US012387529B2

(12) **United States Patent**
Saito

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(45) **Date of Patent: Aug. 12, 2025**

(54) IMAGE PROCESSING APPARATUS, METHOD, AND STORAGE MEDIUM FOR DETECTING ACTION OF A PERSON IN VIDEO IMAGES BASED ON AN OPTIMAL DIRECTION FOR DETECTING A MOTION IN PREDICTED ACTIONS OF A PERSON

(71) Applicant: **CANON KABUSHIKI KAISHA**, Tokyo (JP)

(72) Inventor: **Sho Saito**, Saitama (JP)

(73) Assignee: **CANON KABUSHIKI KAISHA**, Tokyo (JP)

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(21) Appl. No.: **18/312,668**

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(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

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(51) **Int. Cl.**

G06V 20/52	(2022.01)
G06T 7/70	(2017.01)
G06V 10/94	(2022.01)
G06V 40/20	(2022.01)

(52) **U.S. Cl.**

CPC ***G06V 40/20*** (2022.01); ***G06T 7/70*** (2017.01); ***G06V 10/94*** (2022.01); *G06T 2207/20076* (2013.01); *G06T 2207/30196* (2013.01); *G06T 2207/30244* (2013.01)

(58) **Field of Classification Search**

CPC H04N 5/247; G06V 20/52

See application file for complete search history.

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Primary Examiner — Frank Johnson

(74) *Attorney, Agent, or Firm* — Cowan, Liebowitz & Latman, P.C.

(57) **ABSTRACT**

An image processing apparatus according to one aspect of the present invention predicts the next action of a person who has been detected from an image captured by an image capturing apparatus, and selects an optimal image capturing apparatus for detecting the action of the person from among the plurality of image capturing apparatuses based on the predicted action.

20 Claims, 19 Drawing Sheets

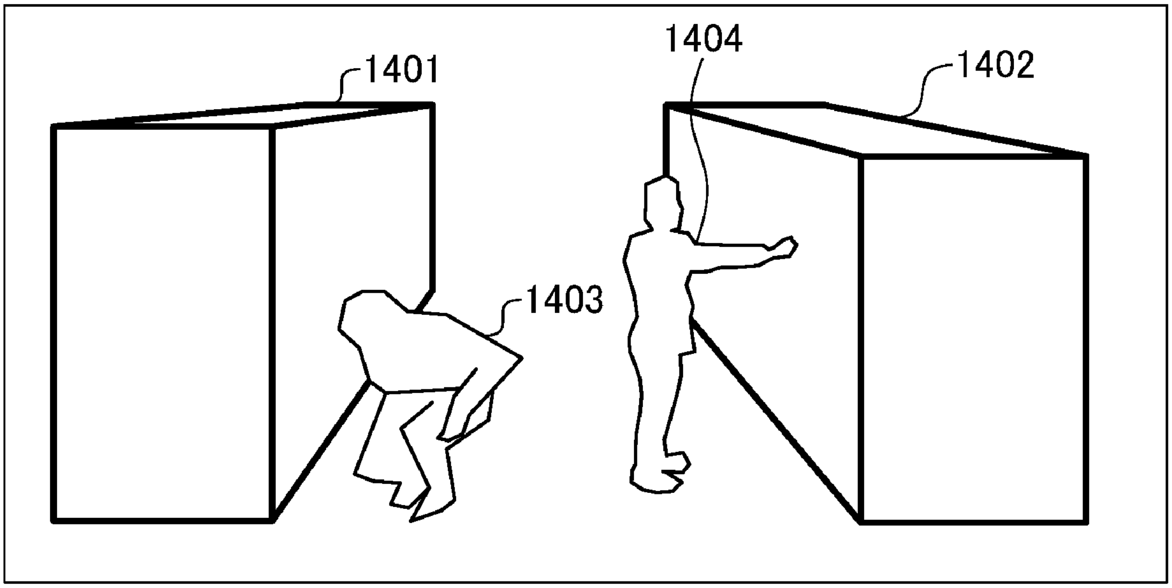

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FIG. 1

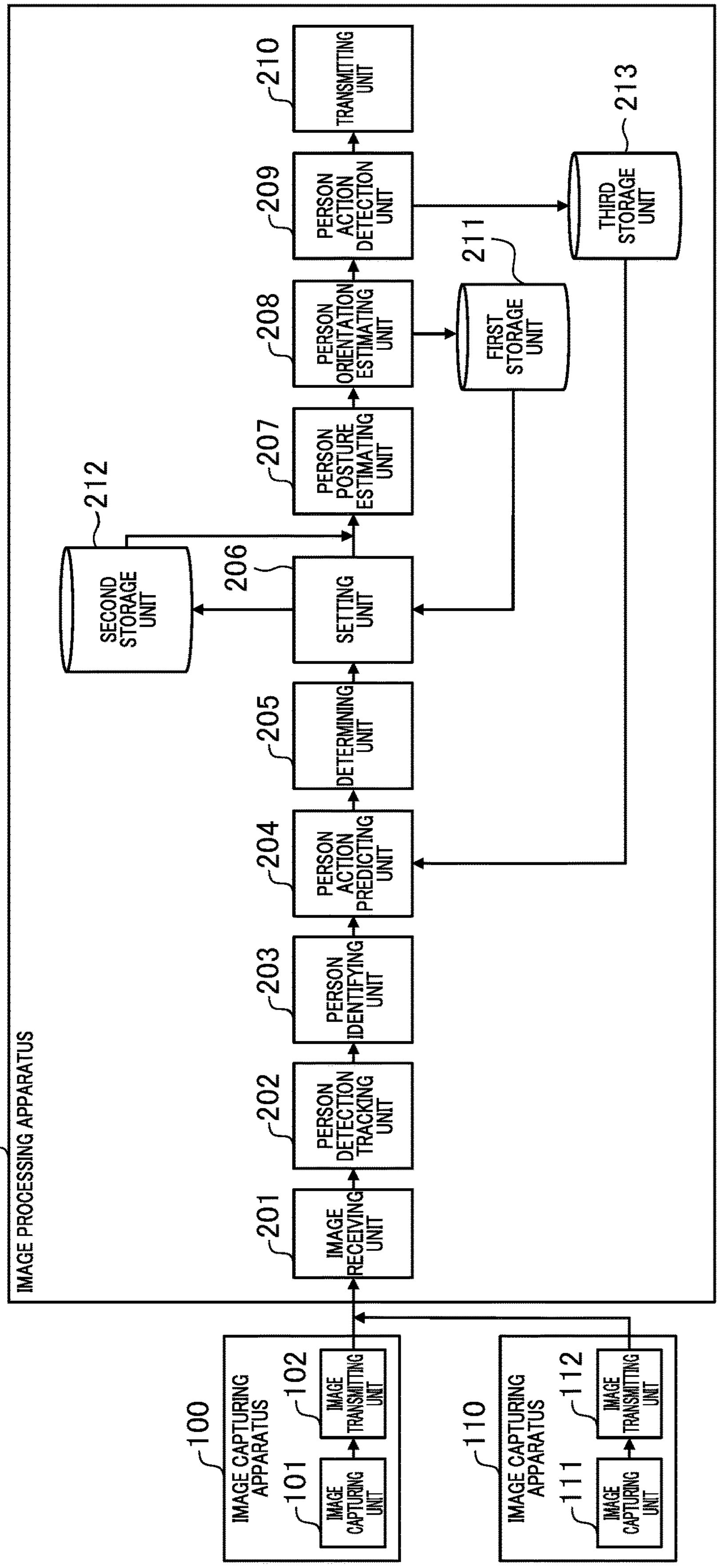
100
IMAGE CAPTURING APPARATUS
101
IMAGE CAPTURING UNIT
102
IMAGE TRANSMITTING UNIT
110
IMAGE CAPTURING APPARATUS
111
IMAGE CAPTURING UNIT
112
IMAGE TRANSMITTING UNIT
200
IMAGE PROCESSING APPARATUS
201
IMAGE RECEIVING UNIT
202
PERSON DETECTION TRACKING UNIT
203
PERSON IDENTIFYING UNIT
204
PERSON ACTION PREDICTING UNIT
205
DETERMINING UNIT
206
SETTING UNIT
212
SECOND STORAGE UNIT
207
PERSON POSTURE ESTIMATING UNIT
208
PERSON ORIENTATION ESTIMATING UNIT
211
FIRST STORAGE UNIT
209
PERSON ACTION DETECTION UNIT
213
THIRD STORAGE UNIT
210
TRANSMITTING UNIT

FIG. 2

TRACKING ID	TRACKING RECTANGLE CENTRAL COORDINATES (X)	TRACKING RECTANGLE CENTRAL COORDINATES (Y)	TRACKING RECTANGLE SIZE (WIDTH)	TRACKING RECTANGLE SIZE (HEIGHT)
...				
100	100	50	30	30
101	300	200	50	60
102	500	400	60	70
103	520	430	70	80
...				

FIG. 3A

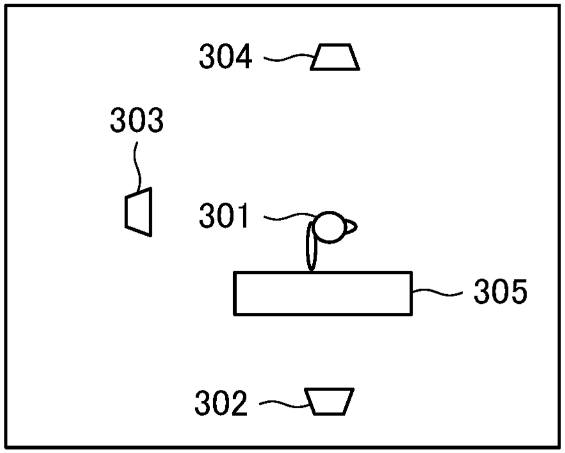

FIG. 3B

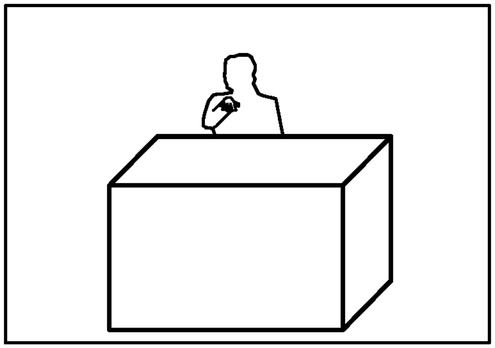

FIG. 3C

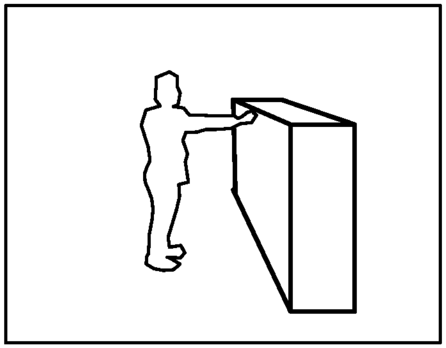

FIG. 3D

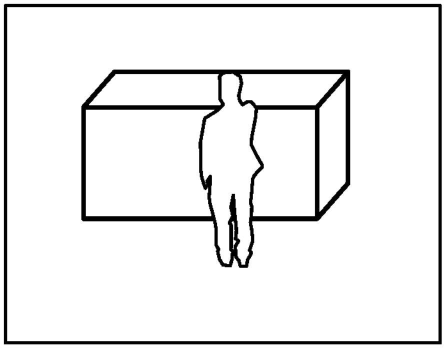

FIG. 4A

DETECTION CANDIDATE ACTION	IDEAL PERSON ORIENTATION	PROBABILITY OF OCCURRENCE (%)
...		
CHECKING SURROUNDINGS ACTION	FRONT	40
REACHING OUT A HAND	SIDE	30
CROUCHING DOWN	SIDE	20
...		

FIG. 4B

IDEAL PERSON ORIENTATION	PROBABILITY OF OCCURRENCE (%)
...	
FRONT	40
SIDE	50
...	

FIG. 5

TRACKING ID	PERSON BODY DETECTION LIKELIHOOD	NOSE COORDINATES (X)	NOSE COORDINATES (Y)	NOSE DETECTION LIKELIHOOD	LEFT EYE COORDINATES (X)	…
			…			
100	0.8	115	55	0.7	120	…
101	0.7	225	210	0.6	235	…
102	0.5	530	420	0.4	545	…
103	0.7	535	450	0.6	550	…
			…			

FIG. 6A

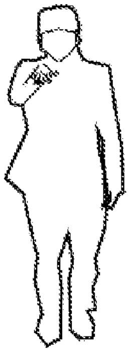

FIG. 6B

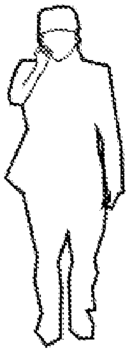

FIG. 6E

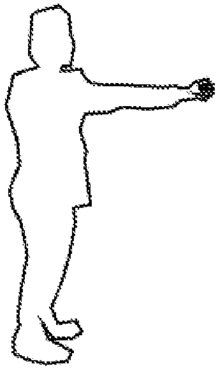

FIG. 6F

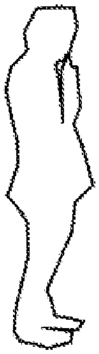

FIG. 6C

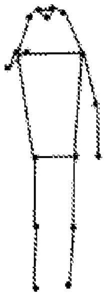

FIG. 6D

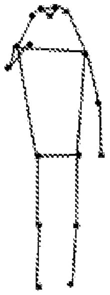

FIG. 6G

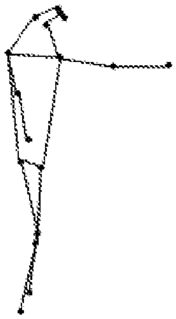

FIG. 6H

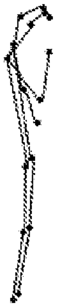

FIG. 6I

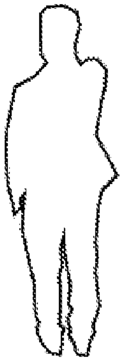

FIG. 6J

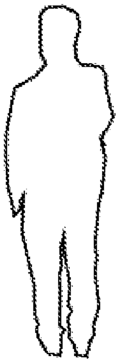

FIG. 6K

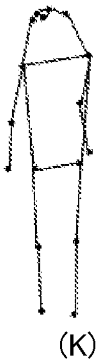

FIG. 6L

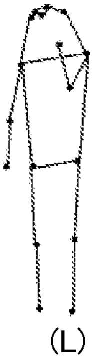

FIG. 6M

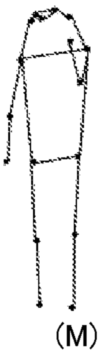

FIG. 7

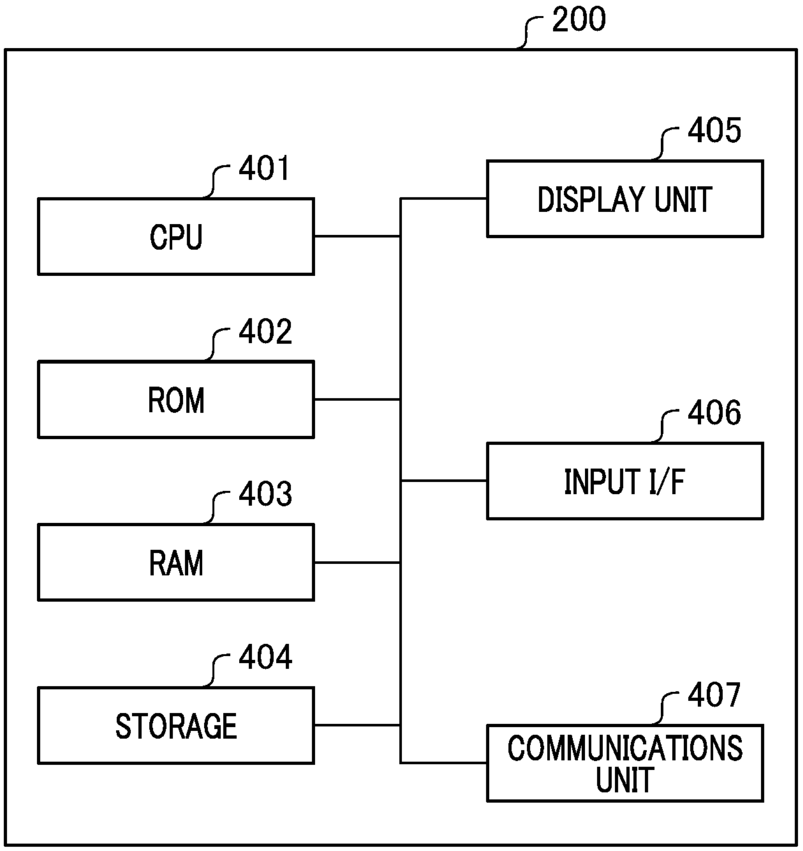
200
401
CPU
402
ROM
403
RAM
404
STORAGE
405
DISPLAY UNIT
406
INPUT I/F
407
COMMUNICATIONS UNIT

FIG. 8

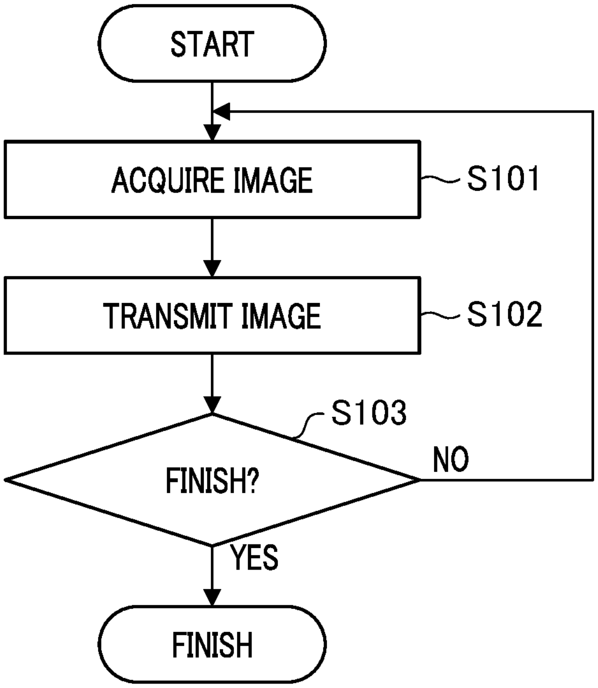
START
ACQUIRE IMAGE
S101
TRANSMIT IMAGE
S102
S103
FINISH?
NO
YES
FINISH

FIG. 9

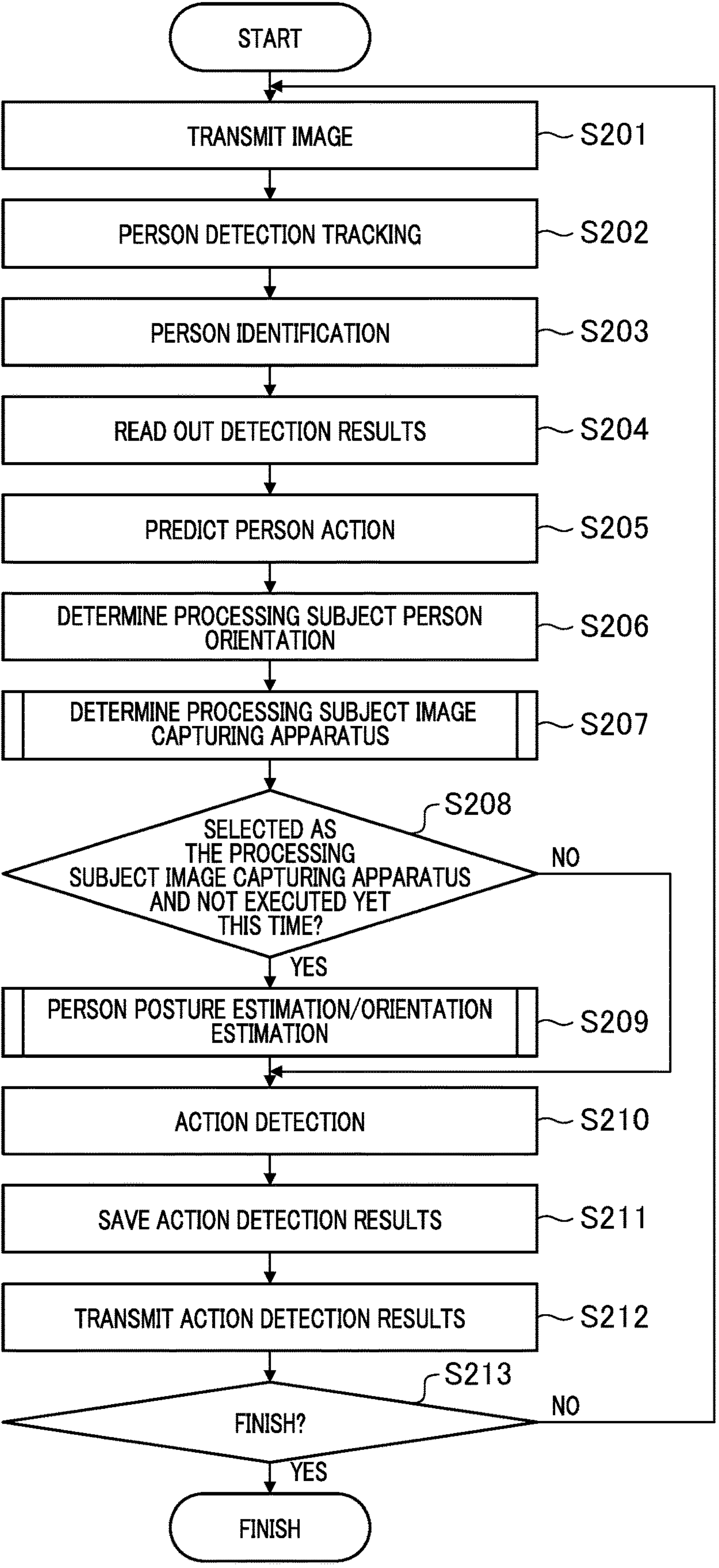
START
TRANSMIT IMAGE
S201
PERSON DETECTION TRACKING
S202
PERSON IDENTIFICATION
S203
READ OUT DETECTION RESULTS
S204
PREDICT PERSON ACTION
S205
DETERMINE PROCESSING SUBJECT PERSON ORIENTATION
S206
DETERMINE PROCESSING SUBJECT IMAGE CAPTURING APPARATUS
S207
S208
SELECTED AS THE PROCESSING SUBJECT IMAGE CAPTURING APPARATUS AND NOT EXECUTED YET THIS TIME?
NO
YES
PERSON POSTURE ESTIMATION/ORIENTATION ESTIMATION
S209
ACTION DETECTION
S210
SAVE ACTION DETECTION RESULTS
S211
TRANSMIT ACTION DETECTION RESULTS
S212
S213
FINISH?
NO
YES
FINISH

FIG. 10

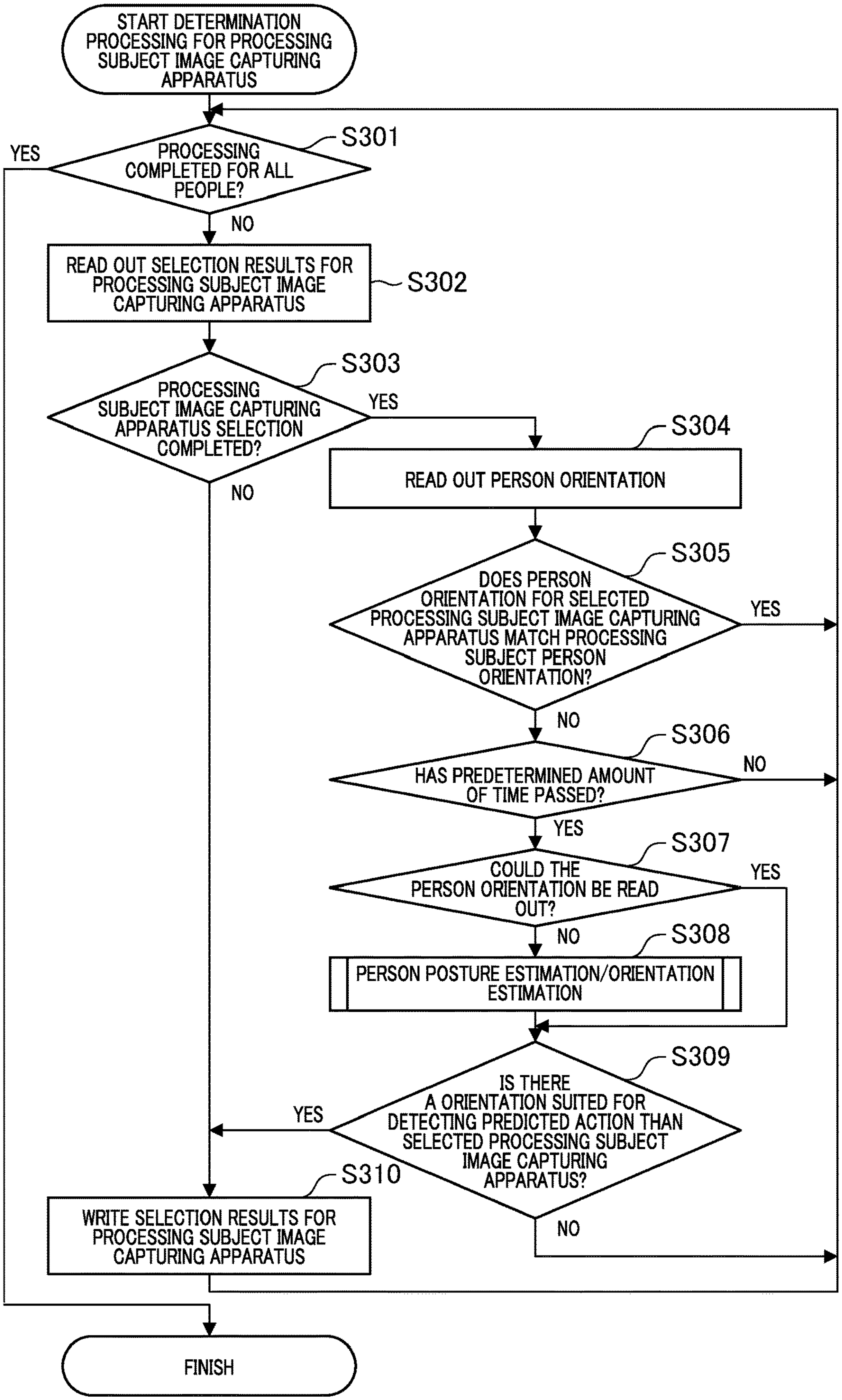
START DETERMINATION PROCESSING FOR PROCESSING SUBJECT IMAGE CAPTURING APPARATUS
S301
PROCESSING COMPLETED FOR ALL PEOPLE?
YES
NO
S302
READ OUT SELECTION RESULTS FOR PROCESSING SUBJECT IMAGE CAPTURING APPARATUS
S303
PROCESSING SUBJECT IMAGE CAPTURING APPARATUS SELECTION COMPLETED?
YES
NO
S304
READ OUT PERSON ORIENTATION
S305
DOES PERSON ORIENTATION FOR SELECTED PROCESSING SUBJECT IMAGE CAPTURING APPARATUS MATCH PROCESSING SUBJECT PERSON ORIENTATION?
YES
NO
S306
HAS PREDETERMINED AMOUNT OF TIME PASSED?
NO
YES
S307
COULD THE PERSON ORIENTATION BE READ OUT?
YES
NO
S308
PERSON POSTURE ESTIMATION/ORIENTATION ESTIMATION
S309
IS THERE A ORIENTATION SUITED FOR DETECTING PREDICTED ACTION THAN SELECTED PROCESSING SUBJECT IMAGE CAPTURING APPARATUS?
YES
NO
S310
WRITE SELECTION RESULTS FOR PROCESSING SUBJECT IMAGE CAPTURING APPARATUS
FINISH

FIG. 11

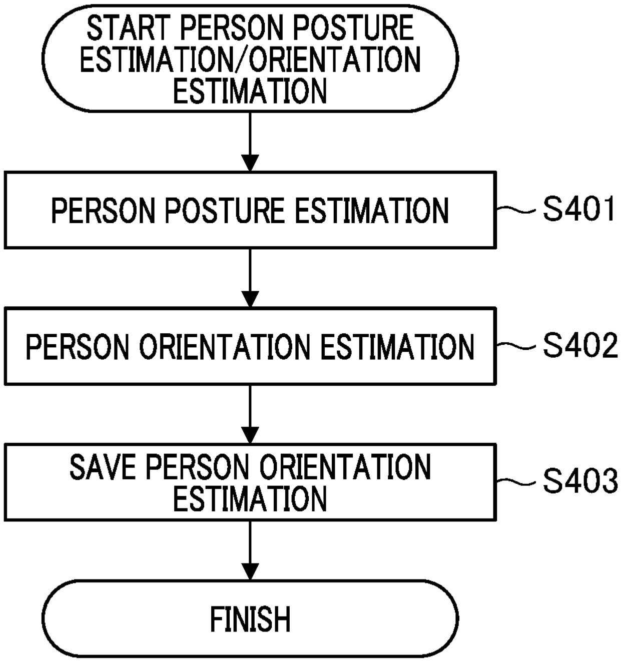
START PERSON POSTURE ESTIMATION/ORIENTATION ESTIMATION
PERSON POSTURE ESTIMATION
S401
PERSON ORIENTATION ESTIMATION
S402
SAVE PERSON ORIENTATION ESTIMATION
S403
FINISH

FIG. 12

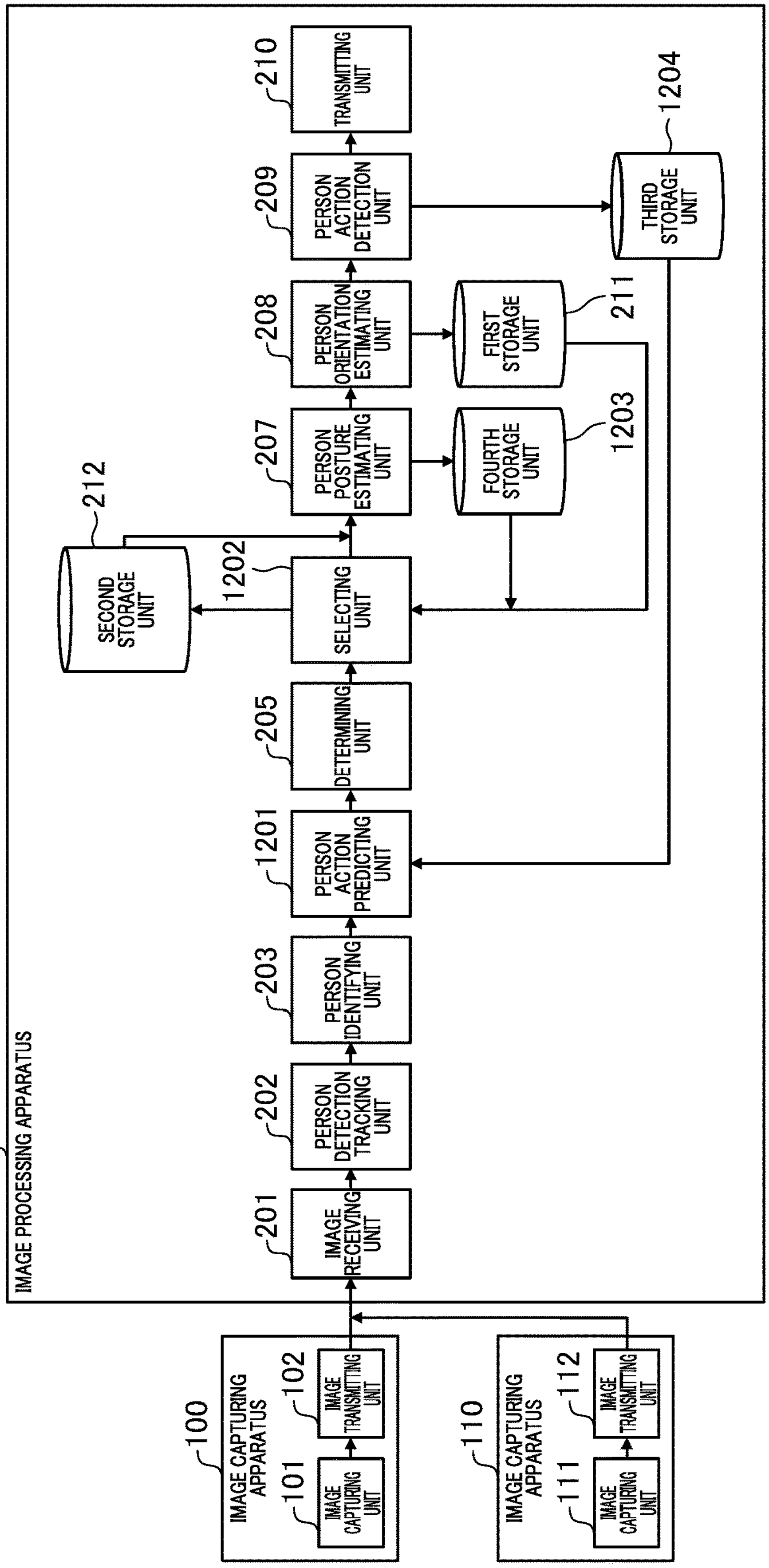
100
IMAGE CAPTURING APPARATUS
101
IMAGE CAPTURING UNIT
102
IMAGE TRANSMITTING UNIT
110
IMAGE CAPTURING APPARATUS
111
IMAGE CAPTURING UNIT
112
IMAGE TRANSMITTING UNIT
200
IMAGE PROCESSING APPARATUS
201
IMAGE RECEIVING UNIT
202
PERSON DETECTION TRACKING UNIT
203
PERSON IDENTIFYING UNIT
1201
PERSON ACTION PREDICTING UNIT
205
DETERMINING UNIT
1202
SELECTING UNIT
212
SECOND STORAGE UNIT
207
PERSON POSTURE ESTIMATING UNIT
1203
FOURTH STORAGE UNIT
208
PERSON ORIENTATION ESTIMATING UNIT
211
FIRST STORAGE UNIT
209
PERSON ACTION DETECTION UNIT
1204
THIRD STORAGE UNIT
210
TRANSMITTING UNIT

FIG. 13

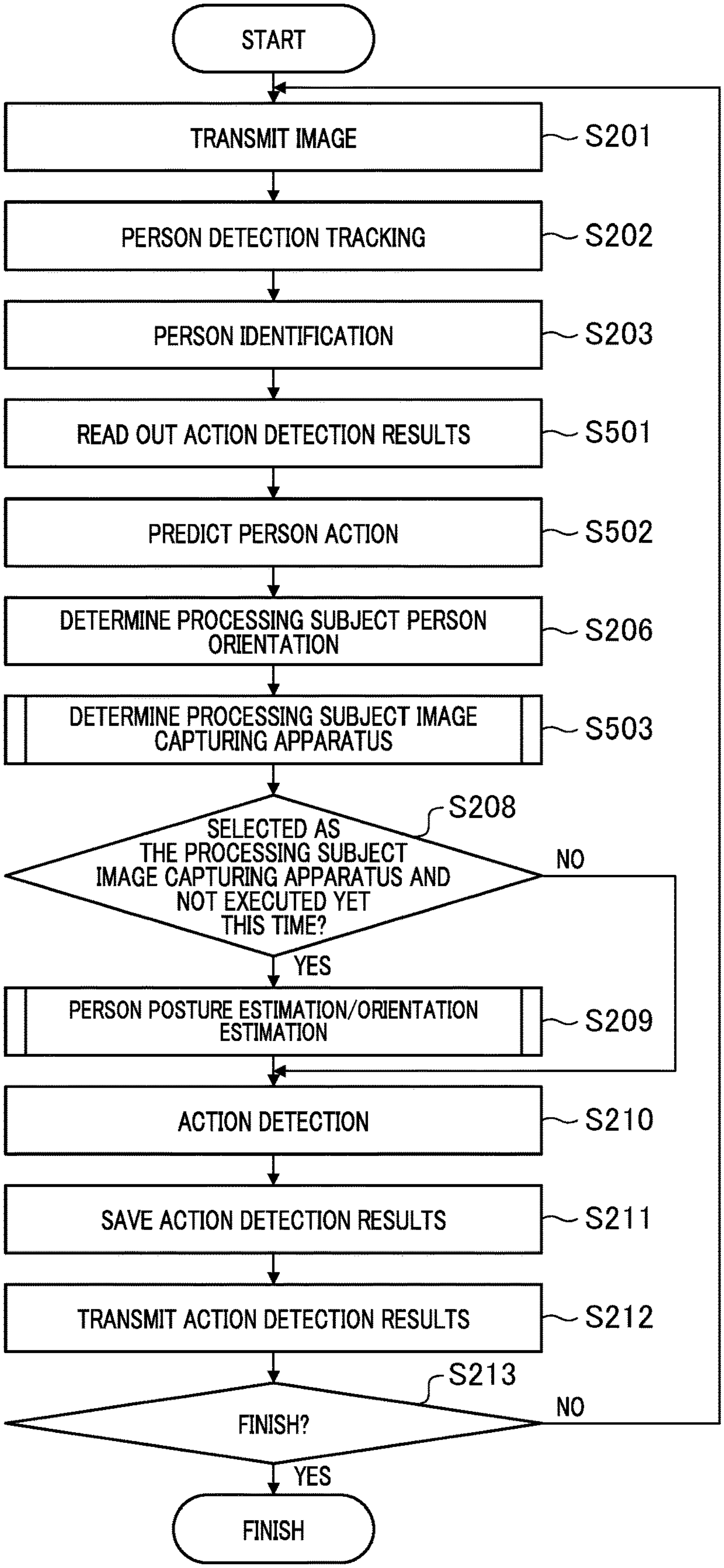
START
TRANSMIT IMAGE
S201
PERSON DETECTION TRACKING
S202
PERSON IDENTIFICATION
S203
READ OUT ACTION DETECTION RESULTS
S501
PREDICT PERSON ACTION
S502
DETERMINE PROCESSING SUBJECT PERSON ORIENTATION
S206
DETERMINE PROCESSING SUBJECT IMAGE CAPTURING APPARATUS
S503
S208
SELECTED AS THE PROCESSING SUBJECT IMAGE CAPTURING APPARATUS AND NOT EXECUTED YET THIS TIME?
NO
YES
PERSON POSTURE ESTIMATION/ORIENTATION ESTIMATION
S209
ACTION DETECTION
S210
SAVE ACTION DETECTION RESULTS
S211
TRANSMIT ACTION DETECTION RESULTS
S212
S213
FINISH?
NO
YES
FINISH

FIG. 14

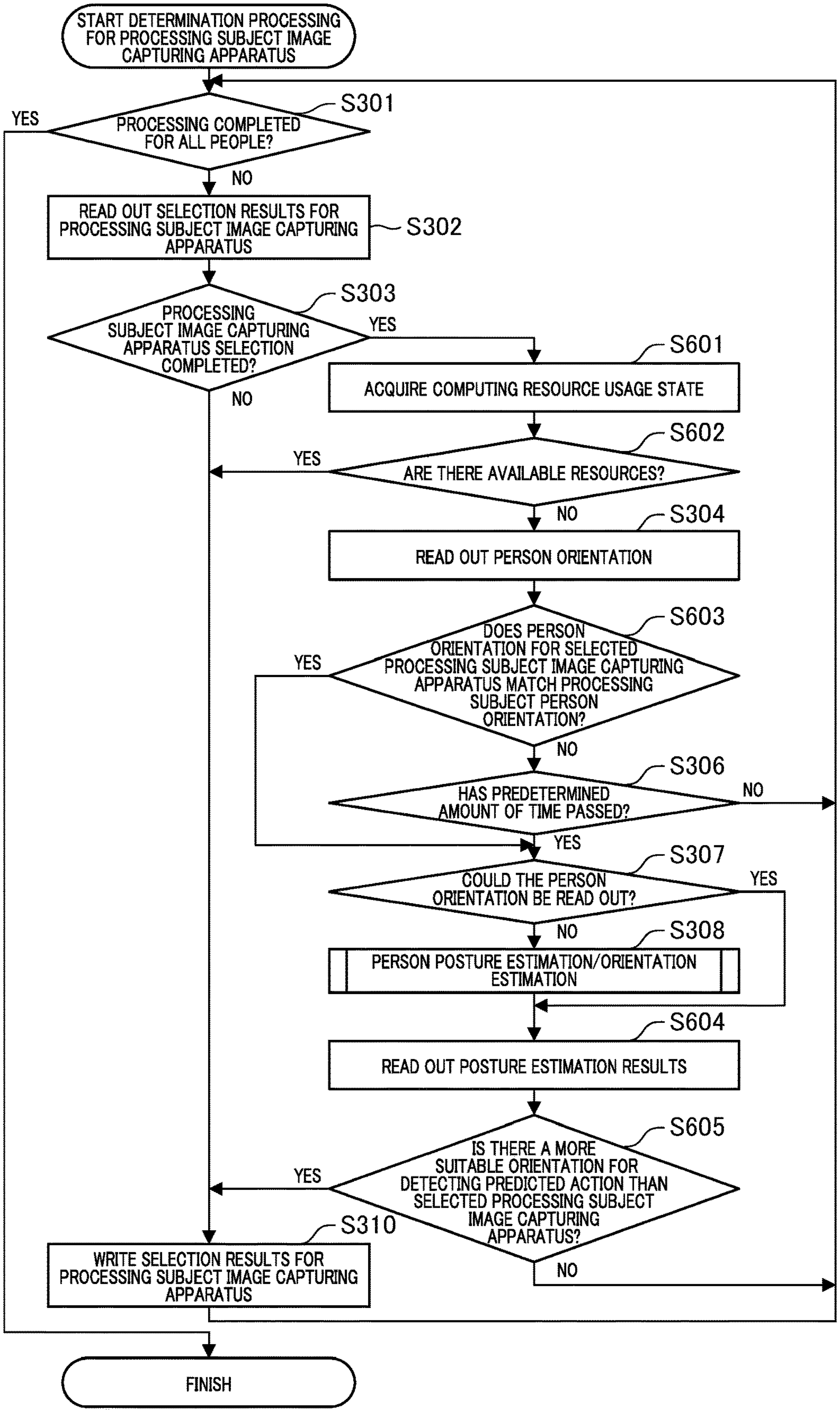
START DETERMINATION PROCESSING FOR PROCESSING SUBJECT IMAGE CAPTURING APPARATUS
S301
PROCESSING COMPLETED FOR ALL PEOPLE?
YES
NO
READ OUT SELECTION RESULTS FOR PROCESSING SUBJECT IMAGE CAPTURING APPARATUS
S302
S303
PROCESSING SUBJECT IMAGE CAPTURING APPARATUS SELECTION COMPLETED?
YES
NO
S601
ACQUIRE COMPUTING RESOURCE USAGE STATE
S602
ARE THERE AVAILABLE RESOURCES?
YES
NO
S304
READ OUT PERSON ORIENTATION
S603
DOES PERSON ORIENTATION FOR SELECTED PROCESSING SUBJECT IMAGE CAPTURING APPARATUS MATCH PROCESSING SUBJECT PERSON ORIENTATION?
YES
NO
S306
HAS PREDETERMINED AMOUNT OF TIME PASSED?
NO
YES
S307
COULD THE PERSON ORIENTATION BE READ OUT?
YES
NO
S308
PERSON POSTURE ESTIMATION/ORIENTATION ESTIMATION
S604
READ OUT POSTURE ESTIMATION RESULTS
S605
IS THERE A MORE SUITABLE ORIENTATION FOR DETECTING PREDICTED ACTION THAN SELECTED PROCESSING SUBJECT IMAGE CAPTURING APPARATUS?
YES
NO
S310
WRITE SELECTION RESULTS FOR PROCESSING SUBJECT IMAGE CAPTURING APPARATUS
FINISH

FIG. 15

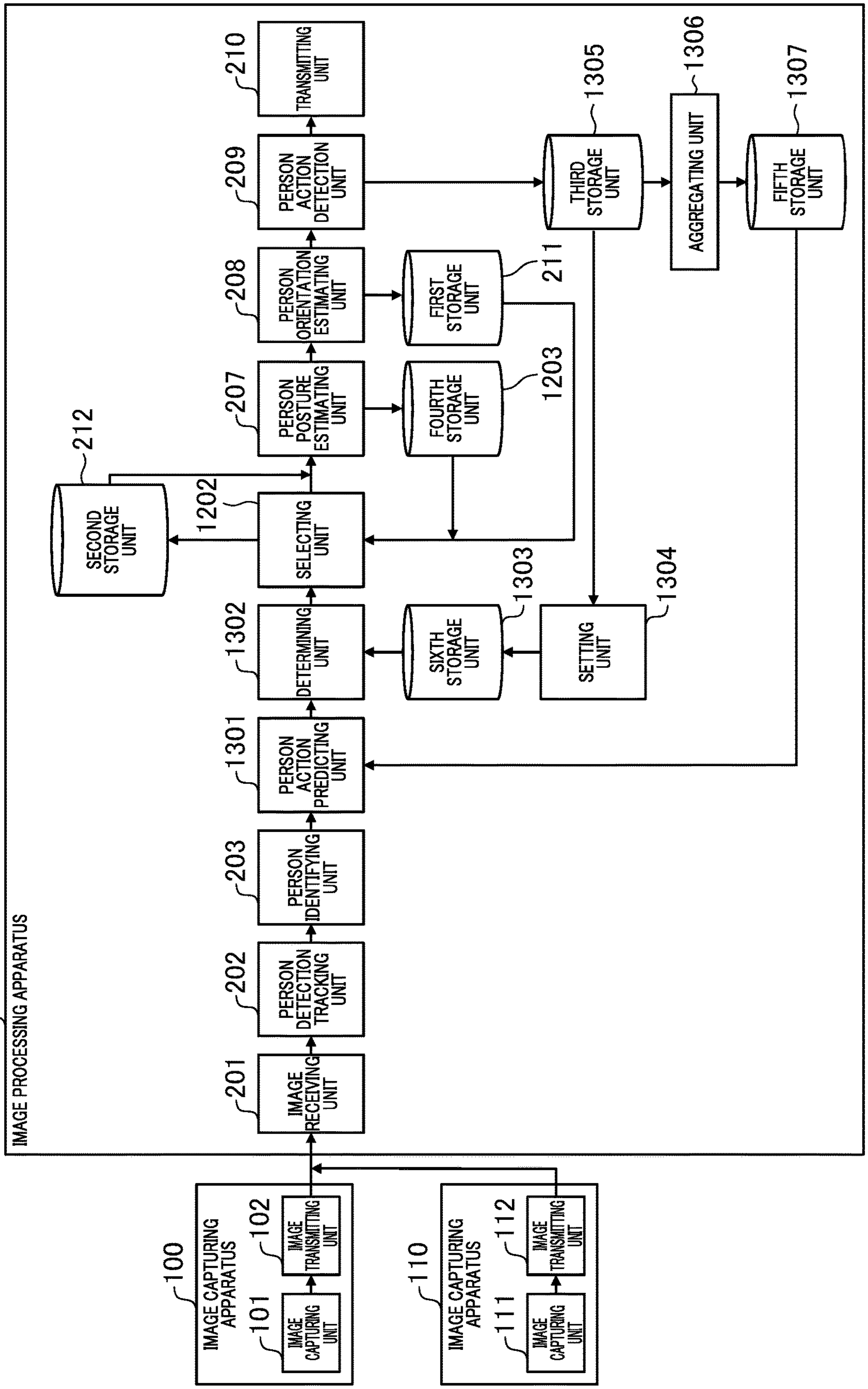
200
IMAGE PROCESSING APPARATUS
201
IMAGE RECEIVING UNIT
202
PERSON DETECTION TRACKING UNIT
203
PERSON IDENTIFYING UNIT
1301
PERSON ACTION PREDICTING UNIT
1302
DETERMINING UNIT
1202
SELECTING UNIT
207
PERSON POSTURE ESTIMATING UNIT
208
PERSON ORIENTATION ESTIMATING UNIT
209
PERSON ACTION DETECTION UNIT
210
TRANSMITTING UNIT
212
SECOND STORAGE UNIT
1203
FOURTH STORAGE UNIT
211
FIRST STORAGE UNIT
1303
SIXTH STORAGE UNIT
1304
SETTING UNIT
1305
THIRD STORAGE UNIT
1306
AGGREGATING UNIT
1307
FIFTH STORAGE UNIT
100
IMAGE CAPTURING APPARATUS
101
IMAGE CAPTURING UNIT
102
IMAGE TRANSMITTING UNIT
110
IMAGE CAPTURING APPARATUS
111
IMAGE CAPTURING UNIT
112
IMAGE TRANSMITTING UNIT

FIG. 16A

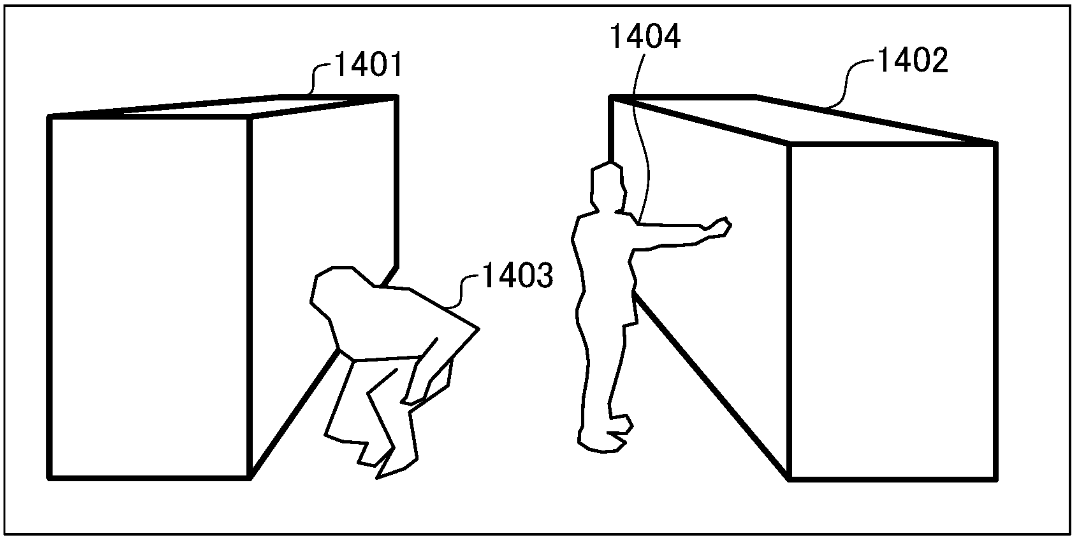

FIG. 16B

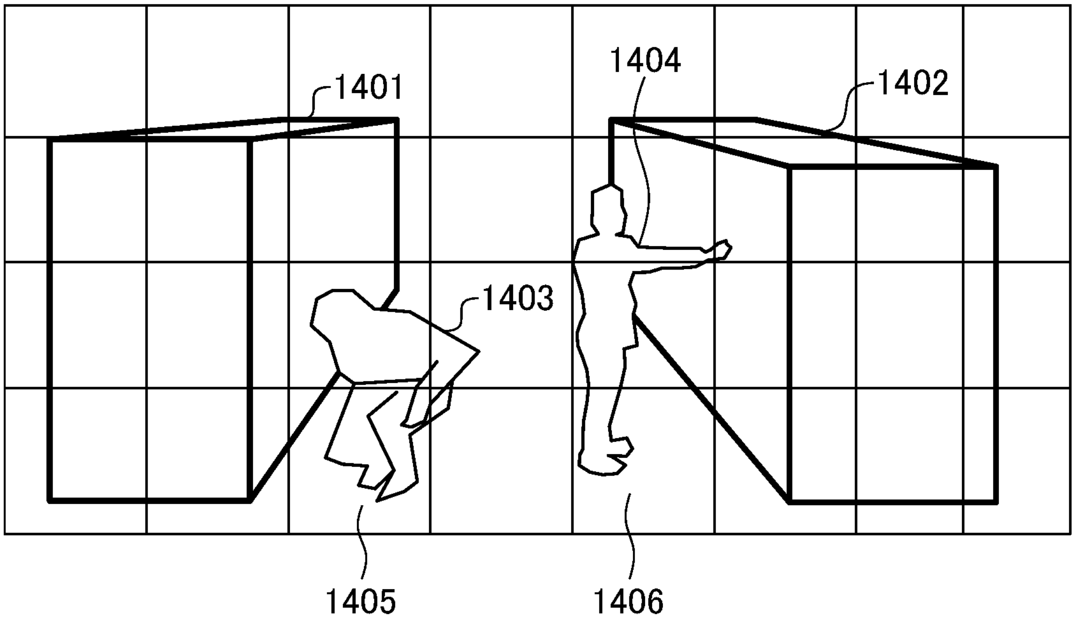

FIG. 17A

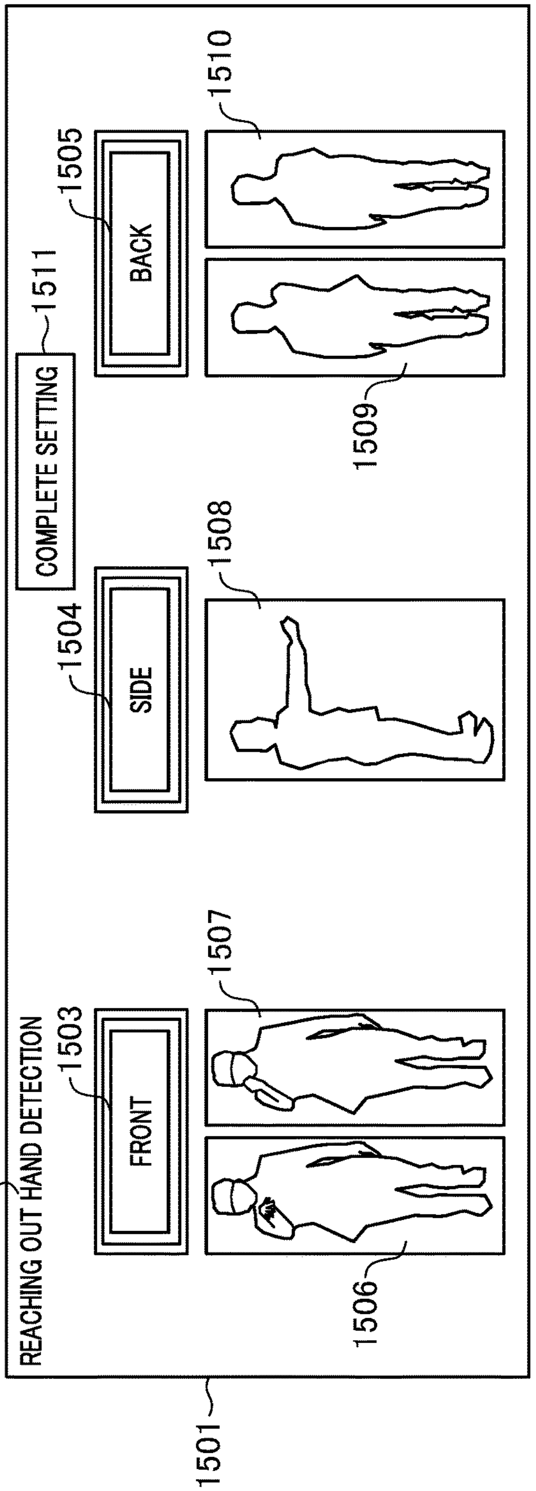

FIG. 17B

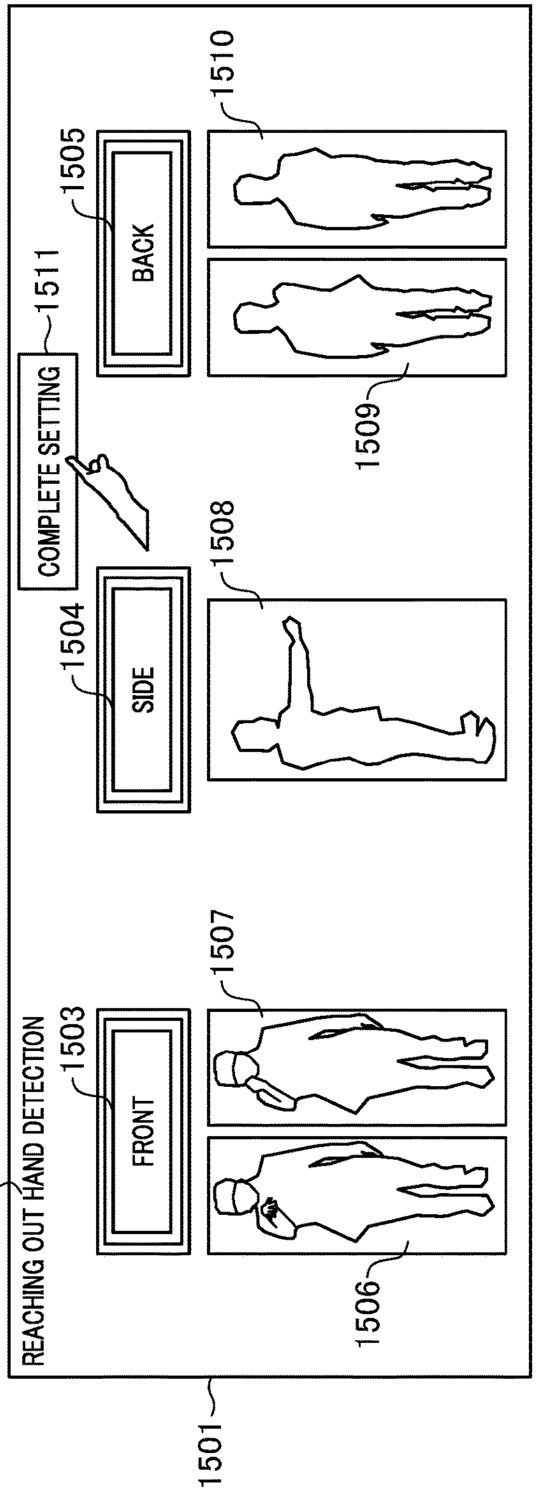

FIG. 18

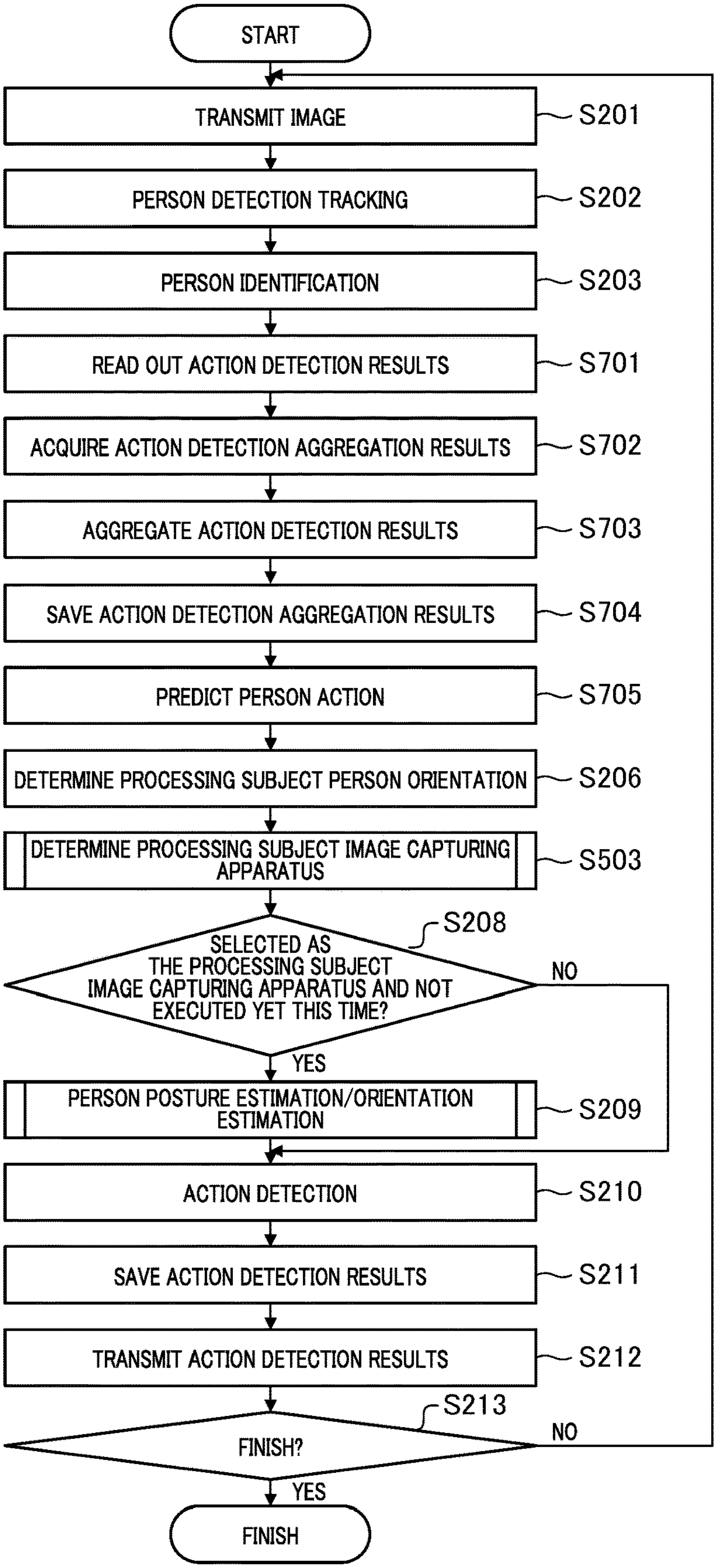
START
TRANSMIT IMAGE
S201
PERSON DETECTION TRACKING
S202
PERSON IDENTIFICATION
S203
READ OUT ACTION DETECTION RESULTS
S701
ACQUIRE ACTION DETECTION AGGREGATION RESULTS
S702
AGGREGATE ACTION DETECTION RESULTS
S703
SAVE ACTION DETECTION AGGREGATION RESULTS
S704
PREDICT PERSON ACTION
S705
DETERMINE PROCESSING SUBJECT PERSON ORIENTATION
S206
DETERMINE PROCESSING SUBJECT IMAGE CAPTURING APPARATUS
S503
SELECTED AS THE PROCESSING SUBJECT IMAGE CAPTURING APPARATUS AND NOT EXECUTED YET THIS TIME?
S208
NO
YES
PERSON POSTURE ESTIMATION/ORIENTATION ESTIMATION
S209
ACTION DETECTION
S210
SAVE ACTION DETECTION RESULTS
S211
TRANSMIT ACTION DETECTION RESULTS
S212
FINISH?
S213
NO
YES
FINISH

FIG. 19

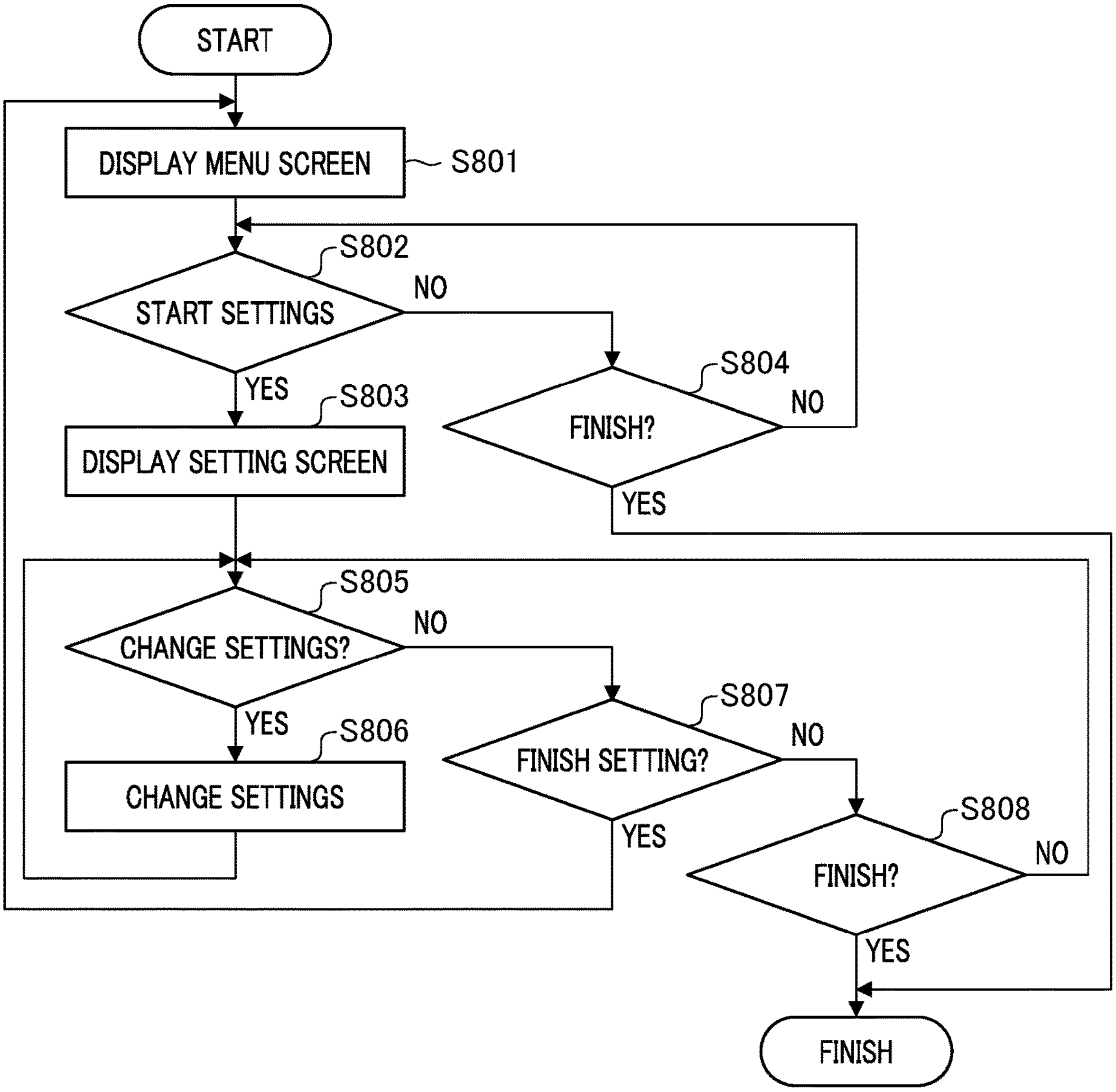
START
DISPLAY MENU SCREEN
S801
S802
START SETTINGS
NO
YES
S803
S804
FINISH?
NO
YES
DISPLAY SETTING SCREEN
S805
CHANGE SETTINGS?
NO
YES
S806
S807
FINISH SETTING?
NO
YES
CHANGE SETTINGS
S808
FINISH?
NO
YES
FINISH

IMAGE PROCESSING APPARATUS, METHOD, AND STORAGE MEDIUM FOR DETECTING ACTION OF A PERSON IN VIDEO IMAGES BASED ON AN OPTIMAL DIRECTION FOR DETECTING A MOTION IN PREDICTED ACTIONS OF A PERSON

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to an image processing apparatus, an image processing method, a program storage medium, and an image processing system.

Description of Related Art

There is a demand for detecting the actions of people in stores for marketing purposes, and the like. As a method for detecting the actions of people, there is a method that detects and tracks a person from an image of a monitoring camera, estimates the position of each body part of the person by performing posture estimation for each tracked person, and performs the detection of a person's actions based on the chronological changes in the posture estimation results. In this context, in order to detect a person's actions, it is necessary to predict the positions of a plurality of body parts with a high accuracy. It is therefore preferable that images are captured of each body part of the person in a state in which it is not hidden, and in which the image is not blurry, and therefore, there is a method that captures images of the person using a plurality of cameras and reduces the influence of body parts being hidden or blurred.

Japanese Unexamined Patent Application, First Publication No. 2017-059945, captures images of the individual body parts of a person using a plurality of cameras, and detects the person's actions after associating these body parts as one human body. It is thereby possible to detect the actions of a person even if a certain body part of this person is hidden from a certain camera, if it is possible to capture an image of that body part with another camera. In Japanese Unexamined Patent Application, First Publication No. 2021-096702, the actions of a person are detected after extracting a feature amount from each body part of which an image has been captured by a plurality of cameras, and averaging the feature amount for each body part. Thereby, even if a body part is hidden or blurred in a specific camera image, and an error occurs in the feature amount, this is averaged with the feature amount for other camera images in which an image of this body part was able to be captured, and therefore, the effects of a body part being hidden or blurred can be reduced.

SUMMARY OF THE INVENTION

One aim of the present invention is to reduce the processing load for detecting the actions of a person.

The image processing apparatus according to one aspect of the present invention predicts actions of a person who has been detected from an image captured by an image capturing apparatus, selects an optimal image capturing device for detecting actions of this person from among a plurality of image capturing apparatuses based on these predicted actions, and detects actions of the person based on an image that has been captured by the optimal image capturing apparatus.

Further features of the present invention will become apparent from the following description of exemplary embodiments with reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram of the configuration of an image processing system in an embodiment.

FIG. **2** is a diagram showing one example of tracking results in an embodiment.

FIG. **3**A to FIG. **3**D are diagrams showing one example of an overhead view of a store and a captured image in an embodiment.

FIG. **4**A to FIG. **4**B are diagrams showing one example of prediction results for a person's actions in an embodiment.

FIG. **5** is a diagram showing one example of pose estimation results in an embodiment.

FIG. **6**A to FIG. **6**M are images of a hand reaching out and similar actions in an embodiment.

FIG. **7** is a diagram showing a hardware configuration for an image processing apparatus in an embodiment.

FIG. **8** is a flowchart showing operations of an image capturing apparatus in an embodiment.

FIG. **9** is a flowchart showing operations of an image processing apparatus of an embodiment.

FIG. **10** is a flowchart showing operations of an image processing apparatus of an embodiment.

FIG. **11** is a flowchart showing the operations of an image processing apparatus of an embodiment.

FIG. **12** is a block diagram for the configuration of an image processing system in an embodiment.

FIG. **13** is a flowchart showing the operations of an image processing apparatus of an embodiment.

FIG. **14** is a flowchart showing the operations of an image processing apparatus of an embodiment.

FIG. **15** is a diagram showing one example of a person action prediction based on a person position in an embodiment.

FIG. **16**A and FIG. **16**B are diagrams showing one example of person action predictions based on a person position in an embodiment.

FIG. **17**A and FIG. **17**B are images of the hand reaching out setting screen in an embodiment.

FIG. **18** is a flowchart showing operations of an image processing apparatus in an embodiment.

FIG. **19** is a flowchart showing setting operations for an image processing apparatus of an embodiment.

DESCRIPTION OF THE EMBODIMENTS

Below, embodiments will be explained in detail with reference to the attached drawings. Note that the following embodiments do not limit the inventions according to the claims. Although a plurality of characteristics is described in the embodiments, the present invention is not limited to inventions for which the entirety of this plurality of characteristics are indispensable to the invention, and in addition, the plurality of characteristics may also be arbitrarily combined. Furthermore, in the attached drawings, the same reference numerals are attached to the same or similar configurations, and redundant explanations are omitted.

The First Embodiment shows, as one example of a monitoring system, an example of a configuration of a system in which a camera has been disposed in a small business such as a convenience store or the like, and when a predetermined person action has been detected, a detection event is transmitted to a separate system. The predetermined person action is, for example, reaching out their hand, crouching down, turning their head and confirming their surroundings, or the like.

FIG. **1** is a diagram showing a configuration of an image processing system according to the First Embodiment. FIG. **2** is a diagram showing one example of tracking results in the First Embodiment.

The image processing system in the First Embodiment is configured by an image capturing apparatus **100**, an image capturing apparatus **110**, and an image processing apparatus **200**. The image capturing apparatus **100** and the image capturing apparatus **110** are cameras, and in the First Embodiment, it is assumed that there is a plurality of these disposed inside of a store, and that they are disposed in positions from which they can capture images of the staff and customers. The image capturing apparatus **100**, the image capturing apparatus **110**, and the image processing apparatus **200** are connected via a communications network. Specifically, they are connected by a computer network such as a wired LAN, a wireless LAN, or the like. LAN is an abbreviation of Local Area Network.

The image capturing apparatus **100** includes an image capturing unit **101** and an image transmitting unit **102**. The image capturing unit **101** is configured by an image capturing lens, image capturing sensors such as a CCD, a CMOS, and the like, a signal processing unit, and the like. The images that have been capturing by the image capturing unit **101** are transmitted to the image transmitting unit **102** at predetermined time intervals.

The image transmitting unit **102** confers additional information such as each type of information for the image capturing apparatus **100**, the time, and the like to the images that have been transmitted from the image capturing unit **101**, converts them to data that is transmittable on the network, and transmits them to the image processing apparatus **200**.

The image capturing apparatus **110** includes an image capturing unit **111** and an image transmitting unit **112**. The image capturing unit **111** is the same as the image capturing unit **101**, and the image transmitting unit **112** is the same as the image transmitting unit **102**, and descriptions thereof will therefore be omitted. In addition, it is preferable that the image capturing apparatus **110** is disposed in a different position than the image capturing apparatus **100**, that is, in a position in which it is able to capture images from a different direction than the image capturing apparatus **100**.

The image processing apparatus **200** is configured to include each functional unit of an image receiving unit **201**, a person detection tracking unit **202** (referred to below as a tracking unit **202**), a person identifying unit **203**, a person action predicting unit **204**, a determining unit **205**, and a selecting unit **206**. Furthermore, the image processing apparatus **200** is configured to include each functional unit of a person posture estimating unit **207**, a person orientation estimating unit **208**, a person action detecting unit **209** (referred to below as a detecting unit **209**), a transmitting unit **210**, a first storage unit **211**, a second storage unit **212**, and a third storage unit **213**.

The image receiving unit **201** receives data that has been transmitted from the image capturing apparatus **100** and the image capturing apparatus **110**, extracts images (image information) from this data, and transmits these to the tracking unit **202**. In this context, in the First Embodiment, the images to be extracted are, for example, frame images (frames).

The tracking unit **202** performs tracking processing that associates the detection processing of people in the images that have been extracted by the image receiving unit **201** and the people who have been detected between images. The tracking unit **202** calculates tracking results (tracking information) by performing person extraction processing and tracking processing. The tracking unit **202** transmits these images and the tracking results to the person identifying unit **203** and the person posture estimating unit **207**.

The detection processing that is performed by the tracking unit **202** is processing that, for example, extracts a person's position in an image using machine learning. A position expresses the central coordinates of a rectangle surrounding a person, and the width and the height of the rectangle, wherein in the First Embodiment, the origin of the rectangle is the upper left side of the image.

The tracking processing that the tracking unit **202** performs is processing that associates people that have been detected between continuous images. Association for the people detected from each image is performed using the length of the line segments that connect the central coordinates of rectangles surrounding the people in each of the continuous images, the change amounts for the width and height of the rectangles, and the predicted positions of the people that have been obtained by past tracking processing, and a tracking ID is conferred to each person. The tracking IDs are conferred so as to enable identifying the same person in a sequence. By this tracking processing, the same tracking ID as in past frames is conferred to people who have already been detected in past frames. In contrast, new tracking IDs are conferred to people who have been newly detected. The tracking results that are calculated by the tracking unit **202** include information such as a tracking ID, and the central coordinates, the width, and the height of the rectangle that surrounds a person, as is shown in FIG. **2**

The person identifying unit **203** performs processing (identification processing) that identifies the same person between images that have been captured by the plurality of image capturing apparatuses based on the images that have been captured by the plurality of image capturing apparatuses and the tracking results that have been output from the tracking unit **202**. Although in the First Embodiment, two image capturing apparatuses, the image capturing apparatus **100** and the image capturing apparatus **110**, are used, the number is not limited thereto, and three or more image capturing apparatuses may also be used. The person identifying unit **203** first extracts each feature amount for the people who have been image captured by each of the image capturing apparatuses (the image capturing apparatus **100**, and the image capturing apparatus **110**) in order to identify them. The feature amounts for the people use one or more of a face, a head, clothing, or the like. The extracted feature value is saved in the person identifying unit **203**. After this, the person identifying unit **203** compares the extracted feature values between the image capturing apparatuses, and in the case in which the degree of similarity is at or above a certain amount (at or above a predetermined threshold), determines that this is the same person. Although in the First Embodiment, for example, the cosine degree of similarity is used as the degree of similarity for the feature amounts, the invention is not limited thereto.

The person action predicting unit **204** predicts the next movement for each person that the tracking unit **202** has detected, and calculates movement prediction results. The person action predicting unit **204** outputs the calculated movement prediction results to the determining unit **205**.

During the calculation of the movement prediction results, the person action predicting unit **204** first reads out the past movement detection results from the third storage unit **213**. Next, a number of occurrences for each movement in each image capturing apparatus and a movement detection history for each person is saved inside the person action predicting unit **204** based on the past action detection results that have been read out. Next, with respect to each detection candidate action, the person action predicting unit **204** calculates the probability of occurrence for each person, and calculates the movement prediction results for each person.

The number of occurrences for each action in each image capturing apparatus, and the movement detection history for each person, and the like are used in the calculation of the probability of occurrence. For example, the number of occurrences for each action in each of the image capturing apparatuses is counted, and the probability of occurrence for actions with a high number of occurrences is raised. In addition, the orders of people's actions are set as action rules, and the probability of occurrence for the next action in the action rules is raised in the case in which a certain action has occurred. The action rules set rules in advance, such as, for example, that after an action of checking surroundings has been detected, there is a high possibility that a hand reaching out will be detected. In addition, the same type of rules may also be found and set by using machine learning based on the action detection history for each person. In the predictions that follow this, in the case in which the action of checking their surroundings has been detected for a certain person, the probability of occurrence for their hand reaching out is raised when action prediction is performed for this person.

In this context, a person orientation in each captured image from the plurality of image capturing apparatuses will be explained using FIG. **3**. FIG. **3** are diagrams showing one example of an overhead view of a store and images captured by a plurality of image capturing apparatuses in the First Embodiment. In the example in FIG. **3**, an image capturing apparatus **302**, an image capturing apparatus **303**, and an image capturing apparatus **304** each capture images in the central direction of the diagrams from different positions (different directions).

FIG. **3**A is an example of an overhead view diagram of a store. FIG. **3**B shows one example of a captured image of the image capturing apparatus **302**. The image in FIG. **3**B is an image that was captured from the frontal orientation of a person **301**. It can be further confirmed from the image shown in FIG. **3**B that the person **301** is reaching their right hand towards a product shelf **305**, and that the lower half of the person **301**'s body is hidden by the product shelf **305**. FIG. **3**C is a diagram showing one example of a captured image of the image capturing apparatus **303**. The image in FIG. **3**C is an image that was captured from a sideways orientation of the person **301**. Furthermore, it can be confirmed from the image shown in FIG. **3**C that the person **301** is not hidden by the product shelf **305**.

FIG. **3**D shows one example of a captured image from the image capturing apparatus **304**. The image in FIG. **3**D is an image that has been captured from the back orientation of the person **301**. It can be further confirmed from the image shown in FIG. **3**D that that the person **301**'s right hand is hidden by the person **301**. As in these examples shown by FIG. **3**, in the case in which images are captured by a plurality of image capturing apparatuses in different positions, even if a captured image is of the same person at the same time, the orientation of the person whose image is captured, and whether or not any part of the person is hidden differ.

The determining unit **205** determines the person orientation for the person who is the subject of the processing (the processing subject person orientation) based on the action prediction results that have been output from the person action predicting unit **204**. In addition, the determining unit **205** outputs the results (the determination results) of the processing subject person orientation that have been determined to the selecting unit **206**. In the First Embodiment, there are two types of determining methods for determining the results of the processing subject person orientation, and which of the selection methods will be used can be switched in advance by the user in the settings. Below, the two types of determination methods will be explained with reference to FIG. **4**

FIG. **4** is a diagram showing one example of person action prediction results in the First Embodiment. FIG. **4**(A) shows one example of a table of action prediction results. FIG. **4**B shows one example of a table combining the occurrence probabilities for each ideal person orientation. Note that the detection candidate actions that are shown in the table in FIG. **4**A are one example, and other detection actions may also be set. In addition, for example, it may also be made such that in the case in which an action that is not a detection action candidate has been detected, the action after this detection is added to this table.

The first determination method is a method that determines the ideal person orientation for actions with a high probability of occurrence as the processing subject person orientation. Using FIG. **4**A as an example, with respect to the action of checking their surroundings, which is an action with a high probability of occurrence, the frontal direction, which is the ideal person orientation, is determined as the processing subject person orientation.

The second determination method determines the ideal person orientation with a high probability of occurrence as the processing subject person orientation after having aggregated the probabilities of occurrence for each ideal person orientation, as in FIG. **4**B. Specifically, using FIG. **4**A as an example, first, the ideal person orientation for reaching out a hand and crouching down are the sideways orientation, and therefore, the sum of their probability of occurrence is added, and the probability of occurrence for each person orientation is aggregated as in FIG. **4**B. In addition, as is shown in the example in FIG. **4**B, the sideways orientation, which is the ideal person orientation with a high probability of occurrence, is determined as the processing subject person orientation. Note that when selecting the processing subject person orientations in the order of the highest probability of occurrence, one selection may be made, or a plurality of selections may also be made in the order of highest probability of occurrence.

The selecting unit **206** selects a processing subject image capturing apparatus (an optimal image capturing apparatus) for action detection for each person based on the determination results for the processing subject person orientation that was determined by the determining unit **205**, and the orientation information for each person in the images that have been captured by each image capturing apparatus that have been read out from the first storage unit **211**.

Specifically, the selecting unit **206** selects the image capturing apparatus that has captured an image in which the orientation of a person matches by comparing this with the determination results for the processing subject person orientation that has been determined by the determining unit **205** and the orientation information for each person in the images that that have been captured by each image capturing apparatus to serve as the processing subject image capturing apparatus. In other words, the selecting unit **206** selects the optimal image capturing apparatus from among the plurality of image capturing apparatuses based on the image capturing direction of the processing subject person according to the movement that has been predicted by the person action predicting unit **204**, and the image capturing directions for the processing subject person from each of the plurality of image capturing devices. Note that during the comparison of the person orientation at this time, it may also be made such that, for example, a predetermined threshold is set as a degree of adaptability, and the image capturing apparatus that captured an image that matches an orientation of the person at or above the predetermined threshold is selected as the processing subject image capturing apparatus. The predetermined threshold can be arbitrarily set by the user. The selecting unit **206** saves the selection results to the second storage unit **212** after the selection of the processing subject image capturing apparatus.

Note that in the case in which the selecting unit **206** has still not selected even one processing subject image capturing apparatus for a person, for example, the image capturing apparatus that captured the image that was first received is selected as the processing subject image capturing apparatus. In contrast, in the case in which the processing subject image capturing apparatus has already been selected, which of the person orientation for the person in the image that has been captured by the already selected processing subject image capturing apparatus, and the person orientation in the image capturing apparatus for the received image is more ideal is determined.

In this context, in the case in which the person orientation for the person in the image that has been captured by the already selected processing subject image capturing apparatus matches the processing subject person orientation, the selecting unit **206** prioritizes the already selected processing subject image capturing apparatus. Thereby, changes to the selection results are thereby inhibited. During the action detection, which accumulates information for a plurality of frames, it is possible to inhibit information accumulation from being redone by inhibiting changes to the selection results for the processing subject image capturing apparatus.

In addition, the selecting unit **206** does not redo the selection of the processing subject image capturing apparatus until a predetermined period of time has elapsed from this selection. Thereby, even if, for example, the person orientation in one frame of the already selected processing subject image capturing apparatus has been wrongly determined, it is possible to exclude the effects of this incorrect determination. The predetermined time for redoing this selection can be suitably set by a user, and for example, can be set to an arbitrary time, such as 1 second, several seconds, or the like.

The person posture estimating unit **207** detects the position in the image of the key points of a person by using machine learning or the like from a full-body image of a person being tracked based on the tracking results that have been output from the human detection tracking unit **202** and the images that have been captured by the plurality of image capturing apparatuses. After this, the detected coordinates and likelihood are output as the posture estimation results. The person posture estimating unit **207** transmits the posture estimation results to the person orientation estimating unit **208** after this processing is completed.

FIG. **5** is a diagram showing one example of posture estimation results in the First Embodiment. The posture estimation results include, for example, as is shown in FIG. **5**, the tracking ID, the coordinates for each key point, and the degree of likelihood. Furthermore, a human body detection likelihood that is calculated based on the detection likelihood for each key point is included. In this context, a key point shows the main organ points and joints of a person, and includes, for example, both eyes, both ears, the nose, both shoulders, both hips, both elbows, both wrists, both knees, both ankles, and the like.

The person orientation estimating unit **208** estimates a person's orientation based on the posture estimation results that have been transmitted from the person posture estimating unit **207**, and saves the estimation results to the first storage unit **211**. The estimated person orientation is one or more of the orientation of their face, the orientation of their body, the orientation of their hand, or the like. In this context, the ideal person orientation for action detection will be explained referring to FIG. **6**.

FIG. **6** is a diagram showing one example of an action of a person reaching out their hand and a similar action. FIG. **6**A and FIG. **6**B are diagrams showing person images with frontal orientations. Note that in the examples that are shown in FIG. **6**A, and FIG. **6**B, the person is wearing a mask. Furthermore, FIG. **6**A is an image of when they are reaching out their hand, and FIG. **6**B is an image of when they are fixing their mask with their hand. FIG. **6**C shows an image of the results of the posture estimation shown in FIG. **6**A. In FIG. **6**C, the positions of each of the estimated key points are shown with circles, and in addition, adjacent key points are shown as being connected with lines. In the same manner, FIG. **6**D shows an image for the results for pose estimation for FIG. **6**B. FIG. **6**D also shows the position of each of the estimated key points with a circle, and in addition shows the adjacent key points as being connected with lines in the same manner as FIG. **6**C and the like.

When comparing FIG. **6**A, and FIG. **6**B, the position and orientation of the fingers are different, and therefore, it is possible to differentiate if they are reaching their hand out, or if they are not reaching their hand out, but are pointing their hand towards their face. However, upon comparing FIG. **6**C and FIG. **6**D, there is no difference in size for the key points for the posture estimation results, and the therefore, it is difficult to distinguish if they are reaching their hand out.

FIG. **6**E and FIG. **6**F are diagrams showing one example of person images with sideways orientations. FIG. **6**E is an image from when they are reaching their hand out, and FIG. **6**F is an image from when they are fixing their mask with their hand. FIG. **6**G shows the results of the posture estimation for FIG. **6**E as an image. In the same manner as in FIG. **6**C and the like, in FIG. **6**G as well, the positions of each of the estimated key points are shown using circles, and in addition, adjacent key points are shown as being connected by lines. In the same manner, FIG. **6**H shows the results of the posture estimation for FIG. **6**F as an image. In the same manner as in FIG. **6**C and the like, in FIG. **6**H as well, the positions of each of the estimated key points are shown using circles, and in addition, adjacent key points are shown as being connected by lines.

Upon comparing the images of FIG. **6**E and FIG. **6**F, it is possible to distinguish if the person is reaching their hand out, or if they are not reaching their hand out but are pointing their hand toward their face based on the differences in the positions and orientations of their fingers. Furthermore, upon comparing FIG. **6**G, and FIG. **6**H, it is easy to distinguish whether or not they are reaching their hand out, because within the key points of the posture estimation results, there are large differences in the coordinates for one wrist of one hand, elbow, and shoulder.

FIG. **6**I and FIG. **6**J are diagrams showing one example of a person image with a back orientation. FIG. **6**I is an image showing when they reached their hand out, and FIG. **6**J is an image showing when they fixed their mask with their hand. FIG. **6**K and FIG. **6**L show the results for the posture estimation in FIG. **6**I as images. In FIG. **6**K and FIG. **6**L as well, in the same manner as in FIG. **6**C and the like, the positions of each of the estimated key points are shown using circles, and in addition, adjacent key points are shown as being connected by lines. Similarly, FIG. **6**M shows the results of the posture estimation in FIG. **6**J as an image. In FIG. **6**M as well, in the same manner as in FIG. **6**C and the like, the positions of each of the estimated key points are shown using circles, and in addition, adjacent key points are shown as being connected by lines.

As is shown in FIG. **6**I and FIG. **6**J, in the back orientation, the movements of the person's hands are hidden by the person's body, and in FIG. **6**K, even though the person is reaching their hand out, there is a mistaken detection in which the key point for the right hand is as though the hand is lowered down. In addition, upon comparing FIG. **6**L and FIG. **6**M, there is no large difference between the key points from the posture estimation results, and therefore, it is difficult to distinguish whether or not they are reaching their hand out.

In the same manner as in this example, it is easier to detect a hand reaching out in the sideways orientation than it is in the front orientation or the back orientation. Note that in this example, the action of fixing a mask with a hand is given as an example of a similar action in comparison to reaching out a hand. However, other similar actions such as a person touching their face with their hand or adjusting their glasses with their hand, and the like, are also the same. In addition, although reaching out their hand has been given as example in this context, in actions other than reaching out their hand, such as the action of turning their face to the side and checking their surroundings, sitting down, and the like, there are also person orientations in which it is easy to distinguish similar actions and key points.

The detecting unit **209** performs action detections for all of the people being tracked based on the tracking results, the posture estimation results, and the person orientation, and outputs the action detection results. After this, along with transmitting these action detection results to the transmitting unit **210**, they are saved on the third storage unit **213**.

After receiving the action detection results that have been detected by the detecting unit **209**, the transmitting unit **210** transmits these action detection results to a transmission destination that has been registered in advance.

The first storage unit **211** (a person orientation storage unit) stores the estimation results that have been transmitted from the person posture estimating unit **207**. The second storage unit **212** (processing subject image capturing apparatus storage unit) stores the selection results that have been selected by the selecting unit **206**. The third store unit **213** (action detection results storage unit) stores the action detection results that have been detected by the detecting unit **209**. Note that as described above, although the image processing apparatus **200** of the First Embodiment may have 3 storage units, the first storage unit **211**, the second storage unit **212**, and the third storage unit **213** may also be made one storage unit.

Next, the hardware configuration of the image processing apparatus **200** will be explained below in reference to FIG. **7**. FIG. **7** is a diagram showing a hardware configuration of the image processing apparatus **200** in the First Embodiment.

The image processing apparatus **200** has a CPU **401**, a ROM **402**, a RAM **403**, a storage **404**, a display unit **405**, an input OF **406**, and a communications unit **407**.

The CPU **401** is configured by at least one computer, and is a central processing unit that executes each type of processing by reading out a control program that has been stored on the Read-Only Memory (ROM) **402**. The Random Access memory (RAM) **403** is used as the main memory of the CPU **401**, and a temporary storage region such as a work area or the like. The storage **404** stores each type of data, each type of program, and the like. The display unit **405** is a monitor, a display, or the like and displays each type of information on a screen. Note that the display unit **405** may also be a display apparatus that is combined with a touch panel. The input I/F **406** is an interface for inputting operation information, and is, for example, a keyboard, a touch panel, or the like. The communications unit **407** performs communication processing with an external apparatus such as the image capturing apparatus **100** or the like wired or wirelessly via a network.

The functions and processing of the image processing apparatus **200** are realized by the CPU **401** reading out a program that is stored on the ROM **402** or the storage **404**, and then executing this program. In addition, as another example, instead of the ROM **402** and the like, the CPU **401** may also read out a program that is stored on a storage medium such as an SD card or the like.

Note that in the First Embodiment, it is assumed that in the image processing apparatus **200**, one processor (the CPU **401**) executes each functional unit and each process shown in the following flowcharts for the image processing apparatus **200** by using at least one memory (the ROM **402**). However, this may also be a different mode. For example, it is also possible to execute each functional unit and each type of processing shown in the following flowcharts in the image processing apparatus **200** by having a plurality of processors, and a plurality of RAMs, ROMs, and storages cooperate. In addition, a portion of the processing may also be executed by using a hardware circuit. In addition, it may also be made such that the functions and processing of the image processing apparatus **200** that are described below are realized using a processor other than a CPU (for example, instead of a CPU, a Graphic Processing Unit (GPU) may also be used)

Next, the processing for the image capturing apparatus **100** in the First Embodiment will be explained below in reference to FIG. **8**. FIG. **8** is a flowchart showing the operations (processing) of the image capturing apparatus **100** in the First Embodiment.

First, during **S101**, the image capturing unit **101** of the image capturing apparatus **100** acquires images by capturing images of the subject region. The images that are acquired at this time are transmitted to the image transmitting unit **102** at predetermined time intervals. Next, during **S102**, the image transmitting unit **102** transmits the images that have been transmitted from the image capturing unit to the image processing apparatus **200**. Next, in **S103**, the CPU **401** determines whether or not there is a request to stop image transmission. In the case in which the determination result is that there is no request to stop image transmission, the processing returns to **S101**, and the same processing is repeated. In contrast, in the case in which there has been a request to stop image transmission, the processing is completed.

Note that although the processing shown in FIG. **9** is the processing for the image capturing apparatus **100**, the processing for the image capturing apparatus **110** is the same as that for the image capturing apparatus **100**. Furthermore, at this time, although it is not illustrated, it is assumed that the image capturing apparatus **110** is performing the same processing in parallel to the processing in the image capturing apparatus **100**, or in joint operation with the processing in the image capturing apparatus **100**.

Next, the processing for the image processing apparatus **200** in the First Embodiment will be explained below with reference to FIG. **9**. FIG. **9** is a flowchart showing the operations (processing) of the image processing apparatus **200** in the First Embodiment.

First, during S**201**, the image receiving unit **201** receives each of the images that have been transmitted from the image capturing apparatus **100** and the image capturing apparatus **110**. Note that in the following explanation, the image capturing apparatus that captured the image that has been received by the image receiving unit **201** is referred to as a determination subject image capturing apparatus. That is, in the First Embodiment, the image capturing apparatus **100** and the image capturing apparatus **110** are the determination subject image capturing apparatuses.

Next, during S**202**, the tracking unit **202** performs person detection processing and tracking processing for each person in the images that have been acquired in S**101**, and calculates the tracking results (tracking information) for each of these people. After this, the tracking unit **202** transmits the calculated tracking results to the person identifying unit **203**.

Next, during S**203**, the person identifying unit **203** extracts (calculates) the person feature amounts from the images that have been acquired by the image capturing apparatus **100**, and the feature amounts for the people from the images that have been acquired by the image capturing apparatus **110**. After this, the person identifying unit **203** compares the feature amounts for the images that have been captured by the image capturing apparatus **100** and the feature amounts for the images that have been captured by the image capturing apparatus **110**, and in the case in which their degree of similarity is at or above a predetermined threshold, performs person identifying processing that determines whether someone is the same person.

Next, in S**204**, the person action predicting unit **204** reads out past action detection results from the third storage unit **213**. Next, during S**205**, the person action predicting unit **204** predicts the actions of the people who have been detected in S**202** based on the past action detection results that have been read out during S**204**, and after calculating action prediction results, outputs these to the determining unit **205**.

Next, during S**206**, the determining unit **205** determines the processing subject person orientation for each person that has been detected during S**202** based on the action prediction results that have been output from the person action predicting unit **204** during S**205**. After this, the determining unit **205** outputs the determination results that have been determined (the processing subject person orientation) to the selecting unit **206**.

Next, during S**207**, the selecting unit **206** determines the processing subject image capturing apparatus (the optimal image capturing apparatus) for each person from the processing subject person orientation that has been output from the determining unit **205** during S**206**, and the orientation information for each person that has been detected in the images that have been captured by each of the image capturing apparatuses. In this context, the processing for determining the processing subject image capturing apparatus for each person during S**207** will be described in detail with reference to FIG. **10**. FIG. is a flowchart showing the determination processing for the processing subject image capturing apparatus for a processing subject person in S**207**.

First, during S**301**, the CPU **401** determines whether or not the selection processing for the processing subject image capturing apparatus for all of the people who are made processing subjects is complete. In the case in which the determination results are that a processing subject image capturing apparatus has been selected for all of the people, the processing for determining the processing subject image capturing apparatus for each person that is shown in FIG. **10** is completed, and the processing proceeds to S**208**. In contrast, in the case in which a processing subject image capturing apparatus has not been selected for all persons, the processing proceeds to S**302**.

Next, during S**302**, the selecting unit **206** reads out the past selection results for the processing subject image capturing apparatuses from the second storage unit **212**. Next, during S**303**, the selecting unit **206** determines whether or not the selection of the processing subject image capturing apparatuses for a predetermined person that is being processed (the processing subject) has been completed. If the determination result is that this has not yet been selected, the processing proceeds to S**310**. In contrast, in the case in which it has been selected, the process proceeds to S**304**. Next, during S**304**, the selecting unit **206** reads out the person orientation information from the first storage unit **211**.

Next, during S**305**, the selecting unit **206** determines whether or not the person orientation for the processing subject image capturing apparatus that has been selected matches the processing subject person orientation. In the case in which the determination results are that the person orientation for the processing subject image capturing apparatus that has been selected and the processing subject person orientation match, the processing returns to S**301**, and the same processing is repeated. In contrast, in the case in which the person orientation for the processing subject image capturing apparatus that has been selected, and the processing subject person orientation do not match, the processing proceeds to S**306**. Note that, when the above-described determination is being made, it may also be made such that for example, a predetermined threshold may be set to serve as the degree of suitability, and whether or not the person orientations match is determined based on this predetermined threshold.

Next, during S**306**, the selecting unit **206** determines whether or not a predetermined amount of time has passed after the selection of the processing subject image capturing apparatus. In the case in which the results of this determination is that a predetermined amount of time has passed, the processing proceeds to S**307**. In contrast, if the predetermined period of time has not passed, the processing proceeds to S**301**.

Next, during S**307**, the selecting unit **206** determines whether or not the person orientation for the determination subject image capturing apparatus has been read out during S**304**. In the case in which the results of this determination are that the person orientation for the determination subject image capturing apparatus has been read out, the process proceeds to S**309**. In contrast, in the case in which the person orientation for determination subject image capturing apparatus has not been read out, the processing proceeds to S**308**.

Next, during S**308**, the person posture estimating unit **207** performs person posture estimation processing and person orientation estimation processing. In this context, the processing for the person posture estimation and the person orientation estimation during S**308** will be explained in detail below with reference to FIG. **11**. FIG. **11** explains the processing for the posture estimation and the person orientation estimation from S**308** by using a flowchart.

First, during S**401**, the person posture estimating unit **207** detects the position on the screen of the key points for a person by using machine learning and the like from a full body image of a predetermined person who is being processed, and outputs the detected coordinates and likelihood to serve as posture estimation results. After this, the person posture estimating unit **207** transmits these posture estimation results to the person orientation estimating unit **208**.

Next, during S**402**, the person orientation estimating unit **208** estimates the person orientation based on the posture estimation results that have been transmitted from the person posture estimating unit **207**. Next, during S**403**, the person orientation estimating unit **208** saves the information for the estimated person orientation to the first storage unit **211**.

Returning to FIG. **10**, next, during S**309**, the selecting unit **206** determines whether or not the person orientation for the determination image capturing apparatus is more suited to the detection of the predicted movement than the person orientation of the processing subject image capturing apparatus that has already been selected. In the case in which the result of this determination is that the person orientation for the determination subject image capturing apparatus is more suited thereto, the processing proceeds to S**310**. In contrast, in the case in which it has been determined that the person orientation for the determination subject image capturing apparatus is not more suited to this, the processing returns to S**301**, and the same processing is repeated.

At the time that this determination is being made, in the case in which only the person orientation of the determination subject image capturing apparatus matches the processing subject person orientation, it is determined that the person orientation for the determination subject image capturing apparatus is more suitable. In all other cases, that is, in the case in which the person orientation for the determination subject image capturing apparatus does not match the processing subject person orientation, a determination is performed to prioritize the processing subject image capturing apparatus that has already been selected. It is thereby possible to suppress the number of times that the selection results are changed. Note that when the above-described determination is being made, it may also be made such that, for example, a predetermined threshold may be set to serve as the degree of suitability, and determination as to whether or not the determination subject image capturing apparatus is suitable for the detection of this predicted action is made based on this predetermined threshold.

Next, during S**310**, the selecting unit **206** selects the determination subject image capturing apparatus to serve as the processing subject image capturing apparatus for the person who is being processed, and saves the selection results to the second storage unit **212**. After these selection results have been stored, the processing returns to S**301**, and the same processing is repeated.

Returning to FIG. **9**, next, during S**208**, the person posture estimating unit **207** determines whether or not the determination subject image capturing apparatus has been selected as the processing subject image capturing apparatus and posture estimation has been executed on the received image. As a result of this determination, in the case in which the processing subject image capturing apparatus is selected, and posture estimation has not been executed on the received image, the processing proceeds to S**209**. In contrast, in the case in which the determination subject image capturing apparatus is selected as the processing subject image capturing apparatus, and posture estimation has already been executed on the received image, the processing proceeds to S**210**.

Next, during S**209**, the same processing as the processing for the above-described S**380** is performed, and an explanation thereof is therefore omitted. Next, during S**210**, the detecting unit **209** performs action detection for all of the people being tracked based on the tracking results, posture estimation results, and person orientations, and outputs the action detection results. Note that the detecting unit **209** performs action detection for all of the people being tracked based on the tracking results that were calculated in S**202**, the posture estimation results that were calculated in S**401** or S**209**, and the person orientations that were calculated during S**402** or S**209**, and outputs the action detection results.

Next, during S**211**, the detecting unit **209** transmits the action prediction results to the transmitting unit **210**, and saves the action prediction results to the third storage unit **213**. Next, during S**212**, the transmitting unit **210** transmits the action detection results to a predetermined transmission destination that has been set in advance.

Next, during S**213**, the CPU **401** determines whether or not there is a request to stop image transmission. In the case in which the result of this detection is that there is no request to stop the image transmission, the processing returns to S**201**, and the same processing is repeated. In contrast, in the case in which there has been a request to stop image transmission, the processing is completed.

As was described above, in the image processing system that is configured by the plurality of image capturing apparatuses and the image processing apparatus **200** in the First Embodiment, the next actions of people in images that have been captured by the image capturing apparatuses are predicted, and posture estimation processing is performed on images with person orientations for which these actions are easily detected. It is thereby possible to reduce the processing load in comparison to cases in which posture estimation and action detection are performed based on video images of all of the people from all of the image capturing apparatuses that are disposed.

In the Second Embodiment, changes to the number of simultaneous posture estimations according to the selection of the processing subject image capturing apparatus taking into consideration processing to switch an action prediction based on a behavior that can become the beginning of an action and a person being hidden, as well as the usage state of the calculation resources, will be explained. Below, the explanation will focus on the portions that are different in comparison to the First Embodiment.

FIG. **12** is a diagram showing a configuration of an image processing system in the Second Embodiment. Note that explanations of the configurations and functional units of the image processing system of the Second Embodiment that are the same as those of the image processing system of the First Embodiment will be omitted.

A third storage unit **1204** is the same configuration as the third storage unit **213** in the First Embodiment, and stores the detection processing results for the detecting unit **209**. These detection processing results are not just a history of the actions that have been detected, but also include the occurrence of behaviors that could have been the start of an action. For example, the behavior of a wrist being raised is an example of a behavior that could be the start of the action of reaching out a hand. Note that as was explained in FIG. **6**, it is difficult to distinguish reaching out a hand from similar actions from the front even if posture estimation is performed. However, it is possible to determine whether or not a wrist is being raised even in the case in which this is viewed from the front. Although even if someone raises their wrist, it does not necessarily mean that they will reach out their hand, it is possible to determine that this could be the start of reaching out their hand or a similar action.

A person action predicting unit **1201** is the same configuration as the person action predicting unit **204** from the First Embodiment, and reads out the past action detection results from the third storage unit **1204**, then determines if a behavior that could be the start of an action is occurring. In the case that the result of this determination is that a behavior that could be the start of an action has occurred, processing is performed to raise the probability of occurrence for this action in the prediction.

For example, in the case in which the behavior of raising a wrist has been confirmed, processing is performed that raises the probability of occurrence for reaching out a hand. Although the added percentage may be arbitrarily set, in this case, for example, 20% is added. In addition, in the case in which the detecting unit **209** detects an action that is different from the action that has been predicted by the person action predicting unit **1201**, the person action predicting unit **1201** performs processing to increase the probability of occurrence for the detected action that is different than this prediction. It is thereby possible to confirm behaviors that may become the start of an action and change predictions even in the case in which past predictions were incorrect.

A fourth storage unit **1203** stores the posture estimation results from the posture estimating unit **207**. The posture estimation results include human body detection likelihood in the same manner as FIG. **5**. The human body detection likelihood becomes low in the case in which a human body is hidden by some kind of obstacle such as their own body, another person, a shelf, or the like.

A selecting unit **1202** is the same configuration as the selecting unit **206** in the First Embodiment, and reads out the posture estimation results from the fourth storage unit **1203**. When selecting the processing subject image capturing apparatus for each person, the selecting unit **1202** selects the image capturing apparatus that has captured the image in which the least amount of the person is hidden to serve as the processing subject image capturing apparatus in the case in which there is a plurality of processing subject image capturing apparatuses for the processing subject person orientation (the case in which a plurality have been selected). Specifically, the image capturing apparatus that captured an image in which the human body detection likelihood for the posture estimation results by the person posture estimating unit **207** is the highest is selected to serve as the processing subject image capturing apparatus. It is thereby possible to select the image capturing apparatus that is least affected by hidden body parts or the like from among the image capturing apparatuses with person orientations that are suitable for the detection of the predicted action. Note that when the selecting unit **1202** selects a processing subject image capturing apparatus for a processing subject person orientation, it may also be made so as to select the processing subject image capturing apparatus by setting a predetermined threshold to serve as the degree of suitability in the same manner as in the First Embodiment.

In addition, the selecting unit **1202** acquires the calculation resource usage state for the image processing apparatus **200**. For example, the CPU usage percentage, the RAM usage percentage, or the application programming interface (API) for use in acquiring the GPU usage percentage that are provided by an Operating System (OS) are used when acquiring the calculation resource usage state. If the calculation resources have a specific level of availability or above based on the acquired calculation resource usage state, it may also be made such that a plurality of processing subject image capturing apparatuses are selected for each person being tracked (for every person who is being tracked). It is thereby possible to perform posture estimation for each person from even more person orientations, and therefore, the accuracy of the action detection is increased.

FIG. **13** is a flowchart showing the operations (processing) of the image processing apparatus **200** in the Second Embodiment. Note that in FIG. **13**, the processing that is the same as that in FIG. **9** will be given the same step numbers, and explanations thereof will be omitted.

During S**501**, the person action predicting unit **1201** acquires the action detection results from the third storage unit **1204**. During S**502**, the person action predicting unit **1201** predicts the actions of the person based on whether a behavior that is the start of a predetermined action is included in the acquired action detection results.

During S**503**, the selecting unit **206** determines the processing subject image capturing apparatuses for each person. In this context, the processing for determining the processing subject image capturing apparatuses in S**503** will be explained using the flowchart in FIG. **14**. FIG. **14** is a flowchart showing the determination processing for the processing subject image capturing apparatus for a processing subject person in S**503**. Note that in FIG. **14**, the processing that is the same as that in FIG. **10** will be given the same step numbers, and explanations thereof will be omitted.

During S**601**, the selecting unit **1202** uses the API for the OS and acquires the calculation resource usage state. During S**602**, the selecting unit **1202** determines whether or not there are resources that are available to an extent that a plurality of processing subject image capturing apparatuses can be selected for predetermined people who are being processed from the acquired calculation resources. In the case in which the result of this determination is that there are available resources, the processing proceeds to S**310**. In contrast, in the case in which there are no available resources, the processing proceeds to S**304**.

During S**603**, the selecting unit **1202** determines whether or not the person orientation for the processing subject image capturing apparatus that has been selected matches the person orientation for the processing subject person. In the case in which, as the result of this determination, the person orientation for the processing subject image capturing apparatus that has been selected matches the person orientation for the processing subject person, the processing proceeds to S**306**. In contrast, in the case in which the person orientation for the processing subject image capturing apparatus that has been selected does not match the processing subject person orientation, the processing proceeds to S**307**. During S**604**, the selecting unit **1202** reads out the posture estimation results from the fourth storage unit **1203**.

During S**605**, the selecting unit **1202** determines whether or not the person orientation for the determination subject image capturing apparatus is more suitable for the detection of the predicted action than the person orientation for the processing subject image capturing apparatus that has already been selected. In the case in which, as the result of this determination, it has been determined the person orientation for the determination processing subject image capturing apparatus is more suitable, the processing proceeds to S**310**. In contrast, in the case in which the person orientation for the processing subject image capturing apparatus that has been selected is not suitable, the processing returns to **S301**, and the same processing is repeated.

Note that in **S605**, in the case in which only the person orientation for the determination subject image capturing apparatus matches the processing subject person orientation, the selecting unit **1202** determines that the person orientation for the determination subject image capturing apparatus is more suitable. In addition, cases are assumed in which the person orientations for both the determination subject image capturing apparatus and the processing subject image capturing apparatus that has already been selected match the processing subject person orientation. In such cases, in the case in which the human body detection likelihood from the posture estimation results is at or higher by a predetermined amount for the results for the determination subject image capturing apparatus, the selecting unit **1202** determines that the person orientation for the determination subject image capturing apparatus is more suitable. It is possible to suppress the number of times that the selection results are changed by prioritizing the processing subject image capturing apparatus that has already been selected in all other cases.

Therefore, the image processing system in the Second Embodiment is able to select the image capturing apparatus that is the least effect by hidden body parts or the like to serve as the processing subject image capturing apparatus from among the image capturing apparatuses for which the person orientation is suitable for detecting the predicted action. In addition, posture estimation can be performed based on a larger number of person orientations for each person according to the available capacity of the computing resources, thereby making it possible to improve the accuracy of the action detection.

In the Third Embodiment, action predictions according to person position, a setting screen for the ideal person orientation for each action, and a results confirmation screen will be explained. Below, the explanation will be given focusing on the parts of the Third Embodiment that are different in comparison to those of the First Embodiment and the Second Embodiment.

FIG. **15** is a diagram showing a configuration of the image processing system of the Third Embodiment. Note that in the configuration of image processing system in the Third Embodiment, explanations of the configurations and functional units that are the same as those in the First Embodiment and the Second Embodiment will be omitted.

A fifth storage unit **1307** stores past aggregation results. An aggregating unit **1306** reads out the action detection results from a third storage unit **1305**, and after this, reads out the past aggregation results from the fifth storage unit **1307**, and aggregates these action detection results together with these past aggregation results. In addition, it may also be made such that the aggregating unit **1306** reads out the action detection results after having previously read out the past aggregation results, and aggregates these together.

As the aggregation method in the aggregating unit **1306**, the images that have been captured by the image capturing apparatuses are separated into block regions, and the number of actions detected for the block regions including the person positions in the images are counted. In this manner, aggregation results for the action detection are generated by aggregating the action detection results for each block region. This aggregation method will be explained below using FIG. **16**.

FIG. **16** is a diagram showing one example of a person action prediction by person position in the Third Embodiment. FIG. **16**A is an image of a person action inside of a store. FIG. **16**B is an image in which the image shown in FIG. **16**A has been separated into block regions.

In the image shown in FIG. **16**, a person **1403** who is crouching down in front of a product shelf **1401** can be confirmed. The leg positions for this person **1403** are included in a block region **1405**, and therefore, the aggregating unit **1306** adds 1 to the crouching down count for this block region **1405**. In addition, in the image shown in FIG. **16**, a person **1404** who is reaching their hand out in front of the product shelf **1405** can also be confirmed. The leg positions for this person are included in the block region **1406**, and therefore, the aggregating unit **1306** adds 1 to the reaching out a hand count for this block region **1406**.

Note that the leg position coordinates x1, and y1 for this person, can be calculated using, for example, the following formula (1) from the entire body frame for the tracking (central coordinates x0, y0, width w, height h).

[Formula 1]

$$x1 = x0 \qquad (1)$$
$$y1 = y0 + (h/2)$$

As the calculation method for a person's feet positions, other than the above Formula (1), for example, from among the right and left ankle positions from the posture estimation results, those for which the y coordinates are large, that is, the ankle positions in the bottom side of the image, may also be used

The aggregating unit **1306** stores the above-described aggregation results for the action detection on the fifth storage unit **1307**. A person action predicting unit **1301** has the same configuration as the person action predicting unit **204** of the First Embodiment, and reads the action detection aggregation results from the first storage unit **1307**. The aggregating unit **1306** uses the aggregation results for the action detection that it has read, and calculates the probability of occurrence for each action in each position for each person for whom actions are predicted based on the action count for each block region.

Specifically, the aggregating unit **1306** makes the sum total for the action count in each block region the denominators, and the action counts for each action in each block region the numerators, and calculates (computes) the probability of occurrence for each action. The probability of occurrence for each action that has been calculated is stored inside the person action predicting unit **1301** as a probability of action occurrence table for each block region. Note that the person action predicting unit **1301** updates the action occurrence tables for each block region each time that a period of time, which was set in advance, has passed. The set time may be set with a unit of several minutes, for example, 5 minutes or the like, or it may also be a unit of several dozen minutes.

The person action predicting unit **1301** reads the probability of action occurrence for blocks including a person position from the probability of action occurrence tables for each block region, and makes this the probability of occurrence of each action for this person. Note that although in this example, aggregation has been performed by the person position, a method may also be used that further performs aggregation for each person orientation in each block region, not just the person positions.

Next, the setting screen for the optimal person orientation for each action for each person and the results confirmation screen will be explained. The action detection results that are stored in the third storage unit **1305** include the person images for the time of detection.

A setting unit **1304** is able to set an optimal person orientation for each action for a person. In addition, the setting unit **1304** reads the images from the time of detection for each action from the third storage unit **1305**, and displays them on the display unit **405**. Below, an example of a setting screen that is displayed on the display unit **405** will be explained with reference to FIG. **17**.

FIG. **17** is an image of a setting screen for reaching out a hand in the Third Embodiment. FIG. **17**A is a diagram showing an image of a setting screen, and is a diagram that shows a state in which the detection results images **1506** to **1510** are displayed on the screen, FIG. **17**B is a diagram showing an image of a setting screen, and is a diagram showing a state in which the user is touching a button and clearing a selection.

1501 shown in FIG. **17** is an example of a detection setting screen for reaching out a hand. The action name that is being set is shown in **1502**. In addition, each of a button **1503** that corresponds to the frontal direction, a button **1504** that corresponds to the sideways direction, and a button **1505** that corresponds to a back direction are disposed on the screen. In addition, each of the detection results images **1506** to **1510** for each orientation are also displayed. The buttons **1503** to **1505** are displayed as being emphasized by being surrounded by a plurality of squares, and this shows that these buttons have been selected. That is, this is in a state in which all of the person orientations, frontal, sideways, and back, have been selected as the optimal person orientations for detecting reaching out a hand.

At this time, if this FIG. **17** is used as an example, the user confirms that the image **1507** for an action that is not reaching out a hand, and the images **1509** and **1510**, for which it is unclear if a hand is being reached out, are included by viewing the detection results images **1506** to **1510** from the setting screen that is displayed on the display unit **405**. After this, as is shown in FIG. **17**B, the user touches the button **1503** and the button **1505**, and clears the selection for front and back. The user confirms that only reaching out a hand is detected for the sideways orientation, and does not touch the button **1504**, thereby not clearing its selection (it remains selected). After this, the user completes the settings by pressing (clicking, or touching) the settings complete button **1511**. The sideways orientation is thereby set as the optimal person orientation for detecting reaching out a hand.

FIG. **18** is a flowchart showing the operations (processing) for the image processing apparatus **200** in the Third Embodiment. Note that in FIG. **18**, the processing that is the same as that in FIG. **9** and FIG. **13** are assigned the same step numbers, and explanations thereof are omitted.

During S**701**, the aggregating unit **1306** reads out the action detection results from the third storage unit **1305**. During S**702**, the aggregating unit **1306***r* reads out the past aggregation results from the fifth storage unit **1307**. During S**703**, the aggregating unit **1306** aggregates the action detection results based on the action detection results that have been read out from the third storage unit **1305**, and the past aggregation results that have been read out from the fifth storage unit **1307**. During S**704**, the aggregating unit **1306** stores the aggregation results on the fifth storage unit **1307**. During S**705**, the person action predicting unit **1301** reads the action detection aggregation results from the fifth storage nit **1307**, and predicts the probability of occurrence for each action for each person who is a processing subject.

FIG. **19** is flowchart for the setting processing for the optimal person orientation for each action in the image processing apparatus **200**.

First, during S**801**, the setting unit **1304** displays s menu screen on the display unit **405**. At this time, the menu screen that is displayed on the display unit **405** displays a selection list for actions to be set, and a commence setting button.

Next, during S**802**, the setting unit **1304** determines whether or not the commence setting button has been pressed. In the case in which, as the result of the determination, the commence setting button has been pressed, the processing proceeds to S**803**. In contrast, in the case in which the commence setting button has not been pressed, the processing proceeds to S**804**.

Next, during S**803**, the setting unit **1304** reads the current settings from the third storage unit **1305**, and displays a settings screen as in FIG. **17**A on the upper portion of the screen of the display unit **405**. The settings screen that is displayed on the screen of the display unit **405** is a setting screen for the action that has been chosen from the list during S**802**.

Next, during S**804**, the setting unit **1304** determines whether or not there is a request to stop. In the case in which, as a result of this determination, there is no request to stop, the processing returns to S**802**, and the same processing is repeated. In contrast, in the case in which there has been a request to stop, the processing is completed.

Next, during S**805**, the setting unit **104** determines whether or not there has been an operation to change the settings. In the case in which, as the result of this determination, there has been an operation to change the settings, the processing proceeds to S**806**. In contrast, in the case in which there has not been an operation to change the settings, the processing proceeds to S**807**.

Next, during S**806**, the setting unit **1304** changes the settings in response to the operation, and outputs the changed settings to a sixth storage unit **1303**. After this, the processing returns to S**805**, and the same processing is repeated. The changes to the settings are, changes such as, for example, selecting the front orientation as the optimal person orientation, or removing this from the selections, and the like.

Next, during S**807**, the setting unit **1304** determines whether or not the settings complete button has been pressed. In the case in which, as the result of this determination, the complete setting button has been pressed, the processing returns to S**801**, and the same processing is repeated. In contrast, in the case in which the change settings button has not been pressed, the processing proceeds to S**808**.

Next, during S**808**, the setting unit **1304** determines whether or not there has been a request to stop. In the case in which, as a result of this determination, there is no request to stop, the processing returns to S**805**, and the same processing is repeated. In contrast, in the case in which there has been a request to stop, the processing is completed.

Above, in the image processing system of the Third Embodiment, it is possible to display a setting screen for the action predictions according to person position, and the optimal person orientation for each action, and a results confirmation screen on the display unit **405**, and it is possible for the user to set the optimal person orientation for each action for a person.

Above, although preferable embodiments of the present invention have been explained above, the present invention is not limited by these embodiments, and various changes and alterations can be made within the scope of the gist thereof. In addition, although a plurality of embodiments have been described above, the present invention can also take the embodiment of a system, apparatus, method, program, recording medium (storage medium), or the like. Specifically, it may also be applied to a system that is configured from a plurality of apparatuses (for example, a host computer, an interface device, an image capturing apparatus, a web application, and the like), and in addition it may also be applied to an apparatus that comprises one device. In addition, it may also be made such that, for example, the functions of the entirety or a portion of each functional unit shown in FIG. **1** are included in an apparatus that is different from the image processing apparatus **200**. Specifically, it may be made such that a storage device that is different from the image capturing apparatuses and the image processing apparatus **200** has these functional units, and that the functions of each embodiment are realized by performing communications with the image processing apparatus **200** based on a wired or wireless connection. In addition, it may also be made such that, for example, one or both of the image capturing apparatus **100** and the image capturing apparatus **110** perform at least a portion of the detection processing and the tracking processing for the people, and that these results are provided to the image processing apparatus **200** along with the captured images. In the same manner, it may also be made such that one or more of the functional units in FIG. **1** are realized by one or more computers that are different from the image processing apparatus **200**. In addition, it may also be made such that the image processing apparatus **200** has image capturing functions that are equivalent to those of the image capturing apparatus **100** and the image capturing apparatus **110**. In this case, the present invention can be configured such that, for example image processing apparatus **200** has the above-described image capturing unit and image transmission unit. In addition, it may also be made such that a portion of or all of the functions of each functional unit shown in FIG. **1** is had by one or more apparatuses that are different from the image processing apparatus **200**, and it is also possible for the image processing apparatus **200** to have image capturing capabilities in addition to all of the functions of FIG. **1**. The same also applies to FIG. **12** and FIG. **15**. In addition, the plurality of image capturing apparatuses that are used for detecting people and the plurality of image capturing apparatuses that serve as the candidates for the optimal image capturing apparatuses do not necessarily need to perfectly correspond to each other. For example, image capturing apparatuses that are used only for detection processing and action prediction for people may also exist in the system.

In addition, it also goes without saying that the aim of the present invention could also be achieved in the following manner. That is, a recording medium (or a storage medium) on which a software program code (a computer program) for realizing the functions of the above-explained examples has been recorded is provided to the system or the apparatus. It also goes without saying that the related storage medium is a computer readable storage medium. In addition, the computer (or CPU or MPU) of this system or apparatus reads out an executes the program code that has been stored on the recording medium. In this case, the program code itself that has been read out from the recording medium executes the functions of the above-described examples, and the recording medium on which this program code has been recorded configures the present invention.

While the present invention has been described with reference to exemplary embodiments, it is to be understood that the invention is not limited to the disclosed exemplary embodiments. The scope of the following claims is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent structures and functions.

This application claims the benefit of Japanese Patent Application No. 2022-081817, May 18, 2022, which is hereby incorporated by reference herein in its entirety

What is claimed is:

1. An image processing apparatus comprising:

one or more memories storing instructions; and

one or more processors executing the instructions to:

predict a plurality of actions of a person who has been detected from images captured by an image capturing apparatus;

determine an orientation of the person based on the action prediction results for each action, and ascertain an ideal orientation of the person suitable for detecting a motion in the predicted action with a highest probability;

select, from among a plurality of image capturing apparatuses, an optimal image capturing apparatus for detecting future actions of the person, wherein the optimal capturing apparatus is selected when the orientation of the person in the images captured by said apparatus most closely matches the ascertained ideal orientation of the same person ascertained from said predicted results; and

detect the future actions of the person based on images that have been captured by the optimal image capturing apparatus.

2. The image processing apparatus according to claim **1**, wherein, the one or more processors select, from among the plurality of image capturing apparatuses, an image capturing apparatus that captures images of the person from an angle that is closest to the determined person orientation to serve as the optimal image capturing apparatus.

3. The image processing apparatus according to claim **1**, wherein the one or more processors are configured to determine the person orientation based further on posture estimation results that have been posture estimated for the person.

4. The image processing apparatus according to claim **3**, wherein the one or more processors are configured to detect actions of the person based on the posture estimation results, the person orientation, and tracking information for the person in the images captured by the optimal image capturing apparatus.

5. The image processing apparatus according to claim **3**, wherein, in the case in which the difference for the person orientation for two or more image capturing apparatuses is less than a threshold, the one or more processors are configured to select an image capturing apparatus that has captured an image of the person in which the person is least hidden in the captured images from among the two or more image capturing apparatuses.

6. The image processing apparatus according to claim **5**, wherein the one or more processors are configured to determine that the person is least hidden in the case in which there is a high human body detection likelihood in the posture estimation results.

7. The image processing apparatus according to claim **1**, wherein the one or more processors are configured to acquire a resource usage state of the image processing apparatus, and select a plurality of image processing apparatuses to serve as the optimal image capturing apparatus for the person according to the resource usage state.

8. The image processing apparatus according to claim **1**, wherein, in the case in which an action that is different from the action that has been predicted has been detected based on an image captured by the optimal image capturing apparatus, the one or more processors are configured adjust a prediction method for an action so as to increase the probability of occurrence for the different action.

9. The image processing apparatus according to claim **2**, wherein the one or more processors are configured to generate aggregation results by aggregating detection results for actions for a person for each separated region in which an image that has been captured by the plurality of image capturing apparatuses has been separated into a plurality of regions.

10. The image processing apparatus according to claim **9**, wherein the one or more processors are configured to predict the actions of the person by using the aggregation results for separated regions to which the person who is the prediction subject for the action belongs.

11. The image processing apparatus according to claim **1**, wherein the person orientation is at least one from among a facial orientation, a body orientation, or a hand orientation.

12. The image processing apparatus according to claim **1**, wherein the one or more processors are configured to select the optimal image capturing apparatus based on a person orientation corresponding to an action of the person for which the probability of occurrence is predicted to be higher.

13. The image processing apparatus according to claim **1**, wherein the one or more processors are configured to predict a probability of occurrence for each of a plurality of person orientations, and to select the optimal image capturing apparatus based on a person orientation for which the probability of occurrence is higher.

14. The image processing apparatus according to claim **1**, wherein the one or more processors are configured to set the person orientation of an action for each action of the person.

15. The image processing apparatus according to claim **14**,

wherein the one or more processors are configured to display an image from a time of action detection for each person orientation on a settings screen of a display apparatus.

16. The image processing apparatus according to claim **1**, wherein the one or more processors are configured to select at least one image capturing apparatus to serve as the optimal image capturing apparatus for one person from the plurality of image capturing apparatuses according to a number of a person who are made subjects of action detection.

17. A control method of an image processing apparatus, wherein the control method comprises:

predicting a plurality of actions of a person who has been detected from images captured by an image capturing apparatus;

determining an orientation of the person based on the action prediction results for each action, and ascertain an ideal orientation of the person suitable for detecting a motion in the predicted action with a highest probability;

selecting, from among a plurality of image capturing apparatuses, an optimal image capturing apparatus for detecting future actions of the person, wherein the optimal capturing apparatus is selected when the orientation of the person in the images captured by said apparatus most closely matches the ascertained ideal orientation of the same person ascertained from said predicted results; and

detecting the future actions of the person based on images that have been captured by the optimal image capturing apparatus.

18. A non-transitory computer-readable storage medium configured to store a computer program comprising instructions for executing following processes:

predicting a plurality of actions of a person who has been detected from images captured by an image capturing apparatus;

determining an orientation of the person based on the action prediction results for each action, and ascertain an ideal orientation of the person suitable for detecting a motion in the predicted action with a highest probability;

selecting, from among a plurality of image capturing apparatuses, an optimal image capturing apparatus for detecting future actions of the person, wherein the optimal capturing apparatus is selected when the orientation of the person in the images captured by said apparatus most closely matches the ascertained ideal orientation of the same person ascertained from said predicted results; and

detecting the future actions of the person based on images that have been captured by the optimal image capturing apparatus.

19. An image processing system comprising an image processing apparatus, and a plurality of image capturing apparatuses that are communicatively connected to the image processing apparatus, wherein

the image processing apparatus that is included in the image processing system has:

at least one memory storing instructions; and

one or more processors configured to execute the instructions, which when executed by the one or more processors, cause the image processing apparatus to:

predict a plurality of actions of a person who has been detected from images captured by one or more image capturing apparatuses from among the plurality of image capturing apparatuses;

determine an orientation of the person based on the action prediction results for each action, and ascertain an ideal orientation of the person suitable for detecting a motion in the predicted action with a highest probability;

select, from among a plurality of image capturing apparatuses, an optimal image capturing apparatus for detecting future actions of the person, wherein the optimal capturing apparatus is selected when the orientation of the person in the images captured by said apparatus most closely matches the ascertained ideal orientation of the same person ascertained from said predicted results; and

detect the future actions of the person based on images that have been captured by the optimal image capturing apparatus;

and wherein, the plurality of image capturing apparatuses included in the image processing system has:

an image capturing unit configured to capture the images; and a transmission unit configured to transmit the captured images to the image processing apparatus.

20. The image processing system according to claim **19**, wherein the plurality of image capturing apparatuses are each disposed such that at least one of a disposure position or a disposure angle of each of the image capturing apparatuses is different.

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