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Picture recognition apparatus, picture recognition method, and non-transitory program recording medium displaying a generated display picture

Abstract

A picture recognition apparatus includes: a person detector that detects a person included in a captured picture and specifies a detection position and a detection size of the person in the captured picture; a frame line determiner that determines a size of a frame line different from the detection size on the basis of the specified detection position of the person; a picture generator that generates a display picture in which the frame line of the determined size is superimposed on the detection position of the captured picture; and a display controller that causes a display device to display the generated display picture.

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Background/Summary

CROSS REFERENCE TO RELATED APPLICATION (1) This application is a continuation of application No. PCT/JP2021/030667, filed on Aug. 20, 2021, and claims the benefit of priority from the prior Japanese Patent Application No. 2020-169598, filed on Oct. 7, 2020, the entire content of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Disclosure

(1) The present disclosure relates to a picture recognition apparatus, a picture recognition method, and a non-transitory program medium.

2. Description of the Related Art

(2) There is known technology for detecting a person included in a captured picture, and generating and displaying a picture in which a rectangular frame line is superimposed on the detected person. A size of the rectangular frame line superimposed and displayed on the captured picture may have an aspect ratio of 2:1 so as to surround a range of the detected person. In addition, technology for displaying a frame line having a size determined to be a standard size (for example, corresponding to a height of 170 cm) on the basis of a distance to a detected person as in JP2019-204374A is also disclosed.

(3) In a case where the size of the frame line is set to a fixed value regardless of the size of the person, there is a possibility that an attribute such as whether the person is an adult or a child cannot be appropriately grasped. On the other hand, in a case where the size of the frame line corresponds to the size of the person, the size of the frame line superimposed on a short person such as the child becomes small. In a case where the size of the frame line is small, there is a possibility of giving an impression that a person exists farther than an actual position at the time of viewing display of a captured picture in which the frame line is superimposed, and there is a possibility of erroneously grasping a position of the short person existing nearby.

(4) The present disclosure has been made in view of the above circumstances, and provides technology for reducing a possibility of erroneously grasping a position of a detected person.

SUMMARY OF THE INVENTION

(5) A picture recognition apparatus according to an embodiment includes: a picture acquirer that acquires a captured picture; a person detector that detects a person included in the captured picture acquired by the picture acquirer and specifies a detection position and a detection size of the person in the captured picture; a frame line determiner that determines a size of a frame line different from the detection size on the basis of the detection position of the person specified by the person detector; a picture generator that generates a display picture in which the frame line of the size determined by the frame line determiner is superimposed on the detection position of the captured picture; and a display controller that causes a display device to display the display picture generated by the picture generator.

(6) Another embodiment is a picture recognition method executed by the picture recognition apparatus. This method includes: acquiring a captured picture; detecting a person included in the acquired captured picture and specifying a detection position and a detection size of the person in the captured picture; determining a size of a frame line different from the detection size on the basis of the specified detection position of the person; generating a display picture in which the frame line of the determined size is superimposed on the detection position of the captured picture; and causing a display device to display the generated display picture.

(7) Still another embodiment is a non-transitory program recording medium comprising a program. This program causes a computer to execute: acquiring a captured picture; detecting a person included in the acquired captured picture and specifying a detection position and a detection size of the person in the captured picture; determining a size of a frame line different from the detection size on the basis of the specified detection position of the person; generating a display picture in

which the frame line of the determined size is superimposed on the detection position of the captured picture; and causing a display device to display the generated display picture.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

- (1) Embodiments will now be described by way of examples only, with reference to the accompanying drawings which are meant to be exemplary, not limiting and wherein like elements are numbered alike in several Figures in which:
- (2) FIG. 1 is a block diagram schematically illustrating a functional configuration of a picture recognition apparatus according to a first embodiment.
- (3) FIG. 2 is a diagram illustrating an example of a captured picture.
- (4) FIG. 3 is a diagram schematically illustrating a detection position and a detection size of a person.
- (5) FIG. 4 is a diagram illustrating an example of a display picture in which a frame line is superimposed.
- (6) FIG. 5 is a flowchart illustrating a flow of a picture recognition method according to the first embodiment.
- (7) FIGS. 6A to 6D are diagrams illustrating another display example of the frame line.
- (8) FIG. 7 is a block diagram schematically illustrating a functional configuration of a picture recognition apparatus according to a second embodiment.
- (9) FIG. 8 is a flowchart illustrating a flow of a picture recognition method according to the second embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

- (10) The invention will now be described by reference to the preferred embodiments. This does not intend to limit the scope of the present invention, but to exemplify the invention.
- (11) Hereinafter, embodiments of the present invention will be described with reference to the drawings. Specific numerical values and the like illustrated in such embodiments are merely examples for facilitating understanding of the invention, and do not limit the present invention unless otherwise specified. In the drawings, elements not directly related to the present invention are not illustrated.

First Embodiment

- (12) Before describing the first embodiment in detail, an outline will be described. In the first embodiment, a person included in a captured picture is detected, and a display picture in which a frame line surrounding the detected person is superimposed on the captured picture is generated and displayed. In the present embodiment, a frame line having a size corresponding to a detection size of the detected person is superimposed, and when a height of the detected person is less than a predetermined value such as less than 120 cm, a display picture in which a frame line having a size larger than the detection size of the person in a vertical direction is superimposed is generated. According to the present embodiment, by superimposing a frame line having a size larger than the detection size on a person having a height less than the predetermined value, a possibility of erroneously recognizing that the detected person exists farther than an actual position due to a small size of the frame line of the detected person in the vertical direction is reduced, and a possibility of erroneously grasping a position of the detected person is reduced.
- (13) FIG. 1 is a block diagram schematically illustrating a functional configuration of a picture recognition apparatus 10 according to the first embodiment. The picture recognition apparatus 10 includes a picture acquirer 12, a person detector 14, a frame line determiner 16, a picture generator 18, a display controller 20, and a storage 22. In the present embodiment, a case where the picture recognition apparatus 10 is mounted on a vehicle will be exemplified. The picture recognition

apparatus **10** is, for example, an apparatus mounted on a vehicle, and includes a control device such as a central processing unit (CPU) provided in the vehicle. The picture recognition apparatus **10** may be structured using a navigation system or the like provided in the vehicle. Further, the picture recognition apparatus **10** may be realized by a portable device such as a video camera device or a smartphone. The picture recognition apparatus **10** may include at least one of a camera **26** and a display device **28**.

(14) Each functional block illustrated in the present embodiment can be realized by an element including a CPU or a memory of a computer or a mechanical device in terms of hardware, and can be realized by a computer program or the like in terms of software. However, here, functional blocks realized by cooperation of these are illustrated. Therefore, those skilled in the art will understand that these functional blocks can be realized in various forms by combining hardware and software.

(15) The picture acquirer **12** acquires a captured picture captured by the camera **26**. The camera **26** is mounted on a vehicle and captures a picture around the vehicle. The camera **26** captures, for example, a picture in front of the vehicle. The camera **26** may capture a picture behind the vehicle or a picture beside the vehicle. The camera **26** is structured to capture a picture of visible light. The camera **26** may be structured to capture red, green, and blue color pictures, or may be structured to capture a monochrome picture of visible light.

(16) The camera **26** may be structured to capture a picture of infrared light. The camera **26** may be so-called infrared thermography, and may be capable of capturing a picture of a neighboring temperature distribution of the vehicle and specifying a neighboring heat source of the vehicle. The camera **26** may be structured to detect mid-infrared light having a wavelength of about 2 μm to 5 μm , or may be structured to detect far-infrared light having a wavelength of about 8 μm to 14 μm .

(17) The captured picture captured by the camera **26** and acquired by the picture acquirer **12** is, for example, a moving picture in which pictures of 30 frames per second are continuous. Processing described below is performed on the moving picture as needed.

(18) FIG. 2 illustrates an example of a captured picture **30** acquired by the picture acquirer **12**. In the example of FIG. 2, a plurality of persons **32a**, **32b**, **32c**, and **32d** are included in the captured picture **30**. The first person **32a** and the second person **32b** are located at a first distance **L1** at which a distance from the vehicle is relatively short. The third person **32c** and the fourth person **32d** are located at a second distance **L2** at which a distance from the vehicle is relatively long. The first distance **L1** corresponds to, for example, a distance of about 15 m to 20 m from the vehicle. The second distance **L2** corresponds to, for example, a distance of about 40 m to 50 m from the vehicle.

(19) The first person **32a** and the third person **32c** are persons having a height of about 170 cm, and the second person **32b** and the fourth person **32d** are persons having a height of about 100 cm and are so-called short persons. In the illustrated example, an appearance size of the second person **32b** who is a short person is about the same as an appearance size of the third person **32c**, that is, a detection size in the captured picture **30**. The detection size is a size on the picture in the captured picture.

(20) The person detector **14** detects a person included in the captured picture acquired by the picture acquirer **12**. The person detector **14** searches for a pedestrian, a cyclist (a person who rides a bicycle), and the like using a person recognition dictionary. The person detector **14** searches the captured picture for a person using the person recognition dictionary, and calculates a person score indicating the possibility that the person exists in a searched section. For example, the person detector **14** detects the person as a person when the person score of the searched section is larger than or equal to a predetermined threshold. The person recognition dictionary used by the person detector **14** is generated by machine learning using a model in which a captured picture of a person or the like is input and a person score is output. As the model used for the machine learning, a convolutional neural network (CNN) or the like can be used. In the example of FIG. 2, the person

detector **14** performs processing of detecting a person on the captured picture **30** acquired by the picture acquirer **12**, and detects a plurality of persons **32a**, **32b**, **32c**, and **32d**.

(21) A shape of the section used for the search by the person detector **14** is determined in advance according to the person recognition dictionary to be used. In the person recognition dictionary according to the present embodiment, the section to be searched is a rectangle, and a ratio of picture sizes in a vertical direction and a horizontal direction of the section is determined to be about 2:1. The shape of the section used for the search corresponds to, for example, picture sizes in the vertical direction and the horizontal direction of a learning picture used in the machine learning for generating the person recognition dictionary.

(22) The person detector **14** specifies a detection position and a detection size of the detected person. The person detector **14** assigns a tag number to the detected person, and stores the detection position and the detection size for each tag number in the storage **22**. The detection position is the position coordinates of a section where a person is detected in the captured picture **30**, and is determined by, for example, the position coordinates at the center of a lower end of the section. The lower end of the section where the person is detected corresponds to a position at the feet of the person, and can also be said to be a ground position where the person is in contact with the ground. The ground position of the person can be used to estimate a distance to the person. The detection size is a size of the section in which the person is detected, and is determined by, for example, the picture size in the vertical direction of the section in which the person is detected. The detection size can be used to estimate the height of the person.

(23) The person detector **14** may calculate a distance to the detected person and store the calculated distance in the storage **22** for each tag number. The person detector **14** may calculate the distance to the person on the basis of the position coordinates in the vertical direction of the ground position of the detected person in the captured picture. The person detector **14** may calculate the distance to the person using a table or a mathematical formula indicating a correlation between the position coordinates in the vertical direction of the captured picture and the distance. The distance to the person in this case is a distance from the vehicle on which the camera **26** is mounted to the person.

(24) The person detector **14** calculates a height of the detected person, and stores the calculated height in the storage **22** for each tag number. The person detector **14** calculates the height of the person on the basis of the ground position of the detected person and the detection size in the vertical direction. The person detector **14** may calculate the height of the person using a table or a mathematical formula indicating a ratio between the detection size and the height determined according to the position coordinates in the vertical direction of the captured picture **30**.

(25) FIG. **3** is a diagram schematically illustrating detection positions and detection sizes of the persons **32a** to **32d** detected in the captured picture **30** illustrated in FIG. **2**. FIG. **3** illustrates sections **34a**, **34b**, **34c**, and **34d** in which the persons **32a** to **32d** are detected in the captured picture **30** of FIG. **2**, and ground positions **36a**, **36b**, **36c**, and **36d** of the persons **32a** to **32d**. The person detector **14** stores at least vertical sizes h_a to h_d of the sections **34a** to **34d** detected as the detection sizes of the persons **32a** to **32d** in the storage **22**. The vertical sizes h_a to h_d of the sections **34a** to **34d** correspond to vertical picture sizes of the persons **32a** to **32d** in the captured picture **30**. The vertical sizes h_a to h_d of the sections **34a** to **34d** are determined by the vertical picture sizes from the feet to the heads of the persons **32a** to **32d**. The person detector **14** stores the coordinates of the ground positions **36a** to **36d** located at the centers of the lower ends of the sections **34a** to **34d** in the storage **22** as the detection positions of the persons **32a** to **32d**.

(26) The frame line determiner **16** determines whether or not a frame line is superimposed on the captured picture **30** on the basis of a detection result of the person detector **14**, and determines a position and a size of the frame line to be superimposed when the frame line is superimposed. The picture generator **18** generates a display picture by superimposing the frame line having the position and the size determined by the frame line determiner **16** on the captured picture **30**. The display controller **20** causes the display device **28** to display the display picture generated by the

picture generator **18**. The display device **28** is, for example, a display mounted on the vehicle.

(27) The frame line determiner **16** determines whether or not to superimpose the frame line on the basis of a distance from the vehicle to the person. The frame line determiner **16** determines to superimpose the frame line when the distance from the vehicle to the person is less than a threshold (for example, 40 m), and determines not to superimpose the frame line when the distance from the vehicle to the person is larger than or equal to the threshold (for example, 40 m). The frame line determiner **16** may determine a color of the frame line to be superimposed according to the distance from the vehicle to the person. For example, when the distance to the person is less than a first threshold (for example, 20 m), a red frame line may be used, and when the distance to the person is larger than or equal to the first threshold (for example, 20 m) and less than a second threshold (for example, 40 m), a yellow frame line may be used. Note that, when the distance to the person is larger than or equal to the second threshold, the frame line may be omitted. The frame line determiner **16** stores the necessity of the determined frame line or the color of the frame line in the storage **22** for each tag number.

(28) The frame line determiner **16** determines the size of the frame line on the basis of a height of the person whose distance is less than the threshold. The frame line determiner **16** determines the size of the frame line according to the height of the person. When the height of the person is larger than or equal to a predetermined value such as larger than or equal to 120 cm, the frame line determiner **16** sets the size of the frame line in the vertical direction to a size equivalent to the detection size of the person. When the height of the person is less than a predetermined value such as less than 120 cm, that is, when the person is short, the frame line determiner **16** sets the size of the frame line in the vertical direction to a size larger than the detection size of the person. The size in the vertical direction of the frame line of the person whose height is less than the predetermined value is, for example, a large size such that the height corresponds to 150 cm to 170 cm at the detection position of the person, and has a size larger than the detection size of the detected person.

(29) The size of the frame line for the person whose height is larger than or equal to the predetermined value may change according to the detection size of the person, and may change according to the height of the person and the distance to the person. That is, the size of the frame line for the person whose height is larger than or equal to the predetermined value is proportional to the height of the person and inversely proportional to the distance to the person. When the distance to the person is the same, the size of the frame line changes according to the height of the person. For example, the frame line superimposed on a person with a height of 180 cm located at the distance of 20 m is larger than the frame line superimposed on a person with a height of 160 cm located at the distance of 20 m in the vertical direction. Further, when the height of the person is the same, the size of the frame line changes according to the distance to the person. For example, the frame line superimposed on a person with a height of 180 cm located at the distance of 10 m is larger than the frame line superimposed on a person with a height of 180 cm located at the distance of 20 m in the vertical direction.

(30) The size of the frame line for the person whose height is less than the predetermined value does not necessarily follow the detection size of the person. For example, for a person whose height is less than a predetermined value, a frame line having a fixed size may be set. In this case, for example, in a case where a person having a height of 100 cm and a person having a height of 90 cm are detected, a frame line having a size corresponding to the height of 180 cm is set for both persons. Further, for a person whose height is less than the predetermined value, the size of the frame line may be set such that the size of the frame line in the vertical direction becomes a value obtained by multiplying the height of the detected person by a coefficient such as 1.5. In this case, for example, a frame line having a size corresponding to a height of 150 cm is set for a person having a height of 100 cm, and a frame line having a size corresponding to a height of 135 cm is set for a person having a height of 90 cm.

(31) FIG. 4 is a diagram illustrating an example of a display picture **40** in which frame lines **42** and

44 are superimposed. In FIG. 4, since the height of the first person **32a** in FIG. 2 is determined to be larger than or equal to the predetermined value on the basis of the ground position **36a** and a vertical size H_a in the display picture **40**, the frame line **42** of the detection size of the first person **32a** is superimposed. That is, the frame line **42** having an aspect ratio of 2:1 is superimposed with the vertical detection size H_a of the first person **32a** as a vertical size. Since the height of the second person **32b** is determined to be less than the predetermined value on the basis of the ground position **36a** and a vertical size H_b in the display picture **40**, the frame line **44** having a size larger than the detection size of the second person **32b** in the vertical direction is superimposed as a frame line having a size different from the detection size of the second person **32b**. In FIG. 4, the frame lines **42** and **44** drawn in the display picture **40** are indicated by thick lines. The frame lines of the first section **34a** and the second section **34b** indicated by broken lines in FIG. 4 are not drawn in the display picture **40**. In FIG. 4, the frame lines **42** and **44** are superimposed only on the first person **32a** and the second person **32b** located at the first distance L_1 that is a short distance, and frame lines are not superimposed on the third person **32c** and the fourth person **32d** located at the second distance L_2 that is a long distance.

(32) The frame line **42** superimposed on the first person **32a** whose height is larger than or equal to the predetermined value has a size corresponding to the detection size of the first person **32a**, and has, for example, the same size as the first section **34a** where the first person **32a** is detected. The size of the frame line **42** may be slightly different from the size of the first section **34a**, and may be different from the size of the first section **34a** by for example, about 5% to 10%. Therefore, the vertical size H_a of the frame line **42** may be the same as, slightly smaller than, or slightly larger than the vertical size h_a of the first section **34a**. The aspect ratio of the frame line **42** is the same as the aspect ratio of the detection size of the first person **32a**, and is 2:1. The frame line **42** is superimposed on the basis of the ground position **36a** of the first person **32a**, and is superimposed such that the center of the lower end of the frame line **42** is matched with the ground position **36a**.

(33) The frame line **44** superimposed on the second person **32b** whose height is less than the predetermined value is larger than the detection size of the second person **32b**. The vertical size H_b of the frame line **44** is significantly larger than the vertical size h_b of the second section **34b** where the second person **32b** is detected, and is, for example, 10% or more larger. In the example of FIG. 4, the vertical size H_b of the frame line **44** is about 1.5 times the vertical size h_b of the second section **34b**. The aspect ratio of the frame line **44** is the same as the aspect ratio of the detection size of the second person **32b**, and is 2:1. That is, the aspect ratio of the frame line **44** is the same as the aspect ratio of the frame line **42**. The frame line **44** is superimposed on the basis of the ground position **36b** of the second person **32b**, and is superimposed such that the center of the lower end of the frame line **44** is matched with the ground position **36b**. As a result, a gap **46** exists between a head of the second person **32b** and an upper end of the frame line **44**. A vertical size of the gap **46** is, for example, 10% or more of the vertical size h_b of the second section **34b**, and is, for example, about 20% to 50%.

(34) According to the display picture **40** of FIG. 4, the frame line **44** larger than the actual height is superimposed on the second person **32b**. As a result, it is possible to cause the second person **32b** to be shown larger than a case where a frame line of the detection size of the second person **32b**, that is, a size corresponding to the second section **34b** indicated by a broken line is superimposed. In addition, since the size of the frame line **44** superimposed on the second person **32b** is close to the size of the frame line **42** superimposed on the first person **32a**, it is possible to more clearly present that the first person **32a** and the second person **32b** are located at substantially the same distance. In addition, since the ground positions **36a** and **36b** of the first person **32a** and the second person **32b** are matched with the lower ends of the frame lines **42** and **44**, it is possible to more clearly present that the first person **32a** and the second person **32b** are located at the same distance depending on the lower end positions of the frame lines **42** and **44**. As a result, it is possible to reduce the possibility of erroneously recognizing that the second person **32b** exists farther than it actually

exists, because the appearance of the second person **32b** is small. For example, it is possible to reduce the possibility of erroneously recognizing that the second person **32b** exists in the vicinity of the second distance **L2** where the third person **32c** having the appearance size equivalent to that of the second person **32b** is located.

(35) FIG. 5 is a flowchart illustrating a flow of a picture recognition method according to the first embodiment. In a case where the picture recognition apparatus **10** is mounted on the vehicle, the start and end of processing of FIG. 5 are started by the use start and end of the vehicle, the start and end of an engine, a power supply, or the like, and the like. Further, the start and the end may be performed by a user's operation or the like.

(36) First, according to the start of the processing, the picture acquirer **12** acquires the captured picture **30** from the camera **26** (**S10**), and starts detecting a person included in the captured picture acquired by the person detector **14** (**S12**). When the person is detected (Y in **S12**), the person detector **14** specifies a detection position and a detection size of the person (**S14**). When a distance to the detected person is less than a threshold (Y in **S16**) and a height of the detected person is less than a predetermined value (Y in **S18**), the frame line determiner **16** determines a size of a frame line to be superimposed on the detection position of the person to be a size different from the detection size of the person, specifically, a size larger than the detection size of the person, and the picture generator **18** generates a display picture in which the frame line of the determined size is superimposed (**S20**). When the height of the detected person is not less than the predetermined value (N in **S18**), a display picture in which a frame line having a size corresponding to the detection size of the person is superimposed on the detection position of the person is generated (**S22**). The generated display picture is displayed on the display device **28** by the display controller **20** (**S24**). When the distance to the person is not less than the threshold (N in **S16**), the processing of **S18** to **S22** is skipped, and the frame line is not superimposed on the person. When no person is detected (N in **S12**), the processing of **S14** to **S22** is skipped, and the captured picture **30** in which the frame line is not superimposed is displayed as it is as a display picture (**S24**).

(37) In the flow described above, when a plurality of persons are detected in the captured picture **30**, the necessity of superimposing the frame line and the size of the frame line to be superimposed are determined for each of the plurality of detected persons by the processing of **S12** to **S22**.

(38) One aspect of the present embodiment may be a non-transitory program recording medium comprising a program. This program may be structured to cause a computer to implement: acquiring a captured picture; detecting a person included in the acquired captured picture and specifying a detection position and a detection size of the person in the captured picture; calculating a height of the person from the detection position and the detection size of the detected person; determining a size of a frame line different from the detection size on the basis of the calculated height of the person; generating a display picture in which the frame line of the determined size is superimposed on the detection position of the captured picture; and causing a display device to display the generated display picture.

(39) Although the present invention has been described with reference to the above-described embodiment, the present invention is not limited to the above-described embodiment, and appropriate combinations or replacements of the respective configurations described in the embodiment are also included in the present invention.

(40) In a modification of the first embodiment, a frame line for a person whose height is less than a predetermined value may be displayed in a mode different from that in FIG. 4. FIGS. 6A to 6D are diagrams illustrating display examples of other frame lines **44a** to **44d** corresponding to the frame line **44** illustrated in FIG. 4. An individual person **32** illustrated in FIG. 6 is a person who has a height less than the predetermined value.

(41) In the frame line **44a** illustrated in FIG. 6A, only a vertical size is large as compared with a size of a section **34** in which the person **32** is detected, and a horizontal size remains the same. Therefore, an aspect ratio of the frame line **44a** in FIG. 6A is larger than about 2:1, which is an

aspect ratio of a detection size of the person **32**. The vertical size of the frame line **44a** in FIG. 6A is larger than twice the horizontal size. For example, the vertical size is about 2.2 to 3.5 times larger than the horizontal size.

(42) In the frame line **44b** illustrated in FIG. 6B, only a horizontal size is large as compared with the size of the section **34** in which the person **32** is detected, and a vertical size remains the same. Therefore, an aspect ratio of the frame line **44b** in FIG. 6B is smaller than about 2:1, which is an aspect ratio of the size of the section **34** in which the person **32** is detected. The horizontal size of the frame line **44b** in FIG. 6B may be smaller than the vertical size of the frame line **44b**, and may be, for example, about 0.6 to 1 times the vertical size.

(43) The frame line **44c** illustrated in FIG. 6C has the same shape and size as the frame line **44** in FIG. 4, but a superimposition position of the frame line **44c** is different. A lower end of the frame line **44c** in FIG. 6C is located below a ground position **36** of the person **32**. A center position of the frame line **44c** in FIG. 6C is matched with, for example, a center position of the section **34** where the person **32** is detected. By shifting and superimposing the frame line **44c** downward, it is possible to give an impression that the person **32** exists closer, and it is possible to further emphasize the presence of the short person.

(44) The frame line **44d** illustrated in FIG. 6D has the same shape and size as the frame line **44** in FIG. 4, but a superimposition position of the frame line **44d** is different, and the superimposition position is shifted in a left-right direction. The frame line **44d** in FIG. 6D is shifted and superimposed in a movement direction or a gaze direction **38** of the detected person **32**. In the example of FIG. 6D, the movement direction or the gaze direction **38** of the person **32** is a right direction, and the center of the frame line **44d** is located on the right side of the ground position **36**. By shifting and superimposing the frame line **44d** in the movement direction or the gaze direction **38** of the person **32**, the movement direction or the gaze direction **38** of the person **32** can be presented, and the behavior of the short person can be suggested. Note that, when the movement direction or the gaze direction **38** of the person **32** is not the left-right direction but a downward direction or an oblique direction, the superimposition position of the frame line **44d** may be shifted in the downward direction or the oblique direction.

(45) The movement direction of the person **32** may be specified on the basis of the transition of the person detection position for each frame of the captured picture as the moving picture, the direction of the limbs of the person, and the like. Further, the gaze direction **38** of the person **32** may be specified on the basis of the direction of the face of the person **32**, and the direction of the face of the person **32** may be regarded as the gaze direction **38**. The direction of the face of the person **32** is specified on the basis of a detection result of the person by the person detector **14**.

(46) In the above-described embodiment, the case where the lower end of the detected section is set to the ground position has been described. In another embodiment, the ground position may be detected on the basis of the picture content of the detected section. For example, in a case where the feet of the person included in the detected section are hidden and invisible, the height of the person may be estimated on the basis of the position and size of the head of the person included in the detected section, and the ground position may be detected on the basis of the estimation result of the height.

(47) In the above-described embodiment, the case where the necessity of the frame line or the color of the frame line is determined according to the distance to the person has been described. In another embodiment, the necessity of the frame line or the color of the frame line may be determined on the basis of the detection position of the person. For example, the frame line determiner **16** may hold the position coordinates in the vertical direction of the captured picture corresponding to the distance (for example, 20 m or 40 m) serving as the above-described threshold as a threshold, and determine the necessity of superimposing the frame line or the color of the frame line on the basis of the threshold of the position coordinates.

(48) In the above-described embodiment, the case where the size of the frame line for the person

whose height is less than the predetermined value is set to the size different from the detection size of the person by enlarging the frame line in the vertical direction or the like, and the frame line having the size different from the detection size of the person is superimposed has been described. In another embodiment, a first frame line corresponding to the detected size and a second frame line having a size larger than the size of the first frame line in the vertical direction may be superimposed on a person whose height is less than a predetermined value. In this case, the frame line surrounding the detected person is a double frame line. In addition, an outline or the like drawn so as to trace the outer shape of the person whose height present in the frame line enlarged in the vertical direction is less than the predetermined value may be added to the frame line and superimposed.

(49) In the above-described embodiment, the frame line is not superimposed on the person whose distance is larger than or equal to the threshold. In another embodiment, a frame line may be superimposed on a person whose distance is larger than or equal to the threshold. For example, when a person whose distance is less than the threshold is not detected, a frame line may be superimposed on a person whose distance is larger than or equal to the threshold. The frame line may be superimposed on the person whose distance is larger than or equal to the threshold regardless of whether or not the person whose distance is less than the threshold is detected.

(50) In the above-described embodiment, the case where the size of the frame line for the person whose height is less than the predetermined value is set to a size different from the detection size of the person by enlarging the frame line in the vertical direction or the like, and the frame line having the size different from the detection size of the person is superimposed has been described. In another embodiment, the necessity of such processing may be determined according to the distance between the person whose height is less than the predetermined value and the person whose height is larger than or equal to the predetermined value. For example, in a case where there is a person whose height is larger than or equal to the predetermined value in the vicinity of the person whose height is less than the predetermined value, for example, in a range corresponding to 2 m, the distance to the person whose height is less than the predetermined value is less likely to be erroneously recognized due to the presence of the person whose height is larger than or equal to the predetermined value. Therefore, in a case where there is no person whose height is larger than or equal to the predetermined value in the vicinity of the person whose height is less than the predetermined value, for example, in a predetermined range such as 2 m, the size of the frame line for the person whose height is less than the predetermined value may be set to a size different from the detection size of the person.

(51) In the above-described embodiment, the case where the distance to the person detected by the person detector **14** is calculated and the height of the detected person is calculated has been described. In another embodiment, instead of the person detector **14**, the distance to the person detected by the frame line determiner **16** may be calculated, and the height of the detected person may be calculated. In this case, the person detector **14** may detect a person included in the captured picture acquired by the picture acquirer **12** and specify a detection position and a detection size of the person in the captured picture. The frame line determiner **16** may determine the size of the frame line different from the detection size on the basis of the detection position of the person specified by the person detector **14**. The frame line determiner **16** may calculate the height of the person from the detection position and the detection size of the person specified by the person detector **14**, and determine the size of the frame line different from the detection size on the basis of the height of the person calculated by the frame line determiner **16**. When the height of the person calculated by the frame line determiner **16** is less than the predetermined value, the frame line determiner **16** may set the size of the frame line to a size larger than the detection size at least in the vertical direction.

Second Embodiment

(52) Next, a second embodiment of the present invention will be described with reference to the

drawings. In the second embodiment, a size of a frame line different from a detection size of a person is determined on the basis of the detection position and the detection size of the person without calculating a height of the person. Hereinafter, the second embodiment will be described focusing on differences from the first embodiment, and drawings or description of common points with the first embodiment will be omitted as appropriate.

(53) FIG. 7 is a block diagram schematically illustrating a functional configuration of a picture recognition apparatus **10a** according to the second embodiment. The picture recognition apparatus **10a** includes a picture acquirer **12**, a person detector **14a**, a frame line determiner **16a**, a picture generator **18**, a display controller **20**, and a storage **22**. In the second embodiment, the picture acquirer **12**, the picture generator **18**, the display controller **20**, and the storage **22** are structured similarly to the first embodiment.

(54) The person detector **14a** detects a person included in a captured picture acquired by the picture acquirer **12**, and specifies a detection position and a detection size of the detected person. The person detector **14a** detects a person included in the captured picture by processing similar to that of a person detector **14** according to the first embodiment, and specifies a detection position and a detection size of the detected person. Unlike the person detector **14** according to the first embodiment, the person detector **14a** may not calculate the height of the detected person.

(55) The frame line determiner **16a** determines the size of the frame line different from the detection size on the basis of the detection position of the person specified by the person detector **14a**. The frame line determiner **16a** is different from the first embodiment in that the size of the frame line is determined on the basis of the detection position of the person and a prescribed size according to the detection position, instead of determining the size of the frame line according to the height of the person. Specifically, when the detection size of the person detected by the person detector **14a** is less than the prescribed size according to the detection position, the size of the frame line is determined such that the size of the frame line is larger than the detection size at least in a vertical direction. The prescribed size according to the detection position is, for example, equivalent to a detection size of a person having a height of 170 cm present at the detection position. The prescribed size may change according to the detection position. For example, the prescribed size may be increased when the detection position in the captured picture is lower, and the prescribed size may be decreased when the detection position in the captured picture is higher. The prescribed size according to the detection position is stored in advance in the storage **22**, for example. The prescribed size according to the detection position can be determined using a table, a mathematical formula, or the like indicating a correlation between the detection position and the prescribed size. The frame line determiner **16a** may be structured similarly to the frame line determiner **16** according to the first embodiment, except for the processing of determining the size of the frame line.

(56) Processing of the person detector **14a** and the frame line determiner **16a** will be described with reference to FIG. 3. The person detector **14a** detects a first person **32a**, and specifies a detection size of a section **34a** where the first person **32a** is detected and a detection position (that is, a ground position **36a**). The frame line determiner **16a** compares the detection size of the first person **32a** with the prescribed size according to the ground position **36a** of the first person **32a**. In a case where the prescribed size corresponds to a detection size of a person having a height of 170 cm and the height of the first person **32a** is larger than or equal to 170 cm, the detection size of the first person **32a** is larger than or equal to the prescribed size according to the ground position **36a**. In this case, the frame line determiner **16a** determines the detection size of the section **34a** in which the first person **32a** is detected as the size of the frame line.

(57) The person detector **14a** detects a second person **32b**, and specifies a detection size of a section **34b** where the second person **32b** is detected and a detection position (that is, a ground position **36b**). The frame line determiner **16a** compares the detection size of the second person **32b** with the prescribed size according to the ground position **36b** of the second person **32b**. In a case

where the prescribed size corresponds to a detection size of a person having a height of 170 cm and the height of the second person **32b** is about 100 cm, the detection size of the second person **32b** is less than the prescribed size according to the ground position **36b**. In this case, the frame line determiner **16a** determines, as the size of the frame line, a size larger than the detection size of the section **34b** in which the second person **32b** is detected at least in the vertical direction. The frame line determiner **16a** may determine the same size as the prescribed size according to the ground position **36b** as the size of the frame line of the second person **32b**.

(58) FIG. **8** is a flowchart illustrating a flow of a picture recognition method according to the second embodiment. The picture acquirer **12** acquires a captured picture **30** from a camera **26** (S50), and detects a person included in the captured picture acquired by the person detector **14** (S52). When the person is detected (Y in S52), the person detector **14** specifies a detection position and a detection size of the person (S54). When a distance to the detected person is less than a threshold (Y in S56) and the detection size of the detected person is less than a prescribed size according to the detection position (Y in S58), the frame line determiner **16** determines the size of the frame line to be superimposed on the detection position of the person to be a size different from the detection size of the person, specifically, a size larger than the detection size of the person, and the picture generator **18** generates a display picture in which the frame line of the determined size is superimposed (S60). When the detection size of the detected person is not less than the prescribed size according to the detection position (N in S58), a display picture in which a frame line having a size corresponding to the detection size of the person is superimposed on the detection position of the person is generated (S62). The generated display picture is displayed on the display device **28** by the display controller **20** (S64). When the distance to the person is not less than the threshold (N in S56), the processing of S58 to S62 is skipped, and the frame line is not superimposed on the person. When no person is detected (N in S52), the processing of S54 to S62 is skipped, and the captured picture **30** in which the frame line is not superimposed is displayed as it is as a display picture (S64).

(59) Also in the second embodiment, effects similar to those of the first embodiment can be obtained. The modification of the first embodiment can also be applied to the second embodiment.

(60) In the above-described embodiment, the case where the distance to the person is calculated on the basis of the captured picture has been described. In another embodiment, the distance to the person may be measured using a sensor different from the camera **26**. For example, any distance measuring sensor such as an ultrasonic sensor, a radar sensor, or light detection and ranging (LIDAR) may be used.

(61) In the above-described embodiment, the case where the picture recognition apparatus **10** is mounted on the vehicle has been described. In another embodiment, the installation location of the picture recognition apparatus **10** is not particularly limited, and may be used for any purpose.

Claims

1. A picture recognition apparatus comprising a memory storing executable instructions that, in response to execution, cause a processor to perform operations comprising: acquiring a captured picture; detecting a person included in the captured picture and specifying a detection position and a detection size of the person in the captured picture; determining a size of a bounding box such that: a) the size of the bounding box is set to a size larger than the detection size at least in a vertical direction when the detection size of the person is less than a prescribed size according to the detection position; and b) the size of the bounding box is set to a size same as the detection size at least in a vertical direction when the detection size of the person is larger than or equal to the prescribed size according to the detection position; generating a display picture in which the frame bounding box of the determined size is superimposed on the detection position of the captured picture; and causing a display device to display the generated display picture.

2. The picture recognition apparatus according to claim 1, wherein the processor further performs operations comprising calculating a height of the person from the detection position and the detection size of the person, and determines the size of the bounding box on the basis of the calculated height of the person.
 3. The picture recognition apparatus according to claim 2, wherein the processor further performs operations comprising setting the size of the bounding box to a size larger than the detection size at least in a vertical direction when the height of the person detected by the person detector is less than a predetermined value.
 4. The picture recognition apparatus according to claim 1, wherein the processor further performs operations comprising: specifying a ground position of the person in the captured picture, and generating a display picture in which the bounding box is superimposed such that a lower end of the frame line having the size determined by the frame line determiner is located at the ground position.
 5. The picture recognition apparatus according to claim 1, wherein the processor further performs operations comprising: specifying a ground position of the person in the captured picture, and generating a display picture in which the bounding box is superimposed such that a lower end of the frame line having the size determined by the frame line determiner is located below the ground position.
 6. A picture recognition method in which a picture recognition apparatus executes: acquiring a captured picture; detecting a person included in the acquired captured picture and specifying a detection position and a detection size of the person in the captured picture; determining a size of a bounding box such that: a) the size of the bounding box is set to a size larger than the detection size at least in a vertical direction when the detection size of the person is less than a prescribed size according to the detection position; and b) the size of the bounding box is set to a size same as the detection size at least in a vertical direction when the detection size of the person is larger than or equal to the prescribed size according to the detection position; generating a display picture in which the bounding box of the determined size is superimposed on the detection position of the captured picture; and causing a display device to display the generated display picture.
 7. A non-transitory program recording medium comprising a program for causing a computer to execute: acquiring a captured picture; detecting a person included in the acquired captured picture and specifying a detection position and a detection size of the person in the captured picture; determining a size of a bounding box such that a) the size of the bounding box is set to a size larger than the detection size at least in a vertical direction when the detection size of the person is less than a prescribed size according to the detection position, and b) the size of the bounding box is set to a size same as the detection size at least in a vertical direction when the detection size of the person is larger than or equal to the prescribed size according to the detection position; generating a display picture in which the bounding box of the determined size is superimposed on the detection position of the captured picture; and causing a display device to display the generated display picture.
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