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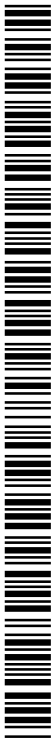
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(54) Title: ESTIMATING SKIN PIGMENTATION TO ESTIMATE SUNBURN AND MELANOMA RISK

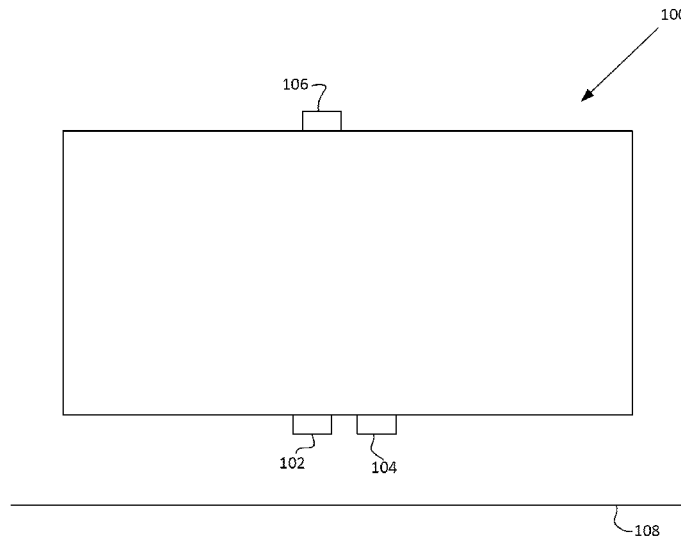


FIG. 1

(57) Abstract: Melanin is a pigment present in human skin that can absorb ultraviolet (UV) light and thereby protect the skin from harmful effects of UV rays, such as sunburn and melanoma. Examples of the present disclosure are directed to methods of determining health risks, such as the risk of sunburn and melanoma, based on an estimate of melanin concentration in the skin of a user and a determination of ambient UV light.

ESTIMATING SKIN PIGMENTATION TO ESTIMATE SUNBURN AND MELANOMA RISK

Field of the Disclosure

[0001] This relates generally to determining health risks due to ultraviolet (UV) light exposure.

Background of the Disclosure

[0002] Melanin is a pigment present in human skin that can absorb ultraviolet (UV) light and thereby protect the skin from harmful effects of UV rays, such as sunburn and melanoma.

Summary of the Disclosure

[0003] Examples of the present disclosure are directed to methods of determining health risks, such as the risk of sunburn and melanoma, based on an estimate of melanin concentration in the skin of a user and a determination of ambient UV light.

Brief Description of the Drawings

[0004] FIG. 1 illustrates an electronic device having an ambient UV light sensor, a light emitter, and a melanin concentration sensor according to examples of the disclosure.

[0005] FIG. 2 illustrates a method of determining a health risk to a user according to examples of the disclosure.

[0006] FIG. 3 is a block diagram illustrating an exemplary API architecture, which may be used in some examples of the disclosure.

[0007] FIG. 4 illustrates an exemplary software stack of an API according to examples of the disclosure.

[0008] FIG. 5 is a block diagram illustrating exemplary interactions between the touch screen and other components of the device according to examples of the disclosure.

[0009] FIG. 6 is a block diagram illustrating an example of a system architecture that may be embodied within any portable or non-portable device according to examples of the disclosure.

Detailed Description

[0010] In the following description of examples, reference is made to the accompanying drawings which form a part hereof, and in which it is shown by way of illustration specific examples that can be practiced. It is to be understood that other examples can be used and structural changes can be made without departing from the scope of the disclosed examples.

[0011] Melanin is a pigment present in human skin that can absorb ultraviolet (UV) light and thereby protect the skin from harmful effects of UV rays, such as sunburn and melanoma. Examples of the present disclosure are directed to methods of determining health risks, such as the risk of sunburn and melanoma, based on an estimate of melanin concentration in the skin of a user and a determination of ambient UV light.

[0012] Although examples disclosed herein may be described and illustrated herein primarily in terms of two sensors, one for sensing melanin and a second for sensing UV light, it should be understood that the examples are not so limited, but are additionally applicable to a single sensor that senses both melanin concentration in the skin of a user and ambient UV light. Additionally, although examples describe sensors as photodiodes and/or photothermal sensors, other sensors may be used to determine melanin concentration and/or ambient UV light.

[0013] FIG. 1 illustrates an electronic device 100 having an ambient UV light sensor 106, a light emitter 102, and a melanin concentration sensor 104 according to examples of the disclosure. The electronic device may be situated proximate to skin 108 of a user so that the melanin concentration sensor 104 faces the skin. For example, the electronic device may be held in the hand of the user or strapped to the user's wrist. In some examples, the light emitter 102 may be co-located with the melanin concentration sensor 104.

[0014] In some examples, the light emitter 102 can emit light having a wavelength in the UV spectrum. For example, the light emitter 102 can emit light having a wavelength of 390 nm, among other possibilities. The light may be emitted to the skin 108, and a portion of the light may be absorbed by melanin in the skin. In some examples, the melanin concentration sensor 104 may include a photodiode configured to sense UV light reflected back, which can be used to estimate an amount of UV light absorbed by melanin in the skin 108, indicating a melanin concentration in the skin of the user. In other examples, the melanin concentration sensor 104 may include a photothermal sensor configured to measure a heat change of the skin 108 due to the absorbance of UV light by the melanin, which can also indicate a melanin concentration in the skin of the user. In some examples, an electronic device may or may not include a light emitter as illustrated in FIG. 1, and some other method may be used to sense a melanin concentration.

[0015] In some examples, the ambient UV light sensor 106 may be a photodiode configured to sense the incidence of light having a wavelength in the UV spectrum. Additionally, the ambient UV light sensor 106 may produce information indicating an amount of UV light incident on the sensor.

[0016] FIG. 2 illustrates a method of determining a health risk to a user according to examples of the disclosure. First light information may be received from a first sensor (200). The first sensor may be a melanin concentration sensor as described above with reference to FIG. 1. The first light information may include an amount of UV light reflected back on the first sensor and/or an estimated amount of UV light absorbed by melanin in the skin of the user, among other possibilities.

[0017] A skin melanin concentration of the user may be determined based on the first light information (204). As described above, the UV light reflected back on the first sensor and/or the UV light absorbed by melanin in the skin of the user may be used to estimate a melanin concentration.

[0018] Second light information may be received from a second sensor (202). The second sensor may be an ambient UV light sensor as described above with reference to FIG. 1. The second light information may include an amount of UV light incident on the second sensor.

[0019] Based on the skin melanin concentration of the user and the second light information, a health risk to the user may be determined (206). The skin melanin concentration can indicate a susceptibility of the user to sunburn and/or melanoma, and the second light information can indicate a present exposure to sunburn/melanoma-causing UV light. Accordingly, a risk of sunburn and/or melanoma can be determined. For example, if the skin melanin concentration indicates that a user is particularly susceptible to a sunburn, and the second light information from an ambient UV light sensor indicates that there is not enough ambient UV light to cause a sunburn, then it can be determined that there is no risk of a sunburn. However, in a similar situation, if the second light information indicates there is enough ambient UV light to cause a sunburn where a user is susceptible to a sunburn, then it can be determined that there is a risk of sunburn. A similar determination can be made for melanoma risk and other health risks associated with exposure to UV light.

[0020] Although present melanin concentration can indicate the skin's ability to absorb UV light, a naturally fair-skinned person may still be more susceptible to melanoma even if that person has increased melanin concentration due to tanning. For example, some fair-skinned people have more pheomelanin in their skin, which can contribute to carcinogenesis of melanoma. An average melanin concentration may be more indicative of naturally fair skin than a present melanin concentration, and thus a health risk to a user may be further determined based on an average skin melanin concentration.

[0021] In some examples, a skin melanin concentration may be determined more than once for a single user, and the skin melanin concentration may be stored in association with an identity of the user. In such a case, the concentrations may be aggregated and/or averaged to determine a risk category for the user. For example, an average melanin concentration may indicate that a user has naturally fair skin, and thus it may be determined that the user belongs to a category of those at risk for melanoma. Then, based on the risk category and sensor information indicating exposure to UV light, it may be determined that the user is presently at risk for melanoma. In some examples, a minimum or maximum melanin concentration may be determined and then used to determine a risk category and/or a health risk to the user.

[0022] In some examples, a determined health risk may be displayed on a display of the electronic device or transmitted to another electronic device for display. The user may be notified of the health risk through the display, haptic feedback, and/or an auditory cue, among other possibilities.

[0023] The examples discussed above can be implemented in one or more Application Programming Interfaces (APIs). An API is an interface implemented by a program code component or hardware component (hereinafter “API-implementing component”) that allows a different program code component or hardware component (hereinafter “API-calling component”) to access and use one or more functions, methods, procedures, data structures, classes, and/or other services provided by the API-implementing component. An API can define one or more parameters that are passed between the API-calling component and the API-implementing component.

[0024] The above-described features can be implemented as part of an application program interface (API) that can allow it to be incorporated into different applications (*e.g.*, spreadsheet apps) utilizing touch input as an input mechanism. An API can allow a developer of an API-calling component (which may be a third party developer) to leverage specified features, such as those described above, provided by an API-implementing component. There may be one API-calling component or there may be more than one such component. An API can be a source code interface that a computer system or program library provides in order to support requests for services from an application. An operating system (OS) can have multiple APIs to allow applications running on the OS to call one or more of those APIs, and a service (such as a program library) can have multiple APIs to allow an application that uses the service to call one or more of those APIs. An API can be specified in terms of a programming language that can be interpreted or compiled when an application is built.

[0025] In some examples, the API-implementing component may provide more than one API, each providing a different view of the functionality implemented by the API-implementing component, or with different aspects that access different aspects of the functionality implemented by the API-implementing component. For example, one API of an API-implementing component can provide a first set of functions and can be exposed to third party developers, and another API of the API-implementing component can be hidden (not exposed) and provide a subset of the first set of functions and also

provide another set of functions, such as testing or debugging functions which are not in the first set of functions. In other examples the API-implementing component may itself call one or more other components via an underlying API and thus be both an API-calling component and an API-implementing component.

[0026] An API defines the language and parameters that API-calling components use when accessing and using specified features of the API-implementing component. For example, an API-calling component accesses the specified features of the API-implementing component through one or more API calls or invocations (embodied for example by function or method calls) exposed by the API and passes data and control information using parameters via the API calls or invocations. The API-implementing component may return a value through the API in response to an API call from an API-calling component. While the API defines the syntax and result of an API call (e.g., how to invoke the API call and what the API call does), the API may not reveal how the API call accomplishes the function specified by the API call. Various API calls are transferred via the one or more application programming interfaces between the calling (API-calling component) and an API-implementing component. Transferring the API calls may include issuing, initiating, invoking, calling, receiving, returning, or responding to the function calls or messages; in other words, transferring can describe actions by either of the API-calling component or the API-implementing component. The function calls or other invocations of the API may send or receive one or more parameters through a parameter list or other structure. A parameter can be a constant, key, data structure, object, object class, variable, data type, pointer, array, list or a pointer to a function or method or another way to reference a data or other item to be passed via the API.

[0027] Furthermore, data types or classes may be provided by the API and implemented by the API-implementing component. Thus, the API-calling component may declare variables, use pointers to, use or instantiate constant values of such types or classes by using definitions provided in the API.

[0028] Generally, an API can be used to access a service or data provided by the API-implementing component or to initiate performance of an operation or computation provided by the API-implementing component. By way of example, the API-implementing component and the API-calling component may each be any one of an operating system, a library, a device driver, an API, an application program, or other

module (it should be understood that the API-implementing component and the API-calling component may be the same or different type of module from each other). API-implementing components may in some cases be embodied at least in part in firmware, microcode, or other hardware logic. In some examples, an API may allow a client program to use the services provided by a Software Development Kit (SDK) library. In other examples an application or other client program may use an API provided by an Application Framework. In these examples the application or client program may incorporate calls to functions or methods provided by the SDK and provided by the API or use data types or objects defined in the SDK and provided by the API. An Application Framework may in these examples provide a main event loop for a program that responds to various events defined by the Framework. The API allows the application to specify the events and the responses to the events using the Application Framework. In some implementations, an API call can report to an application the capabilities or state of a hardware device, including those related to aspects such as input capabilities and state, output capabilities and state, processing capability, power state, storage capacity and state, communications capability, etc., and the API may be implemented in part by firmware, microcode, or other low level logic that executes in part on the hardware component.

[0029] The API-calling component may be a local component (i.e., on the same data processing system as the API-implementing component) or a remote component (i.e., on a different data processing system from the API-implementing component) that communicates with the API-implementing component through the API over a network. It should be understood that an API-implementing component may also act as an API-calling component (i.e., it may make API calls to an API exposed by a different API-implementing component) and an API-calling component may also act as an API-implementing component by implementing an API that is exposed to a different API-calling component.

[0030] The API may allow multiple API-calling components written in different programming languages to communicate with the API-implementing component (thus the API may include features for translating calls and returns between the API-implementing component and the API-calling component); however the API may be implemented in terms of a specific programming language. An API-calling component can, in one

example, call APIs from different providers such as a set of APIs from an OS provider and another set of APIs from a plug-in provider and another set of APIs from another provider (e.g. the provider of a software library) or creator of the another set of APIs.

[0031] FIG. 3 is a block diagram illustrating an exemplary API architecture, which may be used in some examples of the disclosure. As shown in FIG. 3, the API architecture 600 includes the API-implementing component 610 (e.g., an operating system, a library, a device driver, an API, an application program, software or other module) that implements the API 620. The API 620 specifies one or more functions, methods, classes, objects, protocols, data structures, formats and/or other features of the API-implementing component that may be used by the API-calling component 630. The API 620 can specify at least one calling convention that specifies how a function in the API-implementing component receives parameters from the API-calling component and how the function returns a result to the API-calling component. The API-calling component 630 (e.g., an operating system, a library, a device driver, an API, an application program, software or other module), makes API calls through the API 620 to access and use the features of the API-implementing component 610 that are specified by the API 620. The API-implementing component 610 may return a value through the API 620 to the API-calling component 630 in response to an API call.

[0032] It will be appreciated that the API-implementing component 610 may include additional functions, methods, classes, data structures, and/or other features that are not specified through the API 620 and are not available to the API-calling component 630. It should be understood that the API-calling component 630 may be on the same system as the API-implementing component 610 or may be located remotely and accesses the API-implementing component 610 using the API 620 over a network. While FIG. 3 illustrates a single API-calling component 630 interacting with the API 620, it should be understood that other API-calling components, which may be written in different languages (or the same language) than the API-calling component 630, may use the API 620.

[0033] The API-implementing component 610, the API 620, and the API-calling component 630 may be stored in a non-transitory machine-readable storage medium, which includes any mechanism for storing information in a form readable by a machine (e.g., a computer or other data processing system). For example, a machine-readable

medium includes magnetic disks, optical disks, random access memory; read only memory, flash memory devices, etc.

[0034] In the exemplary software stack shown in FIG. 4, applications can make calls to Services A or B using several Service APIs and to Operating System (OS) using several OS APIs. Services A and B can make calls to OS using several OS APIs.

[0035] Note that the Service 2 has two APIs, one of which (Service 2 API 1) receives calls from and returns values to Application 1 and the other (Service 2 API 2) receives calls from and returns values to Application 2. Service 1 (which can be, for example, a software library) makes calls to and receives returned values from OS API 1, and Service 2 (which can be, for example, a software library) makes calls to and receives returned values from both OS API 1 and OS API 2. Application 2 makes calls to and receives returned values from OS API 2.

[0036] FIG. 5 is a block diagram illustrating exemplary interactions between the touch screen and the other components of the device. Described examples may include touch I/O device 1001 that can receive touch input for interacting with computing system 1003 via wired or wireless communication channel 1002. Touch I/O device 1001 may be used to provide user input to computing system 1003 in lieu of or in combination with other input devices such as a keyboard, mouse, etc. One or more touch I/O devices 1001 may be used for providing user input to computing system 1003. Touch I/O device 1001 may be an integral part of computing system 1003 (e.g., touch screen on a smartphone or a tablet PC) or may be separate from computing system 1003.

[0037] Touch I/O device 1001 may include a touch sensing panel which is wholly or partially transparent, semitransparent, non-transparent, opaque or any combination thereof. Touch I/O device 1001 may be embodied as a touch screen, touch pad, a touch screen functioning as a touch pad (e.g., a touch screen replacing the touchpad of a laptop), a touch screen or touchpad combined or incorporated with any other input device (e.g., a touch screen or touchpad disposed on a keyboard) or any multi-dimensional object having a touch sensing surface for receiving touch input.

[0038] In one example, touch I/O device 1001 embodied as a touch screen may include a transparent and/or semitransparent touch sensing panel partially or wholly positioned over at least a portion of a display. According to this example, touch I/O

device 1001 functions to display graphical data transmitted from computing system 1003 (and/or another source) and also functions to receive user input. In other examples, touch I/O device 1001 may be embodied as an integrated touch screen where touch sensing components/devices are integral with display components/devices. In still other examples a touch screen may be used as a supplemental or additional display screen for displaying supplemental or the same graphical data as a primary display and to receive touch input.

[0039] Touch I/O device 1001 may be configured to detect the location of one or more touches or near touches on device 1001 based on capacitive, resistive, optical, acoustic, inductive, mechanical, chemical measurements, or any phenomena that can be measured with respect to the occurrences of the one or more touches or near touches in proximity to device 1001. Software, hardware, firmware or any combination thereof may be used to process the measurements of the detected touches to identify and track one or more gestures. A gesture may correspond to stationary or non-stationary, single or multiple, touches or near touches on touch I/O device 1001. A gesture may be performed by moving one or more fingers or other objects in a particular manner on touch I/O device 1001 such as tapping, pressing, rocking, scrubbing, twisting, changing orientation, pressing with varying pressure and the like at essentially the same time, contiguously, or consecutively. A gesture may be characterized by, but is not limited to a pinching, sliding, swiping, rotating, flexing, dragging, or tapping motion between or with any other finger or fingers. A single gesture may be performed with one or more hands, by one or more users, or any combination thereof.

[0040] Computing system 1003 may drive a display with graphical data to display a graphical user interface (GUI). The GUI may be configured to receive touch input via touch I/O device 1001. Embodied as a touch screen, touch I/O device 1001 may display the GUI. Alternatively, the GUI may be displayed on a display separate from touch I/O device 1001. The GUI may include graphical elements displayed at particular locations within the interface. Graphical elements may include but are not limited to a variety of displayed virtual input devices including virtual scroll wheels, a virtual keyboard, virtual knobs, virtual buttons, any virtual UI, and the like. A user may perform gestures at one or more particular locations on touch I/O device 1001 which may be associated with the graphical elements of the GUI. In other examples, the user may perform gestures at one or more locations that are independent of the locations of graphical elements of the GUI.

Gestures performed on touch I/O device 1001 may directly or indirectly manipulate, control, modify, move, actuate, initiate or generally affect graphical elements such as cursors, icons, media files, lists, text, all or portions of images, or the like within the GUI. For instance, in the case of a touch screen, a user may directly interact with a graphical element by performing a gesture over the graphical element on the touch screen. Alternatively, a touch pad generally provides indirect interaction. Gestures may also affect non-displayed GUI elements (e.g., causing user interfaces to appear) or may affect other actions within computing system 1003 (e.g., affect a state or mode of a GUI, application, or operating system). Gestures may or may not be performed on touch I/O device 1001 in conjunction with a displayed cursor. For instance, in the case in which gestures are performed on a touchpad, a cursor (or pointer) may be displayed on a display screen or touch screen and the cursor may be controlled via touch input on the touchpad to interact with graphical objects on the display screen. In other examples in which gestures are performed directly on a touch screen, a user may interact directly with objects on the touch screen, with or without a cursor or pointer being displayed on the touch screen.

[0041] Feedback may be provided to the user via communication channel 1002 in response to or based on the touch or near touches on touch I/O device 1001. Feedback may be transmitted optically, mechanically, electrically, olfactory, acoustically, or the like or any combination thereof and in a variable or non-variable manner.

[0042] Attention is now directed towards examples of a system architecture that may be embodied within any portable or non-portable device including but not limited to a communication device (e.g. mobile phone, smart phone), a multi-media device (e.g., MP3 player, TV, radio), a portable or handheld computer (e.g., tablet, netbook, laptop), a desktop computer, an All-In-One desktop, a peripheral device, or any other system or device adaptable to the inclusion of system architecture 2000, including combinations of two or more of these types of devices. FIG. 6 is a block diagram of one example of system 2000 that generally includes one or more computer-readable mediums 2001, processing system 2004, I/O subsystem 2006, radio frequency (RF) circuitry 2008, audio circuitry 2010, and sensors circuitry 2011. These components may be coupled by one or more communication buses or signal lines 2003.

[0043] It should be apparent that the architecture shown in FIG. 6 is only one example architecture of system 2000, and that system 2000 could have more or fewer components than shown, or a different configuration of components. The various components shown in FIG. 6 can be implemented in hardware, software, firmware or any combination thereof, including one or more signal processing and/or application specific integrated circuits.

[0044] RF circuitry 2008 can be used to send and receive information over a wireless link or network to one or more other devices and includes well-known circuitry for performing this function. RF circuitry 2008 and audio circuitry 2010 can be coupled to processing system 2004 via peripherals interface 2016. Interface 2016 can include various known components for establishing and maintaining communication between peripherals and processing system 2004. Audio circuitry 2010 can be coupled to audio speaker 2050 and microphone 2052 and can include known circuitry for processing voice signals received from interface 2016 to enable a user to communicate in real-time with other users. In some examples, audio circuitry 2010 can include a headphone jack (not shown). Sensors circuitry 2011 can be coupled to various sensors including, but not limited to, one or more Light Emitting Diodes (LEDs) or other light emitters, one or more photodiodes or other light sensors, one or more photothermal sensors, a magnetometer, an accelerometer, a gyroscope, a barometer, a compass, a proximity sensor, a camera, an ambient light sensor, a thermometer, a GPS sensor, and various system sensors which can sense remaining battery life, power consumption, processor speed, CPU load, and the like.

[0045] Peripherals interface 2016 can couple the input and output peripherals of the system to processor 2018 and computer-readable medium 2001. One or more processors 2018 communicate with one or more computer-readable mediums 2001 via controller 2020. Computer-readable medium 2001 can be any device or medium that can store code and/or data for use by one or more processors 2018. In some examples, medium 2001 can be a non-transitory computer-readable storage medium. Medium 2001 can include a memory hierarchy, including but not limited to cache, main memory and secondary memory. The memory hierarchy can be implemented using any combination of RAM (*e.g.*, SRAM, DRAM, DDRAM), ROM, FLASH, magnetic and/or optical storage devices, such as disk drives, magnetic tape, CDs (compact disks) and DVDs

(digital video discs). Medium 2001 may also include a transmission medium for carrying information-bearing signals indicative of computer instructions or data (with or without a carrier wave upon which the signals are modulated). For example, the transmission medium may include a communications network, including but not limited to the Internet (also referred to as the World Wide Web), intranet(s), Local Area Networks (LANs), Wide Local Area Networks (WLANs), Storage Area Networks (SANs), Metropolitan Area Networks (MAN) and the like.

[0046] One or more processors 2018 can run various software components stored in medium 2001 to perform various functions for system 2000. In some examples, the software components can include operating system 2022, communication module (or set of instructions) 2024, touch processing module (or set of instructions) 2026, graphics module (or set of instructions) 2028, and one or more applications (or set of instructions) 2030. Each of these modules and above noted applications can correspond to a set of instructions for performing one or more functions described above and the methods described in this application (e.g., the computer-implemented methods and other information processing methods described herein). These modules (i.e., sets of instructions) need not be implemented as separate software programs, procedures or modules, and thus various subsets of these modules may be combined or otherwise re-arranged in various examples. In some examples, medium 2001 may store a subset of the modules and data structures identified above. Furthermore, medium 2001 may store additional modules and data structures not described above.

[0047] Operating system 2022 can include various procedures, sets of instructions, software components and/or drivers for controlling and managing general system tasks (e.g., memory management, storage device control, power management, etc.) and facilitates communication between various hardware and software components.

[0048] Communication module 2024 can facilitate communication with other devices over one or more external ports 2036 or via RF circuitry 2008 and can include various software components for handling data received from RF circuitry 2008 and/or external port 2036.

[0049] Graphics module 2028 can include various known software components for rendering, animating and displaying graphical objects on a display surface. In

examples in which touch I/O device 2012 is a touch sensing display (e.g., touch screen), graphics module 2028 can include components for rendering, displaying, and animating objects on the touch sensing display.

[0050] One or more applications 2030 can include any applications installed on system 2000, including without limitation, a browser, address book, contact list, email, instant messaging, word processing, keyboard emulation, widgets, JAVA-enabled applications, encryption, digital rights management, voice recognition, voice replication, location determination capability (such as that provided by the global positioning system (GPS)), a music player, *etc.*

[0051] Touch processing module 2026 can include various software components for performing various tasks associated with touch I/O device 2012 including but not limited to receiving and processing touch input received from I/O device 2012 via touch I/O device controller 2032.

[0052] I/O subsystem 2006 can be coupled to touch I/O device 2012 and one or more other I/O devices 2014 for controlling or performing various functions. Touch I/O device 2012 can communicate with processing system 2004 via touch I/O device controller 2032, which can include various components for processing user touch input (e.g., scanning hardware). One or more other input controllers 2034 can receive/send electrical signals from/to other I/O devices 2014. Other I/O devices 2014 may include physical buttons, dials, slider switches, sticks, keyboards, touch pads, additional display screens, or any combination thereof.

[0053] If embodied as a touch screen, touch I/O device 2012 can display visual output to the user in a GUI. The visual output may include text, graphics, video, and any combination thereof. Some or all of the visual output may correspond to user-interface objects. Touch I/O device 2012 can form a touch sensing surface that accepts touch input from the user. Touch I/O device 2012 and touch screen controller 2032 (along with any associated modules and/or sets of instructions in medium 2001) can detect and track touches or near touches (and any movement or release of the touch) on touch I/O device 2012 and can convert the detected touch input into interaction with graphical objects, such as one or more user-interface objects. In the case in which device 2012 is embodied as a touch screen, the user can directly interact with graphical objects that are displayed

on the touch screen. Alternatively, in the case in which device 2012 is embodied as a touch device other than a touch screen (e.g., a touch pad), the user may indirectly interact with graphical objects that are displayed on a separate display screen embodied as I/O device 2014.

[0054] Touch I/O device 2012 may be analogous to the multi-touch sensing surface described in the following U.S. Patents: 6,323,846 (Westerman et al.), 6,570,557 (Westerman et al.), and/or 6,677,932 (Westerman), and/or U.S. Patent Publication 2002/0015024A1, each of which is hereby incorporated by reference.

[0055] In examples for which touch I/O device 2012 is a touch screen, the touch screen may use LCD (liquid crystal display) technology, LPD (light emitting polymer display) technology, OLED (organic LED), or OEL (organic electro luminescence), although other display technologies may be used in other examples.

[0056] Feedback may be provided by touch I/O device 2012 based on the user's touch input as well as a state or states of what is being displayed and/or of the computing system. Feedback may be transmitted optically (e.g., light signal or displayed image), mechanically (e.g., haptic feedback, touch feedback, force feedback, or the like), electrically (e.g., electrical stimulation), olfactory, acoustically (e.g., beep or the like), or the like or any combination thereof and in a variable or non-variable manner.

[0057] System 2000 can also include power system 2044 for powering the various hardware components and may include a power management system, one or more power sources, a recharging system, a power failure detection circuit, a power converter or inverter, a power status indicator and any other components typically associated with the generation, management and distribution of power in portable devices.

[0058] In some examples, peripherals interface 2016, one or more processors 2018, and memory controller 2020 may be implemented on a single chip, such as processing system 2004. In some other examples, they may be implemented on separate chips.

[0059] Examples of the disclosure can be advantageous in allowing for an electronic device to determine melanin concentration of the skin and sunburn risk based on ambient UV light without the need for the user to input that information, making use of the electronic device easier, more intuitive, and more helpful.

[0060] In some examples, a method of an electronic device including a plurality of sensors is disclosed. The method may include receiving first light information based on data from a first sensor; receiving second light information based on data from a second sensor; based on the first light information, determining a skin melanin concentration; and based on the determined skin melanin concentration and the second light information, determining a health risk. Additionally or alternatively to one or more of the examples described above, the method may further include determining an average skin melanin concentration based on the determined skin melanin concentration and at least one previous skin melanin concentration associated with a user identity; and determining a risk category based on the average skin melanin concentration; wherein the health risk may be further determined based on the risk category. Additionally or alternatively to one or more of the examples described above, the method may further include determining a minimum skin melanin concentration based on the determined skin melanin concentration and at least one previous skin melanin concentration, wherein the health risk may be further determined based on the minimum skin melanin concentration. Additionally or alternatively to one or more of the examples described above, the first sensor may be a photothermal sensor and the second sensor is an ambient ultraviolet light sensor. Additionally or alternatively to one or more of the examples described above, the first light information may indicate an amount of ultraviolet light absorbed by melanin. Additionally or alternatively to one or more of the examples described above, the method may further include emitting ultraviolet light from a light emitter co-located with the first sensor, wherein the first light information may indicate an amount of the ultraviolet light emitted by the light emitter absorbed by melanin. Additionally or alternatively to one or more of the examples described above, determining the health risk may include determining that a user is at risk for sunburn or melanoma due to present exposure to ultraviolet light.

[0061] In some examples, non-transitory computer readable medium may be disclosed. The computer readable medium may contain instructions that, when executed, perform a method of an electronic device including a plurality of sensors. The method may include receiving first light information based on data from a first sensor; receiving second light information based on data from a second sensor; based on the first light information, determining a skin melanin concentration; and based on the determined skin

melanin concentration and the second light information, determining a health risk. Additionally or alternatively to one or more of the examples described above, the method may further include determining an average skin melanin concentration based on the determined skin melanin concentration and at least one previous skin melanin concentration associated with a user identity; and determining a risk category based on the average skin melanin concentration; wherein the health risk may be further determined based on the risk category. Additionally or alternatively to one or more of the examples described above, the method may further include determining a minimum skin melanin concentration based on the determined skin melanin concentration and at least one previous skin melanin concentration, wherein the health risk may be further determined based on the minimum skin melanin concentration. Additionally or alternatively to one or more of the examples described above, the first sensor may be a photothermal sensor and the second sensor is an ambient ultraviolet light sensor. Additionally or alternatively to one or more of the examples described above, the first light information may indicate an amount of ultraviolet light absorbed by melanin. Additionally or alternatively to one or more of the examples described above, the method may further include emitting ultraviolet light from a light emitter co-located with the first sensor, wherein the first light information may indicate an amount of the ultraviolet light emitted by the light emitter absorbed by melanin. Additionally or alternatively to one or more of the examples described above, determining the health risk may include determining that a user is at risk for sunburn or melanoma due to present exposure to ultraviolet light.

[0062] In some examples, an electronic device may be disclosed. The electronic device may include: a processor to execute instructions; a first sensor; a second sensor; and a memory coupled with the processor to store instructions, which when executed by the processor, cause the processor to perform operations to generate an application programming interface (API) that allows an API-calling component to perform a method. The method may include: receiving first light information based on data from the first sensor; receiving second light information based on data from the second sensor; based on the first light information, determining a skin melanin concentration; and based on the determined skin melanin concentration and the second light information, determining a health risk. Additionally or alternatively to one or more of the examples described above,

the method may further include determining an average skin melanin concentration based on the determined skin melanin concentration and at least one previous skin melanin concentration associated with a user identity; and determining a risk category based on the average skin melanin concentration; wherein the health risk may be further determined based on the risk category. Additionally or alternatively to one or more of the examples described above, the method may further include determining a minimum skin melanin concentration based on the determined skin melanin concentration and at least one previous skin melanin concentration, wherein the health risk may be further determined based on the minimum skin melanin concentration. Additionally or alternatively to one or more of the examples described above, the first sensor may be a photothermal sensor and the second sensor is an ambient ultraviolet light sensor. Additionally or alternatively to one or more of the examples described above, the first light information may indicate an amount of ultraviolet light absorbed by melanin. Additionally or alternatively to one or more of the examples described above, the method may further include emitting ultraviolet light from a light emitter co-located with the first sensor, wherein the first light information may indicate an amount of the ultraviolet light emitted by the light emitter absorbed by melanin. Additionally or alternatively to one or more of the examples described above, determining the health risk may include determining that a user is at risk for sunburn or melanoma due to present exposure to ultraviolet light.

[0063] Although the disclosed examples have been fully described with reference to the accompanying drawings, it is to be noted that various changes and modifications will become apparent to those skilled in the art. Such changes and modifications are to be understood as being included within the scope of the disclosed examples as defined by the appended claims.

WHAT IS CLAIMED IS:

1. A method of an electronic device including a plurality of sensors, the method comprising:
 - receiving first light information based on data from a first sensor;
 - receiving second light information based on data from a second sensor;
 - based on the first light information, determining a skin melanin concentration; and
 - based on the determined skin melanin concentration and the second light information, determining a health risk.

2. The method of claim 1, further comprising:
 - determining an average skin melanin concentration based on the determined skin melanin concentration and at least one previous skin melanin concentration associated with a user identity; and
 - determining a risk category based on the average skin melanin concentration; wherein the health risk is further determined based on the risk category.

3. The method of claim 1, further comprising:
 - determining a minimum skin melanin concentration based on the determined skin melanin concentration and at least one previous skin melanin concentration, wherein the health risk is further determined based on the minimum skin melanin concentration.

4. The method of claim 1, wherein the first sensor is a photothermal sensor and the second sensor is an ambient ultraviolet light sensor.

5. The method of claim 1, wherein the first light information indicates an amount of ultraviolet light absorbed by melanin.

6. The method of claim 5, further comprising:
 - emitting ultraviolet light from a light emitter co-located with the first sensor, wherein the first light information indicates an amount of the ultraviolet light emitted by the light emitter absorbed by melanin.

7. The method of claim 1, wherein determining the health risk includes determining that a user is at risk for sunburn or melanoma due to present exposure to ultraviolet light.

8. A non-transitory computer readable medium, the computer readable medium containing instructions that, when executed, perform a method of an electronic device including a plurality of sensors, the method comprising:

receiving first light information based on data from a first sensor;
receiving second light information based on data from a second sensor;
based on the first light information, determining a skin melanin concentration; and
based on the determined skin melanin concentration and the second light information, determining a health risk.

9. The non-transitory computer readable medium of claim 8, the method further comprising:

determining an average skin melanin concentration based on the determined skin melanin concentration and at least one previous skin melanin concentration associated with a user identity; and

determining a risk category based on the average skin melanin concentration;
wherein the health risk is further determined based on the risk category.

10. The non-transitory computer readable medium of claim 8, the method further comprising:

determining a minimum skin melanin concentration based on the determined skin melanin concentration and at least one previous skin melanin concentration, wherein the health risk is further determined based on the minimum skin melanin concentration.

11. The non-transitory computer readable medium of claim 8, wherein the first sensor is a photothermal sensor and the second sensor is an ambient ultraviolet light sensor.

12. The non-transitory computer readable medium of claim 8, wherein the first light information indicates an amount of ultraviolet light absorbed by melanin.

13. The non-transitory computer readable medium of claim 12, the method further comprising:

emitting ultraviolet light from a light emitter co-located with the first sensor, wherein the first light information indicates an amount of the ultraviolet light emitted by the light emitter absorbed by melanin.

14. The non-transitory computer readable medium of claim 8, wherein determining the health risk includes determining that a user is at risk for sunburn or melanoma due to present exposure to ultraviolet light.

15. An electronic device, comprising:

a processor to execute instructions;

a first sensor;

a second sensor; and

a memory coupled with the processor to store instructions, which when executed by the processor, cause the processor to perform operations to generate an application programming interface (API) that allows an API-calling component to perform a method comprising:

receiving first light information based on data from the first sensor;

receiving second light information based on data from the second sensor;

based on the first light information, determining a skin melanin concentration; and

based on the determined skin melanin concentration and the second light information, determining a health risk.

16. The electronic device of claim 15, the method further comprising:

determining an average skin melanin concentration based on the determined skin melanin concentration and at least one previous skin melanin concentration associated with a user identity; and

determining a risk category based on the average skin melanin concentration;
wherein the health risk is further determined based on the risk category.

17. The electronic device of claim 15, the method further comprising:
determining a minimum skin melanin concentration based on the determined skin melanin concentration and at least one previous skin melanin concentration, wherein the health risk is further determined based on the minimum skin melanin concentration.

18. The electronic device of claim 15, wherein the first sensor is a photothermal sensor and the second sensor is an ambient ultraviolet light sensor.

19. The electronic device of claim 15, wherein the first light information indicates an amount of ultraviolet light absorbed by melanin.

20. The electronic device of claim 19, the method further comprising:
emitting ultraviolet light from a light emitter co-located with the first sensor,
wherein the first light information indicates an amount of the ultraviolet light emitted by the light emitter absorbed by melanin.

21. The electronic device of claim 15, wherein determining the health risk includes determining that a user is at risk for sunburn or melanoma due to present exposure to ultraviolet light.

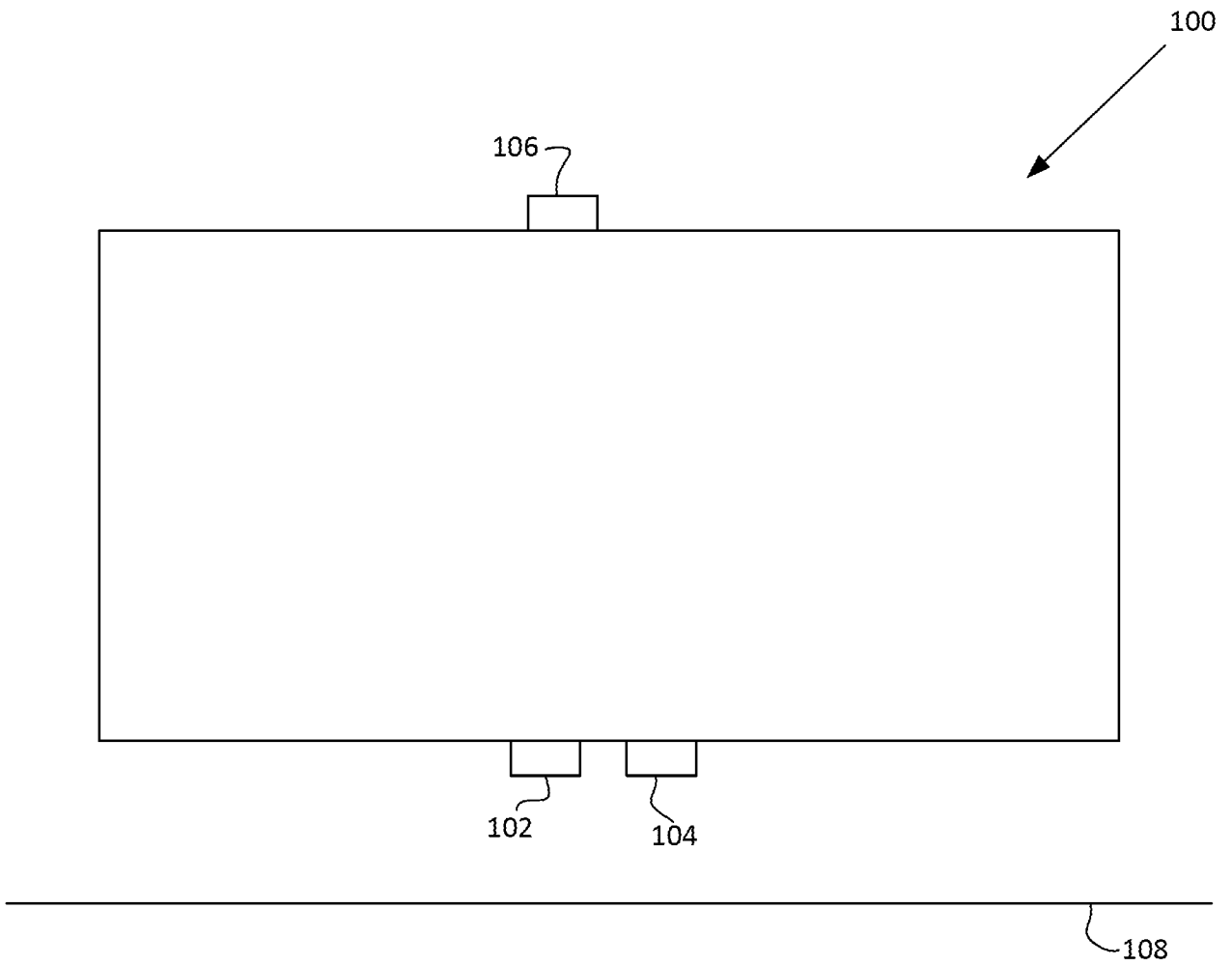


FIG. 1

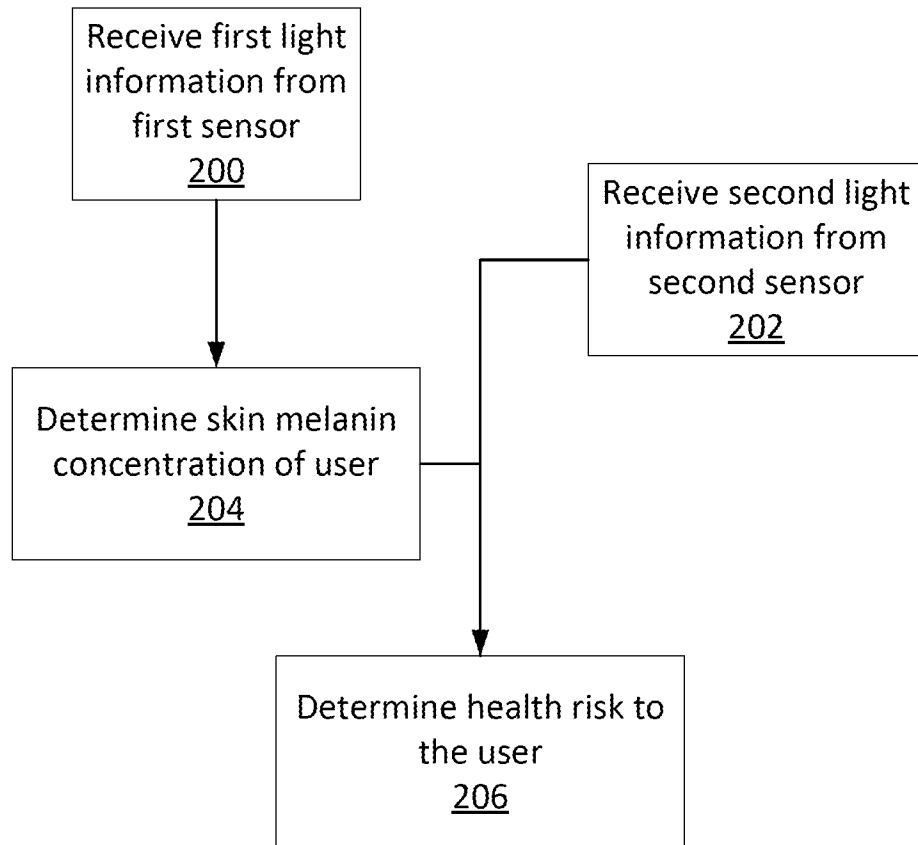


FIG. 2

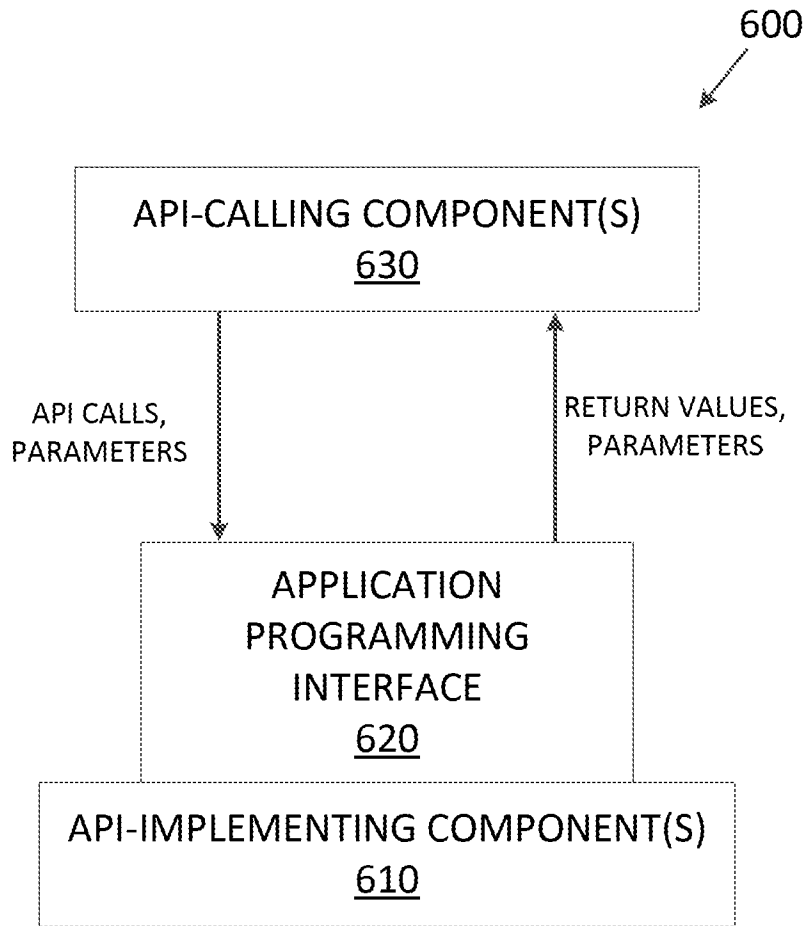


FIG. 3

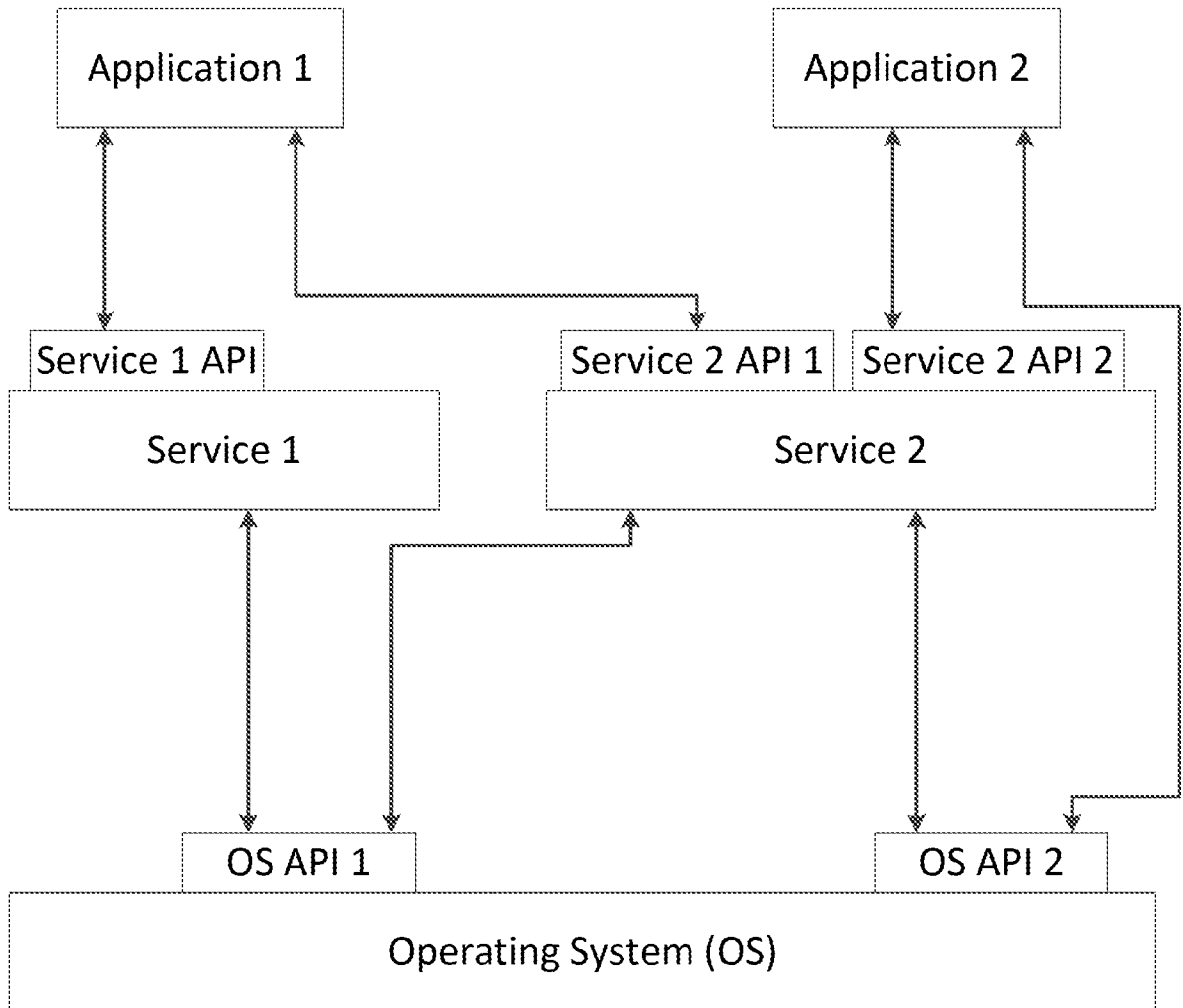


FIG. 4

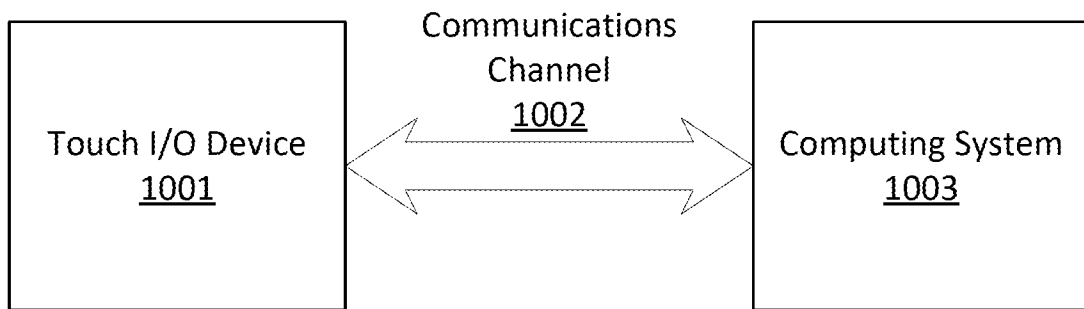


FIG. 5

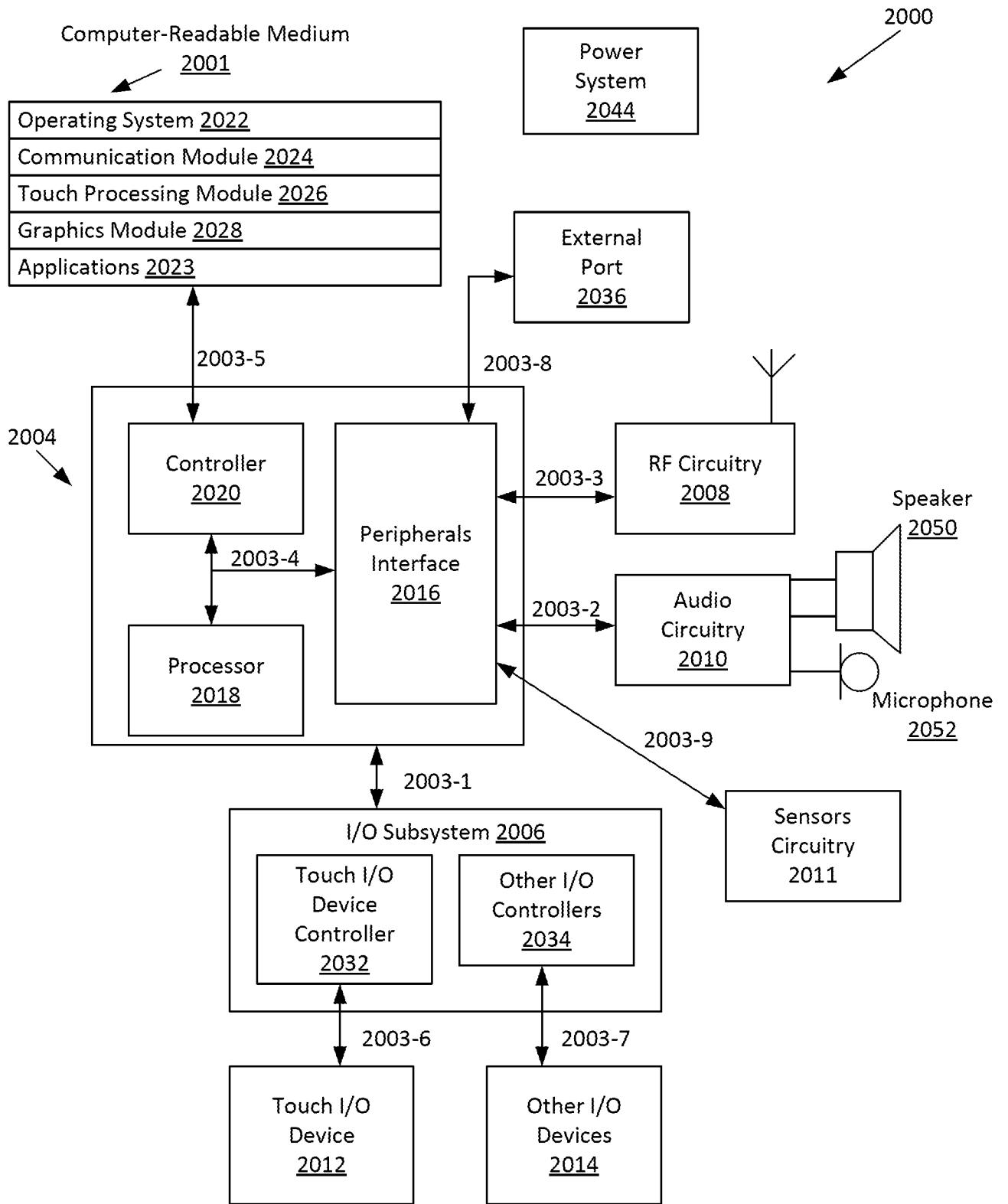


FIG. 6

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2013/078383

A. CLASSIFICATION OF SUBJECT MATTER
INV. G06F19/00
ADD.
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
G06F

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 348 694 B1 (GERSHTEYN MIKHAIL [US] ET AL) 19 February 2002 (2002-02-19) abstract column 3, line 65 - column 4, line 3 column 4, line 52 - line 59 column 6, line 35 - line 67 column 8, line 55 - line 67 column 9, line 17 - line 29 column 10, line 51 - line 59 column 21, line 30 - line 60 ----- -/--	1-21

Further documents are listed in the continuation of Box C.

See patent family annex.

* Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier application or patent but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "&" document member of the same patent family

Date of the actual completion of the international search 14 May 2014	Date of mailing of the international search report 30/05/2014
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Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Sisk, Aisling
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INTERNATIONAL SEARCH REPORT

International application No
PCT/US2013/078383

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 2 568 266 A1 (ETH ZUERICH [CH]) 13 March 2013 (2013-03-13) paragraph [0010] - paragraph [0012] paragraph [0014] paragraph [0017] paragraph [0019] paragraph [0022] paragraph [0030] - paragraph [0034] paragraph [0067] paragraph [0053] - paragraph [0055] -----	1-21
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A	US 2011/191272 A1 (MCGUIRE KEVIN [US]) 4 August 2011 (2011-08-04) paragraph [0014] - paragraph [0015] paragraph [0027] paragraph [0030] paragraph [0034] claim 1 -----	1-21
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INTERNATIONAL SEARCH REPORT

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