

The map coordinate determination unit 16 generates 2D map coordinates (X, Y) based on the plurality of sets of 3D coordinates $(X_1, Y_1, Z_1) - (X_n, Y_n, Z_n)$. The map coordinate determination unit 16 calculates the 2D map coordinates (X, Y) by using a summation average of coordinate values of the plurality of sets of 3D coordinates $(X_1, Y_1, Z_1) - (X_n, Y_n, Z_n)$.

[0019]

The display control unit 17 outputs image data in which position information on the 2D map coordinates (X, Y) is superimposed on the map 81 of the area 80. A display device 18 displays the map 81 of the area 80 and the position information on the 2D map coordinates (X, Y). In the example of Fig. 3, the map 81 is displayed based on map information L acquired from an external storage device.

[0020]

Fig. 4 is a diagram showing a hardware configuration of the position detection device 10 according to the first embodiment. As shown in Fig. 4, the position detection device 10 includes a processor 101 such as a CPU (Central Processing Unit), a memory 102 as a volatile storage device, a nonvolatile storage device 103 such as a hard disk drive (HDD) or a solid state drive (SSD), and a communication unit 104 that executes communication with the outside. The memory 102 is a volatile semiconductor memory such as a RAM (Random Access Memory), for example.

[0021]

Functions of the position detection device 10 are implemented by processing circuitry. The processing circuitry can be either dedicated hardware or the processor 101 executing a program stored in the memory 102. The processor 101 can be any one of a processing device, an arithmetic device, a microprocessor, a

detection device 20. The position detection device 20 calculates the 2D map coordinates (X, Y) of the person 90 based on the images $I_1 - I_n$ and generates the image data for making the display device 18 display the information indicating the 2D map coordinates (X, Y) on the map 81 of the area 80.

[0039]

Fig. 9A is a diagram showing the 2D map coordinates (X, Y) of the person 90 detected based on the images $I_1 - I_n$ captured by the monitoring cameras 11_1 - 11_n on the map 81 of the area 80. Fig. 9B is a diagram showing 2D map coordinates (X, Y) based on 2D coordinates (X_p, Y_p) of the person 90 detected by pedestrian dead reckoning (PDR) on the map 81 of the area 80. Fig. 9A shows an example of the 2D map coordinates (X, Y) calculated by using two monitoring cameras 11_1 and 11_n, and Fig. 9B shows the 2D map coordinates (X, Y) obtained as a result of position calculation by PDR after the person 90 moved to the outside of the image capturing ranges of the monitoring cameras.

[0040]

Fig. 10 is a functional block diagram schematically showing the configuration of the position detection device 20 according to the second embodiment. The position detection device 20 is a device capable of executing a position detection method according to the second embodiment. The position detection device 20 is capable of executing the position detection method according to the second embodiment by executing a position detection program. As shown in Fig. 10, the position detection device 20 includes the image reception unit 13, the person detection unit 14, the coordinate transformation unit 15, a detection value reception unit 23, a terminal position calculation unit 24, a map coordinate determination unit

The map coordinate determination unit 16a calculates the 2D map coordinates (X, Y) based on the 3D coordinates in periods in which the person 90 is detected, and calculates the 2D map coordinates (X, Y) based on the terminal position coordinates (X_p , Y_p) in periods in which the person 90 is not detected.

[0045]

The display control unit 17 outputs the image data in which the position information on the 2D map coordinates (X, Y) is superimposed on the map 81 of the area 80. The display device 18 displays the map 81 of the area 80 and the position information on the 2D map coordinates (X, Y). The map 81 is displayed based on the map information L acquired from the external storage device.

[0046]

Fig. 11 is a flowchart showing a process executed by the terminal position calculation unit 24 of the position detection device 20 according to the second embodiment. In Fig. 11, the terminal position calculation unit 24 calculates a rotation matrix from the detection values (step S42), transforms the posture of the mobile terminal 21 (step S43), calculates acceleration of the mobile terminal 21 (step S44), calculates displacement by performing double integration on the acceleration (step S45), and outputs terminal position coordinates (X_p , Y_p) based on the displacement (step S46). The terminal position calculation unit 24 repeats the above process (steps S42 to S46) until the position detection by the monitoring cameras is restarted, for example (step S41).

[0047]

Fig. 12 is a flowchart showing a process executed by the map coordinate determination unit 16a of the position detection device 20 according to the second embodiment.

device 30 according to a third embodiment. The wearable camera 31 is a small-sized camera that captures an image in the direction of the line of sight of the worker as the person 90, and is referred to also as a smart glass. The wearable camera 31 is carried by the person 90. One or more monitoring cameras 11_1 - 11_n have been installed in the predetermined area 80 in which the instrument panels 40 and the machines 50 have been set. The monitoring cameras 11_1 - 11_n may also be already-existing cameras. The monitoring cameras 11_1 - 11_n respectively capture images of the image capturing ranges R1 - Rn and transmit the images I₁ - I_n to the position detection device 30. The position detection device 30 calculates the 2D map coordinates (X, Y) of the person 90 based on the images I₁ - I_n and generates image data for making the display device display the information indicating the 2D map coordinates (X, Y) on the map 81 of the area 80.

[0051]

Fig. 14A is a diagram showing an example of the instrument panel 40, a device 41 such as an instrument, and a nameplate 42. Fig. 14B is a diagram showing the 2D map coordinates (X, Y) on the map 81 of the area 80 based on a character string recognized by using an image of the nameplate 42.

[0052]

Fig. 15 is a functional block diagram schematically showing the configuration of the position detection device 30 according to the third embodiment. The position detection device 30 is a device capable of executing a position detection method according to the third embodiment. The position detection device 30 is capable of executing the position detection method by executing a position detection program. As shown in Fig. 15, the position detection device 30 includes the image reception

unit 13, the person detection unit 14, the coordinate transformation unit 15, an image reception unit 33, a character recognition unit 34, a character search unit 35, a map coordinate determination unit 16b and the display control unit 17. The hardware configuration of the position detection device 30 is the same as that in Fig. 4.

[0053]

The person detection unit 14 receives an image I_1 captured by the monitoring camera 11_1, executes the process for detecting the person 90 in the images I_1 , and outputs the 2D camera coordinates (u_1, v_1) indicating the position of the detected person 90.

[0054]

The coordinate transformation unit 15 transforms the 2D camera coordinates to the 3D coordinates (X_1, Y_1, Z_1) represented in a predetermined common coordinate system.

[0055]

The character recognition unit 34 recognizes the character string 43 on the nameplate 42 of the device 41 in a wearable camera image I_w captured by the wearable camera 31 when the wearable camera 31 is worn by the person 90.

[0056]

The character search unit 35 searches a layout chart of the devices in the area 80 (e.g., the map 81 describing the device layout) for the recognized character string 43.

[0057]

When the recognized character string 43 is found in the layout chart, the map coordinate determination unit 16b determines the 2D map coordinates (X, Y) based on the position where the character string 43 is found. When the recognized character string 43 is not found in the layout chart, the map coordinate determination unit 16b

nameplate, 43: character string, 90: person, $I_1 - I_n$:
image, I_w : wearable camera image, $(u_1, v_1) - (u_n, v_n)$: two-
dimensional camera coordinates (2D camera coordinates),
 $(X_1, Y_1, Z_1) - (X_n, Y_n, Z_n)$: three-dimensional coordinates
(3D coordinates), (X, Y) : two-dimensional map coordinates
(2D map coordinates), (X_p, Y_p) : terminal position
coordinates, (X_w, Y_w) : wearable camera coordinates.