The following description will discuss, with reference to Figs. 7 to 10, a flow of, for example, determination of the cursor position in accordance with the skeleton data in Embodiment 1.

[0044]

Fig. 7 is a flowchart describing an example of a flow of, for example, determination of the cursor position in accordance with the skeleton data in Embodiment 1. When the process is started (a step S60), the determination section 9 may determine the cursor position in accordance with the skeleton data having been presumed by the presumption section 8 (a step S61).

[0045]

The determination section 9 may calculate a position of a specific part of the hand of the operator in accordance with the skeleton data and determine the cursor position so that the cursor position corresponds to the position. For example, the determination section 9 may calculate a position of a base of a specific finger of the hand of the operator and determine the cursor position so that the cursor position corresponds to the position of the base of the specific finger. For example, the determination section 9 may determine, as the cursor position, a position obtained by adding together (i) a position of the region having been extracted by the region extraction section 8a and containing the hand, the position being located in the captured image data, and (ii) a position of a specific part of the

hand of the operator, the position being calculated in accordance with the skeleton data and located in the hand as a whole.

[0046]

Fig. 8 is an example of a view schematically illustrating a state in which a skeleton is superimposed on image data of a hand 70 of the operator. In an example, the determination section 9 may specify, in accordance with skeleton data 73, a point 72 indicative of a base B of an index finger and determine the cursor position so that the cursor position corresponds to a position of the specified point 72.

[0047]

Subsequently, the determination section (detection section) 9 may detect a gesture (action for operating the electronic device 1) in accordance with the skeleton data 73 having been presumed by the presumption section 8 (a step S62). The gesture (action) detected by the determination section 9 is not particularly limited, and the determination section 9 may detect various gestures (actions), e.g., gestures (actions) such as a click action, a swipe action, and a drag-and-drop action.

[0048]

In an aspect, different gestures may be assigned to respective forms of a skeleton model. In an aspect, a form of the skeleton model is represented by (i) a specific parameter

A position A of a fingertip 81 of the index finger in Fig. 9, the fingertip 81 having been set in the step S62, and a position B of the root 82 of the index finger, the root 82 having been set in the step S63, may be positionally apart from each other as in a state where the hand 80 of the operator is opened.

[0059]

The above description has explained that the fingertip 81 of the index finger, the fingertip 81 having been set in the step S62, can be recognized from an image of the hand of the operator, the image having been acquired from the camera 4, and that the root 82 of the index finger, the root 82 having been set in the step S63, need not be recognizable from an image of the hand of the operator, the image having been acquired from the camera 4. Note, however, that both (a) the fingertip 81 of the index finger, the fingertip 81 having been set in the step S62, and (b) the root 82 of the index finger, the root 82 having been set in the step S63, may be unrecognizable from an image of the hand of the operator, the image having been acquired from the camera 4. This may be because the skeleton and/or the virtual globe model are/is recognized as the information on the hand 80 of the operator as described earlier by recognition of the hand of the operator as illustrated in Fig. 3.

[0060]

The determination section 9 which (i) detects that a distance between the point 91 and the point 92 in the hand 90

Part or all of functions of the electronic devices 1, 141, and 1000 may be realized by hardware of an integrated circuit (IC chip) or the like or may be alternatively realized by software.

[0093]

In the latter case, the electronic devices 1, 141, and 1000 may be realized by, for example, a computer that executes instructions of a program that is software realizing the foregoing functions. Fig. 18 is an example of a block diagram of a computer. A computer 150 may include a central processing unit (CPU) 151 and a memory 152. A program 153 for causing the computer 150 to operate as the electronic devices 1, 141, and 1000 may be stored in the memory 152. Functions of the electronic devices 1, 141 and 1000 may be realized by the CPU 151 reading the program 153 from the memory 152 and executing the program 153.

[0094]

The CPU 151 may be a graphic processing unit (GPU), a digital signal processor (DSP), a micro processing unit (MPU), a floating point number processing unit (FPU), a physics processing unit (PPU), or a microcontroller. Examples of the memory 152 include a random access memory (RAM), a read only memory (ROM), a flash memory, a hard disk drive (HHD), a solid state drive (SSD), and a combination thereof.

[0095]

The computer 150 may further include a communication

Claims

1. An electronic device comprising:

an acquisition section configured to acquire captured image data of a hand of an operator;

a presumption section configured to presume, in accordance with the captured image data, skeleton data corresponding to the hand; and

a determination section configured to determine, in accordance with the skeleton data, a cursor position for operating the electronic device,

wherein the presumption section extracts, by detecting a palm or fist that is a part of the hand in the captured image data, a region containing the hand, and then presumes the skeleton data from the region containing the hand.

2. The electronic device as set forth in claim 1, wherein the presumption section presumes the skeleton data with use of a learning model obtained through machine learning in which a set of the captured image data of the hand and the skeleton data corresponding to the captured image data of the hand is used as training data.

3. The electronic device as set forth in claim 2, wherein the presumption section uses (i) a right-hand recognition learning

model obtained through machine learning in which a set of the captured image data of the right hand and the skeleton data corresponding to the captured image data of the right hand is used as training data and (ii) a left-hand recognition learning model obtained through machine learning in which the captured image data of the left hand and the skeleton data is used as training data to recognize, in accordance with from which of the right-hand recognition learning model and the left-hand recognition learning model the skeleton data has been successfully obtained, whether the hand of the operator is the right hand or the left hand.

4. The electronic device as set forth in any one of claims 1 to 3, wherein the captured image data is an RGB image acquired by a single camera.

5. The electronic device as set forth in any one of claims 1 to 4, wherein the determination section determines the cursor position in accordance with a position of a specific part of the hand, the position being indicated by the skeleton data.

6. An electronic device as set forth in any one of claims 1 to 5, further comprising a detection section configured to detect, in accordance with the skeleton data, an action for operating the electronic device.

7. The electronic device as set forth in claim 6, wherein the detection section detects a click action in accordance with a positional relationship between a tip of a finger and a base of the finger, the positional relationship being indicated by the skeleton data.

8. An electronic device as set forth in claim 6 or 7, further comprising a cursor display section provided on a display screen of the electronic device and configured to display a cursor in accordance with the cursor position having been determined by the determination section.

9. The electronic device as set forth in claim 8, wherein the cursor display section displays the cursor in a display manner corresponding to the action having been detected by the detection section.

10. The electronic device as set forth in claim 8 or 9, wherein the display screen contains a specific region, and in a case where the cursor position having been determined by the determination section is in the specific region, the cursor display section displays the cursor outside the specific region in a display manner different from a display manner in a case where the cursor position is outside the specific region.

11. An electronic device comprising:

an acquisition section configured to acquire captured image data of a hand of an operator;

a presumption section configured to presume, in accordance with the captured image data, skeleton data corresponding to the hand; and

an operation section configured to operate, in accordance with the skeleton data, an application that is executed by the electronic device,

wherein the presumption section extracts, by detecting a palm or fist that is a part of the hand in the captured image data, a region containing the hand, and then presumes the skeleton data from the region containing the hand.

12. A program for causing at least one processor of an electronic device to carry out:

an acquisition process for acquiring captured image data of a hand of an operator;

a presumption process for extracting, by detecting a palm or fist that is a part of the hand in the captured image data, a region containing the hand, and then presuming the skeleton data from the region containing the hand; and

a determination process for determining, in accordance with the skeleton data, a cursor position for operating the electronic device.

13. A program for causing at least one processor of an electronic device to carry out:

an acquisition process for acquiring captured image data of a hand of an operator;

a presumption process for extracting, by detecting a palm or fist that is a part of the hand in the captured image data, a region containing the hand, and then presuming the skeleton data from the region containing the hand; and

an operation process for operating, in accordance with the skeleton data, an application that is executed by the electronic device.