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(54) **METHOD AND APPARATUS FOR WEARABLE REMOTE INTERFACE DEVICE**

(75) Inventors: **Barbara Kruse**, San Francisco, CA (US); **Ryan Steger**, Sunnyvale, CA (US)

(73) Assignee: **Immersion Corporation**, San Jose, CA (US)

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G09G 5/00 (2006.01)

(52) **U.S. Cl.** **345/156**; 345/163

(58) **Field of Classification Search** 345/156–169, 345/173–177

See application file for complete search history.

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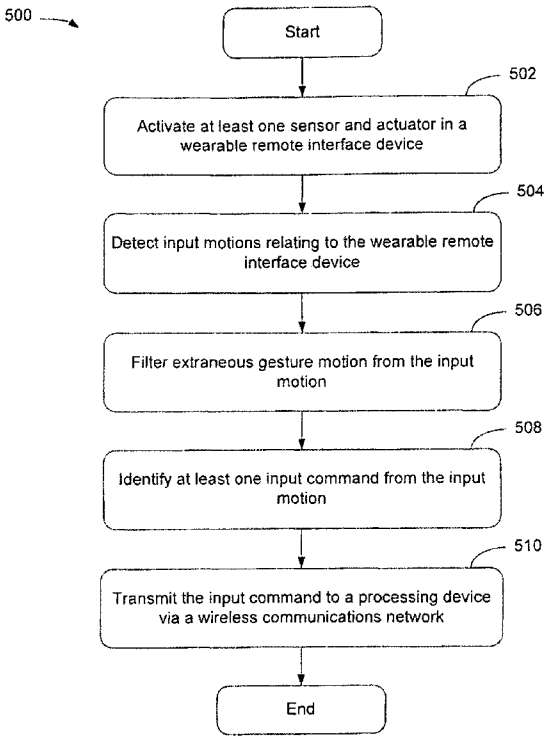
Primary Examiner — Ricardo L Osorio
(74) *Attorney, Agent, or Firm* — Womble Carlyle Sandridge & Rice, PLLC

(57) **ABSTRACT**

A method and apparatus of using a wearable remote interface device capable of detecting inputs from movements are disclosed. The wearable remote interface device, which could be attached to a finger or a hand or any parts of a body, includes a sensor, a filter, an input identifier, and a transmitter. The sensor, in one embodiment, is capable of sensing the movement of the finger or any part of body in which the wearable remote interface device is attached with. Upon detecting the various movements associated with the finger, the filter subsequently removes any extraneous gestures from the detected movements. The input identifier, which could be a part of the filter, identifies one or more user inputs from the filtered movements. The transmitter transmits the input(s) to a processing device via a wireless communications network.

22 Claims, 7 Drawing Sheets



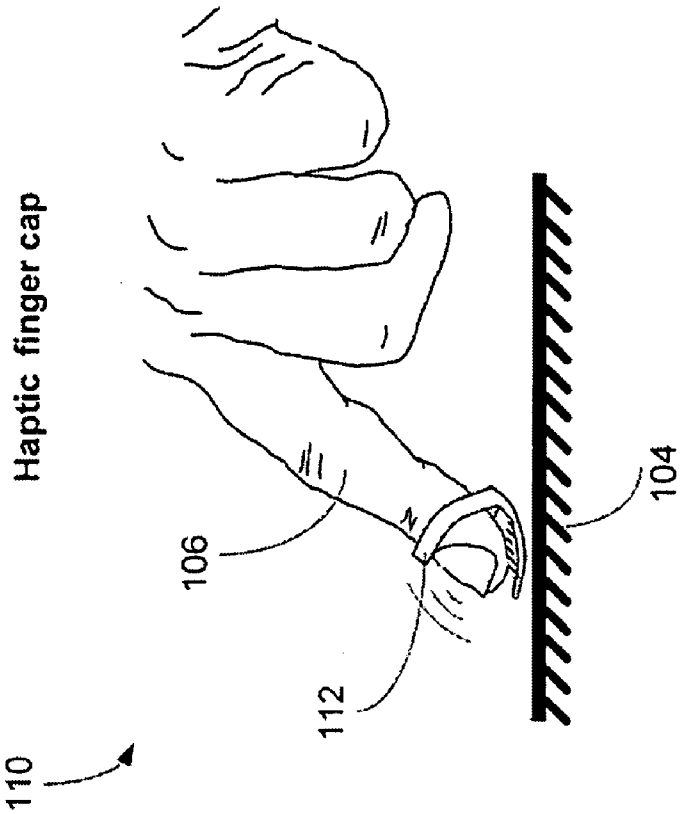


FIG 1B

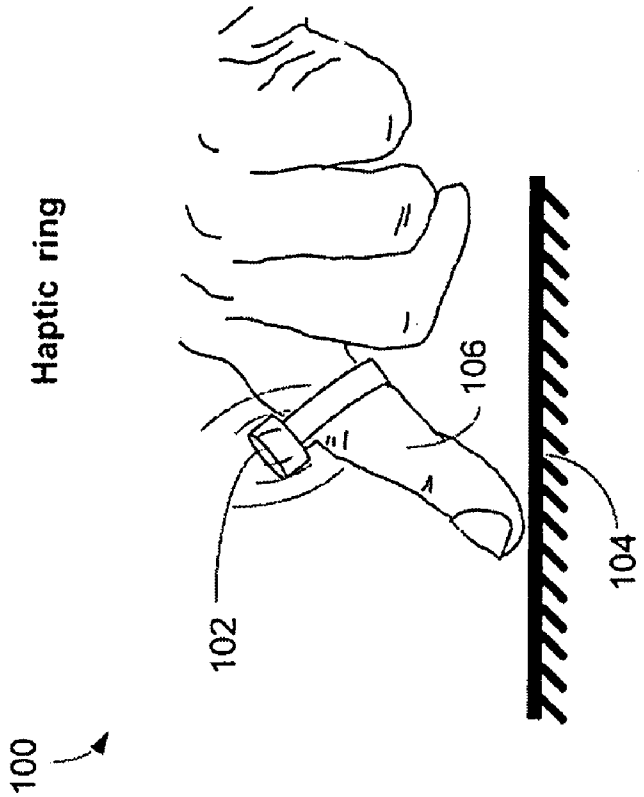


FIG 1A

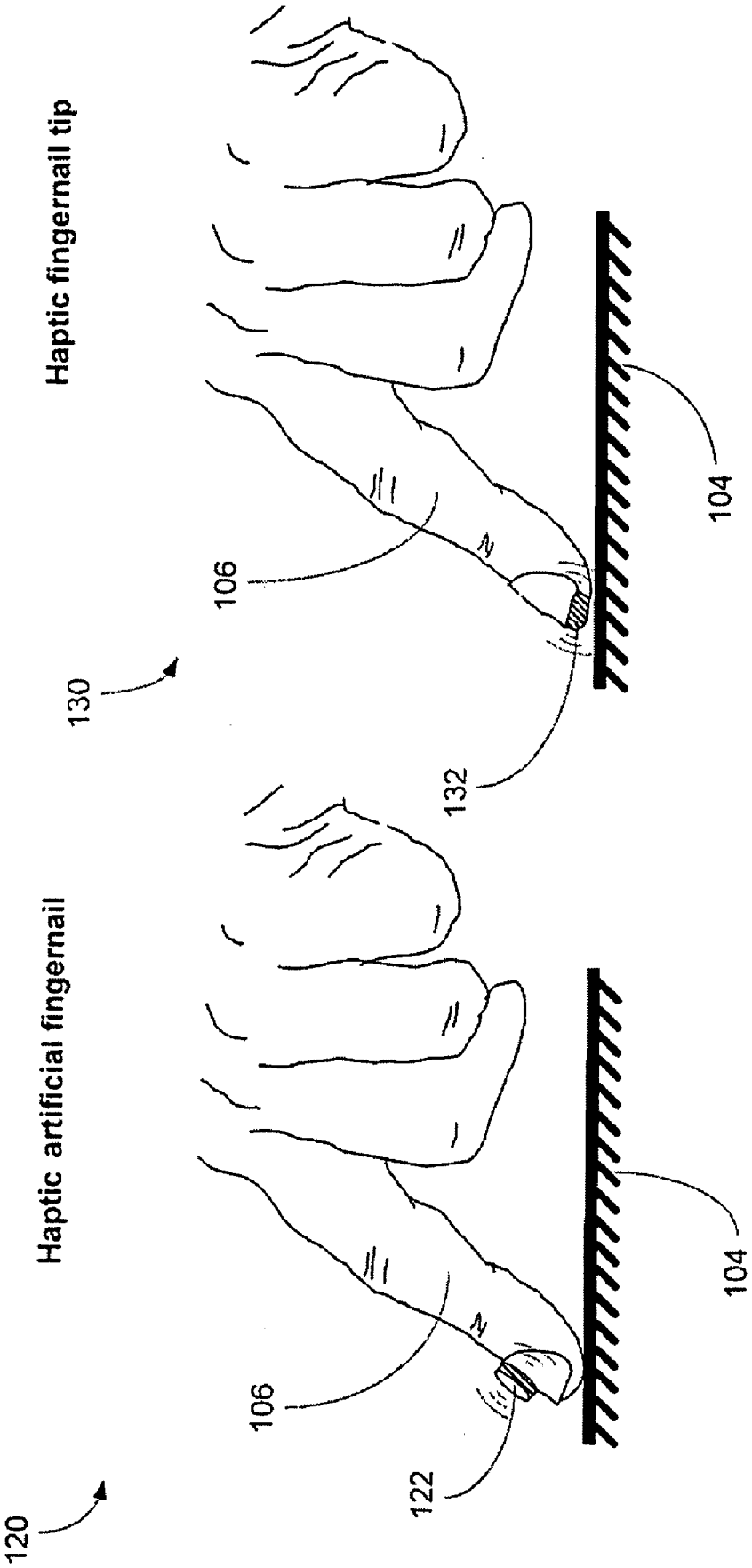

Haptic fingernail tip
130
106
132
104
Haptic artificial fingernail
120
106
122
104

FIG 1D

FIG 1C

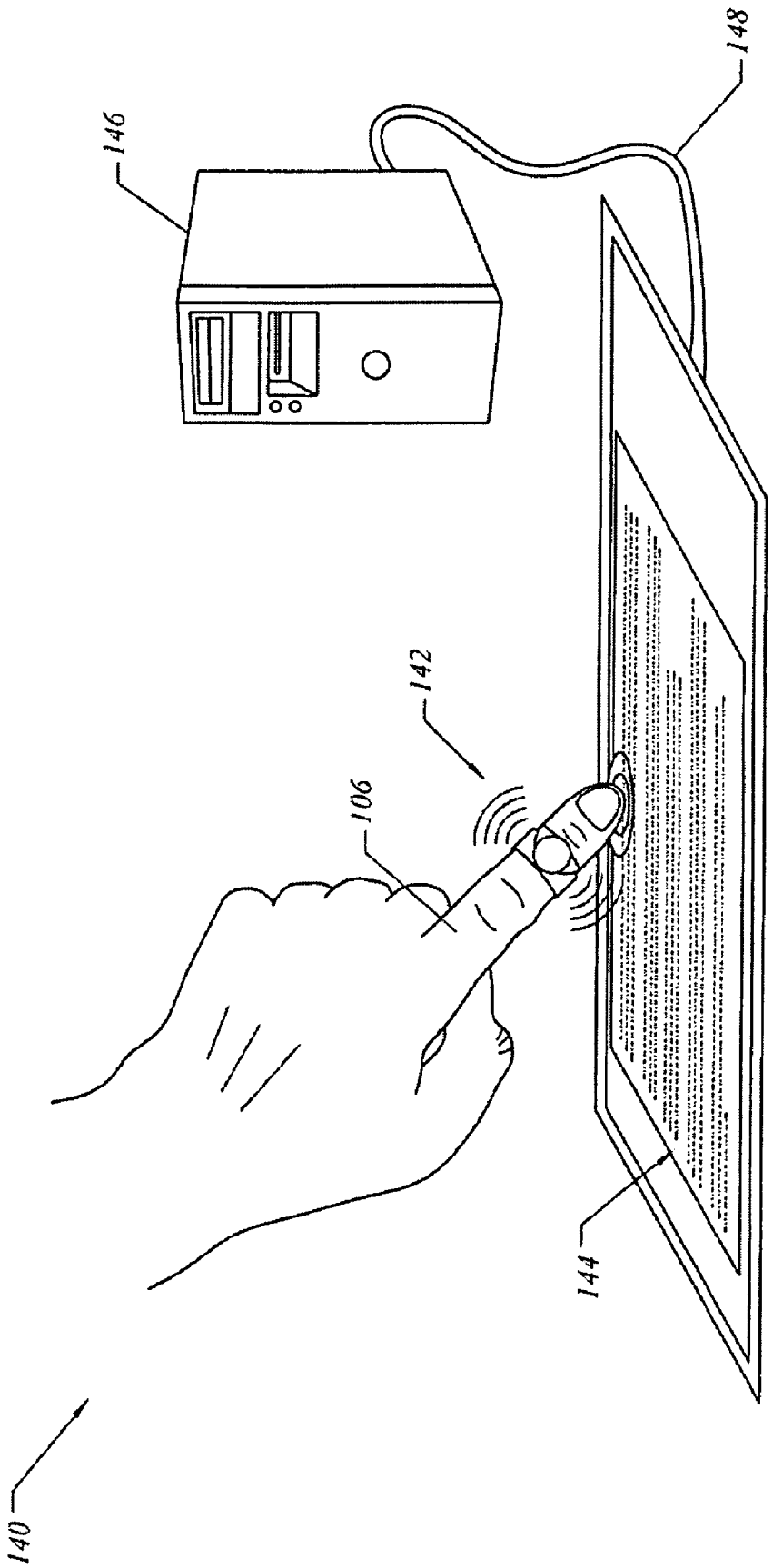


FIG. 1E

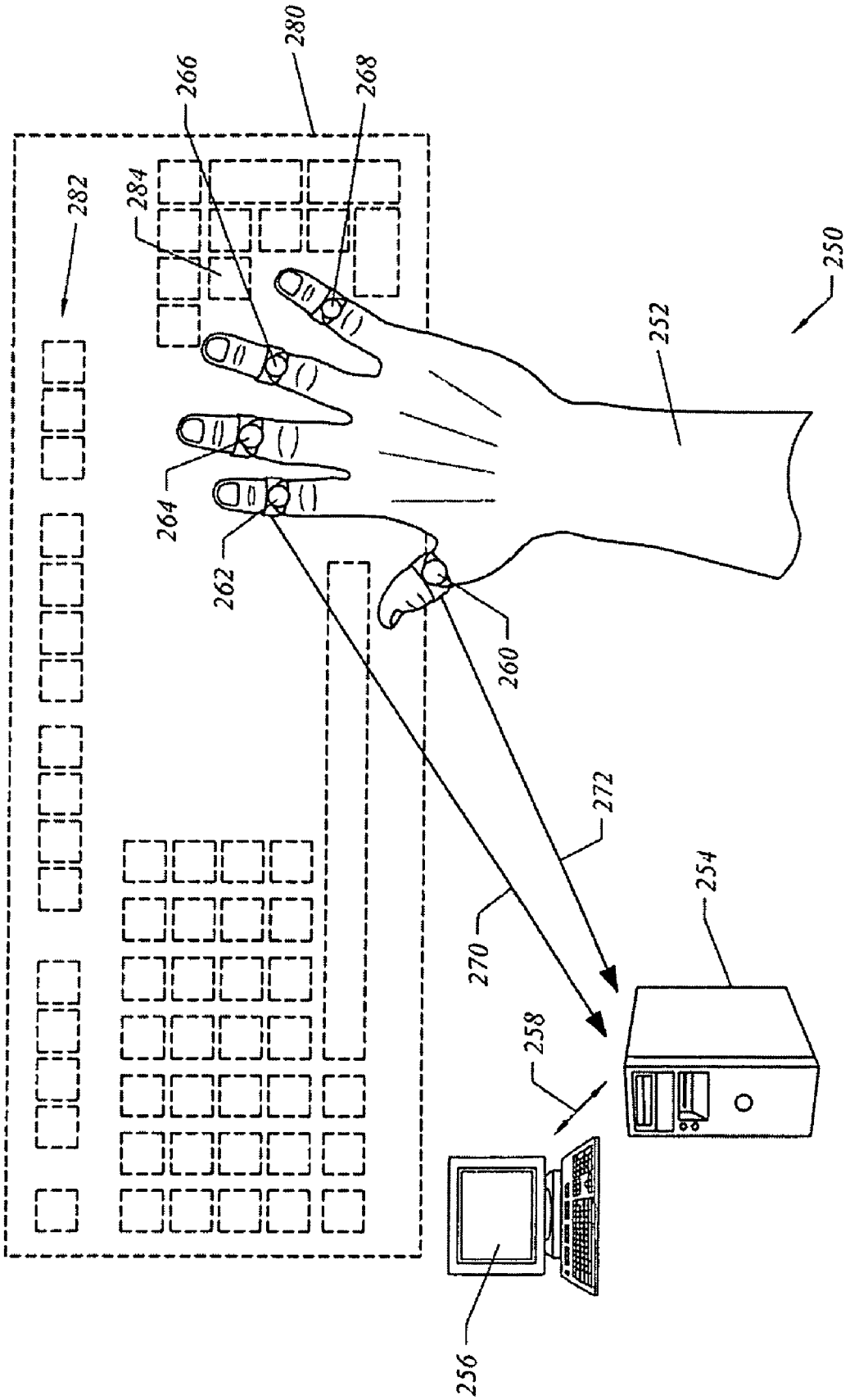
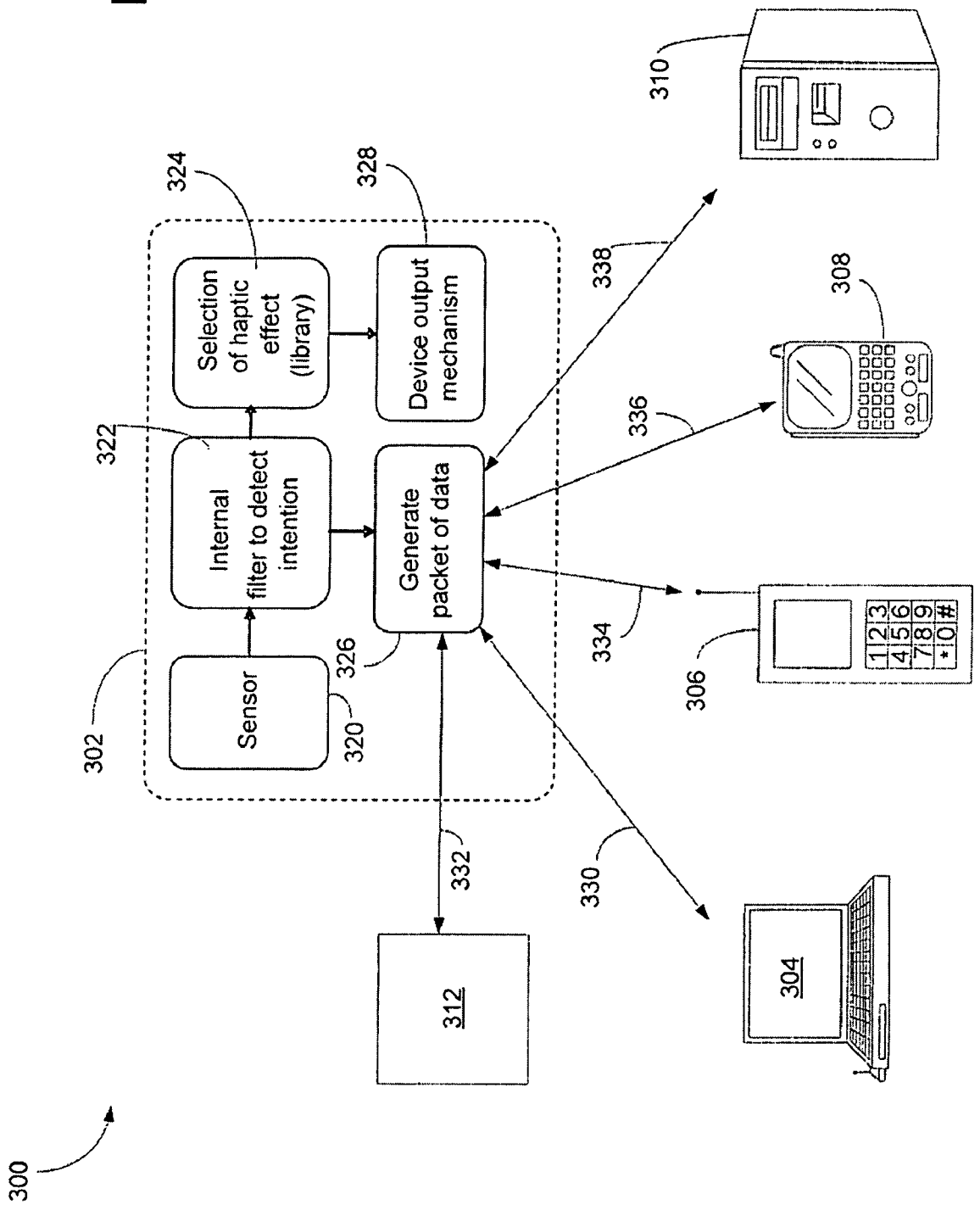


FIG. 2

FIG 3


Sensor
Internal filter to detect intention
Selection of haptic effect (library)
Generate packet of data
Device output mechanism
302
320
322
324
326
328
330
332
334
336
338
300
312
304
306
308
310
1 2 3
4 5 6
7 8 9
* 0 #

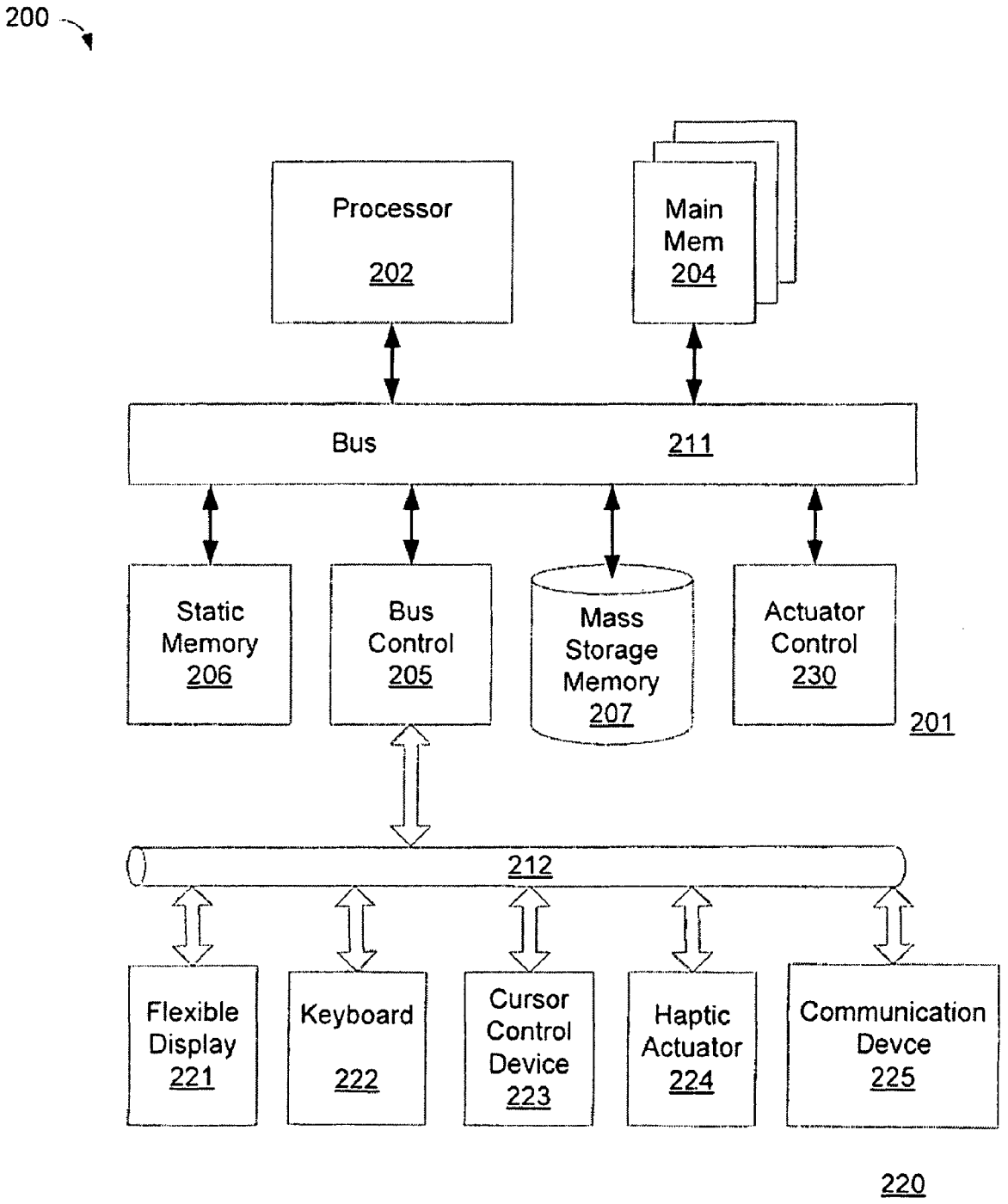

200
Processor
202
Main
Mem
204
Bus
211
Static
Memory
206
Bus
Control
205
Mass
Storage
Memory
207
Actuator
Control
230
201
212
Flexible
Display
221
Keyboard
222
Cursor
Control
Device
223
Haptic
Actuator
224
Communication
Devce
225
220

FIG 4

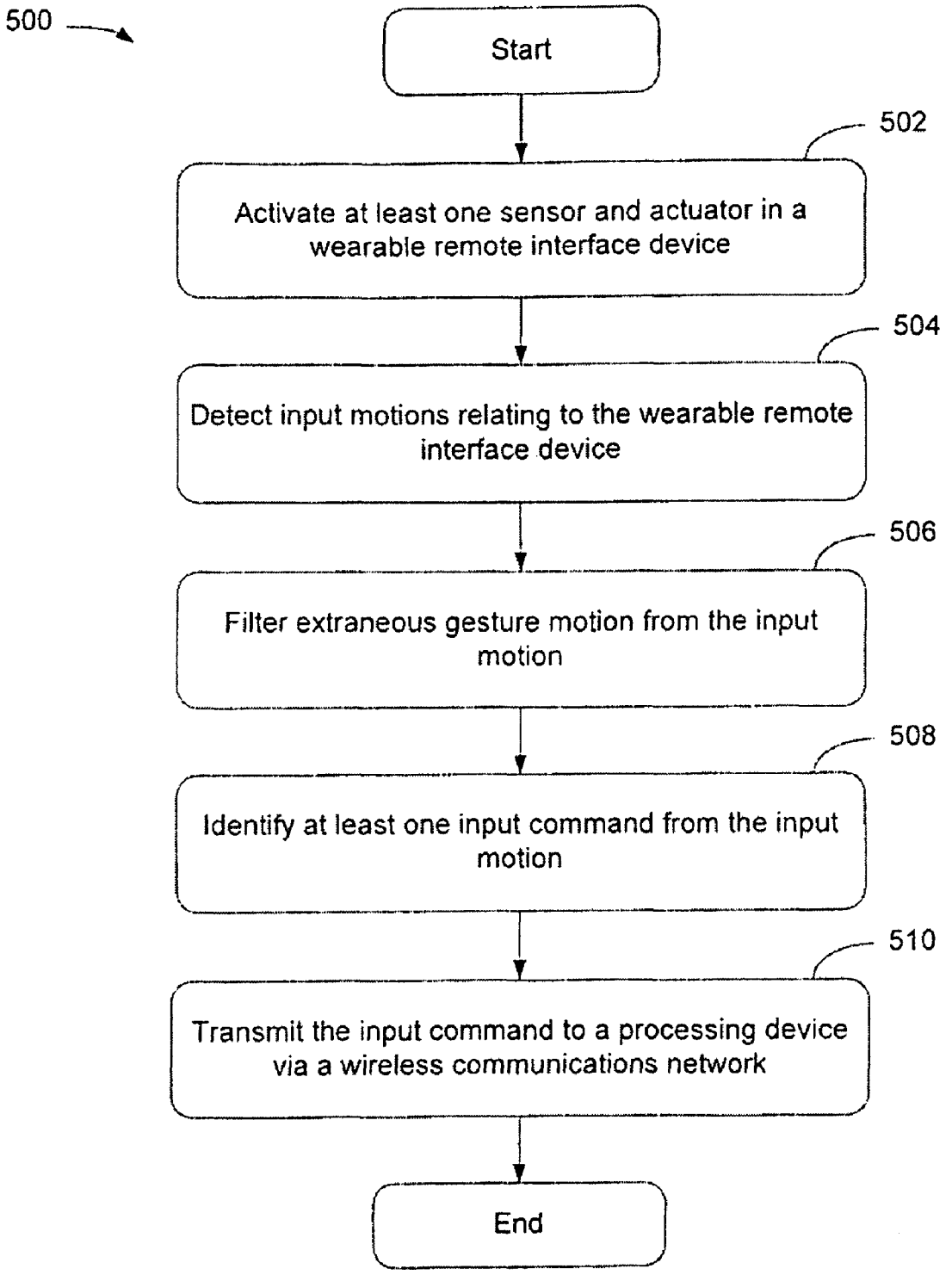

500
Start
502
Activate at least one sensor and actuator in a wearable remote interface device
504
Detect input motions relating to the wearable remote interface device
506
Filter extraneous gesture motion from the input motion
508
Identify at least one input command from the input motion
510
Transmit the input command to a processing device via a wireless communications network
End

FIG 5

METHOD AND APPARATUS FOR WEARABLE REMOTE INTERFACE DEVICE

FIELD

The present invention relates to the field of electronic interface devices. More specifically, the present invention relates to a user interface device having haptic actuators.

BACKGROUND

As computer-based systems, such as game consoles, appliances, personal computers ("PCs"), servers, personal digital assistants ("PDAs"), cellular phones, automated teller machines (ATM), have become more prevalent in recent years, the portability of systems as well as human-machine interface devices becomes increasingly important. Currently available user interface devices, such as keyboards, computer mice, joysticks, phone pads, remote controls, and/or touch screens, have various physical limitations and constraints. For example, a problem associated with the conventional user interface devices is portability because they are typically large and awkward to carry. Another problem associated with typical conventional user interface devices is lack of ergonomic considerations because various physical motions associated with button presses and key strokes can increase user's physical fatigue and discomfort.

SUMMARY

A method and apparatus of using a wearable remote interface device used for detecting inputs through various movements are disclosed. The wearable remote interface device, which could be attached to a finger or a hand or any parts of a body, includes a sensor, a filter, an input identifier, and a transmitter. The sensor, in one embodiment, is capable of sensing the movement of the finger or any part of body in which the wearable remote interface device is attached. Upon detecting the various movements associated with the finger, the filter subsequently removes any extraneous gestures from the detected movements. The input identifier, which could be a part of the filter, identifies one or more user inputs from the filtered movements. The transmitter transmits the input(s) to a processing device via a wireless communications network.

Additional features and benefits of the exemplary embodiment(s) of the present invention will become apparent from the detailed description, figures and claims set forth below.

BRIEF DESCRIPTION OF THE DRAWINGS

The exemplary embodiment(s) of the present invention will be understood more fully from the detailed description given below and from the accompanying drawings of various embodiments of the invention, which, however, should not be taken to limit the invention to the specific embodiments, but are for explanation and understanding only.

FIG. **1**A illustrates a remote input mechanism using a haptic ring interface device in accordance with one embodiment of the present invention;

FIG. **1**B illustrates a remote input mechanism using an interface device of haptic finger cap in accordance with one embodiment of the present invention;

FIG. **1**C illustrates a remote input mechanism using a haptic fingernail interface device in accordance with one embodiment of the present invention;

FIG. **1**D is another example of remote input mechanism illustrating a haptic fingernail tip interface device in accordance with one embodiment of the present invention;

FIG. **1**E is another example of remote input mechanism illustrating a touch screen with a wearable haptic ring in accordance with one embodiment of the present invention;

FIG. **2** is a block diagram illustrating a virtual keyboard using multiple remote finger rings in accordance with one embodiment of the present invention;

FIG. **3** is a block diagram illustrating a remote wearable interface device capable of sensing inputs in accordance with one embodiment of the present invention;

FIG. **4** illustrates a processing device capable of communicating with a wearable interface device in accordance with one embodiment of the present invention; and

FIG. **5** is a flowchart illustrating a process of providing a remote wearable interface device in accordance with one embodiment of the present invention.

DETAILED DESCRIPTION

Embodiments of the present invention are described herein in the context of a method, system and apparatus for communicating with a processing device using a remote wearable interface device. Those of ordinary skilled in the art will realize that the following detailed description of the present invention is illustrative only and is not intended to be in any way limiting. Other embodiments of the present invention will readily suggest themselves to such skilled persons having the benefit of this disclosure.

Reference will now be made in detail to implementations of the exemplary embodiments of the present invention as illustrated in the accompanying drawings. The same reference indicators (or numbers) will be used throughout the drawings and the following detailed description to refer to the same or like parts.

In the interest of clarity, not all of the standard hardware and routine features of the implementations described herein are shown and described. It will, of course, be appreciated that in the development of any such actual implementation, numerous implementation-specific decisions must be made in order to achieve the developer's specific goals, such as compliance with application- and business-related constraints, and that these specific goals will vary from one implementation to another and from one developer to another. Moreover, it will be appreciated that such a development effort might be complex and time-consuming, but would nevertheless be a routine undertaking of engineering for those of ordinary skilled in the art having the benefit of this disclosure.

A method and apparatus using a wearable remote interface device capable of detecting inputs from movements of the wearable remote device are disclosed. The wearable remote interface device, which could be attached to a finger or a hand or any parts of a body, includes a sensor, a filter, an input identifier, and a transmitter. The sensor, in one embodiment, is capable of sensing the movement of the finger or any part of body in which the wearable remote interface device is attached with. Upon detecting the various movements associated with the finger, for example, the filter subsequently removes any extraneous gestures from the detected movements. The input identifier, which could be a part of the filter, identifies one or more user inputs from the filtered movements. The transmitter transmits the input(s) to a processing device via a wireless communications network.

FIG. **1**A illustrates a remote input mechanism **100** using a haptic ring interface device **102** in accordance with one embodiment of the present invention. Mechanism **100**

includes a wearable haptic ring **102**, an index finger **106**, and a surface **104**, wherein wearable haptic ring **102** is capable of sensing inputs from movements of index finger **106**. It should be noted that the underlying concept of the exemplary embodiment of the present invention would not change if additional blocks (circuits or mechanical devices) were added to mechanism **100**.

Wearable haptic ring **102**, also known as a remote interface device or a wearable remote interface device or the like, is designed and structured in a ring shape that can be worn and/or fit on a finger as shown in FIG. **1**A. Various different physical designs of wearable haptic ring **102** may be used to fit for thumbs, index fingers, middle fingers, ring fingers, and/or small fingers to accommodate different sizes and shapes of human fingers. In addition, the shape of wearable haptic ring **102** is further adjusted to fit between the joints of distal interphalangeal ("DIP") joint and proximal interphalangeal ("PIP") joint or between the joints of PIP joint and metacarpophphalangeal ("MCP") joint. Different detecting capabilities of wearable haptic ring **102** may be required depending on the physical location of where wearable haptic ring **102** is attached. For example, the sensitivity of wearable haptic ring **102** attached at the joints between PIP joint and MCP joint can be very different than the sensitivity of wearable haptic ring **102** located at the joints between PIP joint and DIP joint partially due to the fact that for the same finger movements, the actual displacement of wearable haptic ring **102** is different depending on where it is located on the finger. For instance, the displacement of a fingertip is greater than the displacement of up portion (between PIP and MCP) of the finger for the same movement of a finger.

Surface **104**, in one embodiment, is a substantially flat surface such as a tabletop, a wall, or any similar surface that feels flat. When finger **106** touches or collides with surface **104**, wearable haptic ring **102** senses the motion or movement using an accelerometer or similar sensor(s). Upon detecting motion(s) and/or movement(s), wearable haptic ring **102** generates one or more user inputs such as a mouse click in response to the detected information. It should be noted that the detected information includes contacts, motions, positions, and the like. Vibrotactile feedback, in one embodiment, may be provided through a piezo, shape memory alloy ("SMA"), eccentric rotating mass ("ERM") or linear resonant actuator ("LRA"), or the like, to confirm the inputs. It should be noted that the terms "motion(s)" and "movement(s)" are used interchangeably herein. Also, the terms "detecting" and "sensing" are used interchangeably herein.

Wearable haptic ring **102** includes a sensor for sensing the movements and an actuator for providing vibrotactile or haptic feedback. In one embodiment, wearable haptic ring **102** includes a combined sensor and actuator device, which is capable of sensing the inputs such as a key stroke and providing the vibrotactile or haptic feedback to confirm the key stroke. Piezoelectric material, in one embodiment, may be used to construct the sensor/actuator device. Some materials such as piezoelectric material, have the physical property of sensing as well as providing vibrotactile effect. For example, piezoelectric material discharges a current indicating it detected a pressure when its physical shape deforms due to a pressure. The dimension of piezoelectric material can be reduced to a relatively small size such as 5 millimeters by 5 millimeters. Piezoelectric materials, in one embodiment, include crystals and/or ceramics such as quartz (SiO_2). When a voltage potential applies to the piezoelectric material, it deforms from its original shape to an expanded shape. Piezoelectric material may return to its original state as soon as the voltage potential is removed. Piezoelectric material, however, releases a current when it is being pressed. As a result, piezoelectric material can detect an input when it is being pressed.

Similar functions of sensor/actuator may be performed if the piezoelectric material is replaced with other devices such as LRA, ERM, and SMA, wherein SMA, for example, is capable of maintaining its deformed shape for a period of time after the voltage potential is removed. It should be noted that the underlying concept of the embodiments of the present invention does not change if different materials other than piezoelectric actuators are employed.

During the operation, wearable haptic ring **102** worn on a finger uses various sensors including an accelerometer to sense impacts between the fingertip(s) and a surface. Detected impacts and movements are used to identify input commands such as mouse button clicks, key strokes, and other selections. Haptic feedback, for example, is generated to confirm the input command(s) or selections such as a dash rotary button selection. The exemplary embodiment(s) of wearable haptic ring **102**, also referred to as smart fingertips or mouse replacement, provides a remote input/output ("I/O") device to interact with any computers and/or smart objects. The remote I/O device, for example, can be used in place of a computer mouse, a remote control, a keyboard, a phone pad, a touch pad, a touch screen, a touch-screen table computer, etc.

Referring back to FIG. **1**A, wearable haptic ring(s) **102** is configured to be a minimal touch interface device, which puts the input/output interaction at or near the fingertips for communicating with a computer or other electronic device, such as a server, a personal digital assistant ("PDA"), a smart phone, et cetera. Wearable haptic ring **102** attached to a finger or a fingertip can be unique because it operates between the finger(s) doing the touching and the object being touched, rather than confining the touch sensor in the object being touched. Any object or surface **104** can, in this embodiment, become a 'virtually active surface' as the fingertip remote can provide tactile information for any surface capable of communicating with a processing device. In other words, input gestures such as point/drag and button click can be made, for example, like on a touchpad, but is detected on virtually any surface, including user's own fingertips.

An advantage of using a wearable haptic ring **102** is to improve ergonomics because the ring is highly portable and it can be used with any surface(s). Surface **104** can be virtually any surface and it is a part of an interactive device with or without dynamic tactile feedback. Using a wearable haptic ring **102** as a remote interface device can minimize metatarsal syndrome since it reduces user's muscle fatigue and/or discomfort. Wearable haptic ring **102** is applicable to a game console, a universal remote, an interaction in an automobile, an interaction with any appliance, etc.

FIG. **1**B illustrates a remote input mechanism **110** having an interface device of haptic finger cap **112** in accordance with one embodiment of the present invention. Mechanism **110** includes a haptic finger cap **112**, an index finger **106**, and a surface **104**, wherein haptic finger cap **112** is capable of sensing inputs from movements of index finger **106**. It should be noted that the underlying concept of the exemplary embodiment of the present invention would not change if additional blocks were added to mechanism **110**.

Haptic finger cap **112** is configured to be worn on the tip of a finger and it is similar to a thimble or finger cot. In one embodiment, haptic finger cap **112**, having a calibrator, a power device, and a pressure sensor, is capable of detecting various movements associated to the finger, such as contact, motion, and/or position. The pressure sensor, for example, may include a piezo strip, which is configured to deform its

physical shape when it is being pressed. It should be noted that the piezo strip is also capable of providing vibrotactile feedback.

The power device, not shown in FIG. **1**B, provides and regulates sufficient power for haptic finger cap **112** to operate normally. For example, the power device may include a battery or a rechargeable battery. Alternatively, the power device may be capable of generating power via kinetic energy from a moving finger. Furthermore, solar energy, radio frequency, and the like may be used to generate sufficient power for haptic finger cap **112** to operate.

Calibrator, in one embodiment, initializes or calibrates haptic finger cap **112** to a specific virtual interface device, such as a virtual keyboard, a virtual mouse, a virtual keypad, a virtual remote control, another haptic finger cap, et cetera. In one embodiment, haptic finger cap **112** can be calibrated to communicate with a computer, a server, an appliance, or a television set, wherein the home appliance may include a phone, a refrigerator, a microwave oven, a dishwasher, or a washer/dryer. For example, to calibrate a virtual keyboard, a user wears one or more haptic finger caps **112** taps his/her index finger twice to activate the calibration process, and begins to tap "A" key, as of standard keyboard against a surface, and then "B" key. Once every single key on a virtual key board is taped or calibrated, haptic finger cap(s) **112** remembers the position of each key with respect to the surface. In another embodiment, different keyboard standards such as a French language keyboard standard may be calibrated.

Haptic finger cap **112**, in another embodiment, is used to enhance building or facility securities. In one embodiment, haptic finger cap **112** is configured to communicate with a hidden switch, wherein the hidden switch is visible or detectable through haptic finger cap **112**. An invisible or hidden switch may be used to open or shut a door and the switch can only be switched on or off by haptic finger cap **112**. For instance, a user feels a hidden switch via haptic finger cap **112** when the user moves closer to a door. The hidden switch could be a simple on/off switch or a keypad, which requires a secret code for authentication. Upon feeling a virtual switch via haptic feedback due to the presence of nearby hidden switch, the user can enter the secret code on a virtual keypad of the hidden switch to open the door. For a simple on/off switch, the user can simply switch on or off the virtual switch remotely via haptic finger cap **112**. It should be noted that an initial calibration process may be needed for haptic finger cap **112** to configure it as a virtual switch.

In another embodiment, a medical device containing remote haptic mechanism **110** can be embedded in a user's body under the skin for detecting user's input signals. For example, a disabled person may need to use his or her foot or mouth to generate inputs. It should be noted that the embedded device may also be applicable to livestock and/or animals.

FIG. **1**C illustrates an input mechanism **120** having a haptic fingernail interface device **122** capable of sensing inputs in accordance with one embodiment of the present invention. Mechanism **120** includes a haptic fingernail **122**, an index finger **106**, and a surface **104**, wherein haptic fingernail **122** is configured to sense inputs from movements of index finger **106**. It should be noted that the underlying concept of the exemplary embodiment of the present invention would not change if additional blocks were added to mechanism **120**.

Haptic fingernail **122**, in one embodiment, is attached to a finger nail bed. Haptic fingernail **122**, for example, may be attached on top of the nail or attached at or with an artificial nail. Haptic fingernail **122** is configured to perform similar functions as haptic finger cap **112** and/or wearable haptic ring **102**. In one embodiment, haptic fingernail **122** detects movements of finger **106** such as a contact with a surface **104**, or a downward motion of a hand, or a new position from its previous position via an accelerometer and/or through detection of a local deflection of nail surface caused by contact.

FIG. **1**D is another example of remote input mechanism **130** illustrating a haptic fingernail tip interface device **132** capable of sensing inputs in accordance with one embodiment of the present invention. Mechanism **130** includes a haptic fingernail tip interface device **132**, an index finger **106**, and a surface **104**, wherein haptic fingernail tip interface device **132** can detect inputs from movements of index finger **106**. It should be noted that the underlying concept of the exemplary embodiment of the present invention would not change if additional blocks were added to mechanism **130**.

Haptic fingernail tip interface device **132** is, in one embodiment, placed underneath the tip of a fingernail. Similar to haptic fingernail **122**, haptic finger cap **112** and wearable haptic ring **102**, haptic fingernail tip interface device **132** is capable of detecting finger movements such as contact, motion, and position, via finger pressure with respect to surface **104**. In one example, vibrotactile or "click" sensations may be provided via piezo or electrically trigger mechanical mechanisms.

FIG. **1**E is another example of remote input mechanism **140** illustrating a touch screen with a wearable haptic ring **142** in accordance with one embodiment of the present invention. Mechanism **140** includes a wearable ring **142**, a finger **106**, a touch screen **144**, and a computer **146** wherein computer **146** is connected to touch screen **144** via a cable **148**. Wearable haptic ring **142** together with touch screen **144**, in one embodiment, creates a touch screen with remote fingertip haptic effect, in which touch screen **144** provides location information to computer **146** while wearable haptic ring **142** provides haptic effects such as contact click in response to touch screen **144**, which may be a non-haptic touch screen.

The exemplary embodiment(s) of the present invention may replace tactile touch screens with a device using touch inputs such as touch screen **144** and tactile output such as wearable haptic ring **142**. Different images displayed in touch screen **144** may receive different feelings without moving or vibrating the screen.

An advantage of the exemplary embodiment(s) of the present invention is portability since wearable interface device is lightweight and can be worn without being removed when it is not in use. Since computer mice and/or keyboards are large and awkward to carry, wearable interface device can be calibrated to replace such input devices. It should be noted that button presses can be replaced with surface taps.

Another advantage of wearable interface device is simplicity wherein sensors and actuators are located on the sensory organ. For example, ten wearable rings with ten (10) sensors and ten (10) actuators may be needed to achieve the function of a keyboard or other input/output configurations.

FIG. **2** is a block diagram **250** illustrating a virtual keyboard **280** using multiple wearable haptic rings **260-268** in accordance with one embodiment of the present invention. Diagram **250** includes a hand **252**, a server **254**, a personal computer ("PC") **256**, and a virtual keyboard **280**. Hand **252** further includes five wearable haptic rings **260-268** wherein wearable haptic ring **260** is on the thumb, wearable haptic ring **262** is on the index finger, wearable haptic ring **264** is on the middle finger, wearable haptic ring **266** is on the ring finger, and wearable haptic ring **268** is on the small finger. It should be noted that the underlying concept of the exemplary embodiment of the present invention would not change if

additional blocks (circuits or mechanical devices) were added to diagram **250**. It should be further noted that the underlying concept of the exemplary embodiment of the present invention would not change if wearable haptic rings **268** is replaced with haptic finger caps **112**, haptic fingernails **122**, haptic fingernail tips **132**, or a combination of rings, caps, fingernails and tips.

After initial calibration process, wearable haptic rings **260-268**, also known as remote finger rings, are programmed to track the relationship between each finger and the key locations of a virtual keyboard **280**. For instance, wearable haptic rings **260-268** track the locations of every keys, such as the locations of function keys **282** and locations of number keys **284**, and detect "virtual key strokes" when various locations are being contacted or tapped by finger(s). When hands and/or fingers are in motion, wearable haptic rings **260-268** detect inputs from movements of the fingers in accordance with the virtual keyboard **280** and transmit the inputs to server **254**. In one embodiment, vibrotactile feedback may be used to confirm the inputs. It should be noted that an additional left hand, which is not shown in FIG. **2**, with five wearable haptic rings may be added to diagram **250**.

In an alternative embodiment, a piece of paper having a printed standard keyboard picture is used in place of virtual keyboard **280**. Wearable haptic rings **260-268** are calibrated in accordance with the printed keyboard picture on the paper. A user can 'type' or tap on the paper as a regular standard keyboard and the motions of tapping such as key strokes over the paper are detected by wearable haptic rings **260-268**. For example, various user inputs are delineated through various movements, such as pressure on fingertips, collisions on impacts, speed of tapping, and positions from finger to finger. After processing the information of contact, collision and position, wearable haptic rings **260-268** can identify and distinguish gestures, such as pressing buttons and typing on a particular key on a keyboard.

The exemplary embodiment(s) of the present invention places a sensor and/or actuator at or near a user's fingertips to detect contacts and collisions with a surface and to translate the detected motions into control signals for a computer or a similar device. The user touches a surface with specific command gestures, which may or may not mimic natural motions as pointing, dragging, and button clicking, wearable haptic ring(s) or remote finger ring(s) identify the gestures or movements associated with an input command, and filter out other extraneous motions of a hand. The input command is subsequently used to control server **254** and/or PC **256**. Server **254** or PC **256**, in one embodiment, sends haptic data to wearable haptic rings **260-268** for generating a specific type of vibrotactile feedback to confirm the receipt of input command. Haptic data, for example, may also include information relating to virtual textures, input request, an alert, or the like.

FIG. **3** is a block diagram **300** illustrating a remote wearable interface device **302** capable of sensing inputs in accordance with one embodiment of the present invention. Diagram **300** includes a wearable interface device **302**, a PC **304**, a cellular phone **306**, a PDA **308**, a server **310**, and a processing device **312**, which is capable of executing instructions. It should be noted that the underlying concept of the exemplary embodiment of the present invention would not change if additional blocks such as power supply were added to or removed from diagram **300**.

Wearable interface device **302** further includes a sensor **320**, an internal filter **322**, a selector **324**, a generator **326**, and a haptic output device **328**. In one embodiment, sensor **320** is configured to detect position, collision, touch, and contact motions in accordance with the movements of wearable interface device **302**. Filter **322** is used to filter any extraneous movements, which are considered as natural hand movements as oppose to command input movements such as clicking a mouse button. In another embodiment, internal filter **322** is located in a host computer, wherein the filtering process is implemented by a host processor. Generator **326** generates commands in response to the filtered movements and transmits the input commands to one or more processing devices such as PC **304** or PDA **308** via various communication channels **332-338**, which may be wired or wireless communications.

Selector **324** includes one or more libraries used for filing and storing haptic data containing a list of haptic effects. In one embodiment, the list of haptic effects is used to provide a haptic feedback to a user confirming the selected input(s). Each input may have a unique confirmation haptic effect. For example, different input command activates a unique haptic effect to indicate the input command. It should be noted that the library containing haptic data may be located in a host computer. Haptic output device **328** generates haptic feedback in accordance with the haptic data from selector **324**. For example, a vibration effect emulates a mouse click.

A function of wearable haptic ring **102** is that once it is attached to a finger, it uses multiple sensors such as gesture recognition, acceleration, and collision sensing capabilities, to detect and/or sense inputs associated with various finger movements. An application of wearable haptic ring **102** is to emulate a virtual mouse. To emulate a virtual mouse, multiple wearable haptic rings **102** or a glove with multiple haptic fingers may be needed. A user worn wearable haptic ring **102**, for example, calibrates and emulates a mouse button click by tapping his or her finger on a surface **104**. Unlike traditional mouse movements, wearable haptic ring **102** tracks finger motions as well as finger forces. It should be noted that wearable haptic ring **102** can be attached to a finger, a hand, a head, an arm, and the like. Also, wearable haptic ring **102** can emulate any types of virtual input devices such as a virtual keyboard, a virtual keypad, a virtual switch, et cetera.

Having briefly described several embodiments of remote wearable haptic rings capable of communicating with one or more processing devices in which the exemplary embodiment (s) of the present invention operates, FIG. **4** illustrates a processing device **200**. Computer system **200** includes a processing unit **201**, an interface bus **211**, and an input/output ("IO") unit **220**. Processing unit **201** includes a processor **202**, a main memory **204**, a system bus **211**, a static memory device **206**, a bus control unit **205**, a mass storage memory **207**, and an actuator control **230**. Bus **211** is used to transmit information between various components and processor **202** for data processing. Processor **202** may be any of a wide variety of general-purpose processors or microprocessors such as Pentium™ microprocessor, Intel® Core™2 Duo, Intel® Core™2 Quad, Intel® Xeon®, AMD Athlon™ processor, Motorola™ 68040, or Power PC™ microprocessor. Actuator control **230** generates haptic feedback in response to user inputs.

Main memory **204**, which may include multiple levels of cache memories, stores frequently used data and instructions. Main memory **204** may be RAM (random access memory), MRAM (magnetic RAM), or flash memory. Static memory **206** may be a ROM (read-only memory), which is coupled to bus **211**, for storing static information and/or instructions. Bus control unit **205** is coupled to buses **211-212** and controls which component, such as main memory **204** or processor **202**, can use the bus. Bus control unit **205** manages the communications between bus **211** and bus **212**. Mass storage memory **207**, which may be a magnetic disk, an optical disk,

hard disk drive, floppy disk, CD-ROM, and/or flash memories for storing large amounts of data. Actuator control module **230**, in one embodiment, is an independent component (IC) that performs functions of haptic effect control. A function of actuator control **230** is to drive one or more haptic actuators **224**, which could be a remote wearable ring. In another embodiment, actuator control module **230** may reside within processor **202**, main memory **204**, and/or static memory **206**.

I/O unit **220**, in one embodiment, includes a flexible display **221**, keyboard **222**, cursor control device **223**, and communication device **225**. Keyboard **222** may be a conventional alphanumeric input device for communicating information between computer system **200** and computer operator(s). Another type of user input device is cursor control device **223**, such as a conventional mouse, touch mouse, trackball, a finger or other type of cursor for communicating information between system **200** and user(s). Communication device **225** is coupled to bus **211** for accessing information from remote computers or servers, such as server **104** or other computers, through wide-area network. Communication device **225** may include a modem or a wireless network interface device, or other similar devices that facilitate communication between computer **200** and the network.

The exemplary embodiment(s) of the present invention includes various processing steps, which will be described below. The steps of the embodiments may be embodied in machine or computer executable instructions. The instructions can be used to cause a general purpose or special purpose system, which is programmed with the instructions, to perform the steps of the present invention. Alternatively, the steps of the present invention may be performed by specific hardware components that contain hard-wired logic for performing the steps, or by any combination of programmed computer components and custom hardware components. While embodiments of the present invention will be described with reference to the Internet, the method and apparatus described herein is equally applicable to other network infrastructures or other data communications environments.

FIG. **5** is a flowchart illustrating a process of communicating with a remote wearable interface device in accordance with one embodiment of the present invention. At block **502**, the process activates at least one sensor and one actuator in a wearable remote interface device. It should be noted that the sensor and actuator can be a single device. For example, a piezoelectric material may be used for the sensor/actuator device. After block **502**, the process moves to the next block.

At block **504**, the process uses sensor(s) to detect various input motions or movements relating to the wearable remote interface device. As described earlier, the wearable remote interface device can be the wearable haptic ring, the haptic finger cap, the haptic fingernail interface device, or the haptic fingernail tip interface device. In one embodiment, the process is capable of sensing a contact between the finger and a surface and identifying the location for which the contact was made. Alternatively, the process is also capable of sensing a collision between the finger and the surface. Furthermore, the process is able to sense or track the physical location of the finger tip relative to the surface. After block **504**, the process moves to the next block.

At block **506**, the process is configured to filter extraneous gestures or motions from the input motion. In one embodiment, the extraneous gesture or extraneous motion is related to the nature of a hand movement. An input gesture, for example, includes an act of clicking a mouse button or striking a key. Once the extraneous motions are removed, the input motion contains input command(s). After block **506**, the process proceeds to the next block.

At block **508**, the process identifies one or more input commands from the input motion. In one embodiment, the process identifies the input command(s) from the motions in accordance with the calibration of wearable remote interface device. For example, the wearable remote interface device is calibrated to multiple virtual input devices such as a virtual keyboard and a virtual mouse. After block **508**, the process proceeds to the next block.

At block **510**, the process transmits the input command(s) to a processing device via a wireless communications network. The processing device can be a server, a PC, a phone, PDA, et cetera. The wireless communications network may use Bluetooth wireless technology. It should be noted that the wearable remote interface device may be attached to any finger. The process, in one embodiment, is configured to calibrate the wearable remote interface device to a virtual mouse with respect to a surface. Alternatively, the process calibrates the wearable remote interface to a virtual keyboard and a virtual mouse with respect to a surface. Upon generating a tactile feedback signal in response to the input command, the process provides tactile feedback via the actuator in accordance with the tactile feedback signal acknowledging the receipt of the input command.

An advantage of the exemplary embodiment(s) of the invention is to improve ergonomics, wherein physical nature of grasping and moving a given mechanism such as mouse, constrains natural motion of a hand, which often leads to repetitive muscle/joints stress and physical injuries such as carpal tunnel syndrome. By removing the constraining mechanism from the interface, the fingertip remote allows a wide range of motion which can be configured to a user's natural range of motions.

Another advantage of the exemplary embodiment(s) of the invention is to eliminate a need for interactive surface. To communicate with a computer, wearable interface device allows a user to use any surface, including users' own fingertips. For example, while a traditional mouse requires motion across a smooth horizontal surface, fingertip remotes or wearable interface devices allow users to use any surface including their fingertips, seatbacks on an airplane, users' legs, or arms.

While particular embodiments of the present invention have been shown and described, it will be obvious to those skilled in the art that, based upon the teachings herein, changes and modifications may be made without departing from this invention and its broader aspects. Therefore, the appended claims are intended to encompass within their scope all such changes and modifications as are within the true spirit and scope of the exemplary embodiment(s) of is present invention.

What is claimed is:

1. A wearable remote interface device comprising:

a sensor capable of sensing movements of the wearable remote interface device;

a filter coupled to the sensor and configured to remove extraneous gestures from the movements;

an input identifier coupled to the filter and operable to generate an input in response to the movements; and

a transmitter coupled to the input identifier and capable of transmitting the input to a processing device via a wireless communications network.

2. The device of claim **1**, further comprising a finger attaching mechanism coupled to the wearable remote interface device and capable of attaching the wearable remote interface device to a finger.

3. The device of claim 2, further comprising a calibrator coupled to the sensor and capable of calibrating the wearable remote interface device into one of multiple virtual input and output interface devices.

4. The device of claim 3, wherein the calibrator is capable of calibrating the wearable remote interface device into a virtual keyboard.

5. The device of claim 1, further comprising an actuator coupled to the sensor and operable to provide tactile feedback.

6. The device of claim 5, wherein the tactile feedback indicates a confirmation of the input.

7. The device of claim 1, wherein the sensor capable of sensing movements of the wearable remote interface device further includes:

a first detector capable of detecting a contact with a first surface; and

a second detector capable of detecting a collision with a second surface.

8. The device of claim 7, wherein the first detector and the second detector are the same device; and wherein the first surface and the second surface are the same surface.

9. The device of claim 1, wherein the sensor capable of sensing movements of the wearable remote interface device further includes a tracking component capable of tracking physical position of the wearable remote interface device.

10. The device of claim 1, wherein the filter removes extraneous motion relating to natural muscle reflex from the movement.

11. An embedded device configured to be embedded in a body under skin includes the device of claim 1.

12. A method for providing inputs from a remote interactive interface device, comprising:

activating at least one sensor and actuator in a wearable remote interface device;

detecting input motions relating to the wearable remote interface device;

filtering extraneous gesture motion from the input motion;

identifying at least one input command from the input motion; and

transmitting the input command to a processing device via a wireless communications network.

13. The method of claim 12, further comprising attaching the wearable remote interface device to a finger.

14. The method of claim 13, further comprising calibrating the wearable remote interface device to a virtual mouse in response to a surface.

15. The method of claim 14, further comprising calibrating the wearable remote interface to a virtual keyboard and a virtual mouse in response to a surface.

16. The method of claim 15, further comprising:

generating a tactile feedback signal in response to the input command; and

providing a tactile feedback via the actuator in accordance with the tactile feedback signal acknowledging receipt of the input command.

17. The method of claim 13, wherein detecting input motions relating to the wearable remote interface device further includes sensing a contact between the finger and a surface.

18. The method of claim 13, wherein detecting input motions relating to the wearable remote interface device further includes sensing a collision between the finger and a surface.

19. The method of claim 13, wherein detecting input motions relating to the wearable remote interface device further includes sensing a physical location of the finger relative to a surface.

20. A system comprising:

a processing device capable of executing instructions; and

a fingertip remote haptic device coupled to the processing device via a wireless communications network, wherein the fingertip remote haptic device further includes,

a sensor configured to detect movements including a contact input and a collision input between a finger and a surface;

a filter coupled to the sensor and capable of removing extraneous information from the movements;

a command generator coupled to the filter and operable to generate input in response to the movements;

an actuator coupled to the filter and capable of providing a tactile feedback to the finger confirming the input.

21. The system of claim 20, wherein the fingertip remote haptic device further includes a calibrator coupled to the sensor and configured to calibrate the fingertip remote haptic device to a virtual keyboard in response to the surface.

22. The system of claim 20, wherein the sensor is further capable of tracking relative position between the fingertip remote haptic device and the surface.

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