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 15:02
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S45	34	S44 AND (G05D2201/0215).CPC.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 15:17
S46	3316	(G05D2201/0215).CPC.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 15:18
S47	925	B25J11/0005.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 15:53
S48	1474	B25J9/0003.cpc.	US-PGPUB; USPAT; USOCR; FPRS;	OR	ON	2019/09/21 15:53

			EPO; JPO; DERWENT; IBM_TDB			
S50	4572	(A47L2201/00).cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 15:53
S51	10922	(A47L2201/\$).cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 15:54
S53	5173	(G05D2201/0203).cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 15:55
S54	3316	(G05D2201/0215).cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 15:55
S56	267	(G05D2201/0207).cpc. AND (vacuum\$4 OR clean\$4).bi.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 15:55
S58	2113	(Y10S901/01).CPC. AND (vacuum\$4 OR clean\$4).bi.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 15:56
S59	16375	S58 S56 S54 S53 S51 S50 S48 S47 S46	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 15:57
S60	1290	S59 AND ((start\$4 OR origin OR begin\$4) WITH (end OR ending OR ended OR termin\$5 OR finish\$4 OR target\$4 OR destination OR goal OR final))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 16:00
S61	126	S59 AND (((start\$4 OR origin OR begin\$4) WITH (end OR ending OR	US-PGPUB; USPAT;	OR	ON	2019/09/21 16:01

		ended OR termin\$5 OR finish\$4 OR target\$4 OR destination OR goal OR final)) WITH (constrain\$4 OR limit OR uncertainty OR restrict OR restrain OR threshold OR reduce OR reduction OR curtail\$4 OR improve OR correct\$4))	USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
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S63	45	S62 AND (((start\$4 OR origin OR begin\$4) WITH (end OR ending OR ended OR termin\$5 OR finish\$4 OR target\$4 OR destination OR goal OR final)) WITH (constrain\$4 OR limit OR uncertainty OR restrict OR restrain OR threshold OR reduce OR reduction OR curtail\$4 OR improve OR correct\$4))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 16:02
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S66	300	(G05D1/0225).CPC. AND locali\$6 AND relative	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 16:13

S67	229	S66 AND ((dock\$4 NEAR2 station) OR (charg\$4 NEAR2 station) OR (base NEAR2 station) OR (charg\$4 NEAR2 base) OR (recharg\$4 NEAR2 station) OR (recharg\$4 NEAR2 base) OR (home NEAR2 station) OR (dock\$4 NEAR2 home))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 16:16
S68	9	S67 AND locali\$4.ti.ab.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 16:21
S69	42	S64 AND (SLAM! OR locali\$4).ti.ab.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 16:22
S70	17	S64 AND (SLAM! OR locali\$4).ti.ab. AND ((position OR pose OR location) WITH (correct\$4 OR updat\$4 OR uncertainty OR Kalman OR probability))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 16:23
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S74	305	S59 AND uncertainty	US-PGPUB; USPAT; USOCR	OR	ON	2019/09/21 16:32
S75	344	S59 AND uncertain\$4	US-PGPUB; USPAT; USOCR	OR	ON	2019/09/21 16:32
S76	30	S59 AND (uncertain\$4 WITH (correct OR limit\$4))	US-PGPUB; USPAT; USOCR	OR	ON	2019/09/21 16:32
S77	4	EP-0635773-\$ EP-635773-\$	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 16:38
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S80	236	(G05D1/0272).CPC. AND (uncertain\$4 WITH (position\$4 OR point OR node OR location OR pose OR route OR path))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 16:40
S81	79	(G05D1/0272).CPC. AND ((uncertain\$4 WITH (position\$4 OR point OR node OR location OR pose OR route OR path)) WITH (origin OR start\$4 OR destination OR finish\$4 OR end OR ending OR termination OR point))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 16:41
S82	54	(G05D1/0272).CPC. AND ((uncertain\$4 WITH (position\$4 OR node OR location OR pose OR route OR path)) WITH (origin OR start\$4 OR destination OR finish\$4 OR end OR ending OR termination OR point))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 16:41
S83	56	(G05D1/0272).CPC. AND (((uncertain\$4 OR covariance) WITH (position\$4 OR node OR location OR pose OR route OR path)) WITH (origin OR start\$4 OR destination OR finish\$4 OR end OR ending OR termination OR point))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 16:42
S84	56	(G05D1/0272).CPC. AND (((uncertain\$4 OR covariance) WITH (position\$4 OR location OR pose OR route OR path)) WITH (origin OR start\$4 OR destination OR finish\$4 OR end OR ending OR termination OR point))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 16:42
S85	373	(G05D1/0272).CPC. AND (uncertain\$4 OR covariance)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 16:45
S86	323	(G05D1/0272).CPC. AND (uncertain\$4 OR covariance).bi.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	OR	ON	2019/09/21 16:45

			IBM_TDB			
S87	303	S59 AND (uncertain\$4 OR covariance).bi.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 16:45
S88	492	S86 S87	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 16:46
S89	108	S88 AND (origin)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 16:46
S90	18	S88 AND (origin WITH (dock\$4 OR station OR base)) AND (uncertain\$4 OR covariance)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 16:51
S91	8	S88 AND (origin WITH (dock\$4 OR station OR base)) AND (uncertain\$4 OR covariance) and ((dock\$4 OR station OR base) WITH landmark)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 16:54
S92	494	S59 AND (uncertain\$4 OR covariance OR variance).bi.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 16:57
S93	1289	S59 AND (uncertain\$4 OR covariance OR variance OR probability OR likelihood).bi.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 16:57
S94	294	S59 AND (((position\$4 OR pose OR location) NEAR3 (uncertain\$4 OR covariance OR variance OR probability OR likelihood)).bi.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 16:57
S95	142	S59 AND (((position\$4 OR pose OR location) NEAR3 (uncertain\$4 OR covariance OR variance OR probability OR likelihood)).bi. SAME (map\$4 OR	US-PGPUB; USPAT; USOCR; FPRS;	OR	ON	2019/09/21 16:58

		localization OR SLAM! OR landmark OR origin))	EPO; JPO; DERWENT; IBM_TDB			
S96	85	S59 AND (((position\$4 OR pose OR location) NEAR3 (uncertain\$4 OR covariance OR variance OR probability OR likelihood)).bi. SAME (correct\$4 OR updat\$4 OR kalman))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 17:00
S97	2165	(A47L2201/02\$).cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 17:02
S98	1688	(A47L9/2873).cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 17:02
S99	3634	(G05D1/0225).CPC.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 17:02
S100	5896	S97 S98 S99	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 17:03
S101	136	S100 AND SLAM!	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 17:03
S102	13	S101 AND (kalman)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 17:03
S103	884	dock\$4 AND (SLAM! OR locali\$4) AND Kalman	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 17:06
S104	502	S103 AND robot\$4	US-PGPUB; USPAT;	OR	ON	2019/09/21 17:06

			USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S105	439	S103 AND robot\$4 AND (@ad @rlad @prad)<"20161101"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 17:06
S106	529	(docking OR dock) AND (SLAM! OR locali\$4) AND Kalman	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 17:08
S107	400	S106 AND robot\$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 17:08
S108	350	S106 AND robot\$4 AND (@ad @rlad @prad)<"20161101"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 17:08
S109	350	S106 AND robot\$4 AND (@ad @rlad @prad)<"20161101" AND Kalman	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 17:09
S111	3854	901/1.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 17:17
S112	25567	(mobile NEAR2 robot).ti,ab,bsum.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 17:18
S113	7146	(Y10S901/01).CPC.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 17:18

S114	1373	(G05D2201/0207).cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 17:18
S115	45474	S54 S53 S51 S50 S48 S47 S46 S111 S112 S113 S114	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 17:19
S116	1248	S115 AND (SLAM! OR locali\$4).ti,ab,bsum.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 17:19
S117	865	S115 AND (SLAM! OR locali\$4).ti,ab,bsum.	US-PGPUB; USPAT	OR	ON	2019/09/21 17:19
S118	268	S115 AND (SLAM! OR locali\$4).ti,ab,bsum. AND Kalman	US-PGPUB; USPAT	OR	ON	2019/09/21 17:20
S119	63	S118 AND (((base OR docking) ADJ station) ((charg\$4 OR recharg\$4) NEAR (base OR station)) OR dock OR docking)	US-PGPUB; USPAT	OR	ON	2019/09/21 17:21
S120	214	S118 AND (((base OR docking) ADJ station) ((charg\$4 OR recharg\$4) NEAR (base OR station)) OR dock OR docking OR base OR station)	US-PGPUB; USPAT	OR	ON	2019/09/21 17:21
S121	151	S120 NOT S119	US-PGPUB; USPAT	OR	ON	2019/09/21 17:21
S122	2	(US-20090292394-\$).did. or (US- 8315737-\$).did.	US-PGPUB; USPAT	OR	ON	2019/09/21 17:30
S123	51	S119 and (@ad @rlad @prad) <"20161101"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 17:33
S124	63	S118 AND (((base OR docking) ADJ station) ((charg\$4 OR recharg\$4) NEAR (base OR station)) OR dock OR docking or (home NEAR (base OR station)))	US-PGPUB; USPAT	OR	ON	2019/09/21 17:34
S125	2	(US-20170102709-\$).did. or (US- 10019013-\$).did.	US-PGPUB; USPAT	OR	ON	2019/09/21 17:40
S126	138	((G05D1/0225 AND G05D1/0242 AND G05D1/0274).CPC.)	US-PGPUB; USPAT	OR	ON	2019/09/21 17:41
S127	136	S126 and (@ad @rlad @prad) <"20161101"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 17:41
S128	7	("20090177320" "20120020533"	US-PGPUB;	OR	ON	2019/09/21

		"20140295878" "20170135541" "20170273527" "8380350").PN. OR ("10019013" "2017/0102709").URPN.	USPAT; USOCR			17:44
S129	9	S125 S128	US-PGPUB; USPAT; USOCR	OR	ON	2019/09/21 17:44
S130	5	S129 AND (uncertain\$4 OR covariance OR kalman)	US-PGPUB; USPAT; USOCR	OR	ON	2019/09/21 17:44
S131	95	(US-20190045992-\$ or US- 20190212730-\$ or US-20180263451-\$ or US-20180098200-\$ or US-20170277196- \$ or US-20160135655-\$ or US- 20190255991-\$ or US-20180074508-\$ or US-20190235490-\$ or US-20190208979- \$ or US-20190174987-\$ or US- 20190094869-\$ or US-20190049979-\$ or US-20190025838-\$ or US-20190015985- \$ or US-20190015984-\$ or US- 20180373242-\$ or US-20180360285-\$ or US-20180344116-\$ or US-20180210445- \$ or US-20180074509-\$ or US- 20180061137-\$ or US-20180050634-\$ or US-20170303089-\$ or US-20170273527- \$ or US-20170265703-\$).did. or (US- 20170261979-\$ or US-20170235312-\$ or US-20170205822-\$ or US-20150182088- \$ or US-20150032260-\$ or US- 20170131721-\$ or US-20140116469-\$ or US-20140207280-\$ or US-20160148417- \$ or US-20160052133-\$ or US- 20160027207-\$ or US-20150212520-\$ or US-20150212500-\$ or US-20140343783- \$ or US-20140316636-\$ or US- 20140303775-\$ or US-20130060379-\$ or US-20130056032-\$ or US-20130024025- \$ or US-20120259481-\$ or US- 20150261223-\$ or US-20180364052-\$ or US-20170095926-\$ or US-20140207282- \$ or US-20190216011-\$ or US- 20180246518-\$ or US-20180038697- \$).did. or (US-20140100693-\$ or US- 20120323365-\$ or US-20160302639-\$ or US-20140190514-\$ or US-20100070078- \$ or US-20160271795-\$ or US- 20040167667-\$ or US-20190155296-\$ or US-20070118248-\$ or US-20190235083- \$ or US-20190217478-\$ or US- 20040158354-\$ or US-20170285648-\$ or US-20170153646-\$ or US-20140129027- \$ or US-20130216098-\$ or US- 20120230550-\$ or US-20120219207-\$ or US-20120213443-\$ or US-20090292394- \$ or US-20070293985-\$ or US- 20070106423-\$ or US-20050234679-\$ or US-20050182518-\$ or US-20190272462- \$ or US-20170102709-\$ or US- 20130138246-\$).did. or (US- 20100152945-\$ or US-20070244610-\$ or US-20070250212-\$ or US-20120116588- \$ or US-20040111184-\$ or US- 20050221840-\$ or US-20170135541-\$ or US-20090177320-\$).did. or (US-	US-PGPUB; USPAT	OR	ON	2019/09/21 17:46

		10303179-\$ or US-10291765-\$ or US-9529363-\$ or US-7706917-\$ or US-9764468-\$ or US-8315734-\$ or US-8380350-\$).did.				
S132	42	S131 AND (uncertain\$4 OR covariance OR kalman)	US-PGPUB; USPAT; USOCR	OR	ON	2019/09/21 17:46
S133	31	S131 AND (uncertain\$4 OR covariance)	US-PGPUB; USPAT; USOCR	OR	ON	2019/09/21 17:46
S134	28	S133 and (@ad @rlad @prad) <"20161101"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 17:46
S135	741	(mobile NEAR2 robot) AND (kalman OR EKF!) AND (uncertain\$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 17:51
S136	580	S135 AND (((base OR docking) ADJ station) ((charg\$4 OR recharg\$4) NEAR (base OR station)) OR dock OR docking OR base OR station)	US-PGPUB; USPAT	OR	ON	2019/09/21 17:51
S137	222	S135 AND (((base OR docking) ADJ station) ((charg\$4 OR recharg\$4) NEAR (base OR station)))	US-PGPUB; USPAT	OR	ON	2019/09/21 17:51
S138	69	S135 AND (((base OR docking) ADJ station) ((charg\$4 OR recharg\$4) NEAR (base OR station))) WITH (relative OR position OR location OR pose OR distance OR uncertain\$4 OR covariance))	US-PGPUB; USPAT	OR	ON	2019/09/21 17:52
S139	63	S138 and (@ad @rlad @prad) <"20161101"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 17:52
S140	10	S135 AND (((base OR docking) ADJ station) ((charg\$4 OR recharg\$4) NEAR (base OR station))) WITH (relative OR position OR location OR pose OR distance) WITH (correct\$4 OR updat\$4 OR uncertain\$4 OR covariance))	US-PGPUB; USPAT	OR	ON	2019/09/21 17:53
S141	898	(mobile NEAR2 robot) AND (kalman OR EKF!) AND (uncertain\$4 OR covariance)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 17:53
S142	854	S141 and (@ad @rlad @prad) <"20161101"	US-PGPUB; USPAT; USOCR;	OR	ON	2019/09/21 17:54

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
S143	12	S142 AND (((base OR docking) ADJ station) OR ((charg\$4 OR recharg\$4) NEAR (base OR station))) WITH (relative OR position OR location OR pose OR distance) WITH (correct\$4 OR updat\$4 OR uncertain\$4 OR covariance)).bi.	US-PGPUB; USPAT	OR	ON	2019/09/21 17:55
S144	228	S142 AND (((base OR docking) ADJ station) OR ((charg\$4 OR recharg\$4) NEAR (base OR station)))).bi.	US-PGPUB; USPAT	OR	ON	2019/09/21 17:56
S145	97	(US-20190045992-\$ or US-20190212730-\$ or US-20180263451-\$ or US-20180098200-\$ or US-20170277196-\$ or US-20160135655-\$ or US-20190255991-\$ or US-20180074508-\$ or US-20190235490-\$ or US-20190208979-\$ or US-20190174987-\$ or US-20190094869-\$ or US-20190049979-\$ or US-20190025838-\$ or US-20190015985-\$ or US-20190015984-\$ or US-20180373242-\$ or US-20180360285-\$ or US-20180344116-\$ or US-20180210445-\$ or US-20180074509-\$ or US-20180061137-\$ or US-20180050634-\$ or US-20170303089-\$ or US-20170273527-\$ or US-20170265703-\$).did. or (US-20170261979-\$ or US-20170235312-\$ or US-20170205822-\$ or US-20150182088-\$ or US-20150032260-\$ or US-20170131721-\$ or US-20140116469-\$ or US-20140207280-\$ or US-20160148417-\$ or US-20160052133-\$ or US-20160027207-\$ or US-20150212520-\$ or US-20150212500-\$ or US-20140343783-\$ or US-20140316636-\$ or US-20140303775-\$ or US-20130060379-\$ or US-20130056032-\$ or US-20130024025-\$ or US-20120259481-\$ or US-20150261223-\$ or US-20180364052-\$ or US-20170095926-\$ or US-20140207282-\$ or US-20190216011-\$ or US-20180246518-\$ or US-20180038697-\$).did. or (US-20140100693-\$ or US-20120323365-\$ or US-20160302639-\$ or US-20140190514-\$ or US-20100070078-\$ or US-20160271795-\$ or US-20040167667-\$ or US-20190155296-\$ or US-20070118248-\$ or US-20190235083-\$ or US-20190217478-\$ or US-20040158354-\$ or US-20170285648-\$ or US-20170153646-\$ or US-20140129027-\$ or US-20130216098-\$ or US-20120230550-\$ or US-20120219207-\$ or US-20120213443-\$ or US-20090292394-\$ or US-20070293985-\$ or US-20070106423-\$ or US-20050234679-\$ or US-20050182518-\$ or US-20190272462-\$ or US-20170102709-\$ or US-20130138246-\$).did. or (US-20100152945-\$ or US-20070244610-\$ or	US-PGPUB; USPAT	OR	ON	2019/09/21 18:06

		US-20070250212-\$ or US-20120116588-\$ or US-20040111184-\$ or US-20050221840-\$ or US-20170135541-\$ or US-20090177320-\$ or US-20140244094-\$ or US-20120086598-\$.did. or (US-10303179-\$ or US-10291765-\$ or US-9529363-\$ or US-7706917-\$ or US-9764468-\$ or US-8315734-\$ or US-8380350-\$.did.				
S146	64	S145 AND correct\$4	US-PGPUB; USPAT	OR	ON	2019/09/21 18:06
S147	16	(11/581489 11/633883 11/654015 12/379433 15/093974 15/204219 15/314506 15/322103 15/719659).APP.	US-PGPUB; USPAT; USOCR	OR	ON	2019/09/21 18:09
S148	652	((G05D1/0274 AND G05D1/0272).CPC.)	US-PGPUB; USPAT; USOCR	OR	ON	2019/09/21 18:10
S149	622	S148 and (@ad @rlad @prad) <"20161101"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 18:10
S150	161	S149 AND (EKF! OR kalman)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 18:10
S151	26	S149 AND (EKF! OR kalman) AND (correct\$4 NEAR2 (path OR route OR map))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 18:11
S152	4	S149 AND (return\$4 NEAR3 origin)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 18:13
S153	169	S149 AND (start\$4 WITH (end OR ending))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 18:14
S154	3424	((G05D1/0274 OR G05D1/0272).CPC.) and (@ad @rlad @prad)<"20161101"	US-PGPUB; USPAT; USOCR	OR	ON	2019/09/21 18:28
S155	680	S154 AND ((map\$4 OR locali\$4) WITH (updat\$4 OR correct\$4)) AND ((start\$4 OR end\$3) NEAR2 (position OR point OR location OR dock\$4 OR charg\$4 OR base	US-PGPUB; USPAT; USOCR	OR	ON	2019/09/21 18:30

		OR station))				
S156	619	S154 AND ((map\$4 OR locali\$4) WITH (updat\$4 OR correct\$4)) AND ((start\$4 OR end\$3) NEAR2 (position OR point OR location OR dock\$4 OR charg\$4 OR base OR station)) AND G05D1/0274.cpc.	US-PGPUB; USPAT; USOCR	OR	ON	2019/09/21 18:30
S157	132	S154 AND ((map\$4 OR locali\$4) WITH (updat\$4 OR correct\$4)) AND ((start\$4 WITH end\$3) NEAR2 (position OR point OR location OR dock\$4 OR charg\$4 OR base OR station))	US-PGPUB; USPAT; USOCR	OR	ON	2019/09/21 18:31
S158	693	G05D1/0274.cpc. AND loop\$4	US-PGPUB; USPAT; USOCR	OR	ON	2019/09/21 18:37
S159	247	G05D1/0274.cpc. AND loop\$4 AND Kalman	US-PGPUB; USPAT; USOCR	OR	ON	2019/09/21 18:37
S160	234	S159 and (@ad @rlad @prad) <"20161101"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 18:37
S161	0	G05D1/0274.cpc. AND ((loop NEAR2 closure) WITH (uncertainty))	US-PGPUB; USPAT; USOCR	OR	ON	2019/09/21 18:44
S162	51	G05D1/0274.cpc. AND ((loop NEAR2 closure))	US-PGPUB; USPAT; USOCR	OR	ON	2019/09/21 18:44
S163	21	S59 and (loop ADJ closure)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 18:51
S164	251	S59 and (loop NEAR2 clos\$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 18:51
S165	59	(S162 S163 S164) AND uncertainty	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 18:51
S166	54	S165 and (@ad @rlad @prad) <"20161101"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/21 18:51
S167	122	(US-20190045992-\$ or US-20190212730-\$ or US-20180263451-\$ or	US-PGPUB; USPAT	OR	ON	2019/09/22 12:31

US-20180098200-\$ or US-20170277196-\$ or US-20160135655-\$ or US-20190255991-\$ or US-20180074508-\$ or US-20190235490-\$ or US-20190208979-\$ or US-20190174987-\$ or US-20190094869-\$ or US-20190049979-\$ or US-20190025838-\$ or US-20190015985-\$ or US-20190015984-\$ or US-20180373242-\$ or US-20180360285-\$ or US-20180344116-\$ or US-20180210445-\$ or US-20180074509-\$ or US-20180061137-\$ or US-20180050634-\$ or US-20170303089-\$ or US-20170273527-\$ or US-20170265703-\$).did. or (US-20170261979-\$ or US-20170235312-\$ or US-20170205822-\$ or US-20150182088-\$ or US-20150032260-\$ or US-20170131721-\$ or US-20140116469-\$ or US-20140207280-\$ or US-20160148417-\$ or US-20160052133-\$ or US-20160027207-\$ or US-20150212520-\$ or US-20150212500-\$ or US-20140343783-\$ or US-20140316636-\$ or US-20140303775-\$ or US-20130060379-\$ or US-20130056032-\$ or US-20130024025-\$ or US-20120259481-\$ or US-20150261223-\$ or US-20180364052-\$ or US-20170095926-\$ or US-20140207282-\$ or US-20190216011-\$ or US-20180246518-\$ or US-20180038697-\$).did. or (US-20140100693-\$ or US-20120323365-\$ or US-20160302639-\$ or US-20140190514-\$ or US-20100070078-\$ or US-20160271795-\$ or US-20040167667-\$ or US-20190155296-\$ or US-20070118248-\$ or US-20190235083-\$ or US-20190217478-\$ or US-20040158354-\$ or US-20170285648-\$ or US-20170153646-\$ or US-20140129027-\$ or US-20130216098-\$ or US-20120230550-\$ or US-20120219207-\$ or US-20120213443-\$ or US-20090292394-\$ or US-20070293985-\$ or US-20070106423-\$ or US-20050234679-\$ or US-20050182518-\$ or US-20190272462-\$ or US-20170102709-\$ or US-20130138246-\$).did. or (US-20100152945-\$ or US-20070244610-\$ or US-20070250212-\$ or US-20120116588-\$ or US-20040111184-\$ or US-20050221840-\$ or US-20170135541-\$ or US-20090177320-\$ or US-20140244094-\$ or US-20120086598-\$ or US-20100121488-\$ or US-20080027591-\$ or US-20160282870-\$ or US-20110178669-\$ or US-20100324731-\$ or US-20060217837-\$ or US-20050251457-\$ or US-20040249504-\$ or US-20190246600-\$ or US-20170124781-\$ or US-20170351261-\$ or US-20170248963-\$ or US-20190094876-\$ or US-20190094027-\$ or US-20180370728-\$ or US-20180364045-\$ or US-20180361583-\$).did. or (US-20180361581-\$ or US-

		20180284806-\$ or US-20180122136-\$ or US-20170153647-\$ or US-20170123428-\$ or US-20170108867-\$ or US-20160209846-\$).did. or (US-10303179-\$ or US-10291765-\$ or US-9529363-\$ or US-7706917-\$ or US-9764468-\$ or US-8315734-\$ or US-8380350-\$ or US-5696675-\$).did.				
S168	45	S167 AND actions	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/22 12:31
S169	7	S167 AND actions AND closure	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/22 12:32
S170	104	S167 AND ((route OR path\$4 OR map OR virtual OR course) WITH (actions! OR task OR behavior OR movement OR direction OR up OR down OR left OR right OR on OR off OR turn\$4 OR spray\$4 OR camera OR pose))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/22 12:35
S171	2148	S167 AND ((route OR path\$4 OR map OR virtual OR course) WITH (actions! OR task OR behavior OR movement OR direction OR up OR down OR left OR right OR on OR off OR turn\$4 OR spray\$4 OR camera OR pose)) OR closure AND kalman	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/22 12:36
S172	13	S167 AND ((route OR path\$4 OR map OR virtual OR course) WITH (actions! OR task OR behavior OR movement OR direction OR up OR down OR left OR right OR on OR off OR turn\$4 OR spray\$4 OR camera OR pose)) AND closure AND kalman	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/22 12:37
S173	218	robot AND local\$ AND Kalman AND uncertainty AND closure	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/22 12:40
S174	192	S173 and (@ad @rlad @prad) <"20161101"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/22 12:41
S175	218	S173 and (@ad @rlad @prad) <"20190318"	US-PGPUB; USPAT; USOCR; FPRS;	OR	ON	2019/09/22 12:41

			EPO; JPO; DERWENT; IBM_TDB			
S176	3316	(G05D2201/0215).CPC.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/22 12:47
S177	925	B25J11/0005.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/22 12:47
S178	1474	B25J9/0003.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/22 12:47
S179	4572	(A47L2201/00).cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/22 12:47
S180	10922	(A47L2201/\$).cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/22 12:47
S181	5173	(G05D2201/0203).cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/22 12:47
S182	3316	(G05D2201/0215).cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/22 12:47
S183	3854	901/1.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/22 12:47
S184	25567	(mobile NEAR2 robot).ti.ab.bsum.	US-PGPUB; USPAT;	OR	ON	2019/09/22 12:47

			USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S185	7146	(Y10S901/01).CPC.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/22 12:47
S186	1373	(G05D2201/0207).cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/22 12:47
S187	45474	S182 S181 S180 S179 S178 S177 S176 S183 S184 S185 S186	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/22 12:47
S188	896	S187 AND ((loop\$1closure) OR (loop NEAR clos\$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/22 12:47
S189	226	S187 AND ((loop\$1closure) OR (loop NEAR clos\$3)).bi. AND (SLAM! OR kalman).bi.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/22 12:48
S190	118	S187 AND ((loop\$1closure) OR (loop NEAR clos\$3)).bi. AND ((local\$ OR SLAM!) AND kalman AND map).bi.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/22 12:48
S191	8	S187 AND ((loop\$1closure) OR (loop NEAR clos\$3)).bi. AND ((local\$ OR SLAM!) AND kalman AND map).bi. AND (uncertainty OR variance OR covariance) AND (virtual NEAR2 (route OR map OR path))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/22 12:50
S192	36	S190 AND (smartphone OR telephone) AND (display\$4 WITH map WITH (position OR location))	US-PGPUB; USPAT; USOCR	OR	ON	2019/09/22 12:51
S193	1913	((("ROMBOUTS") near3 ("Jaldert")) OR (("GABARDOS") near3 ("Borja")) OR (("PASSOT") near3 ("Jean-Baptiste")) OR (("SMITH") near3 ("Andrew"))).INV.	US-PGPUB; USPAT; USOCR; EPO; JPO;	OR	ON	2019/09/22 14:00

			DERWENT			
S194	123	((("BRAIN") near3 ("CORPORATION"))).AS,AANM.	USPAT	OR	ON	2019/09/22 14:01
S195	253	((("BRAIN") near3 ("CORPORATION"))).AS,AANM.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/22 14:01
S196	6571	((("BRAIN"))).AS,AANM.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/22 14:01
S197	83	S193 AND S196	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/22 14:02
S198	1	S197 AND (virtual NEAR route)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/22 14:02
S199	83	S197 AND (virtual\$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/22 14:02
S200	3	S197 AND (virtual\$4 WITH (map OR path OR route OR segment))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/22 14:03
S201	2083	((("PASSOT") near3 ("Jean-Baptiste")) OR (("SMITH") near3 ("Andrew")) OR (("SZATMARY") near3 ("Botond")) OR (("IBARZ") near3 ("GABARDOS") near3 ("Borja")) OR (("GRIFFIN") near3 ("Cody")) OR (("RAMBOUTS") near3 ("Jaldert")) OR (("SINYAVSKIY") near3 ("Oleg")) OR (("IZHIKEVICH") near3 ("Eugene"))).INV.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2019/09/22 14:08
S202	189	S196 AND S201	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/22 14:09

EAST Search History

S203	218	S202 S194	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/22 14:09
S204	12	S203 AND (virtual\$4 route map (realtime OR real\$1time) travel\$4 actions).bi.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	AND	ON	2019/09/22 14:10
S205	1	("20170102709").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2019/09/22 15:05
S207	1	("20170102709").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2019/09/22 18:17
S208	1	S207 AND (obstacle SAME map)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/22 18:17
S209	0	S207 AND ((3D OR (three OR "3") ADJ (D OR dimension\$2)) OR "3"\$1D)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/09/22 18:22

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S206	1	((collect NEAR2 data) (virtual NEAR route) (virtual NEAR representation) (robot) (actions)).clm.	US- PGPUB; USPAT	AND	ON	2019/09/22 14:07

9/ 23/ 2019 4:53:28 PM

C:\Users\dmoyer\Documents\My Docket\16356160\ EAST Search.wsp

Electronic Acknowledgement Receipt	
EFS ID:	38146633
Application Number:	16356160
International Application Number:	
Confirmation Number:	4530
Title of Invention:	SYSTEMS AND METHODS FOR ROBOTIC MAPPING
First Named Inventor/Applicant Name:	Jaldert Rombouts
Customer Number:	26418
Filer:	Sidharth Kapoor/Cody Nye
Filer Authorized By:	Sidharth Kapoor
Attorney Docket Number:	P23291US01
Receipt Date:	27-DEC-2019
Filing Date:	18-MAR-2019
Time Stamp:	09:53:02
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment		no			
File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Amendment/Req. Reconsideration-After Non-Final Reject	P23291US01_-_2019-12-27_-_Response.pdf	556446	no	14
			63110a508eb8c811be5975795eca6cb2352a6c5d		
Warnings:					

Information:	
Total Files Size (in bytes):	556446
<p>This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.</p> <p><u>New Applications Under 35 U.S.C. 111</u> If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.</p> <p><u>National Stage of an International Application under 35 U.S.C. 371</u> If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.</p> <p><u>New International Application Filed with the USPTO as a Receiving Office</u> If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.</p>	

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Jaldert Rombouts, et al.

Serial No.: 16/356,160

Attorney Docket No.: P23291US01

Examiner: MOYER, DALE

Art Unit: 3664

For: SYSTEMS AND METHODS FOR
ROBOTIC MAPPING

AMENDMENT AND RESPONSE

In response to the non-final Office Action dated September 27, 2019, Applicants respectfully requests entry of this Amendment and Response. This Response is being timely filed by the statutory time period set forth in the Office Action. The Commissioner is hereby authorized to charge any additional fees, which may be required by this paper, to Deposit Account No. 18-0582.

Amendments to the Claims begin on page 2; and

Remarks begin on page 12.

AMENDMENTS TO THE CLAIMS

1 – 20. (Previously Cancelled).

21. (Currently Amended) A system for traveling a robot along a route, comprising:

a memory having computer readable instructions stored thereon; and

at least one ~~[[processor]]~~ processing device ~~[[configured]]~~ configurable to execute the computer readable instructions to,

collect data by at least one sensor coupled to the robot as the robot travels along the route in an environment,

generate a map of the environment and a ~~virtual~~ route on the map in real-time, ~~[[and]]~~ the map being generated concurrently with the collection of the data as the robot travels along the route in the environment, the map corresponding to a ~~virtual~~ representation of the environment, the map including information directed to location and position of the robot along the route in the environment, the map being generated based on measurements taken by the at least one sensor at each one of a plurality of nodes along the route traveled by the robot, each one of the plurality of nodes comprising a range, the range of each one of the plurality of nodes being based on confidence measure at a respective node, and

associate actions undertaken by the robot during traveling along the route with the location and position of the robot on ~~virtual~~ the route on the map.

22. The system of claim 21, wherein the map is either a two-dimensional or three-dimensional representation of the environment, the map includes information directed to location and position of the robot along the route in the environment and obstacles detected by the at least one sensor in the environment.

23. (Currently Amended) The system of claim 21, wherein the at least one ~~processor is further configured~~ processing device is further configurable to execute the computer readable instructions to,

estimate distance traveled by the robot along the route based on revolution of wheels on the robot.

24. (Currently Amended) The system of claim 21, wherein the at least one ~~processor is further configured~~ processing device is further configurable to execute the computer readable instructions to,

estimate distance traveled by the robot along the route based on sequential images captured by the at least one sensor.

25. (Currently Amended) The system of claim 21, wherein the least one ~~processor is further configured~~ processing device is further configurable to execute the computer readable instructions to,

determine the robot ~~has~~ returned to a start position based on detecting a home locator in the environment.

26. (Currently Amended) The system of claim 21, wherein the least one ~~processor is further configured~~ processing device is further configurable to execute the computer readable instructions to,

limit uncertainty of positioning of ~~[[a]]~~ the plurality of nodes along the route traveled by the robot based on constraining start and end positions of the robot at a same point.

27. (Currently Amended) The system of claim 26, wherein each node of the plurality of nodes ~~include~~ comprises an associated probabilistic distribution which corresponds to surrounding region around each node of the plurality of nodes.

28. (Currently Amended) A method for traveling a robot along a route, comprising:

collecting data by at least one sensor coupled to the robot as the robot travels along the route in an environment;

generating a map of the environment and a ~~virtual~~ route on the map in real-time ~~and, the map being generated~~ concurrently with the collection of the data as the robot travels along the route in the environment, the map corresponding to a ~~virtual~~ representation of the environment, the map including information directed to location and position of the robot along the route in the environment, the map being generated based on measurements taken by the at least one sensor at each one of a plurality of nodes along the route traveled by the robot, each one of the plurality of nodes comprising a range, the range of each one of the plurality of nodes being based on confidence measure at a respective node; and

associating actions undertaken by the robot during traveling along the route with the location and position of the robot on ~~virtual~~ the route on the map.

29. (Currently Amended) A non-transitory computer readable medium ~~having~~ comprising computer readable instructions stored thereon that when executed by at least one ~~processor~~ processing device configure the at least one ~~processor~~ processing device to,

collect data by at least one sensor coupled to the robot as the robot travels along the route in an environment;

generate a map of the environment and a ~~virtual~~ route on the map in real-time, ~~[[and]]~~ the map being generated concurrently with the collection of the data as the robot travels along the route in the environment, the map corresponding to a ~~virtual~~ representation of the environment, the map including information directed to location and position of the robot along the route in the environment, the map being generated based on measurements taken by the at least one sensor at each one of a plurality of nodes along the route traveled by the robot, each one of the plurality of nodes comprising a range, the range of each one of the plurality of nodes being based on confidence measure at a respective node; and

associate actions undertaken by the robot during traveling along the route with the location and position of the robot on ~~virtual~~ the route on the map.

30. (New) The system of claim 21, wherein each one of the plurality of nodes along the route traveled by the robot corresponds to a probabilistic function or probabilistic distribution.

31. (New) The system of claim 21, wherein each one of the plurality of nodes along the route traveled by the robot corresponds to position of the robot, the position of the robot is relative to either an initial location or one or more features in the environment.

32. (New) The system of claim 21, wherein the range of each one of the plurality of nodes corresponds to a region around each one of the plurality of nodes such that each one of the plurality of nodes is located within the range.

33. (New) The system of claim 21, wherein size of the range of each one of the plurality of nodes is variable based on confidence in location of each node of the plurality of nodes.

34. (New) The system of claim 21, wherein the at least one processing device is further configurable to execute the computer readable instructions to,
selectively actuate one or more systems as the robot travels along the route, the one or more systems comprises a cleaning system, the cleaning system comprises one or more of water flow, brush, and vacuum cleaner.

35. (New) The method of claim 28, wherein the map is either a two-dimensional or three-dimensional representation of the environment, the map includes information directed to location and position of the robot along the route in the environment and obstacles detected by the at least one sensor in the environment.

36. (New) The method of claim 28, further comprising:
estimating distance traveled by the robot along the route based on revolution of wheels on the robot.
37. (New) The method of claim 28, further comprising:
estimating distance traveled by the robot along the route based on sequential images captured by the at least one sensor.
38. (New) The method of claim 28, further comprising:
determining the robot returned to a start position based on detecting a home locator in the environment.
39. (New) The method of claim 28, further comprising:
limiting uncertainty of positioning of the plurality of nodes along the route traveled by the robot based on constraining start and end positions of the robot at a same point.
40. (New) The method of claim 39, wherein each node of the plurality of nodes comprises an associated probabilistic distribution which correspond to surrounding region around each node of the plurality of nodes.
41. (New) The system of claim 28, wherein each one of the plurality of nodes along the route traveled by the robot corresponds to a probabilistic function or probabilistic distribution.

42. (New) The system of claim 28, wherein each one of the plurality of nodes along the route traveled by the robot corresponds to position of the robot, the position of the robot is relative to either an initial location or one or more features in the environment.

43. (New) The system of claim 28, wherein the range of each one of the plurality of nodes corresponds to a region around each one of the plurality of nodes such that each one of the plurality of nodes is located within the range.

44. (New) The system of claim 28, wherein size of the range of each one of the plurality of nodes is variable based on confidence in location of each node of the plurality of nodes.

45. (New) The system of claim 28, further comprising:
actuating one or more systems selectively as the robot travels along the route, the one or more systems comprises a cleaning system, the cleaning system comprises one or more of water flow, brush, and vacuum cleaner.

46. (New) The non-transitory computer readable medium of claim 29, wherein the map is either a two-dimensional or three-dimensional representation of the environment, the map includes information directed to location and position of the robot along the route in the environment and obstacles detected by the at least one sensor in the environment.

47. (New) The non-transitory computer readable medium of claim 29, wherein the at least one processing device is further configurable to execute the computer readable instructions to,

estimate distance traveled by the robot along the route based on revolution of wheels on the robot.

48. (New) The non-transitory computer readable medium of claim 29, wherein the at least one processing device is further configurable to execute the computer readable instructions to,

estimate distance traveled by the robot along the route based on sequential images captured by the at least one sensor.

49. (New) The non-transitory computer readable medium of claim 29, wherein the at least one processing device is further configurable to execute the computer readable instructions to,

determine the robot has returned to a start position based on detecting a home locator in the environment.

50. (New) The non-transitory computer readable medium of claim 29, wherein the at least one processing device is further configurable to execute the computer readable instructions to,

limit uncertainty of positioning of the plurality of nodes along the route traveled by the robot based on constraining start and end positions of the robot at a same point.

51. (New) The non-transitory computer readable medium of claim 50, wherein each node of the plurality of nodes include an associated probabilistic distribution which correspond to surrounding region around each node of the plurality of nodes.

52. (New) The non-transitory computer readable medium of claim 29, wherein each one of the plurality of nodes along the route traveled by the robot corresponds to a probabilistic function or probabilistic distribution.

53. (New) The non-transitory computer readable medium of claim 29, wherein each one of the plurality of nodes along the route traveled by the robot corresponds to position of the robot, the position of the robot is relative to either an initial location or one or more features in the environment.

54. (New) The non-transitory computer readable medium of claim 29, wherein the range of each one of the plurality of nodes corresponds to a region around each one of the plurality of nodes such that each one of the plurality of nodes is located within the range.

55. (New) The non-transitory computer readable medium of claim 29, wherein size of the range of each one of the plurality of nodes is variable based on confidence in location of each node of the plurality of nodes.

56. (New) The non-transitory computer readable medium of claim 29, wherein the at least one processing device is further configurable to execute the computer readable instructions to,

selectively actuate one or more systems as the robot travels the route, the one or more systems comprises a cleaning system, the cleaning system comprises one or more of water flow, brush, and vacuum cleaner.

REMARKS

Claims 21-56 are pending in the present application. Claims 1-20 were previously cancelled without prejudice. New claims 30-34 and 35-56 have been added via present amendment. Support for claim amendments and new claims filed herein can be found in at least paragraphs [0054], [0061], [0075] to [0090], and corresponding figures of the present application. No new matter has been introduced via present amendment.

Claim Rejection Under 35 U.S.C. § 101

On page 2 of the Office Action, the Examiner rejects claims 21-27 as allegedly being directed to non-statutory subject matter. In particular, claim 21 being directed to software per se.

Applicants respectfully traverse the Examiner's positions and interpretation of the aforementioned claims. Claims 21-27 are directed to statutory subject matter of a "system" for having a "robot" travel "along a route." As noted by the body of the claim, it requires memory, processing device, at least one sensor, and robot, in order for the robot to travel along the route. As such, contrary to the Examiner's position, claim 21, and dependent claims thereof, are directed to statutory subject matter.

Furthermore, even if considered being directed to non-statutory subject matter, the present claims are "integrated into a practical application." As per the new 2019 Guidelines on patent eligibility, the claims are integrated into a practical application of having the robot travel along a route in an environment via use of sensors.

Accordingly, Applicants respectfully traverse the Examiner's position that the claims are directed to non-statutory subject matter, and respectfully request the Examiner to reconsider and withdraw the aforementioned rejection.

Claim Rejection Under 35 U.S.C. § 112(a)

On pages 3-4 of the Office action, the Examiner has rejected claims 21-27 under 35 USC § 112(a) as allegedly failing to comply with the written description requirement.

Without conceding to the Examiner's assertions set forth in the Office Action, the Applicants have amended the claims to render the aforementioned rejection moot. Accordingly, Applicants respectfully request the Examiner to reconsider and withdraw the aforementioned rejection.

Claim Rejections Under 35 U.S.C. §§ 102, 103

On pages 4-6 of the outstanding Office Action, the Examiner has rejected claims 21, 23, 25-29 under 35 USC § 102 as allegedly being anticipated by Kawak et al. (US 2017/0102709).

On pages 6-8 of the outstanding Office Action, the Examiner has rejected claims 22 and 24 under 35 USC § 103 as allegedly being rendered obvious by Kawak in view of Shin et al. (US 2012/0219207).

Without conceding to the Examiner's assertions, Applicants' assert that neither of the cited references, either alone or in combination disclose the amended features cited in claim 21 for example. Contrary to the claimed invention, neither Kwak nor Shin disclose, *inter alia*, "the map being generated based on measurements taken by the at least one sensor at each one of a plurality of nodes along the route traveled by the robot, each one of the plurality of nodes comprising a range, the range of each one of the plurality of nodes being based on confidence measure at a respective node," as recited in claim 21.

Accordingly, claim 21, and dependent claims thereof, are not anticipated or rendered obvious by Kwak and/or Shin. Similar arguments apply to independent claims 28 and 29, and dependent claims thereof.

Conclusion

In view of the foregoing amendments and remarks, Applicants respectfully submit that the application is in condition for allowance, and such action is respectfully requested at the Examiner's earliest convenience. If the Examiner believes an Examiner's Amendment would place the application in condition for allowance, Examiner is welcome to contact Applicants' undersigned counsel to discuss the potential Examiner's Amendment. Please apply any necessary charges or credits to Deposit Account 18-0582, referencing the above attorney docket number.

Date: December 27, 2019

Respectfully submitted,

/Sidharth Kapoor/

Sidharth Kapoor

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Customer Number 26418

REED SMITH LLP

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875				Application or Docket Number 16/356,160		Filing Date 03/18/2019		☐ To be Mailed					
ENTITY: ☐ LARGE ☒ SMALL ☐ MICRO													
APPLICATION AS FILED - PART I													
		(Column 1)		(Column 2)									
FOR		NUMBER FILED		NUMBER EXTRA		RATE (\$)		FEE (\$)					
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))		N/A		N/A		N/A							
☐ SEARCH FEE (37 CFR 1.16(k), (l), or (m))		N/A		N/A		N/A							
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))		N/A		N/A		N/A							
TOTAL CLAIMS (37 CFR 1.16(i))		minus 20 = *				x \$50 =							
INDEPENDENT CLAIMS (37 CFR 1.16(h))		minus 3 = *				x \$230 =							
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))		If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$310 (\$155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).											
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))													
* If the difference in column 1 is less than zero, enter "0" in column 2.						TOTAL							
APPLICATION AS AMENDED - PART II													
		(Column 1)		(Column 2)		(Column 3)							
AMENDMENT		12/27/2019		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR		PRESENT EXTRA		RATE (\$)		ADDITIONAL FEE (\$)	
		Total (37 CFR 1.16(i))		* 36		Minus ** 20		= 16		x \$50 =		800	
		Independent (37 CFR 1.16(h))		* 3		Minus *** 3		= 0		x \$230 =		0	
		☐ Application Size Fee (37 CFR 1.16(s))											
		☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))											
										TOTAL ADD'L FEE		800	
		(Column 1)		(Column 2)		(Column 3)							
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR		PRESENT EXTRA		RATE (\$)		ADDITIONAL FEE (\$)			
		Total (37 CFR 1.16(i))		* Minus **		=		x \$0 =					
		Independent (37 CFR 1.16(h))		* Minus ***		=		x \$0 =					
		☐ Application Size Fee (37 CFR 1.16(s))											
		☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))											
										TOTAL ADD'L FEE			
* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.										LIE			
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".										/TARA A WASHINGTON/			
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".													
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.													

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

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Document Number	Fee Code	Fee Code Description	Amount Paid	Payment Method
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/356,160	03/18/2019	Jaldert Rombouts	P23291US01	4530
26418	7590	04/15/2020	EXAMINER	
REED SMITH LLP			MOYER, DALE S	
P.O. BOX 488 (NYC)				
PITTSBURGH, PA 15230-0488				
			ART UNIT	PAPER NUMBER
			3664	
			NOTIFICATION DATE	DELIVERY MODE
			04/15/2020	ELECTRONIC

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

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

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

nycipdocketing@reedsmith.com
ptoipinbox@reedsmith.com

DETAILED ACTION

Notice of Pre-AIA or AIA Status

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

Status of the Application

This final office action is in response to Applicant's amendment received by the Office on 27 December 2019. Claims 1-56 have been presented in the application, of which, claims 1-20 are cancelled, claims 21, 23-29 are currently amended, claims 22 was previously presented, and claims 30-56 are new.

Accordingly, pending claims 21-56 are addressed herein.

Claim Objections

Claim 42 is objected to because of the following informalities: the word "pf" on line 1 of claim 42 should be changed to the word --of--. Appropriate correction is required.

Claim Rejections - 35 USC § 112

The following is a quotation of 35 U.S.C. 112(b):

(b) CONCLUSION.—The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the inventor or a joint inventor regards as the invention.

The following is a quotation of 35 U.S.C. 112 (pre-AIA), second paragraph:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 41-45 are rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor, or for pre-AIA the applicant regards as the invention.

Regarding claim 41, the claims refer to "the system" on line 1 of claim 41. There is insufficient antecedent basis for this limitation in the claim.

Regarding claim 42, the claims refer to “the system” on line 1 of claim 42. There is insufficient antecedent basis for this limitation in the claim.

Regarding claim 43, the claims refer to “the system” on line 1 of claim 43. There is insufficient antecedent basis for this limitation in the claim.

Regarding claim 44, the claims refer to “the system” on line 1 of claim 44. There is insufficient antecedent basis for this limitation in the claim.

Regarding claim 45, the claims refer to “the system” on line 1 of claim 45. There is insufficient antecedent basis for this limitation in the claim.

Allowable Subject Matter

Claims 21-40 and 46-56 are allowed.

Conclusion

THIS ACTION IS MADE FINAL. Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to DALE MOYER whose telephone number is (571)270-7821. The examiner can normally be reached on Monday-Friday 8am-5pm.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at <http://www.uspto.gov/interviewpractice>.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Khoi H Tran can be reached on 571-272-6919. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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

/Dale Moyer/
Primary Examiner, Art Unit 3664

<i>Index of Claims</i> 	Application/Control No. 16/356,160	Applicant(s)/Patent Under Reexamination Rombouts et al.
	Examiner DALE MOYER	Art Unit 3664

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

CLAIMS									
☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47									
CLAIM		DATE							
Final	Original	09/23/2019	04/11/2020						
	1	-	-						
	2	-	-						
	3	-	-						
	4	-	-						
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	36		=						
	37		=						
	38		=						
	39		=						
	40		=						
	41		✓						
	42		✓						

<p><i>Index of Claims</i></p> 	<p>Application/Control No.</p> <p>16/356,160</p>	<p>Applicant(s)/Patent Under Reexamination</p> <p>Rombouts et al.</p>
	<p>Examiner</p> <p>DALE MOYER</p>	<p>Art Unit</p> <p>3664</p>

CLAIM		DATE								
Final	Original	09/23/2019	04/11/2020							
	43		✓							
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	45		✓							
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	53		=							
	54		=							
	55		=							
	56		=							

<i>Search Notes</i> 	Application/Control No. 16/356,160	Applicant(s)/Patent Under Reexamination Rombouts et al.
	Examiner DALE MOYER	Art Unit 3664

CPC - Searched*		
Symbol	Date	Examiner
G05D1/0225	09/21/2019	DM
G05D1/0272	09/21/2019	DM
G05D1/0274	09/21/2019	DM
G05D1/0246	09/21/2019	DM
G05D1/0234	09/21/2019	DM
G05D2201/0215	09/21/2019	DM
G05D2201/0207	09/21/2019	DM
G05D2201/0203	09/21/2019	DM
A47L9/2873	09/21/2019	DM
A47L2201/02	09/21/2019	DM
B25J9/0003	09/21/2019	DM
B25J9/0005	09/21/2019	DM
Y10S901/01	09/21/2019	DM

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

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

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<i>Search Notes</i> 	Application/Control No. 16/356,160	Applicant(s)/Patent Under Reexamination Rombouts et al.
	Examiner DALE MOYER	Art Unit 3664

Search Notes		
Search Notes	Date	Examiner
considered prosecution history of parent 15/340807	09/21/2019	DM
inventor name search	09/21/2019	DM
assignee search	09/21/2019	DM
ip.com search	09/21/2019	DM
see attached EAST Search History Report	09/21/2019	DM
updated EAST Search	04/11/2020	DM

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

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EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S264	158	(US-20190045992-\$ or US-20190212730-\$ or US-20180263451-\$ or US-20180098200-\$ or US-20170277196-\$ or US-20160135655-\$ or US-20190255991-\$ or US-20180074508-\$ or US-20190235490-\$ or US-20190208979-\$ or US-20190174987-\$ or US-20190094869-\$ or US-20190049979-\$ or US-20190025838-\$ or US-20190015985-\$ or US-20190015984-\$ or US-20180373242-\$ or US-20180360285-\$ or US-20180344116-\$ or US-20180210445-\$ or US-20180074509-\$ or US-20180061137-\$ or US-20180050634-\$ or US-20170303089-\$ or US-20170273527-\$ or US-20170265703-\$).did. or (US-20170261979-\$ or US-20170235312-\$ or US-20170205822-\$ or US-20150182088-\$ or US-20150032260-\$ or US-20170131721-\$ or US-20140116469-\$ or US-20140207280-\$ or US-20160148417-\$ or US-20160052133-\$ or US-20160027207-\$ or US-20150212520-\$ or US-20150212500-\$ or US-20140343783-\$ or US-20140316636-\$ or US-20140303775-\$ or US-20130060379-\$ or US-20130056032-\$ or US-20130024025-\$ or US-20120259481-\$ or US-20150261223-\$ or US-20180364052-\$ or US-20170095926-\$ or US-20140207282-\$ or US-20190216011-\$ or US-20180246518-\$ or US-20180038697-\$).did. or (US-20140100693-\$ or US-20120323365-\$ or US-20160302639-\$ or US-20140190514-\$ or US-20100070078-\$ or US-20160271795-\$ or US-20040167667-\$ or US-20190155296-\$ or US-20070118248-\$ or US-20190235083-\$ or US-20190217478-\$ or US-20040158354-\$ or US-20170285648-\$ or US-20170153646-\$ or US-20140129027-\$ or US-	US-PGPUB; USPAT	OR	ON	2020/04/01 13:34

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S266	5	S265 AND (range WITH node)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/04/02 16:30
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S268	18	S267 AND (range OR distance)	US-PGPUB; USPAT	OR	ON	2020/04/02 16:31
S269	102	S265 AND SLAM!	US-PGPUB; USPAT	OR	ON	2020/04/02 16:35
S270	6176	((G05D2201/0203 OR G05D2201/0215 OR Y10S901/01 OR A47L2201/04 OR A47L11/4011).CPC.)	US-PGPUB; USPAT	OR	ON	2020/04/02 16:36
S271	6047	((G06K9/00664 OR G06T2207/30244).CPC.)	US-PGPUB; USPAT	OR	ON	2020/04/02 16:37
S272	208	S270 AND S271	US-PGPUB; USPAT	OR	ON	2020/04/02 16:37
S273	162	S270 AND S271 and (@ad @rlad @prad)<"20161101"	US-PGPUB; USPAT	OR	ON	2020/04/02 16:37
S274	2	(("20120219207") or ("20170102709")).PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2020/04/02 18:02

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S276	1	(12/458786).APP.	USPAT; USOCR	OR	ON	2020/04/03 14:07
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S281	53	(12/718380 13/017474 13/017518 13/017587 13/017626 13/017690 13/017729 13/026300 13/281018 13/375669 13/456061 13/749497 13/774145 13/775165 14/241864 14/386278 14/537802 14/661940 14/693282 14/962257 14/978123 15/169045 15/182750 15/404038 15/623106 15/638518 16/041286).APP.	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/03 14:08

S282	37	(08/622047 08/665546 09/928669 10/116187 10/526013 10/563957 10/597976 10/739935 10/753403 10/816523 11/165047 11/480017 11/559359 11/833498 11/944952 12/045074 12/096830 12/123125 12/134354 12/219444).APP.	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/03 14:08
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	15/645808 15/650747 15/670881				
	15/672732 15/675045 15/686606				

		15/703885 15/716923 15/792878 15/806145 15/858084 15/890488 15/900015 15/997625 16/011013 16/011269 16/011437 16/026703 16/048179 16/104143 16/160809 16/267175 D/375634).APP.				
S291	188	(S289 AND S290) OR (S281 S283)	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/03 14:17
S292	1569	S290 and (@ad @rlad @prad)<"20161101"	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/03 14:18
S293	182	S291 and (@ad @rlad @prad)<"20161101"	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/03 14:18
S294	0	S275 and normal\$4	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/03 14:18
S295	0	S275 AND correlat\$4	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/03 14:18
S296	0	S275 AND probability	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/03 14:19
S297	0	S275 AND range	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/03 14:19
S298	1	S275 AND depth	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/03 14:19
S299	78	S291 and (@ad @rlad @prad)<"20161101" AND SLAM!	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/03 14:19

S300	67	S291 and (@ad @rlad @prad)<"20161101" AND SLAM!.bi.	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/03 14:19
S301	14	S291 and (@ad @rlad @prad)<"20161101" AND SLAM!.bi. AND node	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/03 14:19
S302	12	S291 and (@ad @rlad @prad)<"20161101" AND SLAM!.bi. AND node AND range	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/03 14:19
S303	2	S291 and (@ad @rlad @prad)<"20161101" AND SLAM!.bi. AND node AND range AND confidence	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/03 14:25
S304	0	(16/356160.app.).CCLS.	US-PGPUB; USPAT; USOCR	OR	OFF	2020/04/03 14:26
S305	1	16/356160.app.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/04/03 14:26
S306	0	("2019/0249998").URPN.	USPAT	OR	ON	2020/04/03 14:27
S307	0	"15340807".app.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/04/03 14:27
S308	2	15/340807.app.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	ON	2020/04/03 14:27

			DERWENT; IBM_TDB			
S309	4	("10274325" "2018/0120116").URPN.	USPAT	OR	ON	2020/04/03 14:27
S310	3	(15/093974 15/276193 15/416361 15/908037).APP.	US-PGPUB; USOCR	OR	ON	2020/04/03 14:27
S311	7	(15/093974 15/276193 15/416361 15/908037).APP.	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/03 14:27
S312	5	S311 and (@ad @rlad @prad)<"20161101"	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/03 14:28
S313	1	16/356160.app. AND confidence	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/04/03 14:32
S314	29	(S275 S300 S312) AND (confidence OR variance OR correlation).bi.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/04/03 14:34
S315	168	(US-20190045992-\$ or US-20190212730-\$ or US-20180263451-\$ or US-20180098200- \$ or US-20170277196-\$ or US- 20160135655-\$ or US-20190255991-\$ or US-20180074508-\$ or US-20190235490-\$ or US-20190208979-\$ or US-20190174987- \$ or US-20190094869-\$ or US- 20190049979-\$ or US-20190025838-\$ or US-20190015985-\$ or US-20190015984-\$ or US-20180373242-\$ or US-20180360285- \$ or US-20180344116-\$ or US- 20180210445-\$ or US-20180074509-\$ or	US-PGPUB; USPAT	OR	ON	2020/04/03 14:36

	US-20180061137-\$ or US-20180050634-\$ or US-20170303089-\$ or US-20170273527-\$ or US-20170265703-\$).did. or (US-20170261979-\$ or US-20170235312-\$ or US-20170205822-\$ or US-20150182088-\$ or US-20150032260-\$ or US-20170131721-\$ or US-20140116469-\$ or US-20140207280-\$ or US-20160148417-\$ or US-20160052133-\$ or US-20160027207-\$ or US-20150212520-\$ or US-20150212500-\$ or US-20140343783-\$ or US-20140316636-\$ or US-20140303775-\$ or US-20130060379-\$ or US-20130056032-\$ or US-20130024025-\$ or US-20120259481-\$ or US-20150261223-\$ or US-20180364052-\$ or US-20170095926-\$ or US-20140207282-\$ or US-20190216011-\$ or US-20180246518-\$ or US-20180038697-\$).did. or (US-20140100693-\$ or US-20120323365-\$ or US-20160302639-\$ or US-20140190514-\$ or US-20100070078-\$ or US-20160271795-\$ or US-20040167667-\$ or US-20190155296-\$ or US-20070118248-\$ or US-20190235083-\$ or US-20190217478-\$ or US-20040158354-\$ or US-20170285648-\$ or US-20170153646-\$ or US-20140129027-\$ or US-20130216098-\$ or US-20120230550-\$ or US-20120219207-\$ or US-20120213443-\$ or US-20090292394-\$ or US-20070293985-\$ or US-20070106423-\$ or US-20050234679-\$ or US-20050182518-\$ or US-20190272462-\$ or US-20170102709-\$ or US-20130138246-\$).did. or (US-20100152945-\$ or US-20070244610-\$ or US-20070250212-\$ or US-20120116588-\$ or US-20040111184-\$ or US-20050221840-\$ or US-20170135541-\$ or US-20090177320-\$ or US-20140244094-\$ or US-20120086598-\$ or US-20100121488-\$ or US-20080027591-\$ or US-20160282870-\$ or US-20110178669-\$ or US-20100324731-\$ or US-20060217837-\$ or US-20050251457-\$ or US-20040249504-\$ or US-20190246600-\$ or US-20170124781-\$ or US-20170351261-\$ or US-				
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		20170248963-\$ or US-20190094876-\$ or US-20190094027-\$ or US-20180370728-\$ or US-20180364045-\$ or US-20180361583-\$).did. or (US-20180361581-\$ or US-20180284806-\$ or US-20180122136-\$ or US-20170153647-\$ or US-20170123428-\$ or US-20170108867-\$ or US-20160209846-\$ or US-20190178654-\$ or US-20120121161-\$ or US-20080033645-\$ or US-20030142587-\$ or US-20130325244-\$ or US-20120197439-\$ or US-20170329347-\$ or US-20160375592-\$ or US-20160378117-\$ or US-20180207791-\$ or US-20090147994-\$ or US-20140350839-\$ or US-20190147220-\$ or US-20180113469-\$ or US-20170262992-\$ or US-20170178355-\$ or US-20160146591-\$ or US-20060165276-\$ or US-20150304634-\$ or US-20180267552-\$).did. or (US-20080119961-\$ or US-20150314443-\$ or US-20100094460-\$ or US-20170203446-\$ or US-20140005933-\$ or US-20120106829-\$ or US-20190249998-\$ or US-20160299508-\$ or US-20090167761-\$).did. or (US-10303179-\$ or US-10291765-\$ or US-9529363-\$ or US-7706917-\$ or US-9764468-\$ or US-8315734-\$ or US-8380350-\$ or US-5696675-\$ or US-10401852-\$ or US-10395117-\$ or US-10334050-\$ or US-10248119-\$ or US-9632502-\$ or US-10012504-\$ or US-9958864-\$ or US-9916703-\$ or US-9910441-\$ or US-9754490-\$ or US-9734455-\$ or US-9720415-\$ or US-9612123-\$ or US-9606539-\$ or US-9507346-\$ or US-10078333-\$ or US-10102629-\$).did.				
S316	149	S315 and (@ad @rlad @prad)<"20161101"	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/03 14:36
S317	72	S316 AND (confidence OR variance OR correlation).bi.	US-PGPUB; USPAT; USOCR; FPRS; EPO;	OR	ON	2020/04/03 14:36

			JPO; DERWENT; IBM_TDB			
S318	13	S317 and (@ad @rlad @prad)<"20161101" AND SLAM!.bi. AND node AND range	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/03 14:37
S319	97	S316 AND (confidence OR variance OR correlation OR probability OR uncertainty).bi.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/04/03 14:39
S320	8	S319 and (@ad @rlad @prad)<"20161101" AND SLAM!.bi. AND node AND range NOT S318	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/03 14:41
S321	71	S316 AND (kalman OR EKF).bi.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/04/03 14:45
S322	11	S321 and (@ad @rlad @prad)<"20161101" AND SLAM!.bi. AND node AND range	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/03 14:45
S323	57	S315 and (@ad @rlad @prad)<"20161101" AND ((depth OR range OR distance) WITH (uncertainty OR variance OR covariance OR correlation OR confidence OR probability OR ellipse OR kalman OR ekf)).bi.	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/03 14:57
S324	57	S315 and (@ad @rlad @prad)<"20161101" AND ((depth OR range OR distance) WITH (uncertainty OR variance OR covariance OR correlation OR confidence OR probability OR ellipse OR kalman OR ekf OR ellipsoid)).bi.	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/03 15:03

S325	1	S275 and (@ad @rlad @prad)<"20161101" AND ((depth OR range OR distance) WITH (uncertainty OR variance OR covariance OR correlation OR confidence OR probability OR ellipse OR kalman OR ekf OR ellipsoid)).bi.	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/03 16:06
S326	1	("20170102709").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2020/04/03 16:07
S327	1	S326 and (@ad @rlad @prad)<"20161101" AND ((depth OR range OR distance) WITH (uncertainty OR variance OR covariance OR correlation OR confidence OR probability OR ellipse OR kalman OR ekf OR ellipsoid)).bi.	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/03 16:07
S328	1	S326 and (@ad @rlad @prad)<"20161101" AND ((depth OR range OR distance OR posision) WITH (uncertainty OR variance OR covariance OR correlation OR confidence OR probability OR ellipse OR kalman OR ekf OR ellipsoid)).bi.	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/03 16:09
S329	1	S326 and (@ad @rlad @prad)<"20161101" AND ((depth OR range OR distance OR position) WITH (uncertainty OR variance OR covariance OR correlation OR confidence OR probability OR ellipse OR kalman OR ekf OR ellipsoid)).bi.	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/03 16:09
S330	1	S326 and (@ad @rlad @prad)<"20161101" AND ((depth OR range OR distance) WITH (bayes OR baysian OR likelihood OR uncertainty OR variance OR covariance OR correlation OR confidence OR probability OR ellipse OR kalman OR ekf OR ellipsoid)).bi.	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/03 16:11
S331	59	S315 and (@ad @rlad @prad)<"20161101" AND ((depth OR range OR distance) WITH (bayes OR	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/03 16:12

		baysian OR likelihood OR uncertainty OR variance OR covariance OR correlation OR confidence OR probability OR ellipse OR kalman OR ekf OR ellipsoid)).bi.				
S332	71	S315 and (@ad @rlad @prad)<"20161101" AND ((position OR pose) WITH (bayes OR baysian OR likelihood OR uncertainty OR variance OR covariance OR correlation OR confidence OR probability OR ellipse OR kalman OR ekf OR ellipsoid)).bi.	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/03 16:14
S333	1	S326 and (@ad @rlad @prad)<"20161101" AND ((position OR pose) WITH (bayes OR baysian OR likelihood OR uncertainty OR variance OR covariance OR correlation OR confidence OR probability OR ellipse OR kalman OR ekf OR ellipsoid)).bi.	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/03 16:14
S334	0	S326 and (@ad @rlad @prad)<"20161101" AND ((position OR pose) WITH (node) WITH (bayes OR baysian OR likelihood OR uncertainty OR variance OR covariance OR correlation OR confidence OR probability OR ellipse OR kalman OR ekf OR ellipsoid)).bi.	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/03 16:15
S335	1	S326 and (@ad @rlad @prad)<"20161101" AND ((position OR pose OR node) WITH (bayes OR baysian OR likelihood OR uncertainty OR variance OR covariance OR correlation OR confidence OR probability OR ellipse OR kalman OR ekf OR ellipsoid)).bi.	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/03 16:16
S336	9	S315 and (@ad @rlad @prad)<"20161101" AND ((position OR pose) WITH (node) WITH (bayes OR baysian OR likelihood OR uncertainty OR variance OR covariance OR correlation OR confidence OR probability OR ellipse OR kalman OR ekf OR ellipsoid)).bi.	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/03 16:16

S337	0	S315 and (@ad @rlad @prad)<"20161101" AND (node WITH (ellipse OR ellipsoid)).bi.	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/03 16:18
S338	10	S315 and (@ad @rlad @prad)<"20161101" AND ((ellipse OR ellipsoid)).bi.	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/03 16:18
S339	37	S315 and (@ad @rlad @prad)<"20161101" AND (confidence)	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/03 16:22
S340	12	13/460261.app. 13/632997.app. 13/790643.app. 14/277270.app. 14/512098.app. 10/739902.app.	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/06 16:49
S341	1	("20110167574").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2020/04/06 18:18
S342	15	13/460261.app. 13/632997.app. 13/790643.app. 14/277270.app. 14/512098.app. 10/739902.app. "20110167574".pn. 11/688213.app.	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/06 18:48
S343	6	S342 AND confidence	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/06 18:48
S344	1	("20140129027").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2020/04/07 11:02
S345	1	S344 AND confidence	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/04/07 11:03
S346	169	(US-20190045992-\$ or US-20190212730-\$ or US-20180263451-\$ or US-20180098200-\$ or US-20170277196-\$ or US- 20160135655-\$ or US-20190255991-\$ or	US-PGPUB; USPAT	OR	ON	2020/04/07 11:27

	US-20180074508-\$ or US-20190235490-\$ or US-20190208979-\$ or US-20190174987-\$ or US-20190094869-\$ or US-20190049979-\$ or US-20190025838-\$ or US-20190015985-\$ or US-20190015984-\$ or US-20180373242-\$ or US-20180360285-\$ or US-20180344116-\$ or US-20180210445-\$ or US-20180074509-\$ or US-20180061137-\$ or US-20180050634-\$ or US-20170303089-\$ or US-20170273527-\$ or US-20170265703-\$).did. or (US-20170261979-\$ or US-20170235312-\$ or US-20170205822-\$ or US-20150182088-\$ or US-20150032260-\$ or US-20170131721-\$ or US-20140116469-\$ or US-20140207280-\$ or US-20160148417-\$ or US-20160052133-\$ or US-20160027207-\$ or US-20150212520-\$ or US-20150212500-\$ or US-20140343783-\$ or US-20140316636-\$ or US-20140303775-\$ or US-20130060379-\$ or US-20130056032-\$ or US-20130024025-\$ or US-20120259481-\$ or US-20150261223-\$ or US-20180364052-\$ or US-20170095926-\$ or US-20140207282-\$ or US-20190216011-\$ or US-20180246518-\$ or US-20180038697-\$).did. or (US-20140100693-\$ or US-20120323365-\$ or US-20160302639-\$ or US-20140190514-\$ or US-20100070078-\$ or US-20160271795-\$ or US-20040167667-\$ or US-20190155296-\$ or US-20070118248-\$ or US-20190235083-\$ or US-20190217478-\$ or US-20040158354-\$ or US-20170285648-\$ or US-20170153646-\$ or US-20140129027-\$ or US-20130216098-\$ or US-20120230550-\$ or US-20120219207-\$ or US-20120213443-\$ or US-20090292394-\$ or US-20070293985-\$ or US-20070106423-\$ or US-20050234679-\$ or US-20050182518-\$ or US-20190272462-\$ or US-20170102709-\$ or US-20130138246-\$).did. or (US-20100152945-\$ or US-20070244610-\$ or US-20070250212-\$ or US-20120116588-\$ or US-20040111184-\$ or US-20050221840-\$ or US-20170135541-\$ or US-				
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	20090177320-\$ or US-20140244094-\$ or US-20120086598-\$ or US-20100121488-\$ or US-20080027591-\$ or US-20160282870- \$ or US-20110178669-\$ or US- 20100324731-\$ or US-20060217837-\$ or US-20050251457-\$ or US-20040249504-\$ or US-20190246600-\$ or US-20170124781- \$ or US-20170351261-\$ or US- 20170248963-\$ or US-20190094876-\$ or US-20190094027-\$ or US-20180370728-\$ or US-20180364045-\$ or US-20180361583- \$).did. or (US-20180361581-\$ or US- 20180284806-\$ or US-20180122136-\$ or US-20170153647-\$ or US-20170123428-\$ or US-20170108867-\$ or US-20160209846- \$ or US-20190178654-\$ or US- 20120121161-\$ or US-20080033645-\$ or US-20030142587-\$ or US-20130325244-\$ or US-20120197439-\$ or US-20170329347- \$ or US-20160375592-\$ or US- 20160378117-\$ or US-20180207791-\$ or US-20090147994-\$ or US-20140350839-\$ or US-20190147220-\$ or US-20180113469- \$ or US-20170262992-\$ or US- 20170178355-\$ or US-20160146591-\$ or US-20060165276-\$ or US-20150304634-\$ or US-20180267552-\$).did. or (US- 20080119961-\$ or US-20150314443-\$ or US-20100094460-\$ or US-20170203446-\$ or US-20140005933-\$ or US-20120106829- \$ or US-20190249998-\$ or US- 20160299508-\$ or US-20090167761-\$ or US-20040167669-\$).did. or (US-10303179- \$ or US-10291765-\$ or US-9529363-\$ or US-7706917-\$ or US-9764468-\$ or US- 8315734-\$ or US-8380350-\$ or US- 5696675-\$ or US-10401852-\$ or US- 10395117-\$ or US-10334050-\$ or US- 10248119-\$ or US-9632502-\$ or US- 10012504-\$ or US-9958864-\$ or US- 9916703-\$ or US-9910441-\$ or US- 9754490-\$ or US-9734455-\$ or US- 9720415-\$ or US-9612123-\$ or US- 9606539-\$ or US-9507346-\$ or US- 10078333-\$ or US-10102629-\$).did.				
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S347	2	S346 and (@ad @rlad @prad)<"20161101" AND (match\$4 WITH (confidence)).bi.	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/07 11:34
S348	27	S346 and (@ad @rlad @prad)<"20161101" AND ((variance covariance chi-squar\$3) WITH (range OR distance OR ellips\$4 OR radius OR diameter)).bi.	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/07 11:50
S349	50	S346 and (@ad @rlad @prad)<"20161101" AND ((variance covariance chi-squar\$3 confidence OR quality or uncertain\$4) WITH (range OR distance OR ellips\$4 OR radius OR diameter)).bi.	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/07 11:51
S350	11	Mahalanobis AND S346	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/07 12:04
S351	13	ellips\$4 AND S346	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/07 12:11
S352	3	reckoning.ab. AND b25j.cpcl.	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/07 15:36
S353	1557	((G05D1/0272).CPC.)	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/07 15:37
S354	251	((G05D1/0272).CPC.) AND confidence	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/07 15:38
S355	227	S354 and (@ad @rlad @prad)<"20161101"	US-PGPUB; USPAT; USOCR	OR	ON	2020/04/07 15:38

EAST Search History (Interference)

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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875			Application or Docket Number 16/356,160		Filing Date 03/18/2019		☐ To be Mailed	
ENTITY: ☐ LARGE ☒ SMALL ☐ MICRO								
APPLICATION AS FILED - PART I								
		(Column 1)	(Column 2)					
FOR		NUMBER FILED	NUMBER EXTRA		RATE (\$)		FEE (\$)	
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))		N/A	N/A		N/A			
☐ SEARCH FEE (37 CFR 1.16(k), (l), or (m))		N/A	N/A		N/A			
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))		N/A	N/A		N/A			
TOTAL CLAIMS (37 CFR 1.16(i))		minus 20 =	*		x \$50 =			
INDEPENDENT CLAIMS (37 CFR 1.16(h))		minus 3 =	*		x \$230 =			
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))		If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$310 (\$155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))								
* If the difference in column 1 is less than zero, enter "0" in column 2.					TOTAL			
APPLICATION AS AMENDED - PART II								
		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT	06/12/2020	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE (\$)	ADDITIONAL FEE (\$)	
	Total (37 CFR 1.16(i))	* 36	Minus	** 36	= 0	x \$50 =	0	
	Independent (37 CFR 1.16(h))	* 3	Minus	*** 3	= 0	x \$230 =	0	
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
						TOTAL ADD'L FEE	0	
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE (\$)	ADDITIONAL FEE (\$)	
	Total (37 CFR 1.16(i))	*	Minus	**	=	x \$0 =		
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x \$0 =		
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
						TOTAL ADD'L FEE		
* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.						LIE		
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This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**
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Electronic Acknowledgement Receipt	
EFS ID:	39704792
Application Number:	16356160
International Application Number:	
Confirmation Number:	4530
Title of Invention:	SYSTEMS AND METHODS FOR ROBOTIC MAPPING
First Named Inventor/Applicant Name:	Jaldert Rombouts
Customer Number:	26418
Filer:	Sidharth Kapoor/Cody Nye
Filer Authorized By:	Sidharth Kapoor
Attorney Docket Number:	P23291US01
Receipt Date:	12-JUN-2020
Filing Date:	18-MAR-2019
Time Stamp:	13:51:05
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment		no			
File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Response After Final Action	P23291US01_-_2020-06-12_-_Response.pdf	544038	no	13
			4321c8c78a032d7b9de963db1d710239b03dd43		
Warnings:					

Information:	
Total Files Size (in bytes):	544038
<p>This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.</p> <p><u>New Applications Under 35 U.S.C. 111</u> If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.</p> <p><u>National Stage of an International Application under 35 U.S.C. 371</u> If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.</p> <p><u>New International Application Filed with the USPTO as a Receiving Office</u> If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.</p>	

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Jaldert Rombouts, et al.

Serial No.: 16/356,160

Attorney Docket No.: P23291US01

Examiner: MOYER, DALE

Art Unit: 3664

For: SYSTEMS AND METHODS FOR
ROBOTIC MAPPING

RESPONSE TO FINAL OFFICE ACTION

PURSUANT TO AFTER FINAL PRACTICE UNDER 37 CFR § 1.116(b)

In response to the Final Office Action dated April 15, 2019, Applicants respectfully request entry of this Amendment and Response pursuant to After Final Practice. *See* MPEP 714. This Response is being timely filed by the statutory time period set forth in the Office Action and within the two-month early response time. The Commissioner is hereby authorized to charge any additional fees, which may be required by this paper, to Deposit Account No. 18-0582.

Amendments to the Claims begin on page 2; and

Remarks begin on page 12.

AMENDMENTS TO THE CLAIMS

1 – 20. (Previously Cancelled).

21. (Previously Presented) A system for traveling a robot along a route, comprising:

a memory having computer readable instructions stored thereon; and

at least one processing device configurable to execute the computer readable instructions to,

collect data by at least one sensor coupled to the robot as the robot travels along the route in an environment,

generate a map of the environment and a route on the map in real-time, the map being generated concurrently with the collection of the data as the robot travels along the route in the environment, the map corresponding to a representation of the environment, the map including information directed to location and position of the robot along the route in the environment, the map being generated based on measurements taken by the at least one sensor at each one of a plurality of nodes along the route traveled by the robot, each one of the plurality of nodes comprising a range, the range of each one of the plurality of nodes being based on confidence measure at a respective node, and

associate actions undertaken by the robot during traveling along the route with the location and position of the robot on the route on the map.

22. (Previously Presented) The system of claim 21, wherein the map is either a two-dimensional or three-dimensional representation of the environment, the map includes

information directed to location and position of the robot along the route in the environment and obstacles detected by the at least one sensor in the environment.

23. (Previously Presented) The system of claim 21, wherein the at least one processing device is further configurable to execute the computer readable instructions to, estimate distance traveled by the robot along the route based on revolution of wheels on the robot.

24. (Previously Presented) The system of claim 21, wherein the at least one processing device is further configurable to execute the computer readable instructions to, estimate distance traveled by the robot along the route based on sequential images captured by the at least one sensor.

25. (Previously Presented) The system of claim 21, wherein the least one processing device is further configurable to execute the computer readable instructions to, determine the robot returned to a start position based on detecting a home locator in the environment.

26. (Previously Presented) The system of claim 21, wherein the least one processing device is further configurable to execute the computer readable instructions to, limit uncertainty of positioning of the plurality of nodes along the route traveled by the robot based on constraining start and end positions of the robot at a same point.

27. (Previously Presented) The system of claim 26, wherein each node of the plurality of nodes comprises an associated probabilistic distribution which corresponds to surrounding region around each node of the plurality of nodes.

28. (Previously Presented) A method for traveling a robot along a route, comprising:

collecting data by at least one sensor coupled to the robot as the robot travels along the route in an environment;

generating a map of the environment and a route on the map in real-time, the map being generated concurrently with the collection of the data as the robot travels along the route in the environment, the map corresponding to a representation of the environment, the map including information directed to location and position of the robot along the route in the environment, the map being generated based on measurements taken by the at least one sensor at each one of a plurality of nodes along the route traveled by the robot, each one of the plurality of nodes comprising a range, the range of each one of the plurality of nodes being based on confidence measure at a respective node; and

associating actions undertaken by the robot during traveling along the route with the location and position of the robot on the route on the map.

29. (Previously Presented) A non-transitory computer readable medium comprising computer readable instructions stored thereon that when executed by at least one processing device configure the at least one processing device to,

collect data by at least one sensor coupled to the robot as the robot travels along the route in an environment;

generate a map of the environment and a route on the map in real-time, the map being generated concurrently with the collection of the data as the robot travels along the route in the environment, the map corresponding to a representation of the environment, the map including information directed to location and position of the robot along the route in the environment, the map being generated based on measurements taken by the at least one sensor at each one of a plurality of nodes along the route traveled by the robot, each one of the plurality of nodes comprising a range, the range of each one of the plurality of nodes being based on confidence measure at a respective node; and

associate actions undertaken by the robot during traveling along the route with the location and position of the robot on the route on the map.

30. (Previously Presented) The system of claim 21, wherein each one of the plurality of nodes along the route traveled by the robot corresponds to a probabilistic function or probabilistic distribution.

31. (Currently Amended) The system ~~pf~~of claim 21, wherein each one of the plurality of nodes along the route traveled by the robot corresponds to position of the robot, the position of the robot is relative to either an initial location or one or more features in the environment.

32. (Previously Presented) The system of claim 21, wherein the range of each one of the plurality of nodes corresponds to a region around each one of the plurality of nodes such that each one of the plurality of nodes is located within the range.

33. (Previously Presented) The system of claim 21, wherein size of the range of each one of the plurality of nodes is variable based on confidence in location of each node of the plurality of nodes.

34. (Previously Presented) The system of claim 21, wherein the at least one processing device is further configurable to execute the computer readable instructions to, selectively actuate one or more systems as the robot travels along the route, the one or more systems comprises a cleaning system, the cleaning system comprises one or more of water flow, brush, and vacuum cleaner.

35. (Previously Presented) The method of claim 28, wherein the map is either a two-dimensional or three-dimensional representation of the environment, the map includes information directed to location and position of the robot along the route in the environment and obstacles detected by the at least one sensor in the environment.

36. (Previously Presented) The method of claim 28, further comprising: estimating distance traveled by the robot along the route based on revolution of wheels on the robot.

37. (Previously Presented) The method of claim 28, further comprising:
estimating distance traveled by the robot along the route based on sequential images captured by the at least one sensor.
38. (Previously Presented) The method of claim 28, further comprising:
determining the robot returned to a start position based on detecting a home locator in the environment.
39. (Previously Presented) The method of claim 28, further comprising:
limiting uncertainty of positioning of the plurality of nodes along the route traveled by the robot based on constraining start and end positions of the robot at a same point.
40. (Previously Presented) The method of claim 39, wherein each node of the plurality of nodes comprises an associated probabilistic distribution which correspond to surrounding region around each node of the plurality of nodes.
41. (Currently Amended) The ~~system~~method of claim 28, wherein each one of the plurality of nodes along the route traveled by the robot corresponds to a probabilistic function or probabilistic distribution.
42. (Currently Amended) The ~~system~~method of claim 28, wherein each one of the plurality of nodes along the route traveled by the robot corresponds to position of the

robot, the position of the robot is relative to either an initial location or one or more features in the environment.

43. (Currently Amended) The ~~system~~method of claim 28, wherein the range of each one of the plurality of nodes corresponds to a region around each one of the plurality of nodes such that each one of the plurality of nodes is located within the range.

44. (Currently Amended) The ~~system~~method of claim 28, wherein size of the range of each one of the plurality of nodes is variable based on confidence in location of each node of the plurality of nodes.

45. (Currently Amended) The ~~system~~method of claim 28, further comprising:
actuating one or more systems selectively as the robot travels along the route, the one or more systems comprises a cleaning system, the cleaning system comprises one or more of water flow, brush, and vacuum cleaner.

46. (Previously Presented) The non-transitory computer readable medium of claim 29, wherein the map is either a two-dimensional or three-dimensional representation of the environment, the map includes information directed to location and position of the robot along the route in the environment and obstacles detected by the at least one sensor in the environment.

47. (Previously Presented) The non-transitory computer readable medium of claim 29, wherein the at least one processing device is further configurable to execute the computer readable instructions to,

estimate distance traveled by the robot along the route based on revolution of wheels on the robot.

48. (Previously Presented) The non-transitory computer readable medium of claim 29, wherein the at least one processing device is further configurable to execute the computer readable instructions to,

estimate distance traveled by the robot along the route based on sequential images captured by the at least one sensor.

49. (Previously Presented) The non-transitory computer readable medium of claim 29, wherein the at least one processing device is further configurable to execute the computer readable instructions to,

determine the robot has returned to a start position based on detecting a home locator in the environment.

50. (Previously Presented) The non-transitory computer readable medium of claim 29, wherein the at least one processing device is further configurable to execute the computer readable instructions to,

limit uncertainty of positioning of the plurality of nodes along the route traveled by the robot based on constraining start and end positions of the robot at a same point.

51. (Previously Presented) The non-transitory computer readable medium of claim 50, wherein each node of the plurality of nodes include an associated probabilistic distribution which correspond to surrounding region around each node of the plurality of nodes.

52. (Previously Presented) The non-transitory computer readable medium of claim 29, wherein each one of the plurality of nodes along the route traveled by the robot corresponds to a probabilistic function or probabilistic distribution.

53. (Previously Presented) The non-transitory computer readable medium of claim 29, wherein each one of the plurality of nodes along the route traveled by the robot corresponds to position of the robot, the position of the robot is relative to either an initial location or one or more features in the environment.

54. (Previously Presented) The non-transitory computer readable medium of claim 29, wherein the range of each one of the plurality of nodes corresponds to a region around each one of the plurality of nodes such that each one of the plurality of nodes is located within the range.

55. (Previously Presented) The non-transitory computer readable medium of claim 29, wherein size of the range of each one of the plurality of nodes is variable based on confidence in location of each node of the plurality of nodes.

56. (Previously Presented) The non-transitory computer readable medium of claim 29, wherein the at least one processing device is further configurable to execute the computer readable instructions to,

selectively actuate one or more systems as the robot travels the route, the one or more systems comprises a cleaning system, the cleaning system comprises one or more of water flow, brush, and vacuum cleaner.

*****END OF CLAIM LISTING*****

REMARKS

Claims 21-56 are pending in the present application. Claims 1-20 were previously cancelled without prejudice. Claims 31 and 41-45 are amended herein to cure minor informalities. No new matter has been introduced via present amendment.

Pursuant to the After Final Practice (*see* MPEP 714), Applicants note that amendments made herein, as discussed below, render moot the claim objections and claim rejections under 35 U.S.C. § 112(b) as set forth in the outstanding final Office action. Accordingly, in view of the remarks and amendments set forth herein, Applicants respectfully request the Examiner to withdraw such objections and rejections, and place the present application in condition for allowance.

Allowable Subject Matter

Applicants thank the Examiner for the indication that claims 21-40 and 46-56 are allowable.

Claim Objection

The Examiner objected to claim 42 because the word “pf” should be amended to “of”. Applicants amend claim 41 to address this objection. On review of the claims, Applicants discovered that claim 31 contained the same informality and amended it to correct this informality. Accordingly, Applicants respectfully request the Examiner to reconsider and withdraw the aforementioned objection.

Claim Rejection Under 35 U.S.C. § 112(b)

On pages 2-3 of the Office action, the Examiner has rejected claims 41-45 under 35 USC § 112(b) as allegedly being indefinite. In particular, the Examiner suggests that there is insufficient antecedent basis for the term “system” in these claims.

Applicants amend claims 41-45 to replace “system” with “method”. Applicants submit that this amendment renders claims 41-45 definite.

Accordingly, Applicants respectfully request the Examiner to reconsider and withdraw the aforementioned rejection, and place the present application in condition for allowance.

Conclusion

In view of the foregoing amendments and remarks, Applicants respectfully submit that all claims in the application are in condition for allowance, and such action is respectfully requested at the Examiner's earliest convenience. If the Examiner believes an Examiner's Amendment would place the application in condition for allowance, Examiner is welcome to contact Applicants' undersigned counsel to discuss the potential Examiner's Amendment. Please apply any necessary charges or credits to Deposit Account 18-0582, referencing the above attorney docket number.

Date: June 12, 2020

Respectfully submitted,

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NOTICE OF ALLOWANCE AND FEE(S) DUE

26418 7590 06/29/2020
REED SMITH LLP
P.O. BOX 488 (NYC)
PITTSBURGH, PA 15230-0488

EXAMINER

MOYER, DALE S

ART UNIT

PAPER NUMBER

3664

DATE MAILED: 06/29/2020

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/356,160	03/18/2019	Jaldert Rombouts	P23291US01	4530

TITLE OF INVENTION: SYSTEMS AND METHODS FOR ROBOTIC MAPPING

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	\$500	\$0.00	\$0.00	\$500	09/29/2020

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

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

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26418 7590 06/29/2020
REED SMITH LLP
P.O. BOX 488 (NYC)
PITTSBURGH, PA 15230-0488

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/356,160	03/18/2019	Jaldert Rombouts	P23291US01	4530

TITLE OF INVENTION: SYSTEMS AND METHODS FOR ROBOTIC MAPPING

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	\$500	\$0.00	\$0.00	\$500	09/29/2020

EXAMINER	ART UNIT	CLASS-SUBCLASS
MOYER, DALE S	3664	700-258000

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

- ☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
- ☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-09 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list

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

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

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(A) NAME OF ASSIGNEE

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

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

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

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

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

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

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

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/356,160	03/18/2019	Jaldert Rombouts	P23291US01	4530
26418	7590	06/29/2020	EXAMINER	
REED SMITH LLP			MOYER, DALE S	
P.O. BOX 488 (NYC)				
PITTSBURGH, PA 15230-0488				
			ART UNIT	PAPER NUMBER
			3664	
DATE MAILED: 06/29/2020				

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

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

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

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

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

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

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

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

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

Notice of Allowability	Application No. 16/356,160	Applicant(s) Rombouts et al.	
	Examiner DALE MOYER	Art Unit 3664	AIA (FITF) Status Yes

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

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

1. ☒ This communication is responsive to the amendment received 12 June 2020.
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

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

3. ☒ The allowed claim(s) is/are 21-56. As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

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

Certified copies:

a) ☐ All b) ☐ Some *c) ☐ None of the:

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

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

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

* Certified copies not received: _____.

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

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

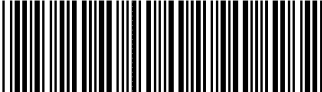
Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

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

Attachment(s)

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

/Dale Moyer/ Primary Examiner, Art Unit 3664	
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Issue Classification 	Application/Control No. 16/356,160	Applicant(s)/Patent Under Reexamination Rombouts et al.
	Examiner DALE MOYER	Art Unit 3664

CPC						
Symbol					Type	Version
G01C		21		32	F	2013-01-01
G01S		17		89	I	2013-01-01
G01S		15		89	A	2013-01-01

CPC Combination Sets					
Symbol		Type	Set	Ranking	Version
					

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	36	
/Dale Moyer/ Primary Examiner, Art Unit 3664	20 June 2020	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	2

Issue Classification 	Application/Control No. 16/356,160	Applicant(s)/Patent Under Reexamination Rombouts et al.
	Examiner DALE MOYER	Art Unit 3664

INTERNATIONAL CLASSIFICATION			
CLAIMED			
G01C		21	
			
NON-CLAIMED			
			

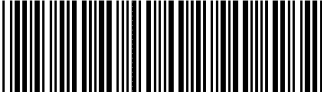
US ORIGINAL CLASSIFICATION	
CLASS	SUBCLASS

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

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	36	
/Dale Moyer/ Primary Examiner, Art Unit 3664	20 June 2020	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	2

U.S. Patent and Trademark Office

Part of Paper No.: 20200620

Issue Classification 	Application/Control No. 16/356,160	Applicant(s)/Patent Under Reexamination Rombouts et al.
	Examiner DALE MOYER	Art Unit 3664

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

CLAIMS															
Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
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	2		11		20		25		29		17		38		27
	3		12	1	21		8		30		18		39		28
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	6		15	4	24		11		33		21		42		31
	7		16	5	25		12		34		22		43		32
	8		17	6	26		14		35		23		44		33
	9		18	7	27		15		36		24		45		34

NONE (Assistant Examiner) _____ (Date) _____		Total Claims Allowed: 36	
/Dale Moyer/ Primary Examiner, Art Unit 3664 (Primary Examiner) _____ (Date) _____		20 June 2020 (Date)	O.G. Print Claim(s) 1 O.G. Print Figure 2

<i>Search Notes</i> 	Application/Control No. 16/356,160	Applicant(s)/Patent Under Reexamination Rombouts et al.
	Examiner DALE MOYER	Art Unit 3664

CPC - Searched*		
Symbol	Date	Examiner
G05D1/0225	09/21/2019	DM
G05D1/0272	09/21/2019	DM
G05D1/0274	09/21/2019	DM
G05D1/0246	09/21/2019	DM
G05D1/0234	09/21/2019	DM
G05D2201/0215	09/21/2019	DM
G05D2201/0207	09/21/2019	DM
G05D2201/0203	09/21/2019	DM
A47L9/2873	09/21/2019	DM
A47L2201/02	09/21/2019	DM
B25J9/0003	09/21/2019	DM
B25J9/0005	09/21/2019	DM
Y10S901/01	09/21/2019	DM

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

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

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<i>Search Notes</i> 	Application/Control No. 16/356,160	Applicant(s)/Patent Under Reexamination Rombouts et al.
	Examiner DALE MOYER	Art Unit 3664

Search Notes		
Search Notes	Date	Examiner
considered prosecution history of parent 15/340807	09/21/2019	DM
inventor name search	09/21/2019	DM
assignee search	09/21/2019	DM
ip.com search	09/21/2019	DM
see attached EAST Search History Report	09/21/2019	DM
updated EAST Search	04/11/2020	DM
updated EAST Search	06/20/2020	DM

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner
G01C	21/32	06/20/2020	DM
G01S	15/89, 17/89	06/20/2020	DM

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OK TO ENTER: /DM/

OK TO ENTER: /DM/

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: Jaldert Rombouts, et al.

Serial No.: 16/356,160

Attorney Docket No.: P23291US01

Examiner: MOYER, DALE

Art Unit: 3664

For: SYSTEMS AND METHODS FOR
ROBOTIC MAPPING

RESPONSE TO FINAL OFFICE ACTION

PURSUANT TO AFTER FINAL PRACTICE UNDER 37 CFR § 1.116(b)

In response to the Final Office Action dated April 15, 2019, Applicants respectfully request entry of this Amendment and Response pursuant to After Final Practice. *See* MPEP 714. This Response is being timely filed by the statutory time period set forth in the Office Action and within the two-month early response time. The Commissioner is hereby authorized to charge any additional fees, which may be required by this paper, to Deposit Account No. 18-0582.

Amendments to the Claims begin on page 2; and

Remarks begin on page 12.

Bibliographic Data

Application No: 16/356,160

Foreign Priority claimed: ☐ Yes ☒ No

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

☐ Met After Allowance

Verified and Acknowledged:

/Dale Moyer/

Examiner's Signature

Initials

Title:

SYSTEMS AND METHODS FOR ROBOTIC MAPPING

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
03/18/2019	700	3664	P23291US01
RULE			

APPLICANTS

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Andrew Smith San Diego, CA, UNITED STATES

CONTINUING DATA

This application is a CON of 15340807 11/01/2016 PAT 10274325

FOREIGN APPLICATIONS

IF REQUIRED, FOREIGN LICENSE GRANTED**

04/03/2019

**** SMALL ENTITY ****

STATE OR COUNTRY

UNITED STATES

ADDRESS

REED SMITH LLP
P.O. BOX 488 (NYC)
PITTSBURGH, PA 15230-0488
UNITED STATES

FILING FEE RECEIVED

\$865

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
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L27	145	L26 AND ((map\$4 OR local\$4) WITH (updat\$4 OR correct\$4)) AND ((start\$4 WITH end\$3) NEAR2 (position OR point OR location OR dock\$4 OR charg\$4 OR base OR station))	US-PGPUB; USPAT; USOCR	OR	ON	2020/06/20 12:01
L28	71	(US-20190246600-\$ or US-20130325244-\$ or US-20160271795-\$ or US-20170102709-\$ or US-20130216098-\$ or US-20170329333-\$ or US-20170329347-\$ or US-20190025838-\$ or US-20180364045-\$ or US-20180361583-\$ or US-20180361581-\$ or US-20180321675-\$ or US-20180246514-\$ or US-20180237019-\$ or US-20180237018-\$ or US-20180231982-\$ or US-20180094938-\$ or US-20180196442-\$ or US-20180089616-\$ or US-20180075643-\$ or US-20180059682-\$ or US-20180043536-\$ or US-20180024564-\$ or US-20180004217-\$ or US-20160327395-\$ or US-20170157769-\$).did. or (US-20170122754-\$ or US-20170095926-\$ or US-20170083021-\$ or US-20160334796-\$ or US-20160282878-\$ or US-20160282867-\$ or US-20160246301-\$ or US-20160195875-\$ or US-20160062361-\$ or US-20160059418-\$ or US-20120095651-\$ or US-20150120125-\$ or US-20150025708-\$ or US-20140343846-\$ or US-20140277900-\$ or US-20140214237-\$ or US-20140214236-\$ or US-20140214235-\$ or US-20140058563-\$ or US-20130261964-\$ or US-20130166193-\$ or US-20130006484-\$ or	US-PGPUB; USPAT	OR	ON	2020/06/20 12:01

		US-20110153136-\$ or US-20120259481-\$ or US-20120247510-\$ or US-20110153338-\$ or US-20090234499-\$).did. or (US-20080065267-\$ or US-20080009966-\$ or US-20080009964-\$ or US-20070188615-\$ or US-20070027612-\$ or US-20070027579-\$ or US-20060217837-\$ or US-20060095160-\$ or US-20050216124-\$ or US-20050085947-\$ or US-20050046373-\$ or US-20040073337-\$ or US-20030117862-\$).did. or (US-10416682-\$ or US-10386846-\$ or US-7211980-\$ or US-5790403-\$ or US-5179329-\$).did.				
L29	76	(US-20160271795-\$ or US-20190246600-\$ or US-20130325244-\$ or US-20170102709-\$ or US-20130216098-\$ or US-20200158514-\$ or US-20180089616-\$ or US-20190332115-\$ or US-20190291748-\$ or US-20170329333-\$ or US-20170329347-\$ or US-20190025838-\$ or US-20180364045-\$ or US-20180361583-\$ or US-20180361581-\$ or US-20180321675-\$ or US-20180246514-\$ or US-20180237019-\$ or US-20180237018-\$ or US-20180231982-\$ or US-20180094938-\$ or US-20180196442-\$ or US-20180075643-\$ or US-20180059682-\$ or US-20180043536-\$ or US-20180024564-\$).did. or (US-20180004217-\$ or US-20160327395-\$ or US-20170157769-\$ or US-20170122754-\$ or US-20170095926-\$ or US-20170083024-\$ or US-20170083021-\$ or US-20170017239-\$ or US-20160334796-\$ or US-20160282878-\$ or US-20160282867-\$ or US-20160246301-\$ or US-20160195875-\$ or US-20160062361-\$ or US-20160059418-\$ or US-20120095651-\$ or US-20150120125-\$ or US-20150025708-\$ or US-20140343846-\$ or US-20140277900-\$ or US-20140214237-\$ or US-20140214236-\$ or US-20140214235-\$ or US-20140058563-\$ or US-20130261964-\$ or US-20130166193-\$ or US-20130006484-\$).did. or (US-20110153136-\$ or US-20120259481-\$ or US-20120247510-\$ or US-20110153338-\$ or US-20090234499-\$ or US-20080065267-\$ or US-20080009966-\$ or US-20080009964-\$ or US-20070188615-\$ or US-20070027612-	US-PGPUB; USPAT	OR	ON	2020/06/20 12:02

		\$ or US-20070027579-\$ or US-20060217837-\$ or US-20060095160-\$ or US-20050216124-\$ or US-20050085947-\$ or US-20050046373-\$ or US-20040073337-\$ or US-20030117862-\$).did. or (US-10416682-\$ or US-10386846-\$ or US-7211980-\$ or US-5790403-\$ or US-5179329-\$).did.				
L30	5	29 NOT 28	US-PGPUB; USPAT	OR	ON	2020/06/20 12:02
L31	5	30 and (@ad @rlad @prad)<"20161101"	US-PGPUB; USPAT	OR	ON	2020/06/20 12:03
L32	1	31 AND (confidence)	US-PGPUB; USPAT	OR	ON	2020/06/20 12:04
L33	5	31 AND (distance OR range OR radius OR radial)	US-PGPUB; USPAT	OR	ON	2020/06/20 12:04
L34	2	31 AND ((distance OR range OR radius OR radial) WITH (node OR confidence OR probability OR likelihood)).bi.	US-PGPUB; USPAT	OR	ON	2020/06/20 12:07

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	12,556	(G01C21/32 or G01S17/89 or G01S15/89).cpc.	US-PGPUB; USPAT	OR	ON	2020/06/20 11:52
L2	0	1 AND (robot map environment location position node range confidence).clm.	US-PGPUB; USPAT	AND	ON	2020/06/20 11:57
L3	2	1 AND (robot map environment node range confidence).clm.	US-PGPUB; USPAT	AND	ON	2020/06/20 11:57

6/20/2020 12:09:02 PM

C:\Users\dmoyer\Documents\My Docket\16356160\EAST Search.wsp

PART B - FEE(S) TRANSMITTAL

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

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

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

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

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

26418 7590 06/29/2020
REED SMITH LLP
P.O. BOX 488 (NYC)
PITTSBURGH, PA 15230-0488

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

Certificate of Mailing or Transmission

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

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/356,160	03/18/2019	Jaldert Rombouts	P23291US01	4530

TITLE OF INVENTION: SYSTEMS AND METHODS FOR ROBOTIC MAPPING

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	\$500	\$0.00	\$0.00	\$500	09/29/2020

EXAMINER	ART UNIT	CLASS-SUBCLASS
MOYER, DALE S	3664	700-258000

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

- ☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
- ☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-09 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list

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

1 Reed Smith LLP
2 Sidharth Kapoor
3

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

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

(A) NAME OF ASSIGNEE

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

Brain Corporation

San Diego, California

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

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

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

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

☒ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. 18-0582

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

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

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

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

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

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

Authorized Signature /Sidharth Kapoor/

Date September 28, 2020

Typed or printed name Sidharth Kapoor

Registration No. 68,159

Electronic Patent Application Fee Transmittal				
Application Number:		16356160		
Filing Date:		18-Mar-2019		
Title of Invention:		SYSTEMS AND METHODS FOR ROBOTIC MAPPING		
First Named Inventor/Applicant Name:		Jaldert Rombouts		
Filer:		Sidharth Kapoor/Cody Nye		
Attorney Docket Number:		P23291US01		
Filed as Small Entity				
Filing Fees for Utility under 35 USC 111(a)				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
UTILITY APPL ISSUE FEE	2501	1	500	500

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				500

Electronic Acknowledgement Receipt	
EFS ID:	40687533
Application Number:	16356160
International Application Number:	
Confirmation Number:	4530
Title of Invention:	SYSTEMS AND METHODS FOR ROBOTIC MAPPING
First Named Inventor/Applicant Name:	Jaldert Rombouts
Customer Number:	26418
Filer:	Sidharth Kapoor/Cody Nye
Filer Authorized By:	Sidharth Kapoor
Attorney Docket Number:	P23291US01
Receipt Date:	28-SEP-2020
Filing Date:	18-MAR-2019
Time Stamp:	14:21:51
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	\$500
RAM confirmation Number	E20209RE22516740
Deposit Account	
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	P23291US01_-_2020-09-28_-_Issue_Fee_Transmittal.PDF	95551	no	1
			a8f0d9c12fbbad430a271fd90cb68860219c16ec		
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30348	no	2
			368735cda28d398e33c535692b8498e03899b533		
Warnings:					
Information:					
Total Files Size (in bytes):			125899		
<p>This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.</p> <p><u>New Applications Under 35 U.S.C. 111</u> If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.</p> <p><u>National Stage of an International Application under 35 U.S.C. 371</u> If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.</p> <p><u>New International Application Filed with the USPTO as a Receiving Office</u> If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.</p>					



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United States Patent and Trademark Office
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APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/356,160	11/03/2020	10823576	P23291US01	4530
26418	7590	10/14/2020		
REED SMITH LLP P.O. BOX 488 (NYC) PITTSBURGH, PA 15230-0488				

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

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

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

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

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

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

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

BRAIN CORPORATION, San Diego, CA;
Jaldert Rombouts, San Diego, CA;
Borja Ibarz Gabardos, London, UNITED KINGDOM;
Jean-Baptiste Passot, Solana Beach, CA;
Andrew Smith, San Diego, CA;

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Doc Code: PA..

Document Description: Power of Attorney

PTO/AIA/82A (07-13)

Approved for use through 09/30/2025. OMB 0651-0035

U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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NOTE: This form is to be submitted with the Power of Attorney by Applicant form (PTO/AIA/82B) to identify the application to which the Power of Attorney is directed, in accordance with 37 CFR 1.5, unless the application number and filing date are identified in the Power of Attorney by Applicant form. If neither form PTO/AIA/82A nor form PTO/AIA/82B identifies the application to which the Power of Attorney is directed, the Power of Attorney will not be recognized in the application.

Application Number	16/356,160
Filing Date	03/18/2019
First Named Inventor	Jaldert Rombouts
Title	SYSTEMS AND METHODS FOR ROBOTIC MAPPING
Art Unit	3664
Examiner Name	DALE S MOYER
Attorney Docket Number	035471.075US2

SIGNATURE of Applicant or Patent Practitioner			
Signature	/Sidharth Kapoor/	Date (Optional)	
Name	Sidharth Kapoor	Registration Number	68,159
Title (if Applicant is a juristic entity)			
Applicant Name (if Applicant is a juristic entity)			
<p>NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. If more than one applicant, use multiple forms.</p>			
☒ *Total of <u>1</u> forms are submitted.			

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

POWER OF ATTORNEY BY APPLICANT

I hereby revoke all previous powers of attorney given in the application identified in either the attached transmittal letter or the boxes below.

Application Number	Filing Date

(Note: The boxes above may be left blank if information is provided on form PTO/AIA/82A.)



I hereby appoint the Patent Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above:

197519

OR



I hereby appoint Practitioner(s) named in the attached list (form PTO/AIA/82C) as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the patent application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above. (Note: Complete form PTO/AIA/82C.)

Please recognize or change the correspondence address for the application identified in the attached transmittal letter or the boxes above to:



The address associated with the above-mentioned Customer Number

OR



The address associated with Customer Number:



Firm or
Individual Name

Address

City

State

Zip

Country

Telephone

Email

I am the Applicant (if the Applicant is a juristic entity, list the Applicant name in the box):

Brain Corporation



Inventor or Joint Inventor (title not required below)



Legal Representative of a Deceased or Legally Incapacitated Inventor (title not required below)



Assignee or Person to Whom the Inventor is Under an Obligation to Assign (provide signer's title if applicant is a juristic entity)



Person Who Otherwise Shows Sufficient Proprietary Interest (e.g., a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document) (provide signer's title if applicant is a juristic entity)

SIGNATURE of Applicant for Patent

The undersigned (whose title is supplied below) is authorized to act on behalf of the applicant (e.g., where the applicant is a juristic entity).

Signature

Andy Ng

Date (Optional)

Name

Andy Ng

Title

General Counsel

NOTE: Signature - This form must be signed by the applicant in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. If more than one applicant, use multiple forms.



Total of 1 forms are submitted.

A Federal agency may not conduct or sponsor, and a person is not required to respond to, nor shall a person be subject to a penalty for failure to comply with an information collection subject to the requirements of the Paperwork Reduction Act of 1995, unless the information collection has a currently valid OMB Control Number. The OMB Control Number for this information collection is 0651-0035. Public burden for this form is estimated to average 3 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the information collection. Send comments regarding this burden estimate or any other aspect of this information collection, including suggestions for reducing this burden to the Chief Administrative Officer, United States Patent and Trademark Office, P.O. Box 1450, Alexandria, VA 22313-1450 or email InformationCollection@uspto.gov. **DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS.** If filing this completed form by mail, send to: **Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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Page 1 of 2
P.O. Box 1450
Alexandria, VA 22313 - 1450
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ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #
16/356,160

RECEIPT DATE / TIME
01/13/2025 06:28:04 PM Z ET

ATTORNEY DOCKET #
P23291US01

Title of Invention

SYSTEMS AND METHODS FOR ROBOTIC MAPPING

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	10823576
CONFIRMATION #	4530	FILED BY	Sidharth Kapoor
PATENT CENTER #	68718590	FILING DATE	03/18/2019
CUSTOMER #	26418	FIRST NAMED INVENTOR	Jaldert Rombouts
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	-

Documents

TOTAL DOCUMENTS: 1

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
16-356160- POA.pdf	2	Power of Attorney	414 KB

Digest

DOCUMENT	MESSAGE DIGEST(SHA-512)
16-356160- POA.pdf	FF5B63AFEF4A357B1479458A92524460033D9EB7392E98214E0CFBB82628A35AD0700F3B26C291E4EEC073DFB29155A90C755C3C7FF93817E2050473445F4E55

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

New Applications Under 35 U.S.C. 111

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

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

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

New International Application Filed with the USPTO as a Receiving Office

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



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UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/356,160	03/18/2019	Jaldert Rombouts	035471.075US2

CONFIRMATION NO. 4530

POA ACCEPTANCE LETTER



OC000000083423324

197519
Pierson Ferdinand, LLP
1101 Pennsylvania Avenue N.W.
Suite 300
Washington, DC 20005

Date Mailed: 01/29/2025

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 01/13/2025.

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

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

/snguyen/