



(19) **United States**
(12) **Reissued Patent**
Orchard et al.

(10) **Patent Number:** **US RE43,587 E**
(45) **Date of Reissued Patent:** **Aug. 14, 2012**

(54) **METHOD AND APPARATUS FOR CONTROLLING A COMPUTING SYSTEM**

(75) Inventors: **John T. Orchard**, Palo Alto, CA (US);
Christopher R. Uhlik, Danville, CA (US)

(73) Assignee: **Durham Logistics LLC**, Las Vegas, NV (US)

(21) Appl. No.: **13/102,951**

(22) Filed: **May 6, 2011**

Related U.S. Patent Documents

Reissue of:

(64) Patent No.: **6,834,249**
Issued: **Dec. 21, 2004**
Appl. No.: **09/823,221**
Filed: **Mar. 29, 2001**

(51) **Int. Cl.**
G06F 15/00 (2006.01)

(52) **U.S. Cl.** **702/141**

(58) **Field of Classification Search** **702/141**
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,214,485	A	7/1980	Berger et al.
5,128,655	A	7/1992	Shore
5,602,566	A	2/1997	Motosyuku
5,797,105	A	8/1998	Nakaya et al.
6,025,830	A	2/2000	Cohen
6,112,141	A	8/2000	Briffe et al.
6,201,544	B1	3/2001	Ezaki
6,201,554	B1	3/2001	Lands
6,242,743	B1	6/2001	DeVito et al.
6,300,933	B1	10/2001	Nagasaki
6,347,290	B1	2/2002	Bartlett
6,357,939	B1	3/2002	Baron

6,369,794	B1	4/2002	Sakurai et al.
6,375,572	B1	4/2002	Masuyama
6,385,351	B1	5/2002	Simske et al.
6,396,497	B1	5/2002	Reichlen
6,411,275	B1	6/2002	Hedberg
6,466,198	B1	10/2002	Feinstein
6,567,101	B1	5/2003	Thomas
6,621,928	B1 *	9/2003	Inagaki et al. 382/199
6,690,358	B2	2/2004	Kaplan
6,834,249	B2	12/2004	Orchard

(Continued)

FOREIGN PATENT DOCUMENTS

JP 9081305 3/1997

(Continued)

OTHER PUBLICATIONS

Ken Hinckley, "Paper: Sensing Techniques for Mobile Interaction". Nov. 5, 2000. [online], [retrieved on Feb. 3, 2012], <http://kenhinckley.wordpress.com/2000/11/05/paper-sensing-techniques-for-mobile-interaction/>.*

(Continued)

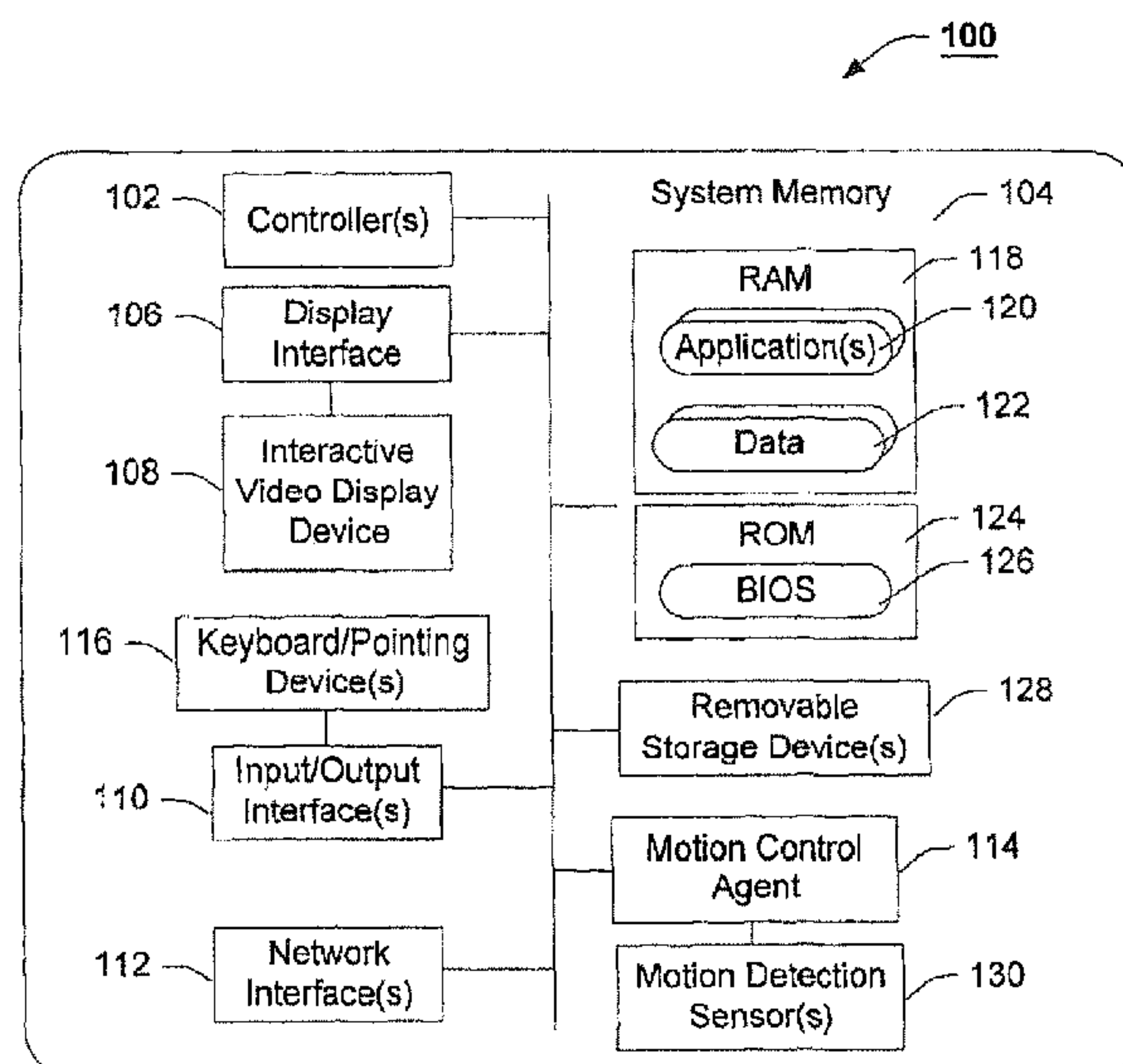
Primary Examiner — Tung S Lau

(74) *Attorney, Agent, or Firm* — Stolowitz Ford Cowger LLP

(57) **ABSTRACT**

A handheld computing device is introduced comprising a motion detection sensor(s) and a motion control agent. The motion detection sensor(s) detect motion of the computing device in one or more of six (6) fields of motion and generate an indication of such motion. The motion control agent, responsive to the indications of motion received from the motion sensors, generate control signals to modify one or more of the operating state and/or the displayed content of the computing device based, at least in part, on the received indications.

26 Claims, 7 Drawing Sheets



U.S. PATENT DOCUMENTS

7,184,020	B2	2/2007	Matsui
7,271,795	B2	9/2007	Bradski
2004/0169636	A1	9/2004	Park et al.
2006/0161379	A1	7/2006	Ellenby
2007/0139373	A1	6/2007	Simon
2011/0136511	A1	6/2011	Patoskie

FOREIGN PATENT DOCUMENTS

WO	9507526	3/1995
WO	9814863	4/1998
WO	9918495	4/1999
WO	9932960	7/1999
WO	07132055	11/2007
WO	09104088	8/2009

OTHER PUBLICATIONS

Analog Devices; Analog Devices Introduces the World's Smallest and Least Expensive Micromachined Tilt/Motion Sensor, PR Newswire, Jun. 12, 2000.

David Small et al.; Design of Spatially Aware Graspable Displays,; CHI '97 extended abstracts on Human factors in computing systems, Mar. 1997, pp. 367-368.

Vesa-Matti Mantyla et al.; Hand gesture recognition of a mobile device user, IEEE International Conference on Multimedia and Expo, vol. 1, 2000, pp. 281-284.

C. Verplaetse; Inertial proprioceptive devices: Self-motion-sensing toys and tools, IBM Systems Journal, vol. 35, Nos. 3 & 4, 1996, pp. 639-650.

Analog Devices Inc.; MEMS sets new portable apps in motion, Electronic Engineering Times, Jun. 19, 2000, p. 162.

Ashok Bindra; Miniature MEMS Accelerometer Adds Motion Sensing to Consumer Products, Electronic Design, vol. 48, No. 13, Jun. 2000, p. 45.

Joel Bartlett; Rock 'n' Scroll is here to stay, IEEE Computer Graphics and Applications, vol. 20, No. 3, May 2000, pp. 40-45.

Ken Hinckley et al.; Sensing Techniques for Mobile Interaction, Proceedings of the 13th annual ACM symposium on User interface software and technology, 2000, pp. 91-100.

George Fitzmaurice; Situated Information Spaces and Spatially Aware Palmtop Computers, Communications of the ACM, vol. 36, No. 7, Jul. 1993, pp. 39-49.

Beverly Harrison et al.; Squeeze Me, Hold Me, Tilt Me! An Exploration of Manipulative User Interfaces, Proceedings of the SIGCHI conference on Human factors in computing systems, 1998, pp. 17-24.

George Fitzmaurice et al.; The Chameleon: Spatially Aware Palmtop Computers, Conference companion on Human factors in computing systems, 1994, pp. 451-452.

Jun Rekimoto; Tilting Operations for Small Screen Interfaces, Proceedings of the 9th annual ACM symposium on User interface software and technology, 1996, pp. 167-168.

Stolowitz Ford Cowger LLP; Related Case Listing; Apr. 26, 2011; 1 page.

* cited by examiner

FIG. 1

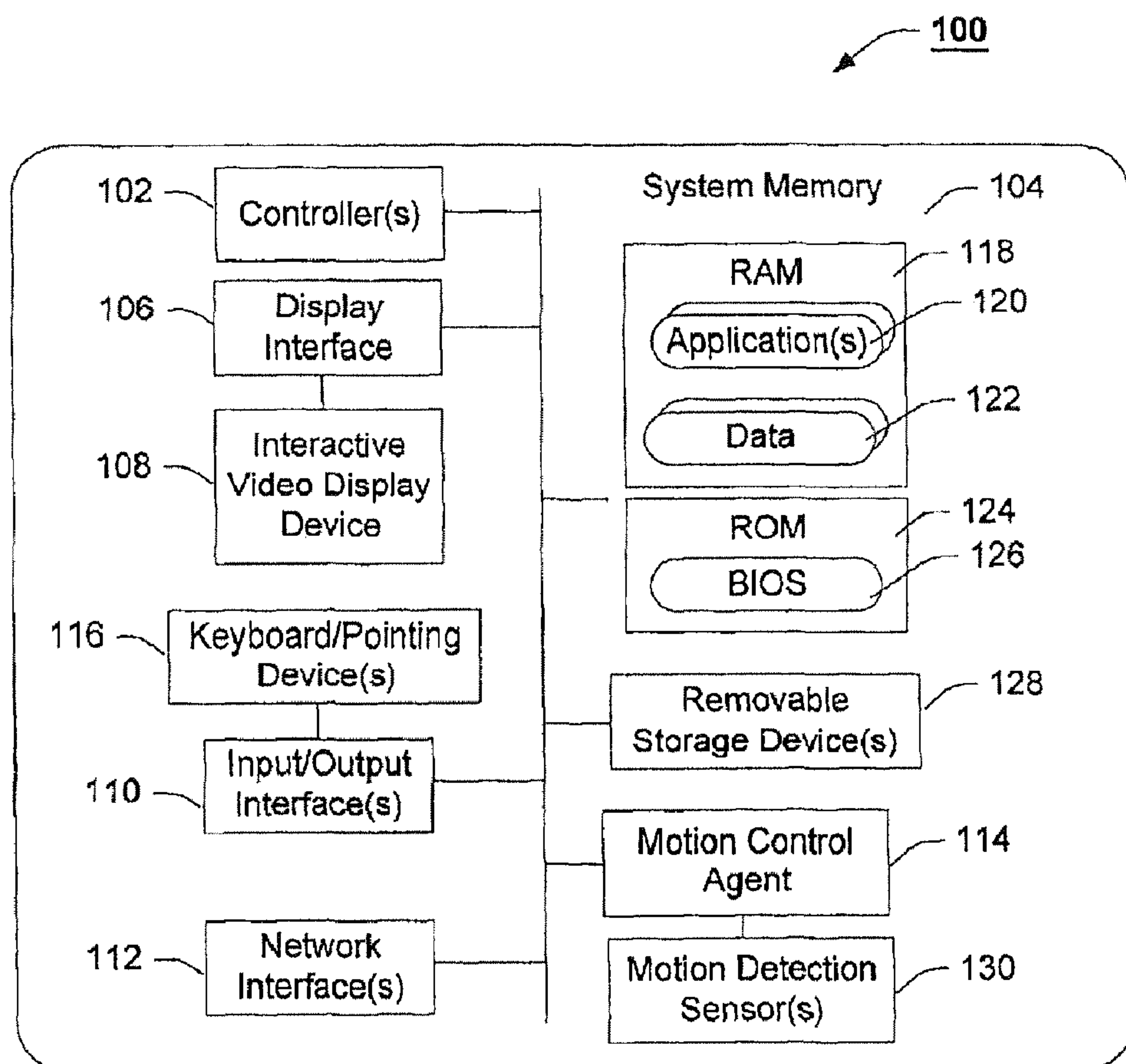


FIG. 2

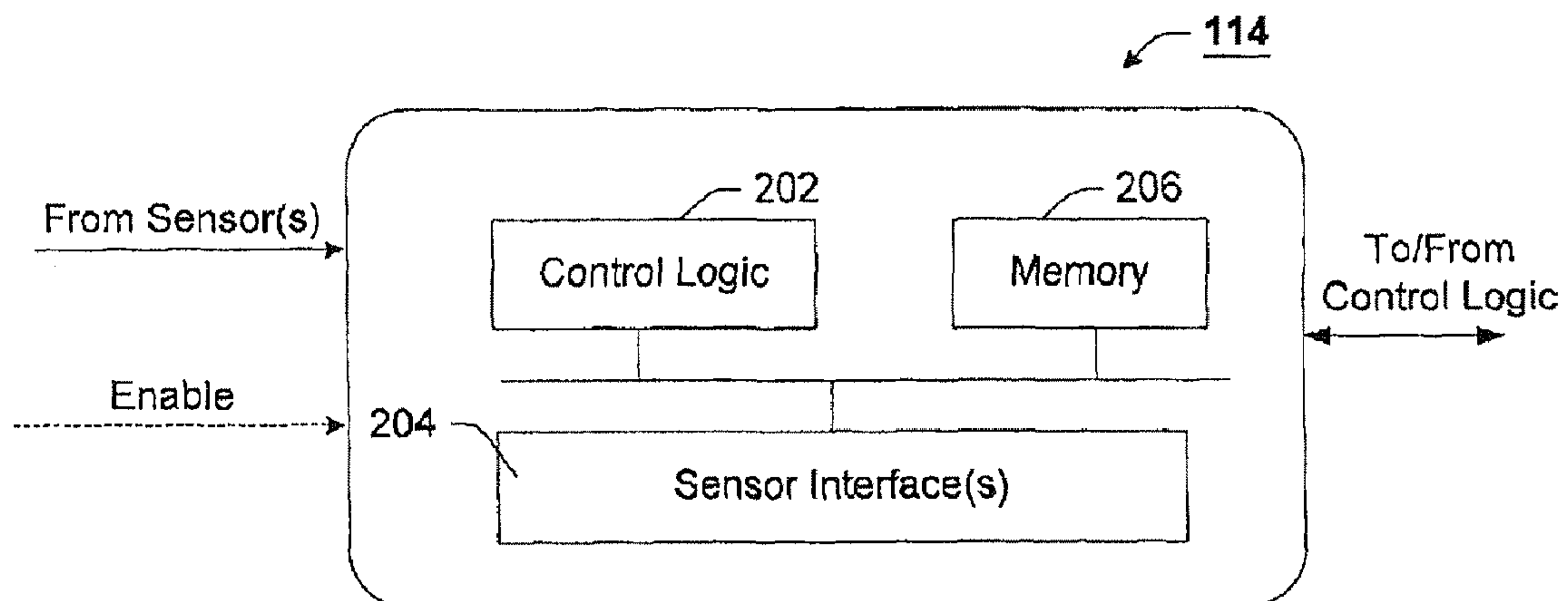


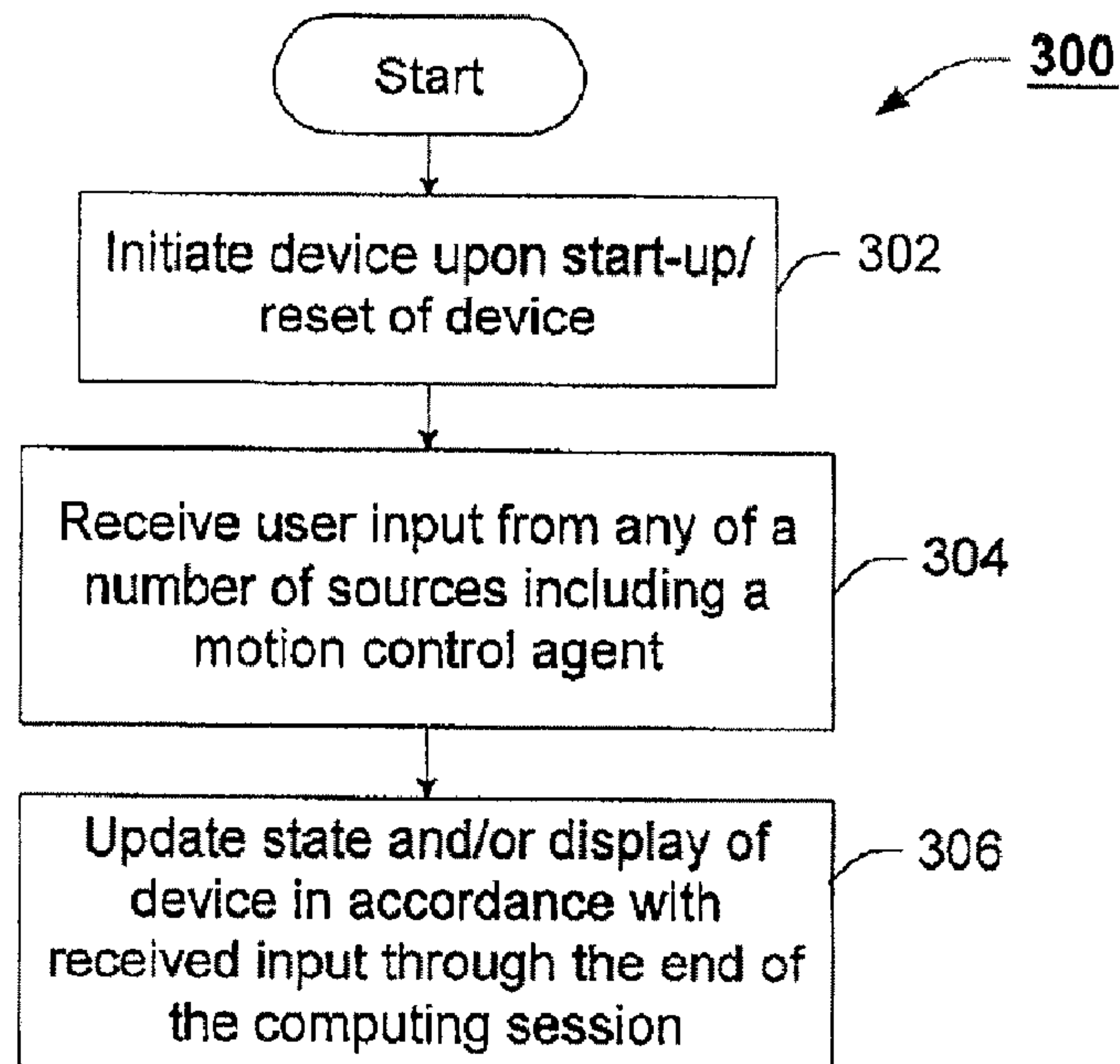
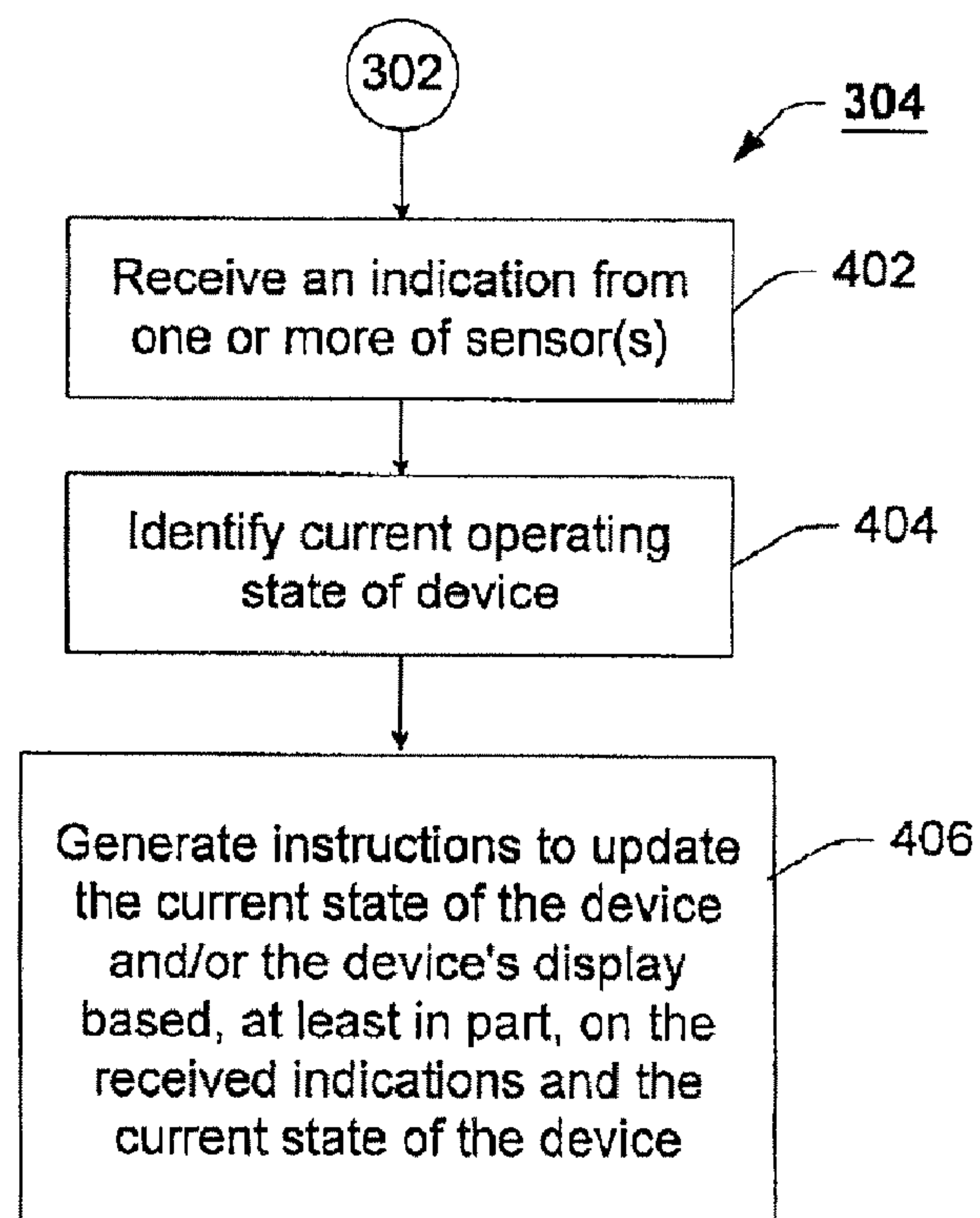
FIG. 3**FIG. 4**

FIG. 5

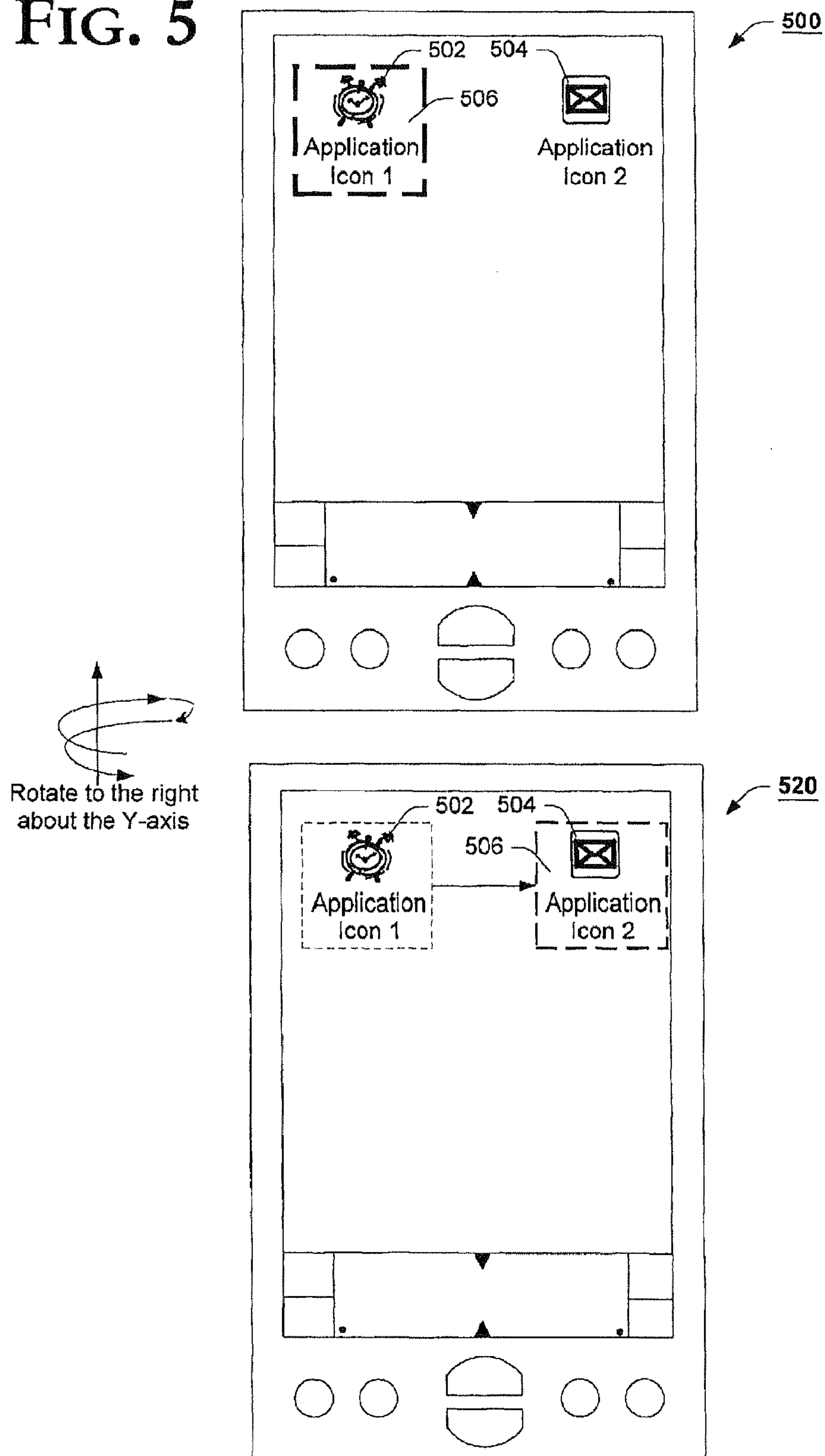


FIG. 6

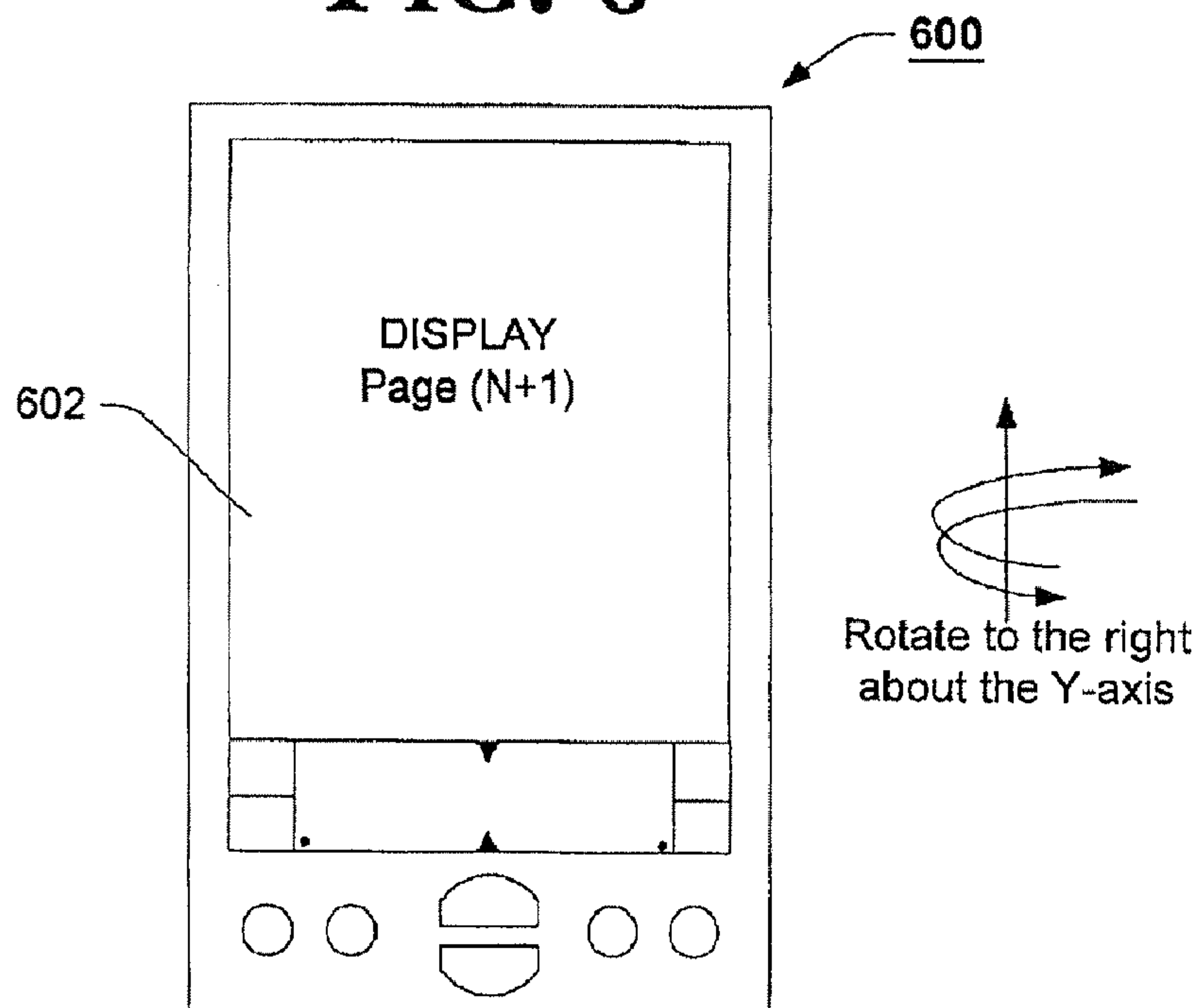


FIG. 7

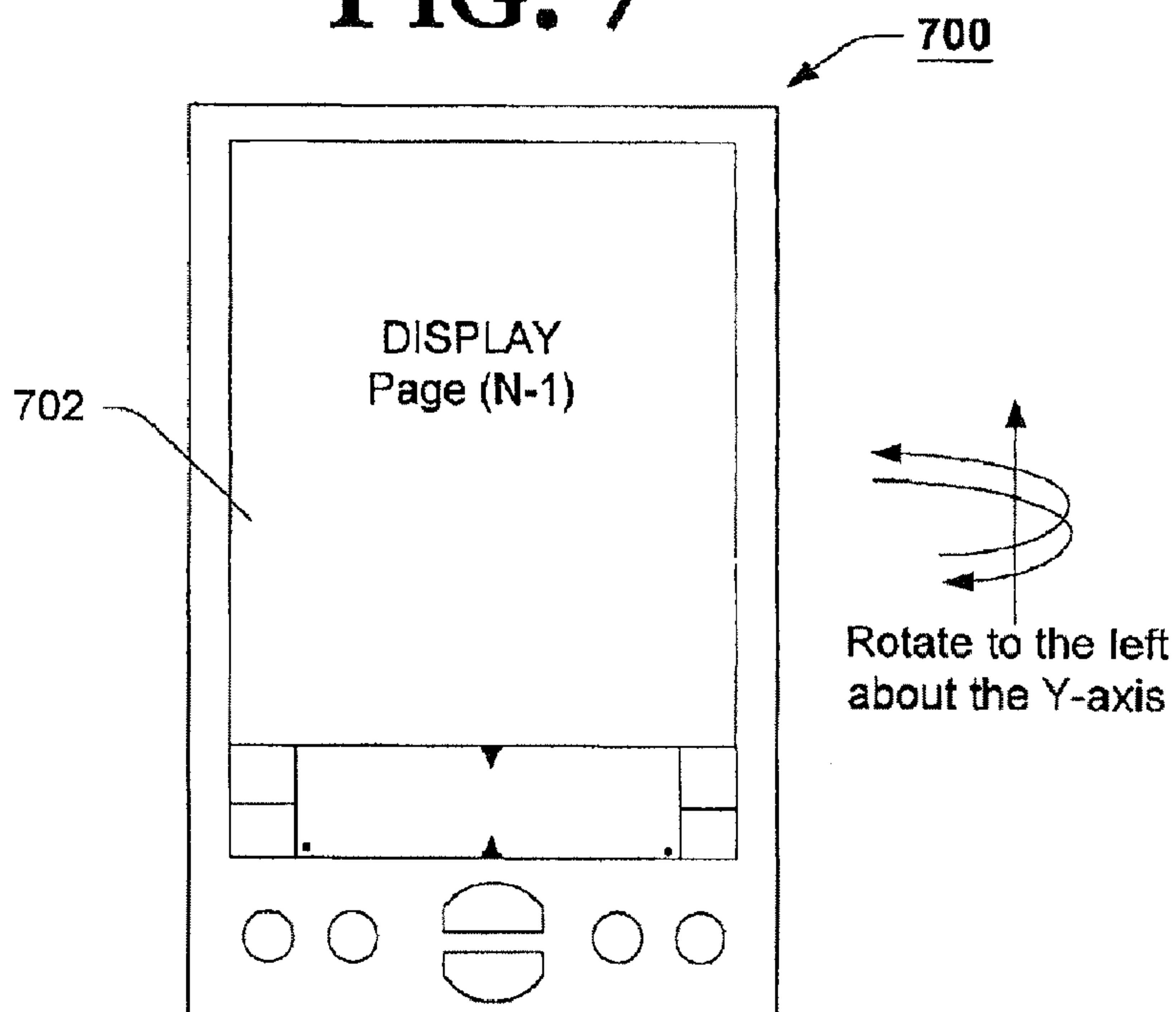


FIG. 8

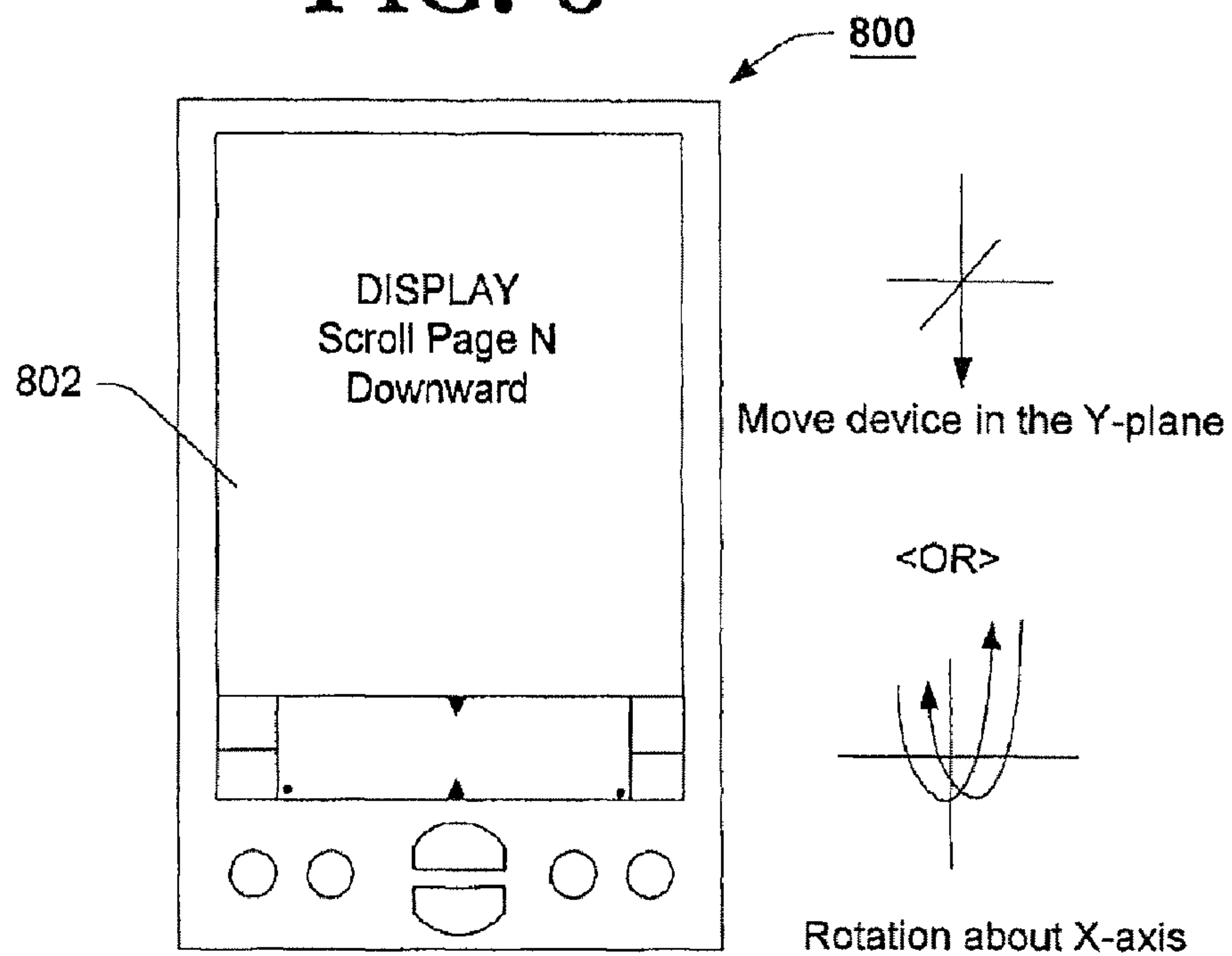


FIG. 9

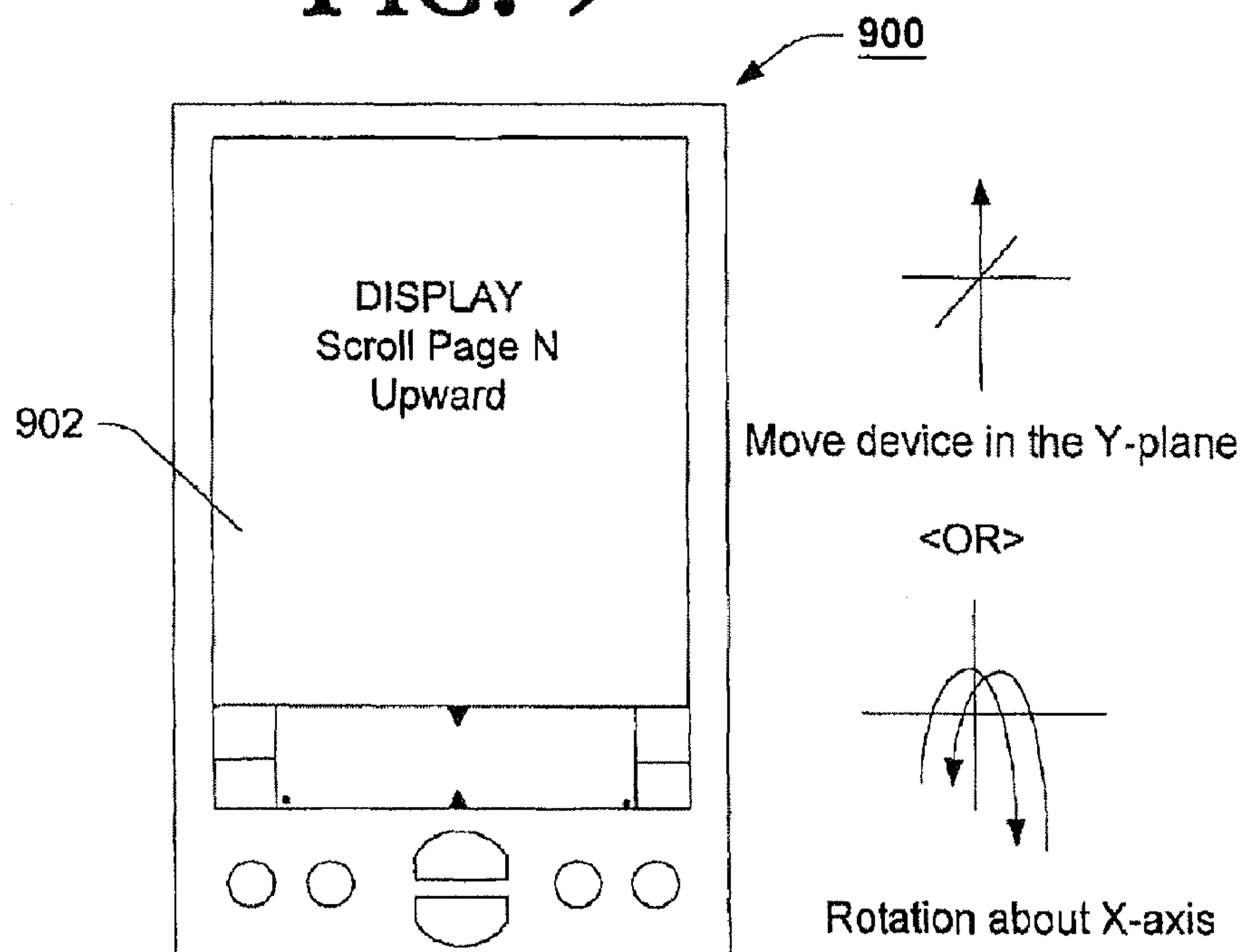


FIG. 10

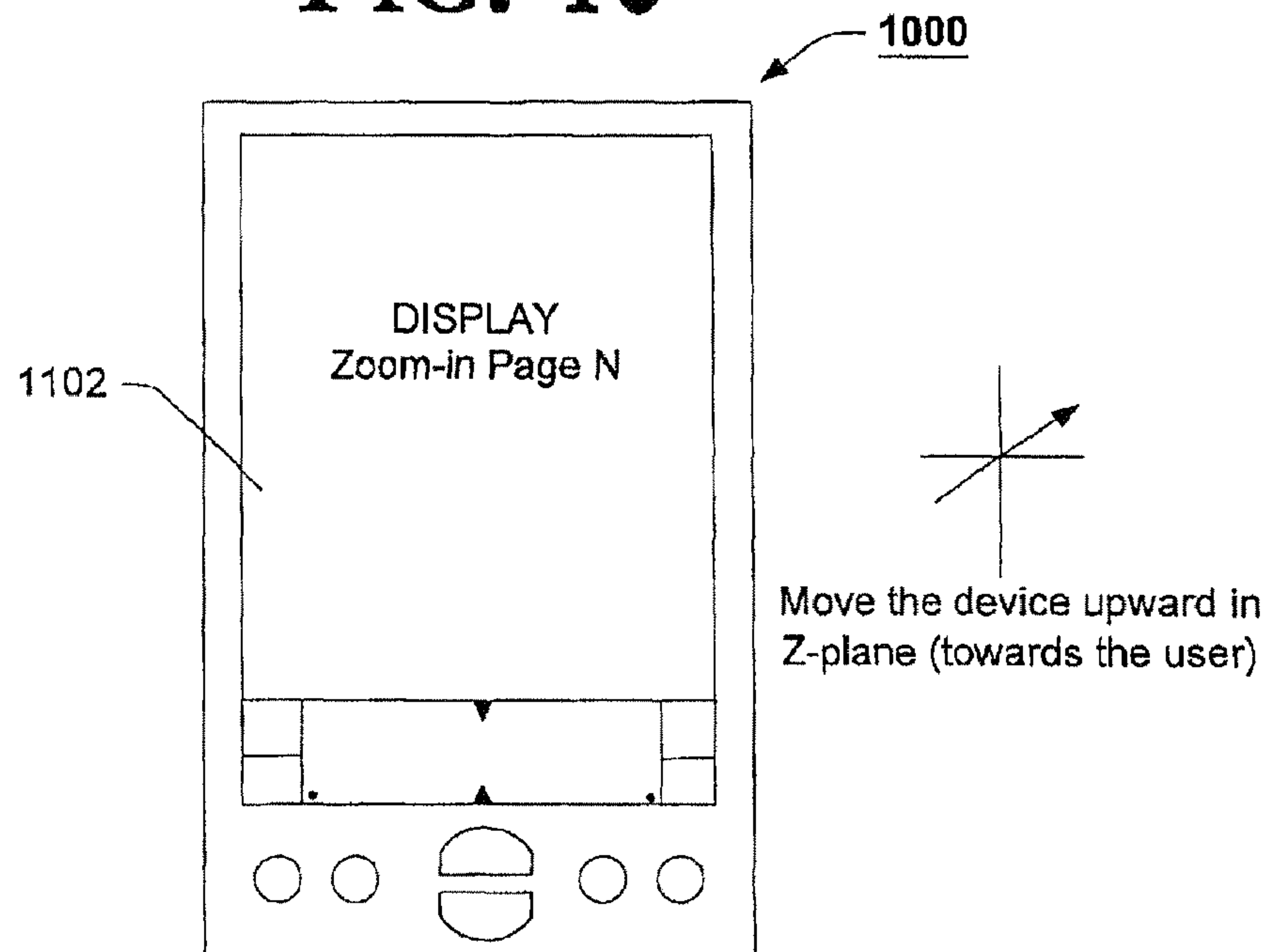


FIG. 11

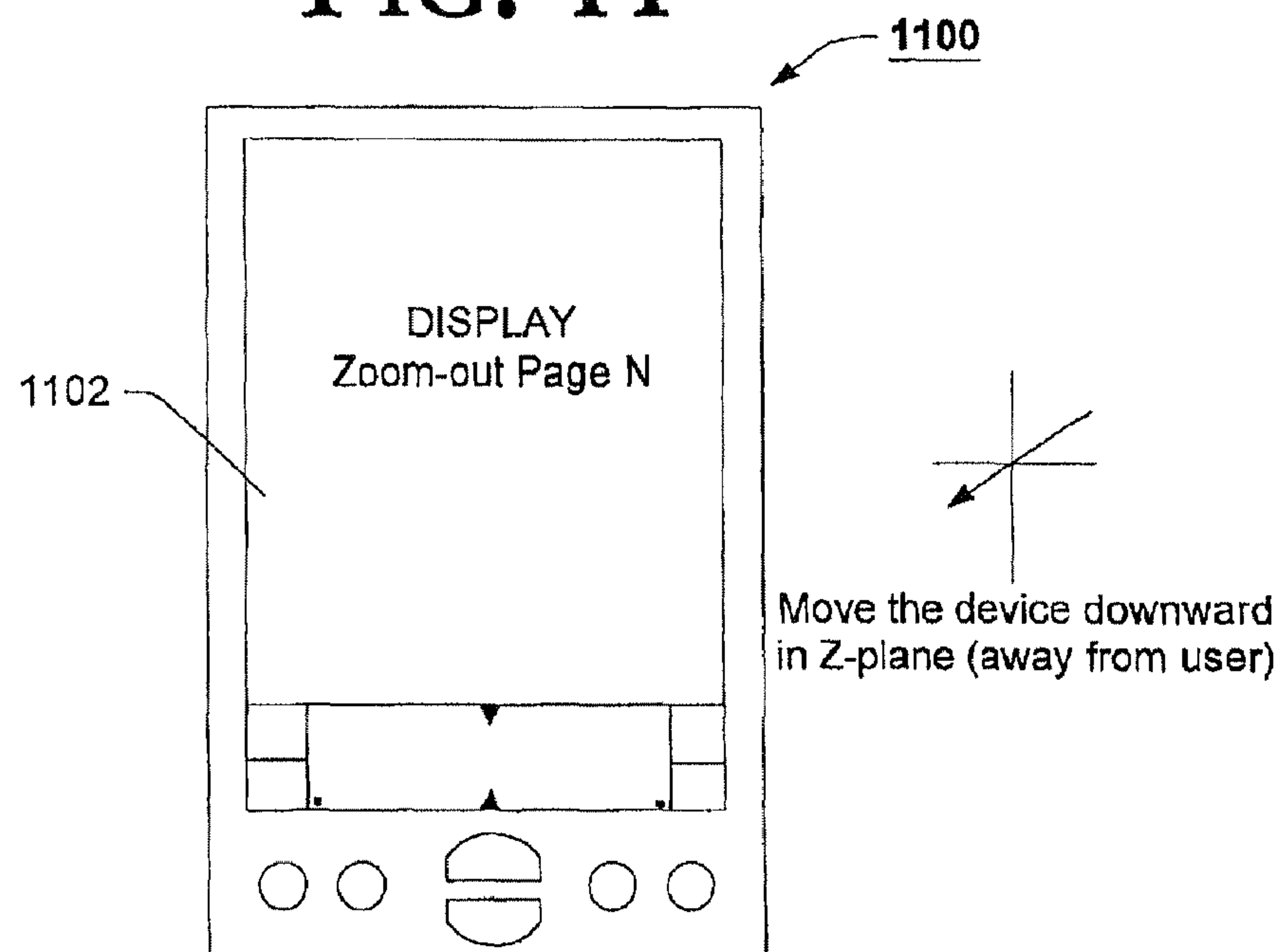
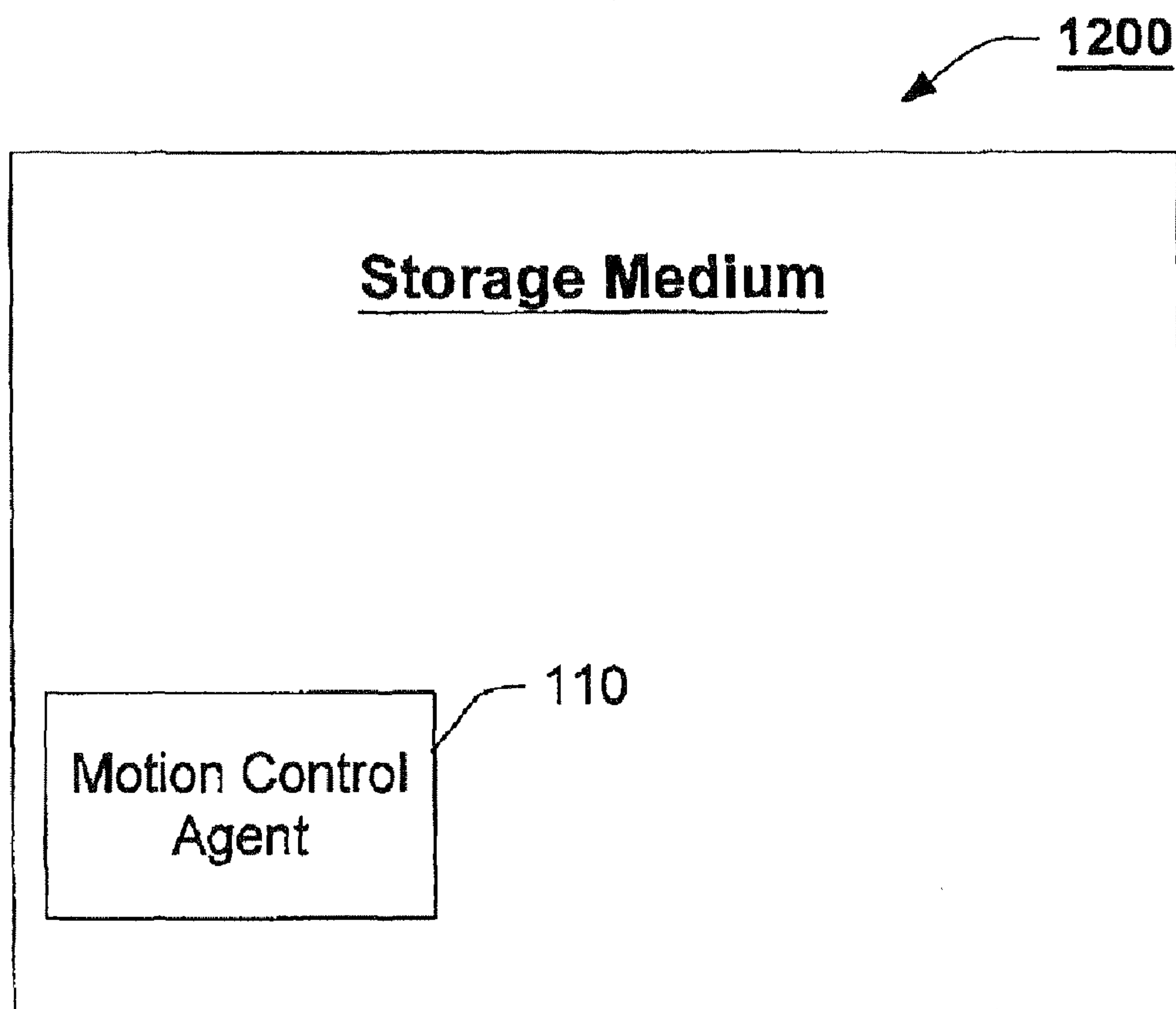


FIG. 12



METHOD AND APPARATUS FOR CONTROLLING A COMPUTING SYSTEM

Matter enclosed in heavy brackets [] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

TECHNICAL FIELD

This invention generally relates to the field of user interfaces and, more particularly, to a method and apparatus for controlling a computing device.

BACKGROUND

Recent advances in computing power and related technology have fostered the development of a new generation of powerful software applications. Gaming applications, communications applications, and multimedia applications have all benefited from increased processing power and clocking speeds. Despite these recent advances, however, the user interface for most computing systems dates back nearly thirty (30) years, i.e., utilizing a keyboard and pointing device to interface with and control certain aspects of the computing environment. These user interface devices are often cumbersome and non-intuitive at best, and may well lead to repetitive motion injuries and are unusable by a significant population of potential computer users at worst. While inconvenient and non-enabling in a desktop environment, such conventional user interface devices may well be dangerous in a mobile, handheld environment.

Despite these problems, many of the conventional mobile computing platforms, e.g., personal digital assistants (PDA), electronic books (or, eBooks), portable communication devices (cell phones, pagers, and the like), portable gaming appliances, and the like inherited similar user interface devices. That is, these mobile computing devices typically rely upon manual buttons, touchscreens, trackpads, trackballs and other traditional pointing devices to control the state of the device and/or the display of content generated by an application. As in the case of the desktop systems, these user interface devices are typically cumbersome to varying degrees as they often require two hands to operate (e.g., touchscreens, trackpads, and trackballs), or do not provide a simple way to control the state of an application and/or the display of content generated within an application.

Thus, a method and apparatus for controlling a computing system is presented, unencumbered by the deficiencies and limitations commonly associated with the prior art.

SUMMARY

A method and apparatus for controlling a computing system is presented. In accordance with a first embodiment of the present invention, a handheld computing device is introduced comprising a motion detection sensor(s) and a motion control agent. The motion detection sensor(s) detect motion of the computing device in one or more of six (6) fields of motion and generate an indication of such motion. The motion control agent, responsive to the indications of motion received from the motion sensors, generate control signals to modify one or more of the operating state and/or the displayed content of the computing device based, at least in part, on the received indications.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention is illustrated by way of example, and not necessarily by way of limitation in the figures of the accompanying drawings in which like reference numerals refer to similar elements.

FIG. 1 is a block diagram of a computing system including a motion control agent, according to one example embodiment of the present invention;

FIG. 2 is a block diagram of an example motion control interface, according to one embodiment of the present invention;

FIG. 3 illustrates a flow chart of an example method facilitating user control of a computing system, in accordance with the teachings of the present invention;

FIG. 4 depicts a flow chart of an example method for controlling a computing system by physically manipulating the computing system, in accordance with one example embodiment of the present invention;

FIG. 5 graphically illustrates control of an operating system (OS) graphical user interface (GUI) to control the state of a computing system using motion control, in accordance with one aspect of the present invention;

FIGS. 6-11 graphically illustrate motion control of the computing system's display of content associated with an executing application, in accordance with another aspect of the present invention; and

FIG. 12 is a graphical illustration of an example storage medium including instructions which, when executed, implement a motion control interface in a computing system.

DETAILED DESCRIPTION

This invention concerns a method and apparatus for controlling the display of a computing system. According to one aspect of the present invention, personal computing devices are provisioned with a motion control agent which, in response to input from one or more motion detection sensor(s) coupled to the motion control agent, issues display control commands to a display control device. Those skilled in the art will appreciate that the introduction of the innovative motion control agent into such computing devices as, for example, a personal digital assistant (PDA), an electronic book (eBook) appliance, personal communication devices, portable gaming devices and the like enables a user to intuitively control the state and/or displayed content of a computing device without the conventional need of pressing button(s), or manipulating a trackpad, trackball, etc. In this regard, the motion control agent represents a new paradigm in user control of computing systems.

Reference throughout this specification to "one embodiment" or "an embodiment" means that a particular feature, structure or characteristic described in connection with the embodiment is included in at least one embodiment of the present invention. Thus, appearances of the phrases "in one embodiment" or "in an embodiment" in various places throughout this specification are not necessarily all referring to the same embodiment. Furthermore, the particular features, structures or characteristics may be combined in any suitable manner in one or more embodiments.

Example Computing System

FIG. 1 illustrates a block diagram of an example computing system within which the teachings of the present invention may be practiced, in accordance with one example embodiment of the present invention. In accordance with the illustrated example embodiment of FIG. 1, a computing system 100 is depicted comprising one or more controller(s) 102,

system memory **104**, a display interface **106**, a video display device **108**, input/output (I/O) interface(s) **110**, network interface(s) **112** and an innovative motion control agent **114** responsive to one or more motion detection sensor(s) **116**, each coupled as shown. In addition to the foregoing, computing system **100** is depicted comprising mass storage device(s) **128** and one or more conventional keyboard/pointing devices **130**, each coupled as depicted. In accordance with the teachings of the present invention, to be developed more fully below, motion control agent **114** generates control signals to control one or more of the operational state and/or the display content of the computing device based, at least in part, on indication(s) of motion received from the one or more motion detection sensor(s) **116**. In this regard, a user of computing device **100** can intuitively control the operating state and/or display content of the computing device without resorting to the conventional I/O means of a keyboard and/or pointing device(s) (**130**) such as a touchpad, trackball, and the like.

As shown, system memory **104** is depicted comprising computer readable medium including a volatile memory such as random access memory (RAM) **118**, and a nonvolatile memory such as read-only memory (ROM) **124**. RAM **118** is depicted comprising applications **120** and/or data that are immediately accessible to and/or available for operation on by control logic, e.g., controller(s) **102**. ROM **124** is depicted comprising a basic input/output system (BIOS) **126** comprising a rudimentary set of routines that help to transfer information between elements within computing device **100** prior to execution of an operating system, e.g., during start-up or reset periods.

Controller(s) **102** implements an operating system (e.g., within applications **120**) and selectively executes other applications **102** in response to user interaction with the computing device. In accordance with one aspect of the present invention, in addition to conventional means of control, controller **102** is responsive to control signals generated by motion control agent **114** to control the operational state and/or display content of the computing device **100**. But for its interaction with motion control agent **114**, controller **102** is intended to represent any of a wide variety of control logic means known in the art such as, for example, a microprocessor, a special purposes controller, a general purpose controller, an application specific integrated circuit (ASIC), a programmable logic device (PLD), a field-programmable gate array (FPGA), and the like.

Input/output (I/O) interface(s) **110** enable input and output devices to interact with the computing device **100** in general, and controllers within the computing device in particular. As shown, I/O interface(s) **110** is coupled to conventional keyboard/pointing devices **130** to receive user input from such devices and generate control signals for use by the controller(s) **102** in response to user interaction with the devices. Similarly, motion control agent **114** generates control signals for use by the controller(s) **102** in response to user interaction with (i.e., movement of) the computing device. According to one implementation, motion control agent **114** is integrated within I/O interface(s) **110**, wherein the motion detection sensor(s) **116** provide indications of motion to the I/O interface(s) **110**, which generates control signals to interact with controller(s) **102**. But for such interaction with, or integration of, motion control agent **114**, I/O interfaces **110** are intended to represent a wide variety of such interfaces known in the art such as, for example, a Universal Serial Bus (USB) interface, a Personal Computing Interface (PCI) bus

interface, a serial bus interface, a parallel bus interface, an infrared interface, a radio frequency (RF) interface, and the like.

As used herein, but for their interaction with motion control agent **114**, each of the display interface **106** and associated display device **108**, network interface(s) **112**, mass storage device(s) **128** and conventional user I/O devices **130** are each intended to represent such elements as they are commonly known in the art.

Motion control agent **114**, as introduced above and will be developed more fully below, generates control signals to controller(s) **102** to modify an operational state and/or display content of the computing device **100** in response to user interaction with the computing device **100**. More particularly, motion control agent **114** issues such control signals in response to indications received from one or more motion detection sensor(s) **116**. The motion detection sensor(s) **116** the physical movement of the computing device **100** in one or more of six (6) fields of motion, i.e., in each of the x-, y- or z-planes, as well as rotational motion about each of the x-, y-, or z-axes. In accordance with one example implementation, when an indication of rotational movement is detected from one or more of the sensor(s) **116**, an indication of a complementary motion is required before the motion control agent **114** issues a control signal. In this regard, motion control agent **114** facilitates rotational control of the computing device, while providing the user with the opportunity to return the device to a proper viewing position after the rotational control.

In accordance with one implementation, motion control agent **114** identifies a current operating state of the computing device, e.g., whether the operating system or another application has operational control over the display **108** of the computing device **100**, and generates control signals in accordance with the operational state and the received indication(s) of motion. That is, the motion control signal generated by motion control agent **114** in response to a particular motion differs if the display device is controlled by the operating system or another application. As will be developed more fully below, motion control agent **114** issues control signals to move an highlighted, active region of an operating system graphical user interface from one icon to another in a direction denoted by user movement of the computing device if the operating system has operational control over the display **108**. An application associated with an icon is selectively invoked in response to control signals generated by motion control agent **114** in response to user movement of the computing device in a particular way. In accordance with one aspect of the invention, motion control agent **114** selectively generates a user interface that enables a user of the computing device to define how the motion control agent **114** responds to certain user movements of the computing device. In this regard, motion control agent **114** provides a flexible I/O solution.

Motion detection sensor(s) **116** generate an indication denoting motion in one or more of six (6) fields of motion. In this regard, motion detection sensors **116** are intended to represent any of a wide variety of such devices with the physical dimensions to be integrated with our exemplary computing devices. Examples of suitable motion detection sensor(s) **116** include micro-accelerometers, liquid-metal switches (e.g., a mercury switch), micro-machined gyroscopes, and the like. It will be appreciated by those skilled in the art that the complexity of the sensor(s) **116** utilized in a particular implementation may well dictate the number of sensor(s) required to provide functionality in all six planes of movement. That is, multiple mercury switches may well be

5

required to provide such functionality, while a single micro-accelerometer or micro-machined gyroscope may well provide the necessary functionality. Any combination of one or more of such devices may well be utilized without deviating from the spirit and scope of the present invention.

It will be appreciated by those skilled in the art that, although illustrated as a plurality of disparate functional elements, one or more of the elements **102-130** may well be combined into multi-functional elements. In accordance with one alternate example implementation, for example, a motion control agent **114** with one or more integrated motion detection sensor(s) **116** is envisioned. In yet another example implementation, motion control agent **114** is implemented as a series of executable instructions within application(s) **120**, selectively invoked by controller(s) **102** to implement the teachings of the present invention. In this regard, computing system **100** is merely intended to illustrate one embodiment of the present invention, as other embodiments of greater or lesser complexity may be developed without deviating from the scope and spirit of the present invention.

Accordingly, but for the introduction of the innovative motion control agent **114** and associated motion detection sensor(s) **116**, computing system **100** is intended to represent any of a wide variety of computing systems known in the art. Example Motion Control Agent

Having introduced the operating environment of the present invention, above, attention is now directed to FIG. 2 wherein a block diagram of an example motion control agent **114** is presented, in accordance with one example embodiment. In accordance with the illustrated example implementation of FIG. 2, motion control agent **114** is presented comprising control logic **202**, one or more motion detection sensor interface(s) **204** and memory **206**, each coupled as shown. As shown, motion control agent **114** receives motion indication(s) from one or more sensor(s) and interacts with control logic (e.g., **102**) of a host computing device (e.g., **100**) to control the operational state and/or display content of the computing device. In addition, in certain implementations, the function of motion control agent **114** is controlled by a user through the use of an enable button that, when depressed, provides an enable indication to the motion control agent. In alternate embodiments, motion control agent **114** relies on a motion threshold of the motion detection sensor(s) to ensure that random movements of the device does not result in a motion indication, thereby affecting the operational state and/or display content of the device. Although illustrated in accordance with a hardware implementation, those skilled in the art will appreciate that motion control agent **114** may well be implemented as a series of executable instructions (e.g., an application **120**) to implement the functions described below. In this regard, the block diagram of FIG. 2 is merely illustrative of one embodiment of the functional elements of the motion control agent, and not a limitation thereof.

As introduced above, motion control agent **114** interacts with other control logic (e.g., controllers **202**) to control one or more of an operational state and/or display content of the computing device. In this regard, motion control agent **114** includes control logic **202** to perform this interfacing function. More particularly, control logic **202** issues control signals to other control logic to control the operational state and/or display content of the computing device **100** in response to indications of motion received from motion detection sensor(s) **116** and with regard to a current operational state of the computing device. Accordingly, control logic **202** interacts with controllers **202** to identify the current operational state of the computing device **100**, e.g., whether the operating system or another application has operational

6

control over the display **108**. Based, at least in part, on the current operational state of the computing device and in response to received indications of motion, control logic **202** selects one or more control signals from a plurality of control signals resident within the control logic **202** or memory **206** to issue to other control logic (**102**) of the computing device.

Sensor interface(s) **204** enable each of the one or more types of motion detection sensor(s) **116** to provide indications of motion to motion control agent **114**. Examples of such interfaces include a control bus, a direct-memory access (DMA) line to control logic **202**, a single control line, an I²C bus, and the like.

As used herein, memory **206** is utilized by control logic **202** to store and maintain operational information and control signal information associated with one or more computing devices. According to one implementation, introduced above, control logic **202** receives information regarding a current operational state of the computing device, wherein such information is stored and maintained in memory **206**. In addition, memory **206** is used to store information used by control logic **202** to translate information received from one or more of a wide variety of motion detection sensor(s) into control signal(s) for any of a wide variety of computing device platforms. In this regard, motion control agent **114** is flexible and readily adaptable for use in a wide variety of computing device platforms. But for its use within and interaction with motion control agent **114**, memory **206** is intended to represent any of a wide variety of memory means known in the art.

Example Operation and Implementation

Having introduced the functional and architectural elements of an example embodiment of the innovative motion control agent **114** with reference to FIGS. 1 and 2, an example operation and implementation will be further developed with reference to FIGS. 3 through 11. For ease of illustration, and not limitation, the operational detail of the motion control agent **114** will be further developed in accordance with the example implementation context of a personal digital assistant (PDA) computing environment. In accordance with such an example implementation, the computing system **100** of FIG. 1 represents a PDA endowed with the innovative motion control agent **114** and associated motion detection sensors **116**. Nonetheless, it will be appreciated by those skilled in the art that computing devices of greater or lesser complexity which utilize a motion control agent to control the state and/or display content of a computing device fall within the spirit and scope of the claims appended hereto.

Turning to FIG. 3, a flow chart of an example method facilitating user control of a computing system is depicted, in accordance with the teachings of the present invention. In accordance with the illustrated example implementation of FIG. 3, the method begins with block **302** upon initiation of the device during start-up or a reset condition. That is, as with conventional I/O means, the motion control agent **114** is selectively invoked upon start-up or reset of the computing device **100** to facilitate control of the device through a user's physical movement of the PDA.

In block **304**, control logic **102** of the PDA receives user input from any of a number of I/O sources including motion control agent **114**. That is to say, integration and initiation of the innovative motion control agent **114** does not disable any of the other I/O means available to the user. In certain instances and applications, control of the operational state and/or display content of the PDA is more conveniently performed with traditional I/O devices **130** such as a trackball, stylus, and the like. In accordance with the teachings of the present invention, as introduced above, computing device **100**

is endowed with motion control agent **114**, which generates control signal representations of user input for transmission to control logic **102** based, at least in part, on the current operational state of the PDA **100** and received indications of motion of the PDA **100** generated by motion detection sensor(s) **116**. An example method for controlling the operational state and/or the display content of a computing device (**100**) is further illustrated with reference to FIG. **4**, below.

In block **306**, in response to such user input (block **304**), control logic **102** updates the operational state and/or display content of the PDA **100** in accordance with received input through the end of the computing session.

FIG. **4** depicts a flow chart of an example method for controlling a computing system by physically moving and manipulating the computing system, in accordance with one example embodiment of the present invention. In accordance with the illustrated example implementation of FIG. **4**, the method begins with block **402**, wherein motion control agent **114** receives an indication of movement from one or more motion detection sensor(s) **116** via sensor interface(s) **204**. In accordance with one example implementation, introduced above, PDA **100** includes one or more motion detection sensor(s) to provide an indication of motion specifically denoting six (6) fields of motion, i.e., movement of the PDA **100** in the x-, y- and z-planes as well as rotational movement of the PDA **100** about the x-, y- and z-axes. According to one example implementation, introduced above, the motion detection sensor(s) **116** may use a motion threshold that must be reached before the motion indications are sent to the motion control agent. In alternate implementations, the computing device **100** may well include an "enable button" that, when depressed by the user enables the motion control agent **114** to respond to motion indications received by the agent **114**. In accordance with one example implementation, motion control agent **114** includes, or has access to memory comprising a listing of control signals associated with indications of movement in each of the six fields based, at least in part, on the current operational state of the PDA **100**.

Accordingly, in block **404**, motion detection agent **114** identifies the current operational state of the PDA **100**. More particularly, control logic **202** periodically receives an update on the operational state of the computing device from controller(s) **102**. In accordance with one example, control logic **202** receives such updates whenever there is a state change of the computing device. In alternate implementations, control logic **202** queries controller **102** for the current operational state. As introduced above, the current operational state is stored and maintained by control logic **202** in memory **206**.

In block **406**, motion control agent **114** generates instructions to update the current state of the device and/or the display content of the device based, at least in part on the received indication(s) and the current state of the device. More particularly, in response to motion indications received from one or more sensor(s) **116** via sensor interface (s) **204**, control logic **202** accesses memory **206** and, depending on the current operational state of the PDA **100** denoted in memory **206**, generates an appropriate control signal(s) for controller(s) **102** to update the operational state and/or display content of the device.

If, for example, the PDA **100** is currently displaying the operating system GUI, select movements of the PDA **100** cause motion detection agent **114** to generate control signals to move a highlighted, active region of the display to move from one icon to another in accordance with the direction of the movement. Certain other movements cause motion detection agent **114** to generate control signals to launch an appli-

cation associated with an icon contained within the highlighted active region of the display.

If, for example, the PDA **100** is implementing an application, certain movements of the PDA **100** cause motion detection agent **114** to generate control signals to display a subsequent page of content, display a previous page of content, scroll a page of content, and/or zoom in/out of the displayed page of content. An example of PDA movements and the associated display response are illustrated in FIGS. **5-11**, below.

Graphical Illustration(s) of Motion Control of a Computing Device

FIG. **5** graphically illustrates an example implementation of using motion control to affect the operating system (OS) graphical user interface (GUI) to control the state of a computing system, in accordance with one aspect of the present invention. In accordance with the illustrated example implementation of FIG. **5**, an operating system (O/S) graphical user interface (GUI) is depicted **500** for a PDA (e.g., **100**) comprising two (2) icons **502**, **504**, each associated with a unique application available for invocation and execution by the PDA. As shown in display **500**, one of the icons **502** is currently selected within a highlighted, active region **506**. By rotating the PDA **100** to the right about the Y-axis, and back again (a complementary motion back to the original viewing position), motion control agent **114** generates instructions (e.g., to controller **102**) to update display **500** to that of **520**. More particularly, the highlighted active region **506** is moved one icon to the right (i.e., in the direction of the rotation). Similarly, rotation to the left about the y-axis (and a complementary motion back again) causes motion control agent **114** to generate control signals to controller **102** to send the highlighted active region back one incremental icon to icon **502**. Similar movements about the x-axis would move the highlighted active region up or down in the active display. In accordance with one implementation, rotation about the z-axis (and a complementary motion back to the starting position) causes motion control agent **114** to issue control signals to controller **102** to launch the application associated with the icon in the highlighted, active region **506**. In this regard, motion control agent **114** provides an intuitive means of interacting with an operating system of a computing device to control the operational state of the device.

Turning next to FIGS. **6-11**, similar graphical illustrations are presented which depict motion control of displayed content of an application, in accordance with one embodiment of the present invention. More particularly, FIGS. **6-11** illustrate resulting updates to displayed content of an application resulting from certain movements of the PDA **100** by the user. For purposes of illustration, assume that the application is an electronic book (eBook) that the user is reading. Rather than using convention input devices to scroll, zoom, paginate the book, a PDA **100** endowed with motion control agent **114** facilitates an intuitive motion control of the application by physically manipulating the electronic device executing the eBook application.

FIG. **6** graphically illustrates updating the display **600** of the PDA **100** to display a subsequent page of the eBook. In accordance with the teachings of the present invention, two alternate means may be employed. In a first, a user slides the PDA **100** to the right in the x-plane to step to the next page. Alternatively, a rotational motion to the right about the y-axis, with a complementary motion back (to the left) about the y-axis to the starting point also steps to the next page. In either case, upon the assertion of an enable button and/or once a motion threshold of one or more sensor(s) is reached, the sensor(s) **116** generate an indication of such motion for

motion control agent **114**, which issues control signals (e.g., to controller **102**) to update the display content. In response, the display **108** is updated to reflect Page (N+1) **602**.

FIG. **7** graphically illustrates updating the display **700** of the PDA **100** to display a previous page of the eBook. In accordance with the teachings of the present invention, two alternate means may be employed. In a first, a user slides the PDA **100** to the left in the x-plane to step to the next page. Alternatively, a rotational motion to the left about the y-axis, with a complementary motion back (to the right) about the y-axis to the starting point also steps to the next page. In either case, upon the assertion of an enable button and/or once a motion threshold of one or more sensor(s) is reached, the sensor(s) **116** generate an indication of such motion for motion control agent **114**, which issues control signals (e.g., to controller **102**) to update the display content. In response, the display **108** is updated to reflect Page (N-1) **702**.

FIG. **8** graphically illustrates updating the display **800** of the PDA **100** to scroll downward within a displayed page of an eBook application. In accordance with the teachings of the present invention, two alternate means may be employed. In a first, a user slides the PDA **100** downward in the y-plane to effect the scroll. Alternatively, a rotational motion upward and forward about the x-axis, with a complementary motion back (downward and backward) about the x-axis to the starting point also scrolls the page. In either case, upon the assertion of an enable button and/or once a motion threshold of one or more sensor(s) is reached, the sensor(s) **116** generate an indication of such motion for motion control agent **114**, which issues control signals (e.g., to controller **102**) to update the display content. In response, the display **108** is updated to reflect Page N **802**.

FIG. **9** graphically illustrates updating the display **900** of the PDA **100** to scroll upward within a displayed page of an eBook application. In accordance with the teachings of the present invention, two alternate means may be employed. In a first, a user slides the PDA **100** upward in the y-plane to effect the scroll. Alternatively, a rotational motion downward and backward about the x-axis, with a complementary motion back (upward and forward) about the x-axis to the starting point also scrolls the page. In either case, upon the assertion of an enable button and/or once a motion threshold of one or more sensor(s) is reached, the sensor(s) **116** generate an indication of such motion for motion control agent **114**, which issues control signals (e.g., to controller **102**) to update the display content. In response, the display **108** is updated to reflect Page N **902**.

FIG. **10** graphically illustrates updating the display **1000** of the PDA **100** to zoom-in on content within a displayed page of an eBook application. In accordance with one example implementation, a user moves the device upward in the z-plane (e.g., towards the user), to effect the zoom. Upon the assertion of an enable button and/or once a motion threshold of one or more sensor(s) is reached, the sensor(s) **116** generate an indication of such motion for motion control agent **114**, which issues control signals (e.g., to controller **102**) to update the display content. In response, the display **108** is updated to reflect Page N **1002**.

FIG. **11** graphically illustrates updating the display **1100** of the PDA **100** to zoom-out on content within a displayed page of an eBook application. In accordance with one example implementation, a user moves the device downward in the z-plane (e.g., away from the user), to effect the zoom. Upon the assertion of an enable button and/or once a motion threshold of one or more sensor(s) is reached, the sensor(s) **116** generate an indication of such motion for motion control agent **114**, which issues control signals (e.g., to controller

102) to update the display content. In response, the display **108** is updated to reflect Page N **1102**.

Alternate Embodiments

FIG. **12** is a block diagram of a storage medium having stored thereon a plurality of instructions including instructions to implement the motion control agent **114**, according to yet another embodiment of the present invention. In general, FIG. **12** illustrates a storage medium/device **1200** having stored thereon a plurality of machine-executable instructions including at least a subset of which that, when executed, implement the innovative motion control agent **114** of the present invention.

As used herein, storage medium **1200** is intended to represent any of a number of storage devices and/or storage media known to those skilled in the art such as, for example, volatile memory devices, non-volatile memory devices, magnetic storage media, optical storage media, and the like. Similarly, the executable instructions are intended to reflect any of a number of software languages known in the art such as, for example, C++, Visual Basic, Hypertext Markup Language (HTML), Java, eXtensible Markup Language (XML), and the like. Moreover, it is to be appreciated that the storage medium/device **1200** need not be co-located with any host system. That is, storage medium/device **1200** may well reside within a remote server communicatively coupled to and accessible by an executing system. Accordingly, the software implementation of FIG. **12** is to be regarded as illustrative, as alternate storage media and software embodiments are anticipated within the spirit and scope of the present invention.

Although the invention has been described in the detailed description as well as in the Abstract in language specific to structural features and/or methodological steps, it is to be understood that the invention defined in the appended claims is not necessarily limited to the specific features or steps described. Rather, the specific features and steps are merely disclosed as exemplary forms of implementing the claimed invention. It will, however, be evident that various modifications and changes may be made thereto without departing from the broader spirit and scope of the present invention. The present specification and figures are accordingly to be regarded as illustrative rather than restrictive. The description and abstract are not intended to be exhaustive or to limit the present invention to the precise forms disclosed.

The terms used in the following claims should not be construed to limit the invention to the specific embodiments disclosed in the specification. Rather, the scope of the invention is to be determined entirely by the following claims, which are to be construed in accordance with the established doctrines of claim interpretation.

In accordance with the foregoing, we claim the following:

1. A handheld computing device comprising:
 - a motion sensor to detect motion of the computing device in one or more of six (6) fields of motion and to generate a motion indication if an initial motion and a complementary motion in a different direction than the initial motion each exceed a motion threshold;
 - a motion control agent to
 - determine an operating state of the computing device,
 - determine whether an operating system or an application has operational control of a display of the computing device, and
 - generate, in response to the motion indication, a first control signal to modify the operating state of the computing device and a second control signal to modify displayed content of the computing device, if the operating system has operational control of the display.

11

2. A handheld computing device according to claim 1, wherein the motion sensor is selected from a group consisting of a micro-accelerometer, a mercury switch, a shock detector, a gyroscope, and a combination thereof.

3. A handheld computing device according to claim 1, the motion sensor to detect motion in one or more of an x-, y- or z-field of motion.

4. A handheld computing device according to claim 1, the motion sensor to detect rotational motion about one or more of an x-, y- or z-axis.

5. A handheld computing device according to claim 1, the motion sensor to detect motion in one or more of an x-, y- or z-field of motion and to rotational motion about one or more of an x-, y- or z-axis.

6. A handheld computing device according to claim 1, the motion control agent to generate the first control signal to move a highlighted, active region from one icon to another icon in an operating system graphical user interface in response to the motion indication in an x- or y-field, or complementary rotational motion about an x- or y-axis if the operating system has operational control of the display.

7. A handheld computing device according to claim 1, the motion control agent to generate the first control signal to invoke an application associated with an icon denoted by a highlighted, active region in response to the motion indication in the z-field, or complementary rotational motion about a z-axis if the operating system has operational control of the display.

8. A handheld computing device according to claim 1, the motion control agent to generate the second control signal to display a subsequent page of content in response to the motion indication in an x-field, or complementary rotational motion about a y-axis if an application has operational control of the display.

9. A handheld computing device according to claim 1, the motion control agent to generate the second control signal to scroll displayed content of an application in response to the motion indication in the y-field, or complementary rotational motion about a x-axis if an application has operational control of the display.

10. A handheld computing device according to claim 1, the motion control agent to generate the second control signal to zoom displayed content of an application in response to the motion indication in the z-field if an application has operational control of the display.

11. A handheld computing device according to claim 1, further comprising:

a storage device including a plurality of executable instructions; and

a control unit, coupled to the storage device, to execute at least a subset of the plurality of instructions to selectively implement the motion control agent.

12. A handheld computing device according to claim 1, wherein the motion control agent is selectively enabled by user assertion of an enable button.

13. A handheld computing device according to claim 1, wherein the computing device is selected from the group consisting of a personal digital assistant (PDA), an electronic book (eBook) appliance, a wireless communications device, and a personal gaming device.

14. A *non-transitory* storage medium comprising a plurality of executable instructions which, when implemented by a computing device, cause the machine to implement a motion control agent to:

receive a motion indication signifying that the computing device is being physically manipulated in one or more of six (6) fields of motion if an initial motion and a comple-

12

mentary motion in a different direction than the initial motion each exceed a motion threshold;

determine an operating state of the computing device;

determine whether an operating system or an application has operational control of a display of the computing device;

generate, in response to the motion indication, a first control signal to modify the operating state of the computing device and a second control signal to modify displayed content of the computing device in response to the motion indication, if the operating system has operational control of the display.

15. [A] *The non-transitory* storage medium according to claim 14, wherein the instructions to generate the first control signal comprise instructions to enable the agent to issue a control signal to move a highlighted, active region from one icon to another icon in an operating system graphical user interface in response to the motion indication signifying motion in an x- or y-field, or complementary rotational motion about an x- or y-axis if the operating system has operational control of the display of the computing device.

16. [A] *The non-transitory* storage medium according to claim 14, wherein the instructions to generate the first control signal comprise instructions to enable the agent to issue a control signal to invoke an application associated with an icon denoted by a highlighted, active region in response to indication of motion in the z-field, or complementary rotational motion about a z-axis if the operating system has operational control of the display of the computing device.

17. [A] *The non-transitory* storage medium according to claim 14, wherein the instructions to generate the second control signal comprise instructions to enable the agent to issue a control signal to display a subsequent page of content in response to indication of motion in the x-field, or complementary rotational motion about a y-axis if the application has operational control of the display of the computing device.

18. [A] *The non-transitory* storage medium according to claim 14, wherein the instructions to generate the second control signal comprise instructions to enable the agent to issue a control signal to scroll displayed content of an application in response to indication of motion in the y-field, or complementary rotational motion about the x-axis if the application has operational control of the display of the computing device.

19. [A] *The non-transitory* storage medium according to claim 14, wherein the instructions to generate the second control signal comprise instructions to enable the agent to generate a control signal to zoom displayed content of an application in response to indication of motion in the z-field if the application has operational control of the display of the computing device.

20. A method for controlling a handheld computing device, the method comprising:

receiving, *at the computing device*, a motion indication of the computing device in one or more of six (6) fields of motion from a motion detection sensor integrated with the computing device if an initial motion and a complementary motion in a different direction than the initial motion each exceed a motion threshold;

determining an operating state of the computing device;

determining whether an operating system or an application has operational control of a display of the computing device;

generating a first control signal to modify the operating state of the computing device and a second control signal to modify displayed content of the computing device in

13

response to the motion indication, if the operating system has operational control of the display.

21. A method according to claim 20, wherein generating the first control signal comprises:

generating a control signal to move a highlighted, active region from one icon to another icon in an operating system graphical user interface in response to indication of motion in an x- or y-field, or complementary rotational motion about an x- or y-axis if the operating system has operational control of the display of the computing device.

22. A method according to claim 20, wherein generating the first control signal comprises:

generating a control signal to invoke an application associated with an icon denoted by a highlighted, active region in response to indication of motion in the z-field, or complementary rotational motion about a z-axis if the operating system has operational control of the display of the computing device.

23. A method according to claim 20, wherein generating the second control signal comprises:

14

generating a control signal to display a subsequent page of content in response to indication of motion in the x-field, or complementary rotational motion about a y-axis if an application has operational control of the display of the computing device.

24. A method according to claim 20, wherein generating the second control signal comprises:

generating a control signal to scroll displayed content of an application in response to indication of motion in the y-field, or complementary rotational motion about the x-axis if the application has operational control of the display of the computing device.

25. A method according to claim 20, wherein generating the second control signal comprises:

generating a control signal to zoom displayed content of an application in response to indication of motion in the z-field if the application has operational control of the display of the computing device.

26. A storage medium comprising a plurality of executable instructions which, when executed by an accessing computing device, implement a method according to claim 20.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : RE43,587 E
APPLICATION NO. : 13/102951
DATED : August 14, 2012
INVENTOR(S) : Orchard et al.

Page 1 of 3

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

On the Title Page:

In Item (56), under "OTHER PUBLICATIONS", in Column 2, Lines 1-2,
delete "Interaction". Nov. 5, 2000." and insert -- Interaction", Nov. 5, 2000, --, therefor.

On Page 2, in Item (56), under "OTHER PUBLICATIONS", in Column 1, Line 1, delete
"Analog" and insert -- "Analog --, therefor.

On Page 2, in Item (56), under "OTHER PUBLICATIONS", in Column 1, Line 2, delete
"Sensor," and insert -- Sensor," --, therefor.

On Page 2, in Item (56), under "OTHER PUBLICATIONS", in Column 1, Line 4, delete
"et al.; Design of Spatially Aware Graspable Display,;" and insert -- et al., "Design of Spatially Aware
Graspable Display," --, therefor.

On Page 2, in Item (56), under "OTHER PUBLICATIONS", in Column 1, Line 7, delete
"et al.; Hand" and insert -- et al., "Hand --, therefor.

On Page 2, in Item (56), under "OTHER PUBLICATIONS", in Column 1, Line 9, delete
"User," and insert -- User," --, therefor.

On Page 2, in Item (56), under "OTHER PUBLICATIONS", in Column 2, Line 1, delete
"Inertial" and insert -- "Inertial --, therefor.

On Page 2, in Item (56), under "OTHER PUBLICATIONS", in Column 2, Line 2, delete
"tools," and insert -- tools," --, therefor.

On Page 2, in Item (56), under "OTHER PUBLICATIONS", in Column 2, Line 4, delete
"Inc.; MEMS" and insert -- Inc., "MEMS --, therefor.

Signed and Sealed this
Eighth Day of January, 2013

A handwritten signature in black ink, reading "David J. Kappos". The signature is written in a cursive, flowing style with a large initial "D".

David J. Kappos
Director of the United States Patent and Trademark Office

CERTIFICATE OF CORRECTION (continued)

Page 2 of 3

U.S. Pat. No. RE43,587 E

On Page 2, in Item (56), under “OTHER PUBLICATIONS”, in Column 2, Line 4, delete “motion,” and insert -- motion,” --, therefor.

On Page 2, in Item (56), under “OTHER PUBLICATIONS”, in Column 2, Line 6, delete “Miniature” and insert -- “Miniature --, therefor.

On Page 2, in Item (56), under “OTHER PUBLICATIONS”, in Column 2, Line 7, delete “Products,” and insert -- Products,” --, therefor.

On Page 2, in Item (56), under “OTHER PUBLICATIONS”, in Column 2, Line 9, delete “Rock” and insert -- “Rock --, therefor.

On Page 2, in Item (56), under “OTHER PUBLICATIONS”, in Column 2, Line 9, delete “stay,” and insert -- stay,” --, therefor.

On Page 2, in Item (56), under “OTHER PUBLICATIONS”, in Column 2, Line 11, delete “et al.; Sensing” and insert -- et al., “Sensing --, therefor.

On Page 2, in Item (56), under “OTHER PUBLICATIONS”, in Column 2, Line 11, delete “Interaction” and insert -- Interaction” --, therefor.

On Page 2, in Item (56), under “OTHER PUBLICATIONS”, in Column 2, Line 14, delete “Situated” and insert -- “Situated --, therefor.

On Page 2, in Item (56), under “OTHER PUBLICATIONS”, in Column 2, Line 15, delete “Computers,” and insert -- Computers,” --, therefor.

On Page 2, in Item (56), under “OTHER PUBLICATIONS”, in Column 2, Line 17, delete “et al.; Squeeze” and insert -- et al., “Squeeze --, therefor.

On Page 2, in Item (56), under “OTHER PUBLICATIONS”, in Column 2, Line 18, delete “Interfaces,” and insert -- Interfaces,” --, therefor.

On Page 2, in Item (56), under “OTHER PUBLICATIONS”, in Column 2, Line 20, delete “et al.; The” and insert -- et al., “The --, therefor.

On Page 2, in Item (56), under “OTHER PUBLICATIONS”, in Column 2, Line 21, delete “Computers,” and insert -- Computers,” --, therefor.

On Page 2, in Item (56), under “OTHER PUBLICATIONS”, in Column 2, Line 23, delete “Tilting” and insert -- “Tilting --, therefor.

On Page 2, in Item (56), under “OTHER PUBLICATIONS”, in Column 2, Line 23, delete “Interfaces,” and insert -- Interfaces,” --, therefor.

CERTIFICATE OF CORRECTION (continued)

Page 3 of 3

U.S. Pat. No. RE43,587 E

On Page 2, in Item (56), under “OTHER PUBLICATIONS”, in Column 2, Line 26, delete “LLP; Related Case Listing; Apr. 26, 2011;” and insert -- LLP, Related Case Listing, Apr. 26, 2011, --, therefor.

In the Specifications:

In Column 1, Line 36, delete “(PDA),” and insert -- (PDAs), --, therefor.

In Column 4, Line 41, delete “move an” and insert -- move a --, therefor.

In the Claims:

In Column 11, Line 60, in Claim 13, delete “gaining” and insert -- gaming --, therefor.