

DESCRIPTION

Invention Title: OBJECT INSPECTION SYSTEM AND METHOD USING
MOBILE ROBOT

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Technical Field

[1] The present disclosure relates to an object inspection system and method using a mobile robot for inspecting an object on which a work process is performed after the work process has been performed on the object.

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[2]

Background Art

[3] Generally, global automobile manufacturers produce millions to tens of millions of vehicles annually, and at the same time, develop the vehicles with various specifications in order to satisfy customer needs. In addition, the manufacturers are continuously developing production technologies to maximally increase the production efficiency and production quality.

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[4] In order to produce a finished vehicle, numerous parts should be assembled, and although automation of equipment has been achieved to this end, until now manual assembly operation is still predominant in the assembly process where workers assemble most of the parts by hand. Accordingly, the assembly quality of the workers may have a significant impact on the

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production quality of the vehicles, so improving the production quality of the vehicles may require improving the assembly quality of the workers.

[5] In order to improve the assembly quality obtained by workers, inspection work for checking the assembly quality may be required after the assembly work is completed by the workers. However, when the inspection of the assembly quality is performed after the completion of vehicle production, the inspection for each part and the detection of defects are unable to be achieved, so inspecting the assembly quality should be performed in real time. However, because of the nature of the manual assembly process, it may be difficult to perform the inspecting of the assembly quality in real time due to issues such as ensuring worker safety or securing space for inspection equipment.

[6] Therefore, it is required to establish a method capable of inspecting the assembly quality obtained by the workers while ensuring their safety.

[7]

[8] The foregoing is intended merely to aid in the understanding of the background of the present disclosure, and is not intended to mean that the present disclosure falls within the purview of the related art that is already known to those skilled in the art.

[9]

Disclosure

Technical Problem

[10] The present disclosure is proposed to solve such problems, and an objective of the present invention is to provide an object inspection system and method using a mobile robot, the system and method capable of inspecting an object, on which a work process is performed, by using the movable and controllable mobile robot after the work process has been performed on the object.

[11]

[12] The technical problems to be achieved in the present disclosure are not limited to the technical problems mentioned above, and other technical problems that are not mentioned will be clearly understood by those skilled in the art to which the present disclosure belongs from the following description.

[13]

Technical Solution

[14] According to the present disclosure for achieving the objective, there is provided an object inspection system using a mobile robot, the system including: the mobile robot configured to move through a plurality of work areas; and a controller configured to perform an inspection for a first work area by moving the mobile robot to the first work area among the plurality of work areas on the basis of an

inspection schedule for the plurality of work areas, determine a state of a second work area before the mobile robot reaches the second work area corresponding to a next work area of the first work area according to the inspection schedule, adjust
5 the inspection schedule when the determined state of the second work area does not satisfy a preset condition, and reset a movement route of the mobile robot on the basis of the adjusted inspection schedule.

[15] For example, the controller may generate the inspection
10 schedule on the basis of a work schedule for the plurality of work areas, and perform the inspection for the first work area on the basis of the generated inspection schedule.

[16] For example, the controller may generate the inspection
15 schedule by further considering at least one of an arrangement condition of the plurality of work areas and the movement route of the mobile robot.

[17] For example, the mobile robot may move to the first work
20 area to capture an image of a workpiece located in the first work area, and the controller may perform the inspection on the basis of the image of the workpiece captured by the mobile robot.

[18] For example, the controller may determine the state of
25 the second work area on the basis of at least one of presence or absence of a worker within the second work area and whether a task for the second work area is completed.

[19] For example, the controller may determine that the state of the second work area does not satisfy the preset condition when the worker is present in the second work area or the task for the second work area is not completed.

5 **[20]** For example, the controller may adjust the inspection schedule on the basis of remaining work areas except for the first work area among the plurality of work areas, so that the next work area of the first work area becomes a work area other than the second work area not on satisfying the preset
10 condition with the state of the second work area.

[21] For example, the controller may derive a plurality of new inspection schedules having the second work area not corresponding to the next work area of the first work area on the basis of the remaining work areas, determine a movement
15 distance for the mobile robot to move for each of the derived plurality of new inspection schedules, and adjust the inspection schedule to be one new inspection schedule having a shortest movement distance that is determined.

[22]

20 **[23]** In addition, according to the present disclosure for achieving the objective, there is provided an object inspection method using a mobile robot, the method including: performing an inspection for a first work area by moving the mobile robot to the first work area among the plurality of
25 work areas on the basis of an inspection schedule for the

plurality of work areas; determining a state of a second work area before the mobile robot reaches the second work area corresponding to a next work area of the first work area according to the inspection schedule; adjusting the inspection
5 schedule when the determined state of the second work area does not satisfy a preset condition; and resetting a movement route of the mobile robot on the basis of the adjusted inspection schedule.

[24] For example, the performing of the inspection may include:
10 generating the inspection schedule on the basis of a work schedule for the plurality of work areas, and performing the inspection for the first work area on the basis of the generated inspection schedule.

[25] For example, the generating of the inspection schedule
15 may include generating the inspection schedule by further considering at least one of an arrangement condition of the plurality of work areas and the movement route of the mobile robot.

[26] For example, the performing of the inspection may include:
20 capturing an image of a workpiece located in the first work area by the mobile robot having moved to the first work area; and performing the inspection on the basis of the image of the workpiece captured by the mobile robot.

[27] For example, the determining of the state may include
25 determining the state of the second work area on the basis of

at least one of presence or absence of a worker within the second work area and whether a task for the second work area is completed.

[28] For example, the determining of the state may include determining that the state of the second work area does not satisfy the preset condition when the worker is present in the second work area or the task for the second work area is not completed.

[29] For example, the adjusting of the inspection schedule may include adjusting the inspection schedule on the basis of remaining work areas except for the first work area among the plurality of work areas, so that the next work area of the first work area becomes a work area other than the second work area not on satisfying the preset condition with the state of the second work area.

[30]

[31] For example, the adjusting of the inspection schedule may include: deriving a plurality of new inspection schedules having the second work area not corresponding to the next work area of the first work area on the basis of the remaining work areas; determining a movement distance for the mobile robot to move for each of the derived plurality of new inspection schedules; and adjusting the inspection schedule to be one new inspection schedule having a shortest movement distance that is determined.

[32]

Advantageous Effects

[33] According to the above description, an object inspection system and method using a mobile robot in the present disclosure may inspect an object, on which a work process is performed, by using the mobile robot in real time, thereby enabling inspection to be performed without limitations on securing space.

[34] In addition, the real-time inspection may be performed by using the mobile robot, and before the mobile robot moves, the state of a work area being inspected is determined, thereby securing the safety of workers.

[35]

Description of Drawings

[36] FIG. 1 is a block diagram illustrating a configuration of an object inspection system using a mobile robot according to one exemplary embodiment of the present disclosure.

[37] FIG. 2 is a view illustrating an object inspection process using the mobile robot according to one exemplary embodiment of the present disclosure.

[38] FIGS. 3 and 4 are views respectively illustrating a work schedule and an inspection schedule according to one exemplary embodiment of the present disclosure.

[39] FIG. 5 is a flowchart illustrating an object inspection method using a mobile robot according to one exemplary embodiment of the present disclosure.

[40]

Mode for Invention

[41] In describing the exemplary embodiment disclosed in the present specification, when it is determined that a detailed description of a related known technology may obscure the subject matter of the exemplary embodiment disclosed in the present specification, the detailed description thereof will be omitted. In addition, the accompanying drawings are only for easy understanding of the exemplary embodiment disclosed in the present specification, the technical idea disclosed in the present specification is not limited by the accompanying drawings, and it should be understood that the accompanying drawings include all changes, equivalents, or substitutes, which are included in the spirit and technical scope of the present disclosure.

[42] Terms including ordinal numbers such as first, second, etc. may be used to describe various components, but the components are not limited by the terms. These terms are only used for the purpose of distinguishing one component from another component.

[43] When a component is described as being "connected", "coupled", or "linked" to another component, that component

may be directly connected, coupled, or linked to that other component. However, it should be understood that yet another component between each of the components may be present. In contrast, when a component is described as being "directly
5 connected", "directly coupled", or "directly linked" to another component, it should be understood that there are no intervening component present therebetween.

[44] As used herein, the singular forms are intended to include the plural forms as well, unless the context clearly
10 indicates otherwise.

[45] It will be further understood that the terms "comprise", "include", "have", etc. when used in the present specification, specify the presence of stated features, integers, steps, operations, elements, components, and/or combinations of them
15 but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or combinations thereof.

[46] In addition, each controller may include: a communication device for communicating with other controllers or sensors in order to control functions in charge; a memory for storing an
20 operating system, logic instructions, and input/output information; and one or more processors for performing determinations, calculations, and decisions, which are required for controlling the functions in charge.

[47] Hereinafter, an exemplary embodiment disclosed in the present specification will be described in detail with reference to the accompanying drawings, but regardless of the reference numerals, the same or similar components are given the same reference numbers, and the overlapping description thereof will be omitted.

[48]

[49] First, a configuration of an object inspection system using a mobile robot according to one exemplary embodiment of the present disclosure will be described with reference to FIGS. 1 and 2.

[50] FIG. 1 is a block diagram illustrating a configuration of the object inspection system using the mobile robot according to one exemplary embodiment of the present disclosure. FIG. 2 is a view illustrating an object inspection process using the mobile robot according to one exemplary embodiment of the present disclosure.

[51] First, referring to FIG. 1, the object inspection system using the mobile robot according to the embodiment of the present disclosure may include a mobile robot 110 and a controller 120 for controlling the mobile robot 110. However, the system illustrated in FIG. 1 mainly shows components related to the exemplary embodiment of the present disclosure, and it is natural that an actual system may be implemented by including more or fewer components.

[52] Each component is described below.

[53] The mobile robot 110 may move around a workpiece 10 and capture an image of the workpiece 10. At this time, the plurality of work areas A to D may be set around the workpiece 10 according to the exemplary embodiment of the present disclosure. The plurality of work areas A to D may mean work areas arbitrarily divided for a worker to perform a task based on one workpiece 10. However, this is an example and is not necessarily limited thereto. For example, the plurality of work areas may be divided into various shapes depending on the size of the workpiece 10 or a work process.

[54] Specifically, the worker may perform the task according to a predetermined work schedule in order to make the workpiece 10 in its finished form, and the mobile robot 110 may move around the workpiece 10 and capture an image of the work results (e.g., the assembly quality) of the workpiece 10 on which the worker has performed the task according to the work schedule.

[55] To this end, according to the exemplary embodiment of the present disclosure, the mobile robot 110 may be provided with a moving part (not shown) for movement and an imaging device (not shown) for photographing the workpiece 10. For example, the mobile robot 110 may be a quadruped walking robot equipped with a multi-joint arm and a high-resolution camera, but this is an example and is not necessarily limited thereto.

[56] Meanwhile, in order to facilitate photographing the workpiece 10 by using the mobile robot 110, location guidance equipment for informing the mobile robot 110 of a photographing location may be provided on the workpiece 10.

5 For example, the location guidance equipment may mean, but are not limited to, optically recognizable markers (i.e., spots, two-dimensional (2D) codes, etc.), tags recognizable in a contactless way at close range (e.g., NFC tags, RFID tags, etc.), magnetic strips, wires, etc. At least one or more
10 kinds of the location guidance equipment provided on the workpiece 10 may be provided for each of the plurality of work areas A to D described above, and the mobile robot 110 may recognize the location guidance equipment provided on the workpiece 10 in each of the plurality of work areas A to D and
15 capture an image of the work results of the workpiece 10 at the corresponding location.

[57] The controller 120 may control the mobile robot 110 to perform an inspection on the workpiece 10. Specifically, the controller 120 may generate an inspection schedule for the
20 workpiece 10 on the basis of the work schedule for the plurality of work areas A to D. In this case, the inspection schedule may mean the inspection schedule for the plurality of work areas A to D. This will be described with reference to FIGS. 3 and 4.

25 **[58]**

[59] FIGS. 3 and 4 are views respectively illustrating a work schedule and an inspection schedule according to one exemplary embodiment of the present disclosure.

[60] FIG. 3 may refer to the work schedule for the plurality of work areas A to D provided from a work management system 200 according to one exemplary embodiment of the present disclosure. For example, the work schedule may be one generated through an algorithm provided in the work management system 200, and it is natural that various work schedules may be generated according to the workpiece 10 or the plurality of work areas A to D.

[61] Meanwhile, according to one exemplary embodiment of the present disclosure, in order to perform the inspection on the workpiece 10 by the controller 120 the mobile robot 110 has to move around the plurality of work areas A to D and photograph the work results of the workpiece 10. However, the work schedule may be generated through an algorithm taking into account the movement route of the worker performing a task as well as the part supply state for the workpiece 10, and when the mobile robot 110 is moved to perform the inspection according to such a work schedule, the mobile robot 110 may move inefficiently, causing the inspection time to increase.

[62] Accordingly, the controller 120 may generate a new inspection schedule on the basis of the work schedule in order to perform the inspection by using the mobile robot 110. That

is, for the efficient movement of the mobile robot 110, the controller 120 may generate the inspection schedule suitable for the mobile robot 110.

[63] To this end, the controller 120 can receive a work schedule for the plurality of work areas A to D from the work management system 200, and may generate the inspection schedule as shown in FIG. 4 from the received work schedule by using an inspection-schedule organizing algorithm provided in the controller 120. At this time, the inspection-schedule organizing algorithm may be an algorithm taking a work schedule as an input value, and taking an inspection schedule as an output value after further taking into account the input value and at least one of the arrangement state of the plurality of work areas A to D and the movement route of the mobile robot 110.

[64] As shown in FIG. 4, the inspection schedule is a schedule generated by taking into account the arrangement of the plurality of work areas A to D and the movement route of the mobile robot 110, and may be one generated regardless of the order of each task in the work schedule. However, it is natural that the work schedule and inspection schedule, both of which are described above through FIGS. 3 and 4, are exemplary and are not necessarily limited thereto.

[65]

[66] Referring back to FIGS. 1 and 2, when the inspection schedule is generated, the controller 120 may perform the inspection on the workpiece 10 by using the mobile robot 110 on the basis of the generated inspection schedule. For example, it is assumed that the inspection schedule generated on the basis of the work schedule is generated in the order of work area A -> work area B -> work area C -> work area D for the plurality of work areas A to D.

[67] The controller 120 may move the mobile robot 110 to a first work area (e.g., work area A) where the inspection should be performed first among the plurality of work areas on the basis of the generated inspection schedule, and may perform the inspection on the first work area. At this time, the controller 120 may determine a current location of the mobile robot 110 and the location of the first work area. In addition, the controller 120 may set a movement route connecting a starting point and a destination by using the current location of the mobile robot 110 as the starting point and the location of the first work area as the destination. The controller 120 may control the mobile robot 110 to move to the first work area by transmitting the set movement route to the mobile robot 110.

[68] When the mobile robot 110 arrives at the first work area, the mobile robot 110 may recognize location guidance equipment provided in the first work area and capture an image of the

workpiece 10. Specifically, the mobile robot 110 may capture an image of the workpiece 10 located in the first work area. On the basis of the received image captured by the mobile robot 110, the controller 120 may perform the inspection on the results of the work performed. For example, the controller 120 may store reference images of respective workpieces 10 corresponding to the plurality of work areas, and the controller 120 may correct errors in a captured image by using the previously stored reference images and images captured by the mobile robot 110. In addition, the controller 120 may extract an image of a part to be inspected from an error-corrected image, and perform deep-learning inspection on the basis of the extracted image, so as to make a pass/fail determination on the results of the work performed on the corresponding part. However, the inspection process of the controller 120 described above is exemplary and is not necessarily limited thereto.

[69]

[70] In addition, the controller 120 may determine the state of the second work area before the mobile robot 110 reaches the second work area (e.g., work area B) corresponding to the next work area of the first work area according to the inspection schedule. In this case, a point in time before the mobile robot 110 reaches the second work area may mean the point in time when the mobile robot 110 is capturing the image

of the workpiece 10 in the first work area, or may mean the point in time when the mobile robot 110 is moving to the second work area after completing the photographing in the first work area.

5 **[71]** In addition, the controller 120 may determine the state of the second work area on the basis of at least one of the presence or absence of a worker within the second work area and whether the current work for the second work area is completed. For example, while performing the task, the worker
10 may transmit the current work location or whether the current work is completed to the task management system 200 by using a wireless communication terminal being carried by himself/herself. The work management system 200 may provide the controller 120 with the information on the worker's
15 location tracking or the information on whether the work is completed, and the controller 120 may determine whether the worker is present in the second work area or whether the work for the second work area is completed on the basis of the information provided from the work management system 200.
20 However, this is an example and is not necessarily limited thereto. For example, the presence or absence of the worker within the second work area may also be determined by receiving information from a detection sensor (not shown) installed near the second work area to detect the worker.

[72] Next, the controller 120 may determine whether the determined state of the second work area satisfies a preset condition. For example, the controller 120 may set, as the preset condition, a case where there is no worker or the task is completed for the second work area. Accordingly, on the basis of the determined state of the second work area, the controller 120 may determine that the preset condition is not satisfied when the worker is present in the second work area or the task for the second work area is not completed.

[73] In a case of not satisfying the preset condition with the state of the second work area, the controller 120 may adjust the inspection schedule. Specifically, the controller 120 may adjust the inspection schedule on the basis of the remaining work areas B to D except for the first work area (i.e., work area A) among the plurality of work areas A to D, so that the next work area of the first work area becomes a work area other than the second work area.

[74] For example, referring to FIG. 2, according to the generated initial inspection schedule, the mobile robot 110 may move to the next work area, which is the second work area (e.g., work area B), and perform photographing when the inspection for the first work area (e.g., work area A) is completed. However, when the mobile robot 110 moves to the second work area according to the existing inspection schedule even when the worker is still present in the second work area

or the task is not completed, it may be difficult to secure the safety of the worker's work environment due to the mobile robot 110 and may cause a concern that the inspection is performed even on an unfinished task, thereby lowering the reliability of the inspection. Accordingly, the controller 120 may determine the state of the second work, and then adjust the inspection schedule when the state of the second work area does not satisfy the preset condition.

[75] The adjusting of the inspection schedule may be performed through an inspection-schedule reorganizing algorithm provided in the controller 120, and in this case, the inspection-schedule reorganizing algorithm may be a different algorithm from the inspection-schedule organizing algorithm described above. However, this is an example and is not necessarily limited thereto. For example, the inspection-schedule reorganizing algorithm may be the same algorithm as the inspection-schedule organizing algorithm, and change the factors considered to derive merely different output values.

[76] Meanwhile, as the controller 120 adjusts the existing inspection schedule, the next work area of the first work area (e.g., work area A) may be work area C or work area D. That is, on the basis of the remaining work areas (e.g., work areas B to D), the controller 120 may derive a plurality of new inspection schedules in which the second work area (e.g., work area B) not satisfying the preset condition does not

correspond to the next work area of the first work area (e.g., work area A). For example, the plurality of new inspection schedules may be derived as those including: a first new inspection schedule in the order of work area C -> work area D -> work area B; a second new inspection schedule in the order of work area C -> work area B -> work area D; a third new inspection schedule in the order of work area D -> work area C -> work area B; and a fourth new inspection schedule in the order of work area D -> work area B -> work area C.

[77] When the plurality of new inspection schedules are derived, the controller 120 may determine a movement distance for the mobile robot 110 to travel for each of the plurality of derived new inspection schedules. Since the objective of the present disclosure is to perform the inspection on the workpiece 10 by efficiently utilizing the mobile robot 110, it may be required to allow the mobile robot 110 to move along an optimal path. Accordingly, the controller 120 may determine the movement distance for the mobile robot 110 to travel for each of the plurality of new inspection schedules, and then select one new inspection schedule having the shortest distance from among the determined movement distances.

[78] In addition, the controller 120 may adjust the existing inspection schedule according to the selected new inspection schedule, and may reset the movement route of the mobile robot 110 on the basis of the adjusted inspection schedule. When

performing an inspection based on the existing inspection schedule, the controller 120 may set the movement route for the plurality of work areas according to the existing inspection schedule. In addition, the controller 120 may transmit the set movement route to the mobile robot 110, so as to cause the mobile robot 110 to move along the set movement route. That is, when the inspection schedule changes, the movement route also changes, so the changed movement route should be transmitted to the mobile robot 110 in order to control the mobile robot 110 according to the change in the inspection schedule.

[79] Accordingly, the controller 120 may transmit the reset movement route back to the mobile robot 110, thereby enabling the mobile robot 110 to photograph each workpiece 10 while moving along the reset movement route. In addition, the controller 120 iteratively perform the process of resetting the movement route of the mobile robot 110 described above.

[80]

[81] In contrast, when the state of the second work area satisfies the preset condition, the controller 120 may cause the mobile robot 110 to move to the second work area along a movement route according to the existing inspection schedule, so as to allow the inspection to be performed according to the existing inspection schedule. At this time, while moving from the first work area to the second work area, the mobile robot

110 may determine whether there is an obstacle approaching the mobile robot 110 through a sensor (not shown) equipped on the mobile robot 110. In particular, by using the sensor, the mobile robot 110 may measure duration during which the obstacle is sensed, and may determine that it is impossible to move to the second work area due to the obstacle when the duration exceeds a preset reference time. At this time, the controller 120 may adjust the existing inspection schedule in order to let the mobile robot 110 to make a turn to a different work area. In this case, the process of adjusting the inspection schedule and resetting the movement route as described above may be performed.

[82] However, when the duration measured through sensing by the sensor of the mobile robot 110 is less than the preset reference time, the mobile robot 110 may determine that a temporary obstacle is present, and may move to the second work area according to the existing inspection schedule while performing its own avoidance maneuver. In this case, the inspection using the mobile robot 110 may be performed upon the arrival to the second work area.

[83]

[84] Meanwhile, according to one exemplary embodiment of the present disclosure, the controller 120 may be a server that is equipped with the inspection-schedule organizing algorithm or the inspection-schedule reorganizing algorithm to generate an

inspection schedule and perform inspection by using the mobile robot 110 according to the inspection schedule. However, this is an example and is not necessarily limited thereto. For example, the functions of the above-described controller 120 may be performed on a single server, but the functions may also be performed in a separate form on a plurality of servers.

[85]

[86] Hereinafter, an object inspection method using a mobile robot according to one exemplary embodiment of the present disclosure will be described with reference to FIG. 5 on the basis of the object inspection system using the mobile robot described above with reference to FIGS. 1 and 2. Meanwhile, since the specific description of each step is described in detail in FIGS. 1 to 4, such description will be omitted below.

[87] FIG. 5 is a flowchart illustrating the object inspection method using the mobile robot according to one exemplary embodiment of the present disclosure.

[88] Referring to FIG. 5, in step S510, a controller 120 may generate an inspection schedule on the basis of a work schedule for a plurality of work areas.

[89] Then, in step S520, the controller 120 may control a mobile robot 110 to move to a first work area among the plurality of work areas on the basis of the generated inspection schedule. When the mobile robot 110 moves to the first work area, the mobile robot 110 may capture an image of

a workpiece 10 located in the first work area, and the controller 120 may perform an inspection through the image captured by the mobile robot 110 in step S530.

[90] After performing the inspection on the workpiece 10 located in the first work area, the controller may determine the state of the second work area, which is the next work area of the first work area in step S540. In this case, step S540 of determining the state of the second work area is described as being performed after the performed inspection, but this is merely exemplary, and it is natural that step S540 may also be performed simultaneously while step S530 is performed.

[91] The controller 120 may determine whether a state of the second work area satisfies a preset condition in step S550, and when the state of the second work area does not satisfy the preset condition (No in S550), the controller 120 may adjust the previously generated inspection schedule in step S560. In addition, in step S570, the controller 120 may reset a movement route of the mobile robot 110 on the basis of the adjusted inspection schedule. Once the movement route is reset, the process after step S520 may be iteratively performed.

[92] when the state of the second work area satisfies the preset condition (Yes in S550), the controller 120 may control the mobile robot 110 to move along the preset movement route according to the previously generated inspection schedule in

step S580. When the mobile robot 110 moves according to the previously generated inspection schedule and arrives at the next work area, the process after step S530 may be iteratively performed.

5 **[93]**

[94] According to the above description, the object inspection system and method using the mobile robot in the present disclosure may inspect the object, on which the work process is performed, by using the mobile robot in real time, thereby enabling the inspection to be performed without limitations on
10 securing space.

[95] In addition, the real-time inspection may be performed by using the mobile robot, and before the mobile robot moves, the state of a work area being inspected is determined, thereby
15 securing the safety of workers.

[96]

[97] Although the preferred exemplary embodiment of the present disclosure has been described for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are
20 possible, without departing from the technical scope and spirit of the present disclosure as disclosed in the accompanying claims.

[98] The above-described present disclosure may be implemented
25 as computer-readable code in a medium on which a program is

recorded. The computer-readable medium includes all types of recording devices in which data readable by a computer system is stored. Examples of the computer-readable medium include a Hard Disk Drive (HDD), a Solid State Disk (SSD), a Silicon Disk Drive (SDD), a ROM, a RAM, a CD-ROM, a magnetic tape, a floppy disk, an optical data storage device, etc. Accordingly, the above detailed description should not be construed as restrictive in all respects but as exemplary. The scope of the present disclosure should be determined by a reasonable interpretation of the appended claims, and all modifications within the equivalent scope of the present disclosure are included in the scope of the present disclosure.

[99]

[100] [Description of the Reference Numerals in the Drawings]

[101] 10: workpiece

[102] 110: mobile robot

[103] 120: controller

[104] 200: work management system

CLAIMS

[Claim 1] An object inspection system using a mobile robot, the system comprising:

5 the mobile robot configured to move through a plurality of work areas; and

10 a controller configured to perform an inspection for a first work area by moving the mobile robot to the first work area among the plurality of work areas based on an inspection schedule for the plurality of work areas, determine a state of a second work area before the mobile robot reaches the second work area corresponding to a next work area of the first work area according to the inspection schedule, adjust the inspection schedule when the determined state of the second
15 work area does not satisfy a preset condition, and reset a movement route of the mobile robot based on the adjusted inspection schedule.

20 [Claim 2] The system of claim 1, wherein the controller generates the inspection schedule based on a work schedule for the plurality of work areas, and performs the inspection for the first work area based on the generated inspection schedule.

25 [Claim 3] The system of claim 2, wherein the controller generates the inspection schedule by further considering at

least one of an arrangement condition of the plurality of work areas and the movement route of the mobile robot.

[Claim 4] The system of claim 1, wherein the mobile robot moves to the first work area to capture an image of a workpiece located in the first work area, and

the controller performs the inspection based on the image of the workpiece captured by the mobile robot.

[Claim 5] The system of claim 1, wherein the controller determines the state of the second work area based on at least one of presence or absence of a worker within the second work area and whether a task for the second work area is completed.

[Claim 6] The system of claim 5, wherein the controller determines that the state of the second work area does not satisfy the preset condition when the worker is present in the second work area or the task for the second work area is not completed.

[Claim 7] The system of claim 1, wherein the controller adjusts the inspection schedule based on remaining work areas except for the first work area among the plurality of work areas, so that the next work area of the first work area becomes a work area other than the second work area not on

satisfying the preset condition with the state of the second work area.

[Claim 8] The system of claim 7, wherein the controller
5 derives a plurality of new inspection schedules having the second work area not corresponding to the next work area of the first work area based on the remaining work areas, determines a movement distance for the mobile robot to move for each of the derived plurality of new inspection schedules, and adjusts the
10 inspection schedule to be one new inspection schedule having a shortest movement distance that is determined.

[Claim 9] An object inspection method using a mobile robot, the method comprising:

15 performing an inspection for a first work area by moving the mobile robot to the first work area among a plurality of work areas based on an inspection schedule for the plurality of work areas;

determining a state of a second work area before the
20 mobile robot reaches the second work area corresponding to a next work area of the first work area according to the inspection schedule;

adjusting the inspection schedule when the determined state of the second work area does not satisfy a preset
25 condition; and

resetting a movement route of the mobile robot based on the adjusted inspection schedule.

[Claim 10] The method of claim 9, wherein the performing
5 of the inspection comprises:

generating the inspection schedule based on a work schedule for the plurality of work areas, and

performing the inspection for the first work area based on the generated inspection schedule.

10 [Claim 11] The method of claim 10, wherein the generating of the inspection schedule comprises:

generating the inspection schedule by further considering at least one of an arrangement condition of the plurality of
15 work areas and the movement route of the mobile robot.

[Claim 12] The method of claim 9, wherein the performing of the inspection comprises:

capturing an image of a workpiece located in the first
20 work area by the mobile robot having moved to the first work area; and

performing the inspection based on the image of the workpiece captured by the mobile robot.

25 [Claim 13] The method of claim 9, wherein the determining

of the state comprises:

determining the state of the second work area based on at least one of presence or absence of a worker within the second work area and whether a task for the second work area is completed.

[Claim 14] The method of claim 13, wherein the determining of the state comprises:

determining that the state of the second work area does not satisfy the preset condition when the worker is present in the second work area or the task for the second work area is not completed.

[Claim 15] The method of claim 9, wherein the adjusting of the inspection schedule comprises:

adjusting the inspection schedule based on remaining work areas except for the first work area among the plurality of work areas, so that the next work area of the first work area becomes a work area other than the second work area not on satisfying the preset condition with the state of the second work area.

[Claim 16] The method of claim 15, wherein the adjusting of the inspection schedule comprises:

deriving a plurality of new inspection schedules having

the second work area not corresponding to the next work area of the first work area based on the remaining work areas;

determining a movement distance for the mobile robot to move for each of the derived plurality of new inspection
5 schedules; and

adjusting the inspection schedule to be one new inspection schedule having a shortest movement distance that is determined.