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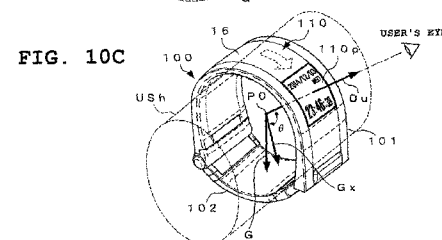
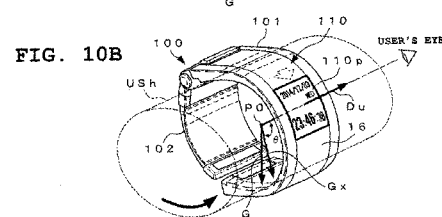
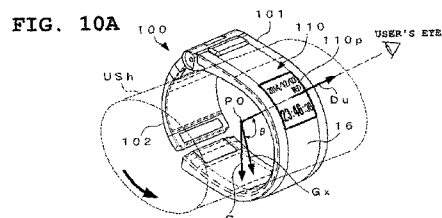
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- (54) Title: DISPLAY DEVICE, INFORMATION DISPLAY METHOD, AND COMPUTER- READABLE NON-VOLATILE STORAGE MEDIUM HAVING INFORMATION DISPLAY PROGRAM STORED THEREON



(57) Abstract: A display device (100) comprising a display section (110) which has a displayable area extending in a first direction, and a display control section which controls the display section (110) to change a position of a display area (110p) where information is displayed in the displayable area (110p), in accordance with a tilt status of the display device (100), and display the information in the display area (110p) whose position has been changed. Such display device (100) ensures that the display area (110p) is always displayed in the user's viewing direction.



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DESCRIPTION**TITLE OF INVENTION**

**DISPLAY DEVICE, INFORMATION DISPLAY METHOD, AND COMPUTER-
READABLE NON-VOLATILE STORAGE MEDIUM HAVING INFORMATION**

5 **DISPLAY PROGRAM STORED THEREON**

TECHNICAL FIELD

[0001] The present invention relates to a display device,
an information display method, and a computer-readable
non-volatile storage medium having an information display
program stored thereon.

10 **BACKGROUND ART**

[0002] In recent years, wearable terminals capable of
acquiring various biological information and physical
information in exercise and daily life by being worn on a human
body and providing useful information have been actively
15 developed and commercialized. For example, Patent Document
1 discloses an aerobic exercise maintaining device which has
a wristwatch-type outer appearance, detects a heart rate and
moving speed by being worn on a wrist of a user, and notifies
the user of various information based on the detected
20 information by notification means or a display section.

[0003] Since this type of wearable terminal is directly worn
on a part of a human body such as a wrist or an arm, it is desired
by the market and users to be thin and light weight and have
a shape with a curvature in accordance with the body part where

the wearable terminal is to be worn. Also, in the recent health-conscious boom and popularity of sports, high quality design and functionality are desired for wearable terminals, sportswear, goods, training machines, and the like. For example, Patent Document 2 discloses a portable device which has a thin, stylish, wristband-type outer appearance and provides various information such as time and time-count information via a display panel curved in accordance with the shape of a wrist or an arm where the portable device is to be worn.

PRIOR ART DOCUMENTS

PATENT DOCUMENTS

[0004]

Patent Document 1: JP 2007-075201 A

15 Patent Document 2: JP 2007-078670 A

[0005] In this wristband-type wearable terminal, if the display area of the display panel or the area thereof is wide, more information can be displayed. However, since the display panel is provided with it being curved, the entire display area cannot be viewed at one time from one direction. Accordingly, there is a problem in that, in order to unfailingly view desired information from among information displayed on the display panel, the user is required to not only change the eye direction but also perform a special motion, such as a motion of rotating a wrist or an arm where the wearable terminal has been worn

so as to change the orientation of the display panel, or a motion of tilting the head, which is very burdensome and inconvenient for the user.

[0006] The present invention has been conceived in light of the above-described problem. An object of the present invention is to provide a display device, an information display method, and a computer-readable non-volatile storage medium having an information display program stored thereon by which a user can easily and unfailingly view information displayed on a display panel having a curved shape while abbreviating a special motion.

SUMMARY OF INVENTION

[0007] In accordance with one aspect of the present invention, there is provided a display device comprising: a display section which has a displayable area extending in a first direction; and a display control section which controls the display section to change a position of a display area where information is displayed in the displayable area, in accordance with a tilt status of the display device, and display the information in the display area whose position has been changed.

[0008] In accordance with another aspect of the present invention, there is provided a display method for a display device including a display section and a display control section, comprising: providing the display section with a

displayable area extending in a first direction; and controlling the display section by the display control section to change a position of a display area where information is displayed in the displayable area, in accordance with a tilt status of the display device, and display the information in the display area whose position has been changed.

[0009] In accordance with another aspect of the present invention, there is provided a non-transitory computer-readable non-volatile storage medium having stored thereon a display program that is executable by a computer for controlling a display device including a display section and a display control section to actualize functions comprising: providing the display section with a displayable area extending in a first direction; and controlling the display section by the display control section to change a position of a display area where information is displayed in the displayable area, in accordance with a tilt status of the display device, and display the information in the display area whose position has been changed.

BRIEF DESCRIPTION OF DRAWINGS

[0010] The present invention can be more deeply understood by the detailed description below being considered together with the following drawings.

FIG. 1A to FIG. 1C are schematic structural diagrams of a first embodiment of a display device according to the present

invention;

FIG. 2A and FIG. 2B are schematic diagrams showing an example of the display device according to the first embodiment when it is worn on a human body;

5 FIG. 3 is a schematic block diagram showing the functional structure of the display device according to the first embodiment;

FIG. 4 is an exploded perspective view showing an example of the assembly structure (inner structure) of the display
10 device according to the first embodiment;

FIG. 5 is a sectional view of the main portion of the display device according to the first embodiment;

FIG. 6 is a flowchart of an example of user viewing direction setting processing applied in an information display
15 method for the display device according to the first embodiment;

FIG. 7 is a schematic diagram for describing a coordinate system of the display device applied in the user viewing direction setting processing according to the first
20 embodiment;

FIG. 8 is a schematic diagram for describing a relation between the tilt of the display device and a user viewing direction which is applied in the user viewing direction setting processing according to the first embodiment;

25 FIG. 9 is a flowchart of an example of information display

processing applied in the information display method for the display device according to the first embodiment;

FIG. 10A to FIG. 10C are perspective views showing an example of information display achieved by information display processing according to the first embodiment; and

FIG. 11 is a flowchart of an example of information display processing applied in an information display method for a display device according to a second embodiment.

DESCRIPTION OF EMBODIMENTS

[0011] Hereafter, embodiments of a display device, an information display method, and an information display program according to the present invention will be described in detail. Here, a display device according to the present invention has been applied in a wristband-type or bracelet-type device that is worn on a wrist of a human body.

[0012] <First Embodiment>

FIG. 1A to FIG. 1C are schematic structural diagrams showing a first embodiment of a display device according to the present invention. FIG. 1A is a schematic perspective view of the structure of the outer appearance of the display device according to the present embodiment, and FIG. 1B is a front view of the display device shown in FIG. 1A when viewed from a diagonally forward left direction (arrow D1 direction). FIG. 1C is a side view of the display device shown in FIG. 1A when viewed from a diagonally forward right direction (arrow D2

direction). FIG. 2A and FIG. 2B are schematic diagrams showing an example of the display device according to the present embodiment when it is worn on a human body. FIG. 3 is a schematic block diagram showing the functional structure of the display device according to the present embodiment.

[0013] (Structure of Outer Appearance)

A display device 100 according to the first embodiment of the present invention has an outer appearance, for example, mainly including a device main body 101 having a curved shape and an opening/closing section 102 rotatably provided on the device main body 101, as shown in FIG. 1A to FIG. 1C.

[0014] Specifically, the device main body 101 is structured by a substantially band-shaped member being curved with a predetermined curvature in a longitudinal direction so as to have a substantially U shape or a substantially C shape when viewed from a side surface side (the arrow D2 direction in FIG. 1C), as shown in FIG. 1A to FIG. 1C. On one end of the device main body 101 in the longitudinal direction (end portion on the upper side in FIG. 1A and FIG. 1C), a rotating section 103 including a rotating shaft is provided.

[0015] The opening/closing section 102 is constituted by a substantially band-shaped member, and its one end (end portion on the upper side in FIG. 1A and FIG. 1C) is connected to the device main body 101 via the rotating section 103, and rotates with respect to the device main body 101, with the rotating

shaft of the rotating section 103 as a pivot (center), as shown in FIG. 1A and FIG. 1C. Accordingly, the opening/closing section 102 is set to be changed between a closed state (indicated by a solid line in FIG. 2B) in which the other end (end portion on the lower side in FIG. 1A and FIG. 1C) of the opening/closing section 102 is adjacent to or in close contact with the other end (end portion on the lower side in FIG. 1A and FIG. 2) of the device main body 101 and an opened state (indicated by a two-dot-chain line in FIG. 2B) in which the other end of the opening/closing section 102 is away from the other end of the device main body 101 by a predetermined length or more.

[0016] (Worn State Example)

In the above-described display device 100, the opening/closing section 102 is rotated with respect to the device main body 101 with the rotating shaft of the rotating section 103 as a pivot, and thereby enters the opened state where the other end of the device main body 101 and the other end of the opening/closing section 102 are away from each other. As a result, an attachment space 101s inside the curved portion of the device main body 101 is opened, whereby the display device 100 can be worn on or removed from a wrist USh. In this open state, when the wrist USh is inserted into the attachment space 101s of the device main body 101, and the opening/closing section 102 is rotated with respect to the device main body

101, the opening/closing section 102 enters the closed state where the other end of the device main body 101 and the other end of the opening/closing section 102 are adjacent to or in close contact with each other, as indicated by the solid line in FIG. 2B. Here, the rotation of the opening/closing section 102 may be stopped by a rotation adjusting member provided to the rotating section 103, only at a position set in advance where the opening/closing section 102 enters the closed state, or may be temporarily stopped in a stepwise manner for each predetermined angle or in a non-stepwise manner.

[0017] As a result, the attachment space 101s of the device main body 101 is defined as a circular shape as shown in FIG. 1C, and the inner surface side (surface on the attachment space 101s side) of the device main body 101 and the opening/closing section 102 come in contact or close contact with the wrist USh, whereby the display device 100 is worn on the wrist USh, as shown in FIG. 2A and FIG. 2B. Note that, although not shown, the display device 100 may include a lock/unlock mechanism that connects the other end of the device main body 101 and the other end of the opening/closing section 102 which are adjacent to or in close contact with each other in the closed state indicated by the solid line in FIG. 2. As a result, once the display device 100 is worn and locked, an accident can be reliably prevented in which the other end of the device main body 101 and the other end of the opening/closing section 102

become separated from each other and fall off the wrist USH when the display device 100 is being used.

[0018] (Functional Structure)

The display device 100 according to the present embodiment, for example, mainly includes a display section 110, an operation section (display area setting section) 120, a sensor section (motion sensor) 130, a communication section 140, a control section (parameter acquiring section and display control section) 150 that is an arithmetic circuit such as a CPU (Central Processing Unit), a storage section 160, and a power supply section 170, as shown in FIG. 3. In the present embodiment, these sections are incorporated in the above-described device main body 101. Note that an example of the inner structure (assembly structure) of the device main body 101 will be described later.

[0019] The display section 110 is provided extending in a band shape in a substantially center area on the outer surface side of the above-described device main body 101 having the curved shape, along the longitudinal direction of the device main body 101, as shown in FIG. 1A, FIG. 1B, FIG. 2A, and FIG. 2B. The display section 110 displays, on the outer surface side of the device main body 101, various information such as current time information and biological and exercise information acquired when the user is moving or performing exercise. In particular, in the present embodiment, the

display section 110 is set such that information desired by the user is displayed in a display area 110p oriented to a user viewing direction, which is a direction in which the user is viewing, in the display screen of the display section 110 irrespective of the orientation or tilt of the display device 100 worn on the user. As this display section 110, various display panels can be applied, such as those of a liquid-crystal type, a light-emitting-element type such as an organic EL, and an electronic paper type. Note that the display section 110 may display information in color or monochrome, and may display not only character information and still images but also moving images.

[0020] The operation section 120 has at least a software key, such as a touch panel, provided on the view field side (front surface side), corresponding to the entire display area of the above-described display section 110. The operation section 120 is used for operations of setting user-desired information and making settings so that the information is displayed in the display area 110p on the display section 110 oriented to the position of the user's eyes. A specific example of operation for displaying user desired information in the display area 110p on the display section 110 oriented to the position of the user's eyes will be described later. Also, the operation section 120 may have a hardware key such as an operation button (push button, slide button, or touch sensor)

provided on the outer surface of the device main body 101 or the opening/closing section 102, or may include both of the software key and the hardware key. The touch panel, the operation button, and the like are also used, for example, for a power supply operation for activating the display device 100 and an operation for setting other operations in the display device 100 (such as operations in the sensor section 130 and the communication section 140).

[0021] The sensor section 130 has at least a sensor that outputs physical information such as acceleration and angular velocity during the movement or exercise of the user, geomagnetism, and gravity as triaxial detection signals orthogonal to one another. Also, the sensor section 130 may have a sensor that acquires biological information such as a pulse, body temperature, and blood pressure during the movement or exercise of the user and environmental information such as barometric pressure, air temperature, and humidity. The detection signal indicating physical information, biological information, or the like acquired by the sensor section 130 is stored as sensor data in a predetermined storage area of the storage section 160 described later.

[0022] The communication section 140 functions as an interface which transmits and receives acquired sensor data and various signals to and from a device (for example, a smartphone, tablet, or personal computer) outside the display

device 100 and/or a network. Here, as a method for transmitting and receiving sensor data and the like from the display device 100 and its external device or the like via the communication section 140, various wireless communication methods and wired communication methods can be applied. In particular, as a wireless communication method to be applied in the communication section 140, Bluetooth (registered trademark) which is a short-distance wireless communication standard for digital devices, Bluetooth (registered trademark) low energy (LE) laid out as a low-power-consumption-type communication standard, NFC (Near field communication), or Wi-Fi (wireless fidelity (registered trademark)) can be favorably applied.

[0023] By executing a predetermined program, the control section 150 controls various operations such as an information display operation by the display section 110, an information selecting operation and a display position setting operation by the operation section 120, a sensing operation by the sensor section 130, an operation of transmitting and receiving sensor data and the like by the communication section 140, a read/write operation by the storage section 160, and a power supply operation by the power supply section 170. Specific examples of the display operation in the display section 110 and the information selecting operation and display position setting operation in the operation section 120 will be described later.

[0024] The storage section 160 stores sensor data acquired by the sensor section 130, various information to be displayed on the display section 110, and a parameter (angle θ described later) for defining a user viewing direction when information is displayed on the display section 110. Also, the storage section 160 stores data and information for use or generated in various operations controlled by the control section 150. The storage section 160 may store a program to be executed by the control section 150. Also, the storage section 160 may be in a form of a removable storage medium such as a memory card so that it is removable from the display device 100.

[0025] The power supply section 170 has a thin curved battery extending in a band shape along the longitudinal direction of the device main body 101 having the curved shape, and supplies driving power outputted from the battery to each section of the display device 100. Here, as a battery to be applied in the present embodiment, for example, a secondary battery capable of being repeatedly charged and discharged may be applied, such as a lithium-ion battery or a nickel-metal-hydride battery. In this embodiment, in addition to the operation of supplying driving power from the battery to each section, the power supply section 170 performs an operation of charging the battery. Note that the power supply section 170 may have a structure where a primary battery such as a commercially-available button-shaped battery or a

power supply by an energy harvest technology for generating electricity by energy such as vibrations, light, heat, and electromagnetic waves is used in combination with the above-described secondary battery.

5 [0026] Also, although omitted in the drawings, the display device 100 according to the present embodiment may include, in addition to the sections shown in FIG. 3, an acoustic section (such as a loudspeaker or buzzer) and/or a vibrating section (such as a vibrator) for giving a notification regarding
10 information displayed on the display section 110, the operation status of the display device 100, and the like. As a result, various sounds such as a buzzer sound and vibrations can be generated to notify the user in accordance with display on the display section 110, the operation status (in particular,
15 an abnormal state) of the display device 100, or the like.

[0027] (Assembly structure and Assembly Method)

FIG. 4 is an exploded perspective view showing an example of the assembly structure (inner structure) of the display device according to the present embodiment, and FIG. 5 is a
20 sectional view of the main portion of the display device according to the present embodiment. Here, FIG. 5 is a schematic view showing a cross-sectional structure of the display device taken along line V-V shown in FIG. 1B (for convenience of explanation, in the specification, "V" is used
25 as a symbol corresponding to the Roman numeral "5" in FIG. 1B).

[0028] The device main body 101 having the outer appearance shown in FIG. 1A to FIG. 1C, for example, mainly includes a main body case 11, a frame 12, a battery 13 (corresponding to the power supply section 170 shown in FIG. 3), a circuit board 14, an exterior cover 15, and a display panel 16 (corresponding to the display section 110 shown in FIG. 3) having a displayable area as an area capable of displaying information provided on an entire surface, as shown in FIG. 4 and FIG. 5. The device main body 101 has the frame 12, the battery 13, the circuit board 14, and the display panel 16 accommodated in an accommodation space 11s formed by the main body case 11 and the exterior cover 15.

[0029] The main body case 11 is formed of a substantially-band-shaped insulating member, and has a shape curved with a predetermined curvature in a longitudinal direction of the band shape, as shown in FIG. 4. Also, the main body case 11 has a structure where both side portions are bent or project externally (in the exterior cover 15 direction in FIG. 4) at least along the longitudinal direction of the band-shaped member. As a result, the main body case 11 has a cross section including the recessed accommodation space 11s, as shown in FIG. 4 and FIG. 5. Also, in the main body case 11, at least at one end (end portion on the upper side in FIG. 4) of the band-shaped member in the longitudinal direction, a plurality of mount holes H11 for connection to the rotating section 103

on the opening/closing section 102 side is provided. Note that the main body case 11 should preferably has, when the display device 100 having at least the frame 12 and the exterior cover 15 mounted in the main body case 11 is worn on a wrist by the user for use, enough rigidity and strength to keep the shape of the accommodating space 11s while allowing deformation to some extent. Also, the main body case 11 should preferably has a texture that does not give an uncomfortable feeling when it comes in contact with a human body (skin).

[0030] The frame 12, for example, is formed of a metal thin plate having a band-like flat shape and has a curved shape corresponding to the predetermined curvature of the main body case 11, as shown in FIG. 4. Alternatively, the frame 12 has an appropriate rigidity so as to have flexibility and deformability for being curved corresponding to the predetermined curvature, so that the device body 101 is not too warped or deformed by small temporary external force. Also, the frame 12 has an intermediate frame section 12a formed by the frame 12 being cut such that both side portions 12c, which are both sides in a width direction of an intermediate portion between both ends 12b of the band-shaped thin plate in the longitudinal direction, are positioned in an area medially shifted in the width direction by a predetermined length so that the intermediate frame section 12a has a length in the width direction shorter than that of each end 12b, as shown

in FIG. 4.

[0031] In the frame 12, a plurality of mount holes H12 for assembling and fixing inside the accommodation space 11s of the main body case 11 are provided at least in one end 12b (end
5 portion on the upper side in FIG. 4) of the band-shaped thin plate in the longitudinal direction. In addition, a board fixing pin P12 for defining an assembling position with respect to the circuit board 14 described later is provided at least on one end 12b of the frame 12 in the longitudinal direction.

10 Here, as the frame 12, a metal material such as iron, stainless steel, aluminum alloy, or the like is adopted. However, the present invention is not limited thereto, and a nonmetal material or structure with an equivalent strength may be adopted.

15 [0032] The battery 13 is structured by a battery with a laminate package formed of a resin film, a thin metal package, or the like being formed in a band shape and integrally fixed to one surface side (main body case 11 side) of the frame 12, and has a curved shape corresponding to the shape of the frame
20 12, as shown in FIG. 4. Alternatively, the battery 13 has flexibility and deformability of being curved corresponding to the shape of the frame 12. Here, the battery 13 has a band-like flat shape having dimensions in accordance with, for example, a substantially entire area of the frame 12, and is
25 attached to a substantially entire area on the one surface side

of the frame 12, as shown in FIG. 4. Accordingly, from a view point from arrow D1 direction shown in FIG. 1A, the battery 13 is exposed outside the both side portions 12c of the intermediate frame section 12a of the frame 12 inside the device main body 101. Note that, although not shown, an output terminal of the battery 13 is electrically connected to the circuit board 14 and the display panel 16 in, for example, areas corresponding to both end portions 12b of the frame 12 in the longitudinal direction.

[0033] The circuit board 14 has functional component mount sections where the sensor section 130, the communication section 140, the control section 150, the storage section 160, and the like described in the above-described functional structure are mounted and pattern formation sections where only wiring patterns are formed, such as signal wiring and antenna wiring. This circuit board 14, for example, is formed of an insulating board having a band-like flat shape with dimensions corresponding to a substantially entire area of the above-described frame 12 and battery 13, and has the functional component mount sections provided at both ends of the band shape in the longitudinal direction, and pattern formation sections 14a provided at an intermediate portion between both ends 14b in the longitudinal direction, as shown in FIG. 4. Also, the circuit board 14 is formed of a thin-film-like or a film-like thin insulating board such as a flexible printed circuit (FPC).

On the pattern formation sections 14a and both ends 14b, wirings are formed on the insulating board. The circuit board 14, for example, has a curved shape corresponding to the predetermined curvature or has flexibility and deformability of being curved corresponding to the predetermined curvature as shown in FIG. 4, and therefore the pattern formation sections 14a can be curved corresponding to the curve of the frame 12.

[0034] In the circuit board 14 provided with the pattern formation sections 14a, an opening 14h of which the substantially center portion have been cut off by a predetermined length in the width direction and which is extending in the longitudinal direction is provided in an intermediate portion excluding both ends 14b of the band shape in the longitudinal direction, as shown in FIG. 4. That is, in the circuit board 14, the opening 14h is defined by both ends 14b in the longitudinal direction and two pattern formation sections 14a coupled to the both ends 14b and each having a length in the width direction shorter than that of the end 14b. Here, the width dimension of the opening 14h provided in the circuit board 14 is set to be larger than the width dimension of the intermediate frame section 12a provided to the frame 12. Accordingly, the intermediate frame section 12a of the frame 12 is positioned between the pattern formation sections 14a forming the opening 14h of the circuit board 14, with a unit formed of the frame 12, the battery 13, and the

circuit board 14 being substantially in close contact with and mounted in the main body case 11, as shown in FIG. 5. That is, the intermediate frame section 12a of the frame 12 and the pattern formation sections 14a of the circuit board 14 are formed such that they do not overlap with each other in a plane when viewed from the laminated direction the frame 12 and the circuit board 14 (viewed from a diagonally forward left direction in FIG. 4 or viewed from below in FIG. 5). Therefore, even if the device main body 101 is warped or deformed, the pattern formation sections 14a of the circuit board 14 do not come in contact with the intermediate frame section 12a of the frame 12. Also, even if the battery expands with time and presses the intermediate frame section 12a of the frame 12 toward the circuit board 14 side, since the intermediate frame section 12 of the frame 12 is in the accommodation space 11s in the opening 14h, the pattern formation sections 14a do not come in contact with the intermediate frame section 12a of the frame 12.

[0035] Also, in at least one end of the circuit board 14 in the longitudinal direction (end on the upper side in FIG. 4), a positioning hole H14 for defining a mounting position with respect to the frame 12 is provided. In the pattern formation sections 14a of the circuit board 14 where pattern formation sections are provided, for example, a sensor signal line for transmitting a detection signal outputted from the sensor

section 130 to the control section 150, a power supply line for supplying drive power supplied from the power supply section 170 to each structure, and a wiring pattern such as an antenna wiring or the like in accordance with the wireless communication method applied in the communication section 140 are formed. Here, by forming a sensor signal line on one of the two pattern formation sections 14a forming the opening 14h and a power supply line on the other one, and then separating them by the opening 14h, it is possible to decrease the influences of an electric field generated in the power supply line and favorably transmit a subtle detection signal outputted from the sensor section 130 to the control section 150. Note that the circuit board 14 may be structured such that the above-described functional component and wiring pattern are mounted or formed only on one surface side of the insulating board, or may be structured such that the functional component and wiring pattern are mounted or formed on both front and back surface sides. Here, the functional component and wiring pattern mounted or formed on the circuit board 14 are covered by a known insulating protection film for protection.

[0036] The exterior cover 15, for example, is formed of an insulating thin plate having a band-like flat shape, and has a curved shape corresponding to the predetermined curvature of the main body case 11, as shown in FIG. 4. Alternatively, the exterior cover 15 has flexibility and deformability of

being curved corresponding to the predetermined curvature of the main body case 11. Also, the exterior cover 15 is mounted such that it closes and seals the open end side (lower side in the drawing) of the accommodation space 11s provided in the main body case 11, as shown in FIG. 5. Here, the exterior cover 15 has characteristics (such as rigidity, heat resistance, moisture resistance, and chemical resistance) by which each structure accommodated in the accommodation space 11s can be protected against at least pressure from outside of the display device 100 (external pressure) and surrounding environments (such as temperature, humidity, and chemical agents). Also, in the present embodiment, the exterior cover 15, for example, is formed of a transparent resin material or glass material.

[0037] On one surface side (accommodation space 11s side) of the exterior cover 15, the display panel 16 functioning as the display section 110 is integrally provided. Also, on the exterior cover 15, a touch panel (omitted in the drawings) functioning as the operation section 120 is integrally provided. As a result, information displayed in the displayable area on the display panel 16 is transmitted via the transparent exterior cover 15 to the view field side, and thereby visually recognized by the user. Based on this information, the user can operate the touch panel to perform various settings. Also, in the exterior cover 15, a plurality of mount holes H15 for closing the accommodation space 11s of

the main body case 11 are provided in both ends (ends on the upper and lower sides in FIG. 4) of the band-shaped thin plate in the longitudinal direction.

[0038] The display panel 16, for example, has a thin display device whose information displayable area has a band-like flat shape, is integrally provided on one surface side (accommodation space 11s side) of the above-described exterior cover 15), and has a curved shape corresponding to the shape of the exterior cover 15, as shown in FIG. 4. Alternatively, the display panel 16 has flexibility and deformability of being curved corresponding to the shape of the exterior cover 15. This display panel 16 is a display panel that can maintain display even if it is being warped or deformed, such as a liquid-crystal display panel having liquid crystal filled between flexible film resin boards, an organic EL display panel having a flexible film resin board provided with an organic EL layer, or an electronic paper display panel having color particles filled between flexible film resin boards.

[0039] Also, the display panel 16 has a band-shaped display area extending in the longitudinal direction (first direction). In the entire or part of the display area, various information are displayed as stand-still information or video information with characters and images. The information displayed on the display panel 16 is visually recognized by being transmitted to the user view field side through the transparent exterior

cover 15. Also, on the view field side of the display panel 16, a touch panel is integrally provided, for example, on the exterior cover 15 so as to correspond to the entire display area. Although omitted in the drawings, for example, at one end of the display panel 16 or the exterior cover 15 in the longitudinal direction, a driver IC for driving the display panel 16 is provided, and is electrically connected to the circuit board 14 and the battery 13 in a nearby area.

[0040] The opening/closing section 102 has a structure in which, for example, the rotating section 103 is provided at one end (end portion on the upper side in FIG. 4) of the substantially-band-shaped member in the longitudinal direction, as shown in FIG. 4. The rotating section 103 includes a rotating shaft, and formed such that the opening/closing section 102 rotates with the rotating shaft as a pivot. This rotating section 103 is provided with a plurality of mount holes H13 for connection with at least the device main body 101.

[0041] In this assembly method for the display device, first, the positions of the mount holes H13 provided in the rotating section 103, the mount holes H11 provided in the main body case 11, and the mount holes H12 provided in the frame 12 are aligned, and male screws B11 are inserted from the inner side of the main body case 11 and the rotating section 103 (on the attachment space 101s side) so as to be screwed into female

screws provided on a holder P11 for fixation, as shown in FIG. 4 and FIG. 5. As a result, the frame 12 and the battery 13 integrally provided in the frame 12 are mounted in the accommodation space 11s of the main body case 11 with them being curved.

[0042] Next, a board fixing pin P12 provided on the frame 12 is fitted into the positioning hole H14 provided in the circuit board 14 to define the mounting position of the circuit board 14 with respect to the frame 12. Then, both ends of the frame 12 and the circuit board 14 in the longitudinal direction are bonded and fixed, for example, with an adhesive, double-sided adhesive tape, or the like. As a result, the circuit board 14 having various functional components mounted therein is mounted in the accommodation space 11s of the main body case 11 with it being curved and substantially in close contact with the frame 12. Also, in an area corresponding to the ends of the frame 12 and the circuit board 14 in the longitudinal direction, the battery 13 and the circuit board 14 are electrically connected to each other. Note that, as a method for positioning and fixing the frame 12 and the circuit board 14, a method of fixing with screws, a method of welding with resin, or a hot melt coating method can be adopted, in addition to the method using an adhesive or double-sided adhesive tape.

[0043] Next, the exterior cover 15 having the display panel

16 integrally provided thereon is arranged to close the accommodation space 11s of the main body case 11, and male screws B12 are inserted from the outer side into the mount holes H15 provided in the exterior cover 15 so as to be screwed into female screws provided on the holder P11 and fixed. As a result, the frame 12, the battery 13, and the circuit board 14 are assembled together, and the accommodation space 11s of the main body case 11 having the display panel 16 accommodated therein is sealed. Here, in an area corresponding to ends of the exterior cover 15 and the circuit board 14 in the longitudinal direction, a driver IC for driving the display panel 16 provided on the exterior cover 15 side, the circuit board 14, and the battery 13 are electrically connected to one another via a flat cable, a spring-type electrode terminal, or the like.

[0044] Then, a cover component C11 is mounted to cover the peripheries of the male screws B12 and the mount holes 15 used for screwing and fixing the exterior cover 15 to the main body case 11 via the holder P11. As a result, moisture intrusion and the like into the sealed accommodation space 11s of the main body case 11 is prevented, and the design quality of the display device 100 is enhanced. In FIG. 4, for convenience of depiction, only one end of the device main body 101 to which the rotating section 103 is connected (end on the upper side in FIG. 4) has been described in detail. However, similar assembly may be performed on the other end (end on the lower

side in FIG. 4) so as to fix both ends of the frame 12, the circuit board 14, and the exterior cover 15 to the main body case 11. Note that the reference numeral C12 in FIG. 4 denotes a cover component which covers the periphery of male screws (omitted in the drawing) for fixing the other end of the exterior cover 15 to the main body case 11, and the reference numeral C13 denotes another cover component mounted on the other end of the main body case 11.

[0045] According to the display device having the above-described assembly structure, the arrangement areas of the battery 13 and the circuit board 14 are determined (positioning operation) by the frame 12, and the battery 13 and the circuit board 14 are laminated and fixed on both surface sides such that the frame 12 is interposed therebetween. In addition, the intermediate frame section 12a and the pattern formation sections 14a formed on the intermediate portions of the frame 12 and the circuit board 14 except both ends are arranged such that they do not overlap with each other in a plane when viewed from the laminated direction of the frame 12 and the circuit board 14, and a predetermined gap 11c is formed so that the pattern formation sections 14a of the circuit board 14 do not come in contact with the battery 13. As a result, in the thin display device having a curved shape with a predetermined curvature, the rigidity and strength of each of the thin battery 13, circuit board 14, and the like incorporated

in the device and the rigidity and strength of the device main body 101 can be ensured to some extent, and warping and deformation occurring by external pressure when the display device is manufactured or used can be decreased. In addition, even if manufacturing variations of components and members, work variations thereof at the time of assembling, and warping or deformation by external pressure at the time of manufacturing or using the display device occur, these variations and the like are absorbed by the arrangement of the intermediate frame section 12a and the pattern formation sections 14a and the gap 11c, whereby damage, exfoliation, and the like of the components and members are prevented and favorable product quality is achieved.

[0046] In the structure of the device main body 101 of the above-described embodiment, the frame 12 having the intermediate frame section 12a, the battery 13, and the circuit board 14 having the opening 14h are laminated and mounted in the main body case 11. However, the present invention is not limited thereto and any structure can be adopted as long as the frame 12 and the circuit board 14 are mounted in the main body case 11 in a manner that they are not damaged by coming in contact with each other due to manufacturing variations of the components and members, work variations thereof at the time of assembling, and warping or deformation at the time of manufacturing or using the display device. That is, the

display device may adopt a structure or a method other than the above-described assembly structure and assembling method. For example, the display device may have a simple band-like flat shape in which the frame 12 and the circuit board 14 do not have the intermediate frame section 12a or the opening 14h. Alternatively, the frame 12, the circuit board 14, and the exterior cover 15 may be fixed to the main body case 11 by a method other than fixation by screws.

[0047] (Information Display Method)

Next, an information display method for the display device according to the present embodiment is described with reference to the drawings.

[0048] FIG. 6 is a flowchart of an example of user viewing direction setting processing applied in the information display method for the display device according to the present embodiment, and FIG. 7 is a schematic diagram for describing a coordinate system of the display device applied in the user viewing direction setting processing according to the present embodiment. Also, FIG. 8 is a schematic diagram for describing a relation between the tilt of the display device and a user viewing direction which is applied in the user viewing direction setting processing according to the present embodiment, and FIG. 9 is a flowchart of an example of information display processing applied in the information display method for the display device according to the present

embodiment. FIG. 10A to FIG. 10C are perspective views showing an example of information display achieved by information display processing according to the present embodiment.

[0049] In the display device according to the present
5 embodiment, user viewing direction setting processing, display information setting processing, and information display processing are mainly performed. Each operation processing is achieved by the control section 150 of the display device 100 executing a predetermined program. Here, in the
10 information display method of the present embodiment described below, an operation status where information display processing is performed corresponds to a normal mode.

[0050] In the user viewing direction setting processing applied in the information display method for the display
15 device 100, first, the user wears the display device 100 on the body, and activates the display device 100 (Step S102), as shown in FIG. 6. Specifically, the opening/closing section 102 is rotated with respect to the device main body 101 of the display device 100 so as to open and close the attachment space
20 101s, whereby the display device 100 is worn on the wrist USh, as shown in FIG. 2B. Then, by the user performing an ON operation on a power supply switch (omitted in the drawings) provided on the operation section 120 of the device main body 101, drive power is supplied from the power supply section 170
25 to each section, whereby the display device 100 is activated

in the normal mode.

[0051] The display device 100 may be set such that, in order to make only the sensor section 130 functions in the sleep mode, the power supply section 170 which supplies power to part of the control section 150 and the sensor section 130 and the sensor section 130 are constantly driven to prevent the power supply section 170 from supplying power to sections other than part of the control section 150 and the sensor section 130. In this case, by the sensor section 130 outputting a start signal to the control section 150 based on biological information such as pulse acquired by the user wearing the device, the entire control section 150 is started. The entirely-started control section 150 outputs a control signal so that the display section 110, the operation section 120, and the like function, and thereby controls the display device 100 to enter the normal mode from the sleep mode.

[0052] Next, the user sets the operation status of the display device 100 such that the display device 100 enters a user viewing direction setting mode (Step S104). Specifically, for example, the user operates the operation section 120 such as the touch panel or push button provided on the device main body 101 of the display device 100 so as to cause the control section 150 to change from the normal mode to the user viewing direction setting mode for setting a user viewing direction. Note that the control section 150 may change from the normal mode to the

user viewing direction setting mode based on physical information detected by the sensor section 130 as a result of the user moving the arm having the display device 100 worn thereon in a predetermined form.

5 [0053] When the display device 100 is set in the user viewing direction setting mode, the control section 150 causes the sensor section 130 to perform a sensing operation so as to acquire predetermined sensor data (Step S106) and, based on the sensor data, detects the tilt (or orientation) of the
10 display device 100 (Step S108).

[0054] Specifically, the control section 150 acquires acceleration data in triaxial directions by an acceleration sensor provided in the sensor section 130. Here, the acceleration data acquired by the acceleration sensor is
15 detected as acceleration components in X, Y, and Z axial directions in a three-dimensional coordinate system S1 set in advance in the display device 100. In the present embodiment, the three-dimensional coordinate system S1 takes, as X plane, a plane passing through the center line Lc of the device main
20 body 101 extending while being curved with a predetermined curvature or the exterior cover 15 and the display panel 16 of the display section 110 in the width direction (transverse direction, which is a second direction), as shown in FIG. 1B, FIG. 1C, and FIG. 7. Also, an origin P0 is set at a position
25 corresponding to the point of intersection between the

rotation axis (which corresponds to X axis described later) of the user's wrist USh having the display device 100 worn thereon in the extending direction and the X plane. Alternatively, the origin P0 is set on the X plane and at a position corresponding to a substantially center of the circular attachment space 101s formed by the device main body 101 and the opening/closing section 102 of the display device 100. An axis passing through the origin P0 and in a direction perpendicular to the X plane (which corresponds to the extending direction of the wrist USh) is defined as X axis. Axes passing through the origin P0 and orthogonal to the X axis and to each other are set as Y axis and Z axis. A plane passing through the origin P0 and perpendicular to the Y axis is defined as Y plane. A plane passing through the origin P0 and perpendicular to the Z axis is defined as Z plane.

[0055] Then, based on the above-described acceleration data in the triaxial directions acquired by the acceleration sensor, the control section 150 detects a vector (gravity direction vector) G indicating a gravity direction, projects the gravity direction vector G onto the X plane in the above-described three-dimensional coordinate system S1, and acquires a vector Gx of the X-plane components (projected components), as shown in FIG. 8. Based on the vector Gx and by arithmetic operation, the control section 150 detects the tilt of the display device 100 with respect to the gravity direction. This operation of

detecting the tilt of the display device 100 may be performed in a temporally-sequential manner every time sensor data is acquired based on a sampling frequency of the acceleration sensor, or may be performed at predetermined time intervals (for example, 0.1 to 0.5 seconds).

[0056] Next, in the displayable area of the band-shaped long display panel 16 functioning as the display section 110, the user sets an arbitrary position of the display area 110p desired by the user in a user viewing direction in which the displayed information can be favorably viewed. The control section 150 judges whether the position of the display area 110p desired by the user has been set (Step S110). Specifically, the user keeps the state of lifting the arm with the display device 100 up to, for example, the height of the chest so as to be able to favorably view the displayed information. In this state, in the band-shaped displayable area of the display panel 16 where information is displayed, the touch sensor corresponding to the position on the display panel 16 where the information can be favorably viewed is directly touched or tapped by a finger tip, whereby the position of the display area 110p is set. The tilt state of the display panel 16 at the time of the setting is detected with the angle θ formed by a line connecting the origin P0 and the position of the display area 110p set by the user and the vector Gx.

[0057] The control section 150 estimates that the user's eyes

when the user has changed his or her posture to easily and favorably view information displayed on the display device 100 worn on the wrist in the user's daily motions or exercise are present on a line extended from the line connecting the origin P0 and the position of the display area 110p set by the user, and sets a direction connecting the origin P0 and the user's view point with respect to the display area 110p as a single user viewing direction. Strictly speaking, this user viewing direction is assumed to be oriented to a position between both eyes of the user, and is not required to correspond to a direction in reverse to a plurality of sight lines from both eyes when the user actually views. Here, in the user viewing direction setting processing, the control section 150, for example, may cause predetermined information to be displayed on the entire band-shaped display area on the display panel 16 and may set a point on the display panel 16 touched by the user as the position of the display area 110p where the user can most easily view the information. Also, the control section 150 may set a point touched by the user without display on the display panel 16 as the position of the display area 110p where the user can most easily view information. Alternatively, the control section 150 may cause predetermined information to be displayed on only part of the display area on the display panel 16, and may set a point touched by the user as the position of the display area 110p where the user

can most easily view information, while changing the position of the displayed information with time in the display panel 16.

[0058] At Step S110, when judged that the position of the display area 110p in the user viewing state has not been set, the control section 150 returns to Step S106 to repeatedly perform the operation of acquiring sensor data and detecting the tilt of the display device 100. Conversely, when judged that the position of the display area 110p in the user viewing state has been set, the control section 150 assumes a direction passing through the origin P0 and the center of the display area 110p designated by the user at Step S110 as a user viewing direction Du, as shown in FIG. 8. Then, the control section 150 acquires the angle θ (parameter) for defining the user viewing direction Du with reference to the vector Gx of the X-plane components of the gravity direction vector G detected at Step S108, and stores the angle θ in a predetermined storage area of the storage section 160 (Step S112). Then, the control section 150 sets the operation status of the display device 100 in the normal mode.

[0059] Next, in the display information setting processing applied to the information display method in the display device 100, the user performs operates the operation section 120 provided on the display device 100 so as to set the type and contents of information to be displayed on the display area

110b oriented to the user viewing direction Du set by the above-described user viewing direction setting processing. Specifically, the user first operates the operation section 120 such as the touch panel or push button provided on the device main body 101 and sets the operation status of the display device 100 in the display information setting mode.

[0060] When the display device 100 is set in the display information setting mode, the control section 150 causes a list or icon of information displayable in the displayable area of the display panel 16. Next, by the user directly touching or tapping, with a finger tip, the touch panel provided on the view field side in the display area where the user's desired information is being displayed so as to select information, the control section 150 sets (registers) the information as display information. Then, the control section 150 sets the operation status of the display device 100 in the normal mode. Here, in a case where the user desires display of a plurality of pieces of information, the control section 150 may also set (register) a display form such as the display position or display sequence of a plurality of pieces of information selected by the user (specifically, arrangement and arrangement sequence in the extending direction of the display panel 16 centering on the display area 110p oriented to the above-described user viewing direction). By displaying one or a plurality of pieces of information in the band-shaped

display area on the display panel 16 at an arbitrary display position(s) or display sequence, the user can view more information easily. Also, as information displayable on the display section 110 in this display information setting processing, various information can be applied, such as a current time, and biological information and exercise information acquired when the user is moving or exercising, as well as an azimuth or weather forecast at a current position, a stock price, traffic information, news flash, and the like. From among these pieces of information, the user can select desired information.

[0061] Note that the above-described user viewing direction setting processing and display information setting processing may be performed as initial setting operation prior to information display processing described later, or may be performed by the user at arbitrary timing during a period in which desired information is being displayed on the display section 110 by information display processing. Also, the above-described user viewing direction setting processing and display information setting processing may be sequentially performed, or may be performed independently and separately from each other.

[0062] Next, in the information display processing applied in the information display method in the display device 100, processing is performed in which the information desired by

the user set in the above-described display information setting processing is displayed in the display area 110p oriented to the user viewing direction D_u set in the user viewing direction setting processing in the band-shaped display area of the display panel 16. Specifically, as with the above-described user viewing direction setting processing, the user first wears the display device 100 and activates the display device 100 in the normal mode (Step S122), as shown in FIG. 9. As a result, the control section 150 causes the sensor section 130 to perform a sensing operation so as to acquire predetermined sensor data (Step S124) and, based on the sensor data, detects the tilt (or orientation) of the display device 100 with respect to a current gravity direction (Step S126).

[0063] Next, the control section 150 determines the display area 110p oriented to the user viewing direction D_u based on the detected tilt of the display device 100 (Step S128). Specifically, based on acceleration data in triaxial directions acquired as sensor data, the control section 150 detects the current gravity direction vector G , and acquires the vector G_x of the X-plane components projected onto the X plane in the three-dimensional coordinate system S_1 , as with the above-described user viewing direction setting processing (refer to FIG. 8). Then, the control section 150 acquires the user viewing direction D_u on the X plane with reference to the

acquired vector G_x of the X-plane components by using the angle θ acquired in advance in the above-described user viewing direction setting processing and stored in the storage section 160. As a result, the control section 150 determines the display area (display area oriented to the user viewing direction) 110p with a predetermined width centering on the user viewing direction, which is a point where the information in the band-shaped display area on the display panel 16 can be easily viewed by the user, and causes the desired information set in the above-described display information setting processing to be constantly displayed in the display area 110p in a desired form (Step S130).

[0064] Then, in this information display state, the control section 150 monitors for the tilt and orientation of the display device 100 detected based on the sensor data acquired at Steps S124 and S126 (Step S132). When judged that the tilt of the display device 100 has been changed, the control section 150 returns to Step S128, repeatedly performs the operation of determining the display area 110p oriented to the user viewing direction D_u based on a newly-detected (that is, changed) tilt of the display device 100 and causing the desired information to be displayed in the display area 110p. Conversely, when judged that the tilt of the display device 100 has not been changed, the control section 150 continues the operation of causing the desired information to be displayed in the current

display area 110p.

[0065] Although omitted in the flowchart shown in FIG. 9, when an input operation for interrupting or ending the processing operation during the above-described information display processing is detected or when a similar input operation or status change is detected by constantly monitoring for change in the operation status of the display device 100, the control section 150 forcibly ends the processing operation. Specifically, the control section 150 detects an operation of turning the power supply switch OFF by the user, a decrease in the remaining amount of battery in the power supply section 170, an anomaly of a function or application during the processing, and the like, and forcibly interrupts and ends the series of processing operations.

[0066] That is, in the present embodiment, the X plane in the three-dimensional coordinate system S1 set in the display device 100 is a plane passing through the center line Lc in the width direction (short-side direction) of the display panel 16 provided in a band shape along the device main body 101 extending and curved with the predetermined curvature, as shown in FIG. 7. In addition, the display area 110p at a position set by the user at which information can be easily viewed by the user (that is, oriented to the user viewing direction Du) is defined by the angle θ on the X plane with reference to the vector Gx of the X-plane components of the

gravity direction vector G detected based on sensor data, as shown in FIG. 8. Accordingly, even if the display device 100 is tilted or the tilt or the orientation of the display device 100 is changed during the information display processing in the normal mode, the control section 150 changes the position of the display area 110p such that the user viewing direction D_u is kept in a certain direction, with reference to the vector G_x of the X-plane components of the gravity direction vector G detected during the information display processing, based on the angle θ acquired in advance by the user viewing direction setting processing and stored.

[0067] That is, for example, if the display device 100 is tilted or the tilt or orientation of the display device 100 is changed with respect to an assumed position of the user's eyes during the information display processing in the normal mode, the control section 150 changes the position of the display area 110p in accordance with only the direction of the vector G_x of the X-plane coordinates of the gravity direction vector G during the information display processing and the angle θ acquired by the user viewing direction setting processing in the user viewing direction setting mode, whereby the position of the display area 110p moves as appropriate in the longitudinal direction of the band-shaped display area on the display panel 16 (refer to a dotted arrow in the drawings) so that the display area 110p is always oriented to the set

user viewing direction D_u , as shown in FIG. 10A to FIG. 10C. As a result of this configuration, desired information is displayed such that the display area 110p is always oriented to a point between the user's eyes.

5 [0068] As described above, in the present embodiment where a display device includes a display section having a band-shaped curved display area capable of displaying more information, even when the tilt or orientation of the display device is changed with it being worn on a user, desired
10 information is displayed in a specific display area oriented to a user viewing direction. As a result of this configuration, the user can easily and unfailingly view desired information without moving the line of sight, rotating a body part where the display device is worn, or moving the head. Also, in the
15 present embodiment, since desired information set in advance by the user is always displayed in a display area oriented to a user viewing direction, an operation for turning on the display of the display section is not required to be performed, and the desired information can be viewed quickly and
20 unfailingly.

[0069] In the present embodiment, one or a plurality of pieces of information are selected as information to be displayed on the display section 110, and the display position and display sequence of these pieces of information can be arbitrarily set.
25 In this case, one or plurality of pieces of information are

sequentially and adjacently arranged in the extending direction of the band-shaped displayable area on the display panel 16, centering on the display area 110p oriented to the user viewing direction Du. Accordingly, as the amount of information increases, the area of a region where information is displayed increases. Therefore, the entire region where the information is displayed may not be easily viewed by the user. Thus, in the present embodiment, by the user performing an operation on the operation section 120 such as an operation of directly touching, tapping, or swiping the touch panel with a finger tip, information displayed simultaneously with the display area 110p in an area on the display section 110 excluding the display area 110p oriented to the user viewing direction Du can be moved to the position where the display area 110p oriented to the user viewing direction Du is displayed. As a result of this configuration, among one or a plurality of pieces of information set in advance, desired information can be displayed at a position where the display area 110p oriented to the user viewing direction Du is being displayed, by a simple operation on the display panel 16, whereby the user can unfailingly view the desired information.

[0070] Also, the characteristics of the display panel 16 applied in the display section 110 according to the present embodiment are not specifically limited. For example, a display device with a narrow angle of visibility may be applied.

In this structure, normal visual recognition of desired information displayed in the display area is possible only when it is viewed from a relatively narrow range centering the user viewing direction D_u . That is, normal visual recognition of display by someone peeking from around can be prevented (inhibited). Therefore, information confidentiality and privacy can be effectively protected.

[0071] Moreover, in the present embodiment, the display device is worn on one of the right and left wrists. However, the display device 100 can be worn on both of the right and left wrists. In this case as well, the user viewing direction D_u is defined in advance by the angle θ with reference to the vector G_x of the X-plane components of the gravity direction vector G in the above-described user viewing direction setting processing. Therefore, desired information can be appropriately displayed in the display area 110p oriented to the user viewing direction D_u . Similarly, even if the display device 100 is worn on one wrist upside down, the user viewing direction D_u is defined with reference to the vector G_x of the X-plane components of the gravity direction vector G . Therefore, desired information can be displayed without being upside down at a correct position when viewed from the user. That is, a user-friendly display device can be provided.

[0072] <Second Embodiment>

Next, a second embodiment of the present invention is

described.

In the above-described first embodiment, information desired by the user is constantly displayed in the display area 110p oriented to the user viewing direction Du on the display panel 16 having a band-shaped curved display area provided in the display section 110. The second embodiment has a feature in which the worn status of the display device 100 and the user's information viewing status of the display section 110 are detected to control the on and off of display on the display section 110. Note that, although a case where both the worn status and the user's information viewing status of the display device 100 are detected is described in the following embodiment, only one of them may be detected to control the on and off of display on the display section section 110.

[0073] FIG. 11 is a flowchart of an example of information display processing applied in an information display method for the display device according to the second embodiment. Note that descriptions of structures and methods equivalent to those of the first embodiment are simplified by referring to the above descriptions as appropriate.

[0074] In the information display processing applied in the display device 100 according to the present embodiment, the user first activates the display device 100 in the normal mode (Step S202), as shown in FIG. 11. As a result, the control section 150 causes the sensor section 130 to perform a sensing

operation to acquire predetermined sensor data (Step S204) and, based on the sensor data, detects the tilt (or orientation) of the display device 100 with respect to the gravity direction (Step S206).

5 [0075] Next, based on the sensor data acquired by the sensor section 130, the control section 150 judges the worn status by judging whether the display device 100 has been worn on the user (Step S208). Specifically, in a state where the display device 100 has been worn on the user, sensor data such as
10 acceleration data and angular velocity data and change in a detected tilt and orientation of the display device 100 may be different as compared to a state where the display device 100 has not been worn but been placed on a desk or the like. The control section 150 constantly or regularly monitors for
15 sensor data acquired by the sensor section 130 or the tilt of the display device 100. Then, for example, when a change continues within a predetermined period of time, the control section 150 judges that the display device 100 has been worn on the user (worn state). If there is no change within the
20 predetermined period of time, the control section 150 judges that the display device 100 has not been worn (unworn state). When judged that the display device 100 is in an unworn state, the control section 150 controls the display operation of the display section 110 to enter an OFF state (Step S218), and
25 repeatedly performs similar judgment processing until the

display device 100 enters a worn state.

[0076] Conversely, when judged that the display device 100 is in a worn state, the control section 150 judges whether the user is in a state of viewing information displayed on the display section 110 (Step S210). Specifically, when viewing information displayed on the display section 110, the user changes his or her posture or makes a movement such that the arm having the display device 100 worn thereon is lifted approximately to the height of the chest and stand still.

Accordingly, the control section 150 monitors for the gravity direction vector G detected based on sensor data acquired by the sensor section 130 and the vector G_x of X-plane components indicating the tilt of the display device 100.

[0077] Then, for example, when a difference in these vector directions (angular difference) is within a predetermined range and this state continues for a predetermined period of time, the control section 150 judges that the user is viewing information displayed on the display section 110 (viewing state). Alternatively, the control section 150 monitors for sensor data acquired by the sensor section 130 and, for example, if the range (degree of variation) of change of the sensor data is within a predetermined range and this state continues for a predetermined period of time, the control section 150 judges that the user is viewing display on the display section 110 (viewing state). By contrast, when the directions of the

gravity direction vector G detected based on the sensor data and the vector G_x of the X-plane components are not in a predetermined direction range or when the range (degree of variation) of change of the sensor data is not within the predetermined range, the control section 150 judges that the user is not viewing information on the display section 110 (non-viewing state). When judged that the user is in a non-viewing state, the control section 150 controls the display operation of the display section 110 to enter an OFF state (Step S220), and repeatedly perform similar judgment processing until the user enters a viewing state.

[0078] Conversely, when judged that the user is in a viewing state, the control section 150 acquires the user viewing direction D_u with reference to the vector G_x of the X-plane components of the current gravity direction vector G detected based on the sensor data, by using the angle θ acquired in advance in the above-described user viewing direction setting processing, and determines the display area 110p oriented to the user viewing direction D_u in the band-shaped display area on the display panel 16 (Step S212). Then, the control section 150 controls the display operation of the display section 110 to enter an ON state, and causes desired information set in the above-described display information setting processing to be displayed in the display area 110p in a desired form (Step S214).

[0079] In this information display state, the control section 150 monitors for the tilt and orientation of the display device 100 based on the sensor data acquired at Steps S204 and S206 (Step S216). When judged that the tilt of the display device 100 has been changed, the control section 150 returns to Step S208, repeatedly performs the operations of judging whether the display device 100 has been worn on the user and judging whether the user is viewing the information on the display section 110 based on newly-acquired sensor data and the tilt of the display device 100 so as to control the on and off of the display on the display section 110. Conversely, when judged that the tilt of the display device 100 has not been changed, the control section 150 continues the operation of displaying the desired information in the current display area 110p.

[0080] Although omitted in the flowchart shown in FIG. 11, when an input operation for interrupting or ending the processing operation during the above-described information display processing is detected or when a similar input operation or status change is detected by constantly monitoring for change in the operation status of the display device 100, the control section 150 forcibly ends the processing operation, as with the above-described first embodiment.

[0081] As described above, in the present embodiment, the

worn state of the display device 100 and the viewing state of the user related to information on the display section 110 are detected, and display on the display section 110 is turned on only when the display device 100 is worn on the user and the user is viewing the information on the display section 110. Conversely, when the user is not wearing the display device 100 or not viewing information on the display section 110, display on the display section 110 is turned off. As a result of this configuration, in the present embodiment, power consumption for information display can be significantly decreased, and the display device 100 can be used for a long period of time without charging or battery exchange, in addition to the achievements of the operations and effects described in the above-described first embodiment.

[0082] In the present embodiment, as a method for controlling ON and OFF of information display on the display section 110, a method has been described in which a specific motion of the display device 100 when the display device 100 is in a worn state and the user is in a viewing state is detected based on sensor data acquired by the sensor section 130. However, the present invention is not limited thereto. That is, any method can be used as long as display on the display section 110 is turned OFF when the display device 100 is not worn (unworn state) or when the user is not viewing information on the display section 110 so that power consumption is decreased.

Therefore, in the present invention, a configuration may be adopted in which, in a state where the display device 100 has been worn on the user, display on the display section 110 is turned ON only when a specific motion (gesture) such as a motion of swinging or quickly waving the arm a plurality of times is performed, and display is turned OFF during the other periods. This specific motion by the user can be judged based on, for example, sensor data detected by the acceleration sensor, angular velocity sensor, or the like provided in the sensor section 130. Note that the method for controlling the display device 100 based on a user specific motion is not limited to the above-described ON/OFF control of display. For example, By being registered, various specific motions can be used for various control operations such as the change of the setting of the above-described operation mode and the display of a menu screen in the display information setting processing.

[0083] In each of the above-described embodiments, acceleration data in triaxial directions acquired by the acceleration sensor is used as sensor data for detecting the tilt of the display device 100. However, the present invention is not limited thereto. That is, in the present invention, any data can be used as long as the tilt of the display device 100 can be detected. For example, sensor data detected by another sensor, such as an angular velocity sensor, gravity sensor, or geomagnetic sensor may be used. In a case where

the present invention is applied to a wearable terminal including various motion sensor, an existing motion sensor may be used as the above-described sensor for detecting the tilt of the display device 100.

5 [0084] Also, in each of the above-described embodiments, as a method for setting a user viewing direction, the method is used in which the touch panel provided on the visual field side of the display area on the display panel 16 is directly touched or tapped by the user. However, the present invention is not
10 limited thereto. That is, in the present invention, any method can be used as long as a user viewing direction can be set. For example, a method may be used in which the display area 110p oriented to the user viewing direction is set by an operation section such as a touch sensor or push button provided
15 on the periphery of the band-shaped display area on the display panel 16. Also, the present invention is not limited to the method in which the user directly set a viewing direction. For example, a method may be used in which the display device 100 includes a camera and a user viewing direction is defined by
20 the camera recognizing the positions of the user's eyes and a relative position of the display device 100.

[0085] Moreover, in each of the above-described embodiments, the display device 100 is worn on a wrist of a human body. However, the present invention is not limited thereto. That
25 is, in the present invention, the display device 100 can be

worn on a wrist or arm, and can also be favorably worn on a part (a part of the human body or not) with a predetermined curvature at a position that can be visually recognized by the user. Also, the present invention is not limited to the structure in which, when viewed from a side surface side (refer to FIG. 1C), the device main body 101 and the display panel 16 have a curved shape with a curvature continuously varied in accordance with the shape of a part of a human body. For example, a structure may be adopted in which a plurality of flat-shaped display panels have a polygonal shape when viewed from a side surface side (in an arrow D2 direction).

[0086] This application is based upon and claims the benefit of priority from Japanese patent application No. 2015-018104, filed February 2, 2015, the entire contents of which are incorporated herein by reference.

[0087] While the present invention has been described with reference to the preferred embodiments, it is intended that the invention be not limited by any of the details of the description therein but includes all the embodiments which fall within the scope of the appended claims.

CLAIMS

1. A display device comprising:

a display section which has a displayable area extending in a first direction; and

a display control section which controls the display section to change a position of a display area where information is displayed in the displayable area, in accordance with a tilt status of the display device, and display the information in the display area whose position has been changed.

2. The display device according to claim 1, further comprising:

a parameter acquiring section which acquires a parameter that defines a user viewing direction which is a direction in which a user is viewing the display area, based on the position of the display area in the displayable area and the tilt status of the display device in a user viewing direction setting mode,

wherein the display control section in a normal mode controls the display section to change the position of the display area based on the tilt status of the display device and the acquired parameter and display the information in the display area whose position has been changed.

3. The display device according to claim 1, wherein the display control section (i) controls the display section to

display the information in the display area and display other information different from the information in an area different from the display area in the displayable area, and
5 (ii) controls the display section to change a display position of the other information displayed in the different area to be in the display area and display the other information at the changed display position of the other information.

4. The display device according to claim 1, further comprising:

a sensor section which detects at least one of gravity acceleration and acceleration or angular velocity; and

5 an acquiring section which acquires at least one of the tilt status and an operation status of the display device, based on at least one of the gravity acceleration and the acceleration or the angular velocity detected by the sensor section,

wherein the display control section controls the display
10 section to turn on or off display of the information in the display area based on at least one of the tilt status and the operation status of the display device detected by the sensor section.

5. The display device according to claim 2, further comprising:

a sensor section which detects gravity acceleration,

wherein the displayable area has a curved surface, and a
5 plane where a direction substantially parallel to the curved
surface corresponds to a normal line is a projection plane,
and

wherein the parameter acquiring section acquires the
parameter which defines the user viewing direction in the
10 projection plane, with reference to a projection component of
a vector of the gravity acceleration detected by the sensor
section with respect to the projection plane.

6. A display method for a display device including a display
section and a display control section, comprising:

providing the display section with a displayable area
extending in a first direction; and

5 controlling the display section by the display control
section to change a position of a display area where information
is displayed in the displayable area, in accordance with a tilt
status of the display device, and display the information in
the display area whose position has been changed.

7. The display method according to claim 6, further
comprising:

acquiring a parameter that defines a user viewing
direction which is a direction in which a user is viewing the
5 display area, based on the position of the display area in the

displayable area and the tilt status of the display device in a user viewing direction setting mode,

wherein the display control section in a normal mode controls the display section to change the position of the display area based on the tilt status of the display device and the acquired parameter and display the information in the display area whose position has been changed.

8. The display method according to claim 6, wherein the display control section (i) controls the display section to display the information in the display area and display other information different from the information in an area different from the display area in the displayable area, and (ii) controls the display section to change a display position of the other information displayed in the different area to be in the display area and display the other information at the changed display position of the other information.

9. The display method according to claim 6, wherein the display device further includes:

a sensor section which detects at least one of gravity acceleration and acceleration or angular velocity; and

an acquiring section which acquires at least one of the tilt status and an operation status of the display device, based on at least one of the gravity acceleration and the acceleration

or the angular velocity detected by the sensor section,

wherein the display control section controls the display
10 section to turn on or off display of the information in the
display area based on at least one of the tilt status and the
operation status of the display device detected by the sensor
section.

10. The display method according to claim 7, wherein the
display device further includes a sensor section which detects
gravity acceleration,

wherein the displayable area has a curved surface, and a
5 plane where a direction substantially parallel to the curved
surface corresponds to a normal line is a projection plane,
and

wherein the parameter which defines the user viewing
direction in the projection plane is acquired with reference
10 to a projection component of a vector of the gravity
acceleration detected by the sensor section with respect to
the projection plane.

11. A non-transitory computer-readable non-volatile storage
medium having stored thereon a display program that is
executable by a computer for controlling a display device
including a display section and a display control section to
5 actualize functions comprising:

providing the display section with a displayable area extending in a first direction; and

controlling the display section by the display control section to change a position of a display area where information
10 is displayed in the displayable area, in accordance with a tilt status of the display device, and display the information in the display area whose position has been changed.

12. The non-transitory computer-readable non-volatile storage medium according to claim 11, further comprising:

acquiring a parameter that defines a user viewing direction which is a direction in which a user is viewing the
5 display area, based on the position of the display area in the displayable area and the tilt status of the display device in a user viewing direction setting mode,

wherein the display control section in a normal mode controls the display section to change the position of the
10 display area based on the tilt status of the display device and the acquired parameter and display the information in the display area whose position has been changed.

13. The non-transitory computer-readable non-volatile storage medium according to claim 11, wherein the display control section (i) controls the display section to display the information in the display area and display other

5 information different from the information in an area
different from the display area in the displayable area, and
(ii) controls the display section to change a display position
of the other information displayed in the different area to
be in the display area and display the other information at
10 the changed display position of the other information.

14. The non-transitory computer-readable non-volatile
storage medium according to claim 11, wherein the display
device further includes:

a sensor section which detects at least one of gravity
5 acceleration and acceleration or angular velocity; and

an acquiring section which acquires at least one of the
tilt status and an operation status of the display device, based
on at least one of the gravity acceleration and the acceleration
or the angular velocity detected by the sensor section,

10 wherein the display control section controls the display
section to turn on or off display of the information in the
display area based on at least one of the tilt status and the
operation status of the display device detected by the sensor
section.

15. The non-transitory computer-readable non-volatile
storage medium according to claim 12, wherein the display
device further includes a sensor section which detects gravity

acceleration,

5 wherein the displayable area has a curved surface, and a
plane where a direction substantially parallel to the curved
surface corresponds to a normal line is a projection plane,
and

10 wherein the parameter which defines the user viewing
direction in the projection plane is acquired with reference
to a projection component of a vector of the gravity
acceleration detected by the sensor section with respect to
the projection plane.

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FIG. 1A

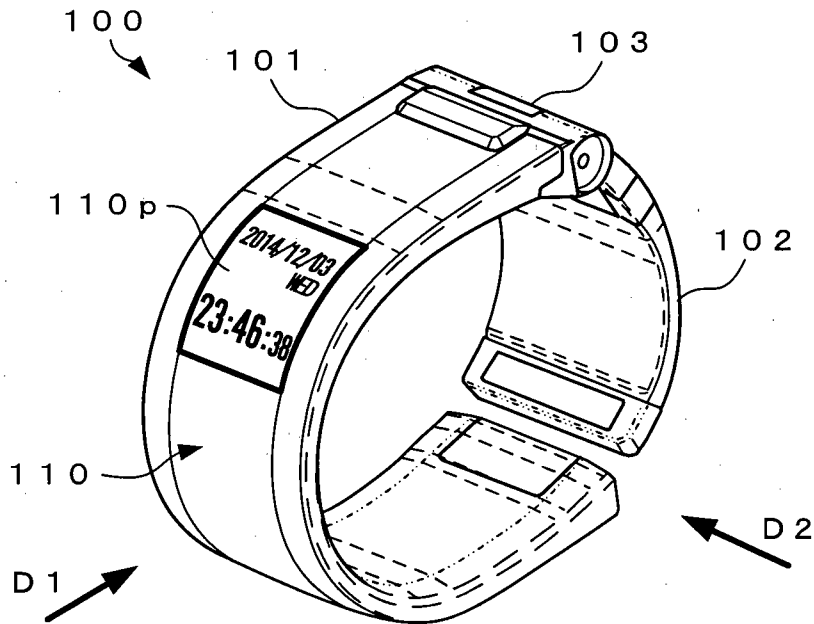


FIG. 1B

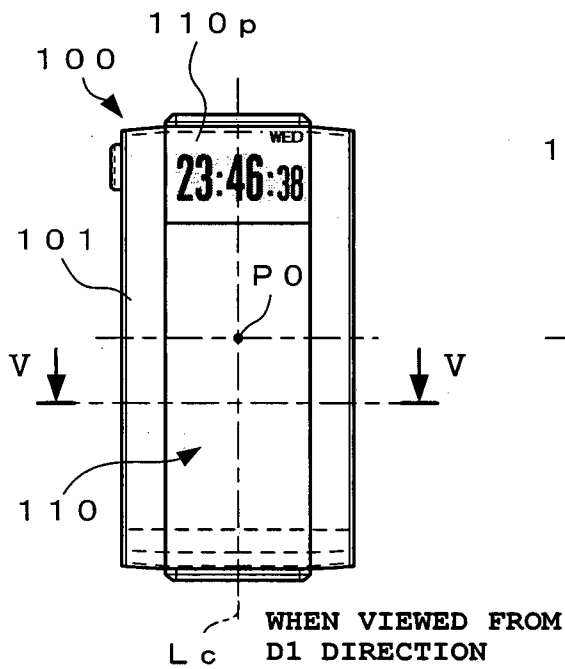
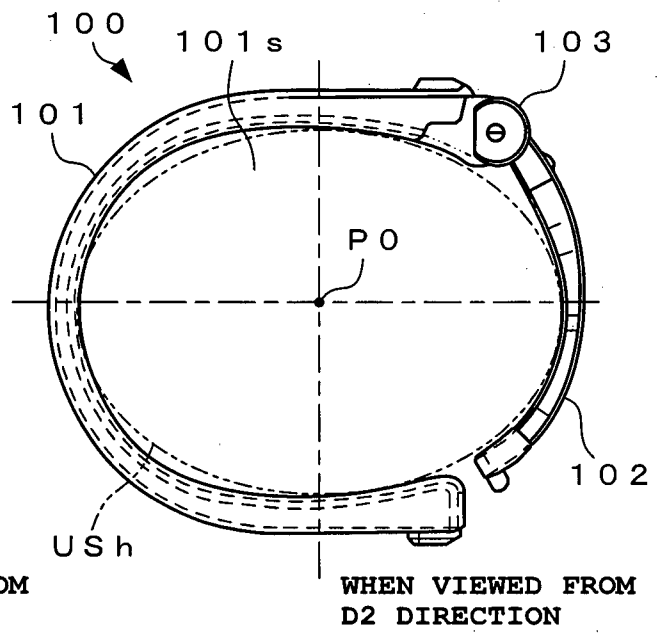


FIG. 1C



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FIG. 2A

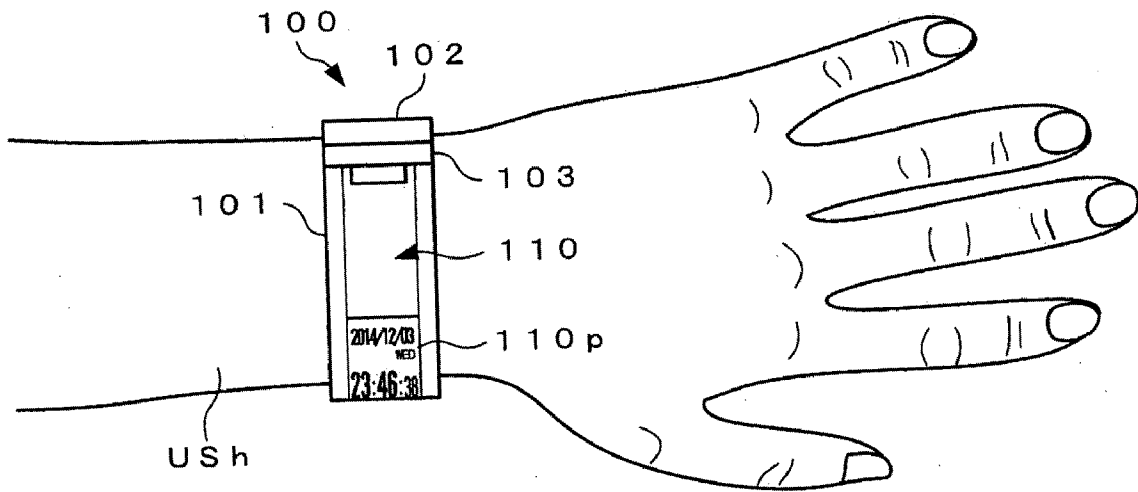


FIG. 2B

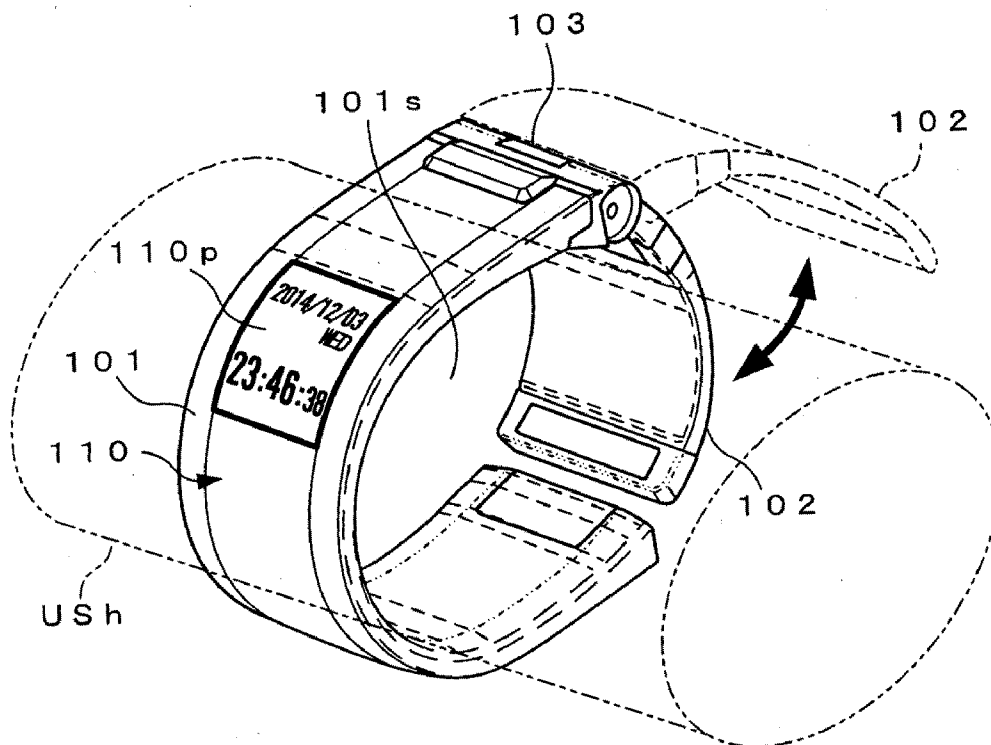


FIG. 3

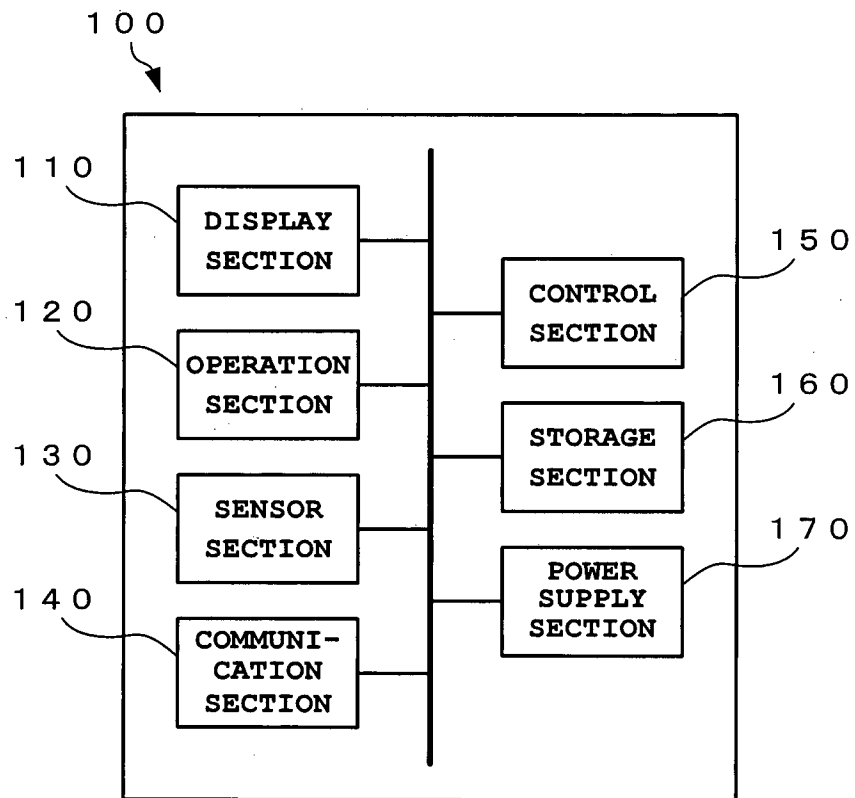


FIG. 4

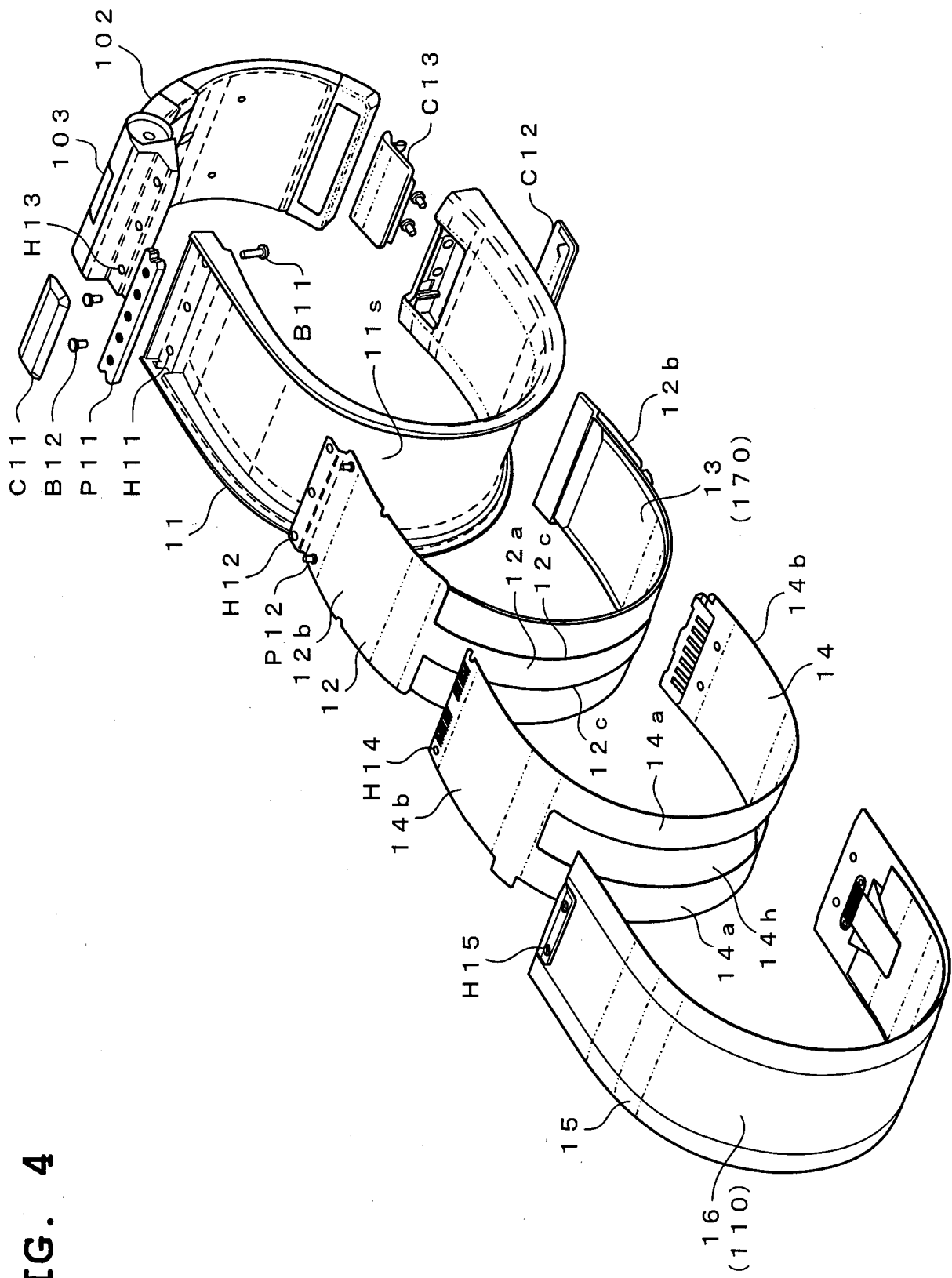
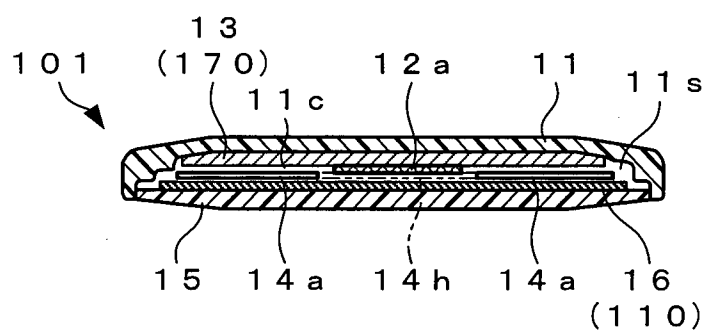


FIG. 5

V-V CROSS SECTION

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FIG. 6

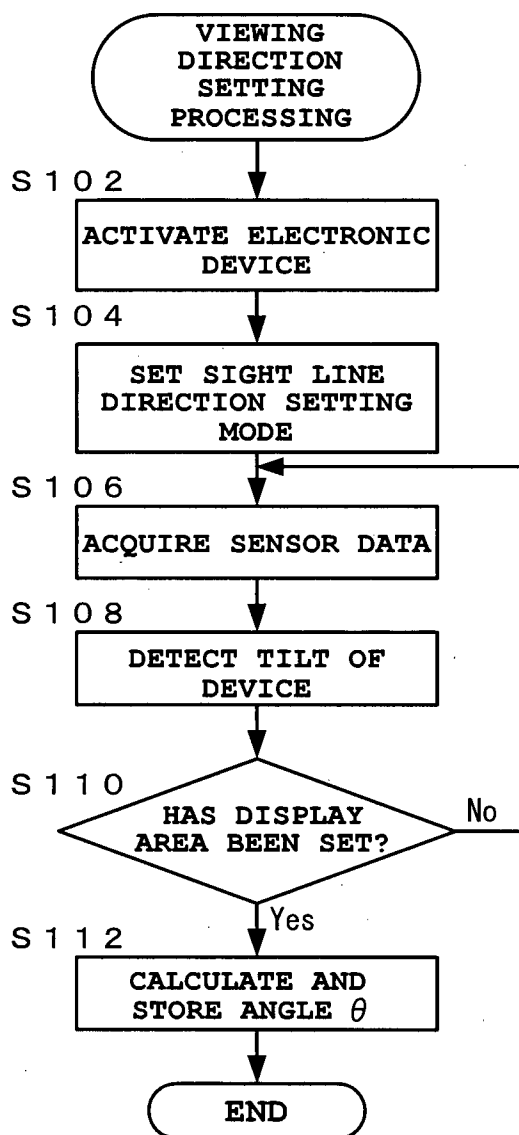


FIG. 7

THREE-DIMENSIONAL COORDINATE SYSTEM S 1

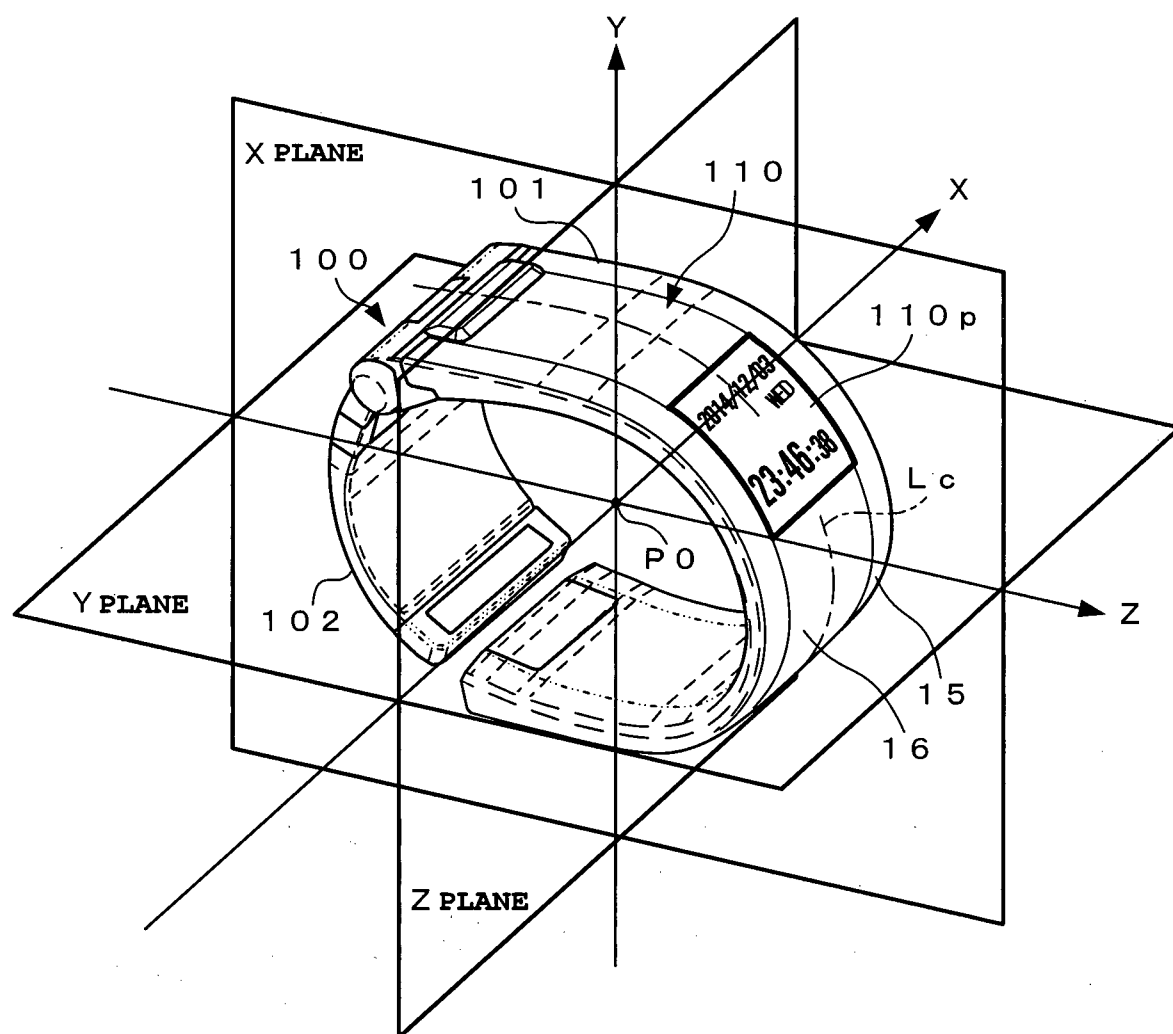
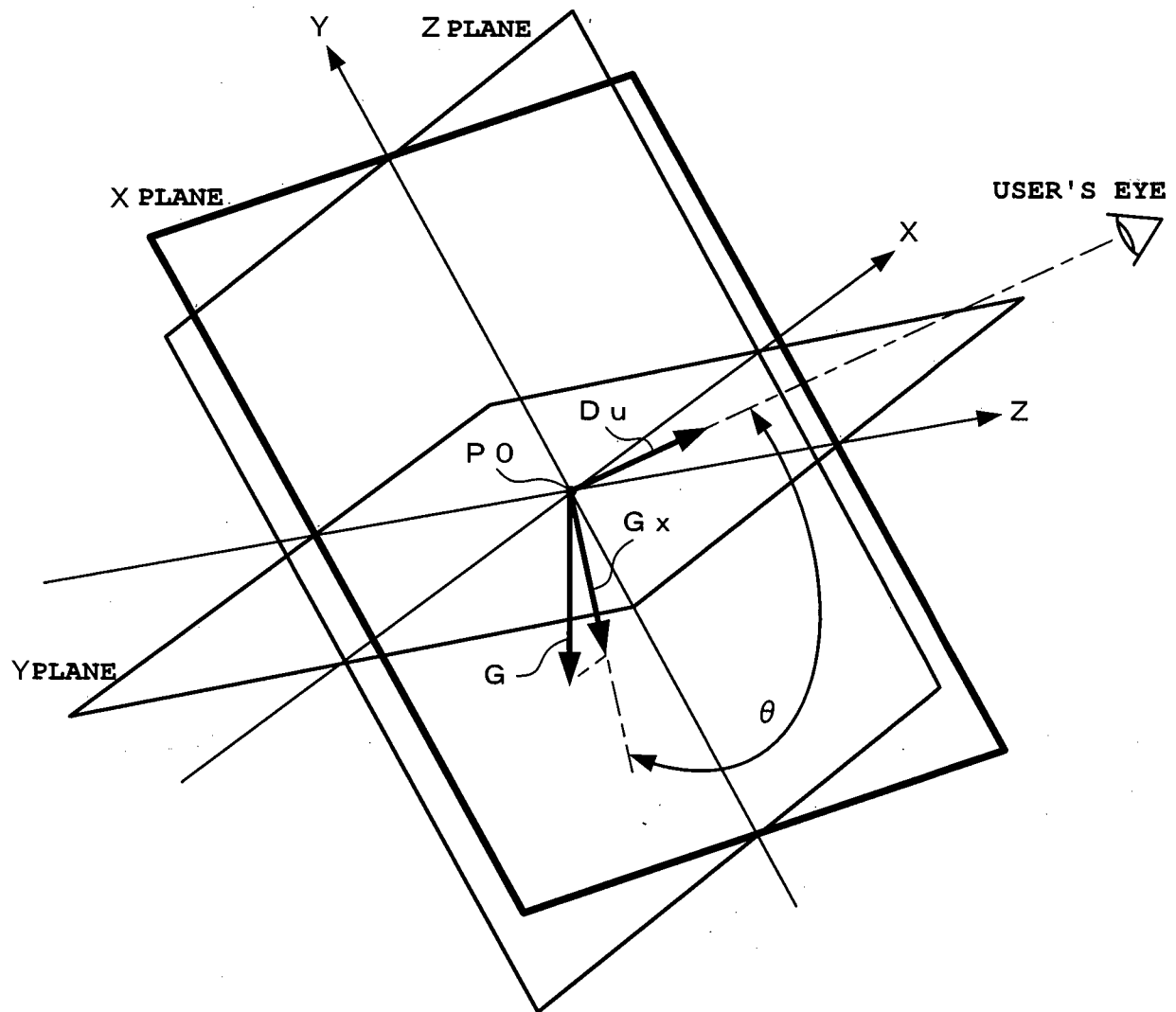
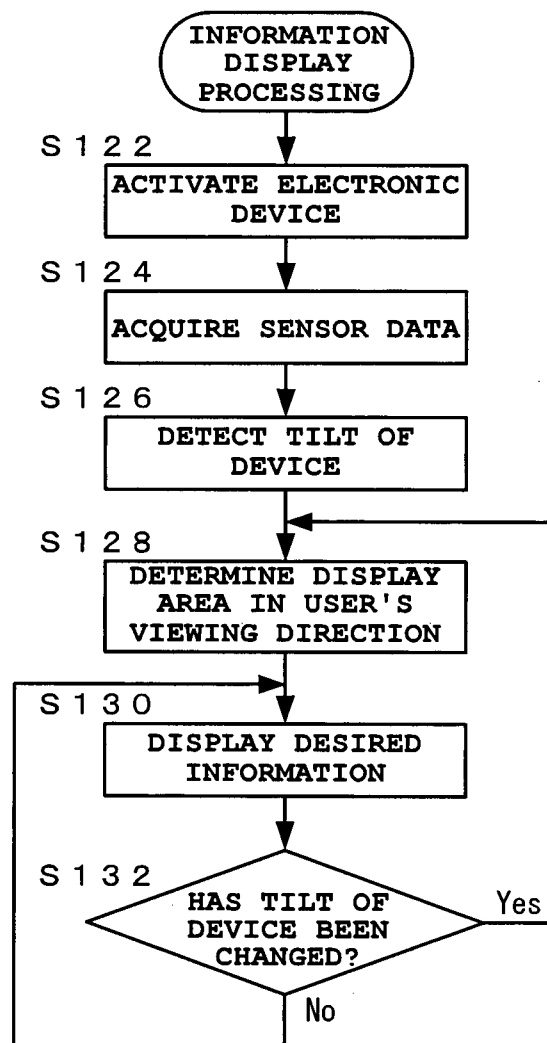


FIG. 8



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FIG. 9



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FIG. 10A

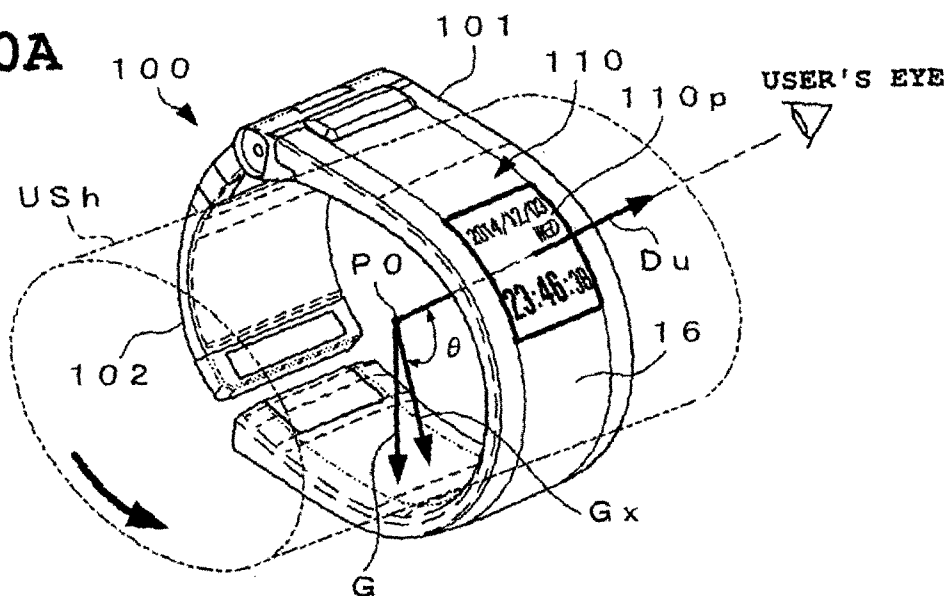


FIG. 10B

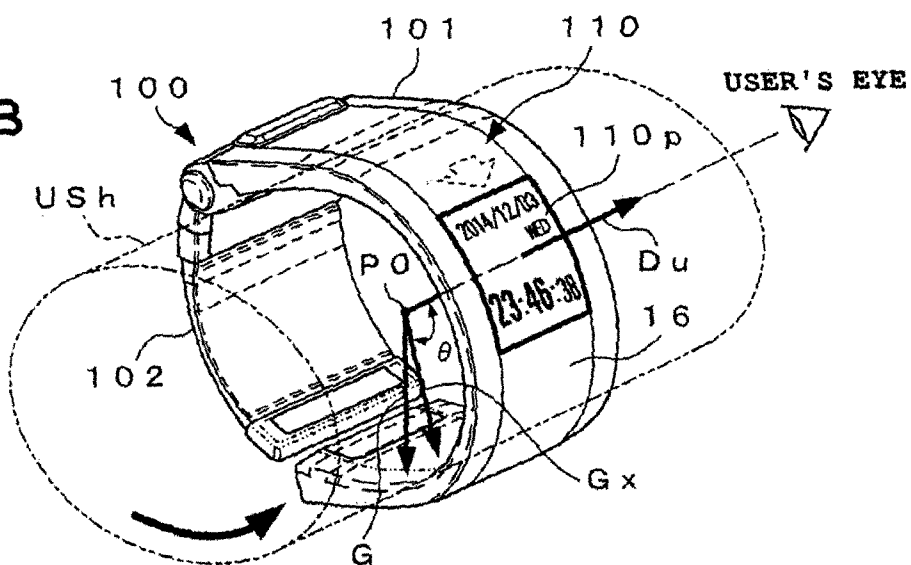
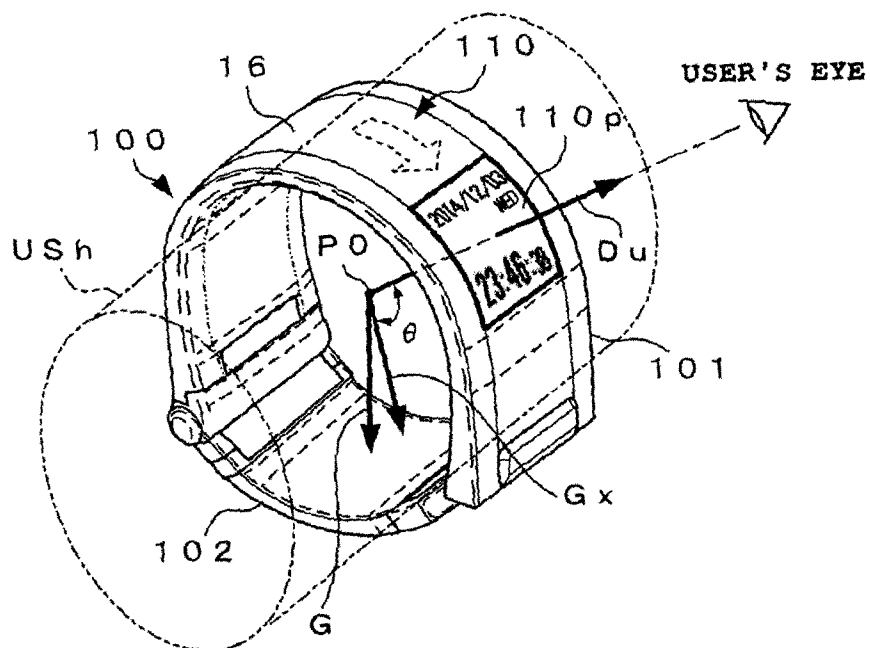
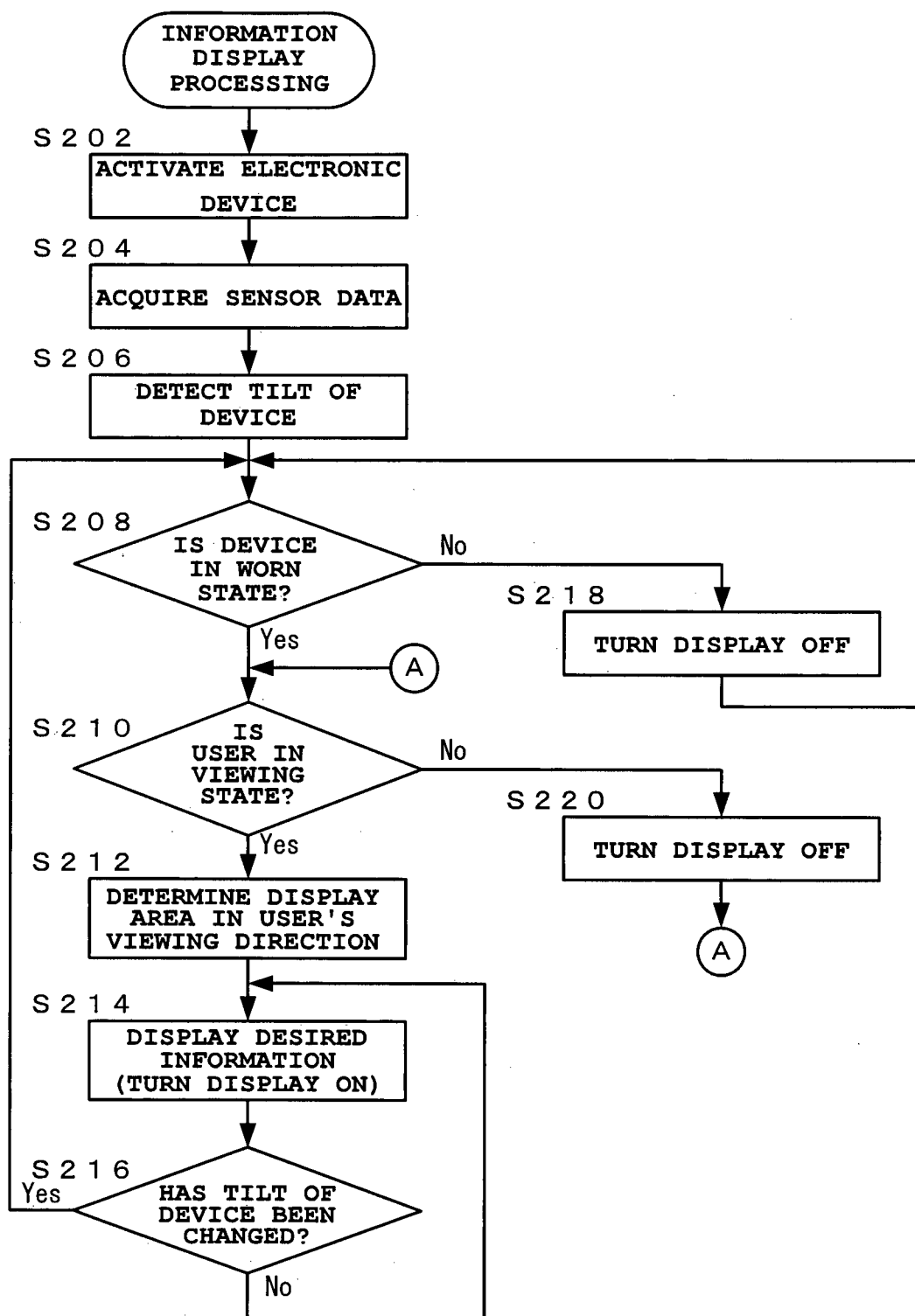


FIG. 10C



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FIG. 11



INTERNATIONAL SEARCH REPORT

International application No

PCT/JP2016/053600

A. CLASSIFICATION OF SUBJECT MATTER

INV. G04G17/04 G04G21/02
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

G04G G01F A61B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2010/029327 A1 (JEE HYUN HO [KR]) 4 February 2010 (2010-02-04)	1-3,5-8, 10-13,15
Y	paragraphs [0028], [0047] - [0058], [0068] - [0072], [0103] - [0105] figures 1-4,12 -----	4,9,14
X	EP 2 639 786 A1 (SAMSUNG ELECTRONICS CO LTD [KR]) 18 September 2013 (2013-09-18) paragraphs [0030] - [0049], [0057], [0058] figures 2,5,6,9 -----	1,2,6,7, 11,12
Y	US 2014/160078 A1 (SEO JOON-KYU [KR] ET AL) 12 June 2014 (2014-06-12) paragraphs [0116] - [0119], [0189] - [0197], [0380], [0381] figures 1-4,14,15,46 -----	4,9,14



Further documents are listed in the continuation of Box C.



See patent family annex.

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

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Date of the actual completion of the international search

24 May 2016

Date of mailing of the international search report

06/06/2016

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Authorized officer

Couteau, Olivier

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/JP2016/053600

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		WO 2014092437 A1	19-06-2014
