

IMAGE PROCESSING SYSTEM AND MARKER

FIELD

Embodiments described herein relate generally to an image processing system and a marker.

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BACKGROUND

Generally, in an image sensor which detects a movement of a person or object from an image captured by a camera, a detection area in which a movement of a person or object can be detected needs to be set at the time of installation.

One example of the detection area setting method is a method of displaying an image captured at the time of installation on a display device and manually designating (setting) a detection area on the display device. However, this method requires a display device which displays an image captured at the time of installation, and also requires time and effort to manually designate a detection area.

Therefore, a method of setting a detection area by providing a marker in a place serving as a feature point of a detection area has been proposed.

However, this method cannot accurately set a detection area if the detection area has a complicated shape and has many feature points.

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SUMMARY

In general, according to one embodiment, an image processing system includes an imaging module, a first detector, an area setting module and a second detector. The imaging module is configured to capture an image of a target including one or more markers, the one or more markers being used for setting a detection area in which a movement of a person or an object is detectable. The first detector is configured to detect the one or more markers from the image captured by the imaging module, each of the one or more markers being

laterally rotatable around a rotation supporting point and having two sides extending from the rotation supporting point. The area setting module is configured to set an area including the two sides
5 constituting each of the one or more markers detected by the marker detector, as a detection area. The second detector is configured to detect a movement of a person or an object within the detection area set by the area setting module.

10 BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic diagram showing a structural example of an image processing system according to the first embodiment.

15 FIG. 2 shows the external appearance of a marker according to the embodiment.

FIG. 3 shows the case of providing the marker according to the embodiment in a wall surface corner.

FIG. 4 is another diagram showing the external appearance of the marker according to the embodiment.

20 FIG. 5 is another diagram showing the external appearance of the marker according to the embodiment.

FIG. 6 is another diagram showing the external appearance of the marker according to the embodiment.

25 FIG. 7 is another diagram showing the external appearance of the marker according to the embodiment.

FIG. 8 is an explanatory diagram showing a difference between the marker shown in FIG. 2 and the markers shown in FIGS. 4 to 7.

30 FIG. 9 is a flowchart showing an example of the procedure of detection area setting processing by an image processing device according to the embodiment.

FIG. 10 is an explanatory diagram providing a supplementary explanation on FIG. 9.

35 FIG. 11 is another explanatory diagram providing a supplementary explanation on FIG. 9.

FIG. 12 is another explanatory diagram providing a supplementary explanation on FIG. 9.

FIG. 13 is another explanatory diagram providing a supplementary explanation on FIG. 9.

5 FIG. 14 shows contour edge component detection results in a case where the marker according to the embodiment is painted in a single color.

10 FIG. 15 is another diagram showing contour edge component detection results in a case where the marker according to the embodiment is painted in a single color.

FIG. 16 shows contour edge component detection results in a case where the marker according to the embodiment is painted in multiple colors.

15 FIG. 17 is another diagram showing contour edge component detection results in a case where the marker according to the embodiment is painted in multiple colors.

20 FIG. 18 is a schematic diagram showing a structural example of an elevator system adopting various functions realized by the image processing system according to the embodiment.

25 FIG. 19 is a schematic diagram showing a structural example of an image processing system according to the second embodiment.

FIG. 20 is an explanatory diagram showing the function of a marker designation direction determination module according to the embodiment.

30 FIG. 21 is a flowchart showing an example of the procedure of detection area setting processing by an image processing device according to the embodiment.

DETAILED DESCRIPTION

Embodiments will be described with reference to the accompanying drawings.

<First Embodiment>

FIG. 1 is a schematic diagram showing a structural example of an image processing system according to the first embodiment.

5 The image processing system is a system which includes a camera 11 (may be referred to also as an imaging module), an image processing device 12, a marker 13, etc., and detects a person, an object, etc., within a specific area from an image captured by the
10 camera 11.

 The camera 11 is a small monitoring camera such as an in-vehicle camera, for example, and has a wide-angle lens and can capture images successively at the rate of several frames per second (for example, 30 frames per
15 second).

 Each of the images (video) successively captured by the camera 11 is analyzed by the image processing device 12 in real time. More specifically, the image processing device 12 detects (a movement of) a person,
20 an object, etc., based on a change in the brightness of an image within a specific area.

 The marker 13 is used for setting a detection area in which the image processing device 12 can detect a person, an object, etc., and a detection area is
25 defined in this manner.

 Here, the marker 13 will be described with reference to FIG. 2.

 FIG. 2 is an explanatory diagram showing the structure of the marker 13 used for setting a detection
30 area, FIG. 2(a) is a perspective view of the external appearance of the marker 13, FIG. 2(b) is a side view of the external appearance of the marker 13 corresponding to FIG. 2(a), FIG. 2(c) is another perspective view of the external appearance of the
35 marker 13, and FIG. 2(d) is another side view of the

external appearance of the marker 13 corresponding to FIG. 2(c).

As shown in FIG. 2(a) and (b), the marker 13 is formed of a plurality of stacked plate members (paperboards) 131a to 131c having the shape of a sector and having side portions r1 and r2 (may be referred to also as a radius), and the plate members 131a to 131c are connected to each other by a shaft member 132 provided in proximity to the center point of the sector in a laterally rotatable manner. That is, the marker 13 also has the shape of a sector (or a circle), and a center angle θ of the sector-shaped marker 13 can be adjusted to an arbitrary angle by rotating some or all of the sector-shaped plates 131a to 131c laterally as shown in FIG. 2(c) and (d).

For example, as shown in FIG. 3(a), if the marker 13 is provided in a place in which the wall surface corner has an acute angle (of X degrees, for example, where $0 \leq X < 90$), the sector-shaped plate members 131 are rotated laterally, and the marker 13 is deformed to have the center angle θ of $(360 - X)$ degrees.

Further, as shown in FIG. 3(b), if the marker 13 is provided in a place in which the wall surface corner has a right angle, the sector-shaped plate members 131 are rotated laterally, and the marker 13 is deformed to have the center angle θ of 270 degrees.

Still further, as shown in FIG. 3(c), if the marker 13 is provided in a place in which the wall surface corner has an obtuse angle (of Y degrees, for example, where $90 < Y < 180$), the sector-shaped plate members 131 are rotated laterally, and the marker 13 is deformed to have the center angle θ of $(360 - Y)$ degrees.

The plate members 131a to 131c, which constitute the marker 13, are painted in a specific color. The

specific color is a fluorescent color, for example, and should preferably be a color which is generally less likely to be used as the color of a floor surface and a wall surface.

5 In FIG. 2, the plate members 131a to 131c are connected to (integrated with) each other by the shaft member 132 provided in proximity to the center point of the sector in a laterally rotatable manner, but for example, the plate members 131a to 131c may be
10 connected to each other in a laterally rotatable manner by providing a concave recess in proximity to the center point on the upper surface of each of the plate members 131a to 131c and providing a convex projection in proximity to the center point (in a location opposed
15 to the concave recess) on the lower surface of each of the plate members 131a to 131c. Alternatively, the plate members 131a to 131c may be connected to each other in a laterally rotatable manner by providing a convex projection in proximity to the center point on
20 the upper surface of each of the plate members 131a to 131c and providing a concave recess in proximity to the center point (in a location opposed to the convex projection) on the lower surface of each of the plate members 131a to 131c.

25 Further, the marker 13 does not necessarily have the shape shown in FIG. 2 but may have the following shapes, for example.

 As shown in FIG. 4(a) and (b), the marker 13 may be formed of the sector-shaped plate members 131 which
30 are stacked on top of each other in a laterally rotatable manner, and unlike the shape of shown in FIG. 2, each of the plate members 131 may have stopper members 133 projecting upward or downward from the side portions r1 and r2. The stopper member 133 provided in
35 a predetermined plate member 131 contacts the stopper

member 133 provided in the opposed plate member 131 when the predetermined plate member 131 is rotated laterally as shown in FIG. 4(c).

5 As shown in FIG. 5(a) and (b), the marker 13 may be formed of the sector-shaped plate members 131 which are stacked on top of each other in a laterally rotatable manner, and unlike the shapes shown in FIGS. 2 and 4, each of the plate members 131 may have projections 134 on the upper surface or lower surface
10 of the sector. The projection 134 provided in a predetermined plate member 131 contacts the projection 134 provided in the opposed plate member 131 when the predetermined plate member 131 is rotated laterally as shown in FIG. 5(c).

15 As shown in FIG. 6(a) and (b), the marker 13 may be formed of the sector-shaped plate members 131 which are stacked on top of each other in a laterally rotatable manner, and unlike the shapes shown in FIGS. 2, 4 and 5, each of the plate members 131 may
20 have a projection 135 provided on the upper surface or lower surface of the sector and a sliding groove 136 provided along the arc of the sector and engaged with the projection 135. The projection 135 provided in a predetermined plate member 131 moves in the sliding
25 groove 136 provided in the opposed plate member 131 and contacts the opposed plate member 131 at the end of the sliding groove 136 when the predetermined plate member 131 is rotated laterally as shown in FIG. 6(c).

The marker 13 may be formed of the sector-shaped
30 plate members 131 which are integrally formed with each other in a bellows-like manner as shown in FIG. 7.

The markers 13 having the shapes shown in FIGS. 4 to 7 have the following advantage. The advantage will be described below based on comparisons between the
35 shape shown in FIG. 2 and the shape shown in FIG. 4

with reference to FIG. 8.

If the marker 13 has the shape shown in FIG. 2 and when the plate members 131 are rotated laterally, a gap (space) such as that shown in FIG. 8(a) may be formed
5 in some cases. Accordingly, the accuracy of edge detection processing of the marker 13 which will be described later may be degraded. On the other hand, as compared to the marker 13 having the shape shown in FIG. 2, the marker 13 having the shape shown in FIG. 4
10 is inferior in compactness (portability), but when the plate members 131 are rotated laterally, the stopper members 133 contact the corresponding stopper members 133, respectively, as shown in FIG. 8(b), and consequently the above-described gap will be less
15 likely to be formed. Accordingly, the edge detection processing of the marker 13 which will be described later can be performed more accurately as compared to a case where the gap is formed.

Note that, although the marker 13 having the shape shown in FIG. 4 has been described as a representative
20 example, the markers 13 having the shapes shown in FIGS. 5 to 7 also have the same advantage.

Further, although the marker 13 is formed of the sector-shaped plate members 131 in the present
25 embodiment, the marker 13 is not limited to this but may be formed of a plurality of triangular plate members.

Now, the description returns to FIG. 1. The image processing device 12 includes a storage 121, a detector
30 122, a marker detector 123, a marker edge detector 124, an area setting module 125, an area setting information storage 126, etc.

The storage 121 stores images captured by the camera 11 and has a buffer area for temporarily storing
35 data necessary for the processing of the detector 122.

The detector 122 detects a person, an object, etc., within a detection area based on a change in brightness within the detection area in the captured image.

5 The marker detector 123 detects (extracts) the marker 13 provided for performing a detection area setting (calibration) as an initial setting on the spot. In the present embodiment, since the marker 13 is assumed to be painted in a specific color such as a fluorescent color, the marker detector 123 detects the
10 marker 13 from an image by extracting an area having a color phase and a color saturation corresponding to the specific color.

 In the present embodiment, since the marker 13 is assumed to have the shape of a sector, the marker
15 detector 123 may detect the marker 13 by extracting a shape close to a circle from an image by using a well-known separable filter, etc.

 Further, if the marker 13 is painted in a predetermined pattern, the marker detector 123 may
20 detect the marker 13 by extracting the predetermined pattern by using a well-known pattern matching method, etc.

 The marker edge detector 124 detects edges corresponding to the side portions r1 and r2 of the
25 marker 13 detected by the marker detector 123. More specifically, the marker edge detector 124 firstly extracts contour edge components of the marker 13 detected by the marker detector 123 by the Sobel edge detection, etc. Subsequently, the marker edge detector
30 124 applies, for example, the Hough transform to the extracted contour edge components, extracts only line components from the extracted contour edge components, and detects edges corresponding to the side portions r1 and r2 of the marker 13.

35 Further, when detecting two edges corresponding to

the side portions r1 and r2 of the marker 13, the marker edge detector 124 detects the intersection point of the detected two edges, as a wall surface corner in which the marker 13 is provided (in other words, as the center point of the sector-shaped marker 13).

The area setting module 125 sets an area including the edges corresponding to the side portions r1 and r2 of the marker 13 detected by the marker edge detector 124, as a detection area. More specifically, the area setting module 125 sets an area defined by extended lines from the edges corresponding to the side portions of the marker 13 detected by the marker edge detector 124, as a detection area.

The area setting information storage 126 stores area setting information indicative of the detection area set by the area setting module 125.

Next, an example of the procedure of the detection area setting processing by the image processing device 12 having the above-described structure will be described with reference to the flowchart shown in FIG. 9.

Firstly, the image processing device 12 acquires an image captured in a condition in which the marker 13 is provided (hereinafter referred to as an initial setting image) from the camera 11 (step S1). Here, it is assumed that an initial setting image shown in FIG. 10 is acquired from the camera 11.

Subsequently, the marker detector 123 in the image processing device 12 detects the marker 13 in the initial setting image (step S2). In this case, three markers 13a to 13c are detected from the initial setting image shown in FIG. 10.

As described above, the marker 13 may be detected by extracting an area having a color phase and a color saturation corresponding to the color of the marker 13

from the initial setting image or may be detected by extracting a shape close to a circular from the initial setting image.

Then, the marker edge detector 124 in the image
5 processing device 12 detects contour edge components of the markers 13a to 13c detected by the marker detector 123 (step S3). In this case, as shown in FIG. 11, edges ea_1 to ea_3 are detected from the marker 13a, edges eb_1 to eb_3 are detected from the marker 13b, and
10 edges ec_1 to ec_3 are detected from the marker 13c.

Subsequently, the marker edge detector 124 extracts only line components from the detected contour edge components, and detects edges corresponding to the side portions $r1$ and $r2$ of the marker 13 (step S4). In
15 this case, as shown in FIG. 12, the edges ea_1 and ea_2 are detected from the marker 13a as the edges corresponding to the side portions, the edges eb_1 and eb_2 are detected from the marker 13b as the edges corresponding to the side portions, and the edges ec_1
20 and ec_2 are detected from the marker 13c as the edges corresponding to the side portions.

Subsequently, the marker edge detector 124 detects the intersection point of the extracted edges corresponding to the side portions $r1$ and $r2$, as a wall
25 surface corner (step S5). In this case, as shown in FIG. 12, the intersection point of the edges ea_1 and ea_2 corresponding to the marker 13a is detected as a wall surface corner $C1$, the intersection point of the edges eb_1 and eb_2 corresponding to the marker 13b is
30 detected as a wall surface corner $C2$, and the intersection point of the edges ec_1 and ec_2 corresponding to the marker 13c is detected as a wall surface corner $C3$.

Next, the area setting module 125 sets a detection area based on the edges corresponding to the side portions r1 and r2 of the marker 13 detected by the marker edge detector 124 and the wall surface corner detected by the marker edge detector 124 (step S6).

In this case, as shown in FIG. 13, an area defined by extended lines ea₁' and ea₂' from the edges ea₁ and ea₂ corresponding to the side portions of the marker 13a in directions opposite to the wall surface corner C1, extended lines eb₁' and eb₂' from the edges eb₁ and eb₂ corresponding to the side portions of the marker 13b in directions opposite to the wall surface corner C2, and extended lines ec₁' and ec₂' from the edges ec₁ and ec₂ corresponding to the side portions of the marker 13c in directions opposite to the wall surface corner C3, is set as a detection area E1.

Subsequently, the area setting module 125 stores area setting information indicative of the set detection area in the setting information storage 126 (step S7), and the processing here ends.

According to the first embodiment, it is possible to realize the detection area setting processing using the marker 13 by providing the marker detector 123, the marker edge detector 124 and the area setting module 125. Since the center angle θ to an arbitrary angle in the marker 13, the marker 13 can designate a direction of setting a detection area. That is, it is possible to reduce the number of markers, as compared to the general method of setting a detection area by recognizing each marker as a point and connecting recognized points to each other.

In the present embodiment, the marker 13 is painted in a single color such as a fluorescent color, but the following trouble may develop in this case.

FIGS. 14 and 15 show contour edge component detection results in a case where the marker 13a painted in the first color (shown on the left side) and the marker 13b painted in the second color different from the first color (shown on the right side) are provided on floor surfaces F1 and F2 having various colors along a wall surface W having various colors.

For convenience of explanation, instead of describing all the illustrations of FIGS. 14 and 15, only some of the illustrations will be described as representative examples.

If all the wall surface W and the floor surfaces F1 and F2 have colors different from the first and second colors as shown in the left side illustration in FIG. 14(a), the marker edge detector 124 can detect the contour edge components of the markers 13a and 13b painted in the first and second colors accurately (sensitively).

On the other hand, if the wall surface W has the first color and the floor surfaces F1 and F2 have a color different from the first and second colors as shown in the center illustration in FIG. 14(a), the marker edge detector 124 can detect the contour edge components of the marker 13b painted in the second color accurately, but cannot detect the contour edge components of the marker 13a painted in the first color accurately because the color of the wall surface W is the same as the color of the marker 13a. More specifically, the edges corresponding to the side portions r1 and r2 of the marker 13a cannot be detected accurately.

In the case of the center illustration in FIG. 14(a), since the marker edge detector 124 can detect the edge corresponding to the arc of the marker 13a, the edges corresponding to the side portions r1

and r2 can be predicted and detected to some extent based on the edge corresponding to the arc.

However, if all the wall surface W and the floor surfaces F1 and F2 have the first color as shown in the center illustration in FIG. 15(a), the marker edge detector 124 cannot detect the contour edge components of the marker 13a painted in the first color (at all or accurately), and unlike the case of the center illustration in FIG. 14(a), the marker edge detector 124 cannot predict or detect the edges.

Accordingly, the area setting module 125 cannot set a detection area or may set a detection area to a wrong place.

To solve this problem, the marker 13 should not be painted in a single color but should be painted in multiple colors.

FIGS. 16 and 17 show contour edge component detection results in a case where the marker 13a (shown on the left side) having an inner circle painted in the first color and an outer circle painted in the second color, and the marker 13b (shown on the right side) having an inner circle painted in the second color and an outer circle painted in the first color are provided on floor surfaces F1 and F2 having various colors along the wall surface W having various colors.

If the markers 13a and 13b are painted in multiple colors as shown in the illustrations shown in FIGS. 16 and 17, the contour edge components of the markers 13a and 13b can be detected accurately in all cases.

For example, even in the center illustration in FIG. 17(a) under the same condition of the wall surface W and the floor surfaces F1 and F2 as that of the center illustration in FIG. 15(a), the marker edge detector 124 can detect the contour edge components of the marker 13a accurately by the inner circle portion

painted in the second color.

In this way, it is possible to realize the contour edge component detection of the marker edge detector 124 accurately and solve the above-described trouble by painting the marker 13 in multiple colors.

Although the marker 13 is assumed to be painted in multiple colors, the marker 13 may be painted in colors similar to each other but different from each other in brightness (lightness).

The various functions realized by the image processing system according to the present embodiment may be applied to an elevator system shown in FIG. 18, for example. An elevator system adopting the functions realized by the image processing system will be described below.

FIG. 18 shows an elevator (car) 20, a car door 21, a hall door 22 and an elevator control device 23 which controls opening and closing of the car door 21.

Recently, various techniques for preventing a person or object from being stuck in the car door 21 of the elevator 20 have been developed, and one example is the elevator system shown in FIG. 18. This elevator system captures an image of the vicinity of the car door 21 by the camera 11, and controls opening and closing of the car door 21 based on the presence or absence of (a movement of) a passenger within a detection area set in proximity to the car door 21. For example, if a passenger is in the detection area, the elevator system stops closing the car door 21 and maintains the car door 21 to be opened, etc.

In the elevator system, a detection area needs to be set to each floor on which the car 20 stops, and if a three-sided frame provided around the hall door 22 has a complicated shape, a maintenance worker sets a detection area by displaying an initial setting image

on a terminal device such as a tablet computer and manually designating an area as a detection area. This is troublesome because a maintenance worker needs to carry a terminal device such as a tablet computer and manually designate a detection area.

However, if the functions realized by the above-described image processing system, in particular, the marker detector 123, the marker edge detector 124 and the area setting module 125 are provided in the image processing device 12, the detection area can be set by the marker 13, and the above-described problem can be solved.

The image processing device 12 shown in FIG. 18 may have the function of detecting a passenger closest to the car door 21 based on a change in the brightness of an image and determining whether the detected passenger has an intention of getting into the car 20 or not based on whether the detected passenger is approaching the car door 21 or not, as a function unique to the elevator system. Further, the image processing device 12 may also have the function of stopping closing the car door 21 and maintaining the car door 21 to be opened if the passenger is determined to have an intention of getting into the car 20.

<Second Embodiment>

Next, the second embodiment will be described. The second embodiment differs from the first embodiment in that the image processing device 12 further includes a marker designation direction determination module 127 as shown in FIG. 19. The same functional elements as those of the first embodiment will be denoted by the same reference numbers, and detailed description thereof will be omitted.

Further, the present embodiment does not assume the case of using the marker 13 painted in a single

color shown in FIGS. 14 and 15, but assumes the case of using the marker 13 having the inner circle and outer circle painted in the first and second colors shown in FIGS. 16 and 17.

5 The marker designation direction determination module 127 defines a place to be set as a detection area based on the color of the inner circle (or the color of the outer circle) of the marker 13. More specifically, based on whether the inner circle of the
10 marker 13 has the first color or not, the marker designation direction determination module 127 determines whether the place to be set as a detection area is located on a side on which the edge corresponding to the arc of the marker 13 has been
15 detected or not when the edges corresponding to the side portions r1 and r2 of the marker 13 are considered as a border.

 In the present embodiment, if the inner circle of the marker 13 has the first color, the marker
20 designation direction determination module 127 determines that the place to be set as a detection area is on a side on which the edge corresponding to the arc of the marker 13 is detected as shown in FIG. 20(a), and if the inner circle of the marker 13 does not have
25 the first color (has the second color), the marker designation direction determination module 127 determines that the place to be set as a detection area is on a side on which the edge corresponding to the arc of the marker 13 is not detected as shown in
30 FIG. 20(b). This is presented by way of example only, and the place to be set as a detection area may be on a side on which the edge corresponding to the arc of the marker 13 is not detected if the inner circle of the marker 13 has the first color, and the place to be set
35 as a detection area may be on a side on which the edge

corresponding to the arc of the marker 13 is detected if the inner circle of the marker 13 does not have the first color.

5 Here, an example of the procedure of the detection area setting processing by the image processing device 12 according to the second embodiment will be described with reference to the flowchart shown in FIG. 21. The same processing as that of the flowchart shown in FIG. 9 will be denoted by the same reference symbols,
10 and detailed description thereof will be omitted.

After the execution of the processing in steps S1 to S5, the marker designation direction determination module 127 determines whether the inner circle of the marker 13 has the first color or not (step S11).

15 As a result of the processing in step S11, if the inner circle of the marker 13 has the first color (yes in step S11), the marker designation direction determination module 127 determines that the place to be set as a detection area is on a side on which the
20 edge corresponding to the arc of the marker 13 is detected, notifies a determination result to the area setting module 125 (step S12), and proceeds to processing in step S14 which will be described later.

On the other hand, as a result of the processing
25 in step S11, if the inner circle of the marker 13 does not have the first color (no in step S11), the marker designation direction determination module 127 determines that the place to be set as a detection area is on a side on which the edge corresponding to the arc
30 of the marker 13 is not detected, and notifies a determination result to the area setting module 125 (step S13).

Subsequently, the area setting module 125 sets a detection area based on the edges corresponding to the
35 side portions r1 and r2 of the marker 13 detected by

the marker edge detector 124, the wall surface corner detected by the marker edge detector 124, and the place (side) to be set as a detection area determined by the marker designation direction determination module 127 (step S14).

After that, the above-described processing in step S7 is executed, and the processing here ends.

Although the marker designation direction determination module 127 defines a place to be set as a detection area in the present embodiment, the marker designation direction determination module 127 may define a place which is not set as a detection area, that is, a place to be excluded from a detection area instead.

According to the second embodiment, since the marker designation direction determination module 127 is further provided, a hollow area can be set as a detection area as shown in FIG. 20(b). Further, detection areas can be set to a floor surface and a hollow area at once, that is, detection areas can be set to various places at once by using the marker 13 having the inner circle painted in the first color and the marker 13 having the inner circle painted in the second color in combination.

According to at least one of the above-described embodiments, an image processing system and a marker which can set a detection area having a complicated shape accurately can be provided.

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 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 of the inventions.

WHAT IS CLAIMED IS:

1. An image processing system comprising:
an imaging module configured to capture an image
of a target including one or more markers, the one or
5 more markers being used for setting a detection area in
which a movement of a person or an object is
detectable;

a first detector configured to detect the one or
more markers from the image captured by the imaging
10 module, each of the one or more markers being laterally
rotatable around a rotation supporting point and having
two sides extending from the rotation supporting point;
an area setting module configured to set an area
including the two sides constituting each of the one or
15 more markers detected by the marker detector, as a
detection area; and

a second detector configured to detect a movement
of a person or an object within the detection area set
by the area setting module.

20 2. The image processing system of Claim 1,
wherein the marker has a shape of a sector, the sector
having the two sides as side portions and the rotation
supporting point as a center point.

3. The image processing system of Claim 2,
25 wherein the first detector detects contour edge
components of the detected marker, detects two line
edge components corresponding to the side portions from
the detected contour edge components, and detects an
intersection point of the detected two line edge
30 components as the center point.

4. The image processing system of Claim 3,
wherein the area setting module extends the detected
two line edge components in directions opposite to a
location in which the center point is detected, and
35 sets an area defined by the extended lines, as the

detection area.

5 5. The image processing system of Claim 3,
wherein the marker has an inner circle portion centered
on the center point and painted in a first color, and
an outer circle portion centered on the center point
and painted in a second color different from the first
color.

10 6. The image processing system of Claim 5,
further comprising a marker designation direction
determination module configured to designate an area to
be set as the detection area based on a color of the
inner circle portion of the marker.

15 7. The image processing system of Claim 6,
wherein
if the inner circle portion of the marker has the
first color, the marker designation direction
determination module determines that the area to be set
as the detection area is on a side on which the edge
component corresponding to an arc among the detected
20 contour edge components is located when the detected
two line edge components are considered as a border
line, and

if the inner circle portion of the marker has the
second color, the marker designation direction
25 determination module determines that the area to be set
as the detection area is on a side on which the edge
component corresponding to an arc among the detected
contour edge components is not located when the
detected two line edge components are considered as a
30 border line.

8. A marker used for setting a detection area for
detecting a movement of a person or an object, the
marker comprising:

35 a plurality of plate members having a shape of a
sector; and

a shaft member provided in proximity to center points of the plate members, wherein

the plate members are connected to each other in a laterally rotatable manner by the shaft member, and

5 a center angle of a sector formed of the plate members is adjustable to an arbitrary angle by rotating some or all of the plate members laterally.

9. The marker of Claim 8, further comprising stopper members projecting upward or downward from side portions of each of the plate members, wherein

10 the stopper member contacts the stopper member provided in the opposed plate member when the plate members are rotated laterally.

10. The marker of Claim 8, further comprising a convex projection projecting from an upper surface or a lower surface of each of the plate members, wherein

the projection contacts the projection provided in the opposed plate member when the plate members are rotated laterally.

20 11. The marker of Claim 8, further comprising: a projection provided on an upper surface or a lower surface of each of the plate members; and

a sliding groove provided along an arc of the sector of each of the plate members and engaged with the projection, wherein

25 the projection moves in the sliding groove provided in the opposed plate member and contacts the opposed plate member at an end of the sliding groove when the plate members are rotated laterally.

30 12. The marker of Claim 8, wherein the plate members are integrally formed with each other in a bellows-like manner.