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- (71) Applicant (for all designated States except US): **DY-NAVIX SYSTEMS LLC** [US/US]; 2100 Wharton Street, Suite 400, Pittsburgh, Pennsylvania 15203 (US).
- (72) Inventors; and
(71) Applicants : **CUNNINGHAM, Bob** [US/US]; Suite 400, 2100 Wharton Street, Pittsburgh, Pennsylvania 15203 (US). **SUTTON, Bill** [US/US]; Suite 400, 2100 Wharton Street, Pittsburgh, Pennsylvania 15203 (US).
- (74) Agents: **JENNINGS, Jason, A.** et al.; Dority & Manning, P.a., P O Box 1449, Greenville, South Carolina 29602-1449 (US).
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(54) Title: A WEARABLE SPEECH GENERATION DEVICE

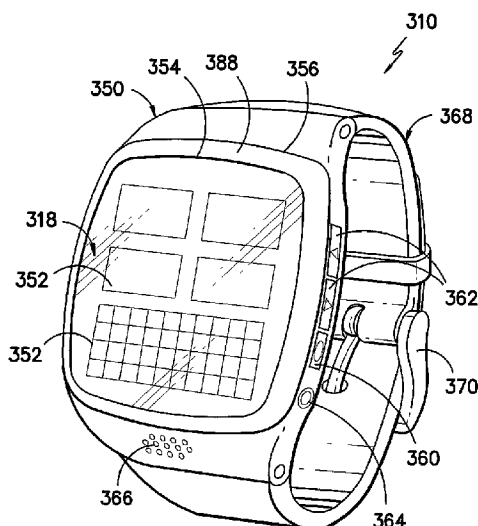


FIG. -3-

(57) Abstract: A wearable speech generation device is disclosed. The speech generation device may generally include a housing configured to be worn on a user's wrist or forearm, a display device attached to or embedded within the housing and a speaker configured to generate an audio output. Additionally, the speech generation device may include a processing unit communicatively coupled to the display device and the speaker. The processing unit may include a processor and a related computer readable medium storing instructions executable by the processor. The instructions stored on the computer readable medium may generally configure the speech generation device to generate text-to-speech output.

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TITLE OF THE INVENTION**A WEARABLE SPEECH GENERATION DEVICE****PRIORITY CLAIM**

[0001] This application claims the benefit of previously filed U.S. Provisional Patent Application entitled "A WEARABLE SPEECH GENERATION DEVICE," assigned USSN 61/364,051, filed July 14, 2010, and which is fully incorporated herein by reference for all purposes.

BACKGROUND OF THE INVENTION

[0002] The present invention generally pertains to portable speech generation devices and, more particularly, to wearable speech generation devices.

[0003] Various debilitating physical conditions, whether resulting from disease or injuries, can deprive the afflicted person of the ability to communicate audibly with persons or devices in one's environment in real time. For example, many individuals may experience speech and learning challenges as a result of pre-existing or developed conditions such as autism, ALS, cerebral palsy, stroke, brain injury and others. In addition, accidents or injuries suffered during armed combat, whether by domestic police officers or by soldiers engaged in battle zones in foreign theaters, are swelling the population of potential users. Persons lacking the ability to communicate audibly can compensate for this deficiency by the use of speech generation devices.

[0004] Speech generation devices (SGDs), some embodiments of which may be known as Alternative and Augmentative Communications (AAC) devices, can include a variety of features to assist with a user's communication. In general, a speech generation device may include an electronic interface with specialized software configured to permit the creation and manipulation of digital messages that can be translated into audio speech output. Additional communication-related features may also be provided depending on user

preferences and abilities. Users may provide input to a speech generation device by physical selection using a touch screen, mouse, joystick, physical input switches or the like or by other means such as eye tracking or head tracking.

[0005] It is estimated that less than ten percent (10%) of the potential users of speech generation devices currently are being served by conventional speech generation devices. This population is highly variable from the standpoint of a range in ages from preschool children through elderly adults and a variety of lifestyles, geographic locations, educational attainments, language sophistication, and available physical motor skills to operate the speech generation device. As such, a need exists for further refinements and improvements to speech generation devices that continuously adapt such devices for a greater number and variety of users.

[0006] Conventional speech generation devices are generally used across a wide range of applications and settings. For example, some speech generation devices are used as desktop devices and other stationary devices. Still other speech generation devices are rendered portable, such as by being mounted on vehicles such as wheelchairs or by being configured as handheld devices.

[0007] In general, specific drawbacks and/or disadvantages are typically associated with conventional SGDs that are used as portable devices. For example, an SGD must generally be disposed in a location that provides a user visual access to the display of the SGD. Thus, for a user who must communicate utilizing an SGD mounted to his wheelchair, bulky conventional devices may potentially block the user's view to other objects in his environment and may also obscure the user from others. This restriction of a user's visual vantage can sometimes be awkward for a user, particularly when the user's mobility within the wheelchair is limited (e.g., the ability of the user to adjust his seating position). Moreover, conventional hand-held devices are often relatively heavy. Thus, these devices can be very burdensome and awkward to carry or otherwise transport. Additionally, heavy devices are typically more likely to result in damage to the SGD if the device is dropped. Accordingly, a need exists to reduce the size, weight and overall portability for some embodiments of an SGD.

[0008] Further, portable speech generation devices are typically rather obtrusive in design and, thus, may often make it awkward and/or difficult for a user to interact with other persons within his environment. In particular, due to

the size and overall appearance of conventional devices, a user may feel self-conscious about using his SGD while out in public. This may be particularly true when a user must carry around a bulky hand-held device to communicate with others, which will typically require the use of both of the user's hands to hold and/or operate the device. Accordingly, a need exists for a portable SGD having an unobtrusive design.

[0009] Additionally, current speech generation devices typically consume large amounts of power. In particular, the display units associated with many conventional SGDs have substantial power requirements which require the SGD be located near an electrical outlet and, thus, limit freedom of movement of the user. Other conventional speech generation devices seek to overcome this problem with the provision of a battery, but still must be recharged or replaced at periodic intervals. Substantial power requirements also can be related to issues of size and weight of a device. Because of these many concerns, a further need exists to generally reduce the power requirements, size and weight of various SGD components, including the display units.

[0010] In light of the various design concerns in the field of speech generation devices, a need continues to exist for refinements and improvements to address such concerns. While various implementations of speech generation devices and associated features have been developed, no design has emerged that is known to generally encompass all of the desired characteristics hereafter presented in accordance with aspects of the subject technology.

BRIEF SUMMARY OF THE INVENTION

[0011] In general, the present subject matter is directed to various exemplary wearable speech generation devices (SGDs).

[0012] For example, exemplary wearable speech generation devices in accordance with aspects of the presently disclosed technology may generally include a central processing unit and a display device attached to or embedded within a compact housing that selectively can be attached to or worn around a user's wrist or forearm. The central processing unit may generally provide processing functionality to the SGD and may include a processor configured to implement communications software and other computer-readable instructions stored on a computer-readable medium of the SGD. Additionally, the display

device may serve as an output feature for the SGD and may be configured to display communication software screens and other graphical user interfaces generated by the central processing unit. The wearable SGD may further include one or more speakers configured to generate audio outputs (e.g., in the form of speech selected by a user). In one embodiment, the speaker(s) may be provided in a remote relationship with the housing and, thus, may be communicatively coupled to the processing unit via a wireless connection. Alternatively, the speaker(s) may be integrated into or otherwise embedded within the housing of the SGD.

[0013] Generally, the central processing unit and any associated input/output devices enable the SGD to transmit and receive messages to assist a user in communicating with others. For example, the SGD may correspond to a particular special-purpose electronic device that permits a user to communicate with others by producing digitized or synthesized speech based on configured messages. Such messages may be preconfigured and/or selected and/or composed by a user within a message window displayed on the display device. Additionally, the variety of input devices and software interface features of the SGD may be provided to facilitate the capture of user input to define what information should be displayed in a message window and ultimately communicated to others as spoken output or other outgoing communication.

[0014] In several embodiments, the wearable SGD may include various different input and output devices. For example, in one embodiment, a touch screen may be associated with the display device. For instance, the touch screen may be combined with or integrated into the display device to enable the capture of user inputs directed to the graphical user interfaces shown on the display device. Additionally, the SGD may further include one or more accelerometers and/or gyroscopes, used in combination or separately, which may be configured to measure the orientation and/or movement of the user's wrist or forearm.

[0015] In general, the disclosed wearable SGD provides numerous advantages for a user of a speech generation device. For example, because the wearable SGD is configured as an item to be worn on a user's wrist or forearm, the SGD can be designed to have a very discreet appearance. As such, a user can confidently use the SGD in public without feeling self-conscious, looking

awkward and/or or having to carry around a bulky device that looks out of place. The wearable SGD may also be adapted to be relatively compact and lightweight. As such, the disclosed SGD is rendered very portable. Additionally, because the SGD is wearable and does not need to be carried, it leaves the user's hands free for other uses and reduces the likelihood of the SGD being dropped and/or damaged. Moreover, due to its accessible location, the wearable SGD also provides for the immediately availability of the communication features and/or other features of the SGD without the user having to obtain their device from their backpack, pocketbook or other item in which a speech generation device may be carried.

[0016] In various embodiments of the present subject matter, additional advantages may be provided by the integration of a touch screen into the wearable SGD. For example, in one embodiment, a capacitive touch screen may be attached to or disposed within the housing such that the touch screen is positioned over the display device and permits the capture of user inputs directed towards the display. Such a touch screen may be particularly well-suited for use with the wearable speech generation device of the present subject matter. For example, a capacitive touch screen may provide advantages such as overall thinness and light weight, which may be desirable for the wrist- or forearm-based ambulatory design. In addition, a capacitive touch panel requires no activation force but only a slight contact, which can be an advantage for a user who may have motor control limitations.

[0017] In several embodiments of the present subject matter, the display device of the wearable SGD may be configured as a flexible display device, which may offer numerous advantages for a speech generation device. For example, a flexible display device may generally permit the wearable SGD to include a display that can be wrapped around the user's entire wrist or forearm. In a particular embodiment of the present subject matter, the flexible display device may be configured as flexible organic light emitting diode (FOLED) display, which can offer even further advantages for a speech generation device. In particular, FOLED displays are generally characterized by low activation or driving voltage, self-luminescence without requiring a backlight, reduced thickness and weight, fast response speed, etc. The reduced weight and power requirements of the FOLED display provide particular advantages for the

disclosed speech generation device as a more lightweight and efficient device helps to increase a potential user's mobility and duration of assisted communication. As such, the freedom of movement of the user may be increased significantly, as the device may be used for longer periods of time between recharging the batteries.

[0018] Still further advantages may be provided when an accelerometer and/or gyroscope is integrated into the SGD as an input device, such as by being attached to or embedded within the housing of the SGD. For example, the accelerometer/gyroscope may be used to capture user inputs (e.g., simple hand gestures) by measuring the orientation and/or movement of a user's wrist or forearm. Thus, in one embodiment, the accelerometer/gyroscope may enable the SGD to recognize numerous physical hand gestures as user inputs, which can then be used to either navigate the graphical user interfaces displayed on the display device or provide input selections to the SGD. Alternatively, user inputs provided by the accelerometer/gyroscope may be associated with particular phrases commonly used by the user, thereby permitting the SGD to be configured to speak such phrases upon the user performing one or more hand gestures.

[0019] Additional aspects and advantages of the invention will be set forth in part in the description that follows, and in part will be obvious from the description, or may be learned by practice of the invention. The various aspects and advantages of the invention may be realized and attained by means of the instrumentalities and combinations particularly described below.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate at least one presently preferred embodiment of the invention as well as some alternative embodiments. These drawings, together with the description, serve to explain the principles of the invention but by no means are intended to be exhaustive of all of the possible manifestations of the invention.

[0021] FIG. 1 illustrates an embodiment of a wearable speech generation device in accordance with aspects of the present subject matter, particularly

illustrating various components of the speech generation device being worn by or attached to a user;

[0022] FIG. 2 illustrates a schematic diagram of hardware components for use with an embodiment of a wearable speech generation device in accordance with aspects of the present subject matter;

[0023] FIG. 3 illustrates a front perspective view of one embodiment of a wearable speech generation device in accordance with aspects of the present subject matter;

[0024] FIG. 4 illustrates a front perspective view of another embodiment of a wearable speech generation device in accordance with aspects of the present subject matter; and

[0025] FIG. 5 illustrates a back perspective view of the embodiment illustrated in FIG. 4.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0026] Reference now will be made in detail to the presently preferred embodiments of the invention, one or more examples of which are illustrated in the accompanying drawings. Each example is provided by way of explanation of the invention, which is not restricted to the specifics of the examples. In fact, it will be apparent to those skilled in the art that various modifications and variations can be made in the present invention without departing from the scope or spirit of the invention. For instance, features illustrated or described as part of one embodiment, can be used on another embodiment to yield a still further embodiment. Thus, it is intended that the present invention cover such modifications and variations as come within the scope of the appended claims and their equivalents.

[0027] Referring to the drawings, FIG. 1 illustrates an embodiment of a wearable speech generation device 10 (SGD) being worn by a user 12 in accordance with aspects of the present subject matter. The wearable SGD 10 may generally be configured to be worn, secured or otherwise disposed on a user's wrist and/or forearm. For example, as shown in FIG. 1 at location 13, the SGD 10 or a portion thereof may take the form of any item wearable on a user's wrist and, thus, may have a similar configuration as that of any known watch, bracelet, wristband or other suitable wrist-based item. Alternatively, the wearable

SGD 10 may be configured as an armband or other arm-mounted item and may be adapted to wrap around a portion of the user's wrist and/or forearm. Additionally, the wrist-worn SGD 10 may generally include a display device and a central processing unit. For example, in one embodiment, the display device and central processing unit may be attached to or embedded within a compact housing configured to be secured to and/or wrapped around the user's wrist and/or forearm at exemplary location 13. The display device and central processing unit will be described in detail with reference to FIGS. 2-5. However, in general, the display device may serve as an output feature of the SGD 10 and may be configured to display communication screens, menus and other graphical user interfaces to the user 12. The central processing unit of the SGD 10 may be configured to provide processing functionality to the various components, including the display device, and may include a processor and related computer readable medium for storing instructions executable by the processor. As such, it should be appreciated that each component of the SGD 10 may be directly or indirectly coupled to the central processing unit via a wired or wireless connection for communication therewith.

[0028] Additionally, the wearable SGD 10 may also include numerous other components including, but not limited to, a touch screen, an accelerometer and/or gyroscope and various other input/output devices. Further, as shown in FIG. 1, for example, the SGD 10 may also include one or more speakers 14 for outputting speech selected by the user 12. In one embodiment, the speakers 14 may be provided in a remote relationship to the user's wrist and/or forearm. Thus, as shown in FIG. 1, one or more speakers 14 may be worn as a pendant around the user's neck at exemplary location 15. In such an embodiment, the speakers 14 may be in communication with the central processing unit via a wired connection or through any suitable wireless communications protocol, such as through a BLUETOOTH connection. In another embodiment, the speakers 14 may be integrated with other components of the SGD 10 on the user's wrist and/or forearm at exemplary location 13. The speaker(s) 14 and various other components and/or features of the SGD 10 will generally be described in greater detail below.

[0029] Referring now to FIG. 2, various electronic components intended for selective use with a wearable speech generation device 10 in accordance with

aspects of the present subject matter are illustrated. Generally, the electronic components may include a combination of hardware, software and/or firmware elements, all of which either correspond to physical tangible apparatuses or which are embedded as instructions on a physical and tangible apparatus such as a computer-readable storage medium. It should be appreciated that the components shown in FIG. 2 may be provided in different configurations and may be provided with different arrangements of direct and/or indirect physical and communicative links to perform the desired functionality of such components. Additionally, it should be appreciated that the solid lines connecting the numbered components depicted in FIG. 2 indicate electronic connections for either the supply of power to a component or for data transmission between the connected components. Such electronic connections may include both wired connections and/or connections via any known wireless communications protocol. Similarly, the solid circle between the battery connection and the connection from the power button/switch indicates that such connections may be electrically and/or mechanically connected.

[0030] In general, the electronic components of an wearable SGD 10 enable the device to transmit and receive messages to assist a user 12 in communicating with others. For example, the SGD 10 may correspond to a particular special-purpose electronic device that permits a user 12 to communicate with others by producing digitized or synthesized speech based on configured messages. Such messages may be preconfigured and/or selected and/or composed by a user 12 within a message window provided as part of the speech generation device user interface. As will be described below, a variety of input devices and software interface features may be provided to facilitate the capture of user input to define what information should be displayed in a message window and ultimately communicated to others as spoken output or other outgoing communication.

[0031] Referring to FIG. 2, the SGD 10 may generally include a central processing unit 16, a display device 18, and various other components and features. As indicated above and shown in FIGS. 3-5, the SGD 10 may also include a housing 350, 450 configured to store or accommodate some or all of the components of the SGD 10. Moreover, in addition to the specific devices/components discussed herein, it should be appreciated that any

peripheral hardware device 30, 34 may be provided and interfaced to the wearable speech generation device 10 via a USB port 32, such as a micro-USB port, or other communicative coupling or may be interfaced to the SGD 10 via any suitable wireless communications protocol.

[0032] Power to the components of the SGD 10 may be provided from any suitable power source, such as a replaceable or rechargeable battery 20 or any other replaceable and/or rechargeable power source. The battery 20 may generally be disposed within the housing 350, 450 (FIGS. 3-5) attached or worn around the user's wrist or forearm. Additionally, a power switch or button 22 may be provided as an interface to toggle the power connection between the battery 20 and any powered components. Moreover, in further embodiments, the SGD 10 may also include a secondary power source, such as a solar or inertial power source, for extending the duration of assisted communication provided by the SGD 10. For example, the SGD 10 may include a solar panel or other solar cell technology, mounted on the wristband 368 (FIG. 3), housing 350,450 (FIGS. 3-5), or other suitable location, for converting absorbed light into electrical energy to power the SGD 10. As another example, the SGD 10 may include an inertial charging unit that generates electrical energy based on the user's wrist and/or forearm motion. Suitable inertial charging units may include piezoelectric charging units and charging units that utilize a combination of one or more oscillating weights coupled to a rotor and generator (e.g., a coil block that transforms a magnetic charge from the rotor into electricity) for generating electrical energy.

[0033] Referring still to FIG. 2, the central processing unit 16 is generally provided to function as the central controller within the SGD 10 and may generally include such components as at least one memory/media element or database for storing data and software instructions as well as at least one processor. It should be appreciated that, in one embodiment, the components of the central processing unit 16 may be configured to be relatively small in size to enable such components to be incorporated into the wearable SGD 10. For example, the components of the central processing unit may be sized and/or otherwise configured similarly to the processing components and/or electronics of any known mobile computing device, handheld computer, mobile phone, cellular

phone, smart phone, personal digital assistant (PDA) or other relatively small electronic device.

[0034] In the particular example of FIG. 2, one or more processor(s) 24 and associated memory/media devices 26a and 26b are configured to perform a variety of computer-implemented functions (i.e., software-based data services). The central processing unit 16 may be adapted to operate as a special-purpose machine by executing the software instructions rendered in a computer-readable form stored in memory/media element 26a. When software is used, any suitable programming, scripting, or other type of language or combinations of languages may be used to implement the teachings contained herein. In other embodiments, the methods disclosed herein may alternatively be implemented by hard-wired logic or other circuitry, including, but not limited to application-specific circuits. Additionally, the one or more processor(s) 24 within the central processing unit 16 may be configured for operation with any predetermined operating systems, such as but not limited to Windows XP, and thus is an open system that is capable of running any application that can be run on Windows XP. Other possible operating systems include Android OS, WebOS, BSD UNIX, Darwin (Mac OS X including "Cheetah," "Leopard," "Snow Leopard" and other variations), Linux, SunOS (Solaris/OpenSolaris), and Windows NT (XP/Vista/7).

[0035] At least one memory/media device (e.g., device 26a in FIG. 2) is dedicated to storing software and/or firmware in the form of computer-readable and executable instructions that will be implemented by the one or more processor(s) 24. Other memory/media devices (e.g., memory/media devices 26b) are used to store data which also will be accessible by the processor(s) 24 and which will be acted on per the software instructions stored in memory/media device 26a. The various memory/media devices of FIG. 2 may be provided as a single portion or multiple portions of one or more varieties of computer-readable media, such as but not limited to any combination of volatile memory (e.g., random access memory (RAM), such as DRAM, SRAM, etc.) and nonvolatile memory (e.g., ROM, flash, hard drives, magnetic tapes, CD-ROM, DVD-ROM, etc.) or any other memory devices including diskettes, drives, other magnetic-based storage media, optical storage media and others. In some embodiments, at least one memory device corresponds to an electromechanical hard drive and/or or a solid state drive (e.g., a flash drive) that easily withstands shocks.

Although FIG. 2 shows two separate memory/media devices 26a and 26b, the content dedicated to such devices may actually be stored in one memory/media device or in multiple devices. Any such possible variations and other variations of data storage will be appreciated by one of ordinary skill in the art.

[0036] In one particular embodiment of the present subject matter, a first portion of memory/media device 26b is configured to store input data received from a user 12 for performing the desired functional steps associated with a speech generation device 10. For example, data in memory 26b may include inputs received from one or more input devices of the SGD 10, including but not limited to a touch screen 36 and/or an accelerometer/gyroscope 38, which may indicate a user's selections language (e.g., language elements in the form of words, phrases, text and/or symbols) to be spoken by the SGD 10 or provide information needed by the SGD 10 to perform its various functions. Memory device 26a includes computer-executable software instructions that can be read and executed by processor(s) 24 to act on the data stored in memory/media device 26b to create new output data (e.g., audio signals, display signals, control signals and the like) for temporary or permanent storage in one of the memory/media devices. Such output data may be later communicated to integrated and/or peripheral output devices, such as a display device 18, speakers 14, other suitable output devices, or as control signals to still further components.

[0037] Referring still to FIG. 2, various input devices may be part of an SGD 10 and, thus, may be coupled directly or indirectly to the central processing unit 16. In general, the different types of input devices (including any optional peripheral devices) may be configured with software instructions to accept user inputs in accordance with one or more input selection methods such as, but not limited to: "Touch Enter", "Touch Exit", "Touch Auto Zoom", "Scanning" and "Physical Gesture" selection methods. In a "Touch Enter" selection method, selection is made upon contact with the touch screen 36 and may include highlight and bold options to visually indicate selection. In a "Touch Exit" method, selection is made upon release as a user 12 moves from selection to selection by dragging a finger or a stylus across the touch screen 36. In a "Touch Auto Zoom" method, a portion of the display that was selected is automatically enlarged for better visual recognition by a user 12. In a "Scanning" mode, highlighting is used

in a specific pattern so that individuals can use a physical switch, button or other device to make a selection when the desired object is highlighted. Selection can be made with a variety of customization options such as a 1-switch autoscan, 2-switch directed scan, 1-switch directed scan with dwell, inverse scanning, and auditory scanning. In a "Physical Gesture" method, which will be described in greater detail below, selection is made by the performance of a physical gesture or hand gesture, with such gesture being detected by the accelerometer/gyroscope 38 of the wearable SGD 10.

[0038] As indicated above, the wearable SGD may include a touch screen 36 for detecting user inputs directed to buttons, menus, or other graphical user interfaces displayed on the display device 18. For example, the display device 18 and touch screen 36 may be integrated together as a touch sensitive display. Thus, in one embodiment, the touch screen 36 may be generally disposed on top of a front surface of the display device 18. As such, input selections may be provided to the SGD 10 via the touch screen 36 by a user 12 pressing/contacting his fingers or applying a stylus to the front of the display device 18.

[0039] It should be appreciated that the touch screen 36 of the present subject matter may generally comprise any suitable touch screen known in the art. Thus, in several embodiments, the touch screen 36 may comprise a resistive touch screen, a capacitive touch screen or a pressure sensitive configuration. In general, a capacitive touch screen may be particularly well-suited for use with the disclosed wearable speech generation device 10. For example, a capacitive touch screen provides advantages such as overall thinness and light weight, which may be desirable for the wrist- or forearm-based ambulatory design of the present subject matter. In addition, a capacitive touch screen requires no activation force but only a slight contact, which can be advantageous for a user 12 who may have motor control limitations. Capacitive touch screens can also accommodate multi-touch applications (i.e., a set of interaction techniques which may allow a user to control graphical applications with several fingers) as well as scrolling. Additionally, capacitive touch screens typically do not require recalibrations, as may be needed with resistive or pressure-sensitive touch screens. Suitable examples of touch screens 36 that may be used with one or more embodiments of the described wearable SGD 10 are disclosed in U.S. Patent Nos. 6,879,319; 6,885,157; 7,042,444; 7,106,307; 7,133,032 and

7,230,608 all to Cok, all of which are hereby incorporated by reference in their entirety for all purposes. Further examples of touch screens 36 that may be used with embodiments of the wearable SGD 10 are disclosed in U.S. Patent Pub. Nos. 2002/0149572 (Shulz) and 2008/0180399 (Cheng), both of which are hereby incorporated by reference in their entirety for all purposes.

[0040] In a particular embodiment of the present subject matter, the touch screen 36 may be configured as a projected capacitive touch screen. A projected capacitive touch screen panel generally comprises a sensor typically formed from a transparent rigid panel (e.g., a relatively thin (0.043") chemically strengthened glass panel) coated with a transparent conductor such as indium tin oxide (ITO). This type of sensor is basically a capacitor in which the plates are the overlapping areas between the horizontal and vertical axes in a grid pattern. Since the human body also conducts electricity, a touch on the surface of the sensor will affect the electric field and create a measurable change in the capacitance of the device. Thus, the transparent rigid panel may be disposed over a front surface of the display device 18 to prevent false activations of the SGD 10 when the transparent panel is inadvertently subjected to pressure. Additionally, each of the icons, buttons, menus or other graphical user interfaces displayed on the display device 18 may be configured as a capacitive switch, which can be activated by the capacitance of the user's body rather than by pressure against the touch screen 36. One particular example of a touch screen for use in accordance with the subject SGD corresponds to a capacitive touch screen such as those offered for sale by Touch International of Austin, Texas.

[0041] It should be appreciated that, in alternative embodiments, the touch screen 36 need not include a transparent rigid panel, such as a glass panel, as the substrate for the active sensing material. Instead, the active sensing material may be deposited on a flexible panel, such as a panel formed from a transparent polymer film (e.g., polyethylene terephthalate (PET) films or polyethylene naphthalate (PEN) films). As such, the touch screen 36 may be configured as a flexible touch screen and may be adapted to be integrated into or otherwise used in conjunction with the flexible display device of the present subject matter, which is described with reference to FIGS. 3-5.

[0042] In addition to the advantages described above, the incorporation of projective capacitive technology into a wearable speech generating device 10

may provide even further advantages for an SGD. For example, the active sensing material of the touch screen can be applied to the back of the transparent flexible or rigid panel. As such, the top surface of the panel can be sealed relative to the speech generation device 10, providing ingress protection against infiltration of moisture and dirt into the device 10. Additionally, when the active electronics and graphics are applied to the back surface of the transparent panel, the top surface may be rendered scratch resistant and, thus, increase the durability of the panel. Moreover, projected capacitance technology also allows for a relatively high resolution device, such as on the order of 10,000 dpi (dots per square inch).

[0043] Still referring to FIG. 2, the wearable SGD 10 may also include one or more accelerometers and/or one or more gyroscopes 38 configured as an input device(s) for the SGD 10, which may be used in combination or separately. Generally, the accelerometer/gyroscope 38 of the present subject matter may be attached to or embedded within the housing 350, 450 (FIGS. 3-5) of the SGD 10 to enable the capture of user inputs, in the form of hand or arm gestures, by measuring the orientation and/or movement of the user's wrist or forearm. Such gestures may permit a user to quickly and efficiently navigate the communication software screens or other graphical user interfaces displayed on the display device 18 or make an input selection by performing only slight hand or arm movements.

[0044] It should be appreciated that the accelerometer of the present subject matter may generally comprise any suitable accelerometer known in the art. For example, in various embodiments, the accelerometer may comprise a piezoelectric, piezoresistive, capacitive, or micro electro-mechanical system (MEMS) accelerometer. Additionally, in a particular embodiment, the accelerometer 38 may comprise any device configured to measure both static and dynamic acceleration forces. As such, the accelerometer may be capable of detecting the angle or orientation at which a user's wrist and/or forearm is tilted and also the direction in which the user's wrist and/or forearm is moving. It should also be appreciated that the gyroscope of the present subject matter may generally comprise any suitable gyroscope known in the art. For example, in various in embodiments, the gyroscope may comprise a ring laser, fiber optic, vibrating or piezoelectric gyroscope.

[0045] To permit the central processing unit 16 to analyze measurements taken by the accelerometer/gyroscope 38, it should be appreciated that the accelerometer/gyroscope 38 may be communicatively coupled to the central processing unit 16, such as through a wired or wireless connection. Additionally, the central processing unit 16 may be capable of executing gesture recognition processing routines configured to associate measurements transmitted from the accelerometer/gyroscope 38 with physical gestures (e.g., hand movements) performed by the user 12. For example, suitable software instructions may be stored within the memory elements 26a, 26b of the central processing unit 16 to enable the processor 24 to implement various gesture recognition algorithms. As such, the accelerometer/gyroscope 38 may enable the SGD 10 to recognize numerous physical gestures as user inputs for navigating graphical user interfaces displayed on the display device 18 or for making an input selection. Thus, in one non-limiting example, the SGD 10 may be configured such that, as a user 12 tilts or rotates his hand in a particular direction (e.g., in a counter-clockwise or leftward direction), objects displayed to the user 12 may be scanned or highlighted in that particular direction. As another example, the SGD 10 may be configured to associate outputs from the accelerometer/gyroscope 38 which exceed a predetermined threshold (e.g., when a user 12 quickly moves his hand up or down at a velocity greater than a predetermined amount) as an input selection of the highlighted object displayed on the display device 18.

[0046] Additionally, inputs provided by the accelerometer/gyroscope 38 may further enable the SGD 10 to associate certain hand or arm gestures with one of a variety of different phrases commonly used by a user 12. For instance, if measurements taken by the accelerometer/gyroscope 38 indicate that a user 12 is holding his hand in a vertical plane that is substantially perpendicular to the horizontal plane of the ground and is waving it from side-to-side, the SGD 10 may be configured to output "Hello" or "How are you doing" through its speaker(s) 14. As another example, if measurements from the accelerometer/gyroscope 38 indicate that a user 12 is holding his hand substantially parallel to the horizontal plane of the ground and is quickly rotating it back and forth, the SGD 10 may be configured to speak "I am doing fine" or "I feel okay today." Of course, it should be apparent to those of ordinary skill in the art that various other gestures and/or

hand movements may be measured by the accelerometer/gyroscope 38 and recognized by the central processing unit 16 as user inputs for the SGD 10.

[0047] It should be appreciated that various other input devices may also be included as components of the wearable SGD 10 of the present subject matter. For example, input devices (e.g., peripheral devices 30 or 34) may include but are not limited to a keyboard, microphone, one or more physical input switches and the like. Such input devices may be in wireless communication with the central processing unit 16 of the SGD 10, such as through any suitable wireless communications protocol, or may be in communication with the central processing unit 16 via a wired connection. For example, the input devices may be communicatively coupled to the central processing unit 16 through a USB port 32 or other communicative coupling defined in the housing of the SGD 10.

[0048] Referring still to FIG. 2, SGD hardware components may also include one or more integrated output devices, such as, but not limited to, a display device 18 and one or more speakers 14. The display device 18 generally serves as an output feature for the SGD 10 and may be configured to display communication screens, menus and other graphical user interfaces generated by the central processing unit 16. As such, it should be appreciated that the display device 18 may generally correspond to any suitable monitor, screen or other output device capable of displaying images to the user 12. For example, suitable display devices may include, but are not limited to, light-emitting diode (LED) displays, electroluminescent displays (ELDs), plasma display panels (PDPs), light emitting polymer displays (LPDs), organic light emitting diode (OLED) displays and liquid crystal displays (LCDs). Additionally, in one exemplary embodiment of the present subject matter, the display device 18 may comprise a flexible display device, such as a flexible OLED (FOLED) display or an electronic paper (Epaper) display, which will be described below with reference to FIGS. 3-5.

[0049] The speaker(s) 14 may generally correspond to any compact high power audio output device and may function as an audible interface for the speech generation device when computer processor(s) 24 utilize text-to-speech functionality. In accordance with the general functionality of a speech generation device 10, a user 12 provides text, symbols corresponding to text, and/or related or additional information in a "Message Window" displayed on the display device 18 which then may be interpreted by a text-to-speech engine and provided as

audio output via the speaker(s) 14. Speech output may be generated in accordance with one or more preconfigured text-to-speech generation tools in male or female and adult or child voices, such as but not limited to such products as offered for sale by CereProc of Edinburgh, Scotland; Cepstral of Pittsburgh, PA; HQ Voices offered by Acapela Group of Mons, Belgium; Flexvoice offered by Mindmaker of San Jose, California; DECTalk offered by Fonix of Salt Lake City, Utah; products by Loquendo of Torino, Italy; VoiceText offered by NeoSpeech of Sunnyvale, California; AT&T's Natural Voices offered by Wizzard of Pittsburgh, Pennsylvania; Microsoft Voices, digitized voice (digitally recorded voice clips) or others.

[0050] The speaker(s) 14 of the present subject matter may be mounted or otherwise disposed at any suitable location relative to the user 12. For example, as shown in FIG. 1, one or more speaker(s) 14 may be worn as a pendant, such as around the user's neck at exemplary location 15. In another embodiment, illustrated in FIG. 3, one or more speakers may be attached to or embedded within the housing 350 of the SGD 310 and output audio through a speaker grille 366 defined in the housing. Of course, it should be appreciated that the speaker(s) 14 may be disposed at any other suitable location including, but not limited to, being attached to the user's clothes or being placed on or mounted to a user's bed, wheelchair, desk, nightstand or the like. Additionally, given the flexibility in locating the speaker(s) 14 of the present subject matter, it should be appreciated that the speaker(s) may be in communication with the central processing unit 16 by any suitable means. For example, in one embodiment, the speakers 14 may be communicatively coupled to the processing unit 16 through a BLUETOOTH connection or any other suitable wireless communications protocol. It should also be appreciated that the wearable SGD 10 may also include a volume control module 44 for regulating the volume of the speaker output.

[0051] It should be appreciated that additional hardware components that optionally may be included within the speech generation device 10 of the present subject matter may include various features for facilitating wireless communication between the components of the SGD 10 and/or between the SGD 10 and other secondary devices. For example, an antenna may be provided to facilitate wireless communication between the central processing unit 16 and

other components of the SGD 10 and/or between the central process unit 16 and other devices in accordance with one or more wireless communications protocols, including but not limited to BLUETOOTH, WI-FI (802.11 b/g) and ZIGBEE wireless communication protocols. Additionally, a wireless network adapter may be provided to enable access to a network, such as but not limited to a dial-in network, a local area network (LAN), wide area network (WAN), public switched telephone network (PSTN), the Internet, intranet or ethernet type networks or others. Further, an infrared (IR) transceiver may be provided to function as a universal remote control for the SGD 10 that may be capable of operating devices in the user's environment, for example including a TV, DVD player, and CD player.

[0052] It should also be appreciated that all graphical user interfaces and other menus that display "buttons" or other features that are selectable by a user 12 correspond to user input features that when selected trigger control signals being sent to the central processing unit 16 within an SGD 10 to perform an action in accordance with the selection of the user buttons. In accordance with disclosed technology, such graphical user interfaces are displayed visually on the display device 18. Some exemplary graphical user interfaces correspond to conventional "QWERTY" keyboards, numeric keypads, or other customized keypads with alphanumeric identifiers. Buttons also may include words, phrases, symbols and other information that can be customized based on user preferences, frequency or use or other parameters.

[0053] Buttons may also be provided by which a user 12 can toggle additional menus and communication software screens such as preconfigured or customized compilations referred to herein as vocabulary lists or vocabulary list boxes. Vocabulary list boxes enable a user 12 to have a wide variety of words and phrases immediately available. By listing groups of related words and phrases, vocabulary list boxes enable a user 12 to quickly search through a wide range of text options when composing a message. For example, a user 12 can select a particular group of words and/or phrases and associate all selected items into a new vocabulary list, which may be named and optionally assigned a unique symbol to visually represent the vocabulary list. Features also may be provided to trigger actions performed by the SGD 10 upon selection of an item from a vocabulary list, for example, to automatically "speak" or provide as audio output

the words/phrases from a vocabulary list box immediately as it is selected by a user 12, or to send the words/phrases from the vocabulary list box to the Message Window as it is selected by a user.

[0054] Referring now to FIG. 3, a front perspective view of an exemplary embodiment of a wearable speech generation device 310 is illustrated in accordance with aspects of the present subject matter. Such a wrist- or forearm-based configuration may generally allow for a relatively compact and lightweight device, thus rendering the disclosed SGD 310 very portable. Additionally, since the SGD 310 may be attached to the user's wrist, the user is not forced to carry around a bulky device, leaving the user's hands free for other uses. In general, the wearable SGD 310 may include many or all of the components and features described with reference to FIG. 2. Additionally, as shown in FIG. 3, the wearable SGD 310 may also include a housing 350 for accommodating such components and a means for attaching the housing 350 to the wrist or forearm of the user 12. For example, the means for attaching the housing 350 may include a wristband 368 (e.g., watchband, armband, bracelet or any other suitable strap/band) and/or a fastening mechanism 370 (e.g., a buckle, clasp, clip, Velcro strips (hook and loop strips), magnets or other suitable fastening mechanism(s)).

[0055] Generally, the housing 350 may serve as a protective casing or covering for the central processing unit 16 and any other internal components of the SGD 310 (e.g., the battery 20, accelerometer/gyroscope 38, and the like (FIG. 2)). Thus, the housing 350 may be formed from any suitable material capable of protecting such components from damage during normal, expected use of the SGD 310. In one embodiment, the housing 350 may be formed from a substantially rigid and/or durable material such as, but not limited to, plastic, thermoplastic, polymer, polyethylene, metal, or resin materials.

[0056] Although not illustrated in FIG. 3, it should be appreciated that the housing 350 may comprise multiple components. For example, the housing 350 may be formed from top and bottom housing components to facilitate efficient assembly of the components of the SGD 310 within the housing 350. The housing 350 may also include one or more internal structural components that may be provided as mounting surfaces for the central processing unit 16 (FIG. 2) and other internal components of the SGD 310. Of course, it should be appreciated that, when the housing 350 includes multiple components, various

connectors may be utilized to establish relative positioning among the various housing components and to secure the components to form an integrated assembly. For example, mating holes, pins and standoffs may be used to orient adjacent housing components with one another. Further, snap-fit features, threaded screws and/or any other suitable fastening mechanism or devices may be used to secure and connect the housing components together.

[0057] Still referring to FIG. 3, the housing 350 may also be configured to accommodate the display device 318 of the SGD 310. In particular, the display device 318 may be mounted or otherwise disposed within the housing 350 so as to provide a user 12 visual access to the communication screens and other graphical user interfaces 352 displayed on the display device 318. Thus, as shown in FIG. 3, an opening 354 may be defined in the front of the housing 350 to permit visual access to the display device 318. Additionally, when the SGD 310 of the present subject matter includes a touch screen 36 (FIG. 2) associated with the display device 318, the housing 350 may further define a recessed area or other embedded feature for accommodating the transparent rigid or flexible panel 388 of the touch screen. Specifically, the transparent panel 388 may be mounted within the front of the housing 350 such that the touch screen is generally disposed over the display device 318 and, thus, enables the touch screen to capture user inputs directed towards the buttons, menus, or other graphical user interfaces 352 displayed on the display device 318. In one embodiment, the perimeter of the transparent panel 388 may be sealed to a bezel 356 associated with the recessed area defined in the front of the housing 350, thereby providing ingress protection to moisture and dirt as well as a flush mounting surface to prevent debris or liquids from accumulating at the interface of the touch screen panel 388 and the housing 350. In such an embodiment, it should be appreciated that the active sensing material of the touch screen may be applied to a back surface of the transparent panel 388 to enable the front surface of the panel 388 to be rendered scratch resistant.

[0058] Still referring to FIG. 3, the housing 350 may also define additional openings to accommodate data input and output as well additional features of the SGD 310. For example, an opening may be defined in the housing 350 to provide a location for a power button 360 by which the user 12 can toggle power for the SGD 310 to "on" or "off" positions. Another opening may be defined in the

housing 350 to permit a volume knob or one or more volume control buttons 362 to be accessible to the user 12 for controlling the volume of the audio output provided by the speakers of the SGD 310. Moreover, further openings may provide a location for data input/output ports. For example, a location for USB ports, such as micro-USB ports, or other communicative ports 364 may be provided for coupling peripheral devices of the SGD 310 to the central processing unit 16 (FIG. 2). Further, in an embodiment of the present subject matter in which the speakers 14 (FIG. 2) of the SGD 310 are embedded within the housing 350, it should be appreciated that one or more openings may be formed within the housing 350 to define a speaker grille 366 to permit audio output from the speakers to radiate outwardly from the housing 350.

[0059] As indicated above, the wearable SGD 310 may also include a means for attaching the housing 350 to the wrist or forearm of a user 12. For example, as illustrated in FIG. 3, a wristband 368 may be coupled to the housing 350 and may be configured to extend around a user's wrist. Generally, the wristband 368 may comprise any suitable type of watchband, armband, bracelet or any other strap/band known in the art which may be secured around the wrist or forearm of the user 12. As such, it should be appreciated that the wristband 368 may be formed from various materials such as metals, woven fabrics or fibers (e.g., nylon), leather, polymers, rubber and other suitable materials. Additionally, as further shown in FIG. 3, the wristband 368 may also include a fastening mechanism 370 for removably securing the wristband 368 around the user's wrist or forearm. For instance, the wristband 368 may include a buckle, clasp, clip, Velcro strips (hook and loop strips), magnets or similar fastening mechanisms configured to allow the housing 350 to be secured to the user 12. Alternatively, the wristband 368 may include expandable or stretchable features, such as elastic bands, expandable metal joints and the like, that enable the wristband 368 to be stretched or otherwise expanded to facilitate installation of the wristband 368 on the user's wrist or forearm.

[0060] In alternative embodiments, it should be appreciated that the wristband 368 may be configured to only partially extend around a user's wrist or forearm. For instance, the wristband 368 may be configured as a cuff band or bracelet and, thus, may define a semi-circular shape having an open side to permit the user's wrist to be inserted into the band 368. In such an embodiment,

it should be appreciated that the wristband 368 may be formed from any suitable rigid or semi-rigid material, such as various metals, plastics, polymer materials and the like or from various flexible materials.

[0061] Additionally, in further embodiments, the wearable SGD 310 of the present subject matter may not include both a separate housing 350 and a separate wristband 368. For example, the housing 350 and wristband 368 may be formed integrally such that a portion of the housing 350 serves as the wristband and is secured around the user's wrist or forearm. Thus, similar to the embodiment illustrated in FIG. 4, the housing 350, itself, may be configured to have a semi-circular shape or other band or strap-like shape that enables the housing 350 to at least partially extend around the user's wrist.

[0062] Referring now to FIGS. 4 and 5, there is illustrated another exemplary embodiment of a wearable speech generation device 410 in accordance with aspects of the present subject matter. Similar to the embodiment described with reference to FIG. 3, the illustrated SGD 410 may include many or all of the components and features described with reference to FIG. 2. For example, the illustrated SGD 410 may include various input/output devices, such as a touch screen, one or more accelerometers/gyroscopes, speakers and the like. Additionally, as shown, the illustrated SGD 410 includes a display device 418 for displaying menus, buttons and other graphical user interfaces 452 generated by the central processing unit. However, unlike the above described embodiment, the display device 418 may be configured as a flexible display device that can be wrapped around a user's wrist or forearm.

[0063] As particularly shown in FIG. 4, the wearable SGD 410 generally includes a flexible display device 418 mounted or otherwise disposed within a band-shaped housing 450. The flexible display device 418 may generally comprise any suitable display device known in the art which is capable of being arced, bowed, folded, or otherwise flexed in order to conform to the shape of the housing 450 within which it is mounted or disposed. Thus, as shown in FIG. 4, when the housing 450 is configured as a wristband or bracelet, the flexible display device may adapted to be flexed into a substantially circular or semi-circular shape. As such, a wearable SGD 410 may be provided that is configured to display communication screens and other graphical user interfaces 452 substantially around the entire circumference of a user's wrist or forearm.

[0064] It should be appreciated that various flexible display devices are known in the art, such as flexible OLED, LCD, electrophoretic and electronic paper displays. For example, flexible displays and methods for creating flexible displays are disclosed in U.S. Patent Nos. 7,357,978 (Schmitz), 7,359,215 (Ochiai), 7,583,426 (Shin), 7,669,310 (Seo), 7,733,560 (Kim) and U.S. Patent Publication Nos. 2008/0136765 (Voutsas), 2009/0278449 (Choi), each of which are incorporated by reference herein in its entirety for all purposes. Additionally, a flexible printed circuit which may be utilized with a flexible display device is disclosed in 7,593,085 (Watanabe), which is incorporated by reference herein in its entirety for all purposes

[0065] In one exemplary embodiment of the present subject matter, the display device 418 may comprise a flexible OLED (FOLED) display. A FOLED display generally comprises many of the same components of an OLED display but may also include flexible components, such as flexible circuitry and a flexible substrate, to enable the display to be folded, flexed or even rolled up into itself. Suitable FOLED displays that may be utilized with the wearable SGD 410 of the present subject matter have been developed by Universal Display Corporation of Ewing, New Jersey, Samsung of Korea with offices in Ridgefield Park, New Jersey, Sony of Tokyo, Japan, LG of Seoul, South Korea, Add-Vision of Scotts Valley, California, the Flexible Display Center of Arizona State University and others.

[0066] In general, a FOLED display employs a plurality of organic light-emitting diodes (OLEDs) capable of light-emitting in one or more layers of organic material (i.e., the emissive layers) by movement and re-combination of electrons (negative charges) with holes (positive charges). When voltage potential is applied to such a device, negatively charged electrons move from a cathode layer into the emissive layer(s). At the same time, positively charged holes move from an anode layer into the same organic light-emitting layer. When the positive and negative charges meet in the emissive layer(s) of organic material, they combine and produce photons having a frequency falling within the spectrum of visible light to provide a desired display.

[0067] As is known, the various layers of an OLED may be formed from numerous different materials. For example, the anode and cathode layer may include materials such as but not limited to one or more metal oxides, one or

more conductive organic materials, or combinations of such materials or others. In particular, the anode layer may comprise a metal oxide, such as indium tin oxide, tin oxide, indium zinc oxide, zinc oxide, or any other suitable material which generally has a high work function, thus promoting the injection of holes into the emissive layer(s). Additionally, the cathode layer may comprise a metal such as aluminum or calcium or any other suitable material having a low work function that promotes injection of electrons into the emissive layer. It should be appreciated that the emissive layer may consist of a single layer or multiple layers of organic materials, such as a polymer, copolymer, a mixture of polymers, a low-molecular weight organic material (i.e., small molecule material) or phosphorescent material. Non-limiting examples of suitable polymers include but are not limited to poly(p-phenylene vinylene) or "PPV" and its derivatives, poly(n-vinylcarbazole) or "PVK" and its derivatives, polyfluorene and its derivatives, poly(paraphenylene) or "PPP" and its derivatives, polythiophene and its derivatives, polysilanes, and others. Non-limiting examples of suitable small molecule materials for use in emissive layer include organo-metallic chelates and conjugated dendrimers.

[0068] In a typical FOLED display, the plurality of layered OLEDs may be arranged in groups in a grid pattern or matrix. Several OLED groups forming a column of the grid may share a common cathode, or cathode line. Additionally, several OLED groups forming a row of the grid may share a common anode, or anode line. The individual OLEDs in a given group emit light when their cathode line and anode line are activated at the same time. A group of OLEDs within the matrix may form one pixel in a display, with each OLED usually serving as one subpixel or pixel cell. Particularly configured driving circuits may be provided to supply the appropriate power levels to the various groups of OLEDs within a FOLED display device. For example, OLED pixels may be deposited or integrated into a flexible thin film transistor (TFT) backplane to form a matrix of pixels that generate light upon electrical activation. Generally, the flexible TFT backplane may function as a series of switches to control the current flowing to each of the OLED pixels. As is known, TFT backplanes are typically formed from semiconductor materials, such as amorphous silicon or polysilicon. Additional details regarding OLED groups/pixels and OLED displays, in general, are described in U.S. Provisional Patent Application No. 60/250,274 filed October 9,

2009 and entitled "Speech Generation Device with OLED Display," which is hereby incorporated by reference in its entirety for all purposes.

[0069] To provide flexibility to the FOLED display, the OLEDs and associated circuitry may be deposited onto a flexible substrate. Generally, the flexible substrate may comprise any material suitable for use as an OLED substrate which may be configured to be flexed or conformed in order to enable the flexible display device 418 to be at least partially wrapped around the a user's wrist or forearm. For example, in one embodiment, the flexible substrate may be formed from ultra-thin, flexible glass (e.g., glass having a thickness of 20 micrometers). Alternatively, the flexible substrate may comprise a thin metal foil, such as a thin stainless steel foil. In a further embodiment, the flexible substrate may be formed from a flexible polymer film, such as a polyethylene terephthalate (PET) film or polyethylene naphthalate (PEN) film.

[0070] It should be appreciated that, in addition to providing flexibility to the display device 418 of the present subject matter, a FOLED display may offer numerous other advantages. In particular, a FOLED display may be generally characterized by low activation or driving voltage, thus providing for longer battery life, self-luminescence without requiring a backlight, reduced thickness, wide viewing angle, fast response speed, high contrast, greater brightness and color, superior impact resistance, ease of handling, etc. The reduced weight and power requirements of a FOLED display provide particular advantages for a portable/wearable speech generation device because more lightweight and efficient devices help increase a potential user's mobility and duration of assisted communication.

[0071] In another exemplary embodiment of the present subject matter, the flexible display device 418 may be configured as an electronic paper (Epaper) display. Flexible Epaper displays are known in the art and, thus, a detailed description of such displays need not be provided herein. However, in one embodiment, an Epaper display may comprise a layered assembly printed or otherwise deposited onto a flexible substrate (e.g., a thin polymer film) which includes a layer of circuitry, such as a layer of flexible TFTs. The layered assembly may generally consist of a plurality of microcapsules suspended in a liquid polymer between two electrode layers, with each electrode layer including an array of aligned electrodes connected to the circuitry to form a pattern of

pixels. Each microcapsule may include a plurality of positively charged white particles and a plurality of negatively charged black particles. As such, when a positive charge is applied to a back side of a pixel, the positively charged white particles of the microcapsules contained within the pixel move to the top of each microcapsule and make the surface of the Epaper display appear white in the location of that pixel. Similarly, when a negative charge is applied to a back side of a pixel, the negatively charged black particles move to the tops of each microcapsule, which makes the surface appear black in the location of such pixel. As such, differing images and screens may be created by applying varying positive and negative charges across the pattern of pixels.

[0072] Of course, it should be appreciated that the components and configuration of the Epaper display described above was simply provided as one example of an Epaper display. In general, Epaper displays may include various components, have varying configurations, and may support both black and white and color applications. Suitable Epaper displays for use with the wearable SGD of the present subject matter are available from E-ink of Cambridge Massachusetts, Bridgestone Corporation having offices in Nashville, Tennessee and Kent Displays of Kent, Ohio.

[0073] Referring still to FIGS. 4 and 5, the housing 450 of the wearable SGD 410 generally may be configured as a wristband or bracelet. For example, as shown in FIGS. 4 and 5, the housing 450 may be shaped as a cuff wristband or bracelet and, thus, may define a semi-circular shape having an open side configured to permit the user's wrist to be inserted into the housing 450. The housing 450 may also serve as a protective casing for the central processing unit 16 (FIG. 2) and/or any other internal components of the SGD 410. In particular, the housing 450 may define a volume between an inner surface of the housing 450 and the flexible display device within which the various components of the SGD 410 may be disposed. For example, as shown in FIGS. 4 and 5, the housing 450 may be defined with a tapered width such that the cross-sectional area of the housing 450 increases from the ends 482 of the housing 450 towards a middle portion 484 of the housing 450. As such, a larger volume may be available in the middle portion 484 for storing the various components of the SGD 410. Additionally, the tapered width may enable the ends 482 of the housing 450

to be designed to be relatively flexible to facilitate installation of the wearable SGD 410 on the user's wrist or forearm.

[0074] Moreover, similar to the embodiment described above with reference to FIG. 3, it should be appreciated that the housing 450 may be formed as a single component or as multiple components that may be combined together into an integrated assembly. For example, the housing 450 may include one or more internal structural components provided as mounting surfaces for the central processing unit 16 (FIG. 2) and the various other internal components of the SGD 410. Additionally, in one embodiment, the housing 450 may be formed from a first and second housing components hingedly coupled together about a centerline of the SGD 410.

[0075] As indicated above, the housing 450 may also be configured to accommodate the flexible display device 418. In particular, the display device 418 may be wrapped or flexed within the housing 450 so as to conform to the band-like shape of the housing 450. Thus, a large opening 454 may be defined in the outer surface of the housing 450 so as to provide a user 12 visual access to the communication screens and other graphical user interfaces 452 displayed on the display device 418. For example, in one embodiment, the flexible display device 418 may be mounted or otherwise disposed within the housing 450 such that the opening 454 forms a frame around the perimeter of the display device 418. Moreover, in embodiments in which a touch screen 36 (FIG. 2) (e.g., a flexible touch screen including a flexible transparent panel) is integrated into or otherwise associated with the display device 418, the housing 450 may further define a recessed area or other embedded feature to enable the touch screen to be disposed over the display device 418 and, thus, capture user inputs directed towards the display.

[0076] Similar to the housing 350 described above with reference to FIG. 3, the illustrated housing 450 may also define additional openings to accommodate data input and output as well additional features of the SGD 410. For example, an opening may be defined in the housing 450 to provide a location for a power button 460 by which the user 12 can toggle power for the SGD 410 to "on" or "off" positions. Another opening may be defined in the housing to permit a volume knob or one or more volume control buttons 462 to be accessible to the user for controlling the volume of the audio output provided by the speakers of the SGD

410. Moreover, further openings may provide a location for data input/output ports. For example, a location for USB ports, such as micro-USB ports, or other communicative ports 464 may be provided for coupling peripheral devices of the SGD 410 to the central processing unit.

[0077] It should be appreciated that the housing 450 may generally be formed from any suitable material. For example, in one embodiment, the housing 450 may be formed from various rigid or semi-rigid materials such as plastic, thermoplastic, polymer, polyethylene, metal, or resin materials. Alternatively, given the inherent flexibility of the flexible display device 418, it should be appreciated that the housing 450 may be formed from a material having two or more stable conditions, such as a bistable material. Thus, in a particular embodiment of the present subject matter, the housing 450 may be formed from a flexible or conformable material chosen such that the housing 450 may be reshaped or transformed from the wristband configuration illustrated in FIGS. 4 and 5 to a flat or planar configuration and vice versa. As such, the disclosed SGD 410 may be wrapped around a user's wrist or forearm and used as a wearable device or may be straightened out into a flat or planar stable condition and used as a hand-held device. Suitable materials for use in such an embodiment may include bistable materials (e.g. bistable spring steel), shape memory materials such as electro-active shape memory polymers, materials including elastic nanoparticles, and other materials capable of being transformed between two or more stable conditions.

[0078] It should also be appreciated that, while the central processing unit 16 (FIG. 2) and the various other internal components of the wearable SGD have been generally described herein as being attached to or disposed within the housing 350, 450 of the SGD, such components may be disposed elsewhere with respect to the SGD housing 350, 450. For example, in alternative embodiments of the present subject matter, it may be desirable for the central processing unit 16 and/or the various other components of the SGD to be disposed in a separate housing module located on or adjacent to the user 12 in order to provide sufficient and/or additional storage space within the SGD housing 350, 450. For example, a separate housing module containing the central processing unit 16 may be stored in a backpack worn by the user or may be connected to the user's clothes through a belt clip or any other suitable mechanical fastener. Of course,

it should be appreciated that the separate housing module may be stored on or in any other item that is sufficiently close to the user 12 to allow communication between the various components of the SGD and the processing unit 16 via a wired or wireless connection. For instance, in various other embodiments, the separate housing module may be disposed in a user's pocketbook, knapsack, shirt pocket, pants pocket and the like. In further embodiments, the separate housing module may be placed on or within a user's wheelchair, bed, chair, nightstand, desk or any other item disposed closely adjacent to the user 12. In even further embodiments, the separate housing module may be attached to the user 12, such as by being worn as a pendant around the user's neck or wrist.

[0079] While the present subject matter has been described in detail with respect to specific embodiments thereof, it will be appreciated that those skilled in the art, upon attaining an understanding of the foregoing may readily produce alterations to, variations of, and equivalents to such embodiments. Accordingly, the scope of the present disclosure is by way of example rather than by way of limitation, and the subject disclosure does not preclude inclusion of such modifications, variations and/or additions to the present subject matter as would be readily apparent to one of ordinary skill in the art.

In the claims:

1. A wearable speech generation device, comprising:
a housing configured to be worn on a user's wrist or forearm;
a display device attached to or embedded within the housing;
a speaker configured to generate an audio output;
a processing unit communicatively coupled to the display device and the speaker, the processing unit including a processor and a related computer readable medium storing instructions executable by the processor,
wherein the instructions stored on the computer readable medium configure the speech generation device to generate text-to-speech output.
2. The wearable speech generation device of claim 1, further comprising a touch screen associated with the display device.
3. The wearable speech generation device of claim 2, wherein the touch screen is attached to or embedded within the housing so that the touch screen is positioned over the display device.
4. The wearable speech generation device of claim 2, wherein the touch screen comprises a capacitive touch screen.
5. The wearable speech generation device of claim 1, further comprising at least one of an accelerometer and a gyroscope communicatively coupled to the processing unit, the at least one of the accelerometer and the gyroscope being attached to or embedded within the housing.
6. The wearable speech generation device of claim 5, wherein the at least one of the accelerometer and the gyroscope is configured to measure at least one of an orientation of the user's wrist or forearm and movement of the user's wrist or forearm.
7. The wearable speech generation device of claim 6, wherein the instructions stored on the computer readable medium further configure the speech generation device to recognize the measurements provided by the at least one of the accelerometer and the gyroscope as user inputs.
8. The wearable speech generation device of claim 1, wherein the display device is configured as a flexible display device.
9. The wearable speech generation device of claim 8, wherein the flexible display device comprises a flexible organic light emitting diode display.

10. The wearable speech generation device of claim 8, wherein the flexible display device comprises an electronic paper display.

11. The wearable speech generation device of claim 8, further comprising a flexible touch screen associated with the flexible display device.

12. The wearable speech generation device of claim 8, wherein the flexible display device is configured to conform to a shape of the housing.

13. The wearable speech generation device of claim 1, further comprising a battery and at least one secondary power source for providing power to the speech generation device.

14. The wearable speech generation device of claim 13, wherein the at least one secondary power source comprises a solar power source or an inertial power surface.

15. The wearable speech generation device of claim 1, further comprising an antenna communicatively coupled to the processing unit.

16. The wearable speech generation device of claim 15, wherein the antenna is configured to facilitate communication between the speech generation device and a secondary device.

17. The wearable speech generation device of claim 1, further comprising means for attaching the housing to the user's wrist or forearm.

18. The wearable speech generation device of claim 17, wherein the means for attaching the housing to the user's wrist or forearm comprises at least one of a wristband and a fastening mechanism.

19. The wearable speech generation device of claim 1, wherein the housing is configured as a wrist band.

20. The wearable speech generation device of claim 1, wherein the housing is formed from a material having two or more stable conditions.

21. The wearable speech generation device of claim 20, wherein the material comprises a bistable material, a shape memory material or a material having elastic nanoparticles.

22. The wearable speech generation device of claim 20, wherein the material is chosen such that the housing is adapted to be transformed from a wristband configuration to a planar configuration.

23. The wearable speech generation device of claim 1, wherein the processing unit is attached to or embedded within the housing.

24. The wearable speech generation device of claim 1, wherein the processing unit is disposed separate from the housing.

25. The wearable speech generation device of claim 1, wherein the speaker is attached to or embedded within the housing.

26. The wearable speech generation device of claim 1, wherein the speaker is disposed separate from the housing.

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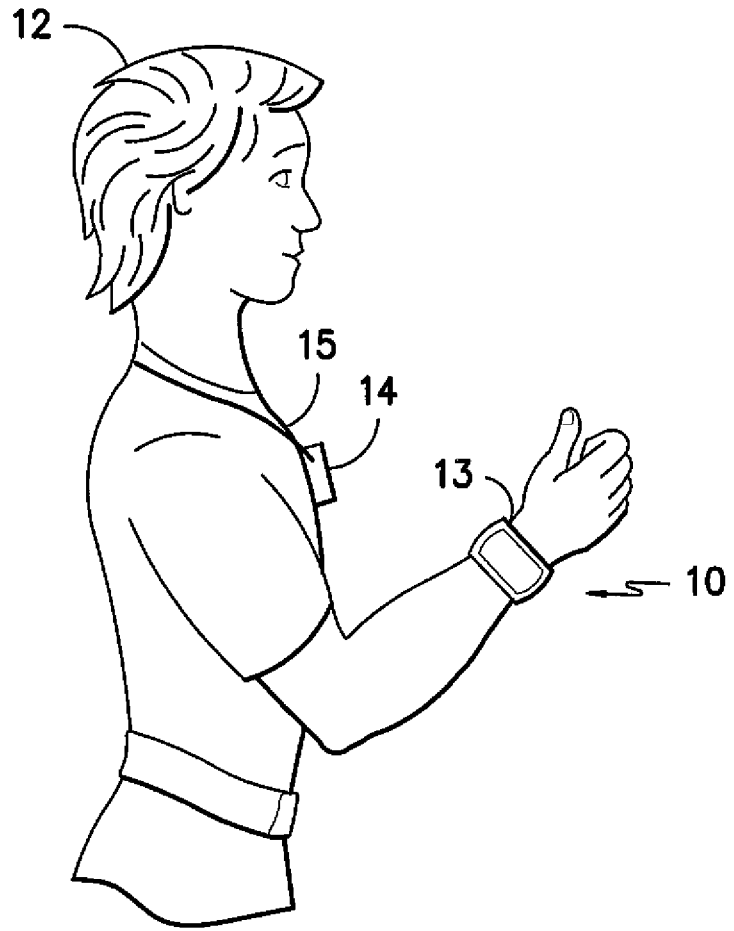


FIG. -1-

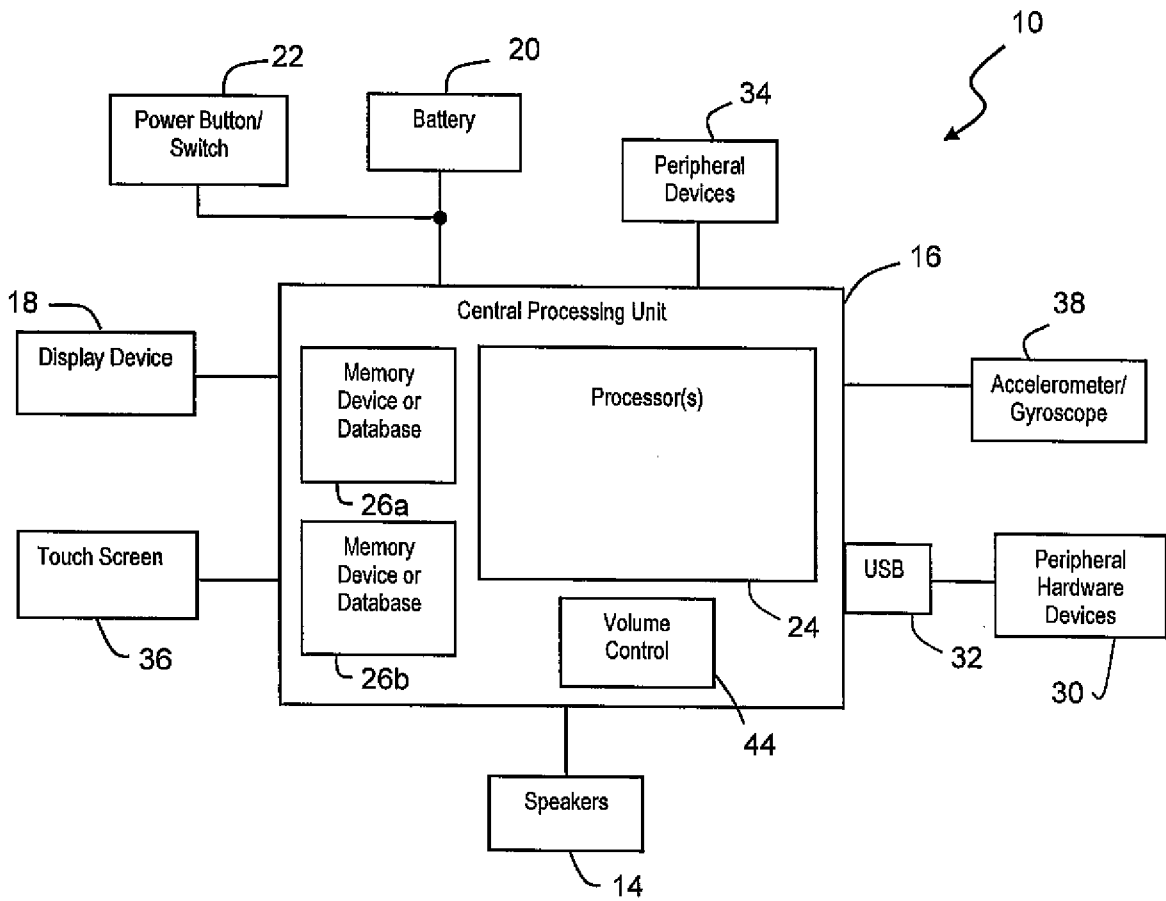


FIG. -2-

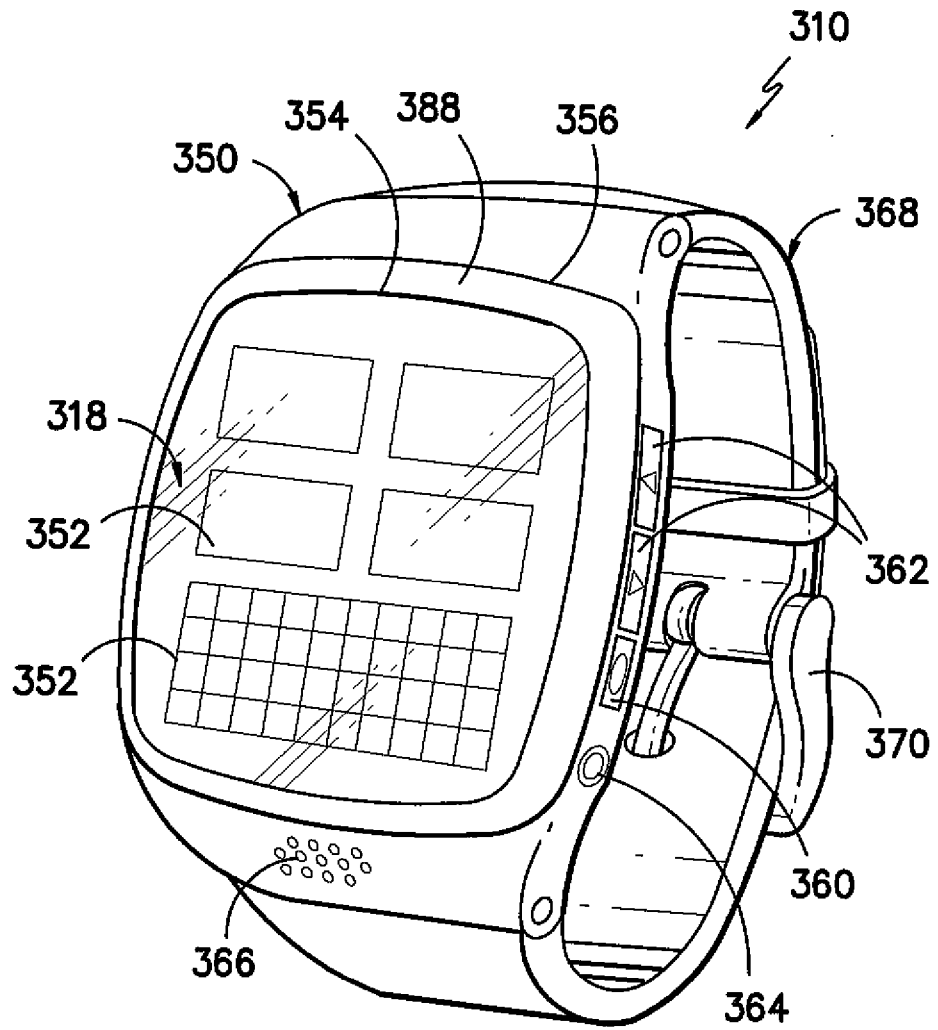


FIG. -3-

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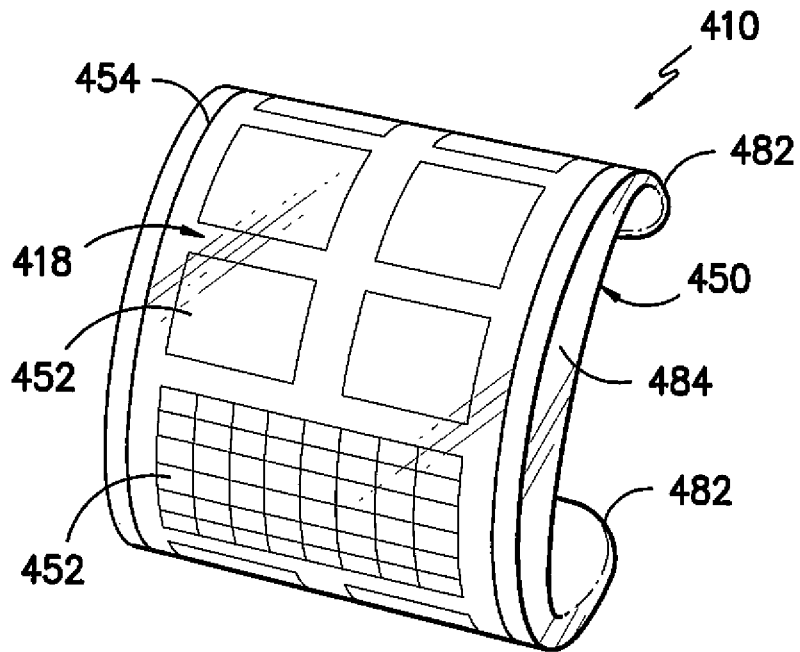


FIG. -4-

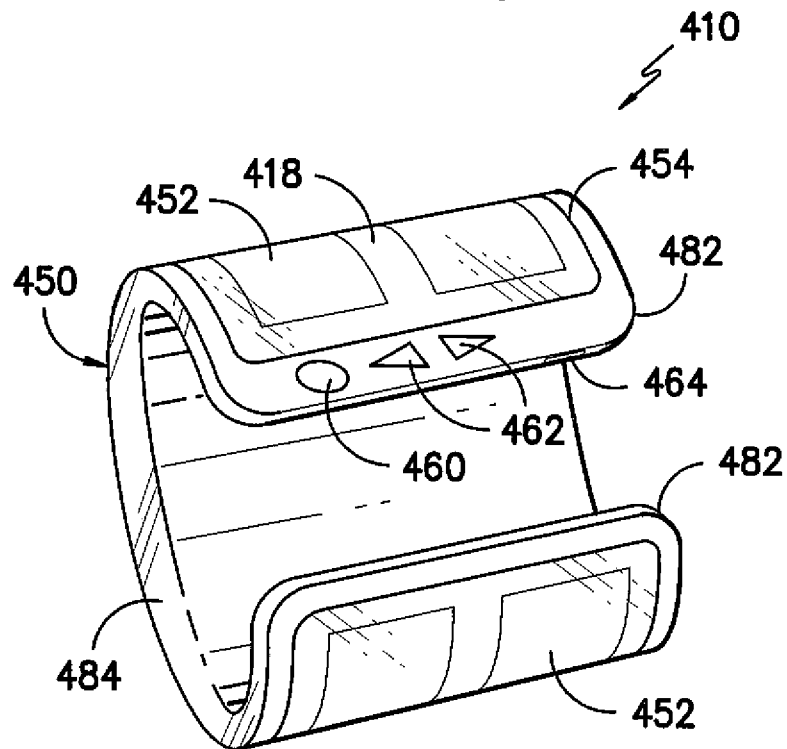


FIG. -5-

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 11/43675

A. CLASSIFICATION OF SUBJECT MATTER
 IPC(8) - G10L 21/06 (2011.01)
 USPC - 704/271
 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)
 USPC: 704/271

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
 USPC: 704/258 (see terms below)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
 PubWEST(PGPB,USPT,USOC,EPAB,JPAB), GOOGLE SCHOLAR
 terms: wrist, forearm, display, speaker, loudspeaker, text-to-speech, voice, synthesis, touch screen, accelerometer, gyroscope, flexible, organic light emitting diode, electronic paper, battery, solar, inertial, bistable, nanoparticle, worn, wearable, OLED, e-paper, planar.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 2007/0178950 A1 (Lewis et al.) 02 August 2007 (02.08.2007), fig. 1-2, para [0013]-[0014],[0020]-[0026], [0037]-[0049].	1-3, 15-19, 23-26 ----- 4-14, 20-22
Y	US 6,705,990 B1 (Gallant et al.) 16 March 2004 (16.03.2004), fig. 1, col 11, ln 11-19.	4
Y	US 2009/0164219 A1 (Yeung et al.) 25 June 2009 (25.06.2009), fig. 1, para [0037]-[0041].	5-7
Y	US 2010/0117975 A1 (Cho) 13 May 2010 (13.05.2010), fig. 2, para [0049]-[0050], [0062], [0065], [0080].	8-12
Y	US 2009/0138207 A1 (Cosentino et al.) 28 May 2009 (28.05.2009), fig. 32, para [0264], [0296].	13-14
Y	US 7,618,260 B2 (Daniel et al.) 17 November 2009 (17.11.2009), col 5, ln 1-7, col 15, ln 36-40.	20-22

Further documents are listed in the continuation of Box C.

* Special categories of cited documents:	"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
"A" document defining the general state of the art which is not considered to be of particular relevance	"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
"E" earlier application or patent but published on or after the international filing date	"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
"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)	"&" document member of the same patent family
"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	

Date of the actual completion of the international search 29 October 2011 (29.10.2011)	Date of mailing of the international search report 17 NOV 2011
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774