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Image processing apparatus, image processing method, and image capture apparatus

Abstract

An image processing apparatus detects, for a plurality of images obtained chronologically, a position of a characteristic area to be tracked, and generates, based on data of the plurality of images, display image data on which an indicator indicating the characteristic area to be tracked is superimposed. The image processing apparatus generates, when a predetermined condition regarding the characteristic area to be tracked or an apparatus that shot the plurality of images is satisfied, the display image data on which an indicator indicating a characteristic area aside from the characteristic area to be tracked is further superimposed. The image processing apparatus generates, when the predetermined condition is not satisfied, the display image data on which an indicator indicating the characteristic area aside from the characteristic area to be tracked is not superimposed.

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References Cited

U.S. PATENT DOCUMENTS

Patent No.	Issued Date	Patentee Name	U.S. Cl.	CPC
2022/0094840	12/2021	Hongu et al.	N/A	N/A

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2022-051280	12/2021	JP	N/A

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Background/Summary

BACKGROUND OF THE INVENTION

Field of the Invention

(1) The present invention relates to an image processing apparatus, an image processing method, and an image capture apparatus, and particularly relates to improvements in a function that utilizes characteristic area detection.

Description of the Related Art

(2) Past image processing apparatuses, such as image capture apparatuses, have detected characteristic areas such as faces and heads from images, and used the characteristic areas to set focus detection areas, for example Japanese Patent Laid-Open No. 2022-51280. Japanese Patent Laid-Open No. 2022-51280 discloses an image capture apparatus that automatically selects a main subject from among detected candidates and executes autofocus to focus on the selected main subject. This document also discloses displaying frame-shaped indicators superimposed on a main subject area and a candidate area.

(3) When displaying an indicator for all detected characteristic areas as described in Japanese Patent Laid-Open No. 2022-51280, if a large number of characteristic areas are detected, displaying the indicators can interfere with shooting, such as by making it difficult to see the subject. Additionally, with Japanese Patent Laid-Open No. 2022-51280, a user cannot know in advance

which candidate area is likely to be a new main subject area when the current main subject area may be switched to an automatically selected main subject area.

SUMMARY OF THE INVENTION

(4) The present invention provides, in one aspect, an image processing apparatus, an image processing method, and an image capture apparatus that realize the display of an indicator for a characteristic area, and which therefore can alleviate at least one of the issues with the past techniques.

(5) According to an aspect of the present invention, there is provided an image processing apparatus comprising: one or more processors that execute a program stored in a memory and thereby function as: a tracking unit configured to detect, for a plurality of images obtained chronologically, a position of a characteristic area to be tracked; and a generating unit configured to generate, based on data of the plurality of images, display image data on which an indicator indicating the characteristic area to be tracked is superimposed, wherein the generating unit: when either of: overlap between the characteristic area to be tracked and another characteristic area; a change in the position or a size of the characteristic area to be tracked; an orientation of the characteristic area to be tracked; or movement of an apparatus that shot the plurality of images satisfies a predetermined condition, generates the display image data on which an indicator indicating a characteristic area aside from the characteristic area to be tracked is further superimposed; and when the predetermined condition is not satisfied, generates the display image data on which an indicator indicating the characteristic area aside from the characteristic area to be tracked is not superimposed.

(6) According to an aspect of the present invention, there is provided an image capture apparatus comprising: a shooting module that shoots a plurality of images chronologically; and an image processing apparatus using the plurality of images shot by the shooting module, wherein the image processing apparatus comprises one or more processors that execute a program stored in a memory and thereby function as: a tracking unit configured to detect, for a plurality of images obtained chronologically, a position of a characteristic area to be tracked; and a generating unit configured to generate, based on data of the plurality of images, display image data on which an indicator indicating the characteristic area to be tracked is superimposed, wherein the generating unit: when either of: overlap between the characteristic area to be tracked and another characteristic area; a change in the position or a size of the characteristic area to be tracked; an orientation of the characteristic area to be tracked; or movement of an apparatus that shot the plurality of images satisfies a predetermined condition, generates the display image data on which an indicator indicating a characteristic area aside from the characteristic area to be tracked is further superimposed; and when the predetermined condition is not satisfied, generates the display image data on which an indicator indicating the characteristic area aside from the characteristic area to be tracked is not superimposed.

(7) According to an aspect of the present invention, there is provided an image processing method executed by an apparatus, the image processing method comprising: detecting, in a plurality of images obtained chronologically, a position of a characteristic area to be tracked; and generating, based on data of the plurality of images, display image data on which an indicator indicating the characteristic area to be tracked is superimposed, wherein the generating includes: when either of: overlap between the characteristic area to be tracked and another characteristic area; a change in the position or a size of the characteristic area to be tracked; an orientation of the characteristic area to be tracked; or movement of an apparatus that shot the plurality of images satisfies a predetermined condition, generating the display image data on which an indicator indicating a characteristic area aside from the characteristic area to be tracked is further superimposed; and when the predetermined condition is not satisfied, generating the display image data on which an indicator indicating the characteristic area aside from the characteristic area to be tracked is not superimposed.

(8) According to an aspect of the present invention, there is provided a non-transitory computer-readable medium having stored therein a program that, when executed by a computer, causes the computer to function as an image processing apparatus comprising: a tracking unit configured to detect, for a plurality of images obtained chronologically, a position of a characteristic area to be tracked; and a generating unit configured to generate, based on data of the plurality of images, display image data on which an indicator indicating the characteristic area to be tracked is superimposed, wherein the generating unit: when either of: overlap between the characteristic area to be tracked and another characteristic area; a change in the position or a size of the characteristic area to be tracked; an orientation of the characteristic area to be tracked; or movement of an apparatus that shot the plurality of images satisfies a predetermined condition, generates the display image data on which an indicator indicating a characteristic area aside from the characteristic area to be tracked is further superimposed; and when the predetermined condition is not satisfied, generates the display image data on which an indicator indicating the characteristic area aside from the characteristic area to be tracked is not superimposed.
(9) Further features of the present invention will become apparent from the following description of exemplary embodiments (with reference to the attached drawings).

Description

BRIEF DESCRIPTION OF THE DRAWINGS
(1) FIG. **1** is a block diagram illustrating an example of the functional configuration of a digital camera serving as an example of an image processing apparatus according to an embodiment.
(2) FIG. **2** is a diagram illustrating an example of the configuration of an image sensor according to the embodiment.
(3) FIG. **3** is a flowchart pertaining to operations by the digital camera according to the embodiment.
(4) FIG. **4** is a flowchart pertaining to operations by the digital camera according to the embodiment.
(5) FIGS. **5**A and **5**B are flowcharts pertaining to operations by the digital camera according to the embodiment.
(6) FIG. **6** is a flowchart pertaining to operations by the digital camera according to the embodiment.
(7) FIGS. **7**A to **7**C are diagrams illustrating examples of the display of an indicator for a characteristic area according to the embodiment.
DESCRIPTION OF THE EMBODIMENTS
(8) Hereinafter, embodiments will be described in detail with reference to the attached drawings. Note, the following embodiments are not intended to limit the scope of the claimed invention. Multiple features are described in the embodiments, but limitation is not made to an invention that requires all such features, and multiple such features may be combined as appropriate. Furthermore, in the attached drawings, the same reference numerals are given to the same or similar configurations, and redundant description thereof is omitted.
(9) Note that the following embodiment will describe a case where the present invention is applied in a digital camera serving as an example of an image processing apparatus. However, an image capture function is not essential to the present invention, and the present invention can be implemented in any electronic device capable of detecting a characteristic area. Examples of such an electronic device include video cameras, computer devices (personal computers, tablet computers, media players, PDAs, and the like), mobile phones, smartphones, game consoles, robots, drones, and dashboard cameras. These are merely examples, however, and the present invention can be applied in other electronic devices as well.

(10) Camera Configuration

(11) FIG. **1** is a block diagram illustrating an example of the functional configuration of a digital camera **100** serving as an example of an image processing apparatus according to the present embodiment.

(12) A lens unit **10** forms an optical image of a subject on an image capturing surface of an image sensor **14**. An aperture stop **12** that functions as a shutter is provided between the lens unit **10** and the image sensor **14**. The lens unit **10** has a focus lens for adjusting the focal distance and a zoom lens for adjusting the angle of view. The focus lens is driven by a focus control unit **42**, and the zoom lens is driven by a zoom control unit **44**, both under the control of a system control unit **50**.

(13) The image sensor **14** may be a publicly-known CCD or CMOS color image sensor having, for example, a primary color Bayer array color filter. The image sensor **14** includes a pixel array, in which a plurality of pixels are arranged two-dimensionally, and peripheral circuitry for reading out signals from the pixels. Each pixel accumulates a charge corresponding to an amount of incident light through photoelectric conversion. By reading out, from each pixel, a signal having a voltage corresponding to the charge amount accumulated during an exposure period, a group of pixel signals (analog image signals) representing an optical image formed on the image capturing surface is obtained.

(14) Dedicated pixels for generating focus detection signals (focus detection pixels) are disposed in the pixel array of the image sensor **14**. FIG. **2** illustrates part of the pixel array in the image sensor **14**. The pixel array includes image capturing pixels **250** for which a photoelectric conversion area is not blocked, and focus detection pixels **251** for which a portion of the photoelectric conversion area is blocked. “R”, “Gr”, “Gb”, and “B” indicate the color of the color filter provided for each pixel. In the example illustrated in FIG. **2**, of the 2×2 pixels serving as a unit of repetition of the primary color Bayer array color filter, the focus detection pixels **251** are disposed at the positions of the B pixels. Note that instead of blocking a portion of the photoelectric conversion area, pixels having a configuration which divides the photoelectric conversion area may be provided as the focus detection pixels. Furthermore, the configuration may be such that pixels having a configuration which divide the photoelectric conversion area are disposed over a broad range (e.g., the entire area) and are also used as image capturing pixels by providing a primary color Bayer array color filter or the like.

(15) A signal group obtained from focus detection pixels, among the focus detection pixels disposed within the focus detection area, for which the right half of the photoelectric conversion area is blocked (an A image), and a signal group obtained from focus detection pixels for which the left half of the photoelectric conversion area is blocked (a B image), are a pair of focus detection signals. A defocus amount is obtained from the phase difference between the pair of focus detection signals.

(16) An A/D converter **16** A/D converts an analog image signal output by the image sensor **14** into a digital image signal (image data).

(17) A timing generator **18** supplies clock signals and control signals to the image sensor **14** and the A/D converter **16**. The operations of the timing generator **18** are controlled by a memory control unit **22** and the system control unit **50**.

(18) An image processing unit **20** generates signals and image data for different purposes, obtains and/or generates various types of information, and so on by applying predetermined image processing to the image data output by the A/D converter **16** or the memory control unit **22**. The image processing unit **20** may be a dedicated hardware circuit, such as an Application Specific Integrated Circuit (ASIC) designed to implement a specific function, for example. Alternatively, the image processing unit **20** may be constituted by a processor such as a Digital Signal Processor (DSP) or a Graphics Processing Unit (GPU) executing software to implement a specific function. The image processing unit **20** outputs the obtained or generated information, data, and the like to the system control unit **50**, the memory control unit **22**, or the like, depending on the purpose of

use.
(19) The image processing applied by the image processing unit **20** can include preprocessing, color interpolation processing, correction processing, detection processing, data processing, evaluation value calculation processing, special effect processing, and so on, for example.
(20) The preprocessing includes signal amplification, reference level adjustment, defective pixel correction, and the like.
(21) The color interpolation processing is performed when the image sensor is provided with a color filter, and interpolates the values of color components that are not included in the individual pixel data constituting the image data. Color interpolation processing is also called “demosaicing”.
(22) The correction processing can include white balance adjustment, tone adjustment, correction of image degradation caused by optical aberrations of the lens unit **10** (image restoration), correction of the effects of vignetting in the lens unit **10**, color correction, and the like.
(23) The detection processing can include detecting and tracking a characteristic area (e.g., the face, head, torso, a particular organ (e.g., an eye, pupil, nose, mouth, or the like) of a human and/or an animal), processing for recognizing a person, or the like.
(24) The data processing can include cropping an area (trimming), image compositing, scaling, and header information generation (data file generation). The image data may be encoded and decoded by the image processing unit **20** instead of by a compression/decompression unit **32**. The generation of display image data and recording image data is also included in the data processing.
(25) The evaluation value calculation processing can include processing such as generating signals, evaluation values, and the like used in automatic focus detection (AF), generating evaluation values used in automatic exposure control (AE), and the like. The aforementioned pair of focus detection pixel signals are also generated through the evaluation value calculation processing.
(26) The special effect processing includes adding bokeh effects, changing color tones, relighting processing, and the like.
(27) Note that these are merely examples of the processing that can be applied by the image processing unit **20**, and the processing applied by the image processing unit **20** is not limited thereto.
(28) The image processing unit **20** outputs the position and size, a detection reliability, and the like of the characteristic area as the result of the detection processing. The detection of the characteristic area by the image processing unit **20** can be realized through any publicly-known method. For example, a face area can be detected by pattern matching using data representing contour shapes of faces, saved in advance in the image processing unit **20**, as a template. Meanwhile, the image processing unit **20** obtains a degree of matching with the template as a reliability, and may take only areas for which the degree of matching is at least a threshold as face areas.
(29) Additionally, a plurality of types of templates pertaining to facial contours may be prepared to increase the number of detectable face types and improve the detection accuracy, and a face area may be detected based on the results of template matching using individual templates. Additionally, the face area may be detected based on a result of template matching using a contour template and a template of a type different from the contour. For example, a portion of the shape of a face may be used as a template. In addition, templates of different sizes may be generated and used according to enlargement and/or reduction in order to detect face areas of different sizes.
(30) Additionally, when a facial organ (an eye, pupil, nose, mouth, or the like) is detected, the image processing unit **20** applies pattern matching using a template pertaining to the shapes of organs, prepared in advance, to the detected face area. The image processing unit **20** obtains a degree of matching with the template as a reliability, and may take only areas for which the degree of matching is at least a threshold as organ areas.
(31) The characteristic area may be detected using a method aside from template matching. For example, the characteristic area can be detected using machine learning (deep learning or the like). For example, the image processing unit **20** can generate a detector for characteristic areas by

applying a trained model prepared for each type of characteristic area to a convolutional neural network (CNN) using a circuit or program that implements the CNN. The trained model (a parameter set) can be prepared in advance in a non-volatile memory **31**, for example. By using different trained models for the same image data, a plurality of types of subject areas can be detected.

(32) For example, a trained model for detecting the pupils, faces, and body parts of dogs and cats, a trained model for detecting pupils, faces, and body parts of birds, and a trained model for detecting vehicles such as trains and automobiles are prepared in the non-volatile memory **31**. By selecting one of the three trained models and applying the model in the image processing unit **20**, the system control unit **50** can cause the image processing unit **20** to detect the characteristic area corresponding to the selected trained model.

(33) By applying the three trained models to the image processing unit **20** in sequence and performing the detection processing three times on the same image data, all types of subject areas corresponding to the three trained models can be detected.

(34) An example in which pattern matching is used to detect faces and organs, such as the pupils, faces, and body parts of dogs, cats, and birds, or vehicles, using trained models, has been described here. However, the types of characteristic areas to be detected are not limited thereto. Furthermore, the combinations of the type of the characteristic area to be detected and the detection method is not limited to that described here.

(35) Tracking processing performed by the image processing unit **20** will be described next. The tracking processing is processing for tracking a specific area for a plurality of images shot chronologically (e.g., a plurality of frames of a moving image, or still images of a plurality of frames shot through continuous shooting). The tracking processing can be realized by repeating pattern matching using a specific area as a template and updating the template according to the area detected through the pattern matching on a frame-by-frame basis.

(36) The image processing unit **20** calculates a correlation value while changing the position of the template with respect to the frame being handled, and detects an area having the highest correlation with the template. The correlation value may be, for example, the sum of the absolute values of differences among the luminance values of the pixels corresponding to the positions. Note that differences in the values of color components, the degree of matching with a histogram, or the like may be obtained as the correlation value instead of luminance values. The method of searching for the most similar area to the template is not particularly limited, and any other publicly-known method can be used.

(37) The system control unit **50** is, for example, at least one processor (CPU) capable of executing programs. By loading a program stored in the non-volatile memory **31** into a memory **30** and executing the program, the system control unit **50** controls the operations of the function blocks constituting the digital camera **100** and realizes the functions of the digital camera **100**.

(38) As part of these operations, the system control unit **50** performs automatic exposure control (AE) and automatic focus detection (AF) based on the evaluation values generated by the image processing unit **20**. Specifically, based on the evaluation value, the system control unit **50** determines exposure conditions (aperture value, shutter speed, and sensitivity) such that the focus detection area is appropriately exposed. The system control unit **50** then drives the aperture stop **12** through an exposure control unit **40** based on the exposure conditions, and controls the operations of the image sensor **14**. Furthermore, the system control unit **50** obtains a defocus amount based on a phase difference between the pair of focus detection pixel signals generated by the image processing unit **20**. Then, based on the defocus amount, the system control unit **50** causes the lens unit **10** to focus on the focus detection area by driving the focus lens of the lens unit **10** through the focus control unit **42**. Note that the system control unit **50** may perform autofocus based on a contrast evaluation value.

(39) Note that in the present embodiment, the system control unit **50** sets the focus detection area

for which the AF evaluation value is generated based on the subject area detected by the image processing unit **20**. For example, setting the subject area or a partial area of the focus detection area to the focus detection area makes it possible to implement autofocus in which the lens unit **10** focuses on the subject area. If the image processing unit **20** has detected a plurality of subject areas, the system control unit **50** selects one of the subject areas as a main subject area and sets that area as the focus detection area. The method for selecting the main subject area from the plurality of subject areas is not particularly limited. The main subject area may be designated by a user, or may be selected by the system control unit **50** based on at least one of the positions, sizes, and reliabilities of the individual subject areas.

(40) The non-volatile memory **31** is electrically rewritable, and stores programs executed by the system control unit **50**, as well as various types of setting values, GUI data, and the like of the digital camera **100**. The trained models and characteristic data used by the image processing unit **20** can also be stored in the non-volatile memory **31**. The memory **30** is used when the system control unit **50** executes programs, for temporarily storing image data, and the like. Part of the memory **30** is also used as a video memory for an image display unit **28**.

(41) The memory control unit **22** controls access to the memory **30** by the A/D converter **16** and the image processing unit **20**. The memory control unit **22** controls the operations of the timing generator **18**.

(42) The image display unit **28** is a display apparatus that displays an image based on the display image data written into the video memory area of the memory **30**. The image display unit **28** functions as an electronic viewfinder (EVF) by immediately displaying shot moving images in the image display unit **28**. The processing for causing the image display unit **28** to function as an EVF is called “live view processing”, and the display image data used in the live view processing is called “live view image data”. The present embodiment assumes that the image display unit **28** is a touch screen.

(43) The compression/decompression unit **32** encodes the recording image data generated by the image processing unit **20**, decodes encoded image data read out from a recording unit **202**, and the like. Although the encoding method is not particularly limited, still images are typically encoded using an encoding method based on the JPEG standard, and moving images are typically encoded using an encoding method based on the MPEG standard.

(44) The exposure control unit **40** drives the aperture stop **12** under the control of the system control unit **50**.

(45) A flash **48** is an auxiliary light source. The system control unit **50** determines whether to turn on the flash **48** based on the settings of the digital camera **100** and the evaluation values generated by the image processing unit **20**. The operations of the flash **48** are controlled by the system control unit **50**.

(46) A mode dial **60** sets the digital camera **100** to one of function modes including power off, an automatic shooting mode, a shooting mode, a panoramic shooting mode, a moving image shooting mode, a playback mode, a PC connection mode, and the like.

(47) A shutter switch **62** is a switch for shooting still images, and includes SW**1**, which turns on when the switch is pressed halfway, and SW**2**, which turns on when the switch is pressed fully. The system control unit **50** recognizes SW**1** being on as a shooting preparation instruction, and SW**2** being on as a shooting instruction. The system control unit **50** executes shooting preparation operations, such as AF and AE operations, in response to the shooting preparation instruction. Additionally, the system control unit **50** executes a series of operations, from shooting a still image to recording, in response to the shooting instruction. The recording image data generated by the image processing unit **20** is encoded by the compression/decompression unit **32** as necessary, and is then recorded into a recording medium **200** through an interface (I/F) **90** in the form of an image data file.

(48) A display change switch **66** switches the image display unit **28** on and off. The power

consumption can be reduced by turning the image display unit **28** off when not in use, e.g., when using an optical viewfinder **104**.
(49) When a zoom switch **72** is operated, the system control unit **50** drives the zoom lens through the zoom control unit **44** and changes the angle of view of the lens unit **10**. Whether to broaden or narrow the angle of view is determined in accordance with the operation of the zoom switch **72**.
(50) "Operation unit **70**" is a collective name for input devices provided in the digital camera **100** that have not been described here. The operation unit **70** includes a menu button, a set button, a directional key, a moving image recording button, and the like. If the image display unit **28** is a touch screen, a touch panel provided in the image display unit **28** is included in the operation unit **70**.
(51) A power source **86** supplies power to the digital camera **100**. The power source **86** may be a battery installed in the digital camera **100**, or may be an external power source such as an AC adapter.
(52) The interface **90** is a communication interface with the recording medium **200**. The recording medium **200** is connected to a connector **92**. The recording medium **200** is a memory card, for example. The recording medium **200** includes a recording unit **202** that stores data, and an interface **204** for communicating with an external device to which a connector **206** of the recording medium **200** is connected (in this case, the digital camera **100**).
(53) A communication unit **110** communicates with the external device through a connector or an antenna **112**. The communication unit **110** supports at least one wired and/or wireless communication standard and has hardware corresponding to the supported standard.
(54) A gyrosensor **115** outputs a signal based on motion (an angular velocity) of the digital camera **100** to the system control unit **50**. The system control unit **50** integrates signals output by the gyrosensor, and detects the motion of the digital camera **100** as a combination of changes in angles about axes. The system control unit **50** can use the detected motion of the digital camera **100** for image stabilization, to detect panning operations, and the like, for example.
(55) Still Image Shooting Processing
(56) Still image shooting processing through which the digital camera **100** shoots and records still images will be described with reference to the flowchart in FIG. **3**.
(57) In step S**301**, the system control unit **50** determines whether the operation mode of the digital camera **100** is set to a still image shooting mode, and executes step S**302** if it is determined that the operation mode is set to the still image shooting mode. If it is not determined that the operation mode is set to the still image shooting mode, operations pertaining to still image shooting and recording will not be performed, and the system control unit **50** therefore ends the still image shooting processing.
(58) In step S**302**, the system control unit **50** determines whether preparations for live view processing are complete, executes step S**303** if the preparations are complete, and repeats step S**302** if not. The system control unit **50** can determine that the preparations for live view processing are complete in response to the timing generator **18** becoming capable of supplying a clock signal, control signals, and the like for live view display to the image sensor **14**, the A/D converter **16**, and the like.
(59) In step S**303**, the system control unit **50** starts the live view processing, and then executes step S**304**. The live view processing is a series of processing for causing the image display unit **28** to function as an EVF. Specifically, processing in which the image sensor **14** shoots a moving image, the image processing unit **20** generates display image data and stores that data in the memory **30**, and that data is displayed in the image display unit **28** is performed continuously. Upon starting the live view processing in step S**303**, the system control unit **50** executes the processing from step S**304** on while continuing to execute the live view processing until the still image shooting mode ends.
(60) The image processing unit **20** also executes subject detection processing on the image data

generated through the live view processing, and outputs the result to the system control unit **50**. Note that the subject detection processing may be performed for all frames of the shot moving image, or may be carried every predetermined number of frames. The system control unit **50** may dynamically determine the frequency at which to perform the subject detection processing by taking into account the shooting or display framerate of the moving image, the processing capabilities of the image processing unit **20**, and the like.

(61) In step S**304**, the system control unit **50** executes main subject determination processing, determines the main subject area from the subject areas detected by the image processing unit **20**, and then executes step S**305**. The main subject determination processing will be described in detail later.

(62) In step S**305**, the system control unit **50** determines whether the main subject area has been determined in the main subject determination processing, executes step S**306** if it is determined that the main subject area has been determined, and executes step S**310** if not.

(63) In step S**306**, the system control unit **50** instructs the image processing unit **20** to superimpose and display an indicator indicating the main subject area along with information on the main subject area. The image processing unit **20** generates image data for the live view display, in which the image of the indicator indicating the main subject area is superimposed, and stores the image data in the memory **30**. The indicator may be at least a part of a rectangular outline bounding the main subject area, for example. It is assumed here that the entire outline, i.e., a frame-shaped indicator, is superimposed and displayed. However, an indicator of any size and in any form that indicates the main subject area can be used.

(64) FIG. **7**A is a diagram illustrating an example of the display of the indicator in the main subject area. Here, the main subject is the person on the right, and a rectangular frame-shaped indicator **701** encompassing the face area is displayed. On the other hand, an indicator **702**, which is visually different from the indicator **701**, is superimposed on an area of a subject detected in the same image but different from the main subject (i.e., a sub-subject). For the sake of simplicity, the indicator displayed for the sub-subject area will be called a “sub-frame” hereinafter.

(65) Returning to FIG. **3**, in step S**307**, the system control unit **50** executes sub-frame display processing, which is indicator display processing for the sub-subject area, and then executes step S**308**. Details of the sub-frame display processing will be given later.

(66) In step S**308**, the system control unit **50** determines whether the sub-frame has been displayed in the sub-frame display processing of step S**307**, executes step S**309** if it is determined that the sub-frame has been displayed, and executes step S**310** if not.

(67) In step S**309**, the system control unit **50** executes main subject switching processing, and then executes step S**310**. The main subject switching processing is processing for switching the main subject in response to a user instruction. Details of the main subject switching processing will be given later.

(68) In step S**310**, the system control unit **50** determines whether to end the shooting mode. The system control unit **50** can determine that the shooting mode is to be ended when, for example, the operation mode of the digital camera **100** has been switched from the still image shooting mode to another mode (e.g., the playback mode), when the power is turned off, or the like. If it is determined that the shooting mode is to be ended, the system control unit **50** ends the still image shooting operations, and executes processing according to the circumstances. On the other hand, if it is not determined that the shooting mode is to be ended, the system control unit **50** executes step S**311**.

(69) In step S**311**, the system control unit **50** determines whether SW**1** of the shutter switch **62** is on, executes step S**312** if it is determined that SW**1** is on, and executes step S**317** if not.

(70) In step S**312**, the system control unit **50** determines whether the main subject area is determined, in the same manner as in step S**305**, executes step S**313** if it is determined that the main subject area is determined, and executes step S**314** if not.

(71) In step S**313**, the system control unit **50** sets the focus detection area based on the main subject area and executes AF processing. Specifically, the system control unit **50** obtains a focus detection signal for the focus detection area from the image processing unit **20**, and obtains a defocus amount. The system control unit **50** then drives the focus lens based on the defocus amount through the focus control unit **42** so that the lens unit **10** focuses on the focus detection area. Meanwhile, the system control unit **50** obtains AE evaluation values for the focus detection area from the image processing unit **20**, executes AE processing, and determines the exposure conditions. The system control unit **50** then executes step S**315**.
(72) In step S**314**, the system control unit **50** obtains the focus detection signal from the image processing unit **20** for a predetermined plurality of areas, and obtains the defocus amount. The system control unit **50** then drives the focus lens through the focus control unit **42** such that the lens unit **10** focuses on an area where the subject distance is the shortest, based on the defocus amount. The system control unit **50** then executes step S**315**. Note that the area in the shooting range where the subject distance is the shortest may be determined based on a defocus map that can be generated using the focus detection pixels of the image sensor **14**, for example.
(73) In step S**315**, the system control unit **50** determines whether SW**2** of the shutter switch **62** is on, executes step S**316** if it is determined that SW**2** is on, and executes step S**317** if not.
(74) In step S**316**, the system control unit **50** executes still image shooting and recording processing. The system control unit **50** executes still image shooting by controlling the aperture stop **12** and the image sensor **14** based on the most recently determined exposure conditions in the shooting preparation instruction made when SW**1** is on. The image processing unit **20** then generates still image data for recording and stores the data in the memory **30**. The system control unit **50** encodes the still image data using the compression/decompression unit **32** as necessary, and then records the image data file in the recording medium **200** through the I/F **90**. Note that the live view processing may be suspended during the still image shooting processing. Once the shooting processing ends, the system control unit **50** executes step S**317**.
(75) In step S**317**, the system control unit **50** determines whether the main subject area is determined, in the same manner as in step S**305**, executes step S**318** if it is determined that the main subject area is determined, and executes step S**304** if not.
(76) In step S**318**, the system control unit **50** causes the image processing unit **20** to execute tracking processing for the main subject area. The image processing unit **20** searches out an area most similar to the main subject area determined through the most recent main subject determination processing in a frame shot later than the frame on which the most recent main subject determination processing was executed (e.g., the next frame). The image processing unit **20** then notifies the system control unit **50** of the position, size, search reliability, and the like of the searched-out area as a result of the tracking processing. The search range may be limited to the detected subject area in the tracking processing performed on the frame on which the subject detection processing has been performed. Note that if an area for which the search reliability satisfies a predetermined threshold is not found, the image processing unit **20** notifies the system control unit **50** that the search processing has failed.
(77) Upon starting the tracking processing, the image processing unit **20** continues the tracking processing with the area detected by the most recently executed tracking processing as the main subject area until the next main subject determination processing is executed. Through this, the image processing unit **20** tracks the area of the same subject.
(78) In step S**319**, the system control unit **50** determines whether the tracking processing has succeeded based on the result of the tracking processing for which the notification was made by the image processing unit **20**. The system control unit **50** determines that the tracking processing has succeeded if, for example, the reliability of the search result satisfies a predetermined threshold. The system control unit **50** executes step S**306** if it is determined that the tracking processing has succeeded, and executes S**304** if not. In this manner, when the tracking processing has failed for the

image processing unit **20**, the main subject determination processing is executed again, and the main subject area tracked by the image processing unit **20** is updated. Note that instead of executing the main subject determination processing when the tracking processing fails once, the main subject determination processing may be executed when the tracking processing has failed a predetermined number of times in a row.

(79) Main Subject Determination Processing

(80) The main subject determination processing in step S**304** will be described in detail next with reference to the flowchart in FIG. **4**.

(81) In step S**401**, the system control unit **50** determines whether an area of a human subject has been detected based on the result of the subject detection processing performed by the image processing unit **20**. Here, it is assumed, as one example, that the targets of the subject detection processing are human subjects, animal subjects, and vehicle subjects. The system control unit **50** executes step S**402** if it is determined that an area of the human subject has been detected, and executes step S**405** if not.

(82) In step S**402**, the system control unit **50** determines whether a plurality of human subject areas have been detected, executes step S**403** if a plurality of areas have been detected, and executes step S**404** if not.

(83) In step S**403**, the system control unit **50** determines the main subject area from the plurality of areas detected. It is assumed here, as an example, that the main subject is determined based on the position and size of the face area. The system control unit **50** can, for example, convert the position and the size into respective weights (coefficients), and determine the main subject by multiplying the values obtained as a result. For example, the position weight can be set in advance such that the weight increases as the distance between the focus detection area and the subject area (e.g., a center-to-center distance) decreases, and the size weight such that the weight increases as the size of the subject area increases. In this case, the system control unit **50** determines the subject area having the highest product of the position and size weights as the main subject area, and then ends the main subject determination processing.

(84) Note that the main subject area may be determined using another method. For example, a weight that increases the closer a face is to facing forward may be used, or a weight that increases the higher the reliability of the detection is may be used.

(85) Step S**404** is executed when there is only one human subject area detected. Accordingly, the system control unit **50** determines the human subject area detected as the main subject area and ends the main subject determination processing.

(86) In step S**405**, the system control unit **50** determines whether an animal subject area has been detected, executes step S**406** if it is determined that such an area has been detected, and executes step S**411** if not.

(87) In step S**406**, the system control unit **50** determines whether a vehicle subject area has been detected, executes step S**407** if it is determined that such an area has been detected, and executes step S**408** if not.

(88) In step S**407**, the system control unit **50** determines the main subject based on the positions and sizes of the individual subject areas, and ends the main subject determination processing. As in the case of a human subject, the main subject can be determined having converted the position and the size into respective weights. However, since both the animal subject and the vehicle subject have been detected, the sizes are normalized before being converted to weights. Specifically, the sizes are normalized such that the sizes of the animal subject and vehicle subject areas are the same, at equal distances in the optical axis direction from the digital camera **100**. For example, the sizes can be normalized by applying coefficients calculated statistically using a plurality of samples in advance to at least one of the animal subject area and the vehicle subject area. Note that the position and size weights may be different from those used for the human subject area.

(89) In step S**408**, the system control unit **50** determines whether a plurality of animal subject areas

have been detected, executes step S**409** if it is determined that a plurality of such areas have been detected, and executes step S**410** if not.
(90) In step S**409**, the system control unit **50** determines the main subject based on the positions and sizes of the individual subject areas, and ends the main subject determination processing. As in the case of a human subject, the main subject can be determined having converted the position and the size into respective weights.
(91) Step S**410** is executed when there is only one animal subject area detected. Accordingly, the system control unit **50** determines the animal subject area detected as the main subject area and ends the main subject determination processing.
(92) In step S**411**, the system control unit **50** determines whether a vehicle subject area has been detected, executes step S**412** if it is determined that such an area has been detected, and executes step S**415** if not.
(93) In step S**412**, the system control unit **50** determines whether a plurality of vehicle subject areas have been detected, executes step S**413** if it is determined that a plurality of such areas have been detected, and executes step S**414** if not.
(94) In step S**413**, the system control unit **50** determines the main subject based on the positions and sizes of the individual subject areas, and ends the main subject determination processing. As in the case of a human subject, the main subject can be determined having converted the position and the size into respective weights.
(95) Step S**414** is executed when there is only one vehicle subject area detected. Accordingly, the system control unit **50** determines the vehicle subject area detected as the main subject area and ends the main subject determination processing.
(96) In step S**415**, the system control unit **50** determines that there is no main subject area, and then ends the main subject determination processing.
(97) Sub-Frame Display Determination
(98) The sub-frame display processing in step S**307** will be described in detail next with reference to the flowcharts in FIGS. **5**A and **5**B. In the sub-frame display processing, whether to display an indicator in a sub-main subject area (the sub-frame) is determined, and when it is determined that the indicator is to be displayed, the indicator is displayed in the sub-subject area to be displayed.
(99) In step S**501**, the system control unit **50** determines whether the main subject area overlaps with the sub-subject area. The system control unit **50** can determine that the main subject area overlaps with the sub-subject area when, for example, the percentage of the part of the main subject area that overlaps with at least one other sub-subject area exceeds a threshold. Alternatively, the system control unit **50** can determine that the main subject area overlaps with the sub-subject area when the sub-subject area overlaps within a range which is a certain distance from the center of a specific partial area of the main subject area (e.g., the face area in a human subject area). These are merely examples, and the determination may be based on other conditions. The system control unit **50** executes step S**509** if it is determined that the main subject area overlaps with the sub-subject area, and executes step S**502** if not.
(100) In step S**509**, the system control unit **50** determines that it is easy to lose sight of the main subject area, and executes step S**510** after setting a flag, for example. A state in which it is “easy to lose sight” of the main subject area can also be said to be a state in which the tracking processing on the current main subject area is likely to become impossible in the near future.
(101) In step S**502**, the system control unit **50** determines whether the main subject area is moving, executes step S**503** if it is determined that the main subject area is moving, and executes step S**508** if not. The system control unit **50** can determine whether the main subject area is moving based on a change over time in the position of the main subject area obtained as a result of the tracking processing, for example, but the determination may be made through another method as well.
(102) In step S**503**, the system control unit **50** determines whether the main subject area is toward the outside of the shooting range. The system control unit **50** can determine that the main subject

area is moving toward the outside of the shooting range when, for example, the shortest distance among the distances between the center of the main subject area and the four sides of the image is decreasing over time. Alternatively, the system control unit **50** may estimate the length of time until a part of the main subject area exits the shooting range based on the amount of movement in the main subject area, and if the estimated length of time is within a predetermined length of time, the main subject area may be determined to be moving toward the outside of the shooting range. Of course, the determination may be made through another method. The system control unit **50** executes step S**505** if it is determined that the main subject area is moving toward the outside of the shooting range, and executes step S**504** if not.

(103) In step S**504**, the system control unit **50** determines whether the digital camera **100** is being panned in the direction in which the main subject area is moving, executes step S**505** if it is determined that the digital camera **100** is being panned, and executes step S**509** if not. If an angular difference between the direction in which the digital camera **100** is moving, based on the signal output by the gyrosensor **115**, and the direction in which the main subject area is moving is less than a threshold, the system control unit **50** determines that the digital camera **100** is being panned in the direction in which the main subject area is moving. Note that the movement of the digital camera **100** may be determined using another method, such as based on a motion vector between frames.

(104) If the panning direction is different from the direction in which the main subject area is moving, or if panning is not being performed, it is assumed that the main subject will move outside the shooting range in the near future and the likelihood that the tracking processing for the current main subject area will fail is relatively high. Accordingly, in step S**509**, the system control unit **50** determines that it is easy to lose sight of the main subject area, and executes step S**510** after setting a flag, for example.

(105) In step S**505**, the system control unit **50** determines whether there is an object that can hide the main subject (an obstruction) located in the direction in which the main subject is moving. The system control unit **50** estimates a change over time in the position of the main subject in the screen and the distance from the digital camera **100** based on the direction and speed in which the main subject area is moving, for example. The system control unit **50** then determines whether an object is present in front of the path along which the main subject is moving based on a defocus map that can be generated using the focus detection pixels of the image sensor **14**, for example. If such an object is present, the system control unit **50** can determine that an obstruction is located in the direction in which the main subject is moving. The system control unit **50** executes step S**509** if it is determined that there is an obstruction located in the direction in which the main subject is moving, and executes step S**506** if not.

(106) If it is determined that there is an obstruction located in the direction in which the subject is moving, it is assumed that the likelihood that the tracking processing for the current main subject area will fail in the near future is relatively high. Accordingly, in step S**509**, the system control unit **50** determines that it is easy to lose sight of the main subject area, and executes step S**510** after setting a flag, for example.

(107) In step S**506**, the system control unit **50** determines whether the size of the main subject area is decreasing over time, executes step S**509** if it is determined that the size is decreasing, and executes step S**507** if not. This determination may be a determination as to whether the distance between the main subject and the digital camera **100** is increasing over time.

(108) If the size of the main subject area is decreasing over time, or if the main subject is moving away from the digital camera **100**, it is assumed that the likelihood that the tracking processing for the current main subject area will fail in the near future is relatively high. Accordingly, in step S**509**, the system control unit **50** determines that it is easy to lose sight of the main subject area, and executes step S**510** after setting a flag, for example.

(109) In step S**507**, the system control unit **50** determines whether the main subject is facing away,

executes step S**509** if it is determined that the main subject is facing away, and executes step S**508** if not. It is assumed here that the main subject is a subject of a type for which the accuracy or the reliability of the tracking processing will drop significantly if the subject is facing away, such as a person, an animal, or the like. For subjects for which the accuracy or the reliability of the tracking processing does not change significantly depending on the orientation, such as vehicle subjects, step S**507** may be skipped, or the subject may be considered as not facing away. Whether the main subject is facing away can be determined using a trained deep learning model capable of determining the direction of subjects, such as the orientation of the face of a person or an animal, for example. The image processing unit **20** determines the orientation of the subject based on the trained model, and notifies the system control unit **50** of the determination result. Note that whether the orientation is one in which the tracking accuracy or reliability will drop may be determined instead of determining whether the subject is facing away.

(110) If it is determined that the main subject is facing away, it is assumed that the likelihood that the tracking processing for the current main subject area will fail in the near future is relatively high. Accordingly, in step S**509**, the system control unit **50** determines that it is likely to fail to detect of the main subject area, and executes step S**510** after setting a flag, for example.

(111) In step S**508**, the system control unit **50** determines that it is not likely to fail to detect of the main subject area, and executes step S**510** after removing the flag that is set, for example.

(112) In step S**510**, the system control unit **50** determines whether the main subject area is easy to lose sight of based on, for example, the state of the flag, executes step S**511** if it is determined that the main subject area is easy to lose sight of, and executes step S**514** if not. Here, the system control unit **50** determines that it is not easy to lose sight of the main subject area if the flag is set (e.g., to 1).

(113) In step S**511**, the system control unit **50** determines whether a sub-subject area is detected by the image processing unit **20**, executes step S**512** if it is determined that a sub-subject area is detected, and executes step S**514** if not.

(114) In step S**512**, the system control unit **50** determines the sub-subject area having the highest priority. For example, the system control unit **50** can determine the sub-subject area having the highest priority by executing the main subject determination processing described with reference to FIG. **4** on the sub-subject area.

(115) In step S**513**, the system control unit **50** instructs the image processing unit **20** to display the sub-frame along with the information of the sub-subject area determined in step S**512**. The image processing unit **20** generates image data for live view display in which a sub-frame is superimposed on the sub-subject area for which information has been obtained from the system control unit **50**, and then ends the sub-frame display processing. FIG. **7**A illustrates an example of the display of the sub-frame **702**. The indicator **701** and the sub-frame **702** displayed in the main subject area differ in terms of color, pattern (e.g., a solid line or a dotted line), and the like so as to be visually distinguishable from each other.

(116) On the other hand, in step S**514**, the system control unit **50** determines not to display the sub-frame and ends the sub-frame display processing.

(117) In this manner, in the present embodiment, even when a sub-subject area is detected, the indicator is displayed only in the main subject area when the main subject area is being tracked in a stable manner. Accordingly, the user can focus on shooting the main subject.

(118) Additionally, when it is determined that the tracking of the main subject area may fail in the near future, the display of an indicator is added for a single sub-subject area which is likely to become a new main subject area that replaces the current main subject area. Accordingly, when the indicator of the sub-subject area is displayed during shooting, the user can ascertain in advance that the tracking of the current main subject area may end soon. Furthermore, the user can ascertain in advance which of the sub-subject areas is likely to become the main subject area next. For example, if the sub-subject area which is likely to become the main subject area next is not the area intended

by the user, they can consider whether to select a different sub-subject area as the new main subject area.

(119) Subject Switching Processing

(120) The main subject switching processing in step S**309** will be described in detail next with reference to the flowchart in FIG. **6**. The main subject switching processing is processing for changing the main subject area in response to a user instruction.

(121) In step S**601**, the system control unit **50** determines whether a touch-down operation is being made on the touch panel of the image display unit **28**. A "touch-down operation" is a state in which the touch panel is sensing contact. The system control unit **50** executes step S**602** if it is determined that a touch-down operation is being performed, and executes step S**605** if not. Note that the system control unit **50** may determine that a touch-down operation is being performed when the touch-down operation has continued for a set amount of time.

(122) In step S**602**, the system control unit **50** instructs the image processing unit **20** to generate live view display image data, in which a sub-frame is displayed on all sub-subject areas that can be selected. FIG. **7**B illustrates an example of the display of sub-frames **802** to **804** on all the sub-subject areas. Note that an indicator **801** is displayed on the main subject area, and thus in step S**602**, an indicator is displayed for all the subject areas detected by the image processing unit **20**. Note that for areas, among the detected sub-subject areas, having a reliability which is less than or equal to a threshold, the indicators need not be displayed, in order to avoid selecting such areas.

(123) In step S**603**, the system control unit **50** determines whether a touch-up has been detected. A "touch-up" is a state in which contact which had been sensed by the touch panel (a touch-down) is no longer sensed. The system control unit **50** executes step S**604** if it is determined that a touch-up has been detected, and repeatedly executes step S**603** if not.

(124) In step S**604**, the system control unit **50** detects the position at which the touch-up was detected (the position at which contact was last detected before the touch-up was detected). The system control unit **50** then sets the subject area including the detected position as the main subject area designated by the user, and then executes step S**615**.

(125) For example, in FIG. **7**B, if a touch-up has been detected within the indicators **801** to **804**, the system control unit **50** sets the subject area corresponding to the indicator including the position at which the touch-up was detected as the main subject area. If a touch-up has been detected in the torso, limb area, or the like of a human or animal subject, the system control unit **50** may set the face area corresponding thereto as the main subject area.

(126) Note that if no touch-up is detected within an indicator, the system control unit **50** may set a subject area for which the distance in the image from the position where the touch-up was detected is less than or equal to a threshold as the main subject area designated by the user. Alternatively, the system control unit **50** may set, as the main subject area, a subject area determined based on the subject distance from the position where the touch-up was detected, the color of the pixel at the position where the touch-up was detected, or the like.

(127) In this manner, when a touch-down operation is detected, an indicator is displayed on all of the selectable subject areas. Accordingly, the user can ascertain the detected subject area and the subject areas that can be selected as the main subject area. Additionally, when a new main subject area is selected, the display of the indicator on areas aside from the main subject area ends, and thus the display of the indicator does not interfere with subsequent shooting.

(128) In step S**605**, the system control unit **50** determines whether an operation on one of a plurality of operation members, included in the operation unit **70**, which correspond to respective ones of a plurality of directions, has been detected, executes step S**606** if such an operation has been detected, and executes step S**610** if not. It is assumed here that the plurality of directions are the left direction and the right direction, and that the plurality of operation members are a left directional key or a right directional key.

(129) In step S**606**, the system control unit **50** determines whether a sub-subject area is present in a

direction corresponding to the directional key detected as being operated in step S**605**, using the current main subject area as a reference. The system control unit **50** executes step S**607** if it is determined that a sub-subject area is present in the direction corresponding to the operated directional key, and executes step S**615** if not.

(130) In step S**607**, the system control unit **50** sets the sub-subject area present in the direction corresponding to the operated directional key as the new main subject area, and then executes step S**608**. Note that when a plurality of sub-subject areas are present in the direction corresponding to the operated directional key, the system control unit **50** sets the sub-subject area closest to the current main subject area as the new main subject area.

(131) In step S**608**, the system control unit **50** displays the indicator on the newly-set main subject area, and instructs the image processing unit **20** to display the sub-frame on the sub-subject areas closest to the newly-set main subject area in the left-right direction. The image processing unit **20** changes the indicators superimposed on the image data for live view display in response to the instruction.

(132) FIG. **7**C is a diagram illustrating an example of the live view display in step S**608**. An indicator **901** is displayed on the new main subject area, and sub-frames **902** and **903** are displayed on the sub-subject areas closest thereto in the left-right direction. Indicators **912** and **931**, indicating that the main subject area can be switched by operating the left directional key and the right directional key, are also displayed to the left and right of the indicator **901**.

(133) In step S**609**, the system control unit **50** determines whether the operation for switching the main subject area has ended, executes step S**615** if it is determined that the operation has ended, and executes step S**605** if not. The system control unit **50** can determine that the operation for switching the main subject area has ended when, for example, the right directional key and the left directional key have not been operated for a continuous set length of time. Alternatively, the system control unit **50** can determine that the operation for switching the main subject area has ended when, for example, the operation of a specific input device aside from the right directional key and the left directional key has been detected.

(134) When the main subject area is changed in response to a directional key being operated, a sub-frame is displayed in each direction for the subject area that will be set as the main subject area the next time that directional key is operated. Accordingly, the user can ascertain which subject area will be set as the main subject area for each directional key the next time that directional key is operated. Additionally, when it is determined that a new main subject area has been selected, the display of the indicator on areas aside from the main subject area ends, and thus the display of the indicator does not interfere with subsequent shooting.

(135) In step S**610**, the system control unit **50** determines whether a subject switch button included in the operation unit **70** has been operated, executes step S**611** if it is determined that the button has been operated, and executes step S**615** if not. The subject switch button is an operation member that switches the characteristic area to be tracked each time it is operated.

(136) In step S**611**, the system control unit **50** determines whether a sub-subject area is detected by the image processing unit **20**, executes step S**612** if it is determined that a sub-subject area is detected, and executes step S**615** if not.

(137) In step S**612**, the system control unit **50** sets the sub-subject area having the highest priority as the main subject area.

(138) In step S**613**, the system control unit **50** instructs the image processing unit **20** to display the indicator on the sub-subject area having the highest priority among the new main subject area and the sub-subject area after the main subject area has been changed, and then executes step S**610**. The image processing unit **20** generates image data for live view display in which the indicator is superimposed on the new main subject area and the sub-subject area having the highest priority.

(139) Each time the subject switch button is operated, the sub-subject area having the highest priority at that point in time is set as the new main subject area. Additionally, when the main

subject area is changed, a sub-frame is displayed in the sub-subject area, having the highest priority at that point in time, which will be selected the next time the subject switch button is operated. Accordingly, the user can ascertain which subject area will be set as the main subject area the next time the subject switch button is operated. Additionally, when it is determined that a new main subject area has been selected, the display of the indicator on areas aside from the main subject area ends, and thus the display of the indicator does not interfere with subsequent shooting.

(140) In this manner, when an operation for changing the main subject area is detected, the method for displaying the indicator for the subject area can be changed according to the type of the operation, which makes it possible to appropriately support the user in selecting a new main subject area. Additionally, when it is determined that the main subject area has been changed, the display of the indicator on areas aside from the main subject area ends, and thus the display of the indicator does not interfere with subsequent shooting.

(141) As described above, according to the present embodiment, in an image processing apparatus having a subject tracking function, when the tracking processing is stable, an indicator is displayed only for the main subject area which is to be tracked. Accordingly, even if a large number of subject areas are detected, there is no risk that displaying the indicator will impair the visibility of the subject. On the other hand, when conditions under which the likelihood that the tracking processing for the current main subject area will fail in the near future is relatively high are satisfied, an indicator display is added to the sub-subject area that is likely to become the main subject area next. The user can ascertain both that the situation is one in which the likelihood that the tracking processing for the current main subject area will fail in the near future is high, and that the subject area which is likely to become the next main subject area, by the indicator being displayed on the sub-subject area.

(142) Furthermore, when the main subject area is to be switched in response to a user instruction, the method for displaying the indicator on the sub-subject area is varied depending on the type of operation performed to make the switch. Specifically, when an operation in which a single subject area can be selected from all subject areas in response to a single operation (e.g., a touch operation), a sub-frame is displayed on all subject areas. This makes it possible for the user to easily ascertain which subject areas can be selected. When an operation for selecting one of the sub-subject areas adjacent to the current main subject area is made in response to the operation, an indicator is displayed only for sub-subject areas which can be selected through the operation. Furthermore, in the case of an operation for causing the image processing apparatus to automatically select a new main subject area, an indicator is displayed only for the one sub-subject area which will be selected next through the operation. Accordingly, the user can appropriately ascertain sub-subject areas that can be selected through the operation. Furthermore, when it is determined that a new main subject area has been selected, ending the display of the indicators on the sub-subject areas makes it possible to avoid impairing the visibility of the subject as a result of indicators being displayed on the sub-subject areas.

Other Embodiments

(143) For example, although the main subject processing is executed in step S**309** of FIG. **3** when the sub-frame is displayed in step S**308**, the main subject processing of step S**309** may be executed regardless of the determination in step S**308**.

(144) Although displaying indicators in the live view display is described here, indicators may be displayed in the same manner for recorded moving image data, moving image data input from the exterior in real time, and the like.

(145) In the above-described embodiment, when a plurality of types of subject areas are detected, the sub-subject area having the highest priority can be determined from subject areas having the same type as the current main subject area. Alternatively, the sub-subject area having the highest priority may be determined from all subject areas aside from the current main subject area, without considering the type of the subject. The configuration may also be such that the user can select

whether to consider the type of the current main subject area when determining the sub-subject area having the highest priority.
(146) Embodiment(s) of the present invention can also be realized by a computer of a system or apparatus that reads out and executes computer executable instructions (e.g., one or more programs) recorded on a storage medium (which may also be referred to more fully as a 'non-transitory computer-readable storage medium') to perform the functions of one or more of the above-described embodiment(s) and/or that includes one or more circuits (e.g., application specific integrated circuit (ASIC)) for performing the functions of one or more of the above-described embodiment(s), and by a method performed by the computer of the system or apparatus by, for example, reading out and executing the computer executable instructions from the storage medium to perform the functions of one or more of the above-described embodiment(s) and/or controlling the one or more circuits to perform the functions of one or more of the above-described embodiment(s). The computer may comprise one or more processors (e.g., central processing unit (CPU), micro processing unit (MPU)) and may include a network of separate computers or separate processors to read out and execute the computer executable instructions. The computer executable instructions may be provided to the computer, for example, from a network or the storage medium. The storage medium may include, for example, one or more of a hard disk, a random-access memory (RAM), a read only memory (ROM), a storage of distributed computing systems, an optical disk (such as a compact disc (CD), digital versatile disc (DVD), or Blu-ray Disc (BD)™), a flash memory device, a memory card, and the like.
(147) 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.
(148) This application claims the benefit of Japanese Patent Application No. 2022-77691, filed May 10, 2022, which is hereby incorporated by reference herein in its entirety.

Claims

1. An image processing apparatus comprising: one or more processors that execute a program stored in a memory and thereby function as a plurality of units comprising: (1) a detecting unit configured to detect characteristic areas from the plurality of images; (2) a selecting unit configured to select a characteristic area to be tracked from the characteristic areas detected from a same image by the detecting unit; (3) a tracking unit configured to detect, for a plurality of images obtained chronologically, a position of the characteristic area to be tracked; and (4) a generating unit configured to generate, based on data of the plurality of images, display image data on which an indicator indicating the characteristic area to be tracked is superimposed, wherein the generating unit: (1) when any of: overlap between the characteristic area to be tracked and another characteristic area; a change in the position or a size of the characteristic area to be tracked; an orientation of the characteristic area to be tracked; or movement of an apparatus that shot the plurality of images satisfies a predetermined condition, generates the display image data on which an indicator indicating a characteristic area aside from the characteristic area to be tracked is further superimposed; and (2) when the predetermined condition is not satisfied, generates the display image data on which an indicator indicating the characteristic area aside from the characteristic area to be tracked is not superimposed, wherein the selecting unit selects the characteristic area to be tracked from the characteristic areas detected from the same image by the detecting unit in response to an operation performed on an operating unit provided in the image processing apparatus, wherein when an operation on a touch screen serving as the operating unit is detected, the generating unit generates display image data in which an indicator is superimposed on each selectable characteristic area, among the characteristic areas from the same image detected by

the detecting unit, and wherein when the operation on the touch screen serving as the operating unit is no longer detected, (1) the selecting unit selects the characteristic area to be tracked in accordance with a position where the operation was last detected, and (2) the generating unit generates display image data in which any indicator indicating a characteristic area is not superimposed on the characteristic areas detected from the same image by the detecting unit, except for the characteristic area selected by the selecting unit.

2. The image processing apparatus according to claim 1, wherein the predetermined condition is set as a condition that the characteristic area to be tracked is likely to become undetectable.

3. The image processing apparatus according to claim 1, wherein the characteristic area on which the indicator is superimposed when the predetermined condition is satisfied is a characteristic area which is most likely to become a new characteristic area to be tracked when the current characteristic area to be tracked becomes undetectable.

4. The image processing apparatus according to claim 1, wherein the characteristic area on which the indicator is superimposed when the predetermined condition is satisfied is a characteristic area, among characteristic areas of a same type as the characteristic area to be tracked, which is most likely to become a new characteristic area to be tracked when the current characteristic area to be tracked becomes undetectable.

5. The image processing apparatus according to claim 1, wherein when an operation is detected on an operation member that switches the characteristic area to be tracked at each operation, the selecting unit selects, as the characteristic area to be tracked, a characteristic area that is different from the current characteristic area to be tracked and has a highest priority from among the characteristic areas detected by the detecting unit.

6. The image processing apparatus according to claim 5, wherein the generating unit generates display image data in which an indicator indicating a characteristic area is superimposed on a characteristic area to be selected when the operation member is operated next.

7. The image processing apparatus according to claim 5, wherein when selection of the characteristic area to be tracked in accordance with the operation on the operation member is determined to have ended, the generating unit generates display image data in which any indicator is not superimposed on the characteristic areas detected from the same image by the detecting unit, except for the characteristic area selected by the selecting unit.

8. An image capture apparatus comprising: a shooting module that shoots a plurality of images chronologically; and an image processing apparatus using the plurality of images shot by the shooting module, wherein the image processing apparatus comprises one or more processors that execute a program stored in a memory and thereby function as a plurality of units comprising: (1) a detecting unit configured to detect characteristic areas from the plurality of images; (2) a selecting unit configured to select a characteristic area to be tracked from the characteristic areas detected from a same image by the detecting unit; (3) a tracking unit configured to detect, for a plurality of images obtained chronologically, a position of the characteristic area to be tracked; and (4) a generating unit configured to generate, based on data of the plurality of images, display image data on which an indicator indicating the characteristic area to be tracked is superimposed, wherein the generating unit: (1) when any of: overlap between the characteristic area to be tracked and another characteristic area; a change in the position or a size of the characteristic area to be tracked; an orientation of the characteristic area to be tracked; or movement of an apparatus that shot the plurality of images satisfies a predetermined condition, generates the display image data on which an indicator indicating a characteristic area aside from the characteristic area to be tracked is further superimposed; and (2) when the predetermined condition is not satisfied, generates the display image data on which an indicator indicating the characteristic area aside from the characteristic area to be tracked is not superimposed, wherein the selecting unit selects the characteristic area to be tracked from the characteristic areas detected from the same image by the detecting unit in response to an operation performed on an operating unit provided in the image

processing apparatus, wherein when an operation on a touch screen serving as the operating unit is detected, the generating unit generates display image data in which an indicator is superimposed on each selectable characteristic area, among the characteristic areas from the same image detected by the detecting unit, and wherein when the operation on the touch screen serving as the operating unit is no longer detected, (1) the selecting unit selects the characteristic area to be tracked in accordance with a position where the operation was last detected, and (2) the generating unit generates display image data in which any indicator indicating a characteristic area is not superimposed on the characteristic areas detected from the same image by the detecting unit, except for the characteristic area selected by the selecting unit.

9. An image processing method executed by an apparatus, the image processing method comprising: detecting characteristic areas from the plurality of images; selecting a characteristic area to be tracked from the characteristic areas detected by the detecting from a same image; detecting, in a plurality of images obtained chronologically, a position of the characteristic area to be tracked; and generating, based on data of the plurality of images, display image data on which an indicator indicating the characteristic area to be tracked is superimposed, wherein the generating includes: (1) when any of: overlap between the characteristic area to be tracked and another characteristic area; a change in the position or a size of the characteristic area to be tracked; an orientation of the characteristic area to be tracked; or movement of an apparatus that shot the plurality of images satisfies a predetermined condition, generating the display image data on which an indicator indicating a characteristic area aside from the characteristic area to be tracked is further superimposed; and (2) when the predetermined condition is not satisfied, generating the display image data on which an indicator indicating the characteristic area aside from the characteristic area to be tracked is not superimposed, wherein the selecting includes selecting the characteristic area to be tracked from the characteristic areas detected from the same image in response to an operation performed on an operating unit provided in the apparatus, wherein when an operation on a touch screen serving as the operating unit is detected, the generating includes generating display image data in which an indicator is superimposed on each selectable characteristic area, among the characteristic areas detected from the same image, and wherein when the operation on the touch screen serving as the operating unit is no longer detected, (1) the selecting includes selecting the characteristic area to be tracked in accordance with a position where the operation was last detected, and (2) the generating includes generating display image data in which any indicator indicating a characteristic area is not superimposed on the characteristic areas detected from the same image, except for the characteristic area selected in the selecting.

10. A non-transitory computer-readable medium having stored therein a program that, when executed by a computer, causes the computer to function as an image processing apparatus comprising: a detecting unit configured to detect characteristic areas from the plurality of images; a selecting unit configured to select a characteristic area to be tracked from the characteristic areas detected from a same image by the detecting unit; a tracking unit configured to detect, for a plurality of images obtained chronologically, a position of the characteristic area to be tracked; and a generating unit configured to generate, based on data of the plurality of images, display image data on which an indicator indicating the characteristic area to be tracked is superimposed, wherein the generating unit: (1) when any of: overlap between the characteristic area to be tracked and another characteristic area; a change in the position or a size of the characteristic area to be tracked; an orientation of the characteristic area to be tracked; or movement of an apparatus that shot the plurality of images satisfies a predetermined condition, generates the display image data on which an indicator indicating a characteristic area aside from the characteristic area to be tracked is further superimposed; and (2) when the predetermined condition is not satisfied, generates the display image data on which an indicator indicating the characteristic area aside from the characteristic area to be tracked is not superimposed, wherein the selecting unit selects the characteristic area to be tracked from the characteristic areas detected from the same image by the

detecting unit in response to an operation performed on an operating unit provided in the image processing apparatus, wherein when an operation on a touch screen serving as the operating unit is detected, the generating unit generates display image data in which an indicator is superimposed on each selectable characteristic area, among the characteristic areas from the same image detected by the detecting unit, and wherein when the operation on the touch screen serving as the operating unit is no longer detected, (1) the selecting unit selects the characteristic area to be tracked in accordance with a position where the operation was last detected, and (2) the generating unit generates display image data in which any indicator indicating a characteristic area is not superimposed on the characteristic areas detected from the same image by the detecting unit, except for the characteristic area selected by the selecting unit.

11. An image processing apparatus comprising: one or more processors that execute a program stored in a memory and thereby function as a plurality of units comprising: (1) a detecting unit configured to detect characteristic areas from the plurality of images; (2) a selecting unit configured to select a characteristic area to be tracked from the characteristic areas detected from a same image by the detecting unit; (3) a tracking unit configured to detect, for a plurality of images obtained chronologically, a position of the characteristic area to be tracked; and (4) a generating unit configured to generate, based on data of the plurality of images, display image data on which an indicator indicating the characteristic area to be tracked is superimposed, wherein the generating unit: (1) when any of: overlap between the characteristic area to be tracked and another characteristic area; a change in the position or a size of the characteristic area to be tracked; an orientation of the characteristic area to be tracked; or movement of an apparatus that shot the plurality of images satisfies a predetermined condition, generates the display image data on which an indicator indicating a characteristic area aside from the characteristic area to be tracked is further superimposed; and (2) when the predetermined condition is not satisfied, generates the display image data on which an indicator indicating the characteristic area aside from the characteristic area to be tracked is not superimposed, wherein the selecting unit selects the characteristic area to be tracked from the characteristic areas detected from the same image by the detecting unit in response to an operation performed on an operating unit provided in the image processing apparatus, and wherein when an operation on one of a plurality of operation members each corresponding to one of a plurality of directions is detected, the selecting unit selects a characteristic area, among the characteristic areas detected from the same image by the detecting unit, that is closest to the characteristic area to be tracked in a direction corresponding to the one of the plurality of operation members, as the characteristic area to be tracked.

12. The image processing apparatus according to claim 11, wherein the generating unit generates display image data in which an indicator is superimposed on each characteristic area closest in each of the plurality of directions to the characteristic area to be tracked that is selected by the selecting unit.

13. The image processing apparatus according to claim 11, wherein when selection of the characteristic area to be tracked in accordance with the operation on the plurality of operation members is determined to have ended, the generating unit generates display image data in which any indicator is not superimposed on the characteristic areas detected from the same image by the detecting unit, except for the characteristic area selected by the selecting unit.

14. An image processing method executed by an apparatus, the image processing method comprising: detecting characteristic areas from the plurality of images; selecting a characteristic area to be tracked from the characteristic areas detected by the detecting from a same image; detecting, in a plurality of images obtained chronologically, a position of the characteristic area to be tracked; and generating, based on data of the plurality of images, display image data on which an indicator indicating the characteristic area to be tracked is superimposed, wherein the generating includes: (1) when any of: overlap between the characteristic area to be tracked and another characteristic area; a change in the position or a size of the characteristic area to be tracked; an

orientation of the characteristic area to be tracked; or movement of an apparatus that shot the plurality of images satisfies a predetermined condition, generating the display image data on which an indicator indicating a characteristic area aside from the characteristic area to be tracked is further superimposed; and (2) when the predetermined condition is not satisfied, generating the display image data on which an indicator indicating the characteristic area aside from the characteristic area to be tracked is not superimposed, wherein the selecting includes selecting the characteristic area to be tracked from the characteristic areas detected from the same image in response to an operation performed on an operating unit provided in the apparatus, and wherein when an operation on one of a plurality of operation members each corresponding to one of a plurality of directions is detected, the selecting includes selecting a characteristic area, among the characteristic areas detected from the same image, that is closest to the characteristic area to be tracked in a direction corresponding to the one of the plurality of operation members, as the characteristic area to be tracked.