

SENSOR DEVICE AND SENSOR ADJUSTMENT SYSTEM

FIELD

Embodiments described herein relate generally to a sensor device and a sensor adjustment system.

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BACKGROUND

In general, sensor devices (safety devices) for preventing persons and objects from being caught are installed in the vicinity of elevators, automatic doors, platform safety gates, etc. Such sensor devices need to be adjusted to be able to normally detect persons and objects in the vicinity thereof. In particular, in the case of sensor devices in which cameras are used, the detectable range easily deviates because of variations in the position and the angle at which they are installed. Thus, minute adjustments are required.

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However, if an adjustment method is difficult, there is a problem that only a skilled maintenance engineer can make adjustments.

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SUMMARY

According to one aspect, there is provided a sensor device installed in vicinity of a door, the sensor device comprising:

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an image capture module configured to successively capture images in an image capture area;

an image recognition module configured to perform an image recognition process for the images captured by the image capture module; and

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a parameter adjuster configured to, if parameter adjustment data for adjusting a predetermined parameter specific to the sensor device is detected as a result of the image recognition process by the image recognition module, change the predetermined parameter in accordance with the detected parameter adjustment data.

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According to another aspect, there is provided a sensor adjustment system including a sensor device installed

in vicinity of a door and an instruction medium configured to instruct the sensor device, wherein

the instruction medium comprises a presentation module configured to present parameter adjustment data for adjusting a predetermined parameter specific to the sensor device, and

the sensor device comprises:

an image capture module configured to successively capture images in an image capture area;

an image recognition module configured to perform an image recognition process for the images captured by the image capture module; and

a parameter adjuster configured to, if parameter adjustment data presented by the instruction medium is detected as a result of the image recognition process by the image recognition module, change the predetermined parameter in accordance with the detected parameter adjustment data.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates a schematic configuration example of a sensor adjustment system including a sensor device according to one embodiment.

FIG. 2 illustrates examples of an installation place of the sensor device.

FIG. 3 illustrates examples of a parameter adjustment data item.

FIG. 4 is a block diagram showing a schematic configuration example of the sensor device.

FIG. 5 illustrates a data structure of a parameter data item.

FIG. 6 is a diagram for explaining an image capture range of the sensor device.

FIG. 7 is a flowchart showing an example of operations of the sensor device.

FIG. 8 is a diagram for explaining a procedure under which a maintenance engineer causes a parameter

adjustment data item to be displayed on an instruction medium.

FIG. 9 illustrates a data structure of a function data item.

5 FIG. 10 is a diagram for explaining configurations of a display module and a notification module provided in the sensor device.

DETAILED DESCRIPTION

10 Embodiments will be described hereinafter with reference to the accompanying drawings.

 In general, according to one embodiment, a sensor device is installed in vicinity of a door. The sensor device includes an image capture module, an image recognition module and a parameter adjuster. The image capture module is configured to successively capture
15 images in an image capture area. The image recognition module is configured to perform an image recognition process for the images captured by the image capture module. The parameter adjuster is configured to, if
20 parameter adjustment data for adjusting a predetermined parameter specific to the sensor device is detected as a result of the image recognition process by the image recognition module, change the predetermined parameter in accordance with the detected parameter adjustment
25 data.

 FIG. 1 illustrates a schematic configuration example of a sensor adjustment system including a sensor device according to one embodiment. The sensor adjustment system is a system for assisting
30 (supporting) a maintenance engineer who decides the initial settings of and makes adjustments to the sensor device installed at a predetermined place. As shown in FIG. 1, the sensor adjustment system includes a sensor device 10 and an instruction medium 20. The sensor
35 device 10 detects a person and an object existing in a predetermined area, and acquires various data items from the detected person and object. The data items

that can be acquired are, for example, parameter adjustment data items which are attached to the detected object and used to adjust various parameters of the sensor device 10, data items indicating how the detected person and object are moving in the predetermined area, and data items indicating the sizes and lengths of the detected person and object. In addition, the sensor device 10 can also acquire a data item on an environment in the predetermined area. The data item on the environment is, for example, an illumination data item indicating the degree of illumination in the predetermined area.

FIG. 2 illustrates examples of an installation place of the sensor device 10. For example, as shown in FIG. 2 (a), the sensor device 10 may be installed at the upper part of the doorway of a car of an elevator. The upper part of the doorway of the car of the elevator is, for example, a frieze board. In addition, as shown in FIG. 2 (b), the sensor device 10 may be installed in the vicinity of an automatic door. Moreover, as shown in FIG. 2 (c), the sensor device 10 may be installed in the vicinity of a platform safety gate. Although not shown in the figures, the sensor device 10 may be installed in the vicinity of a train door, in an elevator hall, etc. These places have been herein cited as examples of the installation place of the sensor device 10. However, the installation place of the sensor device 10 is not limited to these. In the present embodiment, it is assumed that the sensor device 10 is installed at the upper part of the doorway of the car of the elevator as shown in FIG. 2 (a).

The instruction medium 20 is used by a maintenance engineer when deciding the initial settings of the sensor device 10 or adjusting the parameters of the sensor device 10. Specifically, the instruction medium 20 may be a mobile phone, a tablet terminal, a personal computer (PC), etc., which can display a parameter

adjustment data item, or may be a piece of paper, plastic, metal, etc., on which a parameter adjustment data item is printed. An instruction medium which can handle a plurality of parameter adjustment data items, such as a mobile phone or a tablet terminal, may be referred to as a dynamic instruction medium. In contrast, an instruction medium which basically handles one parameter adjustment data item, such as a piece of paper or plastic, may be referred to as a static instruction medium.

FIG. 3 illustrates examples of a parameter adjustment data item. For example, the parameter adjustment data item may be represented by a QR code (registered trademark) as shown in FIG. 3 (a). In addition, the parameter adjustment data item may be represented by handwritten characters, printed characters, a predetermined gradated pattern, a predetermined figure, a pattern changing with time, etc., as shown in FIG. 3 (b) to (f) in this order. The parameter adjustment data item may include a security code. The security code is used when the sensor device 10 confirms whether or not a data item attached to a detected object is a parameter adjustment data item. In the present embodiment, it is assumed that parameter adjustment data items are represented by QR codes as shown in FIG. 3 (a).

FIG. 4 is a block diagram showing a schematic structure example of the sensor device 10 according to the present embodiment. As shown in FIG. 4, the sensor device 10 includes an image capture module 11, an image recognition processor 12, a parameter data storage 13, a parameter adjuster 14, etc. The functions of each of the modules 11 to 14 will be hereinafter described.

The image capture module 11 is, for example, a visible light camera, an infrared camera, or a range imaging camera, and has the function of successively capturing images in an image capture area, using

visible rays or infrared rays. Images (or video) captured by the image capture module 11 are transmitted to the image recognition processor 12. In the present embodiment, the image capture module 11 captures images of parameter adjustment data items and images for sensing (that is, for detecting a person and an object). However, the image capture module 11 may not capture images for sensing. In this case, a laser range scanner, a photoelectric sensor, or the like, is further provided in the sensor device 10 for sensing, as well as the image capture module 11.

When an image transmitted from the image capture module 11 is input, the image recognition processor 12 performs an image recognition process for the input image. In the image recognition process performed herein, well-known techniques such as pattern matching are used. The image recognition processor 12 has the function of, if an object (instruction medium 20) having a parameter adjustment data item for adjusting a parameter of the sensor device 10 has been detected as a result of the image recognition process, acquiring the parameter adjustment data item and transmitting it to the parameter adjuster 14.

On the other hand, if no object (instruction medium 20) having a parameter adjustment data item has been detected as a result of the image recognition process, the image recognition processor 12 performs the following process. The image recognition processor 12 recognizes how a person and an object are moving in the image capture area on the basis of the directions of the person and object which have no parameter adjustment data item but have been detected by the image recognition process. In other words, the image recognition processor 12 acquires data items indicating how the detected person and object are moving in the image capture area from the input image. In addition, the image recognition processor 12 recognizes the sizes

of the person and object which have no parameter adjustment data item but have been detected by the image recognition process. In other words, the image recognition processor 12 acquires data items indicating the sizes of the detected person and object from the input image. Moreover, the image recognition processor 12 recognizes the illumination in the vicinity of the installation place of the sensor device 10 on the basis of the brightness of the input image. In other words, the image recognition processor 12 acquires an illumination data item indicating the illumination in the vicinity of the installation place from the input image. These acquired data items are not used to decide the initial settings of or make parameter adjustments to the sensor device 10. Thus, a detailed explanation thereof is omitted herein. However, briefly speaking, the data items indicating how the detected person and object are moving in the image capture area are transmitted to a door opening and closing controller not shown in the figures, etc., and used to control the opening and closing of a door to prevent the person and object from being caught in the door.

The parameter data storage 13 is a storage unit in which parameter data items on various parameters of the sensor device 10 are stored. For example, as shown in FIG. 5, the parameter data items are data items with which an image capture range (detection range), detection sensitivity, a door width, and a door type are associated, respectively. It should be noted that various data items included in the parameter data items are not limited to the above data items, and may further include, for example, a type ID of an elevator and a car number.

The image capture range represents a range in which (the image capture module 11 of) the sensor device 10 can capture images (in other words, in which

a person and an object can be detected). Specifically, as shown in FIG. 6, the image capture range represents the linear distance L1 between points A and B of a sector spreading with the sensor device 10 as its center. Also, the image capture range may be the curve distance between points A and B shown in FIG. 6, that is, the length L2 of an arc of the sector spreading with the sensor device 10 as its center.

The detection sensitivity represents the resolution of an image (or video) captured by (the image capture module 11 of) the sensor device 10. As the detection sensitivity is higher, that is, as the resolution of an image captured by the image capture module 11 is higher, a person and an object can be more accurately detected as a result of an image recognition process performed by the image recognition processor 12. On the other hand, if the resolution of a captured image is high, the capacity for the image generally becomes large. Thus, there is also a problem that a large number of images cannot be held because of the capacity of an image storage not shown in the figures, in which captured images are stored.

The door width represents the door width of an elevator in which the sensor device 10 is installed. The door type represents how a door of the elevator in which the sensor device 10 is installed opens. It should be noted that the door width and the door type are not data items indicating parameters of the sensor device 10. However, the door width and the door type are herein included in the parameter data items, because they are set by a maintenance engineer with the image capture range and the detection sensitivity when the initial settings of the sensor device 10 are decided.

The parameter adjuster 14 has the function of, when a parameter adjustment data item transmitted from the image recognition processor 12 is input, changing

(rewriting) a value of a parameter of a corresponding item of various parameters indicated by parameter data items stored in the parameter data storage 13 to a value of a parameter indicated by the parameter adjustment data item. The parameter of the sensor device 10 can be thereby adjusted.

An example of operations of the sensor device 10 having the above-described structure will be described next with reference to FIG. 7. First, an operation at the time of parameter adjustments will be herein described.

It should be noted that a maintenance engineer causes a parameter adjustment data item to be displayed (for example, a QC code) on the instruction medium 20 under the procedure shown in FIG. 8 when adjusting a parameter of the sensor device 10. The maintenance engineer first inputs an ID and a password on a login screen shown in FIG. 8 (a). When the login succeeded, the maintenance engineer selects an item of a parameter to be adjusted from various parameters of the sensor device 10 on a screen shown in FIG. 8 (b). Then, the maintenance engineer selects or inputs a specific value of the selected item, that is, a value of the parameter after being adjusted on a screen shown in FIG. 8 (c). It is herein assumed that as shown in FIG. 8 (b) and (c), "Detection sensitivity" is selected as the item of the parameter to be adjusted of the sensor device 10, and "Sensitivity: Low" is selected as its specific value. Accordingly, a parameter adjustment data item for adjusting the detection sensitivity of the sensor device 10 low is displayed on the instruction medium 20 as shown in FIG. 8 (d). It should be noted that when a parameter adjustment data item is displayed on the instruction medium 20, login authentication as shown in FIG. 8 (a) is necessary. Thus, higher security can be achieved than in the case of a static instruction medium such as a piece of paper. For example, in the

case of a static instruction medium such as a piece of paper, if the medium is lost, there is a possibility that a parameter of the sensor device 10 may be aimlessly changed by others. In contrast, in the case of a dynamic instruction medium, even if the medium is lost, such a possibility can be reduced, because the login authentication as shown in FIG. 8 is necessary.

The flowchart of FIG. 7 will be hereinafter described.

First, the sensor device 10 determines whether or not a predetermined operation has been performed by a maintenance engineer (step S1). As an example, the sensor device 10 herein determines whether or not an adjustment button not shown in the figures has been pressed by the maintenance engineer. The predetermined operation may be, for example, an operation of powering on the sensor device 10, an operation of causing the sensor device 10 to recognize a data item indicating the start of adjusting the sensor device 10, or a predetermined gesture in front of the sensor device 10.

If the adjustment button provided in the sensor device 10 has been pressed by the maintenance engineer (YES in step S1), the sensor device 10 transitions from a normal mode to an adjustment mode. On the other hand, if the adjustment button provided in the sensor device 10 has not been pressed by the maintenance engineer (NO in step S1), the flow returns to the above process of step S1 and the sensor device 10 continues operating in the normal mode until the adjustment button is pressed.

When transitioning from the normal mode to the adjustment mode, the sensor device 10 determines whether or not a predetermined time has elapsed since the transition to the adjustment mode (step S2). If the predetermined time has elapsed since the transition to the adjustment mode (YES in step S2), the sensor device 10 transitions from the adjustment mode to the

normal mode, and the flow returns to the above process of step S1. That is, the sensor device 10 continues operating in the normal mode until the adjustment button is pressed again.

5 On the other hand, if the predetermined time has not elapsed since the transition to the adjustment mode (NO in step S2), the image recognition processor 12 in the sensor device 10 performs an image recognition process for an image captured by the image capture
10 module 11 as in the normal mode (step S3).

 Then, the image recognition processor 12 determines whether or not an object having a parameter adjustment data item has been detected as a result of the image recognition process in step S3 (step S4). If
15 an object having a parameter adjustment data item has not been detected (NO in step S4), the flow returns to the above process of step S2.

 On the other hand, if an object having a parameter adjustment data item has been detected (YES in step
20 S4), the image recognition processor 12 acquires the parameter adjustment data item from the detected object (step S5). The acquired parameter adjustment data item is transmitted to the parameter adjuster 14.

 Then, when the parameter adjustment data item
25 transmitted from the image recognition processor 12 is input, the parameter adjuster 14 changes (rewrites) a parameter of a corresponding item of various parameters indicated by parameter data items stored in the parameter data storage 13 in accordance with the input
30 parameter adjustment data item (step S6), and the flow returns to the above process of step S2. That is, the maintenance engineer can successively change parameters without pressing the adjustment button again within a predetermined time after the transition to the
35 adjustment mode.

 Since the sensor device 10 operates as described above, the maintenance engineer can adjust a parameter

of the sensor device 10 simply by pressing the adjustment button provided in the sensor device 10 and holding the instruction medium 20 displaying a parameter adjustment data item over the sensor device 10.

It should be noted that the above processes of steps S1 and S2 may be omitted as appropriate. If the processes of steps S1 and S2 are omitted, the sensor device 10 transitions from the normal mode to the adjustment mode at a point in time when an object having a parameter adjustment data item is detected as a result of an image recognition process. When the change (adjust) of a parameter is finished, the sensor device 10 transitions from the adjustment mode to the normal mode again. Accordingly, a predetermined operation necessary for transitioning from the normal mode to the adjustment mode can be omitted, and the maintenance engineer can adjust the sensor device 10 in a short time.

In addition, the processes shown in FIG. 7 can also be applied when various functions of the sensor device 10 are turned on or off. In this case, the sensor device 10 needs to further include a function data storage in which function data items as shown in FIG. 9 are stored. In addition, in this case, the instruction medium 20 can further display function adjustment data items corresponding to the parameter adjustment data items. As shown in FIG. 9, the function data items are data items which define the on/off settings of various functions of the sensor device 10. The various functions are the function of detecting a person and an object, the function of detecting illumination, the function of detecting the degree of crowding in the vicinity of a door, etc. That is, the maintenance engineer can adjust the on/off settings of the various functions of the sensor device 10 by holding the instruction medium 20 displaying a

function adjustment data item corresponding to a parameter adjustment data item over the sensor device 10.

5 The case where a QR code is used as a parameter adjustment data item to adjust a parameter of the sensor device 10 has been hereinbefore described. Hereinafter, the case where a predetermined gradated pattern or a predetermined figure as shown in FIG. 3 (d) or (e) is used as a parameter adjustment data item to set a door width and a door type included in a parameter data item when deciding the initial settings of the sensor device 10 will be described. It should be noted that the door width and the door type are not parameters of the sensor device 10. It has been explained that in a QR code, an item of a parameter to be adjusted and its specific value are recorded. However, in the predetermined gradated pattern or the predetermined figure, specific values of the door width and the door type are not particularly recorded.

10 It should be noted that also in this case, a maintenance engineer first causes the predetermined gradated pattern (or the predetermined figure) to be displayed on the instruction medium 20 as a parameter adjustment data item under the same procedure as that of FIG. 8. In addition, the maintenance engineer places the instruction medium 20 displaying the predetermined gradated pattern on a floor in the vicinity of a door of an elevator in the image capture area of the sensor device 10. Then, the maintenance engineer decides the settings (initial settings) of the door width and the door type of the elevator by performing an operation of opening the door of the elevator after pressing the adjustment button of the sensor device 10.

15 The operations of the sensor device 10 performed to calculate and determine the door width and the door type will be hereinafter described. It should be noted

that the sensor device 10 is preinformed of the speed at which the door opens and closes.

First, also when the door of the elevator is opened by the maintenance engineer, the image capture module 11 of the sensor device 10 successively captures
5 images in the image capture area as in the normal mode. The captured images are transmitted to the image recognition processor 12. The image recognition processor 12 performs an image recognition process for
10 the images captured by the image capture module 11 as in the normal mode.

The image recognition processor 12 determines whether or not an object having a parameter adjustment data item has been detected as a result of the image
15 recognition process. If it is determined that an object having a parameter adjustment data item has been detected, the image recognition processor 12 measures a time from when the predetermined gradated pattern (or the predetermined figure) starts being visible until
20 the door of the elevator is completely opened (or a time from when the elevator was completely opened until the predetermined gradated pattern becomes invisible). Then, the image recognition processor 12 calculates the door width of the elevator on the basis of the preset
25 speed at which the door opens and closes and the measured time.

In addition, if it is determined that an object having a parameter adjustment data has been detected, the image recognition processor 12 determines how the
30 predetermined gradated pattern (or the predetermined figure) is seen. For example, it is assumed that from the perspective of the sensor device 10, the predetermined gradated pattern becomes lighter toward the left and darker toward the right. Moreover, it is
35 assumed that at first only a light part of the predetermined gradated pattern is visible, and as the door opens, its dark part becomes visible (or that at

first the whole gradated pattern is visible, and as the door closes, it becomes invisible from the dark part). In this case, the image recognition processor 12 can determine that the door type is that of a sliding door that opens by sliding from left to right. Similarly, it is assumed that at first only a part of the predetermined gradated pattern which is not light or dark is visible, and as the door opens, both the light and dark parts become visible (or that at first the whole predetermined gradated pattern is visible, and as the door closes, both the light and dark parts become invisible at the same time). In this case, the image recognition processor 12 can determine that the door type is that of a center open door that opens from the center.

Data items indicating the calculated door width and the determined door type are transmitted to the parameter adjuster 14. When the data items indicating the door width and the door type transmitted from the image recognition processor 12 are input, the parameter adjuster 14 records the data items in the parameter data storage 13 as parameter data items. In this manner, even if a parameter adjustment data item is not a data item in which a specific value is recorded, such as a QR code, it can be used to decide the initial settings of the sensor device 10. In addition, in this case, a plurality of parameters (the door width and the door type) can be recorded by a single process. Thus, the maintenance engineer's workload can be reduced.

According to the above-described embodiment, the sensor device 10 has a structure by which its parameters can be adjusted in accordance with parameter adjustment data items indicated by the instruction medium 20. Through this structure, even those other than a skilled maintenance engineer can easily adjust the parameters of the sensor device 10. In addition, because the sensor device 10 adjusts its parameters in

accordance with the parameter adjustment data items indicated by the instruction medium 20 as described above, variations in the adjustments made by a maintenance engineer can be eliminated.

5 It should be noted that the sensor device 10 may further include a display module and a notification module in addition to the structure shown in FIG. 4. The display module, for example, may be composed of LEDs as shown in FIG. 10 (a). Alternatively, the
10 display module may be composed of a liquid crystal display (LCD) as shown in FIG. 10 (b). Moreover, the display module may be composed of a combination of these. The display module controls the turning on or off of the LEDs in response to the turning on or off of
15 various functions of the sensor device 10 as shown in FIG. 9. In addition, the display module displays the values of various parameters of the sensor device 10 on the LCD. Moreover, the display module may control the turning on or off of the LEDs or may display a message
20 indicating the current mode on the LCD so that it can be determined whether the sensor device 10 is in the normal mode or the adjustment mode.

 As shown in FIG. 10 (c), the notification module may be composed of a speaker. For example, when the
25 adjustment button is pressed by the maintenance engineer and the sensor device 10 transitions from the normal mode to the adjustment mode, the notification module gives notification of this fact with a sound. In addition, when a predetermined time has elapsed
30 since the sensor device 10 transitioned to the adjustment mode and the sensor device 10 transitions from the adjustment mode to the normal mode again, the notification module gives notification of this fact with a sound.

35 In this manner, since the sensor device 10 further includes the display module and the notification module, the maintenance engineer can easily ascertain

the current mode and the turning on or off of various functions of the sensor device 10. Accordingly, the sensor device 10 can be adjusted more smoothly.

5 While certain embodiments have been described, these embodiments have been presented by way of example only, and are not intended to limit the scope of the inventions. Indeed, the novel embodiments described herein may be embodied in a variety of other forms; furthermore, various omissions, substitutions and
10 changes in the form of the embodiments described herein may be made without departing from the spirit of the inventions. The accompanying claims and their equivalents are intended to cover such forms or modifications as would fall within the scope and spirit
15 of the inventions.

WHAT IS CLAIMED IS:

1. A sensor device installed in vicinity of a door, the sensor device comprising:

5 an image capture module configured to successively capture images in an image capture area;

an image recognition module configured to perform an image recognition process for the images captured by the image capture module; and

10 a parameter adjuster configured to, if parameter adjustment data for adjusting a predetermined parameter specific to the sensor device is detected as a result of the image recognition process by the image recognition module, change the predetermined parameter in accordance with the detected parameter adjustment data.

2. The sensor device of Claim 1, wherein the sensor device is installed at an upper part of a doorway of a car of an elevator.

20 3. The sensor device of Claim 1, wherein the parameter adjuster is configured to change the predetermined parameter to a parameter indicated by the detected parameter adjustment data.

25 4. The sensor device of Claim 1, wherein the predetermined parameter includes an image capture range in which the images are capturable by the image capture module and detection sensitivity indicating resolution of the images captured by the image capture module.

30 5. The sensor device of Claim 1, wherein the parameter adjustment data is data which is detectable for a predetermined time in accordance with a predetermined operation by a maintenance engineer.

35 6. The sensor device of Claim 1, wherein the image recognition module is configured to detect a person and an object not having the parameter adjustment data to control opening and closing of the door in addition to the parameter adjustment data.

7. The sensor device of Claim 1, wherein the

parameter adjuster is configured to, if function
adjustment data for turning on or off a predetermined
function specific to the sensor device is detected as a
result of the image recognition process by the image
5 recognition module, turn on or off the predetermined
function in accordance with the detected function
adjustment data.

8. A sensor adjustment system including a sensor
device installed in vicinity of a door and an
10 instruction medium configured to instruct the sensor
device, wherein

the instruction medium comprises a presentation
module configured to present parameter adjustment data
for adjusting a predetermined parameter specific to the
15 sensor device, and

the sensor device comprises:

an image capture module configured to successively
capture images in an image capture area;

an image recognition module configured to perform
20 an image recognition process for the images captured by
the image capture module; and

a parameter adjuster configured to, if parameter
adjustment data presented by the instruction medium is
detected as a result of the image recognition process
25 by the image recognition module, change the
predetermined parameter in accordance with the detected
parameter adjustment data.