US 20070183638A1

(19) United States

(12) Patent Application Publication (10) Pub. No.: US 2007/0183638 A1

Nakamura (43) Pub. Date: Aug. 9, 2007

(54) IMAGE EXTRACTING APPARATUS AND IMAGE EXTRACTING METHOD

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(21) Appl. No.: **11/783,127**

(22) Filed: **Apr. 6, 2007**

Related U.S. Application Data

(62) Division of application No. 09/879,909, filed on Jun. 14, 2001, now Pat. No. 7,212,233.

(30) **Foreign Application Priority Data**

Jun. 14, 2000 (JP) ..... JP 2000-178230

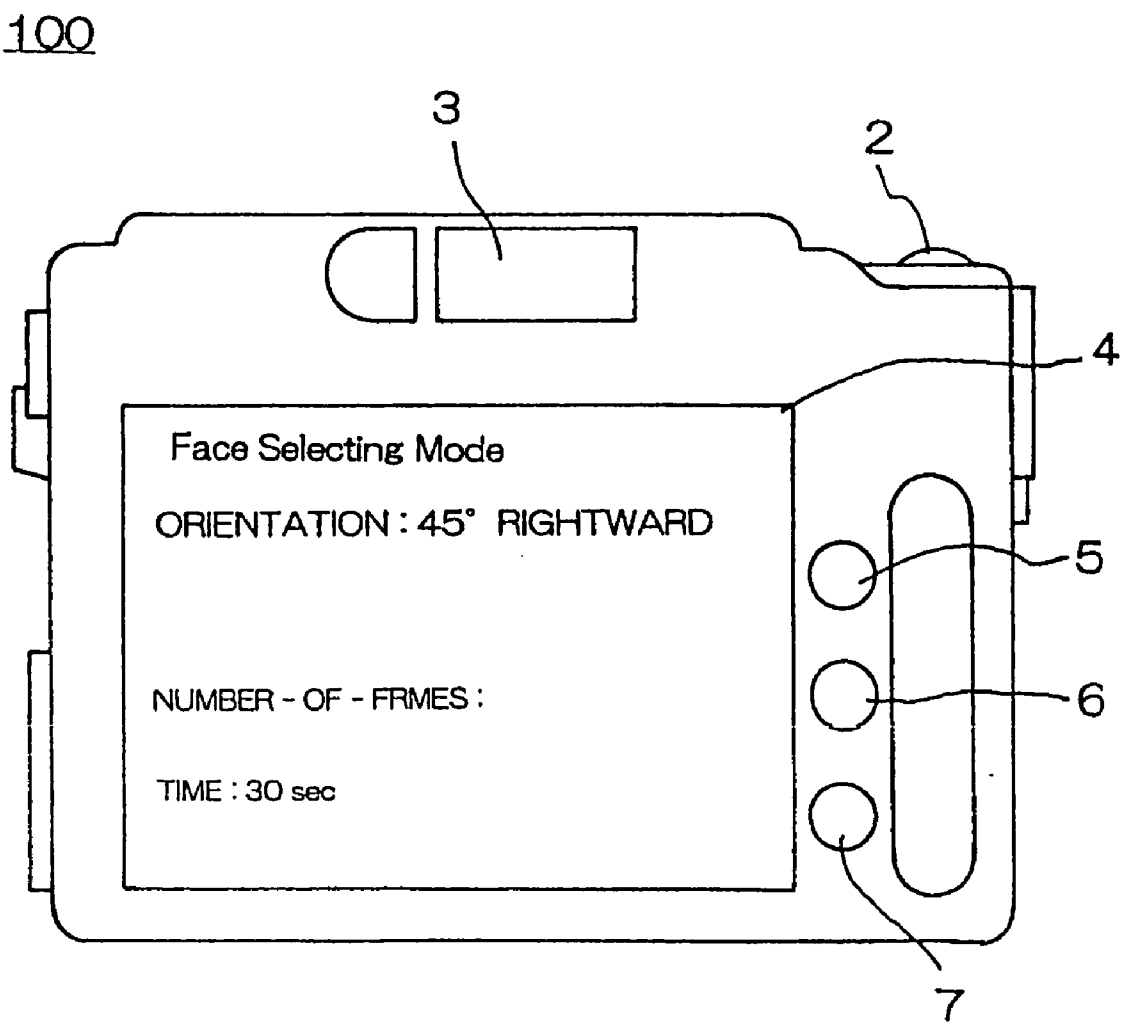
Publication Classification

(51) **Int. Cl.**
G06K 9/00 (2006.01)

(52) **U.S. Cl.** **382/128**

(57) **ABSTRACT**

An object of the present invention is to obtain an image of a subject in a desired pose. To attain this object, an image extracting apparatus according to the present invention is provided with an image database in which a plurality of images is stored, detecting means (S**104**) for detecting the orientation of a subject in an image, and extracting means (S**106**) for extracting an image including a subject in a predetermined orientation (S**102**) from the image database based on the result of the detection by the detecting means.



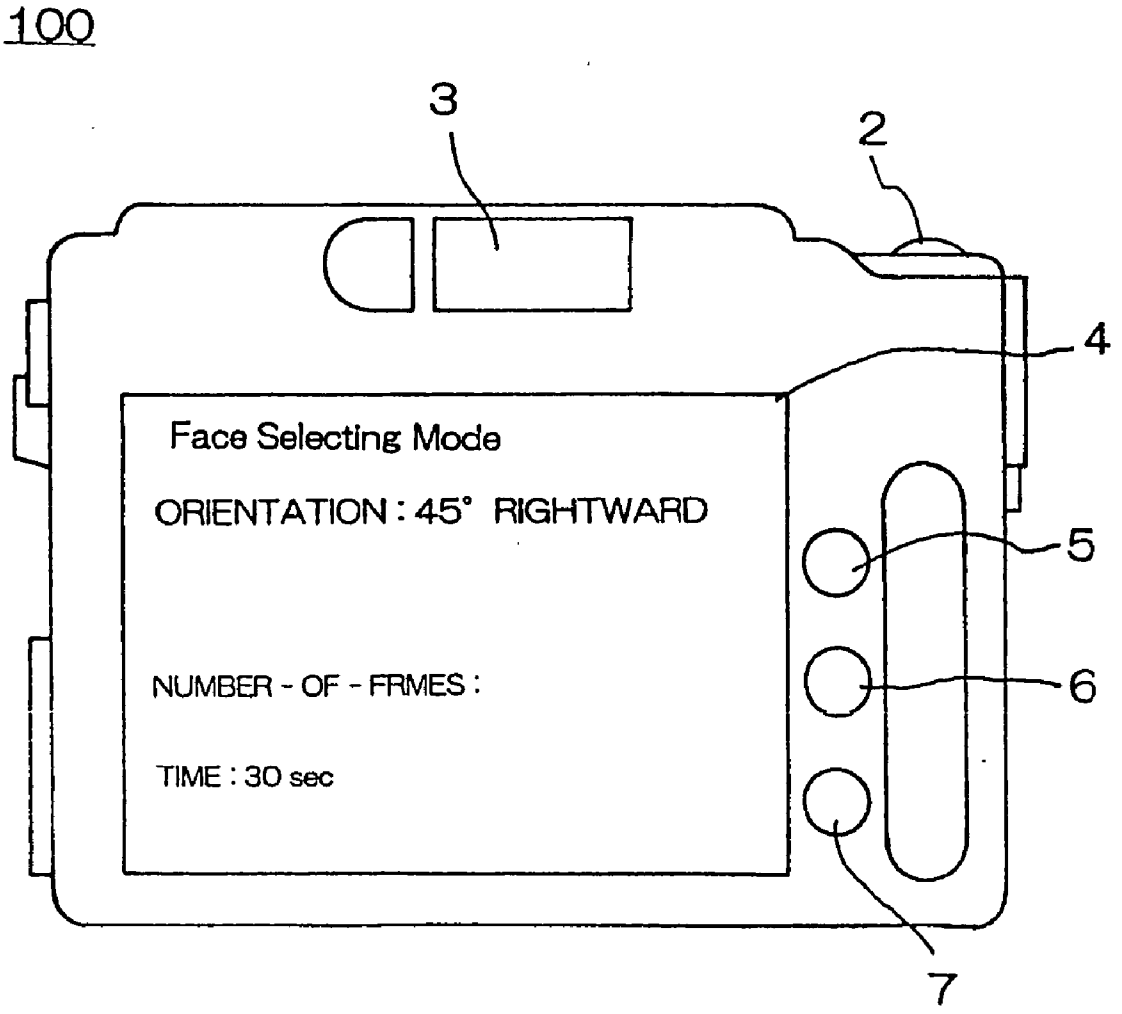

100
3
2
4
Face Selecting Mode
ORIENTATION : 45° RIGHTWARD
NUMBER - OF - FRMES :
TIME : 30 sec
5
6
7

FIG. 1

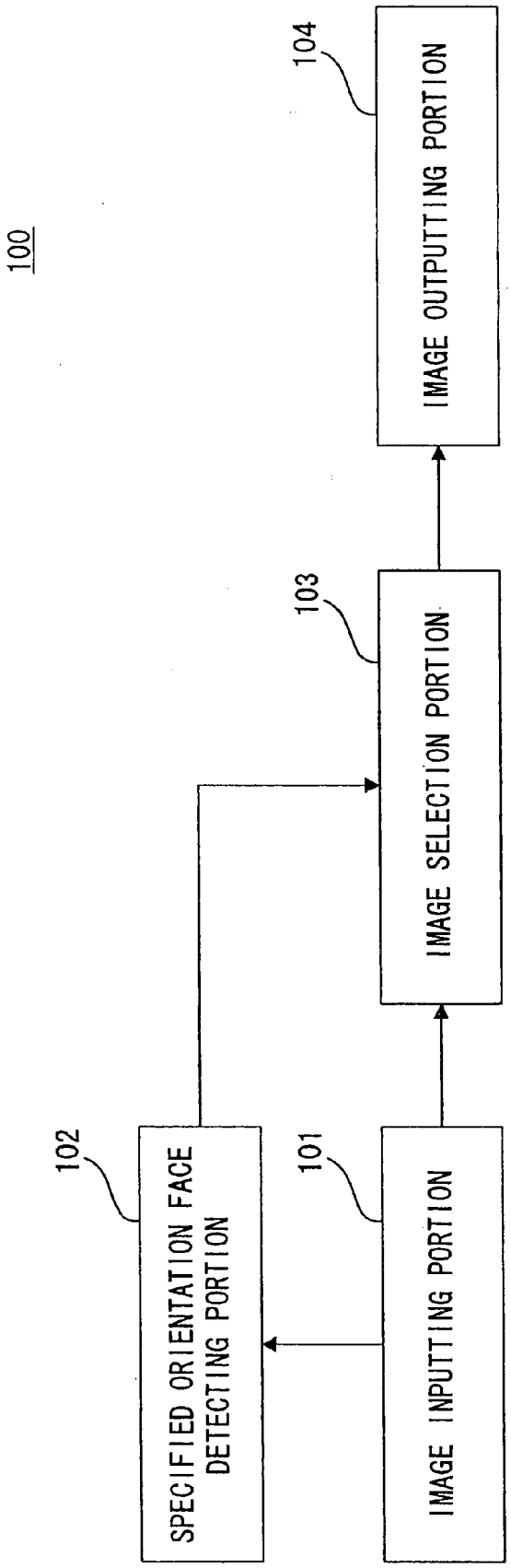

100
104
IMAGE OUTPUTTING PORTION
103
IMAGE SELECTION PORTION
102
SPECIFIED ORIENTATION FACE DETECTING PORTION
101
IMAGE INPUTTING PORTION

FIG. 2

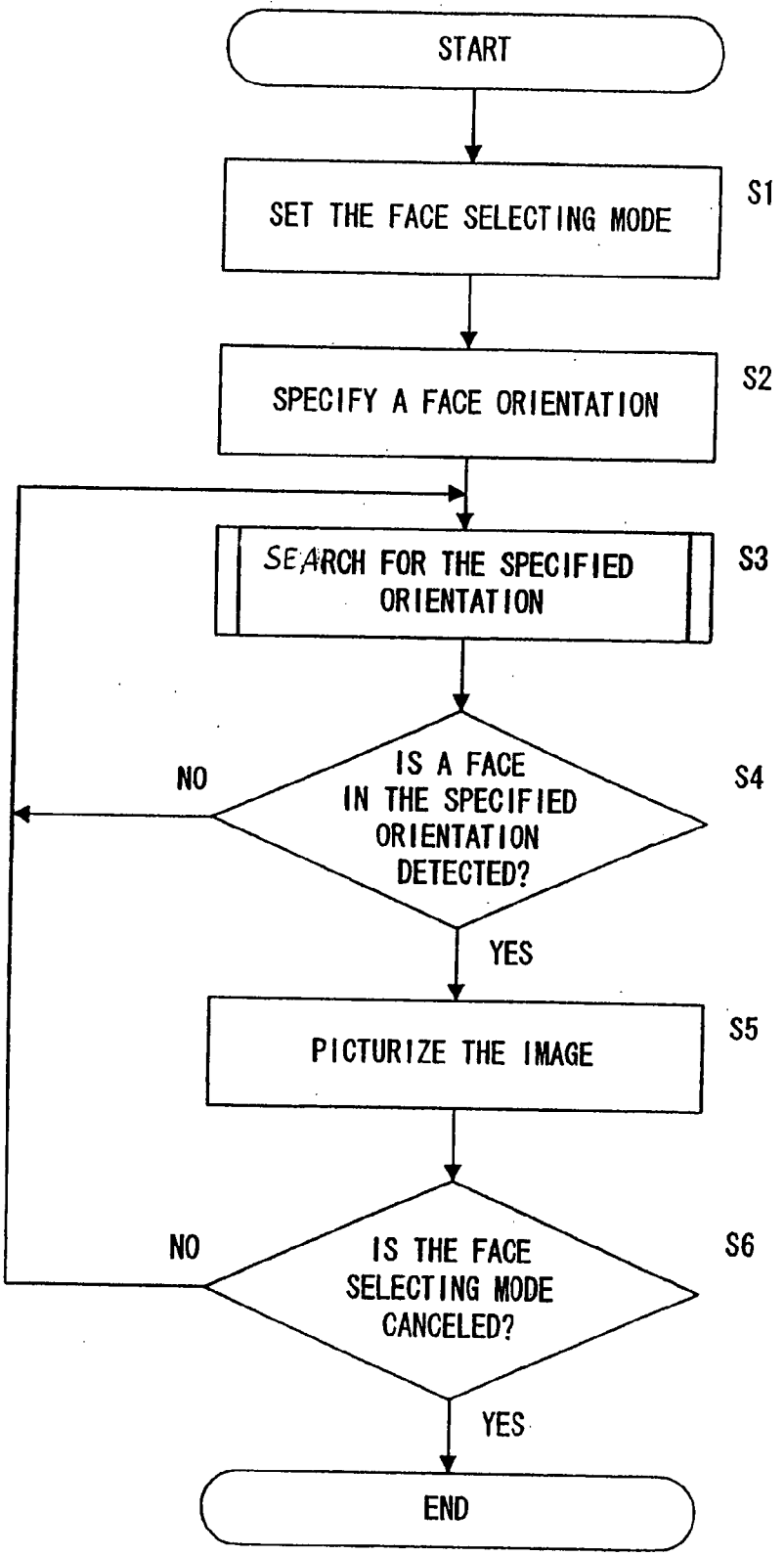

START
SET THE FACE SELECTING MODE
S1
SPECIFY A FACE ORIENTATION
S2
SEARCH FOR THE SPECIFIED ORIENTATION
S3
IS A FACE IN THE SPECIFIED ORIENTATION DETECTED?
S4
NO
YES
PICTURIZE THE IMAGE
S5
IS THE FACE SELECTING MODE CANCELED?
S6
NO
YES
END

FIG. 3

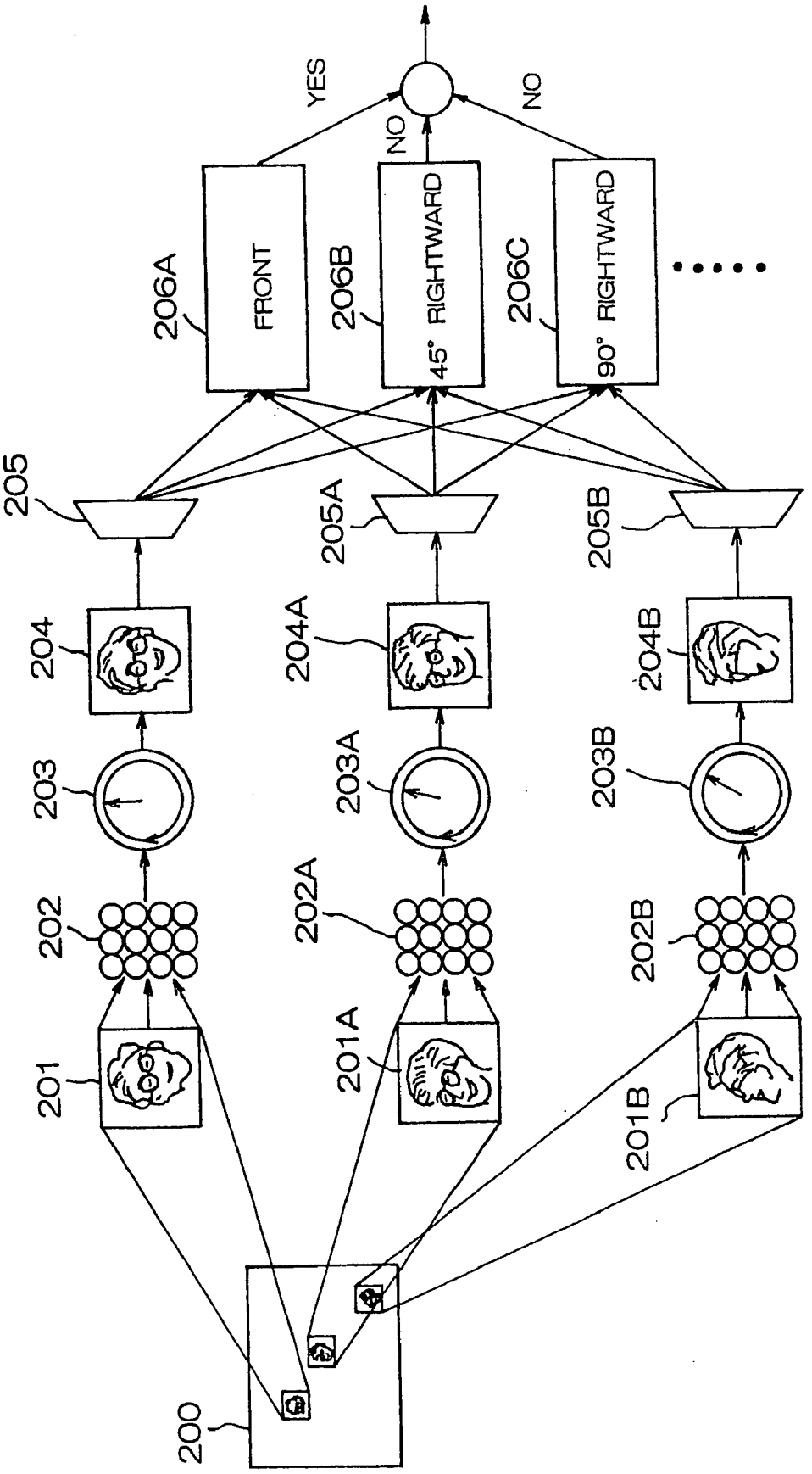

YES
NO
NO
206A
FRONT
206B
45° RIGHTWARD
206C
90° RIGHTWARD
205
205A
205B
204
204A
204B
203
203A
203B
202
202A
202B
201
201A
201B
200

FIG. 4

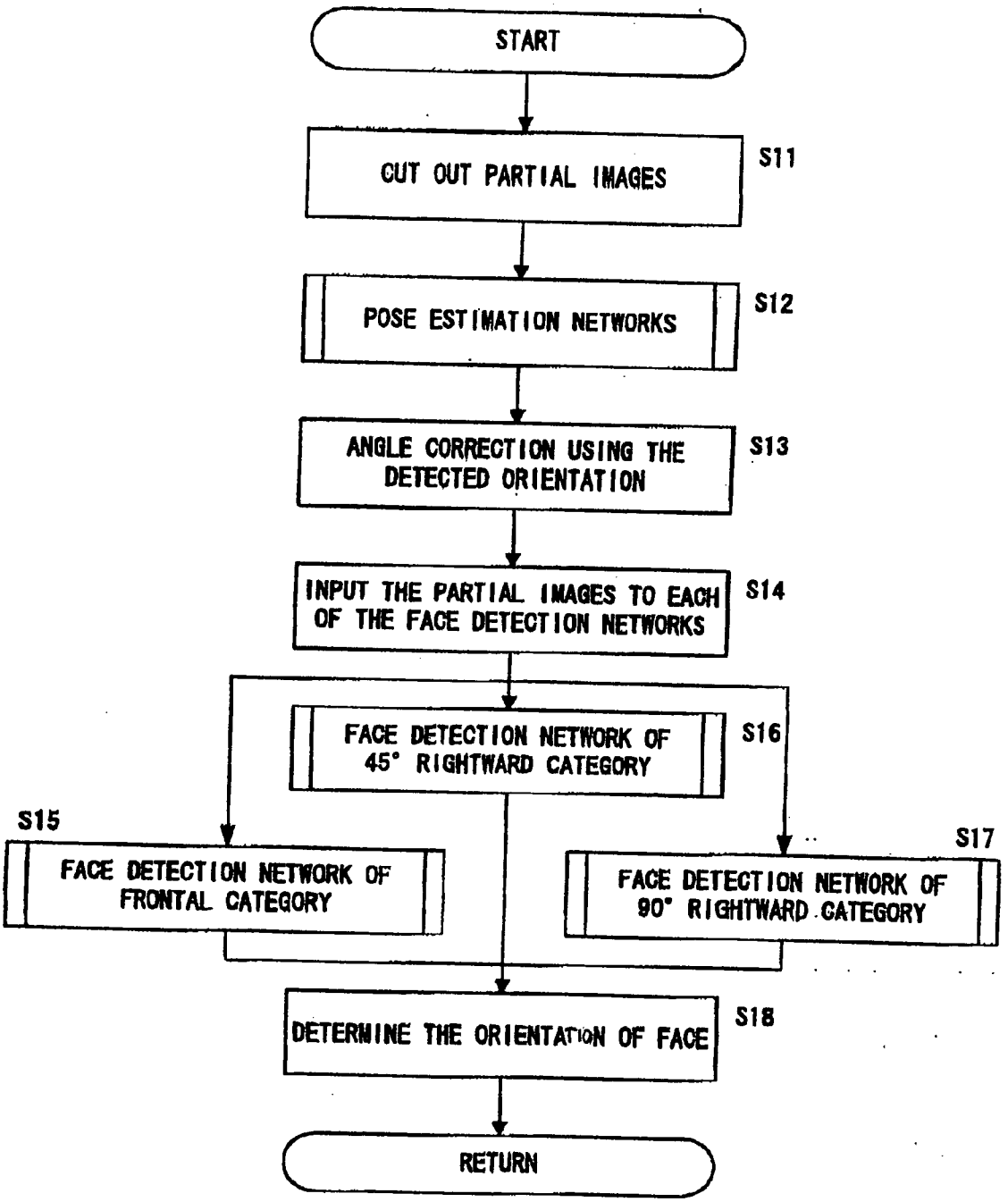

START
CUT OUT PARTIAL IMAGES
S11
POSE ESTIMATION NETWORKS
S12
ANGLE CORRECTION USING THE DETECTED ORIENTATION
S13
INPUT THE PARTIAL IMAGES TO EACH OF THE FACE DETECTION NETWORKS
S14
FACE DETECTION NETWORK OF 45° RIGHTWARD CATEGORY
S16
S15
FACE DETECTION NETWORK OF FRONTAL CATEGORY
S17
FACE DETECTION NETWORK OF 90° RIGHTWARD CATEGORY
DETERMINE THE ORIENTATION OF FACE
S18
RETURN

FIG. 5

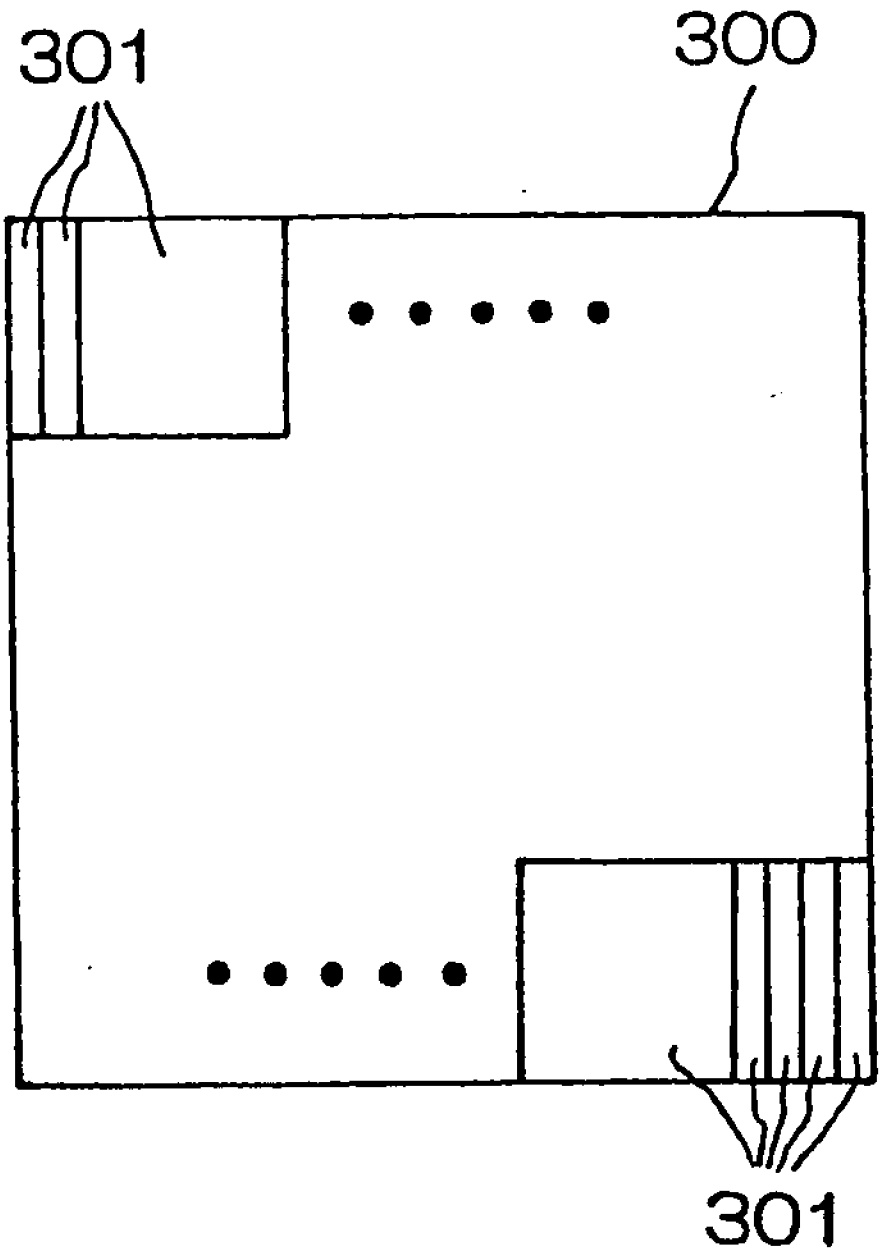


FIG. 6

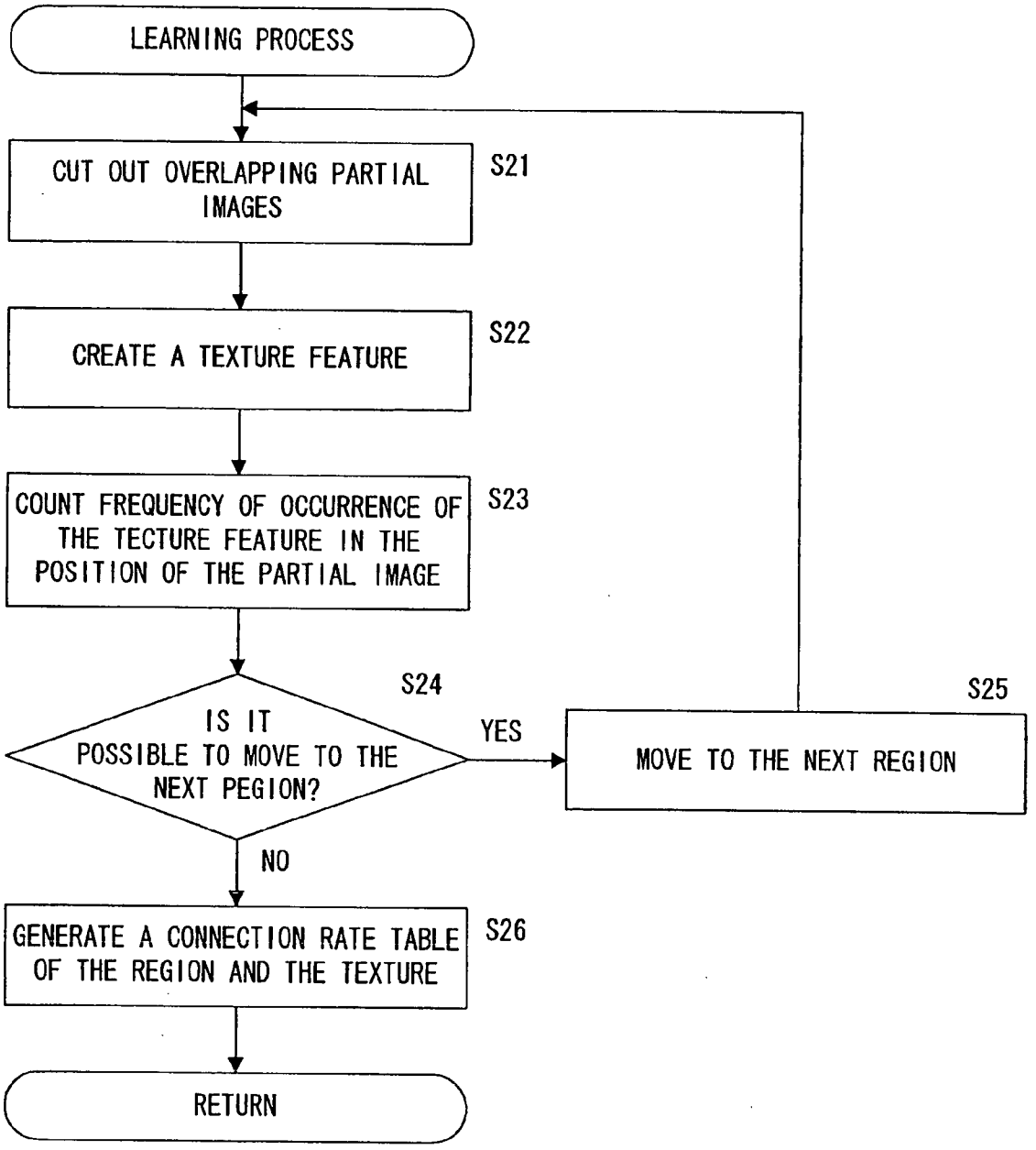

LEARNING PROCESS
CUT OUT OVERLAPPING PARTIAL IMAGES
S21
CREATE A TEXTURE FEATURE
S22
COUNT FREQUENCY OF OCCURRENCE OF THE TECTURE FEATURE IN THE POSITION OF THE PARTIAL IMAGE
S23
S24
IS IT POSSIBLE TO MOVE TO THE NEXT PEGION?
YES
S25
MOVE TO THE NEXT REGION
NO
GENERATE A CONNECTION RATE TABLE OF THE REGION AND THE TEXTURE
S26
RETURN

FIG. 7

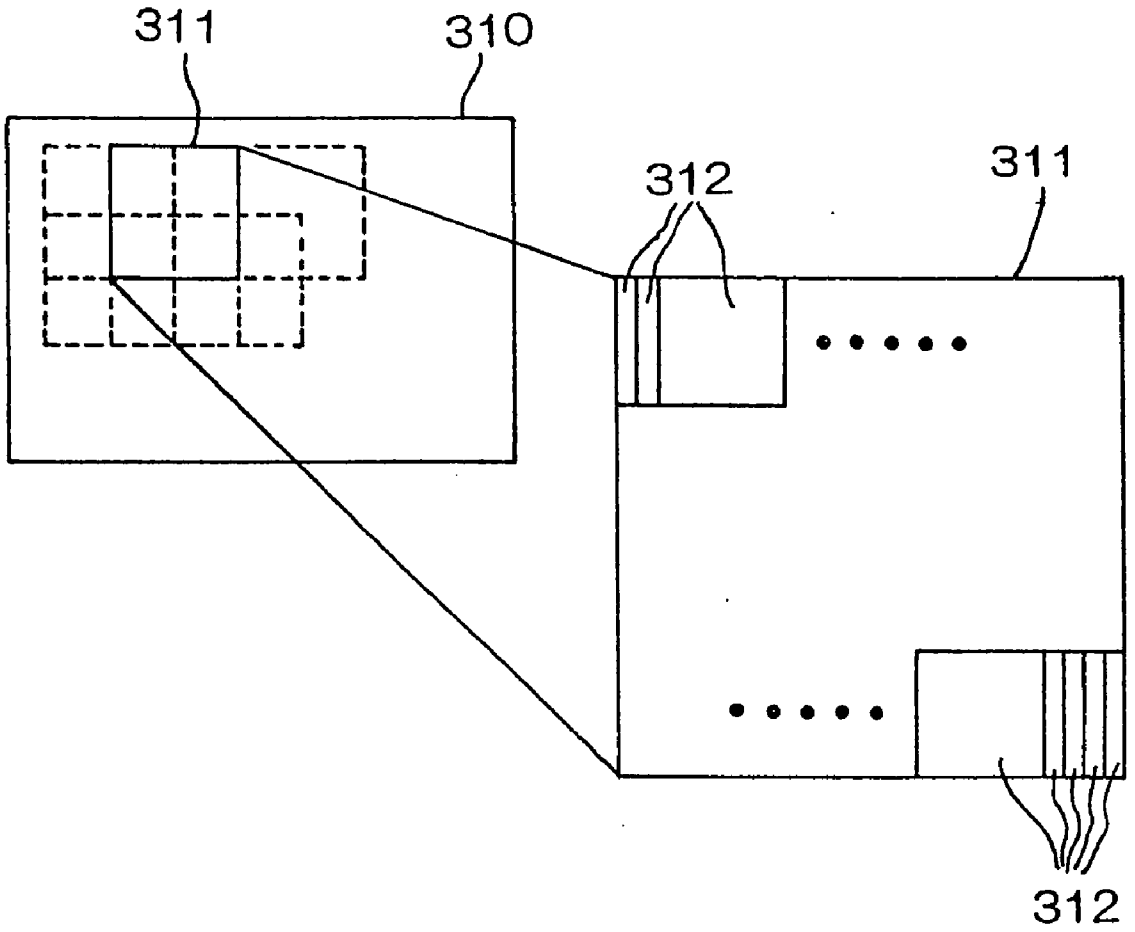


FIG. 8

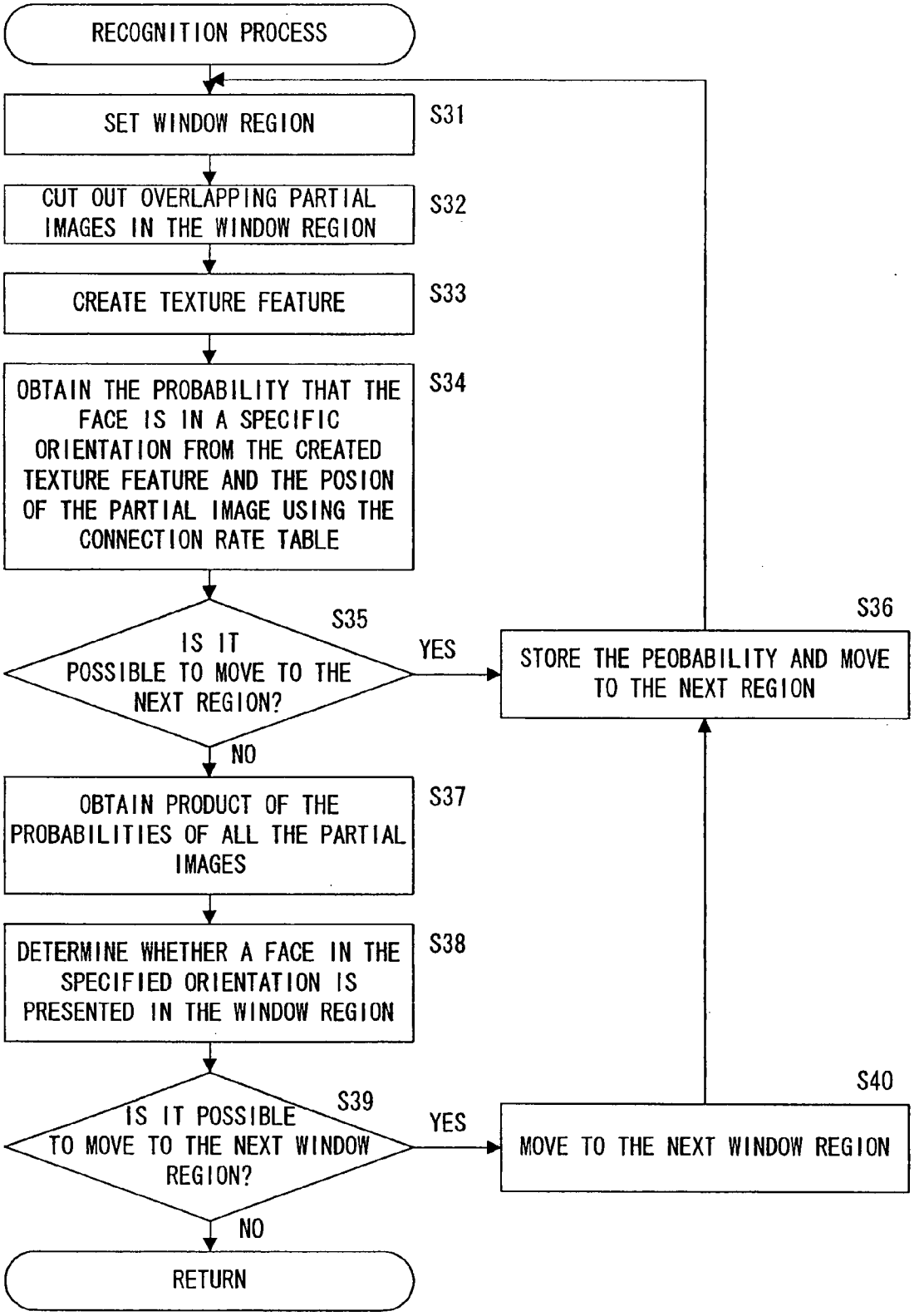

RECOGNITION PROCESS
SET WINDOW REGION
S31
CUT OUT OVERLAPPING PARTIAL IMAGES IN THE WINDOW REGION
S32
CREATE TEXTURE FEATURE
S33
OBTAIN THE PROBABILITY THAT THE FACE IS IN A SPECIFIC ORIENTATION FROM THE CREATED TEXTURE FEATURE AND THE POSION OF THE PARTIAL IMAGE USING THE CONNECTION RATE TABLE
S34
IS IT POSSIBLE TO MOVE TO THE NEXT REGION?
S35
YES
NO
STORE THE PEOBABILITY AND MOVE TO THE NEXT REGION
S36
OBTAIN PRODUCT OF THE PROBABILITIES OF ALL THE PARTIAL IMAGES
S37
DETERMINE WHETHER A FACE IN THE SPECIFIED ORIENTATION IS PRESENTED IN THE WINDOW REGION
S38
IS IT POSSIBLE TO MOVE TO THE NEXT WINDOW REGION?
S39
YES
NO
MOVE TO THE NEXT WINDOW REGION
S40
RETURN

FIG. 9

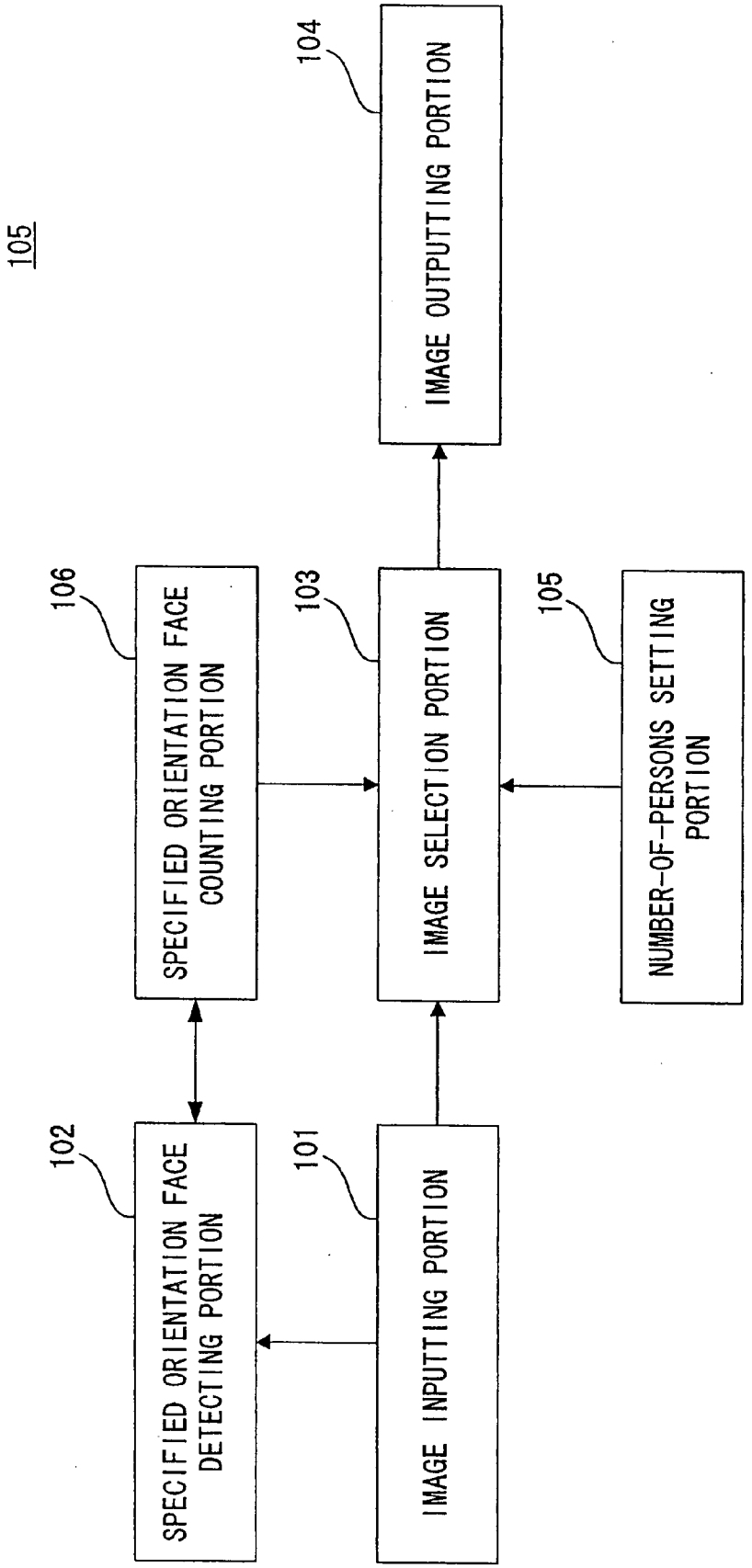

105
104
IMAGE OUTPUTTING PORTION
106
SPECIFIED ORIENTATION FACE COUNTING PORTION
103
IMAGE SELECTION PORTION
105
NUMBER-OF-PERSONS SETTING PORTION
102
SPECIFIED ORIENTATION FACE DETECTING PORTION
101
IMAGE INPUTTING PORTION

FIG. 10

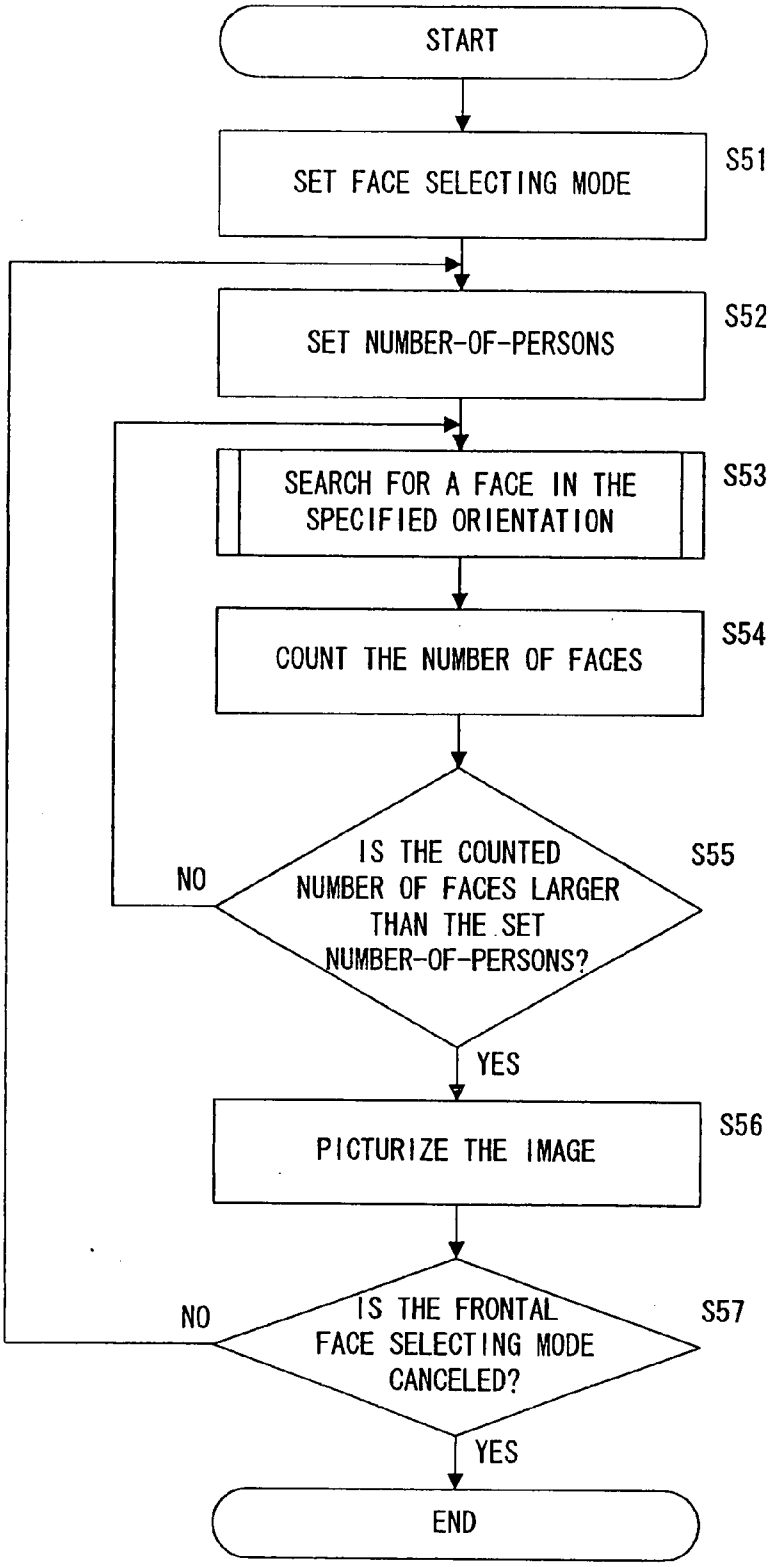

START
SET FACE SELECTING MODE
S51
SET NUMBER-OF-PERSONS
S52
SEARCH FOR A FACE IN THE SPECIFIED ORIENTATION
S53
COUNT THE NUMBER OF FACES
S54
IS THE COUNTED NUMBER OF FACES LARGER THAN THE SET NUMBER-OF-PERSONS?
S55
NO
YES
PICTURIZE THE IMAGE
S56
IS THE FRONTAL FACE SELECTING MODE CANCELED?
S57
NO
YES
END

FIG. 11

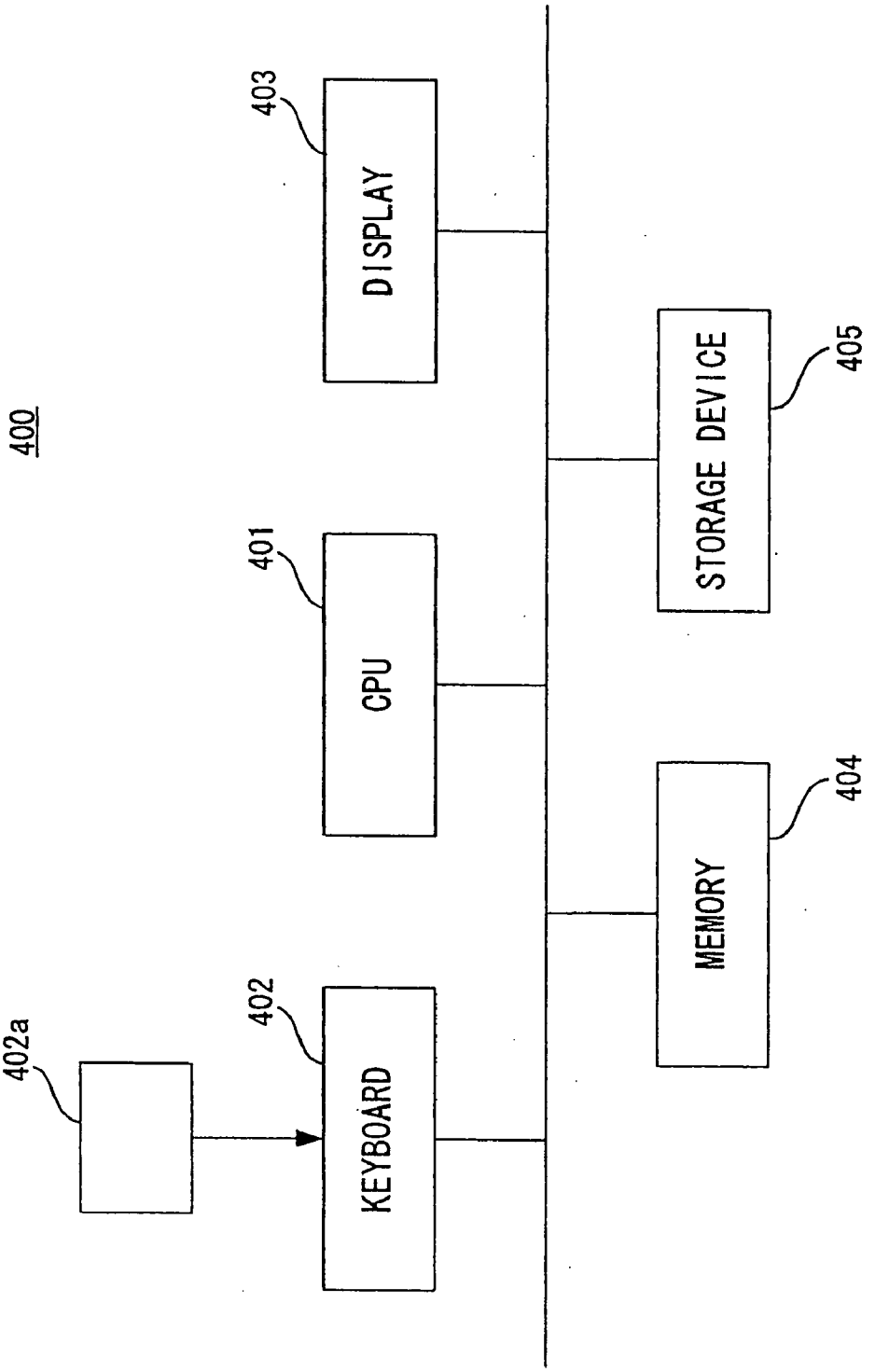

400
403
DISPLAY
401
CPU
402
KEYBOARD
402a
405
STORAGE DEVICE
404
MEMORY

FIG. 12

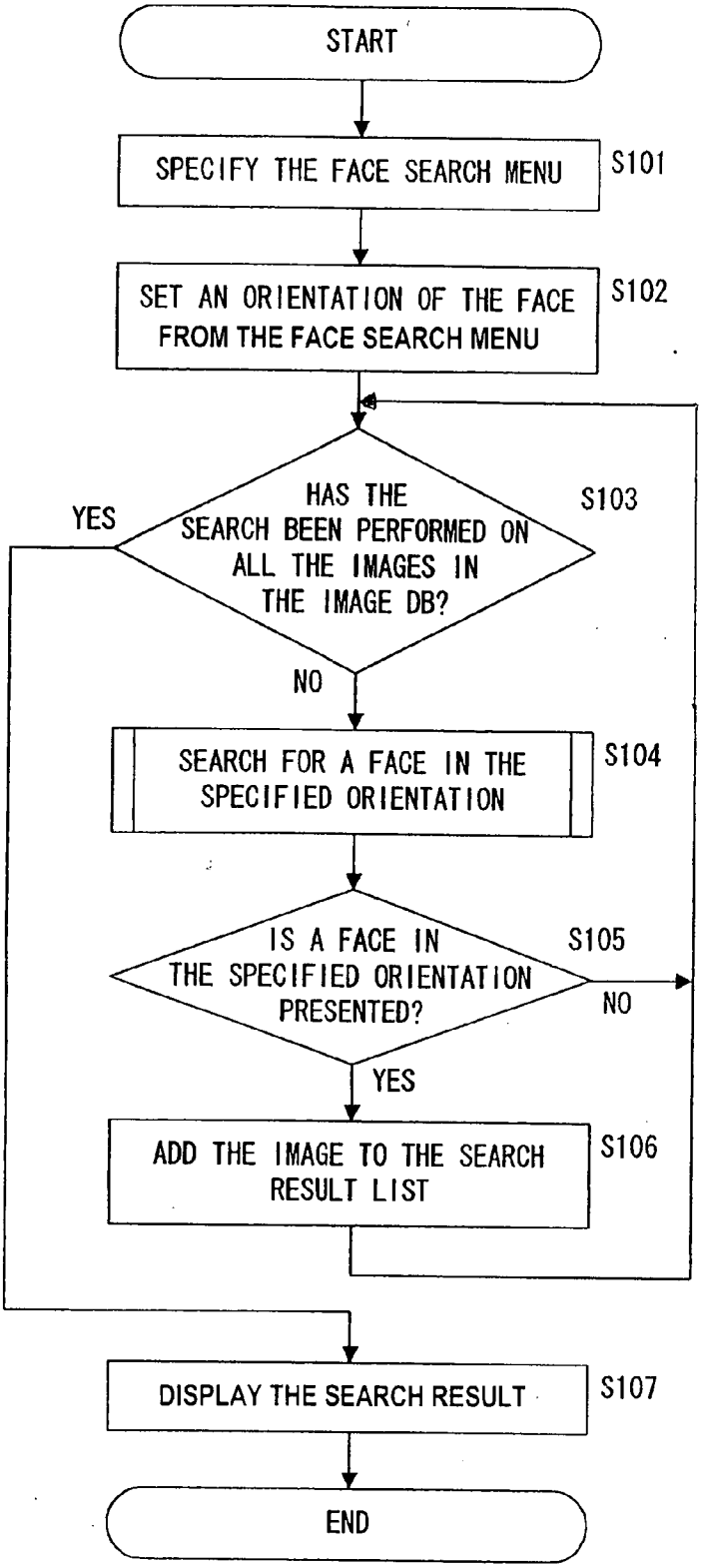

START
SPECIFY THE FACE SEARCH MENU
S101
SET AN ORIENTATION OF THE FACE FROM THE FACE SEARCH MENU
S102
HAS THE SEARCH BEEN PERFORMED ON ALL THE IMAGES IN THE IMAGE DB?
S103
YES
NO
SEARCH FOR A FACE IN THE SPECIFIED ORIENTATION
S104
IS A FACE IN THE SPECIFIED ORIENTATION PRESENTED?
S105
NO
YES
ADD THE IMAGE TO THE SEARCH RESULT LIST
S106
DISPLAY THE SEARCH RESULT
S107
END

FIG. 13

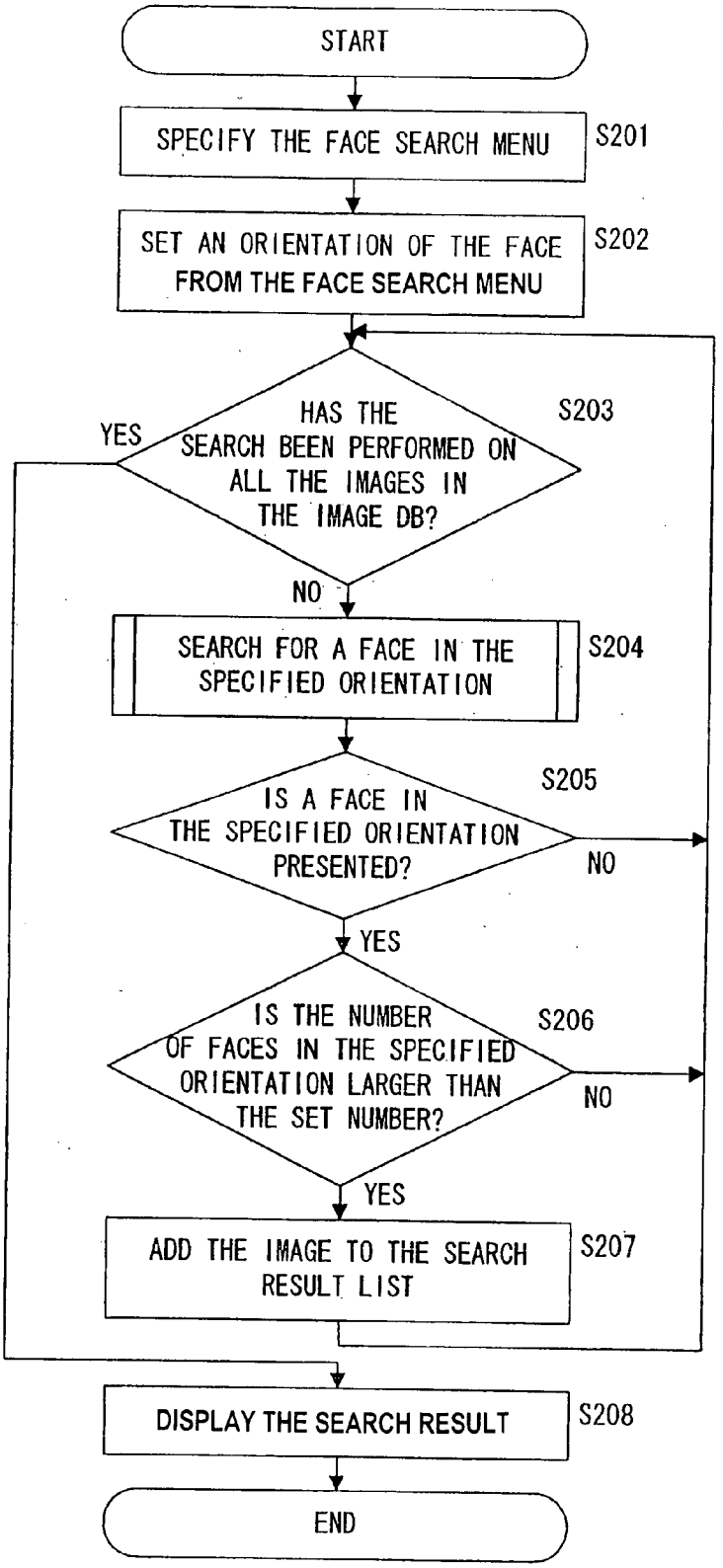

START
SPECIFY THE FACE SEARCH MENU
S201
SET AN ORIENTATION OF THE FACE FROM THE FACE SEARCH MENU
S202
HAS THE SEARCH BEEN PERFORMED ON ALL THE IMAGES IN THE IMAGE DB?
S203
YES
NO
SEARCH FOR A FACE IN THE SPECIFIED ORIENTATION
S204
IS A FACE IN THE SPECIFIED ORIENTATION PRESENTED?
S205
NO
YES
IS THE NUMBER OF FACES IN THE SPECIFIED ORIENTATION LARGER THAN THE SET NUMBER?
S206
NO
YES
ADD THE IMAGE TO THE SEARCH RESULT LIST
S207
DISPLAY THE SEARCH RESULT
S208
END

FIG. 14

IMAGE EXTRACTING APPARATUS AND IMAGE EXTRACTING METHOD

RELATED APPLICATION

[0001] This application is based on application No. 2000-178230 filed in Japan, the entire content of which is hereby incorporated by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to a technology to extract a desired image.

[0004] 2. Description of the Related Art

[0005] Conventionally, as cameras for taking pictures, film-based cameras and digital still cameras have become widespread. With these cameras, a subject in a desired pose can be shot by situating the subject within the frame and depressing the shutter button at the moment when the subject strikes the desired pose.

[0006] In taking a picture, when the subject is stationary, it is necessary to pay attention only to situating the stationary subject within the frame in good balance. However, when the subject is moving, it is necessary to depress the shutter button at the moment when the moving subject strikes a desired pose or makes a desired facial expression.

[0007] However, it is sometimes difficult to depress the shutter button at the moment when the moving subject strikes a predetermined pose or makes a predetermined facial expression. For example, when the subject is an infant, problems arise such that when shooting is performed at a small distance from the infant, his natural facial expression cannot be shot because he is conscious of the camera and that the user misses depressing the shutter button at the moment when the infant turns his eyes on the camera because the infant is moving fast and the user's attention is therefore directed to situating the infant within the frame.

[0008] When a group photo is taken with two or more children as the subjects, it is difficult to make all the children to strike a pose facing toward the front, and it is difficult to depress the shutter button at the moment when all the children face toward the front.

SUMMARY OF THE INVENTION

[0009] An object of the present invention is to solve the above-mentioned problems.

[0010] Another object of the present invention is to provide an image extracting apparatus or an image extracting method capable of obtaining an image in which the subject is in a desired pose.

[0011] Still another object of the present invention is to provide an image extracting apparatus or an image extracting method capable of obtaining from a moving image a still image in which the subject is in a desired pose.

[0012] Still another object of the present invention is to provide an image extracting apparatus or an image extracting method preventing a good moment for picturization from being missed to obtain an image in which the subject is in a desired pose.

[0013] Still another object of the present invention is to provide an image extracting apparatus capable of obtaining an image in which a predetermined number of subjects are in a desired pose when a plurality of subjects is shot.

[0014] These and other objects are attained by an image extracting apparatus comprising: an acquiring portion which acquires a plurality of signals each representative of an image of one or more subjects; a determining portion which determines orientations the subjects based on each of the signals; and an extracting portion which extracts a predetermined signal from among the signals based on the determination.

[0015] Moreover, the above-mentioned objects of the present invention are attained by a n image extracting apparatus comprising: an acquiring portion which acquires a plurality of image signals generated by continuously shooting a subject for which a predetermined orientation is defined; a determining portion which determines an orientation of the subject in each of the images; and an extracting portion which extracts an image signal in which the subject is in a specified orientation, from among the acquired image signals based on the determination.

[0016] Moreover, the above-mentioned objects of the present invention are attained by an image extracting method comprising the steps of: accepting a specification about an orientation; successively generating a signal by photoelectrically converting at predetermined time intervals an optical image of a subject for which a predetermined orientation is defined; successively determining whether the orientation of the subject represented by the generated signal is a specified orientation or not in response to the successive signal generation; and recording a signal determined to be representative of the specified orientation onto a recording medium, wherein by this recording, a subject in the specified orientation is pasteurized.

[0017] Moreover, the above-mentioned objects of the present invention are attained by an image extracting method comprising the steps of: accepting a specification about an orientation; successively acquiring a plurality of image signals representative of an object of a predetermined orientation from a database in which the image signals are stored; successively determining whether the orientation of the object represented by the acquired signal is a specified orientation or not in response to the successive signal acquisition; and displaying, by use of a signal determined to be representative of the specified orientation, an image represented by the signal.

[0018] Moreover, the above-mentioned objects of the present invention are attained by an image extracting method comprising the steps of: accepting a specification about an orientation and a specification about a number; successively generating a signal by photoelectrically converting at predetermined time intervals an optical image including a plurality of subjects of the specified orientation; successively determining whether the orientation of each of the subjects represented by the generated signal is the specified orientation or not in response to the successive signal generation; determining whether at least a specified number of subjects determined to be in the specified orientation are included or not; and recording the signal determined to include at least the specified number of subjects

onto a recording medium, wherein by this recording, at least the specified number of subjects in the specified orientation are shot.

[0019] The invention itself, together with further objects and attendant advantages, will best be understood by reference to the following detailed description taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] FIG. **1** is a rear view of a camera **100** of a first embodiment of the present invention;

[0021] FIG. **2** is a function block diagram showing functions of the camera **100** of the first embodiment;

[0022] FIG. **3** is a flowchart of a picturization processing performed when the camera of the first embodiment is in a face selecting mode;

[0023] FIG. **4** is a view of assistance in explaining the principle of a technique using neural networks;

[0024] FIG. **5** is a flowchart of a processing to determine the orientations of faces in an image;

[0025] FIG. **6** is a view of assistance in explaining the principle of a learning processing in a technique using a probability model;

[0026] FIG. **7** is a flowchart of the learning processing;

[0027] FIG. **8** is a schematic view of assistance in explaining the principle of a recognition processing;

[0028] FIG. **9** is a flowchart of the recognition processing;

[0029] FIG. **10** is a function block diagram showing functions of a camera of a second embodiment;

[0030] FIG. **11** is a flowchart of a picturization processing performed when a camera **150** of the second embodiment is in the face selecting mode;

[0031] FIG. **12** is a block diagram schematically showing the structure of an image extracting apparatus **400** of a third embodiment;

[0032] FIG. **13** is a flowchart of a processing performed by the image extracting apparatus of the third embodiment; and

[0033] FIG. **14** is a flowchart of another processing performed by the image extracting apparatus of the third embodiment.

[0034] In the following description, like parts are designated by like reference numbers throughout the several drawings.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0035] Hereinafter, embodiments of the present invention will be described with reference to the drawings. In the figures, like reference numbers represent like or corresponding members, and descriptions thereof will not be repeated. In the present invention, to picturize means to capture an image of a subject, perform a determination according to the present invention on the captured image, extract the image based on the determination and output the extracted image by a predetermined method. Therefore, when the present invention is carried out by use of a digital camera for picturization, the picturization means not only a process of generating an image signal corresponding to an optical image through photoelectric conversion. In that case, the picturization also includes a process of recording the generated image signal onto a recording medium.

First Embodiment

[0036] A first embodiment is suitable for a case where the subject is one person's face. Images of the subject are successively captured by a digital camera. The orientations of the subject included in the captured images are successively detected. When the subject is in a desired orientation, the image is recorded onto a recording medium.

[0037] FIG. **1** is a rear view of a camera of a first embodiment of the present invention. The camera **100** of this embodiment includes a shutter button **2**, a liquid crystal display **4** for displaying various pieces of information, a viewfinder **3**, a function switching button **5**, an orientation specifying button **6**, and a number-of-persons setting button **7**.

[0038] The function switching button **5** is a button switch for switching functions of the camera such as switching between use and nonuse of the flash and switching between use and nonuse of the self-timer. Switching between a normal shooting mode and a face picturizing mode can be made by use of the function switching button **5**. In the normal shooting mode, the subject is shot in response to a depression of the shutter button **2**. In the face picturizing mode, although details thereof will be described later, the subject is picturized on condition that the subject strikes a desired pose. In addition, in the face picturizing mode, a number-of-frames priority mode or a time priority mode can be specified. This specification is also performed by the function switching button **5**.

[0039] The orientation specifying button **6** is a button switch for setting the pose of the subject, particularly, the orientation of the subject's face when the camera **100** is in the face picturizing mode. The orientation of the subject's face is determined by the relative position relationship between the subject's face and the camera **100**. More specifically, the orientation of the subject's face is determined by the direction from the subject to the camera such as when the subject faces toward the camera **100** or when the subject's head is turned 90° leftward or rightward from the direction to the camera **100**. The angle of the face of the subject image included in the picturized image can be specified by the orientation specifying button **6**.

[0040] The liquid crystal display **4** displays the image to be picturized, when the camera **100** is in the face picturizing mode. With this, the subject's pose can be confirmed by viewing the liquid crystal display **4**. The liquid crystal display **4** also displays various setting conditions such as the remaining number of frames and the set shooting mode, the current time and the like. While the liquid crystal display **4** is provided on the back of the camera **100**, display may be provided within the viewfinder **3**.

[0041] FIG. **2** is a function block diagram showing functions of the camera **100** of the first embodiment. Referring to FIG. **2**, the camera **100** of this embodiment includes an image inputting portion **101** for inputting images, a specified orientation face detecting portion **102** for detecting the

orientations of the faces of the subject images included in the input images, an image selecting portion **103** for selecting an image including a subject image that is in a predetermined orientation from among the input images, and an image outputting portion **104** for outputting the selected image.

[**0042**] The image inputting portion **101** is a light receiving device such as a charge coupled device (CCD), and outputs image data to the specified orientation face detecting portion **102** and the image selecting portion **103**. The specified orientation face detecting portion **102** detects a subject image that is in a specified orientation by detecting the orientations of the faces of the subject images included in the images received from the image inputting portion **101**. Here, the specified orientation is determined by the relative positions of the subject and the camera: a frontal face when the subject faces toward the camera; a face in full profile when the subject turns his head **90** leftward or rightward from the camera; and a face in half profile when the subject turns his head **45** leftward or rightward from the camera. The orientation is specified by the orientation specifying button **6** as an angle through which the subject turns his head from the camera.

[**0043**] The specified orientation face detecting portion **102** detects a face that is in the specified orientation predetermined by the orientation specifying button **6**. When the subject in an image is in the specified orientation, a predetermined signal is output to the image selecting portion **103**, so that the image picturized by the image inputting portion **101** is selected and output to the image outputting portion **104**. The image outputting portion **104** may be the liquid crystal display **4**, or may be a semiconductor memory. Moreover, the image outputting portion **104** may be an apparatus that exposes silver halide film.

[**0044**] Next, a picturization processing performed when the camera **100** is in a face selecting mode will be described. The camera **100** is placed in the face selecting mode by depressing the function switching button **5**. FIG. **3** is a flowchart of the picturization processing performed when the camera **100** of the first embodiment is in the face selecting mode. Referring to FIG. **3**, first, the camera **100** is placed in the face selecting mode (step S**1**). The setting of the face selecting mode is performed by depressing the function switching button **5**.

[**0045**] Then, a face orientation is specified (step S**2**). A display prompting the user to specify a face orientation is provided on the liquid crystal **4**, and a face orientation is specified by depressing the orientation specifying button **6**. The face orientation specified at this step is the specified orientation. The specified orientation is specified by the orientation specifying button **6** as an angle through which the subject turns his head from the camera. For example, the specified orientation is changed to the front, 45° rightward, 90° rightward, 45° leftward and 90° leftward in this order every time the orientation specifying button **6** is depressed, and is selected.

[**0046**] Then, a face that is in the specified orientation is searched for (step S**3**). Whether a subject image whose face is in the orientation specified at step S**2** is included in images or not is determined. This will be concretely described later.

[**0047**] Then, whether a subject image whose face is in the specified orientation is detected or not is determined (step S**4**). When such a subject image is detected, the process proceeds to step S**5**. When a subject image whose face is in the specified orientation is not detected, the process proceeds to step S**3** to repeat the processing until a subject image whose face is in the specified orientation is detected.

[**0048**] At step S**5**, the image picturized by the image inputting portion **101** is selected by the image selecting portion **103** and output to the image outputting portion **104**. By this, the picturization processing is performed.

[**0049**] Then, whether the face selecting mode is canceled or not is determined (step S**6**). When it is canceled, the processing is ended, and when it is not canceled, the process proceeds to step S**3**.

[**0050**] The face selecting mode comprises two modes, the number-of-frames priority mode and the time priority mode. In the number-of-frames priority mode, the face selecting mode is canceled on condition that a predetermined number of images have been selected by the image selecting portion **103**. In the time priority mode, the face selecting mode is canceled on condition that a predetermined time has elapsed since the camera **100** was placed in the face selecting mode. In the time priority mode, by step S**6** being an interrupt processing, there can be cases where no image is selected by the image selecting portion **103** even when a subject image whose face is in the specified orientation is not detected at step S**4**.

[**0051**] Next, techniques for detecting a face in a predetermined orientation from images will be described. There are two techniques for detecting the orientation of the face of a subject image included in an image: a technique using neural networks; and a technique using a probability model. The technique using neural networks is described in H. A. Rowley, "Neutral Network-Based Learning for View-Based Human Face Detection," CMU-CS-99-117, 1999. The technique using a probability model is described in H. Schneiderman, and T. Kanade, "Probabilistic Modeling of Local Appearance and Spatial Relationships for Object Recognition," CVPR98. In the camera **100** of this embodiment, either of these techniques may be employed.

[**0052**] [Technique Using Neutral Networks]

[**0053**] FIG. **4** is a view of assistance in explaining the principle of the technique using neural networks. The technique using neural networks uses two kinds of networks, a pose estimation network and a face detection network. The face detection network is provided for each of a plurality of categories into which faces are classified based on the angles through which the faces are turned in the horizontal direction from the front. The categories are called face orientation categories.

[**0054**] Here, the front indicates a case where the subject faces toward the camera **100**. The face orientation categories are classified based on how much the subject's face is turned in the horizontal direction from the front. The face orientation categories are categories of the face detection network.

[**0055**] In FIG. **4**, a face detection network **206**A is a category when the subject's face looks toward the front (frontal category), a face detection network **206**B is a category when the subject's face is turned 45° rightward from the front (45° rightward category), and a face detection network **206**C is a category when the subject's face is turned

90° rightward from the front (90° rightward category). Like this, the face detection networks **206**A, **206**B and **206**C are provided for the categories, respectively.

[**0056**] The pose estimation network outputs, for an input image, the angle of rotation within the plane of the image from an upright orientation, and the category of the face detection network. The plane of the image from an upright orientation is a plane whose normal is a straight line connecting the camera and the subject. The angle of rotation within the plane of the image is the angle of rotation about the normal. Therefore, the angle of rotation within the plane of the image from an upright orientation is, for example in a case where the subject is a person, the angle of rotation of the face when the subject tilts his head.

[**0057**] FIG. **5** is a flowchart of a processing to determine the orientations of faces in an image. The technique using neural networks will be described with reference to the principle view of FIG. **4** and the flowchart of FIG. **5**. Referring to FIGS. **4** and **5**, partial images **201**, **201**A and **201**B including face images are cut out from an input image **200** (step S**11**). Here, an example is shown in which the partial image **201** includes a frontal face image, the partial image **201**A includes a face image turned 45° rightward, and the partial image **201**B includes a face image turned 90° rightward. The cut out partial images **201**, **201**A and **201**B are input to pose estimation networks **202**, **202**A and **202**B (step S**12**).

[**0058**] The pose estimation networks **202**, **202**A and **202**B output, for the face images included in the input partial images **201**, **201**A and **201**B, the angles of rotation within the plane of the image from an upright orientation and the categories of the face detection network. Then, by use of the angles of rotation within the plane of the image from an upright orientation **203**, **203**A and **203**B detected by the pose estimation networks **202**, **202**A and **202**B, the face images included in the partial images **201**, **201**A and **201**B are angle-corrected so as to be in an upright orientation (step S**13**). Consequently, the rotation within the plane of the image from an upright orientation is corrected, so that the orientations of the faces can be determined more accurately.

[**0059**] Then, corrected partial images **204**, **204**A and **204**B are respectively input to each of the face detection networks **206**A, **206**B and **206**C (step S**14**).

[**0060**] This is for the following reason: When the partial images **204**, **204**A and **204**B are input to the face detection networks **206**A, **206**B and **206**C, the orientations of the face images included in the partial images **204**, **204**A and **204**B are unknown. Therefore, at this point of time, the partial images **204**, **204**A and **204**B are input to the provided face detection networks of all the orientations to determine the orientations of the faces in the partial images **204**, **204**A and **204**B.

[**0061**] In each of the face detection networks **206**, **206**A and **206**B, whether the subject image included in the input partial image is a face or not is determined (steps S**15**, S**16** and S**17**). Consequently, the orientation of the face detection network where the subject image is determined to be a face is determined to be the orientation of the face included in the partial image (step S**18**). For example, when an image of a frontal face is input to the frontal face detection network, the input image is determined to be a face, and the face in the image is determined to be a frontal face. On the contrary, when a face turned 45° is input to the frontal face detection network, the face is not determined to be a face.

[**0062**] When the result of the output from the face detection network is such that the subject image is not a face, it is determined that the subject image included in the partial image **201**, **201**A or **201**B is not a face image or that the orientation is erroneous. In this manner, the orientations of the faces of the subject images included in the partial images of the input image **200** are obtained.

[**0063**] [Technique Using Probability Model]

[**0064**] The technique using a probability model is to determine whether a given region is a face in a specified orientation or not by comparing the posterior probability that the region is a class of a face in the specified orientation and the posterior probability that the region is not the class of a face in the specified direction. In actuality, by use of the Bayes rule, the ratio between the likelihoods of two classes is calculated, and thresholding is performed. The posterior probabilities of the classes are simplified starting with a general form, and are converted into a form of a probability model having a calculable multiplicity.

[**0065**] FIG. **6** is a view of assistance in explaining the principle of a learning processing in the technique using a probability model. Referring to FIG. **6**, an input image **300** for learning is divided into overlapping partial images **301**, and the connection rate distribution of the positions and the texture features of the partial images **301** are calculated for each category. The texture feature is expressed in a compressed and quantized data form, and the probability is calculated by counting the frequency of occurrence of a specific texture in a specific position in the entire area of the input image **300** for learning.

[**0066**] The learning processing is a processing to obtain the probability that a specific texture occurs in a specific position for both a case where the input image **300** includes a face in a specified orientation and a case where the input image **300** does not include a face in the specified orientation, that is, a processing to count the frequency of occurrence of a specific texture feature in the positions of the partial images **301** in the input image **300** that has been found to include a face, and previously obtain the probability thereof.

[**0067**] Learning is performed in a similar manner when the input image **300** does not include a face in the specified orientation. The texture feature of each partial image **301** undergoes dimensional compression by a principal component analysis, and is expressed in a compressed and quantized form projected on a low-level space.

[**0068**] FIG. **7** is a flowchart of the learning processing. Referring to FIGS. **6** and **7**, the overlapping partial images **301** are cut out from the input image **300** (step S**21**).

[**0069**] Then, a specific texture feature is created (step S**22**). Then, the frequency of occurrence of the texture feature in the position of a partial image **301** in the input image **300** is counted (step S**23**).

[**0070**] Then, whether it is possible to move to the next partial image **301** or not is determined (step S**24**), and when it is possible, the process moves to the next region (step S**25**). A case where it is possible to move to the next region

is a case where a partial image **301** to be processed is present, and a case where it is impossible to move to the next region is a case where no partial image **301** to be processed is present. When it is impossible to move to the next region, a connection rate table of the region and the texture is generated (step S**26**). The connection rate table thus obtained is used for a recognition processing described next.

[**0071**] FIG. **8** is a schematic view of assistance in explaining the principle of the recognition processing. FIG. **9** is a flowchart of the recognition processing. Referring to FIGS. **8** and **9**, a window region **311** is set in an input image **310** (step S**31**). The window region is a region included in the input image **310**, and can be cut out arbitrarily.

[**0072**] Then, overlapping partial images **312** are cut out in the window region **311** (step S**32**). Then, a texture feature in a partial image **312** is created (step S**33**), and from the created texture feature and the position of the partial image in the window region **311**, the probability that the face is in a specific orientation is obtained by use of the connection rate table created in the learning processing (step S**34**).

[**0073**] Then, whether it is possible to move to the next partial image or not is determined (step S**35**). When it is possible, the probability obtained at step S**34** is stored, and after moving to the next partial image (step S**36**), the process proceeds to step S**32**.

[**0074**] When there is no partial image to which the process is to move, the product of the probabilities of all the partial images is obtained (step S**37**). This product is set as the likelihood of the window region **311**. Then, from the obtained likelihood, whether a face in the specified orientation is present in the window region or not is determined (step S**38**).

[**0075**] Then, whether a window region to be set next is present in the input image **300** or not is determined (step S**39**). When a window region is present, the process proceeds to step S**40**, and when no window region is present, the process is ended. At step S**40**, the process moves to the next window region, and proceeds to step S**31**.

[**0076**] As described above, in the camera **100** of this embodiment, since picturization is performed when the face included in the input image is in a predetermined orientation, when a portrait of an infant or the like is taken, a natural facial expression of an infant whose face is in a desired orientation can be shot without a good moment to depress the shutter button being missed.

[**0077**] Moreover, since the user can follow the subject with attention only to situating the subject within the viewfinder in good balance, the subject can be shot with ease, and further, it is only when the subject is in a desired orientation that the shutter button is depressed. Consequently, even when the subject is moving fast, the subject can be shot without a good moment to depress the shutter button being missed.

Second Embodiment

[**0078**] A second embodiment is suitable for a case where the subject is a plurality of persons. Images including a plurality of persons' faces are successively captured by a digital camera. The orientations of the faces included in the captured images are successively detected. When a predetermined number of faces are in a desired orientation, the images are recorded onto a recording medium.

[**0079**] FIG. **10** is a function block diagram of assistance in explaining functions of a camera **150** of the second embodiment. Referring to FIG. **10**, the camera **150** of the second embodiment includes an image inputting portion **101** for inputting images, a specified orientation face detecting portion **102** connected to the image inputting portion and for detecting faces in a specified orientation from images included in an input image, a specified orientation face counting portion **106** for counting the number of faces in the specified orientation, an image selecting portion **103** for selecting the image input by the image inputting portion **101** when a predetermined number of faces are in the specified orientation, a number-of-persons setting portion **105** for inputting a condition for selecting an image by the image selecting portion **103**, and an image outputting portion **104** for outputting the selected image.

[**0080**] The camera **150** of the second embodiment is the camera **100** of the first embodiment to which the specified orientation face counting portion **106** and the number-of-persons counting portion **105** are added. The structure except this is similar to that of the camera **100** of the first embodiment, and therefore, the description thereof will not be repeated.

[**0081**] The number-of-persons setting portion **105** includes a number-of-persons setting button **7** and a part of the liquid crystal display **4**. On the part of the liquid crystal display **4**, a number in accordance with the number of depressions of the number-of-persons setting button **7** is displayed. The number displayed on the liquid crystal display **4** is set as the number of persons. The specified orientation face counting portion **106** counts the number of faces detected to be in the specified orientation by the specified orientation face detecting portion **102**.

[**0082**] FIG. **11** is a flowchart of a picturization processing performed when the camera **150** of the second embodiment is in the face selecting mode. When switching to the face selecting mode is made by depressing the function switching button **5**, the camera **150** is placed in the face selecting mode (step S**51**).

[**0083**] When the camera **150** is placed in the face selecting mode, a region for displaying the number of persons is provided in a part of the liquid crystal display **4**. Then, the number of persons can be set by depressing the number-of-persons button **7** (step S**52**). Then, by depressing the shutter button **2**, the number displayed on the liquid crystal display **4** at that point of time is set as the number of persons. In this embodiment, the specified orientation is toward the front. The camera **150** may be structured so that the specified orientation is not limited to toward the front but various orientations can be specified.

[**0084**] At the next step S**53**, faces in the specified orientation, that is, looking toward the camera are searched for (step S**53**). At step S**54**, the number of faces looking toward the front among the faces included in the image is counted by the specified orientation face counting portion **106** (step S**54**). Then, it is determined whether or not the number of faces counted by the specified orientation face counting portion **106** is equal to or larger than the number of persons set by the number-of-persons setting portion **105** (step S**55**).

When the counted number is equal to or larger than the set number of persons, the process proceeds to step S**56**, where the image is selected and output to the image outputting portion **104**. When the counted number is smaller than the set number of persons, the process proceeds to step S**53** to repeat the above-described processing on an image newly input from the image inputting portion **101**.

[**0085**] At step S**57**, whether the face selecting mode (frontal face selecting mode) is canceled or not is determined. When it is canceled, the processing is ended, and when it is not canceled, the process proceeds to step S**52** to repeat the above-described processing. The face selecting mode is canceled on condition that a predetermined time has elapsed or that shooting has been performed a predetermined number of times.

[**0086**] As described above, the camera **150** of the second embodiment is effective when the self-timer function is used in taking a group photo on an occasion such as a group trip. That is, shooting is performed by the camera when the user himself joins the group to be shot and of the persons included in the group, a specified number of persons face toward the front. By doing this, shooting can be performed without concern for time, although shooting is not performed until a predetermined time has elapsed according to the self-timer function.

[**0087**] Moreover, in a case where the user himself takes a picture with a camera, when the subject is a plurality of persons, a picture in which all the persons face toward the front can be taken by observing all the persons' poses and paying attention only to situating the subjects within the viewfinder in good balance when a picture in which all the persons face toward the front is taken.

[**0088**] While an example in which the present invention is applied to a shooting apparatus such as a camera is shown in this embodiment, the present invention is applicable to a case where a still image is extracted from a video-shot moving image.

[**0089**] Moreover, it is considered to use the present invention for image search of an image database or the like. For example, it is possible to extract an image including a person whose head is turned through a specific angle or to perform an image search with an image including three persons in a specific orientation with the keyword.

Third Embodiment

[**0090**] A third embodiment is suitable for extracting a predetermined image from an image database containing images of persons' faces. A determination is made on each of the images stored in the database, and from among the images, an image in which the person's face is in a desired orientation is extracted.

[**0091**] An image extracting apparatus of the third embodiment will be described. FIG. **12** is a block diagram schematically showing the structure of the image extracting apparatus **400** of the third embodiment. Referring to FIG. **12**, the image extracting apparatus **400** includes a central processing unit (CPU) **401** for controlling the entire image extracting apparatus **400**, a keyboard **402**, a pointing device **402***a*, a display portion **403**, a memory **404**, and a storage device **405**.

[**0092**] The pointing device **402***a* which is used together with a mouse is used for inputting data or inputting a search criterion for image search to the image extracting apparatus **400**.

[**0093**] The display portion **403** which is a cathode ray tube (CRT) display or a liquid crystal display displays a user interface for drawing a screen rendered a search criterion, image data rendered a search result, and the like.

[**0094**] In the memory **404**, programs to be executed by the CPU **401** and data necessary for executing the programs are stored. In the storage device **405**, an image database containing a plurality of image data to be searched is stored.

[**0095**] Next, a processing performed by the image extracting apparatus will be briefly described. FIG. **13** is a flowchart of the processing performed by the image extracting apparatus of the third embodiment. In this example, a case will be described where an image including a face in a certain orientation, for example, an image including a face looking toward the front is to be retrieved.

[**0096**] Referring to FIG. **13**, the user specifies a face search menu with the keyboard **402** and the pointing device **402***a* of the image extracting apparatus **400** (step S**101**). The orientation of the face to be retrieved is set from the face search menu (step S**102**).

[**0097**] Whether the search has been performed on all the images in the image database stored in the storage device **405** or not is determined (step S**103**). When the search has been performed on all the images, the process proceeds to step S**107**, and when the search has not been performed on all the images, the process proceeds to step S**104**.

[**0098**] At step S**104**, a face in the specified orientation is searched for. For the search for a face in the specified orientation, the above-described technique using neural networks or technique using a probability model can be used. Then, whether a face in the specified orientation is present or not is determined (step S**105**). When such a face is present, the process proceeds to step S**106**, and when such a face is absent, the process returns to step S**103**.

[**0099**] At step S**106**, the image including a face in the specified orientation is added to the search result list as an image meeting the search criterion. Then, the process returns to step S**103** to continue the search on all the images in the image database.

[**0100**] When it is determined at step S**103** that the search has been performed on all the images in the image database, at step S**107**, the search result is displayed in image table or list form on the display portion **403**, and the processing is ended.

[**0101**] FIG. **14** is a flowchart of another processing performed by the image extracting apparatus of the third embodiment. In this example, a case will be described where an image including a specified number of faces in a specified orientation is to be retrieved when a plurality of faces is included in an image.

[**0102**] Referring to FIG. **14**, the user specifies a face search menu with the keyboard **402** and the pointing device **402***a* of the image extracting apparatus **400** (step S**201**). By specifying the orientation of the faces to be retrieved and the

number of faces in the orientation from the face search menu, the orientation and the number are set (step S**202**).

[**0103**] Whether the search has been performed on all the images in the image database stored in the storage device **405** or not is determined (step S**203**). When the search has been performed on all the images, the process proceeds to step S**208**, and when the search has not been performed on all the images, the process proceeds to step S**204**.

[**0104**] At step S**204**, faces in the specified orientation are searched for. For the search for faces in the specified orientation, the above-described technique using neural networks or technique using a probability model can be used. Then, whether faces in the specified orientation are present or not is determined (step S**205**). When such faces are present, the process proceeds to step S**206**, and when such faces are absent, the process returns to step S**203**.

[**0105**] At step S**206**, whether or not the number of faces in the specified orientation is equal to or larger than the number set at step S**202** is determined. When the number of faces is equal to or larger than the set number, the process proceeds to step S**207**, and when the number of faces is smaller, the process proceeds to step S**203**.

[**0106**] At step S**207**, the image is added to the search result list as an image meeting the search criterion. Then, the process returns to step S**203** to continue the search on all the images in the image database.

[**0107**] When it is determined at step S**203** that the search has been performed on all the images in the image database, at step S**208**, the search result is displayed in image table or list form on the display portion **403**, and the processing is ended.

[**0108**] As described above, with the image extracting apparatus **400** of the third embodiment, an image including a face in a predetermined orientation can be extracted from among the images stored in the image database. When a plurality of faces is included in an image, an image including a predetermined number of faces in a predetermined orientation can be extracted.

[**0109**] Moreover, by the storage device **405** of FIG. **12** being a recording and reproducing apparatus such as a video tape recorder, a desired image can be extracted from among the images recorded on the video tape recorder.

[**0110**] Although the present invention has been fully described by way of examples with reference to the accompanying drawings, it is to be noted that various changes and modifications will be apparent to those skilled in the art. Therefore, unless such changes and modifications depart from the scope of the present invention, they should be construed as being included therein.

1. An image extracting apparatus comprising:

an acquiring portion which acquires a plurality of signals each representative of an image of one or more subjects;

a determining portion which determines orientations the subjects based on each of the signals; and

an extracting portion which extracts a predetermined signal from among the signals based on the determination.

2-13. (canceled)

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