

【DESCRIPTION】

【Invention Title】

AUGMENTED REALITY-BASED CONSTRUCTION PERFORMANCE
REGISTRATION METHOD

【Technical Field】

[1] The present invention relates to an augmented reality-based construction performance registration method, and more particularly to an augmented reality-based construction performance registration method using a construction performance registration application installed on a mobile device for efficient management of construction performance.

【Background Art】

[2] Generally, high-tech industries refer to highly technology-intensive industries with significant effects on related industries, for example, advanced technology-intensive industries centered on cutting-edge technologies such as electronics, new materials, biotechnology, computers, and information and communications. When constructing facilities for such high-tech industries, numerous pipes and cables are installed. For example, constructing a semiconductor production line necessitates the installation of gas

pipes, chemical pipes, electrical cables, and fire protection pipes for equipment performing various processes. In the construction of the semiconductor production line, various applications are known to enable a worker to register the construction state of the pipes and other members and to allow a client to clearly understand the same. Using augmented reality (AR) to register and modify construction performance is also one of such methods.

[3] Augmented reality (AR) refers to a technology that adds computer-generated information to any of the five senses experienced by a user in the real world, i.e., a technology that overlays virtual objects (virtual reality) onto the real world shown to the user's eyes. Unlike virtual reality, which constructs reality only in a computer, augmented reality refers to overlaying virtual information onto the real world.

[4] A method of facilitating management at a plant construction site or an interior construction site using such augmented reality is disclosed in Korean Registered Patent No. 10-2462229 (registered on October 28, 2022). Conventional approaches using augmented reality to manage construction sites or register or modify construction performance, including the above conventional method, have several problems. That is, particularly when fire

protection pipes, gas pipes, chemical pipes, and electrical cables are located on the ceilings at a construction site, in order to implement augmented reality by matching virtual reality with actual reality sensed by a camera equipped in a mobile device (e.g., a tablet computer), touch, drag, and information input must be performed using one hand while the mobile device is held using the other hand. The weight of the mobile device makes it difficult to perform tasks beyond very short periods while holding the mobile device with one hand. Furthermore, when a specific section of a pipe or a specific area of the entire tiles requiring registration or modification of construction performance is selected or deselected, the user must hold the mobile device with one hand while performing these tasks with the other. This leads to frequent selection errors, hindering smooth workflow and significantly slowing down task progress. Therefore, solutions to the above problems are currently being sought in the art to which the present invention pertains.

【Disclosure】

【Technical Problem】

[5] Conventional methods of managing construction sites using augmented reality through a mobile device

have problems in that the weight of the mobile device makes it difficult to perform tasks beyond very short periods while holding the mobile device with one hand and in that, when a specific section of a pipe or a specific area of the entire tiles requiring registration or modification of construction performance is selected or deselected, the user must hold the mobile device with one hand while performing these tasks with the other, whereby the frequency of designation errors is high, resulting in reduced work accuracy, disrupted workflow, or delayed progress, and it is an object of the present invention to provide an augmented reality-based construction performance registration method that is capable of solving the above problems.

【Technical Solution】

[6] A construction performance registration method according to an aspect of the present invention to achieve the above object, which is an augmented reality-based construction performance registration method using a mobile device having a construction performance registration application installed thereon and equipped with a camera configured to capture an image of a construction performance registration target, includes (a) executing the construction performance registration

application to match actual reality of a construction site being captured by the camera with virtual reality related to the construction site, thereby implementing augmented reality related to the construction site so as to be displayed through the mobile device, (b) when a user of the mobile device performs a primary touch input on a target selection button in the state in which a cross pointer is located at an arbitrary point on a virtual position of a registration target in the augmented reality, displaying a start point on the virtual position of the registration target in the augmented reality, (c) when the cross pointer moves a predetermined distance along the virtual position of the registration target in the augmented reality as the mobile device is panned by the user of the mobile device after step (b) and there is a second touch input by the user of the mobile device on the target selection button, displaying an end point and displaying the registration target of the augmented reality from the start point to the end point on the virtual position of the registration target of the augmented reality through the mobile device, and (d) when there is an input by the user of the mobile device to open a registration information input window, displaying the registration information input window together with the registration target in the augmented

reality from the start point to the end point through the mobile device.

[7] In an embodiment, the registration target may be any one of a gas pipe, a fire protection pipe, a chemical pipe, and an electrical cable.

[8] In an embodiment, step (c) may include displaying a straight-line type selection assist line from the start point to a part on the virtual position of the registration target corresponding to a panning end position of the mobile device when the mobile device is panned by the user of the mobile device after step (b).

[9] In an embodiment, the augmented reality-based construction performance registration method may further include displaying information about the registration target above the cross pointer.

[10] In an embodiment, the registration target may be a tile member located on a floor or a side surface.

[11] In an embodiment, in step (b), a selection circle centered on the cross pointer may be further displayed around the cross pointer.

[12] In an embodiment, in step (c), when the selection circle moves along the virtual position of the registration target in the augmented reality, tile members included in the selection circle may be sequentially selected.

[13] In an embodiment, the diameter of the selection circle may increase or decrease in response to a touch input by the user of the mobile device to expand or contract a selection area.

【Advantageous Effects】

[14] The present invention has the effect of solving problems of conventional construction site management methods using augmented reality, whereby it is possible to increase work duration and to increase the work progress speed while enhancing work accuracy when a specific section of a pipe or a specific area of the entire tiles requiring registration or modification of construction performance is selected or deselected by the provision of an augmented reality-based construction performance registration method.

【Description of Drawings】

[15] FIG. 1(a) is a view illustrating a mobile device 1 used for a construction performance registration method using augmented reality according to an embodiment of the present invention and the display state of the mobile device 1 in the state in which a construction performance registration application is executed on the mobile device 1;

[16] FIG. 1(b) is a view showing an example of augmented reality being implemented by executing the construction performance registration application installed on the mobile device 1 shown in FIG. 1(a) in order to implement the construction performance registration method using augmented reality according to the embodiment of the present invention;

[17] FIGs. 2 to 10 are views describing a process of registering construction performance related to pipes or cables according to an embodiment of the present invention; and

[18] FIGs. 11 to 17 are views describing a process of registering construction performance related to floor tiles according to an embodiment of the present invention.

【Best Mode】

[19] The present invention provides a method of enhancing work efficiency by utilizing a construction performance registration application in augmented reality installed on a mobile device during the registration of construction performance, as mentioned above.

[20] Hereinafter, preferred embodiments of the present invention will be described with reference to the accompanying drawings. It should be noted that the accompanying drawings and the embodiments are simplified

and illustrated for the purpose of aiding those skilled in the art to understand the present invention. Furthermore, it should be noted that, although the term "construction performance registration" is used throughout this specification, this should be interpreted broadly to include not only registration of construction performance but also modifications to construction details. Furthermore, in the present invention, a construction performance registration target may be any one of a gas pipe, a fire protection pipe, a chemical pipe, and an electrical cable required during the construction of facilities for high-tech industries.

[21] FIG. 1(a) is a view illustrating a mobile device 1 used for a construction performance registration method using augmented reality according to an embodiment of the present invention and the display state of the mobile device 1 in the state in which a construction performance registration application is executed on the mobile device 1, FIG. 1(b) is a view showing an example of augmented reality being implemented by executing the construction performance registration application installed on the mobile device 1 shown in FIG. 1(a) in order to implement the construction performance registration method using augmented reality according to the embodiment of the present invention, FIGs. 2 to 10 are views describing a

process of registering construction performance related to pipes according to an embodiment of the present invention, and FIGs. 11 to 17 are views describing a process of registering construction performance related to floor tiles according to an embodiment of the present invention.

[22] First, referring to FIG. 1(a), a tablet computer is shown as an example of the mobile device 1, but the mobile device may be a smartphone or a dedicated computing device for implementing augmented reality, in addition to the tablet computer. The mobile device 1 has a construction performance registration application installed thereon, and is equipped with a camera for capturing images of a construction performance registration target. The mobile device 1 fundamentally includes a processing unit and a memory, in addition to the camera, and detailed descriptions of the fundamental components will be omitted. When the construction performance registration application installed on the mobile device 1 is executed, various buttons and a pointer 8, 9, 11, 13, 16, 17, and 19 are displayed on a screen 2 so as to allow a user of the mobile device 1 to operate the welding point management application by scrolling or touching with a finger, as shown in the figure under FIG. 1(a). The various buttons 8, 9, 13, 15,

17, and 19 are positioned to be accessible using the left thumb and the right thumb, considering the state in which the user holds the mobile device 1. In addition, panning of the mobile device 1, which is one of the key elements in the augmented reality-based construction performance registration according to the present invention, is symbolically represented by left and right arrows in the figure above FIG. 1(a). Here, "panning" is used as a term meaning the physical upward, downward, leftward, or rightward movement of the mobile device 1 equipped with the camera in the state in which images of the actual reality in which the construction performance registration target is located, i.e., the construction site, are captured or in the state in which augmented reality is implemented. That is, panning is used as a term meaning the physical movement of the mobile device 1 in the state in which augmented reality is implemented. In the buttons and pointer 8, 9, 11, 13, 16, 17, and 19, reference numeral 11 denotes a cross pointer, and is located at the center on the screen of the mobile device 1. The cross pointer is a reference pointer used to designate the construction performance registration target by aiming the cross pointer 11 at a construction member in the state in which the user of the mobile device 1 holds the device with both hands during a

registration process. Reference numeral 8 is an initialization button, which is used to reset virtual reality implemented on the screen 2 of the mobile device 1. Reference numeral 9 is a button used to delete a construction member to be deleted after aiming at the same with the cross pointer 11 and touching (dragging) the same using a construction target selection button 13. Reference numeral 13 is a construction target selection button 13, which is touched or touched and dragged upward or downward to select the entire construction member, to generate an end point, or to generate a start point, thereby selecting a part of the construction performance registration target. Reference numeral 16 is a button for adjusting the transparency of the screen 2 of the mobile device 1, and is configured such that, for example, dragging downward reduces opacity and dragging upward increases opacity. Reference numeral 17 is a button for exiting the modification screen once the construction performance deletion task is complete. Reference numeral 19 is a button for displaying a performance registration information input window on the screen. When touched by the user, the performance registration information input window is displayed on the screen of the mobile device 1 together with augmented reality. The performance registration information input window includes a section

for inputting performance registration information and a section for managing performance.

[23] FIG. 1(b) is a view showing an example of implementing augmented reality by executing the construction performance registration application installed on the mobile device 1, capturing actual reality in which a specific construction performance registration target is located, and matching the same with virtual reality, and how the various buttons and pointer 8, 9, 11, 13, 16, 17, and 19 shown in the figure under FIG. 1(a) are displayed on the screen of the mobile device implementing the augmented reality is illustrated. It should be noted that the augmented reality illustrated in FIG. 1(b) is merely one example to explain the features of the present invention.

[24] The augmented reality-based construction performance registration method according to the embodiment of the present invention includes a step of implementing augmented reality related to a construction site to be displayed on the screen of the mobile device 1, by executing the construction performance registration application and matching the actual reality of the construction site being captured by the camera with virtual reality related to the construction site. The virtual reality related to the construction site may be

implemented so as to represent various members being installed at the construction site, such as various pipes and floor or wall tiles, in various colors. Next, the augmented reality-based construction performance registration method includes a step of, when the user of the mobile device 1 performs a primary touch input (e.g., a downward drag) on the target selection button 13 in the state in which the cross pointer 11 is located at an arbitrary point on a virtual position of a registration target (i.e., a construction performance registration target), i.e., on the overall position at which the construction performance registration target is being constructed, displaying a start point 12 (see FIG. 3) on the virtual position of the registration target in the augmented reality. Subsequently, the augmented reality-based construction performance registration method includes a step of, after the mobile device 1 is moved leftward and rightward or upward and downward by the user in a direction allowing a certain section of the registration target of the mobile device to be designated, i.e., panned, and when there is a secondary touch input (e.g., dragging upward) by the user on the target selection button 13, displaying an end point and displaying the registration target in augmented reality from the start point to the end point on the virtual

position of the registration target in augmented reality on the screen of the mobile device 1. Through the above processes, it is possible to solve the problem that accuracy is reduced when specifying the construction performance of the registration target using a hand or a pen, as in the prior art, and that, particularly when the registration target is a pipe, it is difficult to draw a line along the pipe with one hand in augmented reality while holding the mobile device with the other hand. Particularly, in the present invention, regarding panning of the mobile device, even if panning is performed in an approximate direction of the line on which the registration target is located, rather than precisely following that line, the panning is implemented to track a vector component in the direction in which the registration target extends, thereby ensuring accurate section designation of the registration target. Then, when the user of the mobile device 1 touches the button denoted by reference numeral 19 (FIG. 1(a)) in order to open the registration information input window, the registration information input window is displayed on the screen 2 of the mobile device 1 along with augmented reality of the construction site including the registration target whose section has been designated from the start point to the end point. (As shown in FIG.

7, the screen may be divided into a left part and a right part.)

[25] A construction performance registration process according to an embodiment of the present invention when the construction performance registration target is a pipe or a cable will be described with reference to FIGs. 2 to 10.

[26] Referring to FIG. 2, first, the augmented reality-based construction performance registration method according to the present invention implements the display of augmented reality related to the construction site on the screen of the mobile device 1 by executing the construction performance registration application and matching the actual reality of the construction site being captured by the camera equipped in the mobile device 1 (FIG. 1(a)) with virtual reality related thereto. In FIG. 2, (a) shows an example of the implemented augmented reality, and (b) separately shows only a virtual line 10 of the construction performance registration target and the cross pointer 11 located at the center of the mobile device 1. That is, when the mobile device 1 is appropriately moved and positioned over the part at which the construction performance registration target is located in the state in which the augmented reality is implemented, the virtual line 10 of

the construction performance registration target is displayed as shown in FIG. 2.

[27] Referring to FIG. 3, in the augmented reality implemented through the mobile device 1, when the user drags the target selection button 13 downward (first touch input) in the state in which the cross pointer 11 is positioned on the virtual position of the construction performance registration target, as in FIG. 2, a start point 12 is displayed on the virtual position 10 of the registration target in the augmented reality. In FIG. 3, (a) shows an example of the implemented augmented reality, and FIG. 3(b) separately shows only the virtual line 10 of the construction performance registration target, the cross pointer 11, and the start point 12.

[28] Referring to FIG. 4, when the user moves (i.e., pans) the mobile device 1 to the left after the start point 12 is displayed, a straight-line type selection assist line 15 is displayed in the augmented reality along the virtual position 10 of the registration target from the start point 12. The selection assist line 15 extends to the part on the virtual position of the registration target corresponding to that position until the end of panning of the mobile device 1. Here, panning the mobile device 1 means moving the mobile device in a direction allowing a specific section of the registration

target to be designated, i.e., moving the mobile device from left to right in the figure. In addition, information about the registration target may be displayed above the cross pointer 11 (reference numeral 14). The information about the registration target may be, for example, the number of selected member elements or the total quantity of the selected member elements (e.g., area or length), but the present invention is not limited thereto. In FIG. 4, (a) shows an example of the augmented reality in which the selection assist line 15 is displayed according to panning of the mobile device 1, and (b) separately shows only the selection assist line 15, the start point 12, and the virtual line 10 of the construction performance registration target.

[29] Referring to FIG. 5, when the user drags the target selection button 13 upward (i.e., secondary touch input) after the panning of the mobile device 1 ends in FIG. 4, an end point (which is not separately indicated in the figure but may be the rightmost point of the registration target SE 13) is displayed, and the registration target in augmented reality is displayed on the screen of the mobile device 1 from the start point to the end point on the virtual position of the registration target in augmented reality. In FIG. 5, the selected registration targets are illustrated as SE1, SE2, and SE3.

[30] Referring to FIG. 6, the augmented reality-based construction performance registration method may further include a step of marking the registration targets in the augmented reality screen with ①, ②, etc.

[31] Referring to FIG. 7, when the user of the mobile device 1 touches the button denoted by reference numeral 19 (FIG. 1(a)) in order to open a registration information input window 20, the registration information input window is displayed through the screen on the right together with the augmented reality of the construction site including the registration target (left screen). The registration information input window 20 is configured to display information such as work package, activity, selected elements (number of selected member elements), and quantity (total quantity of selected member elements), allowing the worker or the client to verify the same (reference numerals 21 to 25). In addition, reference numeral 26 is a file attachment button, and reference numeral 27 is a confirmation and registration completion button.

[32] Referring to FIG. 8, the registration information input window 20 further displays a preview button 52 and a modification button 51 for an attached file.

[33] FIGs. 9 and 10 are views related to modification of performance details. Referring first to FIG. 8, the

registration information input window 20 allows viewing of previously registered performance by date, with the most recent performance displayed at the top when sorted by date. For example, for a single performance (registration target), it is possible to retrieve detailed registration information from a performance management section in the registration information input window 20, to check the attached file, and to select all or a part of the section of the member requiring modification by touching the member selection button, as shown in FIG. 8. Selecting a part of the section is substantially identical to the registration process described above. That is, as shown in FIG. 9, the cross pointer 11 at the center of the screen is aimed at the member SE23 to be deleted, the target selection button 13 is dragged to select the member, and the member is deleted. The deleted member may be displayed, for example, in red.

[34] Next, a process of registering construction performance related to floor tiles according to an embodiment of the present invention will be described with reference to FIGs. 11 to 17. It should be noted that, although the floor tiles are illustrated, the same may apply to wall tiles.

[35] Referring to FIG. 11, in the state in which the

augmented reality screen implemented through the mobile device and the registration information input window 20 are simultaneously displayed on the screen, floor construction is selected in a work package section 21 of the registration information input window 20. Then, the member selection button 2 is touched. Reference symbol F1 denotes the floor surface in the real world in which the tiles are installed.

[36] Referring to FIG. 12, first, the cross pointer 11 located at the center of the screen of the mobile device 1 (FIG. 1(a)) is aimed at a floor tile area SE31 requiring construction performance registration.

[37] Referring to FIG. 13, in the state in which the cross pointer 11 is aimed at the floor tile area SE31 requiring construction performance registration, as in FIG. 12, a primary touch input or scroll is performed on the target selection button 13. Here, the start point is displayed in the shape of a predetermined rectangular area. Then, the tile members requiring construction performance registration are designated while panning the mobile device 1 along the virtual position of the registration target. For floor tile selection, a selection circle centered on the cross pointer 11 is displayed around the cross pointer 11. Furthermore, in order to increase the selection speed by increasing the

number or range of tiles designated at once, the diameter of the selection circle is configured to expand, as shown in FIG. 13. In addition, information about the registration target, including the number of tiles, which are the registration target, and the total area of the tiles, may be further displayed in the selection circle. After selecting all floor tiles requiring construction performance registration through panning on the mobile device 1, the target selection button 13 is secondarily touched or scrolled to select the entire floor tile area requiring construction performance registration.

[38] Referring to FIG. 1, the selection circle 41 and 41' and the cross pointer 11 located at the center thereof are shown separately. As shown in FIG. 14, in order to increase the diameter of the selection circle (from 41 to 41'), a touch point 42 that the user can touch and drag with their hand may exist in the selection circle 41 and 41'.

[39] Referring to FIG. 15, if modification is required for a specific part selected in a performance management section of the registration information input window 20, the modification process may be initiated by touching the modification button indicated by reference numeral 51.

[40] Referring to FIG. 16, which shows the augmented reality displayed on the screen of the mobile device

after the user touches the modification button 51 in FIG. 15, when the member selection button 30 is touched, the cross pointer is aimed at the area of the floor tile requiring modification, similarly to the previous registration process, the target selection button 13 is touched, and the mobile device is panned to select all floor tiles requiring modification, the user ends the selection of the target (member) requiring modification by touching the target selection button 13 again. At this time, similarly, information about the modification target, including the number of tiles and the total area of the tiles, is reflected in real time and displayed in the selection circle. For deletion, after selecting all deletion targets, the user touches the delete button (9) to delete all of the deletion targets. For example, deleted members may be displayed in red. As shown in FIG. 17, after completing the deletion operation, an X button denoted by reference numeral 17 is touched to exit the current performance history modification screen. Then, as shown in FIG. 15, the performance registration information input window is opened again, and the modification button 51 (FIG. 15) located at the bottom of the performance management section is touched to register the performance modification.

[41] The augmented reality-based construction

performance registration method using the mobile device according to the embodiment of the present invention has been described in the above, and it is possible not only to increase the work duration using the mobile device, i.e., the continuous work duration possible while the worker holds the mobile device with both hands, but also to increase the work progress speed while enhancing work accuracy by utilizing the augmented reality-based construction performance registration method according to the present invention.

[42] It should be noted that the scope of the present invention is defined not by the above description but by the appended claims below.

【CLAIMS】

【Claim 1】 An augmented reality-based construction performance registration method using a mobile device having a construction performance registration application installed thereon and equipped with a camera configured to capture an image of a construction performance registration target, the augmented reality-based pipe welding point management method comprising:

(a) executing the construction performance registration application to match actual reality of a construction site being captured by the camera with virtual reality related to the construction site, thereby implementing augmented reality related to the construction site so as to be displayed through the mobile device;

(b) when a user of the mobile device performs a primary touch input on a target selection button in a state in which a cross pointer is located at an arbitrary point on a virtual position of a registration target in the augmented reality, displaying a start point on the virtual position of the registration target in the augmented reality;

(c) when the cross pointer moves a predetermined distance along the virtual position of the registration

target in the augmented reality as the mobile device is panned by the user of the mobile device after step (b) and there is a second touch input by the user of the mobile device on the target selection button, displaying an end point and displaying the registration target of the augmented reality from the start point to the end point on the virtual position of the registration target of the augmented reality through the mobile device; and

(d) when there is an input by the user of the mobile device to open a registration information input window, displaying the registration information input window together with the registration target in the augmented reality from the start point to the end point through the mobile device.

【Claim 2】 The augmented reality-based construction performance registration method according to claim 1, wherein the registration target is any one of a gas pipe, a fire protection pipe, a chemical pipe, and an electrical cable.

【Claim 3】 The augmented reality-based construction performance registration method according to claim 2, wherein step (c) comprises displaying a straight-line type selection assist line from the start point to a part

on the virtual position of the registration target corresponding to a panning end position of the mobile device when the mobile device is panned by the user of the mobile device after step (b).

【Claim 4】 The augmented reality-based construction performance registration method according to claim 2, further comprising displaying information about the registration target above the cross pointer.

【Claim 5】 The augmented reality-based construction performance registration method according to claim 1, wherein the registration target is a tile member located on a floor or a side surface.

【Claim 6】 The augmented reality-based construction performance registration method according to claim 5, wherein, in step (b), a selection circle centered on the cross pointer is further displayed around the cross pointer.

【Claim 7】 The augmented reality-based construction performance registration method according to claim 6, wherein, in step (c), when the selection circle moves along the virtual position of the registration target in

the augmented reality, tile members included in the selection circle are sequentially selected.

【Claim 8】 The augmented reality-based construction performance registration method according to claim 6, wherein a diameter of the selection circle increases or decreases in response to a touch input by the user of the mobile device to expand or contract a selection area.