



- (51) International Patent Classification:
G01P 13/00 (2006.01) *G06F 1/00* (2006.01)
- (21) International Application Number:
PCT/US2015/057338
- (22) International Filing Date:
26 October 2015 (26.10.2015)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
14/561,556 5 December 2014 (05.12.2014) US
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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU,

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- (54) Title: AWARENESS ENHANCEMENT MECHANISM

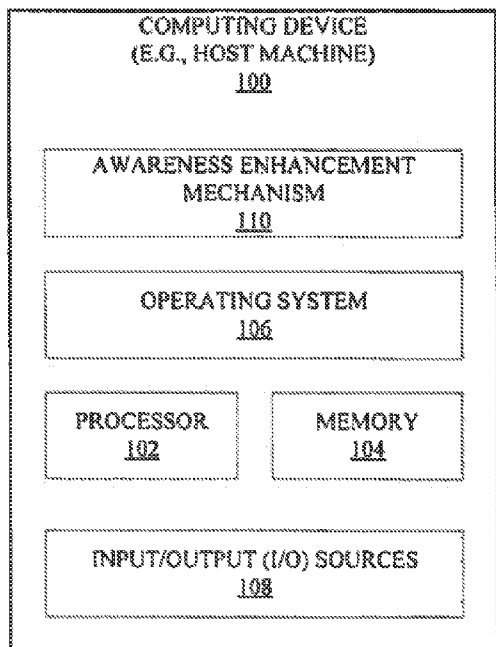


FIG. 1

(57) Abstract: A mechanism is described to facilitate dynamic selection of avatars according to one embodiment. A method of embodiments, as described herein, includes acquiring sensory data, processing the sensory data to detect and identify one or more surrounding objects of which a user should be made aware, determining a relevance of the one or more objects and to prioritize relevant objects as events and providing feedback based on the events.



TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

- *with international search report (Art. 21(3))*
- *with amended claims (Art. 19(1))*

AWARENESS ENHANCEMENT MECHANISM

FIELD

[0001] Embodiments described herein generally relate to wearable computing. More particularly, embodiments relate to dynamic prioritization of surrounding events based on contextual information.

BACKGROUND

[0002] Various wearable device applications are currently being implemented to assist user-awareness of activity outside of the user's field of vision or range of awareness. For example, hearing aid applications focus on using specific algorithms to amplify sound.

However, such applications focus on the simple translation of sensory data from one sense to another, or amplification of the sensory data to a level where the user can perceive it. Moreover existing solutions do not take into account a change surroundings during user activity. Specifically, current assisting devices do not account for a user's full field of awareness in order to provide information to the user.

BRIEF DESCRIPTION OF THE DRAWINGS

[0003] Embodiments are illustrated by way of example, and not by way of limitation, in the figures of the accompanying drawings in which like reference numerals refer to similar elements.

[0004] **Figure 1** illustrates an awareness enhancement mechanism at a computing device according to one embodiment.

[0005] **Figure 2** illustrates one embodiment of an awareness enhancement mechanism.

[0006] **Figure 3** illustrates one embodiment of contextual awareness ranges.

[0007] **Figure 4** illustrates one embodiment of an awareness enhancement device.

[0008] **Figure 5** illustrates one embodiment of a contextual awareness application.

[0009] **Figure 6** illustrates another embodiment of an awareness enhancement device.

[0010] **Figures 7A & 7B** illustrate embodiments of contextual awareness applications.

[0011] **Figures 8** is a flow diagram illustrating one embodiment of a process performed by an awareness enhancement mechanism.

[0012] **Figure 9** illustrates computer system suitable for implementing embodiments of the present disclosure according to one embodiment.

DETAILED DESCRIPTION

[0013] Embodiments may be embodied in systems, apparatuses, and methods for enhanced awareness, as described below. In the description, numerous specific details, such as component and system configurations, may be set forth in order to provide a more thorough understanding of the present invention. In other instances, well-known structures, circuits, and

the like have not been shown in detail, to avoid unnecessarily obscuring the present invention.

[0014] Embodiments provide for an awareness enhancement mechanism that uses logical heuristic models, user sensory capacity and physics to prioritize events that may require user attention. In such embodiments, a combination of contextual information and user training are analyzed to provide awareness enhancement. Accordingly, the awareness enhancement mechanism determines events that are likely to not be noticed by a user while the user is performing different activities based on limitations of the user's senses (e.g., user range of peripheral vision during different tasks). In a further embodiment, prioritization of events is implemented by evaluating characteristics of an event to determine the urgency of notification and best method of notification. In various embodiments, the awareness enhancement mechanism is integrated into a wearable device that includes assistive capabilities.

[0015] **Figure 1** illustrates an awareness enhancement mechanism 110 at a computing device 100 according to one embodiment. In one embodiment, computing device 100 serves as a host machine for hosting awareness enhancement mechanism ("awareness mechanism") 110 that includes a combination of any number and type of components for facilitating dynamic prioritization and notification of events at computing devices, such as computing device 100. In one embodiment, computing device 100 includes a wearable device. Thus, implementation of awareness mechanism 110 results in computing device 100 being an assistive device to determine relevancy and priority in relation to the identification, tracking, and notification of stationary and moving objects that surround a wearer of computing device 100.

[0016] In other embodiments, awareness enhancement operations may be performed at a computing device 100 including large computing systems, such as server computers, desktop computers, etc., and may further include set-top boxes (e.g., Internet-based cable television set-top boxes, etc.), global positioning system (GPS)-based devices, etc. Computing device 100 may include mobile computing devices, such as cellular phones including smartphones (e.g., iPhone® by Apple®, BlackBerry® by Research in Motion®, etc.), personal digital assistants (PDAs), tablet computers (e.g., iPad® by Apple®, Galaxy 3® by Samsung®, etc.), laptop computers (e.g., notebook, netbook, Ultrabook™, etc.), e-readers (e.g., Kindle® by Amazon®, Nook® by Barnes and Nobles®, etc.), etc.

[0017] Computing device 100 may include an operating system (OS) 106 serving as an interface between hardware and/or physical resources of the computer device 100 and a user. Computing device 100 further includes one or more processors 102, memory devices 104, network devices, drivers, or the like, as well as input/output (I/O) sources 108, such as touchscreens, touch panels, touch pads, virtual or regular keyboards, virtual or regular mice, etc.

[0018] **Figure 2** illustrates an awareness enhancement mechanism 110 employed at

computing device 100. In one embodiment, awareness enhancement mechanism 110 may include any number and type of components, such as: processing engine 201, prioritization logic 202, notification logic 203 and training logic 204. In one embodiment, processing engine 201 receives sensory data from a sensor array 220 and performs an analysis and response to events based on the information. In such an embodiment, processing engine 201 processes the sensory data to detect and identify one or more surrounding objects of which wearer of device 100 (or user) should be made aware. Further, processing engine 201 tracks the surrounding objects to determine objects that are stationary and objects that may be moving.

[0019] Prioritization logic 202 determines the relevance of the surrounding objects and prioritizes relevant objects as events based on characteristics of particular events. In one embodiment, the events include a velocity of an oncoming object, a type of object (e.g., alive, intelligent, inert, mobile, etc.), a size of the object. In some embodiments, job-specific rule sets are generated and used to prioritize attention to events that are specifically important for a user's scope of employment (e.g., construction worker, fisherman, law enforcement).

[0020] Notification logic 203 provides feedback to user based on processed events received from processing logic 201 and prioritization 202. In one embodiment, notification logic 203 provides immediate feedback in the form of selective audio amplification in order to augment and extend the users natural auditory awareness. In a further embodiment, non-speech audio (e.g., sonification) may be used to convey information or perceptualized data to the user. In still a further embodiment, objects may be represented with various virtual sounds selected by a user during the training mode.

[0021] In one embodiment, notification logic 203 may implement warning sounds to alert a user prior to the user walking into an object upon processing logic 201 determining that the user does not see the object. In an alternative embodiment, processing logic 201 may wirelessly communicate with other computing device via communication logic 225 to provide warning feedback to prevent collisions. For example, the user may lightly feel he/she is about to walk into an object and be safely guided around the object (e.g., virtual walking stick).

[0022] Training logic 204 implements a training mode that enables customization of awareness enhancement mechanism 110 for a user. According to one embodiment, training logic 204 determines a user's range of senses and how the ranges change during various activities. In such an embodiment, activities may include a user walking down a street with head up, reading with reading material a predetermined distance (e.g., 20cm - 30cm) from the face, watching a particular action at a predetermined distance (e.g., more than 3m) and participating in a conversation with a differing number of individuals.

[0023] In a further embodiment, training logic 204 performs basic reflex tests to

determine an amount forewarning necessary for the user to respond to different kinds of events. In a further embodiment, training logic 204 includes heuristic models to determine how user awareness is impacted by a broad number of activities. In such an embodiment, exemplary activities may include reading (e.g., material at close, middle and long ranges), having an object in front of the user to calculate a level of occultation, walking and paying attention to surroundings to calculate a general state of awareness world, talking on a telephone, talking to a person to account for a narrow focus on the person and the part of the field of vision blocked by the person, napping. According to one embodiment, the training is applied to the heuristic models to create a customized awareness map for the user.

[0024] Figure 3 illustrates one embodiment of contextual awareness ranges determined at training logic 202 during a training mode in which a device 100 learns a user field of vision. In this embodiment, face to face conversation between a user and another person is determined at a close range. During the conversation, training logic 204 increases the contextual awareness range based on user awareness limitations.

[0025] In embodiments, awareness enhancement mechanism 110 receives audio and image data from sensor array 220, where the image data may be in the form of a sequence of images or frames (e.g., video frames). Sensor array 220 may include an image capturing device, such as a camera. Such a device may include various components, such as (but are not limited to) an optics assembly, an image sensor, an image/video encoder, etc., that may be implemented in any combination of hardware and/or software. The optics assembly may include one or more optical devices (e.g., lenses, mirrors, etc.) to project an image within a field of view onto multiple sensor elements within the image sensor. In addition, the optics assembly may include one or more mechanisms to control the arrangement of these optical device(s). For example, such mechanisms may control focusing operations, aperture settings, exposure settings, zooming operations, shutter speed, effective focal length, etc. Embodiments, however, are not limited to these examples.

[0026] Image sources may further include one or more image sensors including an array of sensor elements where these elements may be complementary metal oxide semiconductor (CMOS) sensors, charge coupled devices (CCDs), or other suitable sensor element types. These elements may generate analog intensity signals (e.g., voltages), which correspond to light incident upon the sensor. In addition, the image sensor may also include analog-to-digital converter(s) ADC(s) that convert the analog intensity signals into digitally encoded intensity values. Embodiments, however, are not limited to these examples. For example, an image sensor converts light received through optics assembly into pixel values, where each of these pixel values represents a particular light intensity at the corresponding sensor element. Although

these pixel values have been described as digital, they may alternatively be analog. As described above, the image sensing device may include an image/video encoder to encode and/or compress pixel values. Various techniques, standards, and/or formats (e.g., Moving Picture Experts Group (MPEG), Joint Photographic Expert Group (JPEG), etc.) may be employed for this encoding and/or compression.

[0027] In a further embodiment, sensor array 220 may include other types of sensing components, such as context-aware sensors (e.g., myoelectric sensors, temperature sensors, facial expression and feature measurement sensors working with one or more cameras, environment sensors (such as to sense background colors, lights, etc.), biometric sensors (such as to detect fingerprints, facial points or features, etc.), and the like.

[0028] During operation, processing engine 201 may generate ambient noises, or supplement existing noises, based on computer image recognition and other contextual data. For example, a user may be surrounded by many people and only hear chatter. A simulated range of background music/atmospheric tones may supplement the existing background noise to evoke a wide range of moods from upbeat happy to ominous fear based on a three-dimensional mapping, object recognition, ambient lighting, contextual awareness, location, time of day, news/events, etc. This feedback may be formed into subtle cues to alert the user to either enjoy the party or escape from an impending riot.

[0029] **Figure 4** illustrates one embodiment of a device 100 implementing an awareness enhancement mechanism 110. As shown in **Figure 4**, device 100 is a wearable device worn on a user's head. Device 100 includes sensors 220 that enable the wearer to have contextual awareness of approaching objects. **Figure 5** illustrates one embodiment of a contextual awareness application performed by the device 100 shown in **Figure 4**. As shown in **Figure 5**, the central field vision of a user is focused on reading a book, which causes temporary tunnel vision and a loss of peripheral vision. However, awareness enhancement mechanism 110 provides contextual awareness of objects approaching on each side of the user while reading the book. For example, awareness enhancement mechanism 110 provides the user with awareness of objects (e.g., a person and a train) peripherally approaching to the left, as well as awareness of a person peripherally approaching to the right.

[0030] **Figure 6** illustrates another embodiment of a device 100 implementing an awareness enhancement mechanism 110. In this embodiment, device 100 is a wearable device worn on a user's ear. In this embodiment, device 100 uses contextual activity information to determine a user's level of awareness. **Figures 7A & 7B** illustrate embodiments of a contextual awareness application performed by the device 100 shown in **Figure 6**. **Figure 7A** shows that a user's external focus is reduced due to being engaged in a conversation. Accordingly, awareness

enhancement mechanism 110 increases contextual information awareness. **Figure 7B** shows that a user's external focus is at a maximum. Thus, awareness enhancement mechanism 110 may decrease contextual information awareness.

[0031] **Figures 8** is a flow diagram illustrating one embodiment of a process 800 performed by an awareness enhancement mechanism. Process 800 may be performed by processing logic that may comprise hardware (e.g., circuitry, dedicated logic, programmable logic, etc.), software (such as instructions run on a processing device), or a combination thereof. In one embodiment, method 800 may be performed by awareness enhancement mechanism 110. The processes of method 800 are illustrated in linear sequences for brevity and clarity in presentation; however, it is contemplated that any number of them can be performed in parallel, asynchronously, or in different orders. For brevity, clarity, and ease of understanding, many of the details discussed with reference to **Figures 1** and **2** are not discussed or repeated here.

[0032] At processing block 810, one or more approaching objects are detected and identified by awareness enhancement mechanism 110. At processing block 820, prioritization occurs to determine relevance of the one or more objects and to prioritize relevant objects as events. At processing block 830, the object is represented with a virtual sound. At processing block 840, the user is notified of the approaching object using the virtual sound.

[0033] In an exemplary use case implementing process 800, a user could be napping with eyes closed when awareness enhancement mechanism 110 performs process 800 to notify the user of a person walking towards the user from a direction of approach. In one embodiment, the notification is performed with the person being represented with simulated surround sound footsteps since the person's footsteps may be too quiet or masked by ambient noise in the environment. In another example, the user may be sunbathing on the beach, with ocean waves drowning out the sounds of people playing nearby. In such an instance, enhancement mechanism 110 may be trained to only notify the user of a stranger approaching the user in a straight line, while ignoring users that are walking past.

[0034] In yet another example, awareness enhancement mechanism 110 may identify an errant frisbee gliding quickly towards a user's head from behind and make the user virtually aware of the frisbee sooner than the real-world environment, thus providing more time to respond and properly duck out of the way. In still another example, quiet noise of an electric vehicle failing to yield at a crosswalk may be artificially boosted by awareness enhancement mechanism 110 with simulated surround sound to increase awareness of its trajectory to the user, who may be texting while walking and about to collide with the vehicle.

[0035] It is contemplated that any number and type of components may be added to and/or removed from awareness enhancement mechanism 110 to facilitate various embodiments

including adding, removing, and/or enhancing certain features. For brevity, clarity, and ease of understanding of awareness enhancement mechanism 110, many of the standard and/or known components, such as those of a computing device, are not shown or discussed here. It is contemplated that embodiments, as described herein, are not limited to any particular

5 technology, topology, system, architecture, and/or standard and are dynamic enough to adopt and adapt to any future changes.

[0036] Computing system 900 includes bus 905 (or, for example, a link, an interconnect, or another type of communication device or interface to communicate information) and processor 910 coupled to bus 905 that may process information. While computing system 900 is
10 illustrated with a single processor, electronic system 900 and may include multiple processors and/or co-processors, such as one or more of central processors, graphics processors, and physics processors, etc. Computing system 900 may further include random access memory (RAM) or other dynamic storage device 920 (referred to as main memory), coupled to bus 805 and may store information and instructions that may be executed by processor 910. Main memory 920
15 may also be used to store temporary variables or other intermediate information during execution of instructions by processor 910.

[0037] Computing system 900 may also include read only memory (ROM) and/or other storage device 930 coupled to bus 905 that may store static information and instructions for processor 910. Data storage device 940 may be coupled to bus 905 to store information and
20 instructions. Data storage device 940, such as magnetic disk or optical disc and corresponding drive may be coupled to computing system 900.

[0038] Computing system 900 may also be coupled via bus 905 to display device 950, such as a cathode ray tube (CRT), liquid crystal display (LCD) or Organic Light Emitting Diode (OLED) array, to display information to a user. User input device 960, including alphanumeric
25 and other keys, may be coupled to bus 905 to communicate information and command selections to processor 910. Another type of user input device 960 is cursor control 970, such as a mouse, a trackball, a touchscreen, a touchpad, or cursor direction keys to communicate direction information and command selections to processor 910 and to control cursor movement on display 950. Camera and microphone arrays 990 of computer system 900 may be coupled to bus
30 905 to observe gestures, record audio and video and to receive and transmit visual and audio commands.

[0039] Computing system 900 may further include network interface(s) 980 to provide access to a network, such as a local area network (LAN), a wide area network (WAN), a metropolitan area network (MAN), a personal area network (PAN), Bluetooth, a cloud network,
35 a mobile network (e.g., 3rd Generation (3G), etc.), an intranet, the Internet, etc. Network

interface(s) 980 may include, for example, a wireless network interface having antenna 985, which may represent one or more antenna(e). Network interface(s) 980 may also include, for example, a wired network interface to communicate with remote devices via network cable 987, which may be, for example, an Ethernet cable, a coaxial cable, a fiber optic cable, a serial cable, or a parallel cable.

[0040] Network interface(s) 980 may provide access to a LAN, for example, by conforming to IEEE 802.11b and/or IEEE 802.11g standards, and/or the wireless network interface may provide access to a personal area network, for example, by conforming to Bluetooth standards. Other wireless network interfaces and/or protocols, including previous and subsequent versions of the standards, may also be supported.

[0041] In addition to, or instead of, communication via the wireless LAN standards, network interface(s) 980 may provide wireless communication using, for example, Time Division, Multiple Access (TDMA) protocols, Global Systems for Mobile Communications (GSM) protocols, Code Division, Multiple Access (CDMA) protocols, and/or any other type of wireless communications protocols.

[0042] Network interface(s) 980 may include one or more communication interfaces, such as a modem, a network interface card, or other well-known interface devices, such as those used for coupling to the Ethernet, token ring, or other types of physical wired or wireless attachments for purposes of providing a communication link to support a LAN or a WAN, for example. In this manner, the computer system may also be coupled to a number of peripheral devices, clients, control surfaces, consoles, or servers via a conventional network infrastructure, including an Intranet or the Internet, for example.

[0043] It is to be appreciated that a lesser or more equipped system than the example described above may be preferred for certain implementations. Therefore, the configuration of computing system 900 may vary from implementation to implementation depending upon numerous factors, such as price constraints, performance requirements, technological improvements, or other circumstances. Examples of the electronic device or computer system 900 may include without limitation a mobile device, a personal digital assistant, a mobile computing device, a smartphone, a cellular telephone, a handset, a one-way pager, a two-way pager, a messaging device, a computer, a personal computer (PC), a desktop computer, a laptop computer, a notebook computer, a handheld computer, a tablet computer, a server, a server array or server farm, a web server, a network server, an Internet server, a work station, a mini-computer, a main frame computer, a supercomputer, a network appliance, a web appliance, a distributed computing system, multiprocessor systems, processor-based systems, consumer electronics, programmable consumer electronics, television, digital television, set top box,

wireless access point, base station, subscriber station, mobile subscriber center, radio network controller, router, hub, gateway, bridge, switch, machine, or combinations thereof.

[0044] Embodiments may be implemented as any or a combination of: one or more microchips or integrated circuits interconnected using a parentboard, hardwired logic, software
5 stored by a memory device and executed by a microprocessor, firmware, an application specific integrated circuit (ASIC), and/or a field programmable gate array (FPGA). The term "logic" may include, by way of example, software or hardware and/or combinations of software and hardware.

[0045] Embodiments may be provided, for example, as a computer program product
10 which may include one or more machine-readable media having stored thereon machine-executable instructions that, when executed by one or more machines such as a computer, network of computers, or other electronic devices, may result in the one or more machines carrying out operations in accordance with embodiments described herein. A machine-readable medium may include, but is not limited to, floppy diskettes, optical disks, CD-ROMs (Compact
15 Disc-Read Only Memories), and magneto-optical disks, ROMs, RAMs, EPROMs (Erasable Programmable Read Only Memories), EEPROMs (Electrically Erasable Programmable Read Only Memories), magnetic or optical cards, flash memory, or other type of media/machine-readable medium suitable for storing machine-executable instructions.

[0046] Moreover, embodiments may be downloaded as a computer program product,
20 wherein the program may be transferred from a remote computer (e.g., a server) to a requesting computer (e.g., a client) by way of one or more data signals embodied in and/or modulated by a carrier wave or other propagation medium via a communication link (e.g., a modem and/or network connection).

[0047] References to "one embodiment", "an embodiment", "example embodiment",
25 "various embodiments", etc., indicate that the embodiment(s) so described may include particular features, structures, or characteristics, but not every embodiment necessarily includes the particular features, structures, or characteristics. Further, some embodiments may have some, all, or none of the features described for other embodiments.

[0048] In the following description and claims, the term "coupled" along with its
30 derivatives, may be used. "Coupled" is used to indicate that two or more elements co-operate or interact with each other, but they may or may not have intervening physical or electrical components between them.

[0049] As used in the claims, unless otherwise specified the use of the ordinal adjectives
35 "first", "second", "third", etc., to describe a common element, merely indicate that different instances of like elements are being referred to, and are not intended to imply that the elements

so described must be in a given sequence, either temporally, spatially, in ranking, or in any other manner.

[0050] The following clauses and/or examples pertain to further embodiments or examples. Specifics in the examples may be used anywhere in one or more embodiments. The various features of the different embodiments or examples may be variously combined with some features included and others excluded to suit a variety of different applications. Examples may include subject matter such as a method, means for performing acts of the method, at least one machine-readable medium including instructions that, when performed by a machine cause the machine to performs acts of the method, or of an apparatus or system for facilitating hybrid communication according to embodiments and examples described herein.

[0051] Some embodiments pertain to Example 1 that includes an apparatus to facilitate awareness enhancement, comprising a sensor array to acquire sensory data, processing engine to process the sensory data to detect and identify one or more surrounding objects of which a user should be made aware, prioritization logic to determine relevance of the one or more objects and to prioritize relevant objects as events and notification logic to provide feedback based on the events.

[0052] Example 2 includes the subject matter of Example 1, wherein the processing engine tracks the surrounding objects to determine objects that are stationary and objects that are moving.

[0053] Example 3 includes the subject matter of Example 1, wherein the prioritization logic generates job-specific rule sets to prioritize attention to events related to a scope of employment.

[0054] Example 4 includes the subject matter of Example 1, wherein the events include at least one of a velocity of an oncoming object, a type of object, a size of the object.

[0055] Example 5 includes the subject matter of Example 1, wherein the notification logic provides feedback in the form of selective audio amplification in order to augment and extend natural auditory awareness.

[0056] Example 6 includes the subject matter of Example 1, wherein the notification logic provides feedback in the form of non-speech audio to convey perceptual data.

[0057] Example 7 includes the subject matter of Example 1, further comprising training logic to implement a training mode to customize awareness enhancement.

[0058] Example 8 includes the subject matter of Example 7, wherein the training logic determines a range of senses and how the range changes during activities.

[0059] Example 9 includes the subject matter of Example 8, wherein the training logic performs reflex tests to determine an amount of forewarning to respond to events.

[0060] Example 10 includes the subject matter of Example 7, wherein the training logic includes heuristic models to determine how awareness is impacted by activities.

[0061] Example 11 includes the subject matter of Example 10, wherein the training logic applies the heuristic models to create a customized awareness map.

5 [0062] Some embodiments pertain to Example 12 that includes a method to facilitate awareness enhancement comprising acquiring sensory data, processing the sensory data to detect and identify one or more surrounding objects of which a user should be made aware, determining a relevance of the one or more objects and to prioritize relevant objects as events and providing feedback based on the events.

10 [0063] Example 13 includes the subject matter of Example 12, further comprising tracking the surrounding objects to determine objects that are stationary and objects that are moving.

[0064] Example 14 includes the subject matter of Example 12, wherein the events include at least one of a velocity of an oncoming object, a type of object, a size of the object.

15 [0065] Example 15 includes the subject matter of Example 12, wherein the feedback is provided in the form of selective audio amplification in order to augment and extend natural auditory awareness.

[0066] Example 16 includes the subject matter of Example 12, wherein the feedback is provided in the form of non-speech audio to convey perceptual data.

20 [0067] Example 17 includes the subject matter of Example 12, further comprising performing training to customize awareness enhancement.

[0068] Example 18 includes the subject matter of Example 17, wherein the training comprises determining a range of senses and how the range changes during activities.

25 [0069] Example 19 includes the subject matter of Example 17, wherein the training comprises performing reflex tests to determine an amount of forewarning to respond to events.

[0070] Example 20 includes the subject matter of Example 17, wherein the training comprises performing applying heuristic models to create a customized awareness map.

30 [0071] Some embodiments pertain to Example 21 that includes at least one machine-readable medium comprising a plurality of instructions that in response to being executed on a computing device, causes the computing device to carry out operations comprising acquiring sensory data, processing the sensory data to detect and identify one or more surrounding objects of which a user should be made aware, determining a relevance of the one or more objects and to prioritize relevant objects as events and providing feedback based on the events.

35 [0072] Example 22 includes the subject matter of Example 21, comprising a plurality of instructions that in response to being executed on a computing device, causes the computing

device to further carry out operations comprising tracking the surrounding objects to determine objects that are stationary and objects that are moving.

[0073] Example 23 includes the subject matter of Example 21, comprising a plurality of instructions that in response to being executed on a computing device, causes the computing device to further carry out operations comprising performing training to customize awareness enhancement.

[0074] Example 24 includes the subject matter of Example 23, wherein the training comprises determining a range of senses and how the range changes during activities.

[0075] Example 25 includes the subject matter of Example 24, wherein the training comprises performing reflex tests to determine an amount of forewarning to respond to events.

[0076] Some embodiments pertain to Example 26 that includes at least one machine-readable medium comprising a plurality of instructions that in response to being executed on a computing device, causes the computing device to carry out the operations of claims 12-20.

[0077] Some embodiments pertain to Example 27 that includes a system to facilitate awareness enhancement comprising means for acquiring sensory data, means for processing the sensory data to detect and identify one or more surrounding objects of which a user should be made aware, means for determining a relevance of the one or more objects and to prioritize relevant objects as events and means for providing feedback based on the events.

[0078] Example 28 includes the subject matter of Example 27, further comprising means for tracking the surrounding objects to determine objects that are stationary and objects that are moving.

[0079] Example 29 includes the subject matter of Example 27, wherein the events include at least one of a velocity of an oncoming object, a type of object, a size of the object.

[0080] Example 30 includes the subject matter of Example 27, wherein the feedback is provided in the form of selective audio amplification in order to augment and extend natural auditory awareness.

[0081] The drawings and the forgoing description give examples of embodiments. Those skilled in the art will appreciate that one or more of the described elements may well be combined into a single functional element. Alternatively, certain elements may be split into multiple functional elements. Elements from one embodiment may be added to another embodiment. For example, orders of processes described herein may be changed and are not limited to the manner described herein. Moreover, the actions any flow diagram need not be implemented in the order shown; nor do all of the acts necessarily need to be performed. Also, those acts that are not dependent on other acts may be performed in parallel with the other acts.

The scope of embodiments is by no means limited by these specific examples. Numerous

variations, whether explicitly given in the specification or not, such as differences in structure, dimension, and use of material, are possible. The scope of embodiments is at least as broad as given by the following claims.

CLAIMS

What is claimed is:

1. An apparatus to facilitate awareness enhancement comprising:
a sensor array to acquire sensory data;
5 processing engine to process the sensory data to detect and identify one or more
surrounding objects of which a user should be made aware;
prioritization logic to determine relevance of the one or more objects and to prioritize
relevant objects as events; and
notification logic to provide feedback based on the events.
- 10 2. The apparatus of claim 1, wherein the processing engine tracks the surrounding objects to
determine objects that are stationary and objects that are moving.
3. The apparatus of claims 1 and 2, wherein the prioritization logic generates job-specific
rule sets to prioritize attention to events related to a scope of employment.
4. The apparatus of claims 1-3, wherein the events include at least one of a velocity of an
15 oncoming object, a type of object, a size of the object.
5. The apparatus of claims 1-4, wherein the notification logic provides feedback in the form
of selective audio amplification in order to augment and extend natural auditory awareness.
6. The apparatus of claims 1-5, wherein the notification logic provides feedback in the form
of non-speech audio to convey perceptual data.
- 20 7. The apparatus of claims 1-6, further comprising training logic to implement a training
mode to customize awareness enhancement.
8. The apparatus of claims 1-7, wherein the training logic determines a range of senses and
how the range changes during activities.
9. The apparatus of claims 1-8, wherein the training logic performs reflex tests to determine
25 an amount of forewarning to respond to events.
10. The apparatus of claims 1-9, wherein the training logic includes heuristic models to
determine how awareness is impacted by activities.
11. The apparatus of claims 1-10, wherein the training logic applies the heuristic models to
create a customized awareness map.
- 30 12. A method to facilitate awareness enhancement comprising:
acquiring sensory data;
processing the sensory data to detect and identify one or more surrounding objects of
which a user should be made aware;
determining a relevance of the one or more objects and to prioritize relevant objects as
35 events; and

providing feedback based on the events.

13. The method of claim 12, further comprising tracking the surrounding objects to determine objects that are stationary and objects that are moving.

14. The method of claims 12 and 13, wherein the events include at least one of a velocity of an oncoming object, a type of object, a size of the object.

15. The method of claims 12-14, wherein the feedback is provided in the form of selective audio amplification in order to augment and extend natural auditory awareness.

16. The method of claims 12-15, wherein the feedback is provided in the form of non-speech audio to convey perceptual data.

17. The method of claims 12-16, further comprising performing training to customize awareness enhancement.

18. The method of claims 12-17, wherein the training comprises determining a range of senses and how the range changes during activities.

19. The method of claims 12-18, wherein the training comprises performing reflex tests to determine an amount of forewarning to respond to events.

20. The method of claims 12-19, wherein the training comprises performing applying heuristic models to create a customized awareness map.

21. At least one machine-readable medium comprising a plurality of instructions that in response to being executed on a computing device, causes the computing device to carry out operations of claims 12-20.

22. A system to facilitate awareness enhancement comprising:

means for acquiring sensory data;

means for processing the sensory data to detect and identify one or more surrounding objects of which a user should be made aware;

means for determining a relevance of the one or more objects and to prioritize relevant objects as events; and

means for providing feedback based on the events.

23. The system of claim 22, further comprising means for tracking the surrounding objects to determine objects that are stationary and objects that are moving.

24. The system of claims 22 and 23, wherein the events include at least one of a velocity of an oncoming object, a type of object, a size of the object.

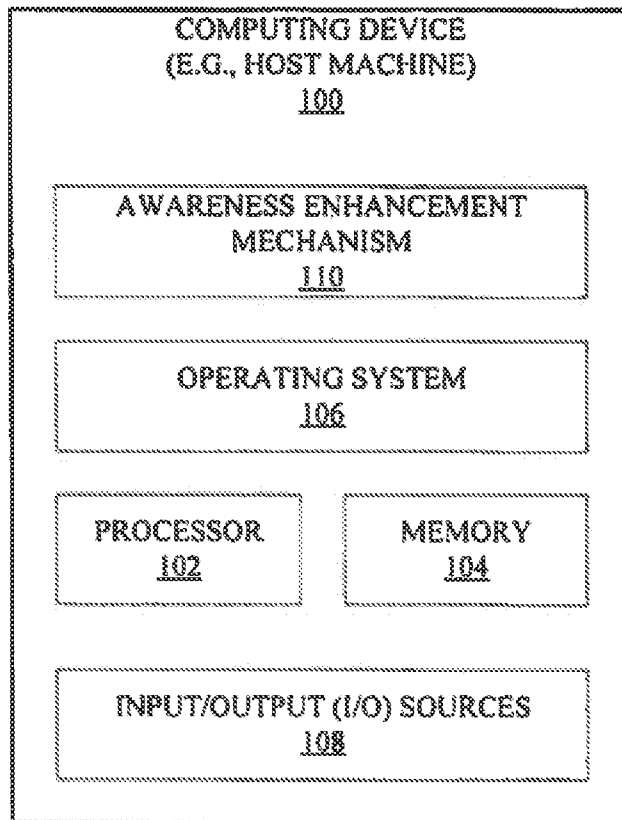
25. The system of claims 22-24, wherein the feedback is provided in the form of selective audio amplification in order to augment and extend natural auditory awareness.

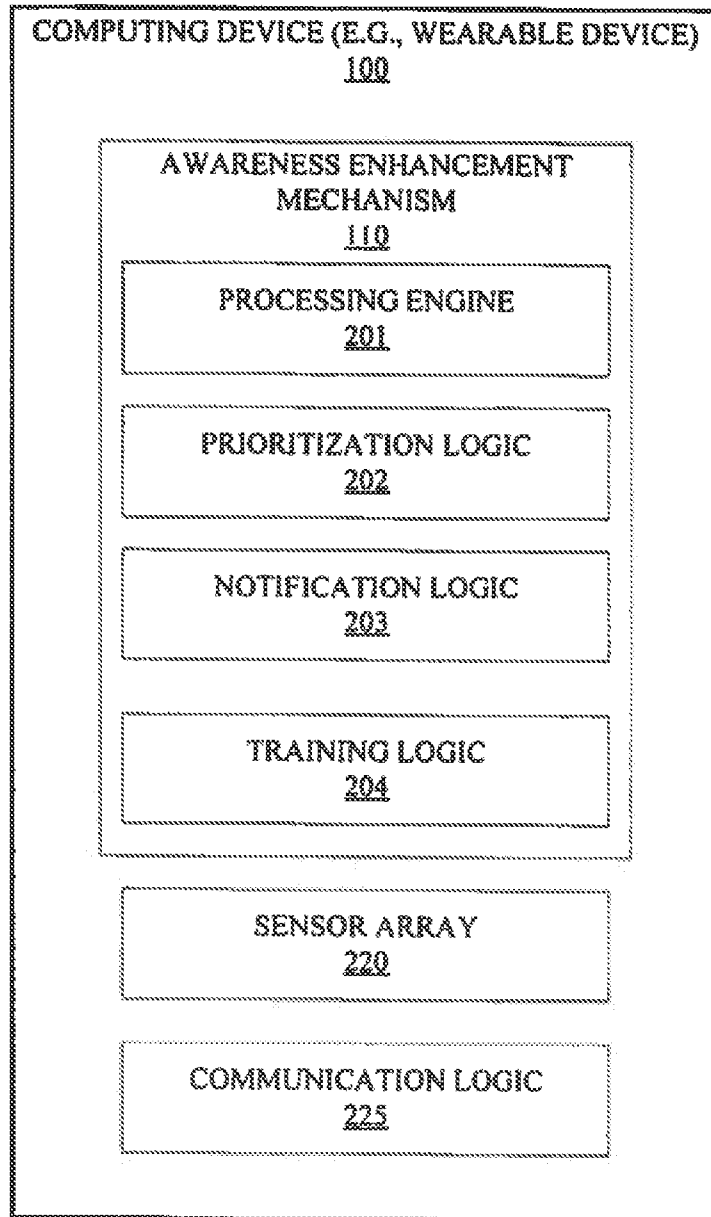
AMENDED CLAIMS
received by the International Bureau on 1 March 2016 (01.03.2016)

1. (Original) An apparatus to facilitate awareness enhancement comprising:
a sensor array to acquire sensory data;
processing engine to process the sensory data to detect and identify one or more
surrounding objects of which a user should be made aware;
prioritization logic to determine relevance of the one or more objects and to prioritize
relevant objects as events; and
notification logic to provide feedback based on the events.
2. (Original) The apparatus of claim 1, wherein the processing engine tracks the
surrounding objects to determine objects that are stationary and objects that are moving.
3. (Previously Presented) The apparatus of claim 2, wherein the prioritization logic
generates job-specific rule sets to prioritize attention to events related to a scope of employment.
4. (Previously Presented) The apparatus of claim 3, wherein the events include at least one
of a velocity of an oncoming object, a type of object, a size of the object.
5. (Previously Presented) The apparatus of claim 1, wherein the notification logic provides
feedback in the form of selective audio amplification in order to augment and extend natural
auditory awareness.
6. (Previously Presented) The apparatus of claim 1, wherein the notification logic provides
feedback in the form of non-speech audio to convey perceptual data.
7. (Previously Presented) The apparatus of claims claim 1, further comprising training logic
to implement a training mode to customize awareness enhancement.
8. (Previously Presented) The apparatus of claim 7, wherein the training logic determines a
range of senses and how the range changes during activities.

9. (Previously Presented) The apparatus of claim 8, wherein the training logic performs reflex tests to determine an amount of forewarning to respond to events.
10. (Previously Presented) The apparatus of claims claim 9, wherein the training logic includes heuristic models to determine how awareness is impacted by activities.
11. (Previously Presented) The apparatus of claims claim 10, wherein the training logic applies the heuristic models to create a customized awareness map.
12. (Original) A method to facilitate awareness enhancement comprising:
 - acquiring sensory data;
 - processing the sensory data to detect and identify one or more surrounding objects of which a user should be made aware;
 - determining a relevance of the one or more objects and to prioritize relevant objects as events; and
 - providing feedback based on the events.
13. (Original) The method of claim 12, further comprising tracking the surrounding objects to determine objects that are stationary and objects that are moving.
14. (Previously Presented) The method of claim 13, wherein the events include at least one of a velocity of an oncoming object, a type of object, a size of the object.
15. (Previously Presented) The method of claim 12, wherein the feedback is provided in the form of selective audio amplification in order to augment and extend natural auditory awareness.
16. (Previously Presented) The method of claim 12, wherein the feedback is provided in the form of non-speech audio to convey perceptual data.
17. (Previously Presented) The method of claim 12, further comprising performing training to customize awareness enhancement.

18. (Previously Presented) The method of claim 17, wherein the training comprises determining a range of senses and how the range changes during activities.
19. (Previously Presented) The method of claim 17, wherein the training comprises performing reflex tests to determine an amount of forewarning to respond to events.
20. (Previously Presented) The method of claim 17, wherein the training comprises performing applying heuristic models to create a customized awareness map.
21. (Original) At least one machine-readable medium comprising a plurality of instructions that in response to being executed on a computing device, causes the computing device to carry out operations of claims 12-20.
22. (Original) A system to facilitate awareness enhancement comprising:
means for acquiring sensory data;
means for processing the sensory data to detect and identify one or more surrounding objects of which a user should be made aware;
means for determining a relevance of the one or more objects and to prioritize relevant objects as events; and
means for providing feedback based on the events.
23. (Original) The system of claim 22, further comprising means for tracking the surrounding objects to determine objects that are stationary and objects that are moving.
24. (Previously Presented) The system of claim 22, wherein the events include at least one of a velocity of an oncoming object, a type of object, a size of the object.
25. (Previously Presented) The system of claim 22, wherein the feedback is provided in the form of selective audio amplification in order to augment and extend natural auditory awareness.

**FIG. 1**

**FIG. 2**

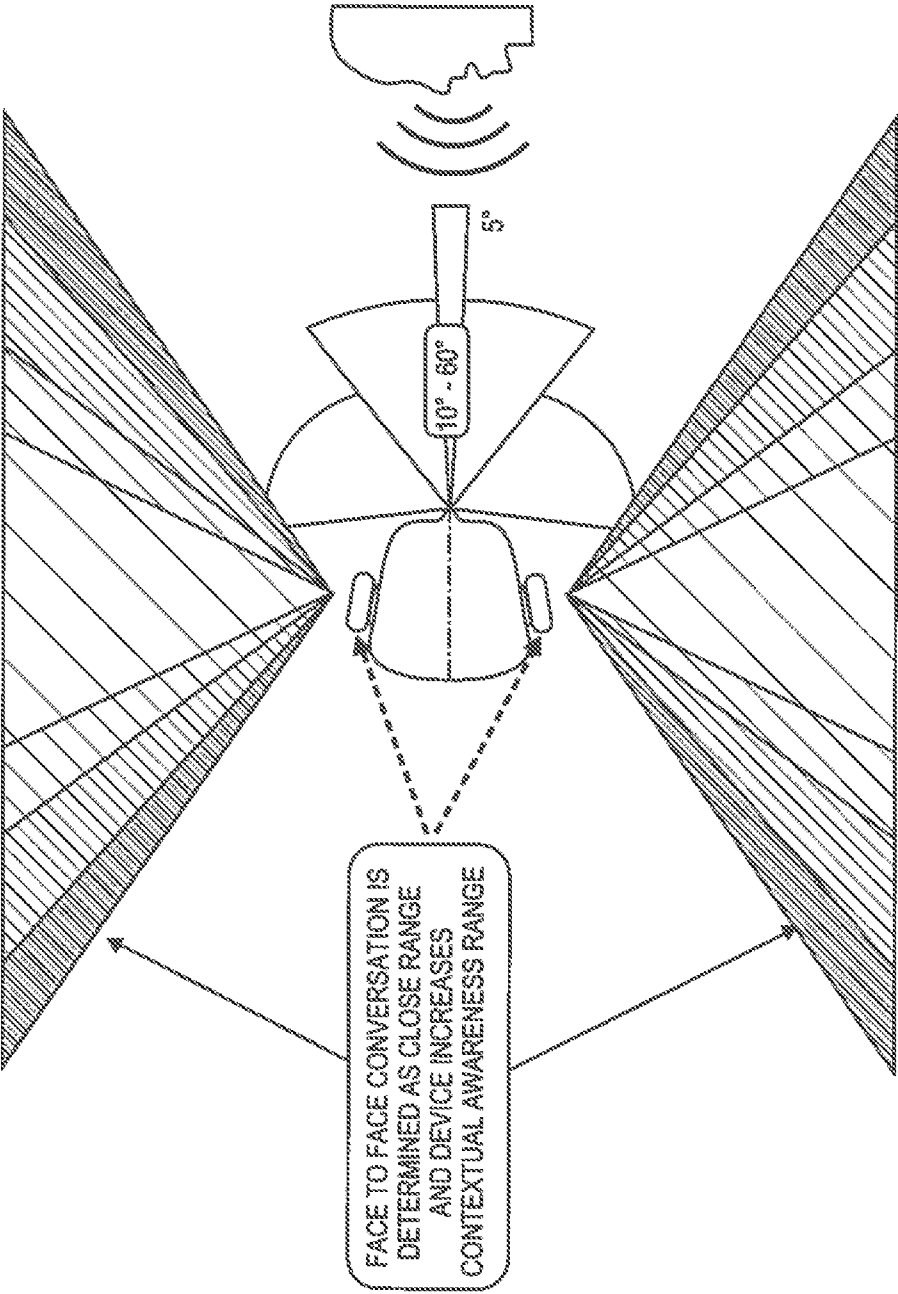


FIG. 3

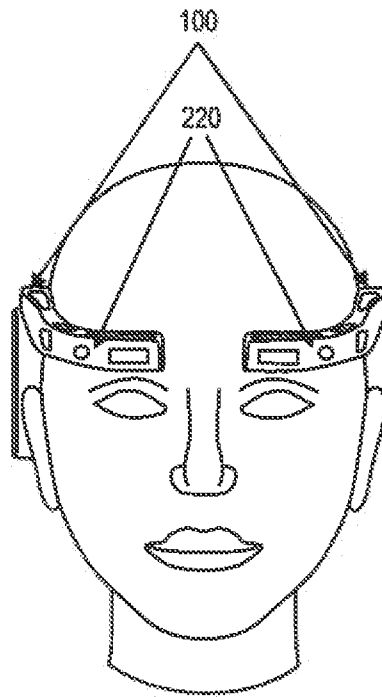


FIG. 4

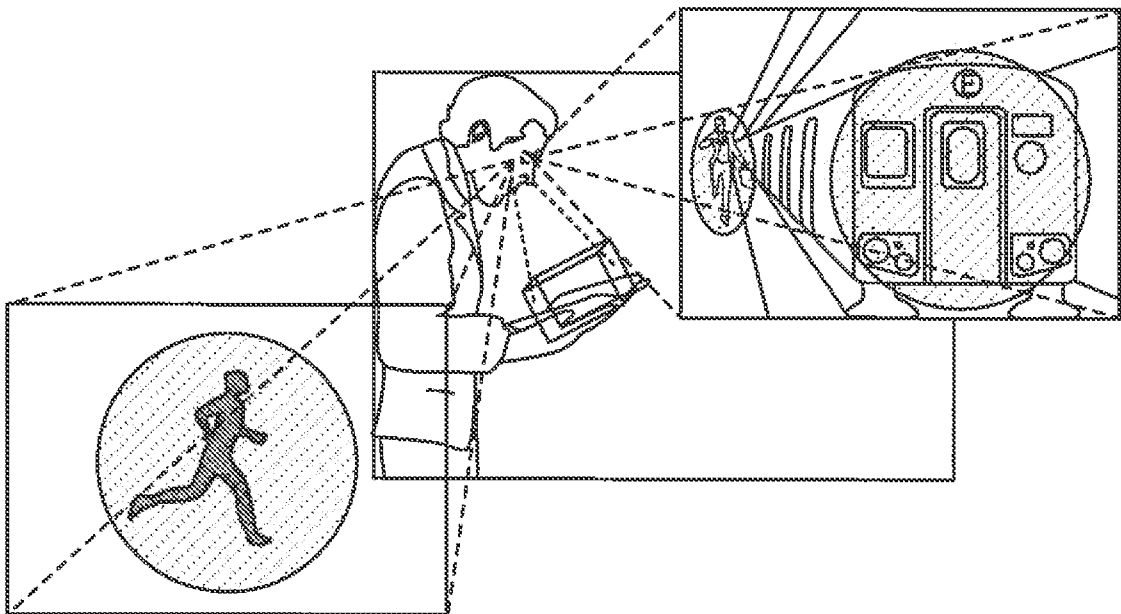


FIG. 5

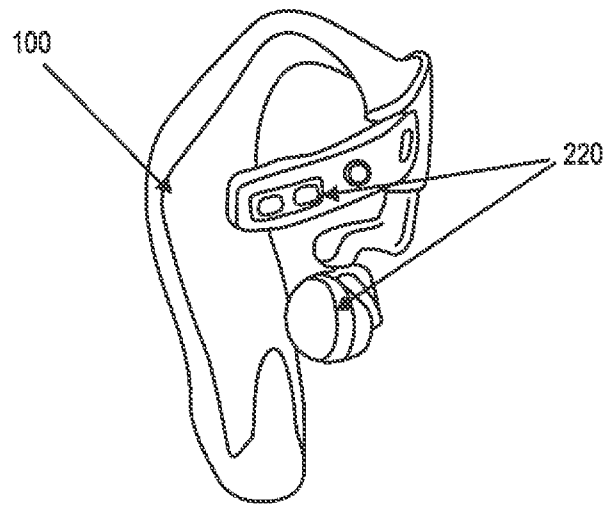


FIG. 6

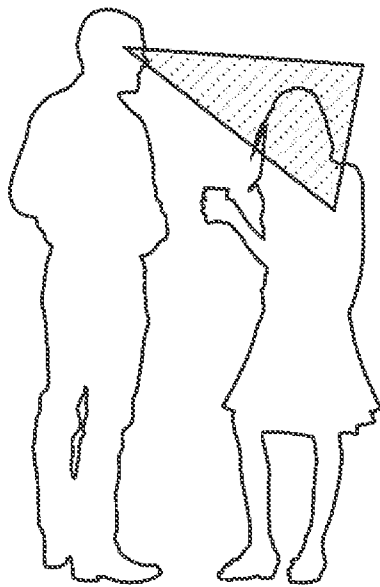


FIG. 7A

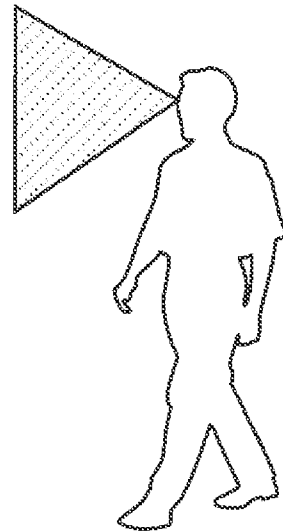
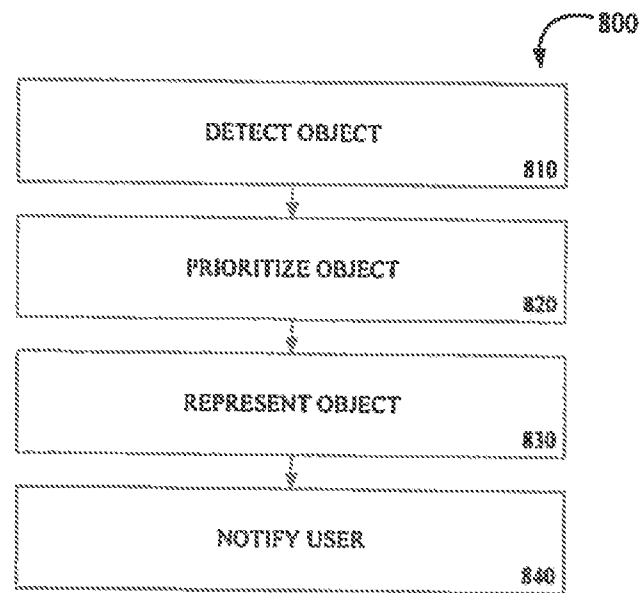


FIG. 7B

**FIG. 8**

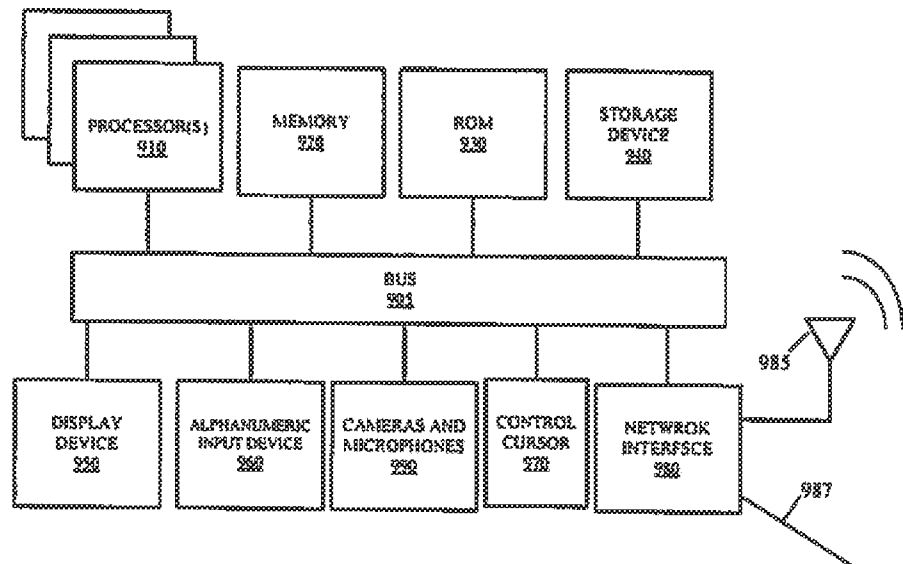


FIG. 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2015/057338**A. CLASSIFICATION OF SUBJECT MATTER****G01P 13/00(2006.01)i, G06F 1/00(2006.01)i**

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)

G01P 13/00; G08B 3/00; G01B 21/16; G06F 3/0487; G01C 21/20; G09G 5/00; G01D 21/00; G06F 3/01; A63B 71/00; G06F 1/00

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

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & keywords: wearable computing, awareness, object, prioritization

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2013-0131985 A1 (JAMES D. WEILAND et al.) 23 May 2013 See abstract, paragraphs [0037]-[0082], claim 17 and figures 1-8.	1-2, 12-13, 22-23
Y	US 2013-0335301 A1 (ADRIAN WONG et al.) 19 December 2013 See abstract, paragraphs [0081]-[0107] and figures 5B-5D.	1-2, 12-13, 22-23
A	US 2013-0311132 A1 (SONY CORPORATION) 21 November 2013 See abstract, paragraphs [0005]-[0015] and figures 1-6.	1-2, 12-13, 22-23
A	US 2014-0347265 A1 (INTERAXON INC.) 27 November 2014 See abstract, claim 1 and figures 1A-35B.	1-2, 12-13, 22-23
A	US 2008-0096726 A1 (RAYMOND W. RILEY et al.) 24 April 2008 See abstract, claim 1 and figure 1.	1-2, 12-13, 22-23

☐ 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

03 February 2016 (03.02.2016)

Date of mailing of the international search report

04 February 2016 (04.02.2016)

Name and mailing address of the ISA/KR

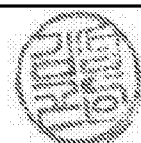
International Application Division
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INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2015/057338**Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☒ Claims Nos.: 3-11, 14-21, 24-25
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of any additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2015/057338

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2013-0131985 A1	23/05/2013	None	
US 2013-0335301 A1	19/12/2013	CN 103975268 A US 2015-0277119 A1 US 9081177 B2 WO 2013-052855 A2 WO 2013-052855 A3	06/08/2014 01/10/2015 14/07/2015 11/04/2013 30/05/2013
US 2013-0311132 A1	21/11/2013	None	
US 2014-0347265 A1	27/11/2014	WO 2014-138925 A1	18/09/2014
US 2008-0096726 A1	24/04/2008	CN 101583403 A CN 101583403 B CN 103007493 A CN 103028228 A CN 103028228 B CN 103120841 A EP 2059310 A2 EP 2554224 A1 EP 2554224 B1 EP 2570159 A1 EP 2602007 A1 JP 2010-502368 A JP 2014-237043 A JP 2014-237044 A JP 2015-006418 A JP 5653038 B2 US 2010-0279825 A1 US 2012-0179278 A1 US 2014-0018946 A1 US 2015-0258375 A1 US 2015-0258376 A1 US 2015-0258377 A1 US 2015-0258378 A1 US 2015-0258379 A1 US 2015-0265902 A1 US 7771320 B2 US 8152695 B2 US 8568278 B2 WO 2008-030484 A2 WO 2008-030484 A3	18/11/2009 12/12/2012 03/04/2013 10/04/2013 12/08/2015 29/05/2013 20/05/2009 06/02/2013 13/08/2014 20/03/2013 12/06/2013 28/01/2010 18/12/2014 18/12/2014 15/01/2015 14/01/2015 04/11/2010 12/07/2012 16/01/2014 17/09/2015 17/09/2015 17/09/2015 17/09/2015 17/09/2015 17/09/2015 24/09/2015 10/08/2010 10/04/2012 29/10/2013 13/03/2008 10/07/2008