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(54) **SENSOR SUPPORT SYSTEM, TERMINAL, SENSOR, AND METHOD FOR SUPPORTING SENSOR**

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(57) **ABSTRACT**

A sensor support system includes a sensor and a terminal device configured to display form information of the sensor. The sensor includes a two-dimensional code (storage tag) which can be read from the terminal device and which is configured to store the form information of the sensor. The terminal device is configured to calculate position information of the sensor from an image of the sensor, configured to generate a virtual image of the form information of the sensor, and configured to display on a display an image in which the virtual image is superimposed on an image of the sensor taken by a camera.

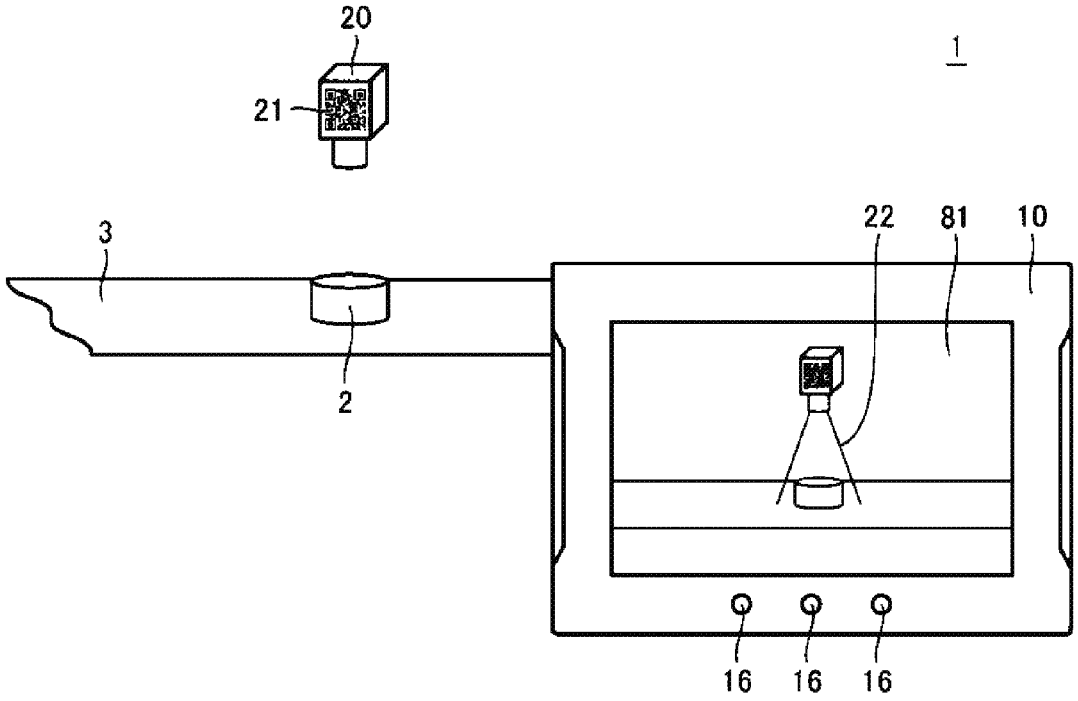


FIG. 1

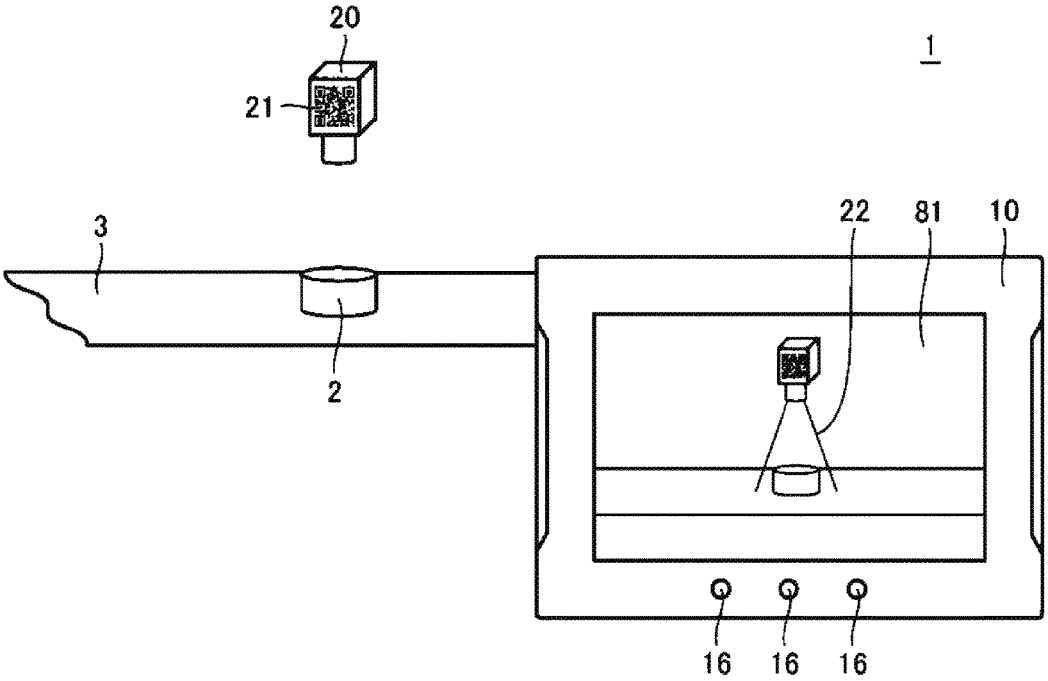
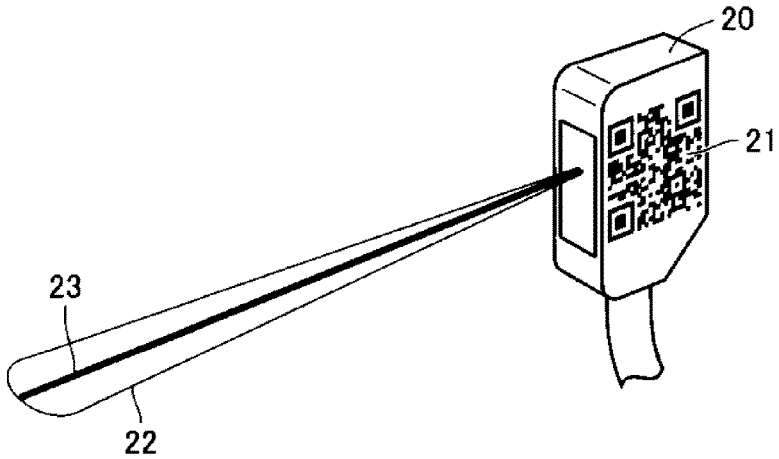


FIG. 2



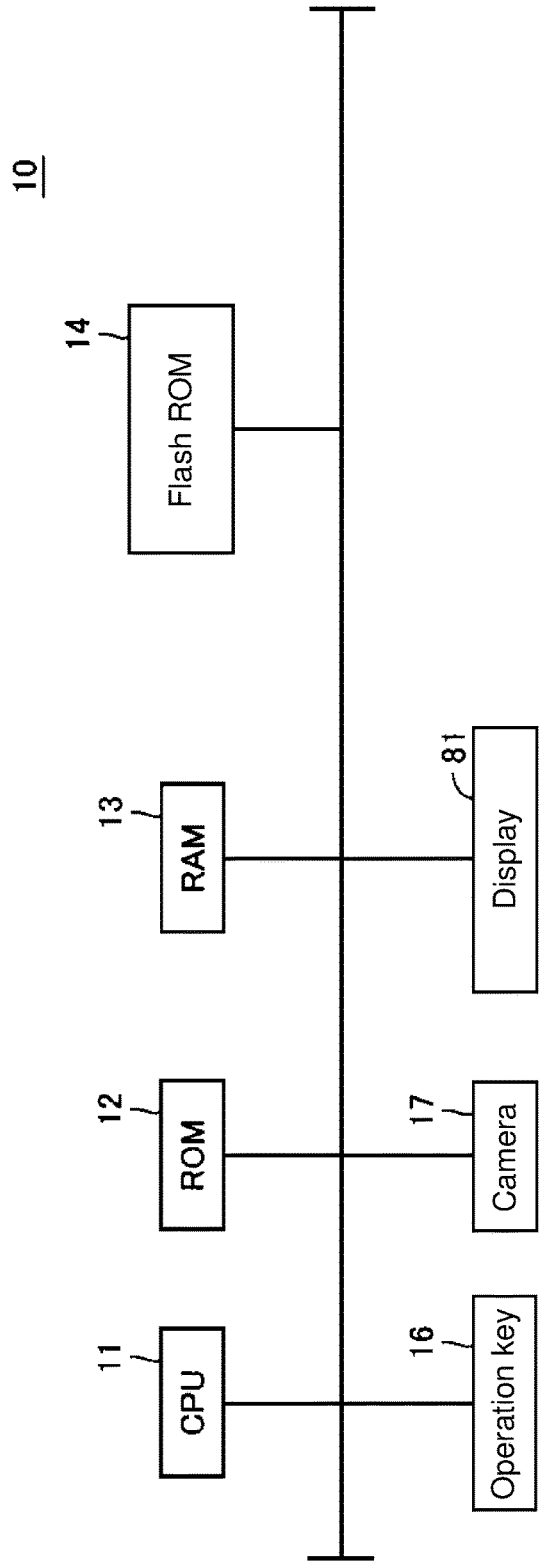

10
14
Flash ROM
13
RAM
8t
Display
12
ROM
17
Camera
11
CPU
16
Operation key

FIG. 3

FIG. 4

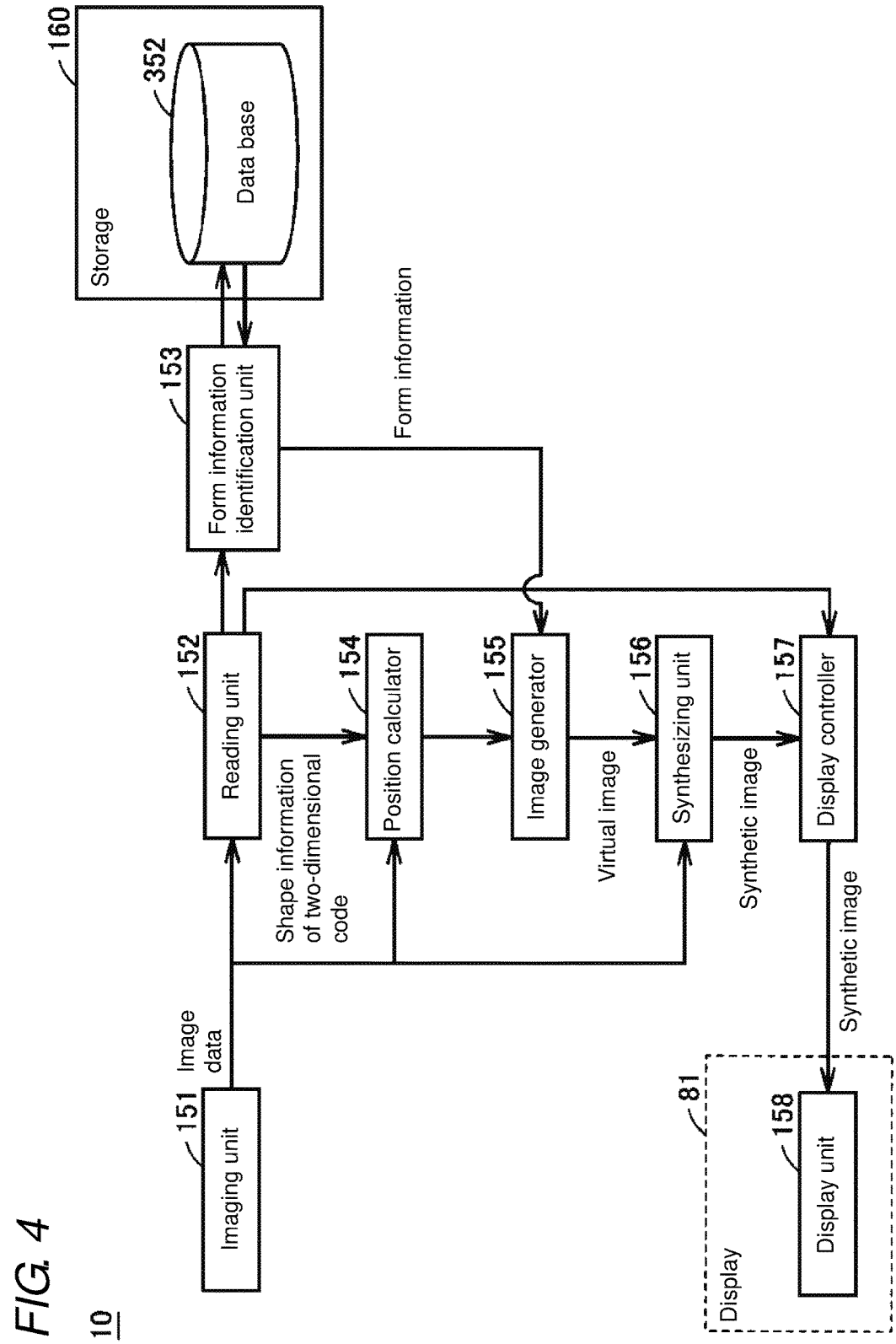

10
160
Storage
352
Data base
153
Form information identification unit
Form information
152
Reading unit
154
Position calculator
155
Image generator
156
Synthesizing unit
157
Display controller
Shape information of two-dimensional code
Virtual image
Synthetic image
Synthetic image
151
Imaging unit
Image data
81
Display
158
Display unit

FIG. 5

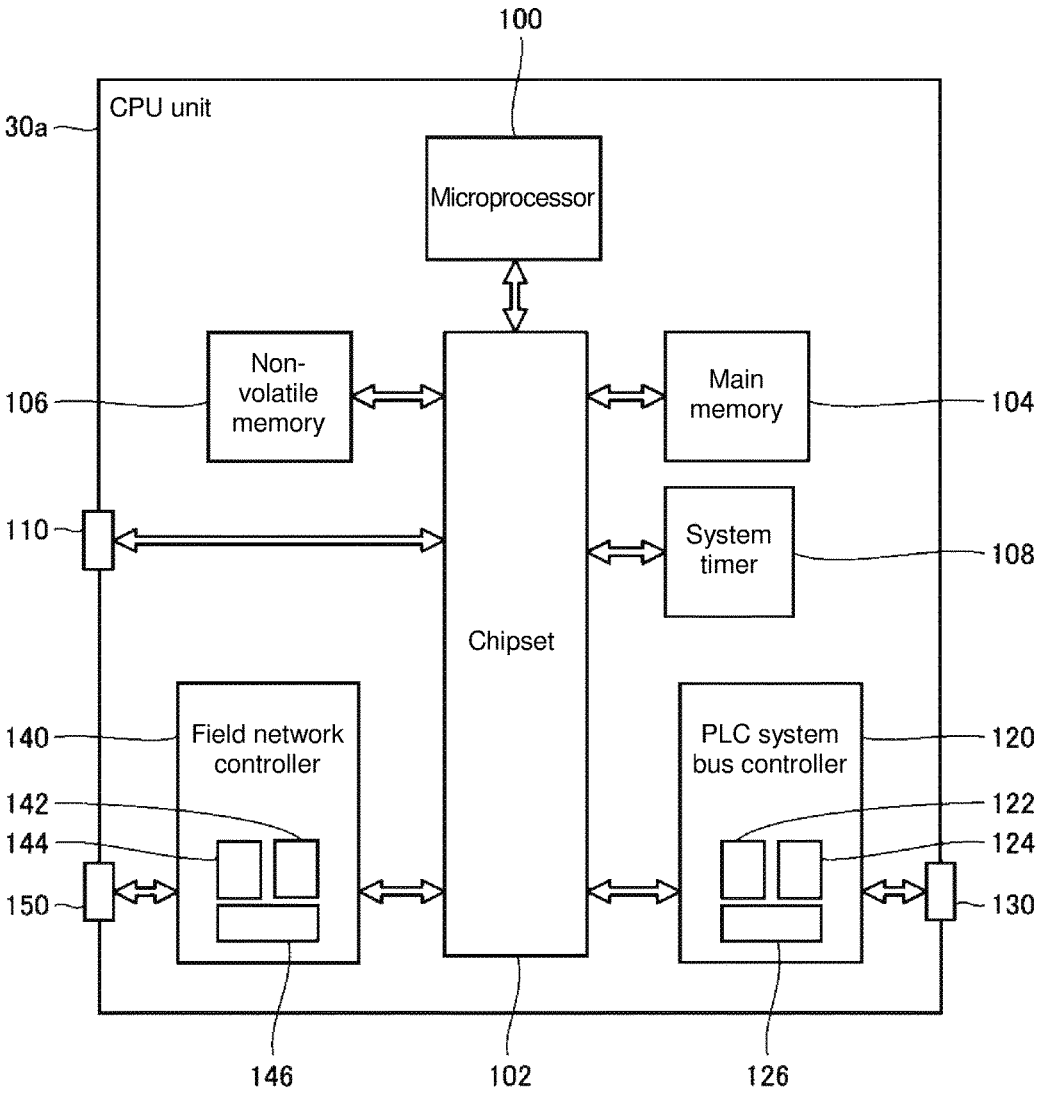

100
CPU unit
30a
Microprocessor
Non-volatile memory
106
Main memory
104
110
System timer
108
Chipset
140
Field network controller
PLC system bus controller
120
142
122
144
124
150
130
146
102
126

FIG. 6

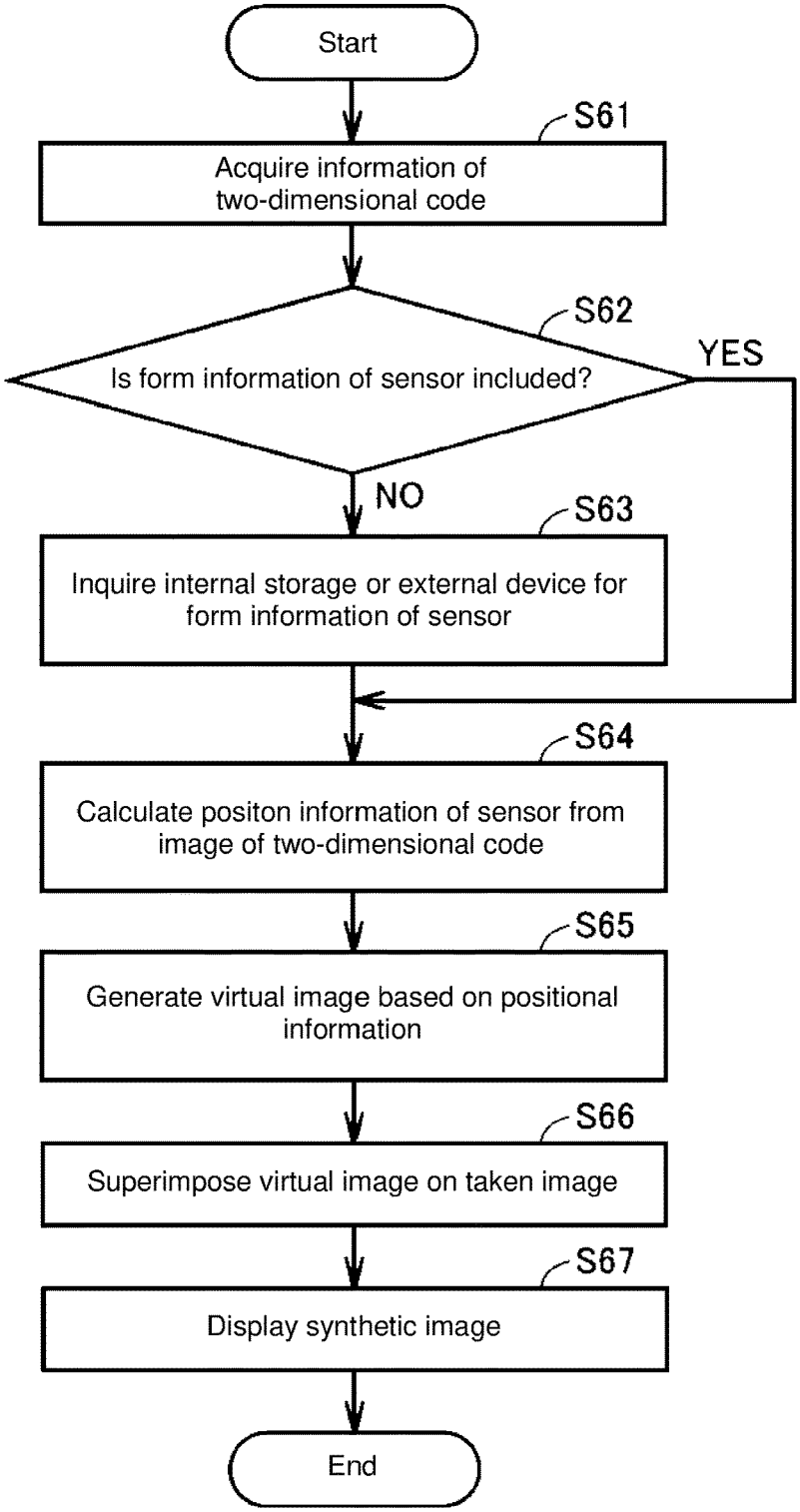

Start
S61
Acquire information of two-dimensional code
S62
Is form information of sensor included?
YES
NO
S63
Inquire internal storage or external device for form information of sensor
S64
Calculate positon information of sensor from image of two-dimensional code
S65
Generate virtual image based on positional information
S66
Superimpose virtual image on taken image
S67
Display synthetic image
End

FIG. 7

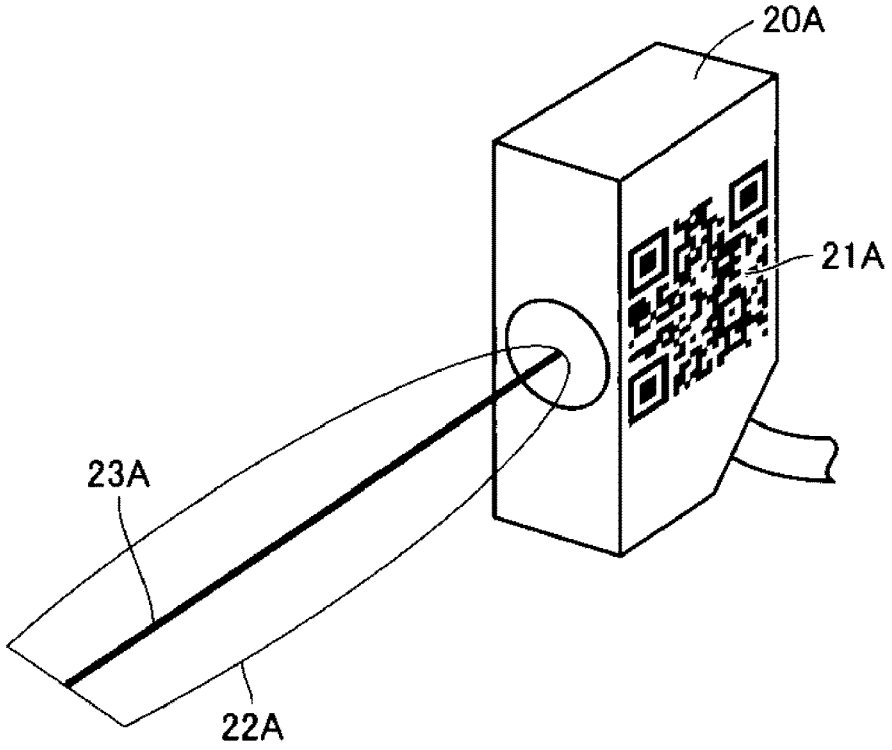


FIG. 8

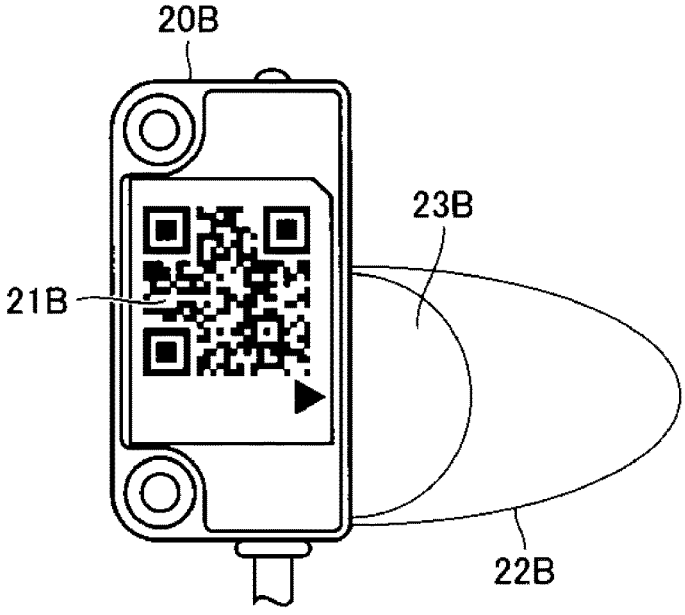


FIG. 9

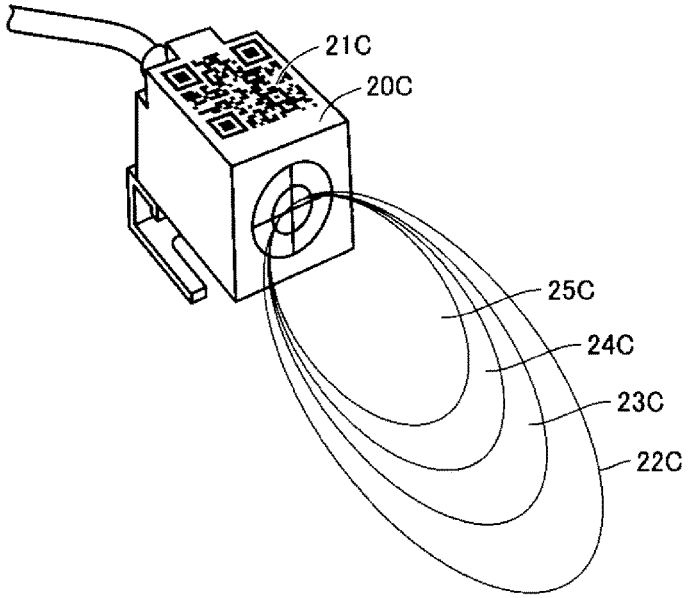
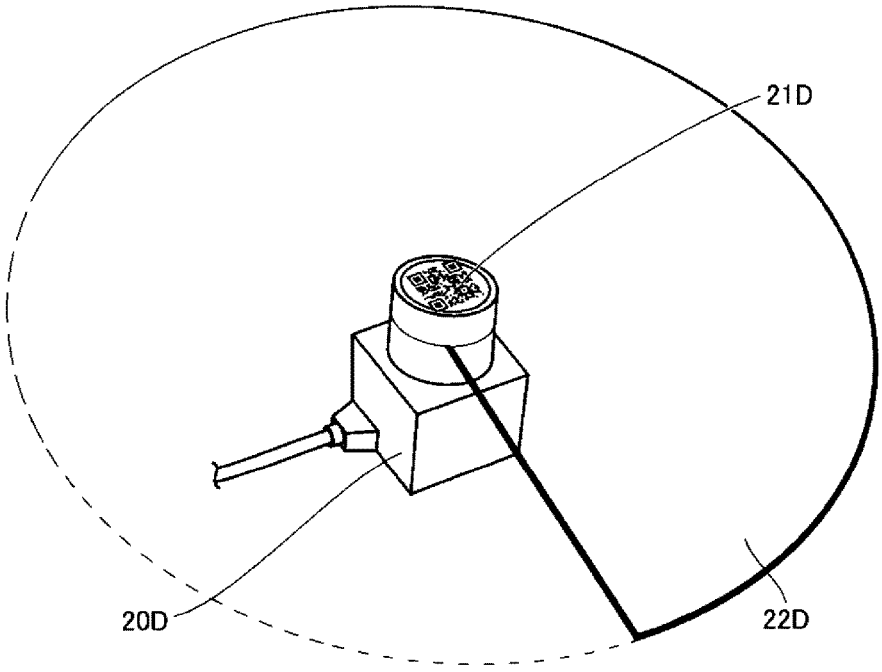


FIG. 10



SENSOR SUPPORT SYSTEM, TERMINAL, SENSOR, AND METHOD FOR SUPPORTING SENSOR

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application is based on Japanese Patent Application No. 2017-005029 filed with the Japan Patent Office on Jan. 16, 2017, the entire contents of which are incorporated herein by reference.

FIELD

[0002] The disclosure relates to a sensor support system, a terminal, a sensor, and a method for supporting a sensor which support installation, setting, and the like of a sensor by displaying form information of the sensor on the terminal.

BACKGROUND

[0003] In order to detect objects, various types of sensors are installed in machines and equipment used in many production sites. The various types of sensors include a photoelectric sensor and the like disclosed in JP2015-158999 A, for example. JP2015-158999 A exemplifies a reflection type photoelectric sensor and discloses a photoelectric sensor in which detection light emitted from a light projection element is reflected by an object and the return light is received by a light receiving element.

[0004] When the photoelectric sensor disclosed in JP2015-158999 A is installed in a machine or equipment, it is necessary to install the photoelectric sensor to be adjusted at a position at which the detection light emitted from the light projection element radiates an object. However, the detection light emitted from the light projection element is invisible for naked eyes; therefore, it is impossible to install the photoelectric sensor in a machine or equipment while checking the detection light. Further, in order to determine whether the photoelectric sensor is installed in a detection area in which an object can be detected, it is necessary to perform positioning by repeatedly detecting an object being actually moved.

SUMMARY

[0005] One or more aspects may provide a sensor support system, a terminal, a sensor, and a method for supporting a sensor in which form information of the sensor is displayed on the terminal so that operation of installation and setting of the sensor can be efficiently performed.

[0006] A sensor support system according to an aspect includes: a sensor; and a terminal configured to display form information of the sensor. The sensor includes a storage tag which is readable from the terminal and which is configured to store the form information of the sensor. The terminal includes: an imaging unit configured to take an image of the sensor; a reading unit configured to read information from the storage tag of the sensor; a position calculator configured to calculate position information of the sensor from the image of the sensor taken by the imaging unit, an image generator configured to generate a virtual image of the form information, based on the position information calculated by the position calculator; a synthesizing unit configured to superimpose the virtual image on the image of the sensor taken by the imaging unit to synthesize a synthetic image; and a display configured to display the synthetic image synthesized by the synthesizing unit.

[0007] It may be preferable that the form information of the sensor includes at least a detection direction and a detection area of the sensor.

[0008] It may be preferable that the form information includes further shape information of the storage tag, and the position calculator calculates the position information of the sensor by comparing the shape information of the storage tag read by the reading unit with the image of the storage tag taken by the imaging unit.

[0009] It may be preferable that the reading unit reads out relevant information related to the read information of the storage tag, from a storage of the terminal or an external storage.

[0010] It may be preferable that the storage tag is a two-dimensional code.

[0011] According to another aspect, a terminal is configured to display form information of a sensor. The sensor includes a storage tag which is readable from the terminal and which is configured to store the form information of the sensor. The terminal includes: an imaging unit configured to take an image of the sensor; a reading unit configured to read information from the storage tag of the sensor; a position calculator configured to calculate position information of the sensor from the image of the sensor taken by the imaging unit; an image generator configured to generate a virtual image of the form information, based on the position information calculated by the position calculator; a synthesizing unit configured to superimpose the virtual image on the image of the sensor taken by the imaging unit to synthesize a synthetic image; and a display configured to display the synthetic image synthesized by the synthesizing unit.

[0012] According to another aspect, a sensor causes a terminal to display form information. The terminal includes: an imaging unit configured to take an image of the sensor; a reading unit configured to read information from the storage tag of the sensor; a position calculator configured to calculate position information of the sensor from the image of the sensor taken by the imaging unit; an image generator configured to generate a virtual image of the form information, based on the position information calculated by the position calculator; a synthesizing unit configured to superimpose the virtual image on the image of the sensor taken by the imaging unit to synthesize a synthetic image; and a display configured to display the synthetic image synthesized by the synthesizing unit. The sensor includes a storage tag which is readable from the terminal and which is configured to store the form information of the sensor.

[0013] According to another aspect, form information of the sensor is displayed on a terminal in a method for supporting a sensor. The method for supporting a sensor includes: taking an image of the sensor including a storage tag which is readable from the terminal and which is configured to store the form information of the sensor; reading information from the storage tag of the sensor; calculating position information of the sensor from the taken image of the sensor; generating a virtual image of the form information, based on the calculated position information; superimposing the virtual image on the taken image of the sensor to synthesize a synthetic image; and displaying the synthetic image.

[0014] With a sensor support system according to the present technology, a virtual image of form information of

a sensor is displayed, on a display of a terminal, to be superimposed on an image of the sensor; therefore, the form information of the sensor is made visible so that installation and setting of the sensor can be efficiently performed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] FIG. **1** is a schematic diagram illustrating a schematic configuration of a sensor support system in an embodiment;

[0016] FIG. **2** is a schematic diagram illustrating a schematic configuration of a sensor in an embodiment;

[0017] FIG. **3** is a schematic diagram illustrating a hardware configuration of a terminal device in an embodiment;

[0018] FIG. **4** is a schematic diagram illustrating a functional configuration of a terminal device in an embodiment;

[0019] FIG. **5** is a schematic diagram illustrating a hardware configuration of a CPU unit in an embodiment;

[0020] FIG. **6** is a flowchart illustrating a display process on a terminal device in an embodiment;

[0021] FIG. **7** is a schematic diagram illustrating a schematic configuration of a first modified example of a sensor in an embodiment;

[0022] FIG. **8** is a schematic diagram illustrating a schematic configuration of a second modified example of a sensor in an embodiment;

[0023] FIG. **9** is a schematic diagram illustrating a schematic configuration of a third modified example of a sensor in an embodiment; and

[0024] FIG. **10** is a schematic diagram illustrating a schematic configuration of a fourth modified example of a sensor in an embodiment.

DETAILED DESCRIPTION

[0025] Hereinafter, embodiments will be described in detail with reference to the drawings. Note that in the drawings, the same reference sign represents the same or equivalent part.

A. Configuration of Sensor Support System

[0026] A sensor support system according to an embodiment has a function for supporting an operation of installation and setting of a sensor to be installed in a machine or equipment at, for example, a production site, and the sensor support system can make visible form information of the sensor such as a detection direction and a detection area. First, with reference to FIG. **1**, a configuration of the sensor support system according to an embodiment will be described.

[0027] FIG. **1** is a schematic diagram showing a schematic configuration of a sensor support system in an embodiment. A sensor support system **1** includes a terminal device **10** and a sensor **20**. As described later, the terminal device **10** may be added with a configuration communicable with an external device so that information about the sensor **20** can be collected. As the external device, a PC, a data base, a programmable logic controller (PLC) for controlling the sensor **20** can be considered. In the following description, a configuration will be described as an example. In the configuration, when the terminal device **10** is added with a configuration communicable with an external device, the terminal device **10** communicates with a PLC for controlling the sensor **20**.

[0028] The terminal device **10** includes an operation key **16**, a display **81** as a display unit, and a camera as an imaging unit (see FIG. **3**). Note that in an example of the terminal device **10** shown in FIG. **1**, the camera is provided not on a case surface on the side of the display **81** but on the case surface on the opposite side of the display **81**; however, the configuration is not limited to this example. For example, the camera may be connected through a cable or the like instead of being provided directly on the case of the terminal device **10**. When the camera takes an image of the sensor **20**, the terminal device **10** reads the form information of the sensor **20** from a two-dimensional code **21** (storage tag) attached on the sensor **20**. The form information of the sensor **20** includes information about installation and setting of the sensor **20** such as a detection direction and a detection area of the sensor **20**. Therefore, the terminal device **10** can read the form information of the sensor **20** from the two-dimensional code **21** and can display a virtual image **22** showing the detection area of the sensor **20** in such a manner that, for example, the virtual image is superimposed on the image of the sensor **20** taken by the camera. Note that the sensor **20** is an optical sensor for measuring, for example, a height or concavity and convexity of the surface of a product (object **2**) flowing on a production line **3**, and in order to detect correctly, the detection direction and the detection area of the sensor need to be disposed at the right position with respect to the object **2**.

[0029] In order to superimpose the virtual image **22** on the taken image of the sensor **20**, it is necessary to calculate the position information of the sensor and to adjust the position and size of the virtual image **22**. Regarding the position information of the sensor, the position and the distance of the sensor **20** are calculated on the terminal device **10** by comparing shape information of the two-dimensional code **21** itself included in the two-dimensional code **21** with the taken image of the two-dimensional code **21**. Specifically, the terminal device **10** calculates the position (posture and inclination) of the sensor **20** from distortion of the imaged two-dimensional code **21**, and calculates the distance (depth) from the camera to the sensor **20** from the size of the imaged two-dimensional code **21**. The terminal device **10** specifies the position of the sensor **20** in the taken image on the basis of the position information of the sensor, adjusts the position and size of the virtual image **22** in accordance with the image of the sensor **20**, and generates a synthetic image in which the taken image of the sensor **20** and virtual image **22** are combined. Note that the shape information of the two-dimensional code **21** itself does not have to be included in the two-dimensional code **21**, and it is possible to refer to the shape information stored in another storage (for example, a storage of the terminal device **10** or other storages).

[0030] By seeing the synthetic image of the terminal device **10** shown in FIG. **1**, an operator can see the detection area of the sensor **20** and can easily check whether the object **2** is in the detection area of the sensor **20** or not. Therefore, the installation and setting of the sensor **20** can be efficiently performed with the sensor support system **1** according to an embodiment.

[0031] The terminal device **10** can read out relevant information stored in a storage such as the storage of the terminal device **10** or an external device (for example, a PLC) other than the form information of the sensor **20** included in the two-dimensional code **21**. The relevant information

includes, for example, a manual of the sensor **20** and information about how to countermeasure troubles. The terminal device **10** displays the read-out relevant information such that the read-out relevant information is superimposed on the image of the sensor **20**; thus, it is also possible to simultaneously view the relevant information required to install and set the sensor **20**, thereby improving the operation efficiency of the operator. Note that the configuration may be made such that the link information is included in the two-dimensional code **21** and the form information of the sensor **20** (for example, the detection direction and the detection area of the sensor **20**) itself is stored in the storage of the terminal device **10** or the storage of an external device.

B. Configuration of Sensor

[0032] Next, the sensor **20** will be specifically described. FIG. **2** is a schematic diagram showing a schematic configuration of the sensor **20** in an embodiment. The sensor **20** is, for example, a photoelectric sensor and uses projected light to detect the presence or absence of an object or change of a surface of an object. The photoelectric sensor is configured with a light projecting unit for emitting light and a light receiving unit for receiving light, and the photoelectric sensor detects change, in the intensity of the light reaching the light receiving unit, caused by the projected light being interrupted or reflected by an object. To detect an object correctly by a photoelectric sensor, the object needs to be in the detection direction and to be included in the detection area. The detection direction of the photoelectric sensor is the direction in which the optical axis projected from the light projecting unit extends, and the detection area is the optical axis itself. Further, the photoelectric sensor has an error in the detection area around the optical axis. However, it is not easy to check whether the optical axis of the photoelectric sensor extends in the direction of the object and to check how large the error in the detection area is. To address this issue, by obtaining the form information of the sensor **20** from the two-dimensional code **21**, the terminal device **10** displays a virtual image **23** showing the optical axis of the sensor **20** and the virtual image **22** showing the error in the detection area in such a manner that the virtual image **23** and the virtual image **22** are superimposed on the image of the sensor **20** as shown in FIG. **2**, so that the optical axis and the detection area of the sensor **20** can be visualized.

C. Hardware Configuration of Terminal Device

[0033] Next, a hardware configuration of the terminal device **10** will be specifically described. FIG. **3** is a schematic diagram showing the hardware configuration of the terminal device **10** in an embodiment. The terminal device **10** shown in FIG. **3** is equipped with a central processing unit (CPU) **11** for performing various calculations, a read only memory (ROM) **12**, a random access memory (RAM) **13**, a flash ROM **14** for storing various programs in a non-volatile manner, the operation key **16**, a camera **17**, and the display **81**. These parts are mutually connected to one another through an internal bus. Further, a communication interface needs to be equipped for the terminal device **10** to be communicably connected to an external device.

[0034] The display **81** may be configured only with a display or may be configured to have a touch panel disposed to cover the display **81**. If a communication interface is provided, an Ethernet (registered trade mark) InterFace (IF), a serial IF, and a universal serial bus (USB) IF can be provided, for example.

[0035] The CPU **11** expands the program stored in the flash ROM **14** on the RAM **13** or the like to execute the program. The ROM **12** generally stores programs such as an operating system (OS). The RAM **13** is a volatile memory and is used as a working memory.

D. Functional Configuration of Terminal Device

[0036] Next, a functional configuration of the terminal device **10** will be specifically described. FIG. **4** is schematic diagram showing the functional configuration of the terminal device in an embodiment. The terminal device **10** shown in FIG. **4** is equipped with an imaging unit **151**, a reading unit **152**, a form information identification unit **153**, a position calculator **154**, an image generator **155**, a synthesizing unit **156**, a display controller **157**, a display unit **158**, and a storage **160**.

[0037] Note that the imaging unit **151** corresponds to the camera **17** shown in FIG. **3** and the like. The display unit **158** corresponds to the display **81**. The storage **160** corresponds to the flash ROM **14** and the ROM **12**.

[0038] The storage **160** has a data base **352**. The data base **352** stores the form information of the sensor **20** and the relevant information.

[0039] If a setting menu for the sensor **20** is chosen by the operation key **16** (see FIG. **3**) or the like, the imaging unit **151** activates the camera **17** to perform an imaging process. The imaging unit **151** takes an image of the sensor **20** and sends the image data obtained by the imaging to the reading unit **152**. The image data includes the two-dimensional code **21** attached on the sensor **20**. The imaging unit **151** may take a still image or may take a moving image. In the following, for the sake of convenience, it is supposed that the image data is taken as a still image.

[0040] The reading unit **152** reads information from the two-dimensional code **21** included in the image data. If the image data does not include the two-dimensional code **21**, the reading unit **152** sends an instruction to the display controller **157** to display on the display unit **158** a message saying that the sensor **20** needs to be imaged again such that the two-dimensional code **21** is included. The information read from the two-dimensional code **21** includes the form information of the sensor **20** and the shape information of the two-dimensional code **21**. If the form information of the sensor **20** is included in the two-dimensional code **21** itself, the form information identification unit **153** identifies the form information of the sensor **20** based on the information sent from the reading unit **152**. On the other hand, if the form information of the sensor **20** is not included in the two-dimensional code **21** itself, the form information identification unit **153** reads out the form information of the sensor **20** from the data base **352** based on the information sent from the reading unit **152** and identifies the form information of the sensor **20**. The reading unit **152** sends the shape information of the two-dimensional code **21** to the position calculator **154**.

[0041] The position calculator **154** compares the shape information of the two-dimensional code **21** with the image of the two-dimensional code **21** taken by the imaging unit **151** to calculate the position information of the sensor **20**. The position information of the sensor **20** includes the information of the position and the distance of the sensor **20**

in the image taken by the imaging unit **151**. The position calculator **154** sends the calculated position information of the sensor **20** to the image generator **155**.

[0042] The image generator **155** generates a virtual image (for example, the virtual image **23** representing the optical axis and the virtual image **22** representing the error in the detection area [see FIG. **2**]) in accordance with the form information of the sensor **20** sent from the form information identification unit **153**. Further, the image generator **155** adjusts the position and size of the virtual image so that the generated virtual image can be superimposed on the image of the sensor **20**. Specifically, the image generator **155** identifies a light projection port from the taken image of the sensor **20** and turns the virtual image **23** so that the direction of the virtual image **23** representing the optical axis coincides with the direction of the light emitted from the light projection port. The image generator **155** sends the adjusted virtual image to the synthesizing unit **156**. Note that in the image generator **155**, the process of calculating the position of the virtual image from the position information of the sensor **20** and other processes can be performed in the same way as processes in the augmented reality technology.

[0043] The synthesizing unit **156** combines the image of the sensor **20** taken by the imaging unit **151** and the virtual image sent from the image generator **155** to synthesize a synthetic image. Note that if the virtual image sent from the image generator **155** cannot be successfully superimposed on the image of the sensor **20** taken by the imaging unit **151**, the synthesizing unit **156** may feed back error information to the image generator **155** so as to make the image generator **155** adjust the virtual image again. The synthesizing unit **156** sends the synthesized synthetic image to the display controller **157**.

[0044] The display controller **157** makes the display unit **158** (that is, the display **81**) display the synthetic image sent from the synthesizing unit **156**. Further, the display controller **157** can make the display unit **158** display various information (for example, a numerical value and a character string) transmitted from an external device.

E. Hardware Configuration of PLC

[0045] Supposing that the terminal device **10** is provided with a communication interface connected to a PLC as an external device so as to collect information about the sensor **20**, the configuration of the PLC as a connection destination will be described. Specifically, a hardware configuration of a CPU unit of the PLC will be described. FIG. **5** is a schematic diagram showing the hardware configuration of the CPU unit in an embodiment. A CPU unit **30***a* shown in FIG. **5** is a component included in the PLC and includes a microprocessor **100**, a chipset **102**, a main memory **104**, a non-volatile memory **106**, a system timer **108**, a PLC system bus controller **120**, a field network controller **140**, and a USB connector **110**. The chipset **102** is connected to each of other components through various buses.

[0046] The microprocessor **100** and the chipset **102** are typically configured in accordance with a general-purpose computer architecture. That is, the microprocessor **100** decodes and executes instruction codes serially supplied from the chipset **102** according to an internal clock. The chipset **102** communicates internal data with the various components connected to the chipset **102** and generates instruction codes necessary to the microprocessor **100**. Further, the chipset **102** has a function to cache the data or the like obtained as a result of the execution of arithmetic processing on the microprocessor **100**.

[0047] The CPU unit **30***a* has the main memory **104** and the non-volatile memory **106** as storages.

[0048] The main memory **104** is a volatile storage area (RAM) and holds various types of programs to be executed on the microprocessor **100** after the CPU unit **30***a* is powered on. Further, the main memory **104** is used also as a working memory when the microprocessor **100** executes various programs. As the main memory **104** described above, a device such as a dynamic random access memory (DRAM) or a static random access memory (SRAM) is used.

[0049] On the other hand, the non-volatile memory **106** stores, in a non-volatile manner, data such as a real-time operating system (OS), a system program for the PLC, a user program, a motion calculation program, and a system setting parameter, and the form information of the sensor **20**. These programs and data are copied, if necessary, in the main memory **104** for the microprocessor **100** to access. As the non-volatile memory **106** described above, a semiconductor memory such as a flash memory can be used. Alternatively, a magnetic recording medium such as a hard disk drive or an optical recording medium such as a digital versatile disk random access memory (DVD-RAM) can be used.

[0050] The system timer **108** generates an interrupt signal and provides the interrupt signal to the microprocessor **100** at a fixed cycle. Typically, interrupt signals are each generated at each of a plurality of different cycles in accordance with specifications of hardware; however; setting can be made such that an interrupt signal is generated at an arbitrary cycle by an operating system (OS), a basic input output system (BIOS), or the like. This interrupt signal generated by the system timer **108** is used to realize various control operations.

[0051] The CPU unit **30***a* has the PLC system bus controller **120** and the field network controller **140** as a communication circuit.

[0052] A buffer memory **126** functions as a transmission buffer for data to be output to another unit (hereinafter also referred to as "output data") through a PLC system bus **130** and a reception buffer for data input from another unit (hereinafter also referred to as "input data") through the PLC system bus **130**. Note that the output data generated by arithmetic processing on the microprocessor **100** is primitively stored in the main memory **104**. Then, the output data to be transferred to a specific unit is read out from the main memory **104** and temporarily stored in the buffer memory **126**. Further, the input data transferred from another unit is temporarily held in the buffer memory **126** and is then moved to the main memory **104**.

[0053] A DMA control circuit **122** performs transfer of output data from the main memory **104** to the buffer memory **126** and transfer of input data from the buffer memory **126** to the main memory **104**.

[0054] A PLC system bus control circuit **124** performs processing of transmission of the output data in the buffer memory **126** to another unit connected to the PLC system bus **130**, reception of the input data from another unit connected to the PLC system bus **130**, and storing of the input data in the buffer memory **126**. Typically, the PLC system bus control circuit **124** provides functions of a physical layer and a data link layer in the PLC system bus **130**.

[0055] The field network controller **140** controls transmission and reception of data through a field network **150**. That is, the field network controller **140** controls transmission of output data and reception of input data in conformity with the standard of an employed field network **150**. As described above, the field network **150** in conformity with the EtherCAT (registered trade mark) standard is used in an embodiment; therefore, the field network controller **140** including hardware for performing normal Ethernet (registered trade mark) communication is used. According to the EtherCAT (registered trade mark) standard, it is possible to use a general Ethernet (registered trade mark) controller which realizes a communication protocol in conformity with the normal Ethernet (registered trade mark) standard. However, if some types of industrial Ethernet (registered trade mark) are used as the field network **150**, an Ethernet (registered trade mark) controller of special specification is used, which controller is compatible with the communication protocol of a dedicated specification different from a normal communication protocol. Alternatively, if a field network **150** other than the industrial Ethernet (registered trade mark) is used, the dedicated field network controller in conformity with the standard is used. The PLC communicates with the communication interface of the terminal device **10** through the field network controller **140**.

[0056] A DMA control circuit **142** transfers output data from the main memory **104** to a buffer memory **146** and input data from the buffer memory **146** to the main memory **104**.

[0057] A field network control circuit **144** performs transmission processing of the output data in the buffer memory **146** to another device connected to the field network **150**, reception processing of the input data from another device connected to the field network **150**, and storage processing of the received data in the buffer memory **146**. Typically, the field network control circuit **144** provides functions of a physical layer and a data link layer in the field network **150**.

[0058] The USB connector **110** is an interface for connecting an external device such as a PLC support device and the CPU unit **30***a* to each other. Typically, a program executable on the microprocessor **100** of the CPU unit **30***a* and the like transferred from an external device are taken into the PLC through the USB connector **110**.

F. Support Process of Terminal Device

[0059] A support process of the installation and setting of the sensor performed on the terminal device **10** will be described in more detail. The support process is performed on the CPU **11** of the terminal device **10**. FIG. **6** is a flowchart for describing a display process on the terminal device in an embodiment. In the flowchart shown in FIG. **6**, the CPU **11** acquirers the information of the two-dimensional code **21** attached on the sensor **20** from the image of the sensor **20** taken by the camera **17** (step S**61**).

[0060] Next, the CPU **11** determines whether the acquired information of the two-dimensional code **21** includes the form information of the sensor **20** (step S**62**). If the acquired information of the two-dimensional code **21** does not include the form information of the sensor **20** (step S**62**: NO), the CPU **11** inquires a storage in the terminal device **10** (for example, the PLC and the like) or an external device for the form information of the sensor **20** (step S**63**). As a result of the inquiry, the CPU **11** acquires the form information of the sensor **20** from the storage in the terminal device **10** or the external device. If the acquired information of the two-dimensional code **21** includes the form information of the sensor **20** (step S**62**: YES), the CPU **11** does not inquire the storage in the terminal device **10** or the external device for the form information of the sensor **20**.

[0061] Next, the CPU **11** compares the shape information of the two-dimensional code **21** included in the information of the two-dimensional code **21** with the image of the two-dimensional code **21** taken by the camera **17** to calculate the position information of the sensor **20** (step S**64**).

[0062] Next, based on the position information of the sensor **20** calculated in step S**64**, the CPU **11** generates a virtual image of the form information of the sensor **20** (for example, the detection direction, the detection area of the sensor **20**, and the like) (step S**65**).

[0063] Next, the CPU **11** superimposes the virtual image generated in step S**65** on the image of the sensor **20** (picked-up image) taken by the camera **17** (step S**66**).

[0064] Next, the CPU **11** displays the image (synthetic image) synthesized in step S**66** on the display **81** (step S**67**).

[0065] As described above, in the sensor support system **1** according to an embodiment, the position information of the sensor **20** is calculated from the image of the sensor **20** to generate the virtual image **22** of the form information of the sensor **20**, and the display **81** displays the image in which the virtual image **22** is superimposed on the image of the sensor taken by the camera **17**. Therefore, in the sensor support system **1**, the terminal device **10** can visualize the form information of the sensor **20**, whereby the operation of the installation and setting of the sensor **20** can be efficiently performed.

[0066] Further, the form information of the sensor **20** includes at least the detection direction and the detection area of the sensor **20**. Therefore, the terminal device **10** can visualize and display the detection direction and the detection area of the sensor **20**, whereby the operation of the installation and setting of the sensor **20** can be efficiently performed.

[0067] In addition, the form information of the sensor **20** further includes the shape information of the two-dimensional code (storage tag), and the position calculator **154** compares the shape information of the two-dimensional code (storage tag) read by the reading unit **152** with the image of the two-dimensional code (storage tag) taken by the imaging unit **151** to calculate the position information of the sensor **20**. Therefore, in the terminal device **10**, there is no need for an operator to specify the position (posture and inclination) of the sensor **20** or the distance (depth) to the sensor **20**, and the operator has only to take an image of the sensor **20** with the camera **17** to generate an image on which the virtual image of the form information of the sensor **20** is superimposed.

[0068] Further, the reading unit **152** reads out the relevant information (for example, the manual of the sensor **20** and the like) related to the read information of the two-dimensional code (storage tag) from the storage of the terminal device **10** or a storage of an external device. Therefore, the terminal device **10** can generate an image on which the relevant information of the sensor **20** is superimposed, whereby the operation of the installation and setting of the sensor **20** can be efficiently performed.

G. Types of Sensors

[0069] With reference to FIG. **2**, the photoelectric sensor is described as a specific example of the sensor **20**. However, the sensor **20** is not limited to the photoelectric sensor and may be other types of sensors. In the following, typical types of sensors will be described.

[0070] The case that the sensor is an ultrasonic sensor will be specifically described. FIG. **7** is a schematic diagram showing a schematic configuration of a first modified example of the sensor in an embodiment. A sensor **20**A is an ultrasonic sensor and detects the presence or absence of an object or the distance to the object by transmitting ultrasonic waves towards the object by a transmitter and receiving the reflected waves by a receiver. To detect an object correctly by an ultrasonic sensor, the object needs to be in the detection direction and within the detection area. The detection direction of the ultrasonic sensor is the direction in which the ultrasonic waves transmitted from the transmitter propagate, and the detection area is a surrounding area of the ultrasonic waves. However, it is not easy to check whether the propagation direction of the ultrasonic waves transmitted from the ultrasonic sensor is directed to the object or to check how the detection area is positioned. To address this issue, the terminal device **10** acquires the form information of the sensor **20**A from the two-dimensional code **21**A and displays as shown in FIG. **7** the image of the sensor **20**A on which are superimposed the virtual image **23**A of the center line, of the detection area, indicating the propagation direction of the ultrasonic waves and the virtual image **22**A representing the detection area, so that the center line of the detection area and the detection area of the sensor **20**A can be visualized.

[0071] Next, the case that the sensor is a non-contact door switch will be specifically described. FIG. **8** is a schematic diagram showing a schematic configuration of a second modified example of the sensor in an embodiment. A sensor **20**B is a non-contact door switch and has different detection areas, one of which is for detecting the transition from an ON state to an OFF state and the other of which is for detecting the transition from an OFF state to an ON state; and the switching between an ON state and an OFF state has hysteresis. However, with respect to the non-contact door switch, it is not easy to check how much difference there is between the detection area for detecting the transition from an ON state to an OFF state and the detection area for detecting the transition from an OFF state to an ON state. To address this issue, the terminal device **10** acquires the form information of the sensor **20**B from the two-dimensional code **21**B and displays as shown in FIG. **8** the image of the sensor **20**B on which the virtual image **22**B representing the detection area for detecting the transition from an ON state to an OFF state of the sensor **20**B and the virtual image **23**B representing the detection area for detecting the transition from an OFF state to an ON state are superimposed, so that the difference between the detection areas of the sensor **20**B can be visualized.

[0072] Next, the case that the sensor is a proximity switch will be specifically described. FIG. **9** is a schematic diagram showing a schematic configuration of a third modified example of the sensor in an embodiment. A sensor **20**C is a proximity switch and has different detection areas depending on the types of objects. However, with respect to the proximity switch, it is not easy to check which type of object has what size of a detection area. To address this issue, the terminal device **10** acquires the form information of the sensor **20**C from the two-dimensional code **21**C and displays as shown in FIG. **9** the image of the sensor **20**C on which, for example, a virtual image **22**C representing the detection area capable of detecting aluminum, a virtual image **23**C representing the detection area capable of detecting brass, a virtual image **24**C representing the detection area capable of detecting stainless steel, a virtual image **25**C representing the detection area capable of detecting iron are superimposed, so that the difference among the detection areas, of the sensor **20**C, for respective types of objects can be visualized.

[0073] Next, the case that the sensor is an area sensor will be specifically described. FIG. **10** is a schematic diagram showing a schematic configuration of a fourth modified example of the sensor in an embodiment. A sensor **20**D is an area sensor, and the detection area is not fixed but temporally changes. However, with respect to the area sensor, it is not easy to check how the detection area is changing. To address this issue, the terminal device **10** acquires the form information of the sensor **20**D from the two-dimensional code **21**D, and at the same time, a synchronization signal is transmitted from the sensor **20**D to the terminal device **10** so that the timings of the screen display of a detection area **22**D of the sensor **20**D and the screen display of the terminal device **10** are in synchronism to each other. Thus, the image of the sensor **20**D on which the temporally changing detection area of the sensor **20**D is superimposed is displayed as shown in FIG. **10**, so that the change of detection area **22**D of the sensor **20**D can be visualized.

H. Modified Examples

[0074] (1) In the sensor support system **1** according to an embodiment, the two-dimensional code **21** may include all of the form information of the sensor **20**, the storage **160** of the terminal device **10** may include the form information of the sensor **20**, or a storage of an external device may include the form information of the sensor **20**. Alternatively, in the sensor support system **1** according to an embodiment, part of the form information of the sensor **20** may be included in each of the two-dimensional code **21**, the storage **160** of the terminal device **10**, and a storage of an external device. Further, the above description describes that in the sensor support system **1** according to an embodiment, the form information of the sensor **20** is stored in the storage of the PLC as an external device; however, other than the PLC, the form information of the sensor **20** may be stored in a PC or a data base which is communicable with the terminal device **10**.

[0075] (2) The above description describes that the position calculator **154** according to an embodiment compares the shape information of the two-dimensional code and the image of the two-dimensional code taken by the imaging unit **151** with each other to calculate the position information of the sensor **20**. However, the present invention is not limited to the above configuration, and the position calculator **154** may calculate the position information of the sensor **20** by comparing the shape information of the sensor **20** itself and the image of the sensor **20** taken by the imaging unit **151** with each other.

[0076] (3) The above description describes that the storage tag attached on the sensor **20** according to an embodiment is a two-dimensional code. However, the storage tag is not limited to a two-dimensional code, and the storage tag may

be a bar code, an identification number, or the like and may be a magnetic tape or an IC chip. However, if a magnetic tape or an IC chip is employed as the storage tag, it is necessary to provide on the reading unit **152**, in addition to the imaging unit **151**, a separate reading device which can read information from the storage tag.

[0077] (4) The above description describes that in the sensor support system **1** according to an embodiment, the display unit **158** of the terminal device **10** displays thereon the synthetic image on which the virtual image of the form information of the sensor **20** is superimposed. However, the present invention is not limited to the above configuration, and the synthetic image on which the virtual image of the form information of the sensor **20** is superimposed may be displayed on a smartphone or a head mounted display.

[0078] (5) The sensor according to an embodiment may be a moving object such as a robot arm having a certain movable range, and the configuration may be made such that the object having a two-dimensional code attached thereon is imaged by the terminal device **10** so that the virtual image of the movable range of the object is generated from the information of the two-dimensional code, and the virtual image is displayed on the display unit **158** of the terminal device **10**, being superimposed on the image of the object.

[0079] It should be understood that an embodiment disclosed herein is an example in all respects and is not restrictive. The scope of the present invention is not defined by the above description but defined by the claims, and it is intended that the scope of the present invention includes all variations within the meaning and the scope equivalent to the claims.

1. A sensor support system comprising:
- a sensor; and
- a terminal configured to display form information of the sensor,
- wherein
- the sensor includes:
  - a storage tag which is readable from the terminal and is configured to store the form information of the sensor,
- the terminal includes:
  - an imaging unit configured to take an image of the sensor;
  - a reading unit configured to read information from the storage tag of the sensor;
  - a position calculator configured to calculate position information of the sensor from the image of the sensor taken by the imaging unit,
  - an image generator configured to generate a virtual image of the form information, based on the position information calculated by the position calculator;
  - a synthesizing unit configured to superimpose the virtual image on the image of the sensor taken by the imaging unit to synthesize a synthetic image; and
  - a display configured to display the synthetic image synthesized by the synthesizing unit.

2. The sensor support system according to claim **1**, wherein the form information of the sensor includes at least a detection direction and a detection area of the sensor.

3. The sensor support system according to claim **1**, wherein the form information further includes shape information of the storage tag, and the position calculator calculates the position information of the sensor by comparing the shape information of the storage tag read by the reading unit with the image of the storage tag taken by the imaging unit.

4. The sensor support system according to claim **1**, wherein the reading unit reads out relevant information related to the read information of the storage tag, from a storage of the terminal or from an external storage.

5. The sensor support system according to claim **1**, wherein the storage tag is a two-dimensional code.

6. A terminal for displaying form information of a sensor, wherein the sensor includes a storage tag which is readable from the terminal and which is configured to store the form information of the sensor, the terminal comprising:
- an imaging unit configured to take an image of the sensor;
- a reading unit configured to read information from the storage tag of the sensor;
- a position calculator configured to calculate position information of the sensor from the image of the sensor taken by the imaging unit,
- an image generator configured to generate a virtual image of the form information, based on the position information calculated by the position calculator;
- a synthesizing unit configured to superimpose the virtual image on the image of the sensor taken by the imaging unit to synthesize a synthetic image; and
- a display configured to display the synthetic image synthesized by the synthesizing unit.

7. A sensor which causes a terminal to display form information, wherein the terminal includes:
- an imaging unit configured to take an image of the sensor;
- a reading unit configured to read information from a storage tag of the sensor;
- a position calculator configured to calculate position information of the sensor from the image of the sensor taken by the imaging unit, an image generator configured to generate a virtual image of the form information, based on the position information calculated by the position calculator;
- a synthesizing unit configured to superimpose the virtual image on the image of the sensor taken by the imaging unit to synthesize a synthetic image; and
- a display configured to display the synthetic image synthesized by the synthesizing unit,
- the sensor comprising:
- the storage tag which is readable from the terminal and is configured to store the form information of the sensor.

8. A method for supporting a sensor, in which method form information of a sensor is displayed on a terminal, the method for supporting a sensor comprising:
- taking an image of the sensor including a storage tag which is readable from the terminal and is configured to store the form information of the sensor;
- reading information from the storage tag of the sensor;
- calculating position information of the sensor from the taken image of the sensor;
- generating a virtual image of the form information, based on the calculated position information;
- superimposing the virtual image on the taken image of the sensor to synthesize a synthetic image; and
- displaying the synthetic image.

9. The sensor support system according to claim **2**, wherein the form information further includes shape information of the storage tag, and
- the position calculator calculates the position information of the sensor by comparing the shape information of the

storage tag read by the reading unit with the image of the storage tag taken by the imaging unit.

10. The sensor support system according to claim **2**, wherein the reading unit reads out relevant information related to the read information of the storage tag, from a storage of the terminal or from an external storage.

11. The sensor support system according to claim **3**, wherein the reading unit reads out relevant information related to the read information of the storage tag, from a storage of the terminal or from an external storage.

12. The sensor support system according to claim **9**, wherein the reading unit reads out relevant information related to the read information of the storage tag, from a storage of the terminal or from an external storage.

13. The sensor support system according to claim **2**, wherein the storage tag is a two-dimensional code.

14. The sensor support system according to claim **3**, wherein the storage tag is a two-dimensional code.

15. The sensor support system according to claim **4**, wherein the storage tag is a two-dimensional code.

16. The sensor support system according to claim **9**, wherein the storage tag is a two-dimensional code.

17. The sensor support system according to claim **10**, wherein the storage tag is a two-dimensional code.

18. The sensor support system according to claim **11**, wherein the storage tag is a two-dimensional code.

19. The sensor support system according to claim **12**, wherein the storage tag is a two-dimensional code.

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