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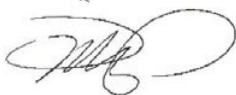
I served as Chief Examiner of the certified court interpreter test for the State of California and as a translator and interpreter for various federal agencies through the U.S. Department of State of for more than a decade. I served as an instructor at the University of California at Berkeley and the Middlebury Institute of International Studies at Monterey.

I have more than 30 years of experience translating thousands of technical, legal, and business submitted to, among others, Korean judicial authorities, various U.S. federal courts, the U.S. International Trade Commission (ITC), and the USPTO Patent Trial and Appeal Board (PTAB).

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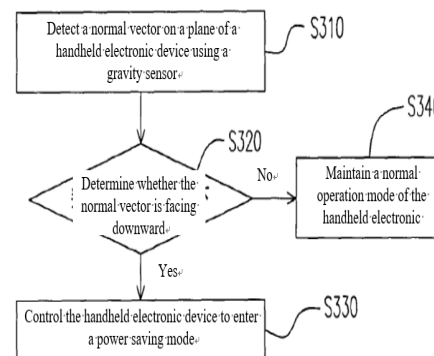
1 page of Claims, 5 pages of Specification, 4 pages of Attached Drawings

(54) Title of the Invention

POWER MANAGEMENT METHOD FOR HANDHELD ELECTRONIC DEVICE

(57) Abstract

The invention discloses a power management method for a handheld electronic device, which uses a gravity sensor (G-sensor) to detect the normal vector in the plane of the handheld electronic device and determine whether the normal vector is facing downward. In a power saving mode, the gravity sensor continues to detect the normal vector, and when the normal vector deviates from the downward direction, the handheld electronic device is controlled to return to a normal operation mode. Accordingly, according to a placement state of the device, the handheld electronic device is controlled in time to enter the power saving mode, without complicated procedures such as menu operations, etc., thus providing a more intuitive and convenient power management approach.



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1. A power management method for a handheld electronic device, comprising the steps of:
detecting a normal vector in a plane of the handheld electronic device using a gravity sensor;
determining whether the normal vector is facing downward; and
if the normal vector is facing downward, determining whether a state of the normal vector facing downward is maintained for more than a first specific time; and
when the state of the normal vector facing downward is maintained for more than the first specific time, controlling the handheld electronic device to enter a power saving mode.
2. The method according to claim 1, wherein the plane of the handheld electronic device is a plane containing a screen of the handheld electronic device when the handheld electronic device is placed horizontally.
3. The method according to claim 1, wherein the handheld electronic device is a flip handheld electronic device, and the plane of the handheld electronic device is an upper cover containing a screen of the handheld electronic device.
4. The method according to claim 1, wherein the normal vector comprises an x-component, a y-component and a z-component.
6. The method according to claim 4, wherein the step of determining whether the normal vector is facing downward comprises:
determining whether the z-component of the normal vector is negative and its x-component and y-component each falls in a specific range; and
when the z-component of the normal vector is negative and both its x-component and y-component fall within that specific range, determining that the normal vector is facing downward.
6. The method according to claim 4, wherein the step of determining whether the normal vector is facing downward comprises:
determining whether the z-component of the normal vector is negative and its x-component and y-component are both zero; and
when the z-component of this normal vector is negative and its x-component and y-component are both 0, determining that the normal vector is facing downward.
7. The method according to claim 1, characterized by further comprising:
continuing to detect the normal vector of the plane of the handheld electronic device;
determining whether the normal vector deviates from the downward-facing direction; and
if the normal vector deviates from the downward direction, controlling the handheld electronic device to return to a normal operation mode.
8. The method according to claim 7, wherein after the step of determining that the normal vector deviates from the downward direction, the method further comprises:
determining whether a state of the normal vector deviating from the downward direction is maintained for more than a second specific time; and
controlling the handheld electronic device to return to the normal operation mode when the state of the normal vector deviating from the downward direction is maintained for more than a second specific time.
9. The method according to claim 7, wherein the entry of the handheld electronic device to the power saving mode is controlled by an operating system of the handheld electronic device, and the return to the normal operation mode is controlled by an embedded controller of the handheld electronic device.
10. The method according to claim 1, wherein the power saving mode comprises one of a sleep mode and a hibernate mode.

POWER MANAGEMENT METHOD FOR HANDHELD ELECTRONIC DEVICE

Technical Field

[0001] The present invention relates to a power management method, and in particular, a power management method using a gravity sensor.

Background Art

[0002] With the rapid changes in technology, the functions provided by handheld electronic devices such as mobile phones, personal digital assistants and notebook computers tend to be diversified. In addition to basic functions such as calling, text messaging and note taking, the connection to the Internet for web page browsing and email sending and receiving has also become one of indispensable functions of handheld electronic devices. Various functions not only can bring people convenience in life, but also can be used as tools for leisure and entertainment at ordinary times, which makes handheld electronic devices become one of the most popular high-tech electronic products nowadays.

[0003] Handheld electronic devices are mostly used in outdoor locations, and in this situation where there is no external power supply, the power of the entire handheld electronic device can only be supplied by a battery installed in it. It can be seen that for handheld electronic devices, power management is the most important issue. How to implement the timely control of the handheld electronic device to enter a power saving mode according to an operation state of a user to thus improve the use efficiency of the battery extend the battery life is particularly critical for the power management.

[0004] However, for the current power saving function of the handheld electronic device, the user needs to preset a period of time, and the handheld electronic device will enter the power saving mode only when the user's operation on the handheld electronic device stops and the accumulated stop time exceeds the preset time. In this pattern, a state needs to be maintained for a period of time before the handheld electronic device enters the power saving mode, still consuming a lot of power. In addition to the above pattern of presetting a time, the user can also manually search for and enable the power saving mode through multiple menu selections when stopping using the handheld electronic device. However, this manual pattern not only wastes time, but also requires relatively complex operations that often make the user feel reluctant to perform, and in the end cannot achieve the power saving effect.

Summary of the Invention

[0005] In view of this, the present invention provides a power management method for a handheld electronic device that uses a gravity sensor (G-sensor) to detect a tilt state of the handheld electronic device to determine whether to enter a power saving mode and thus save power.

[0006] In order to achieve the above or other purposes, the present invention proposes a power management method for a handheld electronic device. First, the gravity sensor is used to detect a normal vector on a plane of the handheld electronic device, then it is determined whether the normal vector is facing downward, if the normal vector is facing downward, it is determined whether a state of the normal vector facing downward is maintained for more than a first specific time, and the handheld electronic device is controlled to enter the power saving mode when the state of the normal vector facing downward is maintained for more than the first specific time.

[0007] In the present invention, preferably the plane of the handheld electronic device is a plane containing a screen of the handheld electronic device when the handheld electronic device is placed horizontally.

[0008] In the present invention, preferably the normal vector includes an x-component, a y-component and a z-component. The step of determining whether the normal vector is downward facing includes determining whether the z-component of the normal vector is negative and the x-component and y-component of the normal vector both fall within a specific range. When the z-component of the normal

vector is negative and the x-component and y-component of the normal vector both fall within the specific range, the normal vector is determined to be facing downward.

[0009] In the present invention, preferably the above method also includes continuing to detect the normal vector on the plane of the handheld electronic device and determining whether the normal vector deviates from a downward direction, and if the normal vector deviates from the downward direction, the handheld electronic device is controlled to return to a normal operation mode.

[0010] In the present invention, preferably, after the step of determining that the normal vector deviates from the downward direction, the method also includes determining whether a state of the normal vector deviating from the downward direction is maintained for more than a second specific time, and when the state of the normal vector deviating from the downward direction is maintained for more than the second specific time, the handheld electronic device is controlled to return to the normal operation mode.

[0011] In the present invention, preferably an operating system of the handheld electronic device controls a process of the handheld electronic device entering the power saving mode, and an embedded controller of the handheld electronic device controls the returning to the normal operation mode.

[0012] In the present invention, preferably the power saving mode includes one of a sleep mode and a hibernate mode. The handheld electronic device includes one of a mobile phone, a smart phone, a personal digital assistant (PDA) phone, and an ultra-mobile personal computer (UMPC).

[0013] The invention determines whether a front side of the handheld electronic device is facing downward according to magnitudes of the normal vector on the front side of the handheld electronic device detected by the gravity sensor, so as to control the handheld electronic device to enter the power saving mode without the need to operate through the menu and other complicated procedures, but to provide a more intuitive and convenient way of power management.

[0014] In order to make the above and other purposes, features and advantages of the present invention more obvious and understandable, the following embodiments and preferable embodiments, in conjunction with the drawings, are described in detail as follows.

Brief Description of the Drawings

[0015] FIG. 1 is a block diagram of a handheld electronic device illustrated in accordance with an embodiment of the present invention.

[0016] FIG. 2 is a schematic diagram of a normal vector on a plane of the handheld electronic device illustrated in accordance with an embodiment of the present invention.

[0017] FIG. 3 is a flow chart diagram of a power management method for a handheld electronic device illustrated in accordance with an embodiment of the present invention.

[0018] FIG. 4 is a flow chart diagram of a power management method for a handheld electronic device illustrated in accordance with an embodiment of the present invention.

[0019] FIG. 5 is a flow chart diagram of a power management method for a handheld electronic device illustrated in accordance with an embodiment of the present invention.

Detailed Description

[0020] Usually when a user operates a handheld electronic device equipped with a screen, such as a bar handheld electronic device or a slide handheld electronic device, a front side (i.e., a side that includes the screen) of the device is facing upward. Even when the user stops operating the device and places it on a table or other object, the front side usually is also facing upward, unless the user does not want other people to see the contents on the screen of the device or wants to stop using the device indeed, he may place the device with the front side facing downward. In addition, if the device is a flip-up handheld electronic device, an upper cover portion provided with the screen is also facing upward or tilted upward when the user uses the device, and when the user wants to stop using the device, an upper cover provided with the screen is usually facing downward or closed to avoid other people to see the contents on the screen.

[0021] As can be seen from the above, when the device is placed with the front side facing downward

or the upper cover provided with the screen facing downward, it almost means that the user wants to stop using the device, and in this case if the device can be instantly brought into a power saving mode, an unnecessary power waste can be saved, thereby increasing a standby time of the handheld electronic device. The present invention is a power management method for a handheld electronic device developed on the basis of the above concept. In order to make the content of the present invention clearer, the following embodiments are given as examples of how the present invention can indeed be implemented accordingly. [0022] FIG. 1 is a block diagram of a handheld electronic device illustrated in accordance with an embodiment of the present invention. Referring to FIG. 1, the handheld electronic device 100 of this embodiment includes a system board 110, a screen 120, an embedded controller 130, a gravity sensor (G- sensor) 140, and an operating system 150. For example, the handheld electronic device 100 is a mobile phone, a smart phone, a touch phone, a personal digital assistant phone (PDA phone) or an ultra-mobile personal computer (Ultra-Mobile PC, UMPC), without limiting its scope.

[0023] This embodiment is primarily a handheld electronic device 100 equipped with a gravity sensor (G-sensor) 140 to detect a normal vector on a plane of the handheld electronic device 100. The plane, for example, is a plane containing the screen of the handheld electronic device placed horizontally, or an upper cover of a flip-up handheld electronic device that contains a screen thereof during use. FIG. 2 is a schematic diagram of the normal vector on the plane of the handheld electronic device illustrated in accordance with an embodiment of the present invention. Referring first to FIG. 2(a), which illustrates a situation where the handheld electronic device is placed with the front side facing upward, a plane 210 is the plane containing the screen, and the normal vector is a vector that is perpendicular to the plane 210 and facing toward a z-axis direction. Referring further to FIG. 2(b), which illustrates a schematic diagram of the handheld electronic device with the front side facing downward, the plane 210 is the plane containing the screen, and the normal vector is a vector that is perpendicular to the plane 210 and facing opposite the z-axis direction.

[0024] Detection data of the above normal vector is transmitted to the operating system 150 through the embedded controller 130 and the system board 110, and the operating system 150 analyzes and processes the data to decide whether to enable the power saving mode. In detail, when the operating system 150 determines that the normal vector is pointing downward, the operating system 150 controls the handheld electronic device to enter the power saving mode, so as to perform power saving actions such as turning off the screen 120; otherwise, a normal operation mode is maintained.

[0025] Once the power saving mode is enabled, the control of the handheld electronic device 100 is handed over to the embedded controller 130, and in this case the gravity sensor 140 continues to detect the normal vector on the plane of the handheld electronic device 100. When the normal vector deviates from an original downward direction, the embedded controller 130 controls the handheld electronic device back to the normal operation mode, and gives the control back to the operating system 150 for operation by the user. The following provides another embodiment to describe detailed steps of the power management method for the handheld electronic device 100.

[0026] FIG. 3 is a flow chart diagram of a power management method for a handheld electronic device illustrated in accordance with an embodiment of the present invention. Referring to FIG. 3, this embodiment is applicable to the handheld electronic device 100 of the preceding embodiment to bring the handheld electronic device to a power saving mode in a timely manner when a front side of the handheld electronic device or an upper cover provided with a screen is detected to be facing downward, in the following steps:

[0027] First, a normal vector on a plane of the handheld electronic device is detected using a gravity sensor (G-sensor) (step S310). The plane is a plane containing the screen of the handheld electronic device (the plane 200 as shown in FIG. 2) placed horizontally. The normal vector is transmitted to an operating system via an embedded controller and a system board for subsequent analysis and processing.

[0028] The operating system then determines whether the normal vector is facing downward (step S320). In detail, the normal vector on the plane of the handheld electronic device includes an x component, a y component and a z component. When the handheld electronic device is placed horizontally, the x component and the y component of the normal vector are both 0, and whether the normal vector is facing upward or downward may be determined according to a magnitude of the z component. In particular, when the operating system determines that the z component of the normal vector is negative, the normal vector may be determined to be facing downward.

[0029] Following the above description, if the normal vector is determined to be facing downward, the

operating system will further control the handheld electronic device to enter the power saving mode (step S330); otherwise, if the normal vector is determined to be not facing downward, the handheld electronic device maintains a normal operation mode (step S340). The above power saving mode includes a sleep mode or a hibernate mode, and the content of the power saving mode can be customized by the user according to his preferences or habits, the scope of which is not limited in this embodiment.

[0030] From the above, it can be seen that whether the handheld electronic device or the upper cover provided with the screen is placed to be facing downward can be determined according to magnitudes of the normal vector detected using the gravity sensor, so as to perform timely bringing of the handheld electronic device into the power saving mode, thereby saving power consumption. It is worth noting that in the determination of the direction of the normal vector of the handheld electronic device, different determination results may be obtained due to different placement angles or changes in the placement angle of the handheld electronic device carried by the user. The present invention provides respective solutions for both cases, with respective embodiments provided below for detailed description.

[0031] FIG. 4 is a flow chart diagram of a power management method for a handheld electronic device illustrated in accordance with an embodiment of the present invention. Referring to FIG. 4, this embodiment is also applicable to the handheld electronic device 100 of the preceding embodiment to bring the handheld electronic device into a power saving mode in a timely manner when a front side of the handheld electronic device or an upper cover provided with a screen is detected to be facing downward. In particular, unlike the preceding embodiment, this embodiment provides a buffer space to allow the handheld electronic device to achieve the same power saving effect when a normal vector on the front side is not facing downward, in the following steps:

[0032] First, the normal vector on a plane of the handheld electronic device is detected using a gravity sensor (step S410). The plane is a plane containing the screen of the handheld electronic device placed horizontally. The normal vector is transmitted to an operating system via an embedded controller and a system board for subsequent analysis and processing.

[0033] The operating system then determines whether the normal vector is facing downward. In detail, the normal vector on the plane of the handheld electronic device includes an x component, a y component and a z component. Generally, as long as the x component and y component of the normal vector are both 0 and the z component is negative, the normal vector can be determined to be facing downward. However, with an object placement habit of the user or difference of placement environments, the front side of the device may not necessarily be facing downward, causing the normal vector on the front side to include an x component or y component (i.e., the x component and/or the y component are not 0). Accordingly, in addition to determining whether the z component of the normal vector is negative, this embodiment also includes determining whether the x component and the y component of the normal vector fall within specific ranges respectively (step S420).

[0034] When the z component of the normal vector is negative and the x component and the y component both fall within specific ranges, the normal vector is determined to be facing downward, and in this case the operating system further controls the handheld electronic device to enter the power saving mode (step S430); otherwise, if the z component of the normal vector is not negative or the x component or the y component does not fall within the specific range, the handheld electronic device maintains the normal operation mode (step S440).

[0035] For example, referring to FIG. 2(b), which provides a specific range (as shown by a dashed line) for the normal vector, when the normal vector falls within the specific range, the normal vector may be determined to be pointing in a downward direction, and the handheld electronic device may be brought into the power saving mode accordingly.

[0036] For another example, in use of a flip-up handheld electronic device, if the upper cover provided with the screen is merely tilted downward slightly, the normal vector does not fall within the specific range, and therefore the flip-up handheld electronic device is not brought into the power saving mode.

[0037] Through the above method, even if the device is placed with the front side slightly deviating from the direct downward direction, it can still be determined that the user wants to stop using the device, and therefore the device is brought into the power saving mode. In addition, the present invention also provides a buffer time to determine whether the user wants to bring the device into the power saving mode indeed, rather than inadvertently leaving the front side of the device facing downward.

[0038] FIG. 5 is a flow chart diagram of a power management method for a handheld electronic device in accordance with an embodiment of the present invention. Referring to FIG. 5, the present embodiment

is also applicable to the handheld electronic device 100 of the preceding embodiment to bring the handheld electronic device into a power saving mode when a front side of the handheld electronic device is detected to be facing downward. Unlike the preceding embodiment, this embodiment provides a buffer time, so that after the handheld electronic device is determined to be facing downward and maintained for a specific period of time, it is determined that the user wants to temporarily turn off the device, and therefore the device is controlled to enter the power saving mode, in the following steps:

[0039] First, a normal vector on a plane of the handheld electronic device is detected using a gravity sensor (step S510). The plane is a plane containing a screen of the handheld electronic device placed horizontally. The normal vector is transmitted to an operating system via an embedded controller and a system board for subsequent analysis and processing.

[0040] The operating system then determines whether the normal vector is facing downward (step S520). Detailed steps for determining whether the normal vector is facing downward are the same as or similar to those in the preceding embodiments, which are not repeated here.

[0041] When the normal vector is determined to be facing downward, it is further determined whether a downward state of the normal vector is maintained for a first specific time (step S530). When the normal vector is facing downward and maintained for a time more than the first specific time, the handheld electronic device is controlled to enter the power saving mode (step S540); otherwise, if the normal vector deviates from a downward direction before being maintained for the specific time, the handheld electronic device is not brought into the power saving mode, and is maintained in a normal operation mode (step S550).

[0042] It is worth mentioning that this embodiment also includes a step of turning on the device when the user wants to use the device again after the device enters the power saving mode. After the device enters the power saving mode, the control of the device is handed over to the embedded controller, and in this case the gravity sensor of the device continues to detect the normal vector on the plane of the handheld electronic device. Data of the detected normal vector is transmitted to the embedded controller, and the embedded controller analyzes the data to determine whether the normal vector deviates from the downward direction (step S560). If the normal vector deviates from the downward direction, the embedded controller further determines whether the normal vector deviates from the downward direction for a time more than a second specific time (step S570), and only when the normal vector deviates from the downward direction for the time more than the second specific time, the embedded controller controls the handheld electronic device to return to the normal operation mode (step S580). In addition, if the normal vector is determined to not deviate from the downward direction or the time of deviation from the downward direction does not exceed the specific time, the handheld electronic device is maintained in the power saving mode (step S590).

[0043] In summary, the power management method for the handheld electronic device of the present invention determines whether to enable the power saving mode by detecting a placement angle of the handheld electronic device, and when the front side of the handheld electronic device is facing downward, determines that the user stops using, so as to introduce the power saving mode in a timely manner to save power. Correspondingly, when the front side of the handheld electronic device deviates from the downward direction, it means that the user wants to use the device again, and the device returns to the normal operation mode. As such, a more intuitive and convenient way of power management is provided.

[0044] Although the present invention has been revealed as above with the preferable embodiments, it is not intended to limit the present invention, and anyone skilled in the art may make some changes and modifications without departing from the spirit and scope of the present invention, so that the scope of protection of the present invention shall be as defined by the claims.

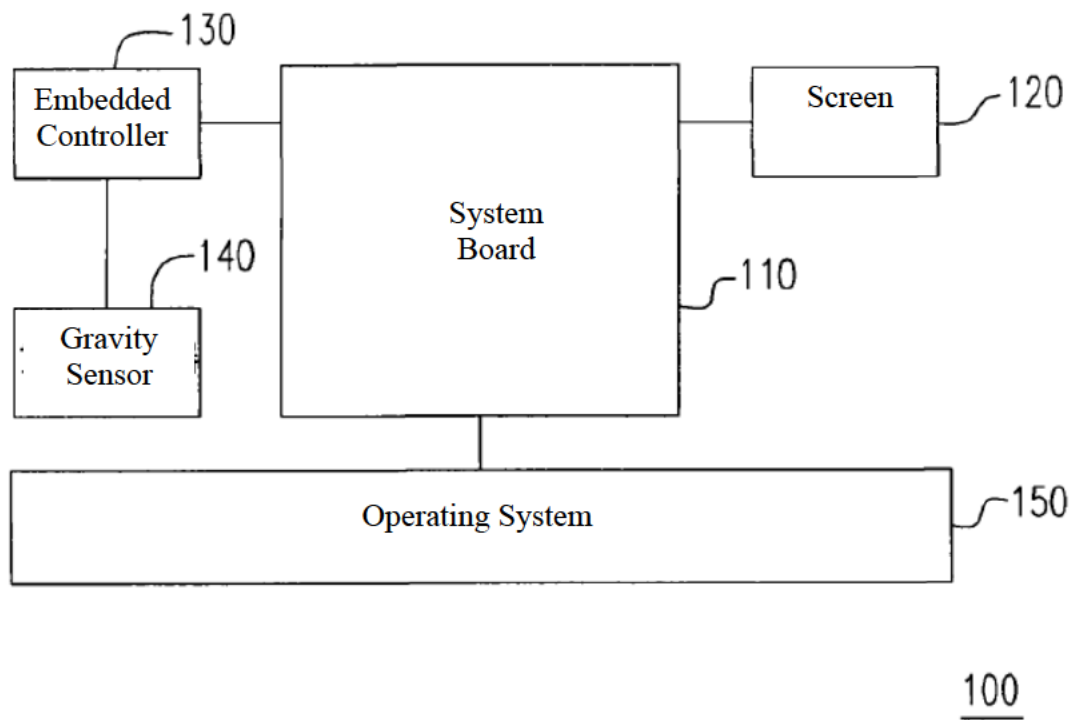


FIG. 1

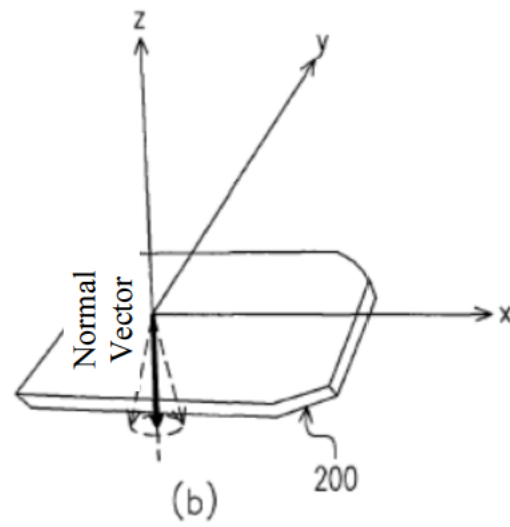
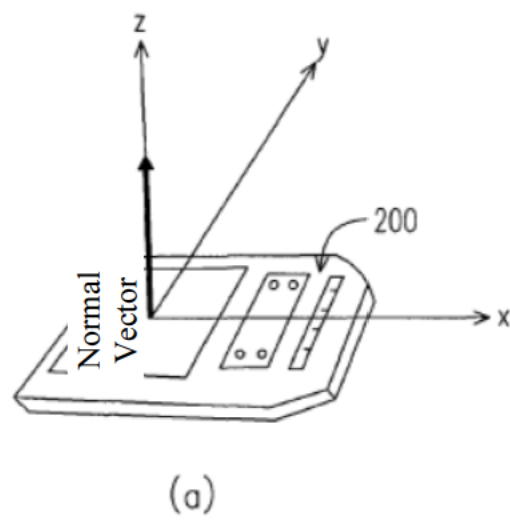


FIG. 2

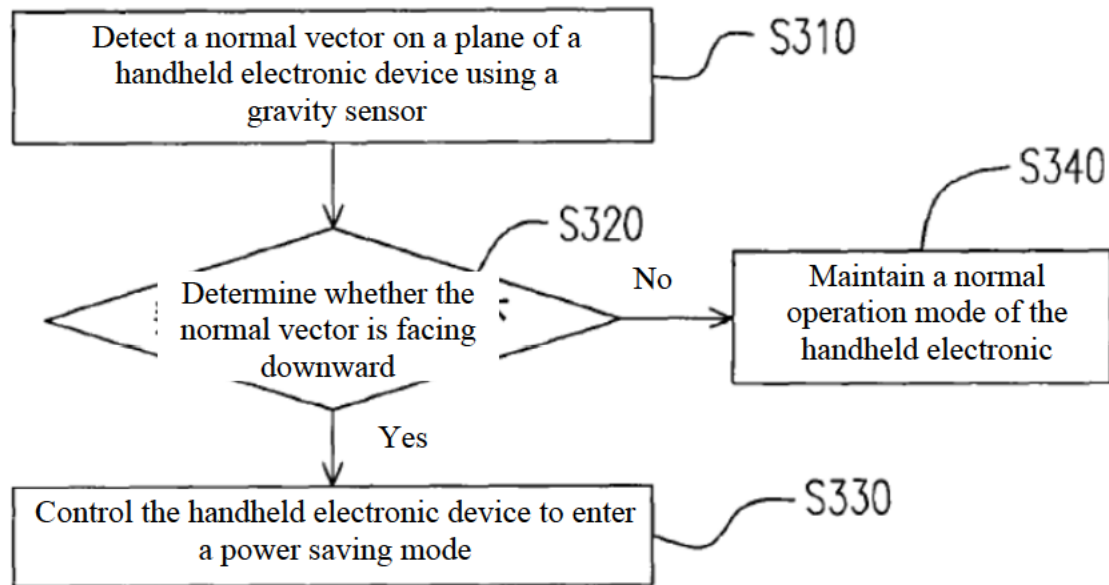


FIG. 3

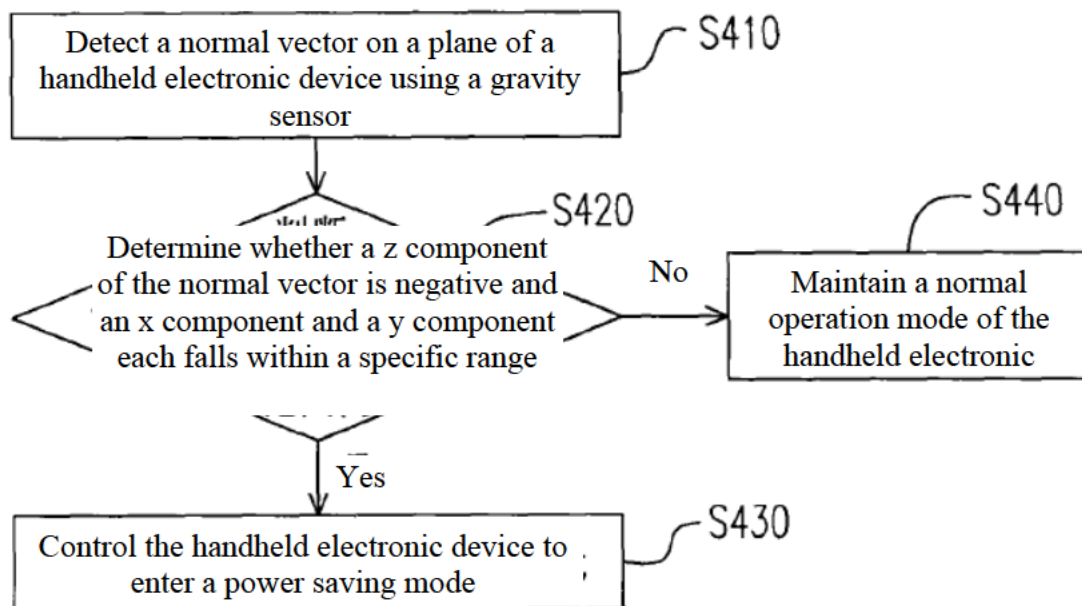


FIG. 4

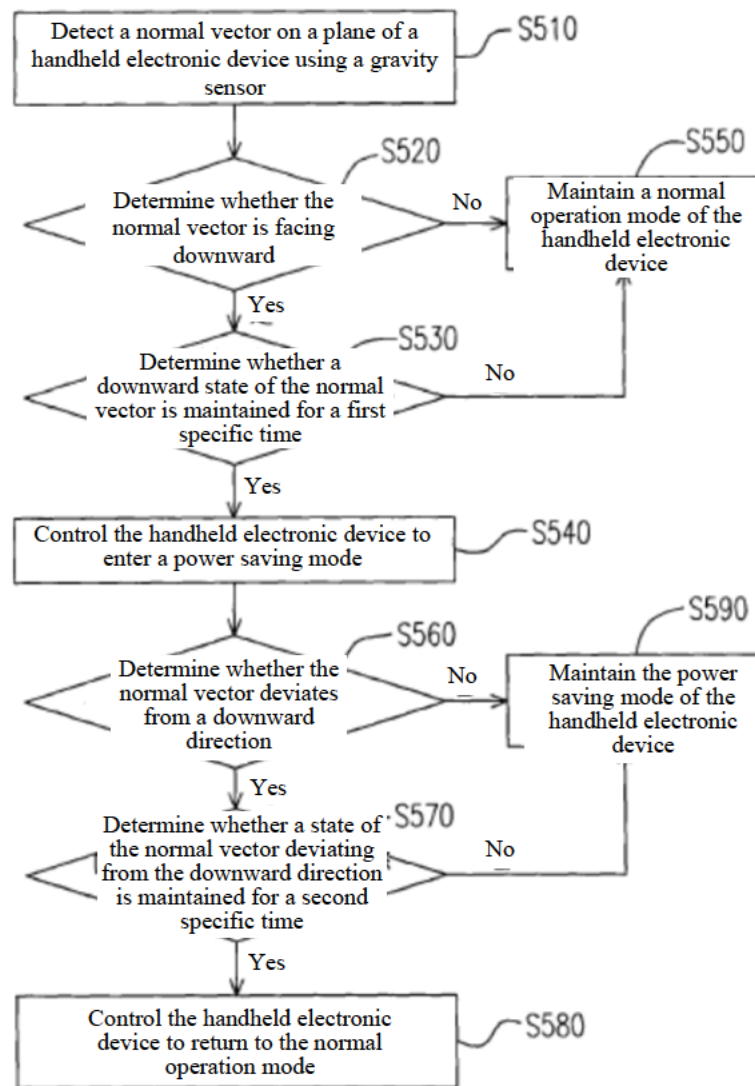


FIG. 5