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 (EXHIBIT NAME) Abstract 1
 (EXHIBIT NAME) Drawings 1

(DOCUMENT TITLE) Specification

(TITLE OF THE INVENTION) Control apparatus, control method, and program

(TECHNICAL FIELD)

(0001)

The present invention relates to a control device, a control method, and a program.

(BACKGROUND ART)

(0002)

Mixed Reality (MR) technology and Virtual Reality (VR) technology, which allow a user to perceive a space different from the real world using an HMD (Head Mounted Display), are known. In such technologies, studies are being conducted on various types of control of the HMD that may be performed while the user is wearing the HMD (head-mounted display).

(0003)

Patent Literature 1 discloses an information processing apparatus that recognizes an input device and an operation medium (a user's hand) that operates the input device, and switches applications in accordance with the recognition results. For example, when the information processing device recognizes a keyboard, which is an input device, and the user's hand, it launches a text editor application that allows text input by operating the keyboard. On the other hand, when the information processing device recognizes a controller, which is an input device, and a hand, it launches an application that performs CG adjustment by operating the controller.

(PRIOR ART LITERATURE)

(PATENT LITERATURE)

(0004)

(PATENT LITERATURE 1) Japanese Unexamined Patent Application Publication 2017-059062

(OUTLINE OF THE INVENTION)

(PROBLEM TO BE SOLVED BY THE INVENTION)

(0005)

Here, the information processing apparatus described in Patent Literature 1 switches the application to be launched when it recognizes both an input device and an operation medium. For this reason, for example, when a user controls an electronic device such as an HMD without using an input device, it is not possible to switch to an appropriate application. Therefore, there were instances in which the user could not control the electronic device in accordance with the control method desired by the user.

(0006)

Accordingly, the present invention aims to provide a technique for controlling an electronic device in accordance with a control method desired by a user.

(MEANS FOR SOLVING THE PROBLEM)

(0007)

One aspect of the present invention is:

a control device for controlling an electronic device, comprising:

a selection means for selecting either a first control mode or a second control mode as the control mode for controlling the electronic device, based on a state of a specific body part of a user; and

a control means that 1) will perform control of the electronic device in accordance with the state of the specific body part of the user, which is determined based on imaging by imaging means when the selection means has been used to select the first control mode; and 2) will perform control of the electronic device in accordance with an operation involving physical contact by the user with a specific operation member when the selection means has been used to select the second control mode.

(0008)

One aspect of the present invention is:

a control method for controlling an electronic device, comprising:

a selection step for selecting either a first control mode or a second control mode as the control mode for controlling the electronic device, based on a state of a specific body part of a user; and

a control step that 1) will perform control of the electronic device in accordance with the state of the specific body part of the user, which is determined based on imaging by imaging means when the first control mode has been selected in the selection step; and 2) will perform control of the electronic device in accordance with an operation involving physical contact by the user with a specific operation member when the second control mode has been selected in the selection step

(EFFECT OF THE INVENTION)

(0009)

According to the present invention, an electronic device can be controlled according to a control method desired by a user.

(BRIEF DESCRIPTION OF THE DRAWINGS)

(0010)

(FIGURE 1) is a diagram illustrating an information processing system according to the first embodiment.

(FIGURE 2) is an internal configuration diagram of an HMD or the like according to the first embodiment.

(FIGURE 3) is a diagram explaining the ray control mode according to the first embodiment.

(FIGURE 4) is a diagram explaining the tracking control mode according to the first embodiment.

(FIGURE 5) is a flowchart of the mode selection process according to the first embodiment.

(FIGURE 6) is a flowchart of the mode selection process according to the second embodiment.

(FIGURE 7) is a diagram explaining a method for selecting a control mode according to the second embodiment.

(FIGURE 8) is a flowchart of the mode selection process according to the third embodiment.

(EXAMPLES OF EMBODIMENT OF THE INVENTION)

(0011)

Hereinafter, each embodiment will be described with reference to the drawings. The same or equivalent constituent elements, members, and processes shown in the drawings are denoted by the same reference numerals, and any redundant description will be omitted as appropriate. Also, in the drawings, some constituent elements, members, and processes are omitted from the illustration.

(0012)

<Embodiment 1>

Referring to Figure 1, information processing system 1 according to the first embodiment will be described. Information processing system 1 includes HMD 100, image processing device 110, and controller 120.

(0013)

HMD 100 is a head-mounted display device (electronic device) that may be worn on the user's head. HMD 100 displays a composite image, which is a combination of an image captured by HMD 100 of the area in front of the user and content such as CG (computer graphics) in a form corresponding to the orientation of HMD 100.

(0014)

Image processing device 110 is a control device (electronic device) that controls HMD 100. Image processing device 110 is, for example, a smartphone, a tablet terminal, or a PC (personal computer). Image processing device 110 may be connected to HMD 100 wirelessly or via a wired connection. Image processing device 110 generates a composite image by combining a captured image and CG, and transmits the composite image to HMD 100. Each component of image processing device 110 may also be included in HMD 100.

(0015)

Controller 120 is a device for performing various controls of HMD 100. If image processing device 110 is in a specific control mode, when a user operation is performed on controller 120, HMD 100 is controlled in response to the user operation. For example, as shown in Figure 1, controller 120 has a ring-like (ring-type) shape such that it can be worn on a user's finger. If controller 120 can be worn on a user's finger, the user can move their hand freely while wearing controller 120. Controller 120 also has a button with a built-in optical trackpad (hereinafter referred to as "OTP"). Controller 120 performs wireless communication via Bluetooth with image processing device 110.

(0016)

For example, a menu including a pointer may be displayed on HMD 100 if the user long-presses the OTP button. After that, the user can align the pointer with a desired item by placing their finger on the OTP and sliding it in any direction. Then, the user can perform a confirmation operation to decide the selection of that item by pressing down on the OTP button. While the shape of controller 120 has been described as ring-shaped, it is not limited to this. For example, the shape of controller 120 may be a wearable shape that can be worn on the hand, such as a glove. In this way, controller 120 is preferably in a form that can be held by the user's hand or worn on the hand such that it is easy for the user to use.

(0017)

Controller 120 may include any operating member instead of the OTP, as long as the user can perform operations by physical contact. For example, controller 120 may include any of a touchpad, a touch panel, a directional pad, a joystick, or a trackpad device instead of the OTP.

(0018)

(Internal configuration of the HMD)

The internal configuration of HMD 100 will be described with reference to Figure 2. HMD 100 includes HMD control unit 201, imaging unit 202, image display unit 203, and orientation sensor unit 204.

(0019)

HMD control unit 201 controls each component of HMD 100. When HMD control unit 201 acquires a composite image (an image in which a captured image obtained by imaging unit 202 capturing the space in front of the user and CG are combined) from image processing apparatus 110, it displays the composite image on image display unit 203. Therefore, the user can see the composite image displayed on image display unit 203 by wearing HMD 100. The user can experience various mixed realities in which CG is fused with the real space.

(0020)

Image capturing unit 202 includes two cameras (image capturing devices). The two cameras are placed near the positions of the user's left and right eyes when HMD 100 is worn in order to capture the same space as the space that the user normally sees. The images captured by the two cameras of the subject (the area in front of the user) are outputted to image processing apparatus 110. In addition, the two cameras in imaging unit 202 can acquire information on the distance from the two cameras to the subject as distance information through distance measurement using stereo cameras.

(0021)

Image display unit 203 displays the composite image. Image display unit 203 includes, for example, a liquid crystal panel or an organic EL panel. When the user is wearing HMD 100, an organic EL panel is placed in front of each of the user's eyes.

(0022)

Attitude sensor unit 204 detects the attitude (and position) of HMD 100. Then, attitude sensor unit 204 detects (acquires) the attitude of the user (the user wearing HMD 100) corresponding to the attitude (and position) of HMD 100. Attitude sensor unit 204 includes an inertial measurement unit (IMU; Inertial Measurement Unit). Attitude sensor unit 204 outputs information about the user's attitude (attitude information) to image processing device 110.

(0023)

(Internal configuration of the image processing device)

Referring to Figure 2, the internal configuration of image processing device 110 will be described. Image processing device 110 includes control unit 211, content DB 212, and communication unit 213.

(0024)

Control unit 211 receives an image (captured image) acquired by imaging unit 202 and attitude information acquired by attitude sensor unit 204 from HMD 100. Control unit 211 performs image processing on the captured image to cancel aberrations in the optical system of imaging unit 202 and the optical system of image display unit 203. Then, control unit 211 synthesizes the captured image and an arbitrary CG to generate a composite image. Control unit 211 transmits the composite image to HMD control unit 201 in HMD 100.

(0025)

Control unit 211 controls the position, orientation, and size of the CG in the composite image based on the information (distance information and orientation information) acquired by HMD 100. For example, when placing a virtual object indicated by the CG near a specific object existing in real space in the space represented by the composite image, control unit 211 increases the size of the virtual object (CG) as the distance between the specific object and imaging unit 202 becomes shorter. By controlling the position, orientation, and size of the CG in this way, control unit 211 can generate a composite image in which a CG object not placed in the real space appears as if it were placed in the real space.

(0026)

Content DB 212 is a storage unit that stores information such as CG. Control unit 211 is capable of switching the CG read from content DB 212 (that is, the CG used to generate the composite image).

(0027)

(Internal configuration of the controller)

With reference to Figure 2, the internal configuration of controller 120 will be described. Controller 120 includes controller control unit 221, operation unit 222, and communication unit 223.

(0028)

Controller control unit 221 controls each component of controller 120.

(0029)

Operation unit 222 includes a button with a built-in OTP. Information regarding presses or finger slides on the OTP at operation unit 222 (operation information) is transmitted to image processing device 110 via communication unit 223.

(0030)

For example, the user can move the pointer displayed on HMD 100 to a predetermined position by sliding a finger on the OTP. Additionally, the user can instruct HMD 100 or image processing device 110 to perform specific processing by pressing a button on the OTP. In this way, the user can control HMD 100 by combining finger sliding and button pressing on the OTP. More specifically, for example, the user can display a menu on HMD 100 by long-pressing the OTP button, and can select the desired location by positioning the pointer and then pressing the OTP button.

(0031)

Communication unit 223 performs wireless communication with image processing device 110 (communication unit 213).

(0032)

(Regarding the control modes)

In this embodiment, image processing apparatus 110 controlling HMD 100 (such as switching CG in the composite image displayed on HMD 100 or controlling movement of the CG position) can be realized by the following three control modes (control methods).

(0033)

The first control mode is, as described above, a control mode that controls HMD 100 in response to an operation on the OTP of controller 120 (an operation involving physical contact by the user) (hereinafter referred to as the "OTP control mode"). If image processing device 110 is set to the OTP control mode, control unit 211 controls HMD 100 according to user operations on the OTP.

(0034)

The second control mode is a control mode (hereinafter referred to as "ray control mode") that controls HMD 100 using a virtual ray corresponding to the direction of the user's hand. If image processing device 110 is set to the ray control mode, control unit 211 controls HMD 100 according to the position of a virtual ray extending in the direction pointed to by the user's hand.

(0035)

Specifically, in the ray control mode, control unit 211 determines (recognizes) the direction of the user's hand based on the color and shape of the user's hand captured in the captured image. At this time, control unit 211 displays a CG of a ray extending in the direction pointed to by the index finger on image display unit 203, as shown in Figure 3. Then, control unit 211 displays (moves) a pointer at the position where the ray is directed. Therefore, the user can change the position and direction of the ray by changing the orientation of their hand.

(0036)

In ray control mode, for example, if the state in which the ray is directed at a specific display item continues for longer than a predetermined time, a process (determination process) for determining to select the specific item indicated by the ray is executed. For example, a menu panel (a panel for displaying a menu) is always displayed in a corner of the screen on image display unit 203, and when the determination process is performed with the ray directed at this panel, the menu is displayed.

(0037)

For example, in the ray control mode, as shown in Figure 3, control unit 211 displays, as a menu, CGs of panels 301 to 303 corresponding to each of the three options in the composite image. At this time, when the state in which a ray is directed at one panel 303 continues for longer than a predetermined time, control unit 211 performs processing corresponding to panel 303 at which the ray is directed.

(0038)

An inertial measurement unit (IMU) provided in controller 120 worn on the user's hand may be used to determine the direction in which the user is pointing. Specifically, control unit 211 may improve the matching rate between the direction in which the user is pointing and the direction in which the ray extends, based on both information acquired by the inertial measurement unit (information on the tilt and acceleration of controller 120) and information such as the finger orientation determined from the image.

(0039)

The third control mode is a control mode for controlling HMD 100 using hand tracking according to the position of the user's hand (hereinafter referred to as the "tracking control mode"). If image processing apparatus 110 is set to the tracking control mode, control unit 211 determines (recognizes) the position of the hand based on the orientation, color, and shape of the user's hand appearing in the captured image. Then, control unit 211 controls HMD 100 according to the position of the hand in the space represented by the composite image (specifically, the distance between the hand and the CG).

(0040)

Control unit 211, for example, as shown in Figure 4, displays CGs of panels 301 to 303 indicating three choices in the composite image, and calculates the distance between the three panels 301 to 303 and the fingertip of the index finger of the hand in the space represented by the composite image. Then, control unit 211 determines that the panel has been selected if a state in which the distance between any of the three panels 301 to 303 and the fingertip is equal to or less than a predetermined distance continues for longer than a predetermined time. Then, control unit 211 performs decision processing according to the selected panel. Even in the tracking control mode, as with the ray control mode, a menu panel (a panel for displaying a menu) is displayed in the corner of the screen of image display unit 203.

(0041)

Note that each of the three control modes has its advantages and disadvantages. For example, in control modes (ray control mode and tracking control mode) that perform control based on the hand state (the hand state determined based on a captured image), the user can perform intuitive and quick control. On the other hand, these control modes require the hand to be within the imaging range, so it is necessary to always keep the hand at a certain height. For this reason, the ray control mode and tracking control mode are not suitable for prolonged control. On the other hand, while rapid control is not easy in OTP control mode, the user can control HMD 100 with their hands lowered. In other words, in OTP control mode, stable control by the user can be expected even if the control time extends for a long period.

(0042)

Furthermore, in ray control mode, because HMD 100 can be controlled according to the ray, it is convenient when selecting display items (panels) that are at a distance from the hand. On the other hand, tracking control mode is convenient when selecting display items (panels) that are close to the hand.

(0043)

In this way, the three control modes are suitable for different usage scenarios. Therefore, if it is possible to appropriately switch (select) a control mode for controlling HMD 100 from among these control modes, it is possible to improve user convenience.

(0044)

(Regarding the mode selection process)

Referring to the flowchart in Figure 5, the mode selection process for selecting a control mode to be used to control HMD 100 from among the three control modes (operation modes) will be described. When the user starts using HMD 100, the processing of this flowchart starts. The flowchart of Figure 5 is implemented by control unit 211 (a processor or the like) executing a program.

(0045)

In Step S501, control unit 211 determines whether the user's hand appears in a predetermined range of the captured image (camera angle of view of imaging unit 202; imaging range). If the user's hand appears in the predetermined range, the process proceeds to Step S502. On the other hand, if the user's hand does not appear in the predetermined range, the process proceeds to Step S503. Here, the predetermined range is, for example, the entire range of the captured image (imaging range). However, if the hand is captured at the edge of the captured image, it may be difficult to determine the shape or the like of the hand because the entire hand is not captured. For this reason, the predetermined range may be an area slightly inside the captured image, in which the hand can be sufficiently captured. Also, the predetermined range may be, for example, a range fixed based on the position of the user's face.

(0046)

In Step S502, control unit 211 calculates the distance from imaging unit 202 (HMD 100) to the user's hand by distance measurement using the stereo camera formed by the two cameras in imaging unit 202. Then, control unit 211 determines whether the distance from imaging unit 202 to the user's hand is greater than the threshold value Th (in other words, the user's hand is farther from HMD 100 than the threshold value Th).

(0047)

Here, when control via a ray is generally desired, the user performs a motion to point at an object, and the hand tends to extend forward at that time. In other words, the position of the user's hand tends to be relatively far from the user. Therefore, if the distance from imaging unit 202 to the user's hand is longer than the threshold value Th , there is a high possibility that the user is pointing to a distant position away from the user, and for this reason, the process proceeds to Step S504 to set the ray control mode. On the other hand, if the distance from imaging unit 202 to the user's hand is equal to or less than the threshold Th , there is a high possibility that the user is selecting a position close to the user by bringing the user's hand closer, and the process proceeds to Step S505 to set the tracking control mode.

(0048)

There are individual differences in the range that a user's hand can reach. For this reason, control unit 211 may set an appropriate value for each individual as the threshold Th by setting the threshold Th in Step S502 according to the user's arm length that has been inputted in advance. In this case, control unit 211 increases the value of the threshold Th as the user's arm length becomes longer. For example, control unit 211 sets a length that is a predetermined multiple (such as 0.8 times) of the user's arm length as the threshold Th .

(0049)

Also, HMD 100 may be equipped with (or use) a ToF (Time of Flight) sensor to measure the distance from imaging unit 202 to the user's hand. Furthermore, control unit 211 may estimate the distance from imaging unit 202 to the user's hand based on the size of the hand in the captured image.

(0050)

In Step S503, control unit 211 selects an OTP control mode (a control mode by OTP using controller 120) as the control mode for controlling HMD 100.

(0051)

In Step S504, control unit 211 selects the ray control mode as the control mode for controlling HMD 100.

(0052)

In Step S505, control unit 211 selects the tracking control mode as the control mode for controlling HMD 100.

(0053)

In Step S506, control unit 211 enables the control mode that was selected in Steps S503 through S505. In other words, when a user action (operation) corresponding to the selected control mode is performed, control unit 211 controls HMD 100 (the display of image display unit 203) in response to the action (operation). Furthermore, control unit 211 disables the control modes other than the selected control mode. For example, if the OTP control mode is selected, control unit 211 controls HMD 100 in response to an operation on the OTP, while not controlling HMD 100 in response to the shape or position of the user's hand. Note that control unit 211 may display different UIs (user interfaces) on image display unit 203 depending on the control mode that has been enabled. Control unit 211 may display items (such as characters representing the name of the control mode) on image display unit 203 such that the control mode that has been enabled can be recognized.

(0054)

In Step S507, control unit 211 determines whether the processing to end operation of HMD 100 has been performed. For example, when an operation to press the power button of HMD 100 is performed, processing to end operation of HMD 100 is performed. If it is determined that the processing to end operation of HMD 100 has not been performed, the process returns to Step S501. If it is determined that the processing to end operation of HMD 100 has been performed, the processing of this flowchart ends, and operation of HMD 100 ends.

(0055)

The state of the user's hand (whether the user's hand is captured within a predetermined range, and the distance between imaging unit 202 and the user's hand) tends to reflect the user's intentions regarding how they wish to control HMD 100. Therefore, according to Embodiment 1, because it is possible to switch to a control mode that matches the user's intention, it becomes possible to control HMD 100 according to a control mode that matches the user's intentions. Accordingly, the convenience of user control of HMD 100 is improved.

(0056)

Also, by disabling the control modes that were not selected, it is possible to reduce processing in image processing device 110, giving rise to expectations of an effect of reducing power consumption in image processing device 110. For example, image processing device 110 may be controlled so as not to communicate with controller 120 when the OTP control mode is disabled.

(0057)

Although the processing of each step in the flowchart shown in Figure 5 has been described as being executed by control unit 211, this processing may also be executed by HMD control unit 201 of HMD 100.

(0058)

Also, in Step S501, if it is determined that the user's hand is captured within a predetermined range, the processing of Step S502 may not be performed, and the processing of Step S504 or S505 may be performed. For example, if it is determined in Step S501 that the user's hand is captured within a predetermined range, control unit 211 may select a control mode that was set in advance by the user from among the ray control mode and the tracking control mode.

(0059)

<Embodiment 2>

Hereinafter, with reference to Figure 6, information processing system 1 according to Embodiment 2 that selects (switches) the control mode of HMD 100 will be described. In Embodiment 2, because the mode selection processing differs from that in Embodiment 1, the mode selection processing will be described below.

(0060)

The processing of the flowchart in Figure 6 differs only in the processing of Step S501 and Step S502 in the flowchart of Figure 5. Therefore, in the following description, only the processing of Steps S601 through S603, which replaces the processing of Step S501 and Step S502, will be described.

(0061)

In Step S601, control unit 211 determines whether the user's hand is touching the OTP of controller 120. If it is determined that the user's hand is touching the OTP, it is considered that the user is preparing to operate the OTP, and the process proceeds to Step S503. If it is determined that the user's hand is not touching the OTP, the process proceeds to Step S602.

(0062)

In Step S602, control unit 211 determines whether the user's hand is captured within a predetermined range of the captured image (camera angle of view). If it is determined that the user's hand is not captured within the predetermined range, control requiring hand imaging (control using ray or hand tracking) is not possible, and the process returns to Step S601. If it is determined that the user's hand is captured within the predetermined range, the process proceeds to Step S603.

(0063)

In Step S603, control unit 211 determines whether the angle θ between the direction indicated by the user's finger and the horizontal direction (horizontal plane) is greater than a threshold value θ_{th} (see Figure 7). If the angle θ is smaller than the threshold θ_{th} , the process proceeds to Step S504 to select the ray control mode. On the other hand, if the angle θ is equal to or greater than the threshold θ_{th} , the process proceeds to Step S505 to select the tracking control mode. In other words, as shown in Figure 7, if the angle $\theta = \theta_1$, because the angle θ is smaller than the threshold θ_{th} , the process proceeds to Step S504. If the angle $\theta = \theta_2$, because the angle θ is equal to or greater than the threshold θ_{th} , the process proceeds to Step S505.

(0064)

Generally, when a user wants to perform control using a ray, the user performs a movement of pointing at objects such as options, and at that time, the hand extends forward. As a result, the finger tends to point in a direction close to the horizontal direction in front of the user. In other words, when a user wants to perform control using a ray, the angle θ tends to be small. On the other hand, when the user wants to perform control using hand tracking, the direction the finger points tends to be relatively closer to the user's upward vertical direction than in the case of ray-based control, as shown in Figure 4. In other words, when the user wants to perform control using hand tracking, the angle θ tends to be large.

(0065)

Therefore, if the control mode is selected according to the magnitude of the angle θ , the control mode desired by the user can be appropriately selected. Therefore, control unit 211 can control HMD 100 according to the control method desired by the user.

(0066)

In the above description, control unit 211 switched the control mode by comparing the angle θ between the horizontal direction and the direction pointed by the finger with the threshold value θ_{th} . On the other hand, control unit 211 may change the threshold value θ_{th} depending on the conditions. For example, because attitude sensor unit 204 can detect the degree to which the user is leaning forward or backward (the inclination of the user's upper body), control unit 211 may determine the threshold θ_{th} based on the user's upper body inclination each time the processing of Step S602 is performed. For example, control unit 211 makes the threshold θ_{th} smaller as the user leans further forward.

(0067)

The state of the user's hand (whether or not the user is touching the OTP, and the angle between the direction the user's finger is pointing and the horizontal direction) tends to reflect the user's intentions regarding how they want to control HMD 100. Therefore, according to the second example of embodiment, information processing system 1 can more appropriately select the control mode desired by the user based on whether or not the user is touching the OTP, or based on the angle between the direction in which the user's finger is pointing and the horizontal direction.

(0068)

If it is determined in Step S601 that the hand is not touching the OTP, the process may proceed to Step S603 instead of Step S602. Also, in Step S601, control unit 211 may determine whether the user's hand is open (at least one of the user's fingers is not bent) or closed. Whether or not the user's hand is open can be determined by analyzing the captured image and/or whether or not the hand is in contact with the outer circumference of the ring of controller 120. If it is determined that the user's hand is closed (all of the fingers of the user's hand are bent), the process proceeds to Step S503 because there is a low possibility of performing control by ray or tracking. If it is determined that the user's hand is open (at least one finger of the user's hand is not bent), the process proceeds to Step S602. Note that the phrase "hand is open" may be interpreted as the "index finger is not bent," while "hand is closed" may be interpreted as the "index finger is bent."

(0069)

<Embodiment 3>

In the following, referring to Figure 8, information processing system 1 according to Embodiment 3 for selecting (switching) the control mode of HMD 100 will be described. In Embodiment 3, because the mode selection processing differs from that in Embodiments 1 and 2, the mode selection processing will be described below while referring to Figure 8.

(0070)

Also, the flowchart shown in Figure 8 differs from the flowchart in Figure 5 only in Steps S805 and S806. Therefore, only Steps S805 and S806 will be described.

(0071)

In Embodiments 1 and 2, information processing system 1 controls HMD 100 by selecting any one of the OTP control mode, the ray control mode, and the tracking control mode. On the other hand, in Embodiment 3, information processing system 1 selects a plurality of control modes as the control modes to be used to control HMD 100.

(0072)

In Step S805, control unit 211 selects the ray control mode, as in Step S504, and simultaneously selects the OTP control mode. As a result, in Step S506, simultaneous control of the operation of HMD 100 using rays and control of the operation of HMD 100 using OTP become possible. For example, if control of the pointer position using both rays and OTP is possible simultaneously, the user can point the pointer to a rough position using rays with the left hand and fine-tune the position using the ring-type controller 120 worn on a finger of the right hand.

(0073)

In Step S806, control unit 211 selects the tracking control mode and simultaneously selects the OTP control mode. As a result, in Step S506, simultaneous control of the operation of HMD 100 using hand tracking and control of the operation of HMD 100 using OTP become possible.

(0074)

In this way, in Embodiment 3, when the ray control mode or the tracking control mode is selected, information processing system 1 also selects the OTP control mode. In other words, in Step S805, a control mode capable of both control using rays and control using OTP is selected, while in Step S806, it can be understood that a control mode capable of both control using hand tracking and control using OTP is selected. In Embodiment 3, because the OTP control mode is always enabled, information processing system 1 can always control HMD 100 in response to operations on the OTP.

(0075)

Instead of the ray control mode or the tracking control mode, a control mode may be used that controls HMD 100 according to the combination of bent (or unbent) fingers among the five fingers of the hand in the captured image. Also, instead of the ray control mode and tracking control mode that control HMD 100 according to the state of the hand, a control mode that controls HMD 100 according to the state of another specific body part of the user may be used. For example, a control mode that controls HMD 100 according to the position and movement of the user's forearm may be used. When using a control mode that controls HMD 100 according to the position and movement of the user's arm, for example, if imaging unit 202 can image the forearm (if the forearm appears in the captured image), control unit 211 will select that control mode. On the other hand, if imaging unit 202 cannot capture an image of the forearm, control unit 211 selects the OTP control mode.

(0076)

Alternatively, a control mode that controls HMD 100 according to the number of eye blinks in a predetermined time may be used. For example, when using a control mode that controls HMD 100 according to the number of eye blinks in a predetermined time, if an imaging unit that images the eyes (an imaging unit different from imaging unit 202) can capture images of both of the user's eyes, control unit 211 selects that control mode. On the other hand, if the imaging unit cannot capture images of both of the user's eyes, control unit 211 selects the OTP control mode.

(0077)

Also, in the above-noted description, "if A is greater than or equal to B, the process proceeds to Step S1, and if A is smaller than (lower than) B, the process proceeds to Step S2" may be read as "if A is greater than (higher than) B, the process proceeds to Step S1, and if A is less than or equal to B, the process proceeds to Step S2." Conversely, "if A is greater than (higher than) B, the process proceeds to Step S1, and if A is less than or equal to B, the process proceeds to Step S2" may be read as "if A is greater than or equal to B, the process proceeds to Step S1, and if A is smaller than (lower than) B, the process proceeds to Step S2." For this reason, unless a contradiction arises, the expression "A or more" may be replaced with "A or greater (higher; longer; more)," and may be read as or replaced with "greater (higher; longer; more) than A." On the other hand, the expression "A or less" may be replaced with "A or smaller (lower; shorter; fewer)," and may be replaced with or read as "smaller (lower; shorter; fewer) than A." Further, "greater (higher; longer; more) than A" may be read as "A or more," and "smaller (lower; shorter; fewer) than A" may be read as "A or less."

(0078)

While the present invention has been described in detail above based on its preferred embodiments, the present invention is not limited to these specific embodiments, and various forms that do not depart from the gist of the present invention are also included in the present invention. Parts of the above-described embodiments may be combined as appropriate.

(0079)

Each functional unit of each of the above-described embodiments (and modifications) may or may not be implemented as separate hardware. The functions of two or more functional units may be implemented by common hardware. Each of the multiple functions of one functional unit may be implemented by separate hardware. Two or more functions of one functional unit may be implemented by common hardware. Furthermore, each functional unit may or may not be implemented by hardware such as an ASIC, FPGA, or DSP. For example, the apparatus may include a processor and a memory (storage medium) in which a control program is stored. Furthermore, the functions of at least some of the functional units of the apparatus may be implemented by the processor reading and executing the control program from the memory.

(0080)

(Other examples of embodiment)

The present invention can also be realized by a process of supplying a program that realizes one or more functions of the above embodiments to a system or apparatus via a network or storage medium, and having one or more processors in the computer of the system or apparatus read and execute the program. It can also be implemented by a circuit (such as an ASIC) that implements one or more functions.

(EXPLANATION OF REFERENCES)

(0081)

1: Information processing system, 100: HMD,
110: Image processing device, 120: Controller,
202: Imaging unit, 211: Control unit

(DOCUMENT TITLE) Scope of Patent Claims

(CLAIM 1)

A control device for controlling an electronic device, comprising:

a selection means for selecting either a first control mode or a second control mode as the control mode for controlling the electronic device, based on a state of a specific body part of a user; and

a control means that 1) will perform control of the electronic device in accordance with the state of the specific body part of the user, which is determined based on imaging by imaging means when the selection means has been used to select the first control mode; and 2) will perform control of the electronic device in accordance with an operation involving physical contact by the user with a specific operation member when the selection means has been used to select the second control mode.

(CLAIM 2)

The control device described in Claim 1 that is characterized by the fact that it has a determination means for determining whether the specific part is included in a predetermined range;

wherein the selection means selects the first control mode when it is determined that the specific part is included in the predetermined range, and selects the second control mode when it is determined that the specific part is not included in the predetermined range.

(CLAIM 3)

The control device described in Claim 2

wherein the predetermined range is the imaging range of the imaging means.

(CLAIM 4)

The control device described in any one of Claim 1 through Claim 3 that is characterized by the fact that,

when the selection means is selecting the first control mode, the control means controls the electronic device according to the state of the specific part determined based on the imaging, and controls the electronic device according to an operation involving physical contact by the user with the specific operation member.

(CLAIM 5)

The control device described in Claim 1

wherein the selection means selects the second control mode when the user is touching the specific operation member, and selects the first control mode when the user is not touching the specific operation member.

(CLAIM 6)

The control device described in any one of Claim 1 through Claim 5 that is characterized by the fact that the specific part is a hand.

(CLAIM 7)

The control device described in Claim 6 wherein the first control mode is either the third control mode or the fourth control mode;

and the control means 1) will perform control of the electronic device in accordance with a position on an extension line in the direction indicated by the user's hand when the selection means has been used to select the third control mode,

and 2) will perform control of the electronic device in accordance with the position of the user's hand when the selection means has been used to select the fourth control mode.

(CLAIM 8)

The control device described in Claim 7 that is characterized by the fact that, when the selection means selects the first control mode,

if the distance between the position of the user's hand and the imaging means is greater than a first threshold, the selection means selects the third control mode as the first control mode;

and when the distance between the position of the user's hand and the imaging means is shorter than the first threshold value,

the selection means selects the fourth control mode as the first control mode.

(CLAIM 9)

The control device described in Claim 8

wherein the first threshold value is a value based on the length of the user's arm.

(CLAIM 10)

The control device described in Claim 7 that is characterized by the fact that, when selecting the first control mode, the selection means

will select the third control mode as the first control mode if the angle between the direction indicated by the user's hand and the horizontal direction is smaller than the second threshold value,

and will select the fourth control mode as the first control mode if the angle between the direction indicated by the user's hand and the horizontal direction is larger than the second threshold value.

(CLAIM 11)

The control device described in any one of Claim 1 through Claim 10, wherein the specific operation member is any one of an optical trackpad, a touch pad, a touch panel, a cross key, a joystick, and a trackpad device.

(CLAIM 12)

The control device described in any one of Claim 1 through Claim 11, wherein the specific operation member is included in a controller,

and the controller is in a form capable of being held or worn by a user's hand.

(CLAIM 13)

The control device described in Claim 12, wherein the controller is capable of being worn on a user's finger.

(CLAIM 14)

A control method for controlling an electronic device, comprising:

a selection step for selecting either a first control mode or a second control mode as the control mode for controlling the electronic device, based on a state of a specific body part of a user; and

a control step that

1) will perform control of the electronic device in accordance with the state of the specific body part of the user, which is determined based on imaging by imaging means when the first control mode has been selected in the selection step; and 2) will perform control of the electronic device in accordance with an operation involving physical contact by the user with a specific operation member when the second control mode has been selected in the selection step.

(CLAIM 15)

A program for causing a computer to function as each means of the control device according to any one of Claims 1 to 13.

(DOCUMENT TITLE) Abstract

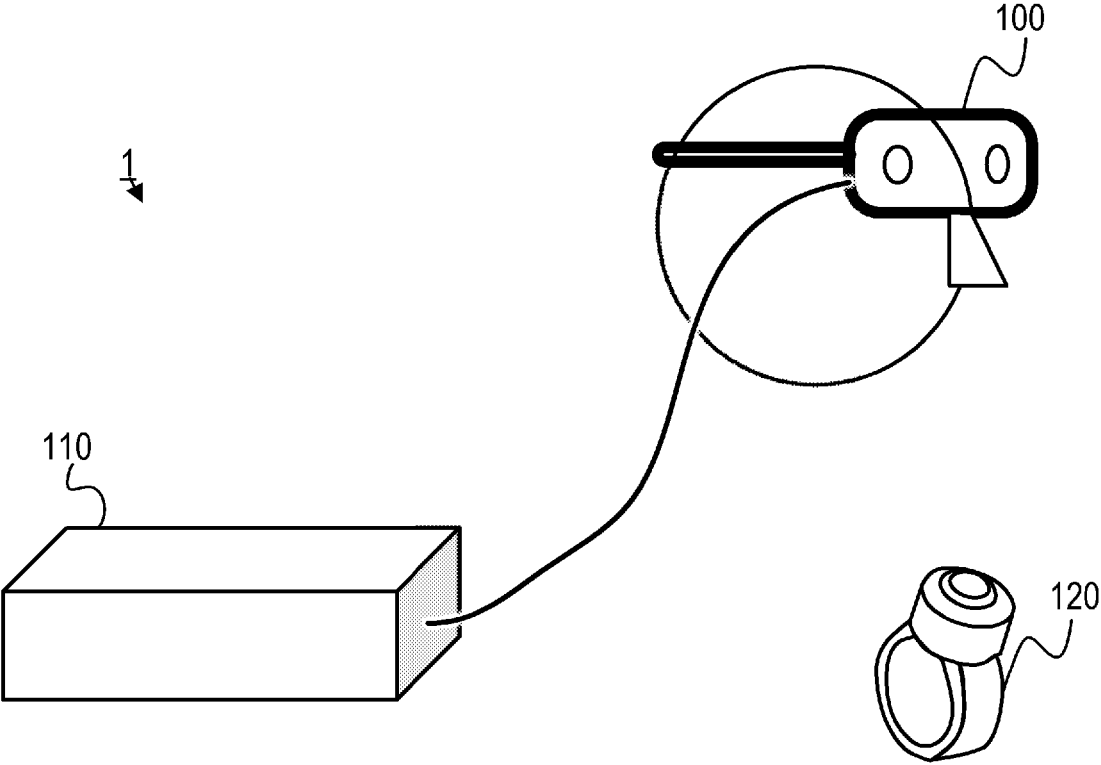
(ABSTRACT)

(PROBLEM) To provide a technology for controlling an electronic device in accordance with a control method desired by a user.

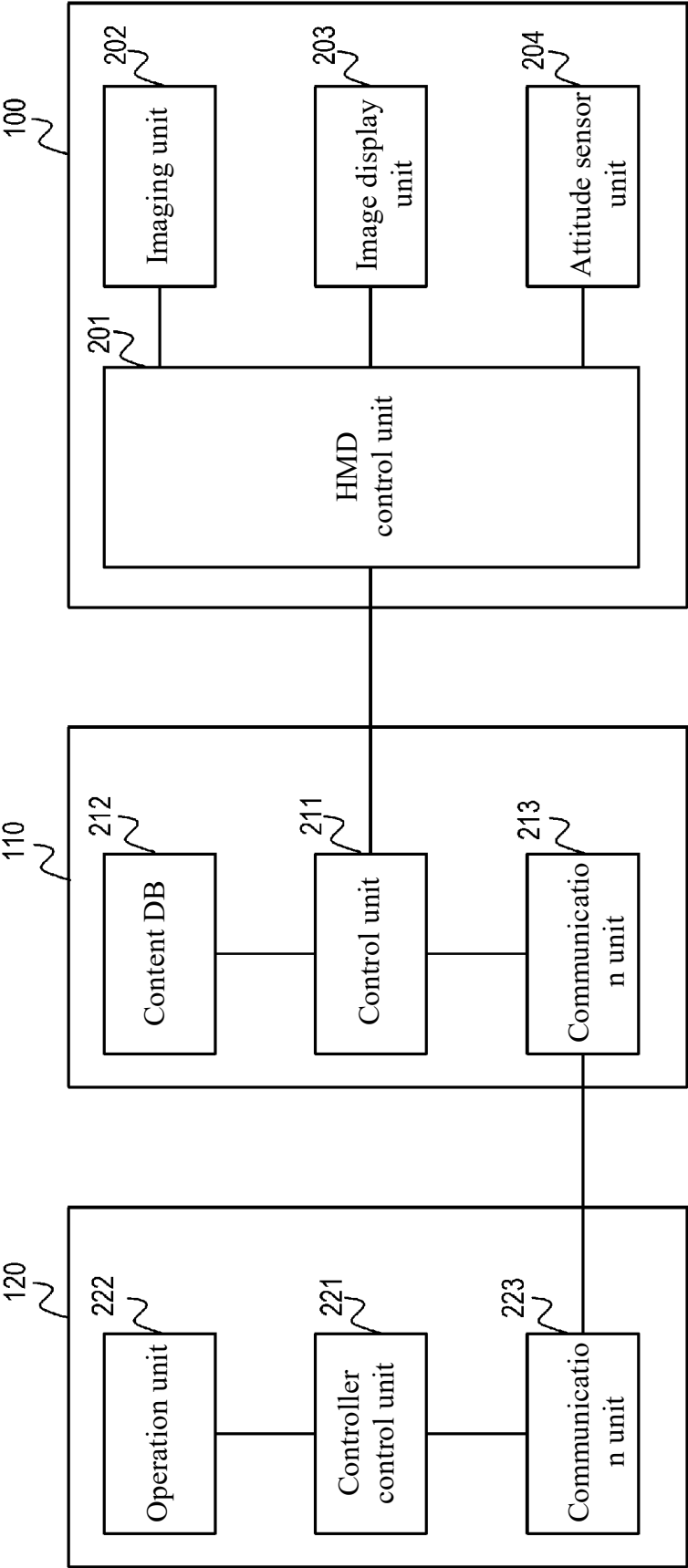
(MEANS FOR SOLVING) A control device for controlling an electronic device comprising a selection means for selecting either a first control mode or a second control mode as the control mode for controlling the electronic device, based on a state of a specific body part of a user; and a control means that 1) will perform control of the electronic device in accordance with the state of the specific body part of the user, which is determined based on imaging by imaging means when the selection means has been used to select the first control mode; and 2) will perform control of the electronic device in accordance with an operation involving physical contact by the user with a specific operation member when the selection means has been used to select the second control mode.

(REPRESENTATIVE DRAWING/FIGURE) Figure 5

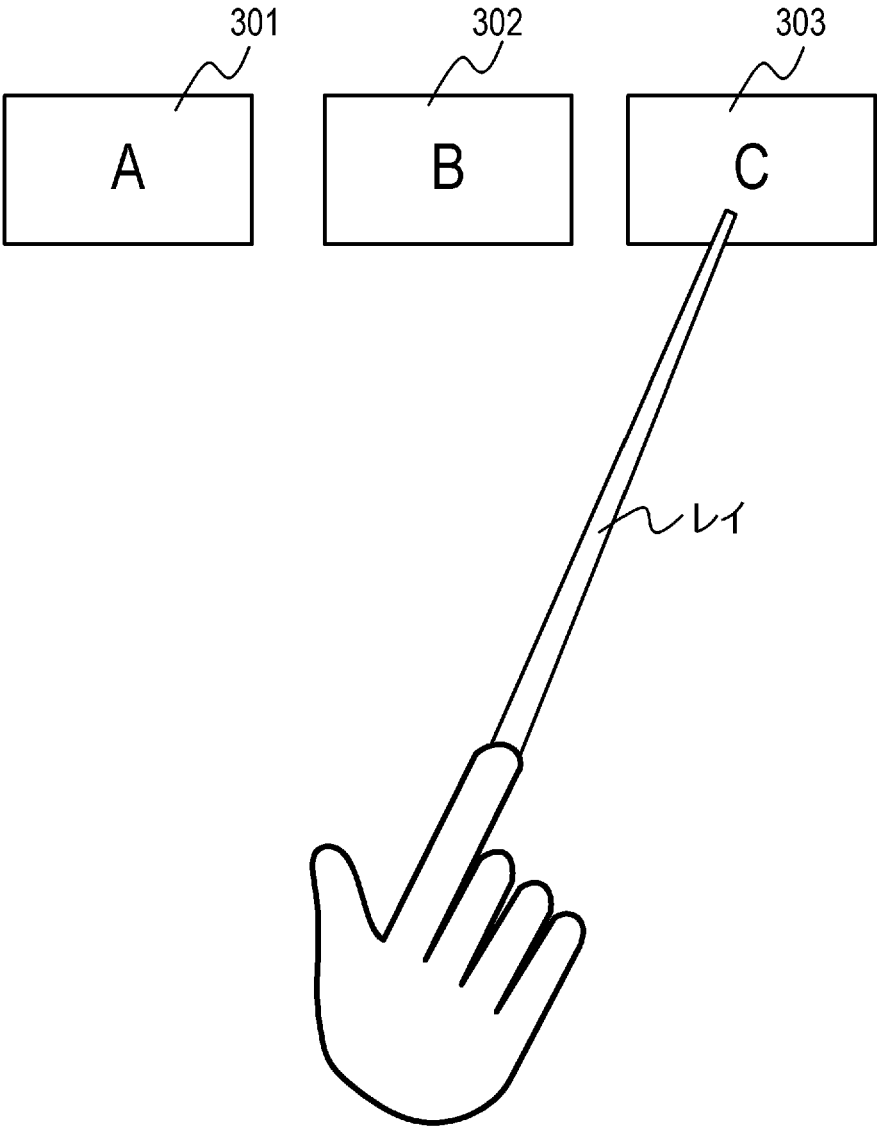
(DOCUMENT TITLE) Drawings
(FIGURE 1)



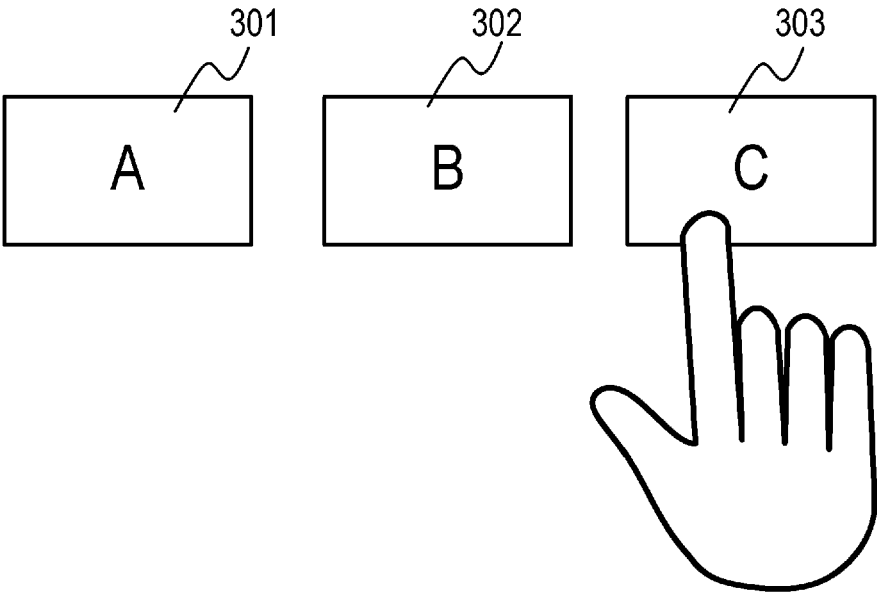
(FIGURE 2)



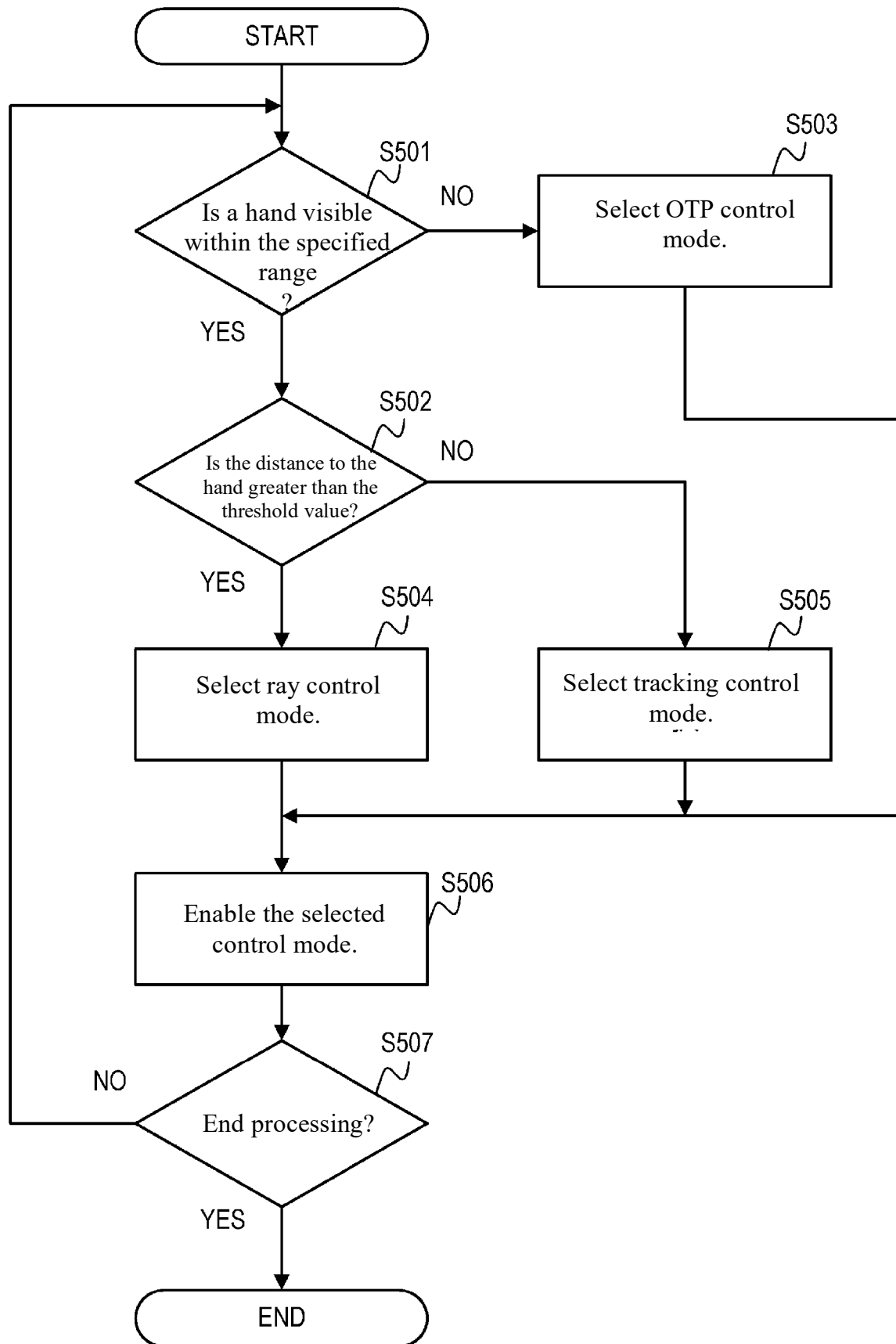
(FIGURE 3)



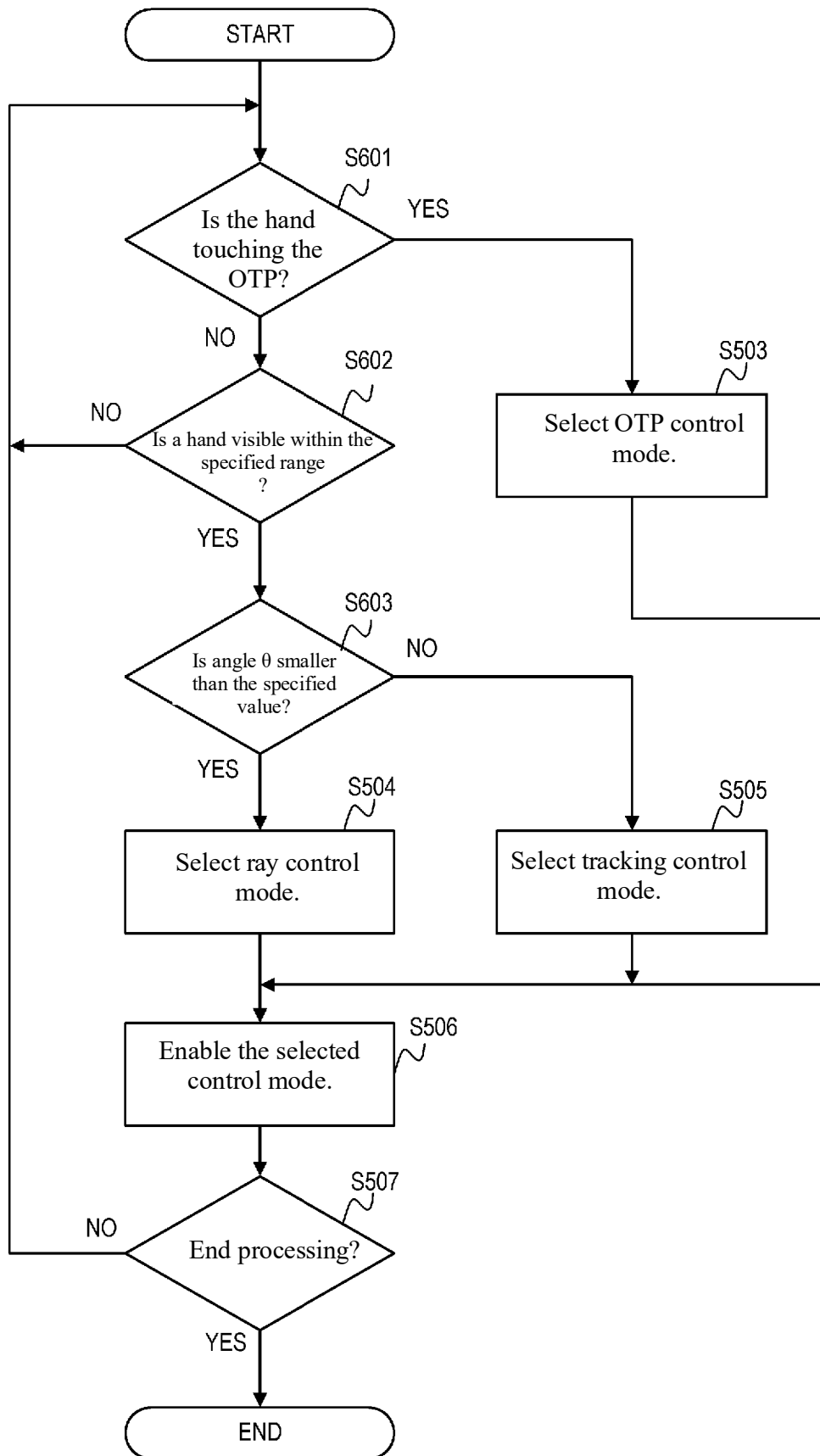
(FIGURE 4)



(FIGURE 5)

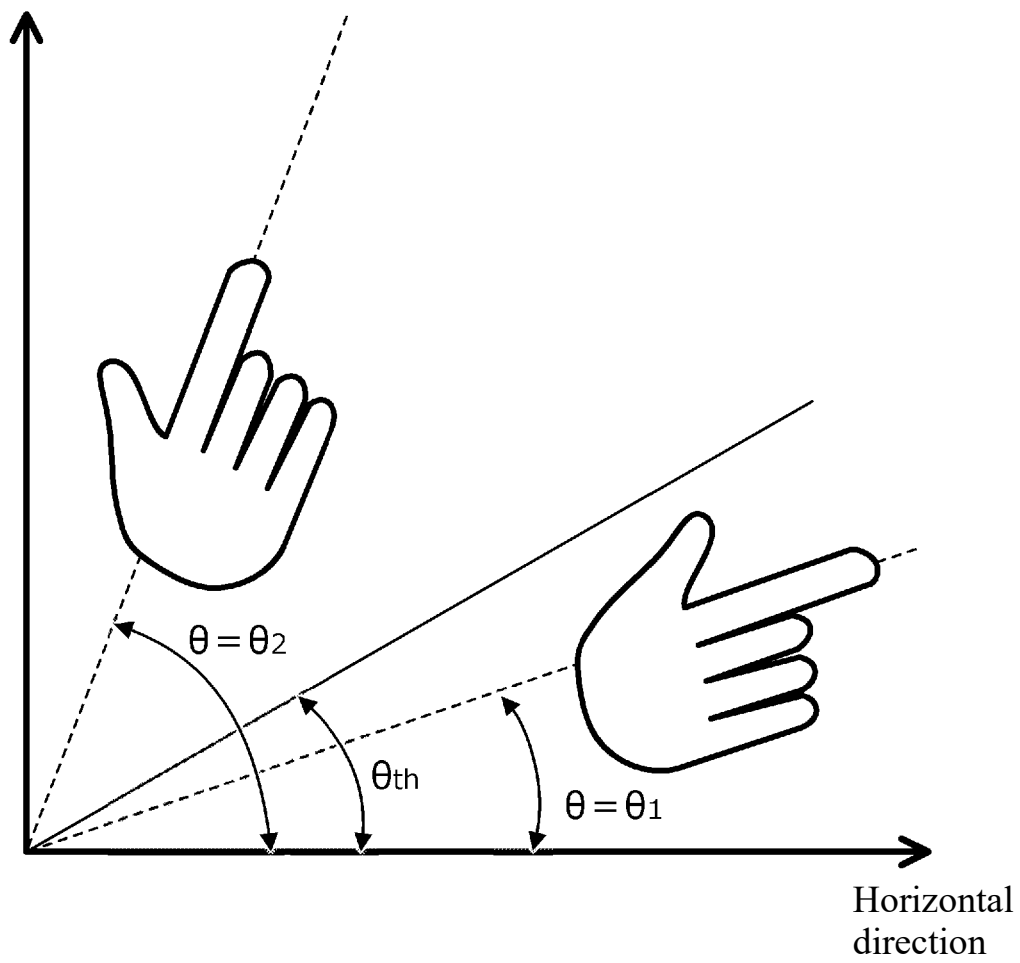


(FIGURE 6)

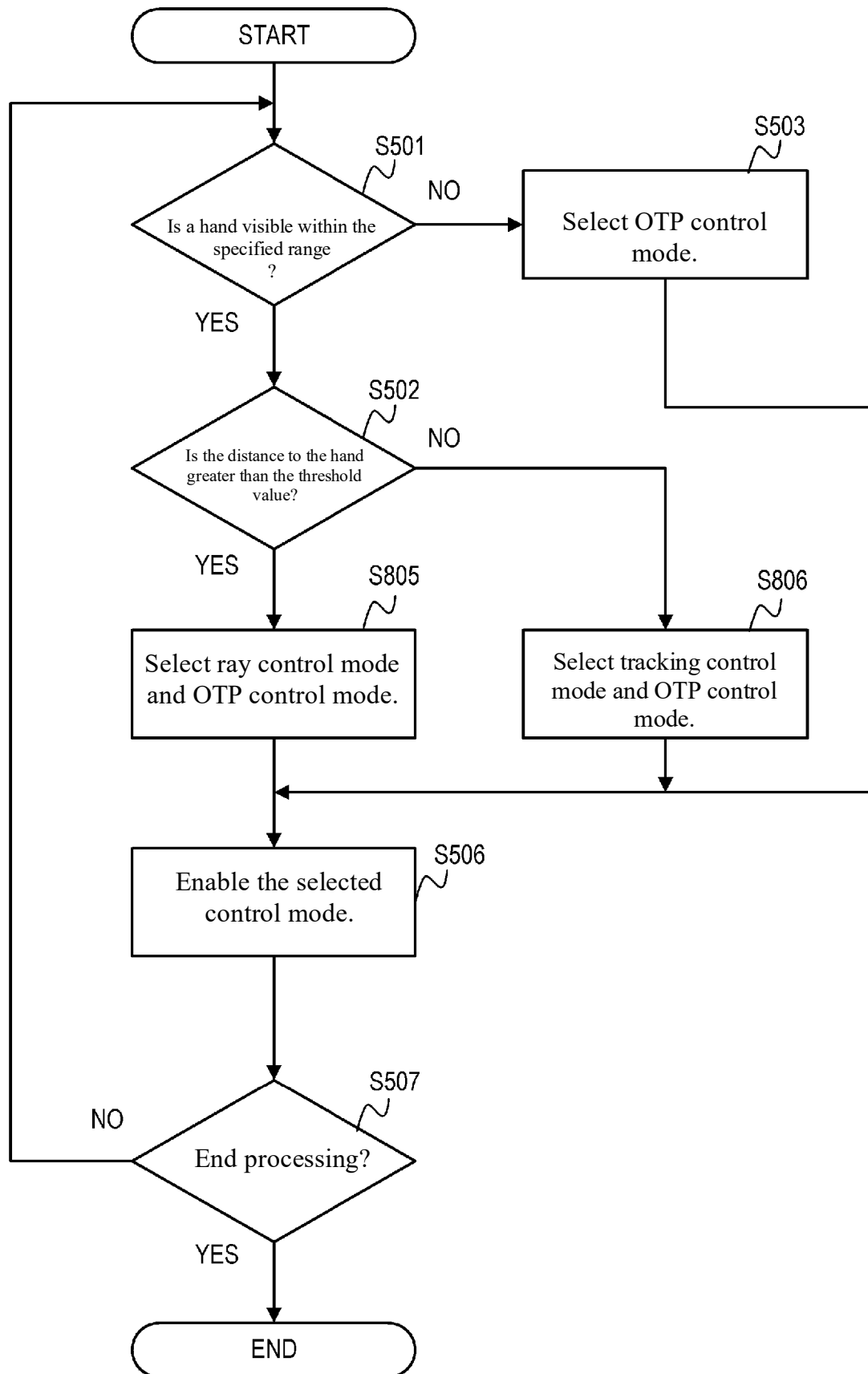


(FIGURE 7)

Vertical upward direction



(FIGURE 8)



Applicant history

000001007

19900830

New registration

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