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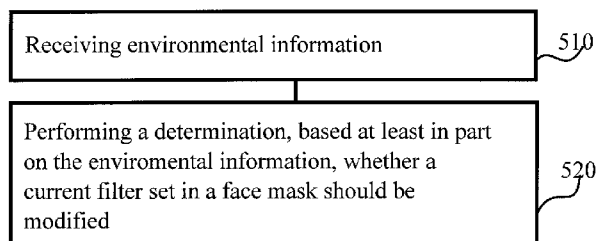
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(54) **Title:** FACE MASK

FIGURE 5



(57) **Abstract:** An apparatus comprising a receiver (250) configured to receive environmental information, and at least one processing core (240) configured to perform a determination, based at least in part on the environmental information, whether a current filter set in a face mask (100) should be modified. Furthermore, the determination is based at least in part on health information.

FACE MASK

FIELD OF INVENTION

5 **[0001]** The present invention relates to the field of face masks and interaction with them.

BACKGROUND OF INVENTION

10 **[0002]** Industrial pollution in cities and industrial areas can cause adverse health effects in humans. Pollution may comprise gaseous and/or particulate pollution, wherein gaseous pollution may comprise, for example, chemical compounds of carbon and/or sulphur, and particulate pollution may comprise solid particles of different sizes and compositions. Particulate emissions occur from diesel engines, for example.

15 **[0003]** An example of a specific type of pollution is PM_{2.5}, by which it is meant particles smaller than 2.5 micrometres. Such particles tend to penetrate into the gas exchange regions in human lungs. Very small particles, of less than 100 nanometres in size, may pass through the lungs to other organs of the body. Carbon monoxide, CO, is another example of a specific type of pollution. CO is generated in partial oxidation of carbon-containing compounds, when there is not enough oxygen to yield carbon dioxide, CO₂, which is another specific type of pollution.

20 **[0004]** The composition of pollution may be controlled to alleviate the effects pollution has on human health. For example, fuels used may be regulated to control their sulphur content, which reduces the quantity of sulphur compounds in exhaust gases. Fuels additives, such as those comprising lead, may be regulated or banned to prevent their absorption into the biosphere.

25 **[0005]** Pollution levels may be controlled by regulating industrial activity, for example by zoning industrial areas at a distance from residential areas. In some cases, industrial activity may be controlled by requiring that some industrial facilities close down on certain days, to control the overall output of pollutants into the atmosphere.

[0006] Automobile engines may be designed to combust fuel as completely as possible, reducing the quantity of CO output by the engines. This is useful since automobiles are typically used even in residential areas. Automobiles may be required to be furnished with catalytic converters or other vehicle emissions control devices, which
5 convert toxic pollutants in exhaust gas to less dangerous compounds, for example via a redox reaction.

[0007] In medical facilities such as clinics or hospitals, airborne particles may spread infectious diseases, such as influenza. On the other hand, some patients may be on oxygen feeds which may leak and alter the composition of air. Industrial facilities may experience
10 bursts of pollution when industrial processes being run enter polluting phases, while during other phases the level of pollution may be lower. Workers in medical and industrial facilities need protection from infectious or polluting agents, as they spend in these facilities while performing their duties.

[0008] Face masks may be used to prevent pollutants from entering the human body
15 via aspiration. Face masks, or facial masks, may comprise any arrangement wherein a filter is disposed over the nose and/or mouth to at least in part filter incoming air.

SUMMARY OF THE INVENTION

20 [0009] The invention is defined by the features of the independent claims. Some specific embodiments are defined in the dependent claims.

[0010] According to a first aspect of the present invention, there is provided an apparatus comprising a receiver configured to receive environmental information, and at least one processing core configured to perform a determination, based at least in part on
25 the environmental information, whether a current filter set in a face mask should be modified.

[0011] Specific variants of the first aspect may comprise at least one feature from the following bulleted list:

- the determination is based at least in part on health information of a user

- the environmental information comprises at least one of a gas concentration, a carbon dioxide concentration, a carbon monoxide concentration, a sulphur dioxide concentration, a particle concentration, a pollen concentration and an ultraviolet flux
- 5 • the health information comprises at least one of an age of the user, an allergy status of the user, a genetic characteristic of the user, a pulmonary capacity of the user, an oxygen saturation level of the user and a pulse level of the user
- the determination is based at least in part on a type of filter in the current filter set
- the receiver is arranged to receive the environmental information from at least one
10 sensor comprised in the face mask
- the receiver is arranged to receive the environmental information via a communications network from a server
- the apparatus is configured to request the environmental information from the server
- 15 • the apparatus is configured to provide a sensory signal indicating the current filter set should be modified, responsive to a determination the current filter set should be modified.

[0012] According to a second aspect of the present invention, there is provided a method comprising receiving environmental information, and performing a determination,
20 based at least in part on the environmental information, whether a current filter set in a face mask should be modified.

[0013] Specific variants of the second aspect may comprise at least one feature corresponding to a feature from the preceding bulleted list laid out in connection with the first aspect.

25 [0014] According to a third aspect of the present invention, there is provided a method, comprising storing information characterizing a facial expression, receiving information from at least one electromyographic sensor, and determining whether the received information matches the stored information, and responsive to a match causing a face mask to perform an action.

[0015] According to a fourth aspect of the present invention, there is provided a method, comprising obtaining at least two of environmental information, physiological information and location information, causing transmitting of the obtained information from a face mask apparatus to a server, receiving from the server a user profile, and
5 authorizing sharing of the user profile.

[0016] According to a fifth aspect of the present invention, there is provided a method, comprising receiving and storing information defining a list of actions, and for each action a time instant and target location, causing transmission of the information defining each time instant and target location toward a server, receiving environmental
10 information concerning each target location at the time instant corresponding to the respective target location, and determining at least one filter to be employed in a face mask based on the received environmental information

[0017] According to a sixth aspect of the present invention, there is provided an apparatus comprising at least one processing core and at least one memory including
15 computer program code, the at least one memory and the computer program code being configured to, with the at least one processing core, cause the apparatus at least to store information characterizing a facial expression, receive information from at least one electromyographic sensor, and determine whether the received information matches the stored information, and responsive to a match causing a face mask to perform an action

[0018] According to a seventh aspect of the present invention, there is provided an apparatus comprising at least one processing core and at least one memory including
20 computer program code, the at least one memory and the computer program code being configured to, with the at least one processing core, cause the apparatus at least to obtain at least two of environmental information, physiological information and location
25 information, causing transmission of the obtained information from a face mask apparatus to a server, receive from the server a user profile, and authorize sharing of the user profile.

[0019] According to an eighth aspect of the present invention, there is provided an apparatus comprising at least one processing core and at least one memory including
30 computer program code, the at least one memory and the computer program code being configured to, with the at least one processing core, cause the apparatus at least to receive and storing information defining a list of actions, and for each action a time instant and target location, cause transmission of the information defining each time instant and target

location toward a server, receive environmental information concerning each target location at the time instant corresponding to the respective target location, and determine at least one filter to be employed in a face mask based on the received environmental information.

5 **[0020]** According to a ninth aspect of the present invention, there is provided an apparatus comprising means for receiving environmental information, and means for performing a determination, based at least in part on the environmental information, whether a current filter set in a face mask should be modified.

10 [0021] According to a tenth aspect of the present invention, there is provided a non-transitory computer readable medium having stored thereon a set of computer readable instructions that, when executed by at least one processor, cause an apparatus to at least receive environmental information, and perform a determination, based at least in part on the environmental information, whether a current filter set in a face mask should be modified.

15 Industrial Applicability

[0022] At least some embodiments of the present invention find industrial application in improving the functioning of face masks, improving their filtering function.

BRIEF DESCRIPTION OF THE DRAWINGS

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[0023] FIGURE 1 illustrates an example face mask illustrating concepts in accordance with at least some embodiments of the present invention;

[0024] FIGURE 2 illustrates an example system accordance with at least some embodiments of the present invention;

25 **[0025]** FIGURE 3 illustrates an example apparatus capable of supporting at least
some embodiments of the present invention;

[0026] FIGURE 4 illustrates signalling in accordance with at least some embodiments of the present invention;

[0027] FIGURE 5 is a first flow chart of a first method in accordance with at least some embodiments of the present invention, and

[0028] FIGURE 6 is a flow chart of a more specific variant of the method illustrated in FIGURE 5.

5 [0029] FIGURE 7 is a second flow chart of a method in accordance with at least some embodiments of the present invention.

[0030] FIGURE 8 is a flow chart of a more specific variant of the method illustrated in FIGURE 7.

10 [0031] FIGURE 9 is a third flow chart of a method in accordance with at least some embodiments of the present invention.

[0032] FIGURE 10 is a flow chart of a more specific variant of the method illustrated in FIGURE 9.

[0033] FIGURE 11 is a fourth flow chart of a method in accordance with at least some embodiments of the present invention.

15 [0034] FIGURE 12 is a flow chart of a more specific variant of the method illustrated in FIGURE 11.

DETAILED DESCRIPTION OF EXAMPLE EMBODIMENTS

20 [0035] A face mask may be enabled to inform a user when a filter of the mask should be inserted, removed or replaced, to improve the protection the mask provides and avoid unnecessary filtration. A filter may be changed responsive to a change in environmental pollutants that are present, for example.

[0036] FIGURE 1 illustrates an example face mask illustrating concepts in
25 accordance with at least some embodiments of the present invention. Mask 100 comprises a face mask arranged to be placed over the mouth and/or nose of a person. Mask 100 has a filter portion 110 adapted to receive at least one filter. Strap 120 is adapted to hold mask against the face of user 130.

[0037] Mask 100 may comprise further units, which are not illustrated in FIGURE 1. Such further units may comprise, for example, a battery unit arranged to store electrical energy, a communication unit configured to communicate with nodes, a memory configured to store information, a processing module comprising at least one processing core, at least one sensor, and/or an interaction unit arranged to provide indications to user 130, for example audible beeps or speech.

[0038] Filter portion 110 may be adapted to receive at least one filter. In some embodiments, filter portion 110 may receive at least two filters. A filter in filter portion 110 is disposed so that air inhaled by user 130 passes through the filter, such that air arriving in the inside of mask 100 is filtered air. In case filter portion 110 has received two filters, air passing through filter portion 110 to the inside of mask 100 is filtered by both of the filters received in filter portion 110.

[0039] A filter may comprise a particulate filter and/or a chemical filter. A particulate filter may comprise, for example, a mesh comprising openings that are small enough to prevent particles from passing through the filter, while admitting gases through the filter. The size of the openings determines the largest particle size that can pass through the filter. For example, if the opening size is one micrometre, than gases and particles smaller than one micrometre can pass through the filter, while particles larger than one micrometre are prevented from passing through.

[0040] A chemical filter may be arranged to prevent certain gases from passing through it. For example, a filter may comprise a membrane impregnated with chemicals, the chemicals being reactive with the gas that is to be filtered. For example, a carbon monoxide filter may comprise chemicals that react with carbon monoxide, thus reducing the quantity of carbon monoxide in air that has passed through the filter, compared to gas that has not passed through the filter. Thus when a carbon monoxide filter is received in filter portion 110, air inside mask 100, that user 130 breathes, has a lower CO concentration than air surrounding the mask. Likewise a sulphur dioxide, SO₂, concentration may be at least in part controlled by a filter received in filter portion 110, so that air in mask 100 has a lower SO₂ concentration than air surrounding the mask.

[0041] The mask illustrated in FIGURE 1 is an example only, the invention is by the inclusion of FIGURE 1 in the present document not restricted to embodiments comprising a mask resembling that in FIGURE 1.

[0042] FIGURE 2 illustrates an example system accordance with at least some embodiments of the present invention. Mask 100 and filter portion 110 correspond to the same structures in FIGURE 1. The system of FIGURE 2 further comprises support portion 200, which may be in communication with mask 100 via channel 201. Channel 201 may be a wire-line channel or at least in part a wireless channel, such as for example a Bluetooth or Bluetooth-LE channel. In some embodiments, channel 201 is absent. In some embodiments, mask 100 and support portion 200 are implemented as one physical object.

[0043] Support portion comprises at least one of a battery 210, communications unit 220, a memory 230, a processing module 240, at least one sensor 250 and interaction unit 260.

[0044] Battery 210 may comprise a lithium-ion battery or other kind of chemical or mechanical arrangement configured to store electrical energy. Battery 210 may be rechargeable. Battery 210 may be configured to provide electrical energy to entities comprised in mask 100 and/or support portion 200. Communications unit 220 may be arranged to provide the system of FIGURE 2 with communications capability with other nodes, such as for example with an environmental server. Communications unit 220 may be enabled to communicate over, for example a cellular or non-cellular radio access technology. Where channel 201 is present, communications unit 220 may control it.

[0045] Memory 230 may be configured to store information, such as for example environmental information and/or health information. Memory 230 may comprise magnetic, solid-state or holographic memory, for example. Processing module 240 may comprise at least one processor, the at least one processor comprising at least one processing core. Processing module 240 may be configured to control the functioning of the system of FIGURE 2, for example based on computer instructions stored in memory 230. Sensor 250 may comprise, for example, an environmental sensor arranged to determine at least one environmental parameter, such as CO concentration, ultraviolet, UV, flux or particle concentration. Interaction unit 260 may comprise, for example a display screen suitable for presenting textual information to a user, or a speaker suitable for providing audible information, such as beeps or synthesized speech to the user.

[0046] The system of FIGURE 2 is an example, the invention is not restricted to architectures that comply with what is illustrated in FIGURE 2. For example, at least one sensor may be comprised in mask 100 instead of in support portion 200. Support portion

200 may take the form of a box or module that is carried by the user when the user is carrying mask 100. For example, support portion 200 may be attached to strap 120 of FIGURE 1. Depending on the embodiment, the physical dimensions of support module 200 need not be large.

5 **[0047]** In use, processing module 240 may be configured to determine, whether a filter set in filter portion 110 should be modified. Possible reasons for a modification include that a filter has been in use in filter portion 110 for a period of time that exceeds a predetermined threshold, and that environmental conditions change.

10 **[0048]** A modification of filter set means that the set of filters received in filter portion 110 is altered. For example, if there is no filter in filter portion 110, placing a filter there changes the set of filters in filter portion 110. For example, if there is one filter in filter portion 110, removing the filter, replacing it with another one, or adding a second filter would modify the filter set in filter portion 110. For example, if there are two filters in filter portion 110, any change in the two filters such as removal or replacement would
15 modify the filter set in filter portion 110. In other words, a filter set may comprise zero or more filters present in filter portion 110.

20 **[0049]** Processing module 240 may be configured to receive environmental information, and based at least in part on the environmental information, perform a determination whether the filter set in filter portion 110 should be modified. The determination may be based also on information concerning the current filter set, that is, information concerning which filters are currently in filter portion 110. The information concerning the current filter set may be stored in memory 230, for example, and/or processing module 240 may obtain it from filter portion 110. Filter portion 110 may have a reader device configured to determine from a filter received in filter portion 110
25 information identifying a type of the received filter. To enable this, filters may have a near-field communication, NFC, tag, barcode, 2D barcode or other kind of machine-readable indication comprising an indicator of filter type. Memory 230 may store information concerning how long each filter has been in filter portion 110.

30 **[0050]** For example, in case processing module 240 receives environmental information indicating that a level of particles in the air has increased, it may indicate to the user that a particle filter should be inserted in filter portion 110, in case such as filter is not already there.

[0051] Processing module 240 may determine, based at least in part on the environmental information, that a filter may be replaced with another one. For example, in case air surrounding mask 100 no longer has significant levels of a pollutant removed by a first filter, but has significant levels of a pollutant removed by a second filter, processing module 240 may cause an indication to be provided to the user that the first filter may be replaced with the second filter.

[0052] The determination on whether to modify the filter set may depend at least in part on health information pertaining to the user. Such health information, which may be stored on memory 230 or be received via communications unit 220 from another source, may indicate, for example, that the user is allergic to a specific type of pollen. In case the environmental information then indicates that a level of the specific type of pollen is significant, processing module 240 may cause an indication to be provided to the user that a filter capable of filtering this type of pollen should be placed in filter portion 110. A user not allergic to this pollen would not be prompted to insert this filter, since she would not benefit from it. A pollen filter may comprise a particle filter, with the size of openings in the filter chosen to be smaller than a characteristic size of these pollen particles.

[0053] An advantage of removing unnecessary filters from the filter set is that drawing in air through filter portion 110 may become easier, since the user needn't draw the air through filters that aren't needed. In embodiments where air is pushed or pulled through filter portion 110 by at least one electrical fan, removing unnecessary filters from the filter set saves energy and increases battery life.

[0054] To perform the determination, processing module 240 may obtain a location of mask 100. The location may be obtained from a satellite positioning receiver comprised in mask 100 or support portion 200, or another unit accessible to processing module 240. The location may be inquired from a communication network, such as for example a cellular communications network, accessible to communications unit 220. A location may be expressed as an identity of a cell that communications unit 220 is attached to, for example. Processing module 240 may transmit the location to a server, to obtain in response environmental information concerning the location where mask 100 is. Alternatively or additionally to processing module 240 providing the location to the server, processing module 240 may provide an identity, such as for example an identity of mask 100, the user, or a subscriber identity of communications unit 220. Using the identity, the

server or another node may be enabled to determine the location, and then cause the correct environmental information to be provided back to processing module 240.

[0055] Processing module 240 may request the health information of the user, for example via communications unit 220. An advantage of this compared to a solution where the health information is locally stored, is that in case the health information is updated the user need not re-configure the health information in memory 230. In some embodiments, processing module 240 is configured to request the health information every now and then, and else use health information stored, or cached, in memory 230. The health information may be requested, for example, from a healthcare provider of the user, using appropriate credentials. Alternatively the health information may be input by the user, for example by linking mask 100 with a personal computer.

[0056] Alternatively to, or additionally to, providing an indication to the user to change the filter set, processing module 240 may be configured to provide an indication to put mask 100 on, in case the mask is not on. Processing module 240 may determine whether the mask is on from a sensor disposed, for example, in strap 120. If strap 120 is in a stretched position, the mask is likely in use. Thus processing module 240 is enabled to know when it is not in use, and to cease providing the indication to put it on as a response to the mask being put on. In case the filter set is appropriate considering the environmental information, and optionally also the health information, the user may just be prompted to put the mask on. In case the filter set is not appropriate, the user may be prompted by the indication to modify the filter set and put the mask on.

[0057] In case the environmental information, and optionally the health information, indicates no filtering of air is necessary, and the user is using the mask, processing module 240 may be configured to provide an indication to the user that the mask may be removed.

[0058] In some embodiments, processing module 240 is configured to share information concerning use of the mask and/or changes in the filter set. This information may be shared with a cloud service of the user and/or other entities the user chooses. The sharing may be automatic once configured to occur.

[0059] In some embodiments support portion 200, mask 100 and/or other parts of the mask apparatus, are furnished with at least one sensor enabled to determine at least one pollutant level. In these embodiments, the environmental information may be received in

processing module 240 partly or entirely from such sensor or sensors. For example, a sensor may be configured to measure a quantity of particles that satisfies a certain size criterion, and responsive to an indication from this sensor that the quantity increases above a threshold, processing module 240 may verify that a particle filter is included in the current filter set. In case it is not, processing module 240 may cause an indication to be provided to the user to insert a particle filter in filter portion 110.

[0060] Alternatively or additionally, at least one sensor may determine physiological information concerning the user, such as for example heart rate or oxygen saturation level. Such physiological information may be used as the health information. In case physiological information is gathered this way, in some embodiments health information is not fetched separately from a source external to the mask apparatus.

[0061] FIGURE 3 illustrates an example apparatus capable of supporting at least some embodiments of the present invention. Illustrated is device 300, which may comprise, for example, to support portion 200 of FIGURE 2. Comprised in device 300 is processor 310, which may comprise, for example, a single- or multi-core processor wherein a single-core processor comprises one processing core and a multi-core processor comprises more than one processing core. Processor 310 may comprise a Qualcomm Snapdragon 800 processor, for example. Processor 310 may comprise more than one processor. A processing core may comprise, for example, a Cortex-A8 processing core manufactured by ARM Holdings or a Brisbane processing core produced by Advanced Micro Devices Corporation. Processor 310 may comprise at least one Qualcomm Snapdragon and/or Intel Atom processor. Processor 310 may comprise at least one application-specific integrated circuit, ASIC. Processor 310 may comprise at least one field-programmable gate array, FPGA. Processor 310 may be means for performing method steps in device 300. Processor 310 may be configured, at least in part by computer instructions, to perform actions. Processor 310 may correspond to processing module 240 of FIGURE 2.

[0062] Device 300 may comprise memory 320. Memory 320 may comprise random-access memory and/or permanent memory. Memory 320 may comprise at least one RAM chip. Memory 320 may comprise magnetic, optical and/or holographic memory, for example. Memory 320 may be at least in part accessible to processor 310. Memory 320 may be means for storing information. Memory 320 may comprise computer instructions that processor 310 is configured to execute. When computer instructions configured to

cause processor 310 to perform certain actions are stored in memory 320, and device 300 overall is configured to run under the direction of processor 310 using computer instructions from memory 320, processor 310 and/or its at least one processing core may be considered to be configured to perform said certain actions. Memory 320 may
5 correspond to memory 230 of FIGURE 2.

[0063] Device 300 may comprise a transmitter 330. Device 300 may comprise a receiver 340. Transmitter 330 and receiver 340 may be configured to transmit and receive, respectively, information in accordance with at least one cellular or non-cellular standard. Transmitter 330 may comprise more than one transmitter. Receiver 340 may comprise
10 more than one receiver. Transmitter 330 and/or receiver 340 may be configured to operate in accordance with global system for mobile communication, GSM, wideband code division multiple access, WCDMA, long term evolution, LTE, IS-95, wireless local area network, WLAN, Ethernet and/or worldwide interoperability for microwave access, WiMAX, standards, for example. Transmitter 330 and receiver 340 may be comprised, for
15 example, in communications unit 220 of FIGURE 2.

[0064] Device 300 may comprise a near-field communication, NFC, transceiver 350. NFC transceiver 350 may support at least one NFC technology, such as NFC, Bluetooth, Wibree or similar technologies. NFC transceiver 350 may be comprised in communications unit 220 of FIGURE 2, for example.

[0065] Device 300 may comprise user interface, UI, 360. UI 360 may comprise at least one of a display, a keyboard, a touchscreen, a vibrator arranged to signal to a user by causing device 300 to vibrate, a speaker and a microphone. A user may be able to operate device 300 via UI 360, for example to input health information into the mask apparatus, instruct the mask apparatus to be switched on or off and/or to receive indications from the
20 mask apparatus. UI 360 may be comprised in interaction unit 260 of FIGURE 2, for example.

[0066] Device 300 may comprise or be arranged to accept a user identity module 370. User identity module 370 may comprise, for example, a subscriber identity module, SIM, card installable in device 300. A user identity module 370 may comprise information
30 identifying a subscription of a user of device 300. A user identity module 370 may comprise cryptographic information usable to verify the identity of a user of device 300 and/or to facilitate encryption of communicated information and billing of the user of

device 300 for communication effected via device 300. User identity module 370 may be comprised in communications unit 220 of FIGURE 2, for example.

[0067] Processor 310 may be furnished with a transmitter arranged to output information from processor 310, via electrical leads internal to device 300, to other devices comprised in device 300. Such a transmitter may comprise a serial bus transmitter arranged to, for example, output information via at least one electrical lead to memory 320 for storage therein. Alternatively to a serial bus, the transmitter may comprise a parallel bus transmitter. Likewise processor 310 may comprise a receiver arranged to receive information in processor 310, via electrical leads internal to device 300, from other devices comprised in device 300. Such a receiver may comprise a serial bus receiver arranged to, for example, receive information via at least one electrical lead from receiver 340 for processing in processor 310. Alternatively to a serial bus, the receiver may comprise a parallel bus receiver.

[0068] Processor 310, memory 320, transmitter 330, receiver 340, NFC transceiver 350, UI 360 and/or user identity module 370 may be interconnected by electrical leads internal to device 300 in a multitude of different ways. For example, each of the aforementioned devices may be separately connected to a master bus internal to device 300, to allow for the devices to exchange information. However, as the skilled person will appreciate, this is only one example and depending on the embodiment various ways of interconnecting at least two of the aforementioned devices may be selected without departing from the scope of the present invention.

[0069] FIGURE 4 illustrates signalling in accordance with at least some embodiments of the present invention. On the vertical axes are disposed, from left to right, interaction unit 260, sensor 250, processing module 240, SRV-A corresponding to a health server, and finally SRV-B corresponding to an environmental information server. Time advances from the top toward the bottom. Interaction unit 260, sensor 250 and processing module 240 are comprised in a mask apparatus such as that illustrated in FIGURE 2. Sensor 250 is optional in the sense that it is not present in all embodiments of the invention.

[0070] In optional phase 410, processing module 240 may inquire for environmental information from SRV-B. The inquiry of phase 410 may comprise an indication of a location of a mask apparatus comprising processing module 240, and/or an identity of the mask apparatus. The message of phase 410 may be transmitted over a suitable protocol

connection, such as for example an internet protocol, IP, connection. The message of phase 410 may be encrypted to protect any sensitive information therein, such as for example a location and/or identity of a user.

5 [0071] In phase 420, SRV-B provides to processing module 240 environmental information. The environmental information may be specific to a location of the mask apparatus, or it may be generic, covering many locations. In the latter case, processing module 240 may be configured to select from the generic environmental information the part that is relevant to a present location of the mask apparatus. In optional phase 430, processing module 240 receives environmental information from a sensor comprised in the mask apparatus. In some embodiments, processing module 240 receives environmental information from sensor 240 but not from SRV-B. Where processing module 240 does not transmit a request for environmental information, SRV-B may provide it periodically, for example hourly or daily.

15 [0072] In optional phase 440, processing module 240 may inquire from SRV-A health information. The message of phase 440 may be a protocol message, like the message of phase 410. The message of phase 440 may comprise information relating to the user of the mask apparatus, for example a name or identifier of the user. In optional phase 450, SRV-A may provide health information, for example health information of the user of mask apparatus, to processing module 240. The messages of phases 440 and 450 may be encrypted, for example using hypertext transport protocol secure, HTTPS, to protect sensitive health information. In some embodiments, in addition to or alternatively to SRV-A, processing module 240 obtains health information from a sensor comprised in the mask apparatus. In these cases, such sensor-originated health information may comprise physiological information such as heart rate or oxygen saturation.

25 [0073] Although illustrated in FIGURE 4 as occurring between phases 420 and 440, phase 430 may occur at any point before phase 460. Likewise phases 440 and 450 may occur before phase 420 alternatively to the order depicted in FIGURE 4.

[0074] In phase 460, processing module 240 performs a determination, based at least in part on the environmental information, whether a current filter set in a face mask should be modified. Where health information is provided, the determination may be based at least in part on the health information as well. The determination may be based at least in part on a current filter set.

[0075] Responsive to the determination of phase 460 indicating that the filter set should be modified, for example by adding a filter to the filter set, processing module 240 in phase 470 provides an indication of this to interaction unit 260, which in turn may provide a sensory indication to the user. The sensory indication may comprise at least one of an audible signal and a textual display, for example. In optional phase 480, processing module 240 may determine whether the user has acted on the indication of phase 470, and responsive to the user having acted on the indication processing module 240 may instruct, in optional phase 490, interaction module to acknowledge to the user that the filter set is now optimized. Such an acknowledgement may comprise a short audible tap or other kind of sensory indication informing the user that he or she has successfully modified the filter set.

[0076] FIGURE 5 is a first flow chart of a first method in accordance with at least some embodiments of the present invention. The phases of the illustrated method may be performed in processing module 240, for example. Phase 510 comprises receiving environmental information. The environmental information may be received in processing module 240, for example. Phase 520 comprises performing a determination, based at least in part on the environmental information, whether a current filter set in a face mask should be modified.

[0077] FIGURE 6 is a flow chart of a more specific variant of the method illustrated in FIGURE 5. Optional phase 610 comprises forming a connection between a server, for example an environmental or health server, and a mask apparatus. Phase 620 comprises receiving health information, for example from a health server, a sensor or a memory internal to the mask apparatus. Phase 630 comprises receiving environmental information, for example from an environmental information server or at least one sensor comprised in the mask apparatus. Phase 640 comprises comparing health information to a threshold, wherein the threshold may depend on the environmental information. In case health information is not present, default health information may be used. Responsive to the threshold not being exceeded, processing returns to phase 620. In case the threshold is exceeded, for example in case a concentration of particles exceeds a user-specific or default health threshold, an indication is provided to a user to modify a current filter set in the mask apparatus.

[0078] FIGURE 7 is a second flow chart of a second method in accordance with at least some embodiments of the present invention. The phases of this method may be performed in support portion 200, for example. Phase 710 comprises storing information characterizing a facial expression. Phase 720 comprises receiving information from at least one electromyographic sensor, such as for example an electrode. Finally, phase 730 comprises determining whether the received information matches the stored information, and responsive to a match causing a face mask to perform an action. The action may comprise, for example, performing a determination as to whether a current set of filters in the face mask should be changed.

[0079] FIGURE 8 is a flow chart of a more specific variant of the method illustrated in FIGURE 7. In phase 810, the user performs a facial action, such as for example a sequence of facial expressions or other actions with facial muscles. In phase 820, at least one electromyographic sensor, such as, for example, at least one electrode, records data on the facial action of phase 810. In phase 830, the data recorded in phase 820 is provided to processing module 240. In phase 840, processing module 240 pre-processes the data to render it comparable to reference data characterising a facial expression. In phase 850 it is determined, for example in processing module 240, whether the data recorded in phase 820 matches with the reference data. In case it does not, processing returns to phase 820. In case it does, processing advances to phase 860, where the processing module causes the face mask to perform an action, such as for example determining whether a current set of filters in the face mask should be modified.

[0080] FIGURE 9 is a third flow chart of a method in accordance with at least some embodiments of the present invention. The phases of this method may be performed in processing module 240, for example. Phase 910 comprises obtaining at least two of environmental information, physiological information and location information. Phase 920 comprises causing transmitting of the obtained information from a face mask apparatus to a server. Phase 930 comprises receiving from the server a user profile. Finally, optional phase 940 comprises authorizing sharing of the user profile.

[0081] FIGURE 10 is a flow chart of a more specific variant of the method illustrated in FIGURE 9. In phase 1010, a user puts a face mask on. In phase 1020, sensors are activated, the sensors being comprised in the mask apparatus, the sensors measuring

environmental and physiological data. For example, the sensors may measure environmental carbon monoxide concentration and an oxygen saturation level of the user.

[0082] In phase 1030, data measured by the sensors is provided to processing module 240. In phase 1040, the processing module causes a location estimate to be obtained, for example by requesting a location estimate from a cellular network, or by using a satellite positioning apparatus comprised in the face mask apparatus. In phase 1050, the processing module causes the environmental, physiological and location information to be transmitted to a server, for example over an IP connection.

[0083] In phase 1060 the server generates a user profile based on the information provided to it in phase 1050. For example, the server may include in the profile information concerning where the user tends to move and at what time, and what his physiological state may be at the time. For example, if the user tends to take a jog in a certain place in the evenings, he will be present there in a physically stressed physiological state that may make him more vulnerable to pollution.

[0084] In phase 1070, the profile is provided to processing module 240. In phase 1080, the profile is presented to the user, or provided to the user in another way, such as for example by allowing its download to the user's computer. In phase 1090, the user sets filter conditions concerning the data comprised in the profile, for example, he may limit updates to the profile only to times when he has a high heart rate, that is, when he is exercising. In phase 1095, the server is configured by the user, for example via the mask apparatus, to share the profile with a third party.

[0085] FIGURE 11 is a fourth flow chart of a method in accordance with at least some embodiments of the present invention. Phase 1110 comprises receiving and storing information defining a list of actions, and for each action a time instant and target location. Phase 1120 comprises causing transmission of the information defining each time instant and target location toward a server. Phase 1130 comprises receiving environmental information concerning each target location at the time instant corresponding to the respective target location. In other words, the received information characterizes an environmental condition of each target location at the time instant defined for that target location. Phase 1140 comprises determining at least one filter to be employed in a face mask based at least in part on the received environmental information.

[0086] FIGURE 12 is a flow chart of a more specific variant of the method illustrated in FIGURE 11. In phase 1210, a user sets a list of actions to perform, a so-called to-do list. The list comprises for each item a target time scope and location. The target time scope and location may be filled in with the assistance of a calendar application, for example. The calendar application may be configured to recommend target locations, for example. In phase 1220, the to-do list items with their associated information are stored in memory, for example memory 230 discussed above.

[0087] In phase 1230, processing module 240 causes transmission of the location information associated with the actions to a server, and inquires for environmental information of the locations during the target time scope. The inquiring may be explicit or implicit, in that the server may automatically provide environmental information relating to the locations at the target time scopes responsive to receiving the locations and time scopes. In phase 1240, the environmental information is received in processing module 240. So, for example, the face mask apparatus may obtain environmental information relating to a jogging track the user has a habit of using, the obtained environmental information being specifically for the time of space the user plans to jog there.

[0088] Finally, in phase 1250, processing module 240 recommends filters to the user for use during the to-do list actions. Processing module 240 may, optionally, generate actions to the to-do list, these generated actions relating, for example, to changing filters in filter portion 110 at set times in dependence of expected environmental conditions.

[0089] It is to be understood that the embodiments of the invention disclosed are not limited to the particular structures, process steps, or materials disclosed herein, but are extended to equivalents thereof as would be recognized by those ordinarily skilled in the relevant arts. It should also be understood that terminology employed herein is used for the purpose of describing particular embodiments only and is not intended to be limiting.

[0090] Reference throughout this specification to “one embodiment” or “an embodiment” means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment of the present invention. Thus, appearances of the phrases “in one embodiment” or “in an embodiment” in various places throughout this specification are not necessarily all referring to the same embodiment.

[0091] As used herein, a plurality of items, structural elements, compositional

elements, and/or materials may be presented in a common list for convenience. However, these lists should be construed as though each member of the list is individually identified as a separate and unique member. Thus, no individual member of such list should be construed as a de facto equivalent of any other member of the same list solely based on their presentation in a common group without indications to the contrary. In addition, various embodiments and example of the present invention may be referred to herein along with alternatives for the various components thereof. It is understood that such embodiments, examples, and alternatives are not to be construed as de facto equivalents of one another, but are to be considered as separate and autonomous representations of the present invention.

[0092] Furthermore, the described features, structures, or characteristics may be combined in any suitable manner in one or more embodiments. In the following description, numerous specific details are provided, such as examples of lengths, widths, shapes, etc., to provide a thorough understanding of embodiments of the invention. One skilled in the relevant art will recognize, however, that the invention can be practiced without one or more of the specific details, or with other methods, components, materials, etc. In other instances, well-known structures, materials, or operations are not shown or described in detail to avoid obscuring aspects of the invention.

[0093] While the forgoing examples are illustrative of the principles of the present invention in one or more particular applications, it will be apparent to those of ordinary skill in the art that numerous modifications in form, usage and details of implementation can be made without the exercise of inventive faculty, and without departing from the principles and concepts of the invention. Accordingly, it is not intended that the invention be limited, except as by the claims set forth below.

WHAT IS CLAIMED IS:

1. An apparatus comprising:

a receiver configured to receive environmental information, and

5 at least one processing core configured to perform a determination, based at least in part on the environmental information, whether a current filter set in a face mask should be modified.

2. The apparatus according to claim 1, wherein the determination is based at least in part on health information of a user.

10 3. The apparatus according to claim 1 or 2, wherein the environmental information comprises at least one of a gas concentration, a carbon dioxide concentration, a carbon monoxide concentration, a sulphur dioxide concentration, a particle concentration, a pollen concentration and an ultraviolet flux.

15 4. The apparatus according to claim 2 or 3, wherein the health information comprises at least one of an age of the user, an allergy status of the user, a genetic characteristic of the user, a pulmonary capacity of the user, an oxygen saturation level of the user and a pulse level of the user.

5. The apparatus according to any preceding claim, wherein the determination is based at least in part on a type of filter in the current filter set.

20 6. The apparatus according to any preceding claim, wherein the receiver is arranged to receive the environmental information from at least one sensor comprised in the face mask.

7. The apparatus according to any of claims 1 – 5, wherein the receiver is arranged to receive the environmental information via a communications network from a server.

8. The apparatus according to claim 7, wherein the apparatus is configured to request the environmental information from the server.

25 9. The apparatus according to any preceding claim, wherein the apparatus is configured to provide a sensory signal indicating the current filter set should be modified, responsive to a determination the current filter set should be modified.

10. A method comprising:

receiving environmental information, and

performing a determination, based at least in part on the environmental information, whether a current filter set in a face mask should be modified.

5 11. The method according to claim 10, wherein the determination is based at least in part on health information of a user, whether the current filter set should be modified.

12. The method according to claim 10 or 11, wherein the environmental information comprises at least one of a carbon dioxide concentration, a carbon monoxide concentration, a sulphur dioxide concentration, a particle concentration, a pollen concentration and an
10 ultraviolet flux.

13. The method according to claim 11 or 12, wherein the health information comprises at least one of an age of the user, an allergy status of the user, a genetic characteristic of the user, a pulmonary capacity of the user, an oxygen saturation level of the user and a pulse level of the user.

15 14. The method according to any of claims 10 - 13, wherein the determination is based at least in part on a type of filter in the current filter set.

15. The method according to any of claims 10 - 14, comprising receiving the environmental information from at least one sensor comprised in the face mask.

20 16. The method according to any of claims 10 - 15, comprising receiving the environmental information via a communications network from a server.

17. The method according to claim 16, further comprising requesting the environmental information from the server.

25 18. The method according to any of claims 10 - 17, further comprising providing a sensory signal indicating the current filter set should be modified, responsive to a determination the current filter set should be modified.

19. The method of any of claims 10 - 18, further comprising receiving physiological information, and wherein the determination is based at least in part on the physiological information.

20. A method, comprising:

storing information characterizing a facial expression;

receiving information from at least one electromyographic sensor, and

determining whether the received information matches the stored

5 information, and responsive to a match causing a face mask to perform an action.

21. A method, comprising;

obtaining at least two of environmental information, physiological
information and location information;

causing transmitting of the obtained information from a face mask
10 apparatus to a server;

receiving from the server a user profile, and

authorizing sharing of the user profile.

22. A method, comprising:

receiving and storing information defining a list of actions, and for each
15 action a time instant and target location;

causing transmission of the information defining each time instant and
target location toward a server;

receiving environmental information concerning each target location at
the time instant corresponding to the respective target location, and

20 determining at least one filter to be employed in a face mask based on the
received environmental information.

23. An apparatus comprising at least one processing core and at least one memory
including computer program code, the at least one memory and the computer program code
being configured to, with the at least one processing core, cause the apparatus at least to:

25 store information characterizing a facial expression;

receive information from at least one electromyographic sensor, and

determine whether the received information matches the stored information, and responsive to a match causing a face mask to perform an action.

24. An apparatus comprising at least one processing core and at least one memory including computer program code, the at least one memory and the computer program code
5 being configured to, with the at least one processing core, cause the apparatus at least to:

obtain at least two of environmental information, physiological information and location information;

causing transmission of the obtained information from a face mask apparatus to a server;

10 receive from the server a user profile, and

authorize sharing of the user profile.

25. An apparatus comprising at least one processing core and at least one memory including computer program code, the at least one memory and the computer program code being configured to, with the at least one processing core, cause the apparatus at least to:

15 receive and storing information defining a list of actions, and for each action a time instant and target location;

cause transmission of the information defining each time instant and target location toward a server;

20 receive environmental information concerning each target location at the time instant corresponding to the respective target location, and

determine at least one filter to be employed in a face mask based on the received environmental information.

26. An apparatus comprising:

means for receiving environmental information, and

25 means for performing a determination, based at least in part on the environmental information, whether a current filter set in a face mask should be modified.

27. A non-transitory computer readable medium having stored thereon a set of computer readable instructions that, when executed by at least one processor, cause an apparatus to at least:

receive environmental information, and

5 perform a determination, based at least in part on the environmental information, whether a current filter set in a face mask should be modified.

28. A computer program configured to cause a method in accordance with at least one of claims 10 – 22 to be performed.

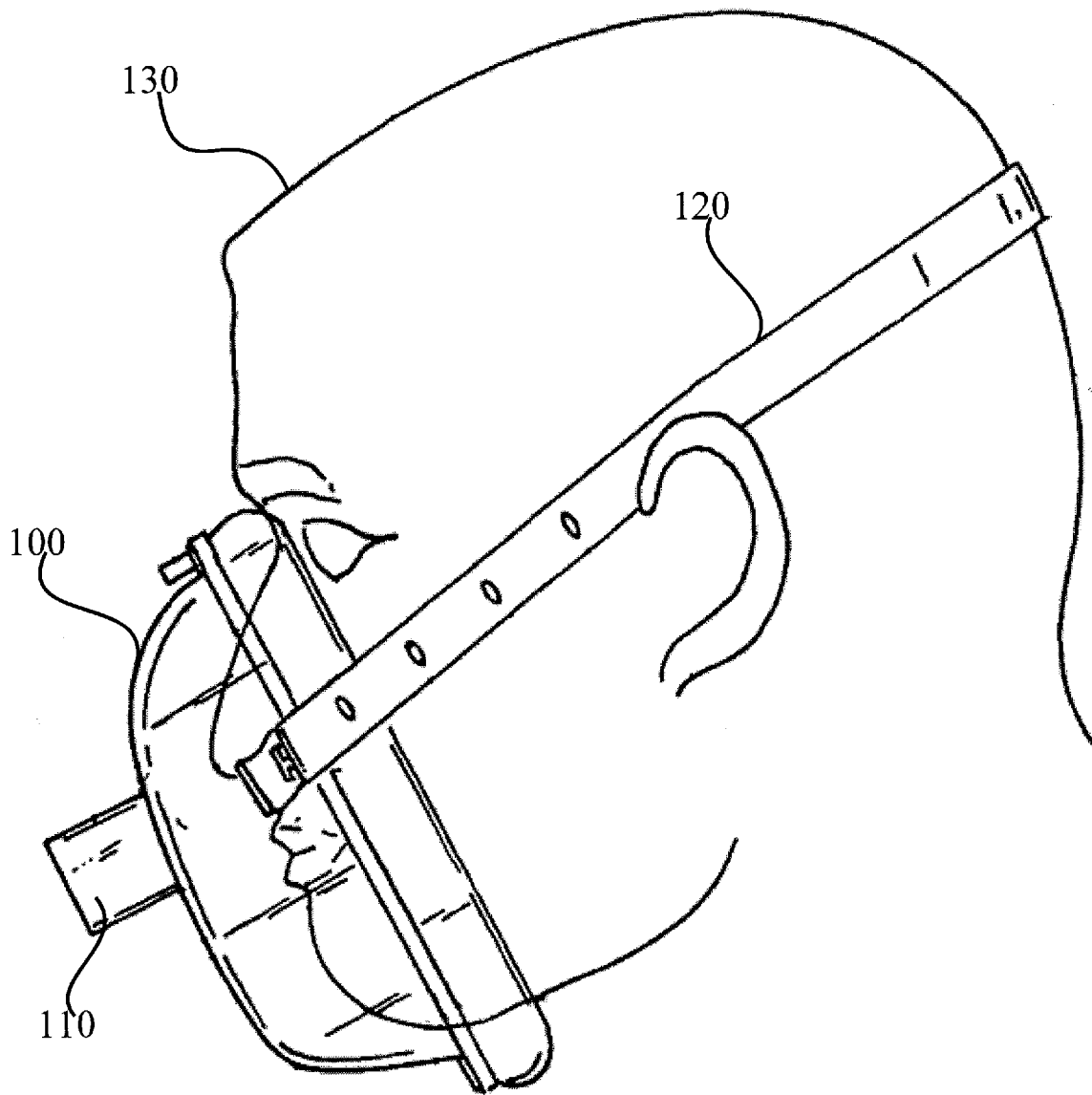


FIGURE 1

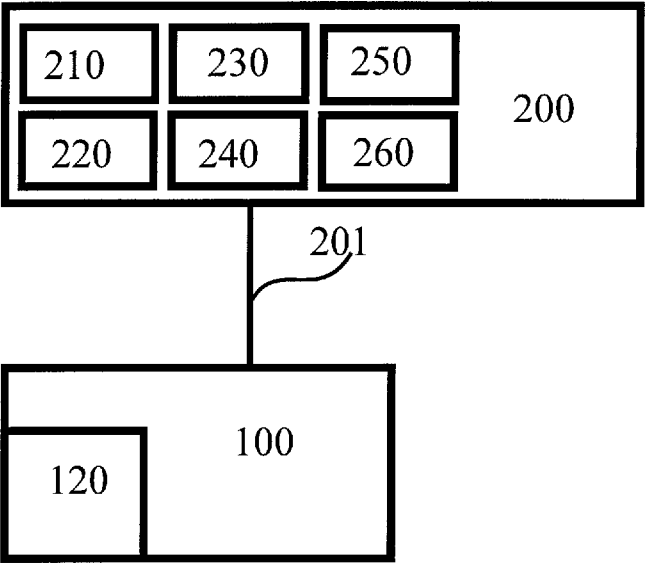


FIGURE 2

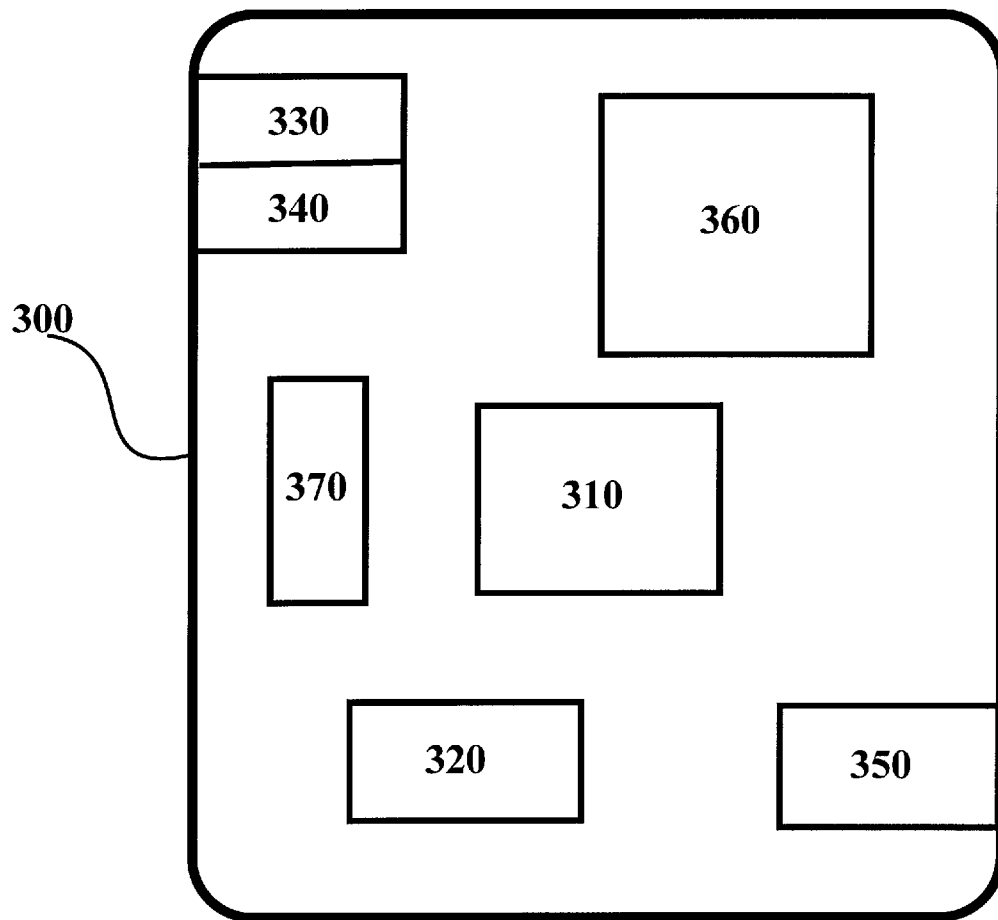


FIGURE 3

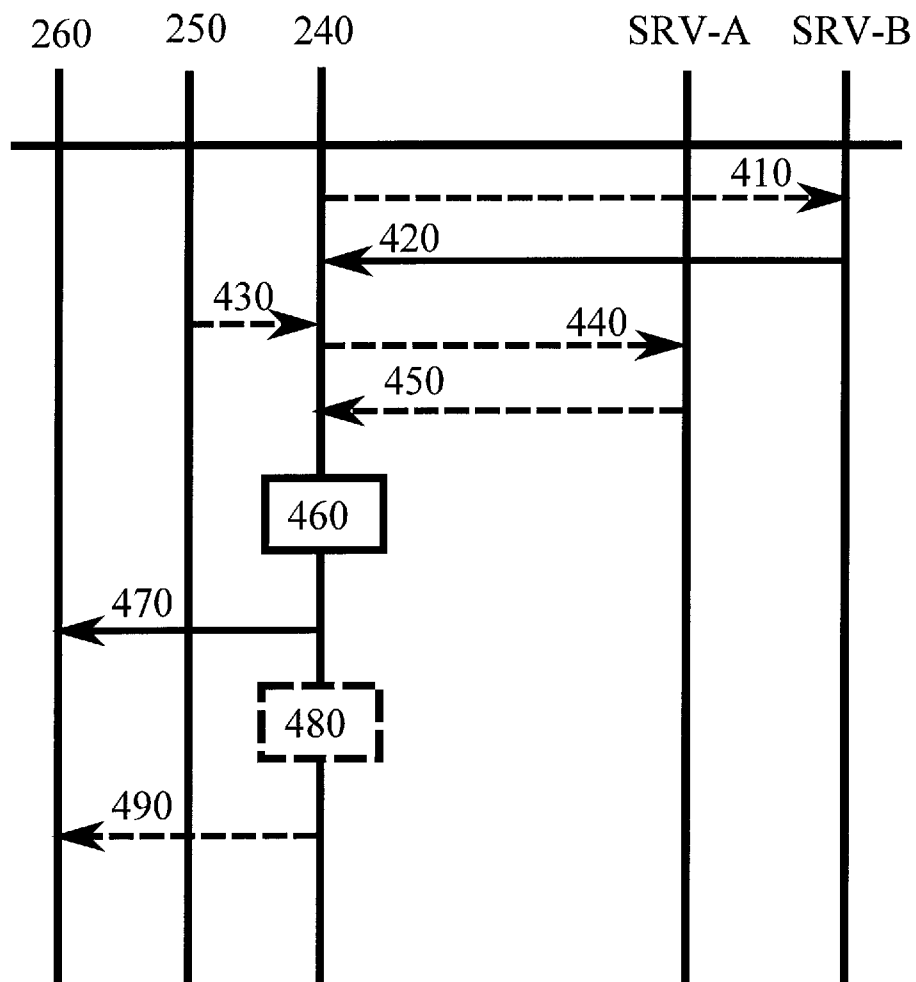


FIGURE 4

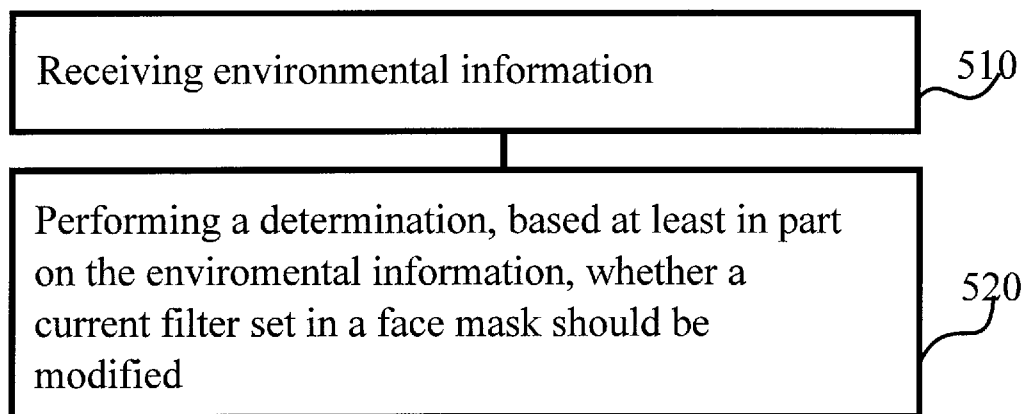


FIGURE 5

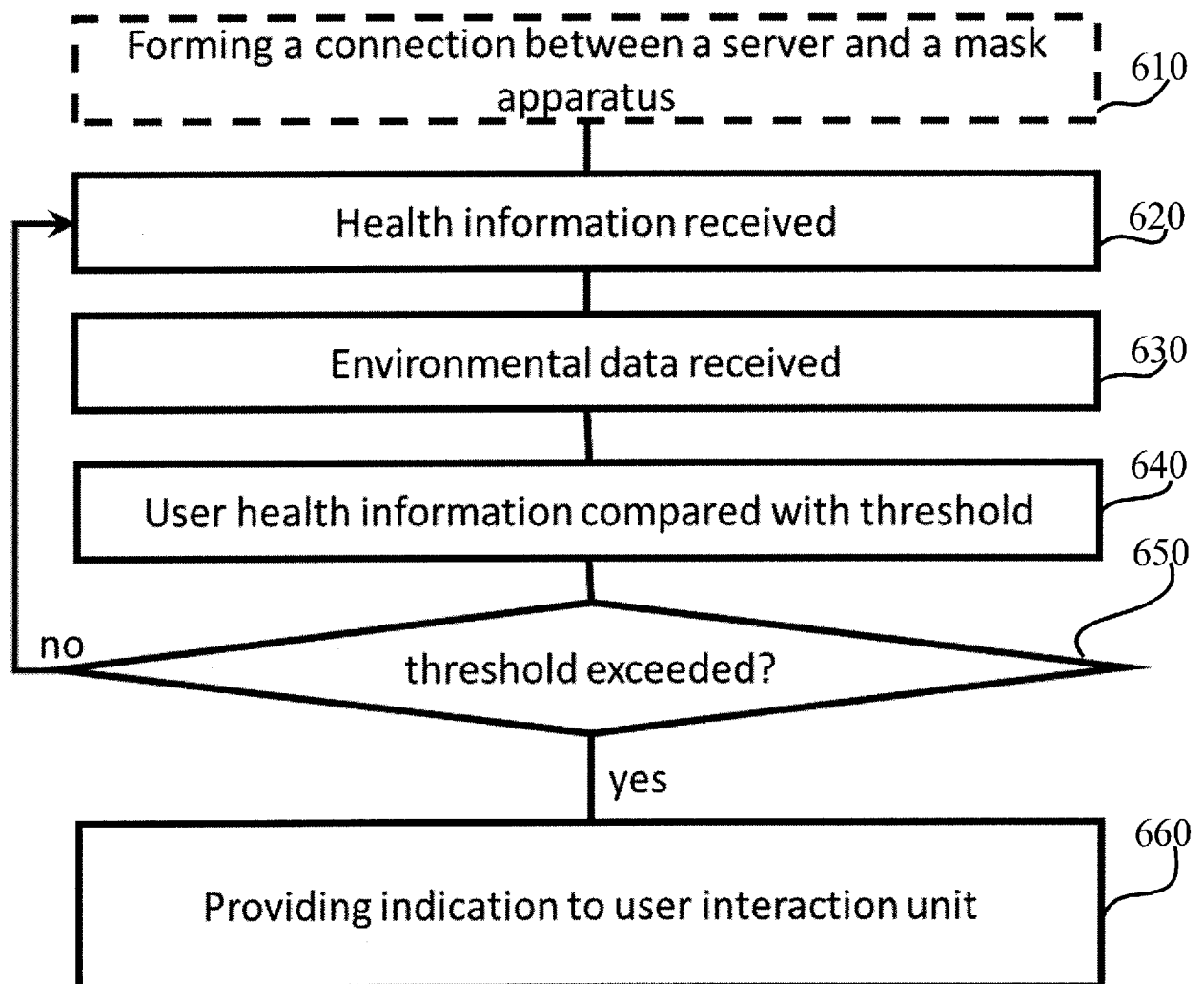


FIGURE 6

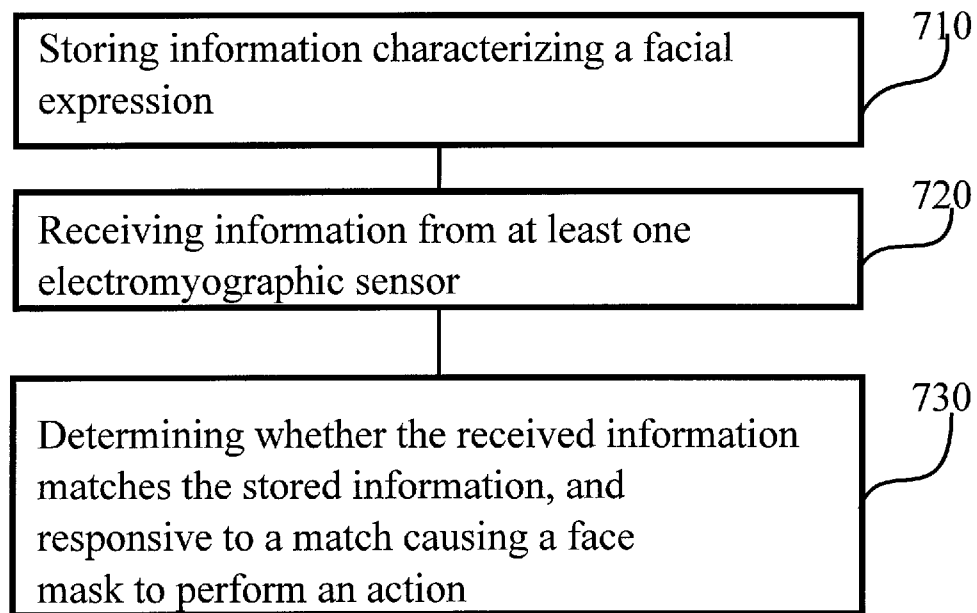


FIGURE 7

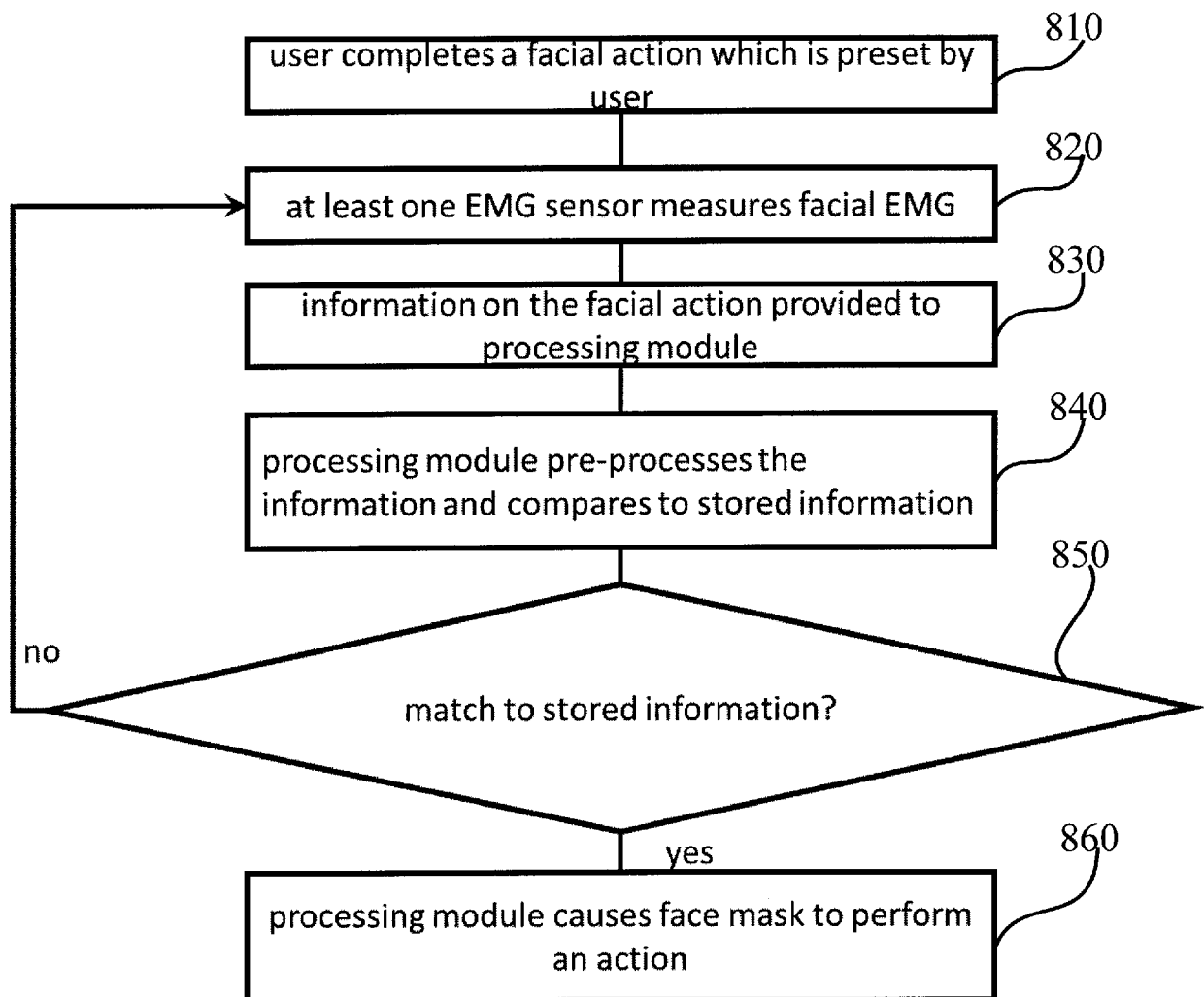


FIGURE 8

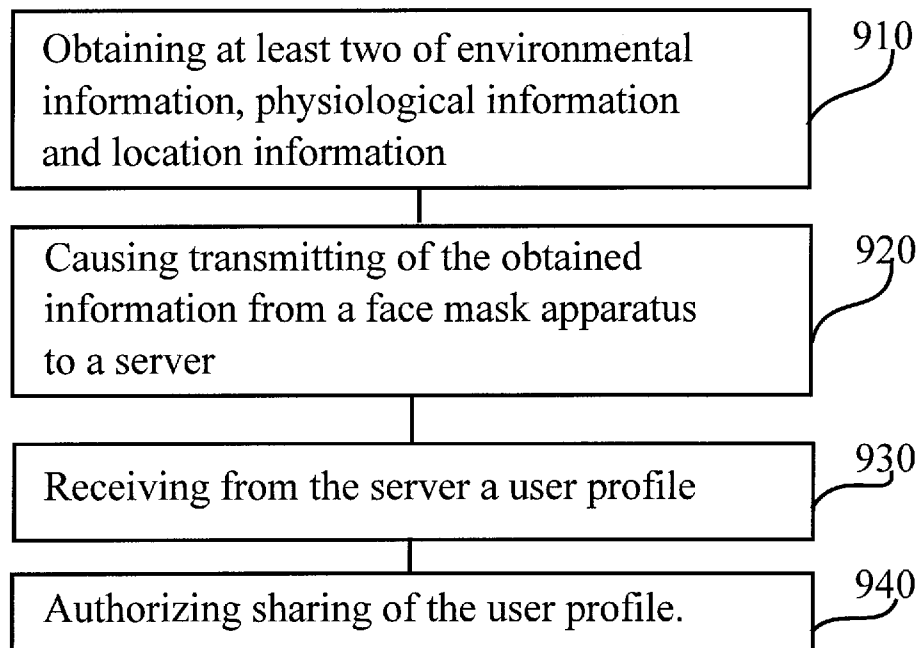


FIGURE 9

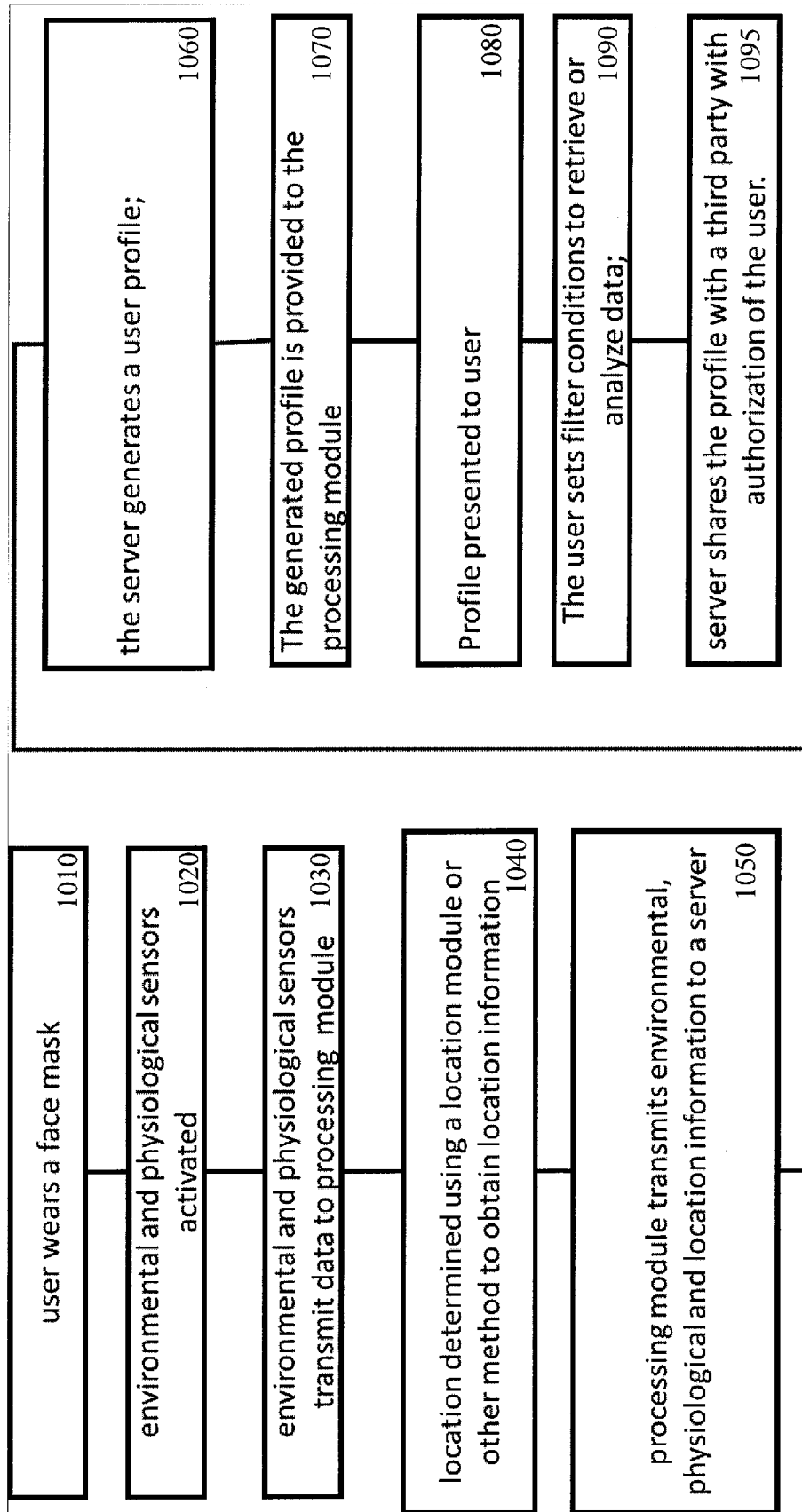


FIGURE 10

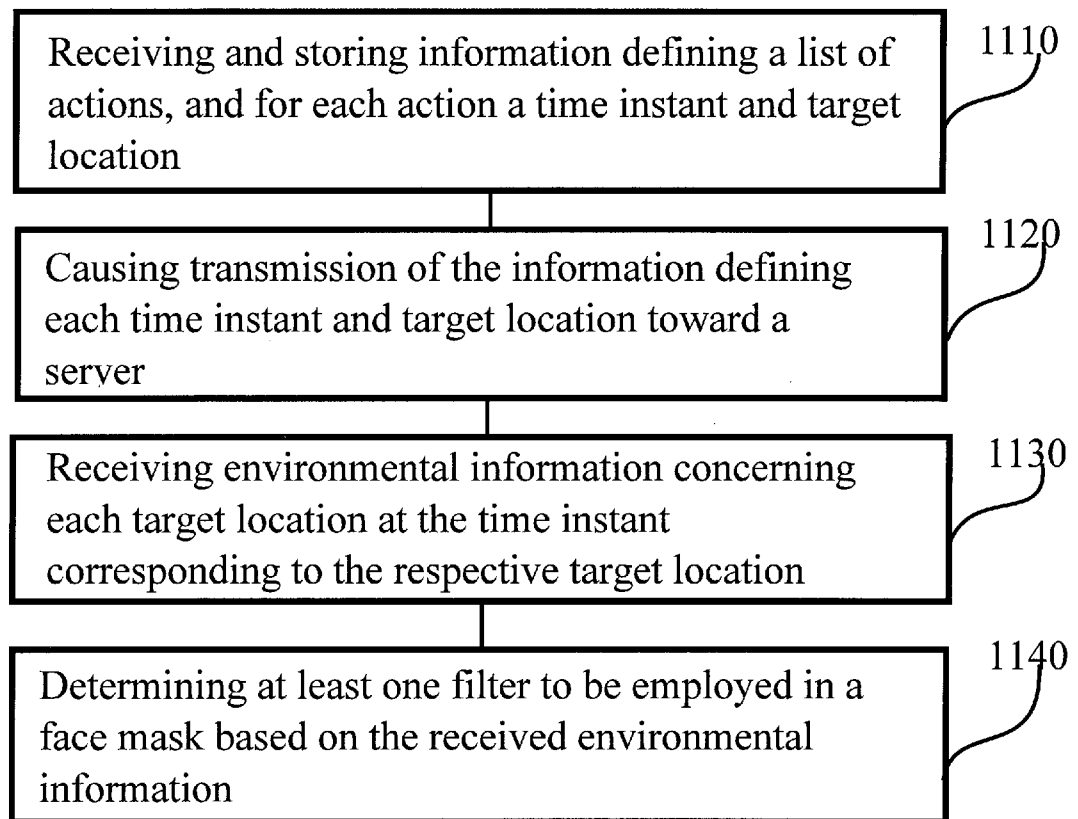


FIGURE 11

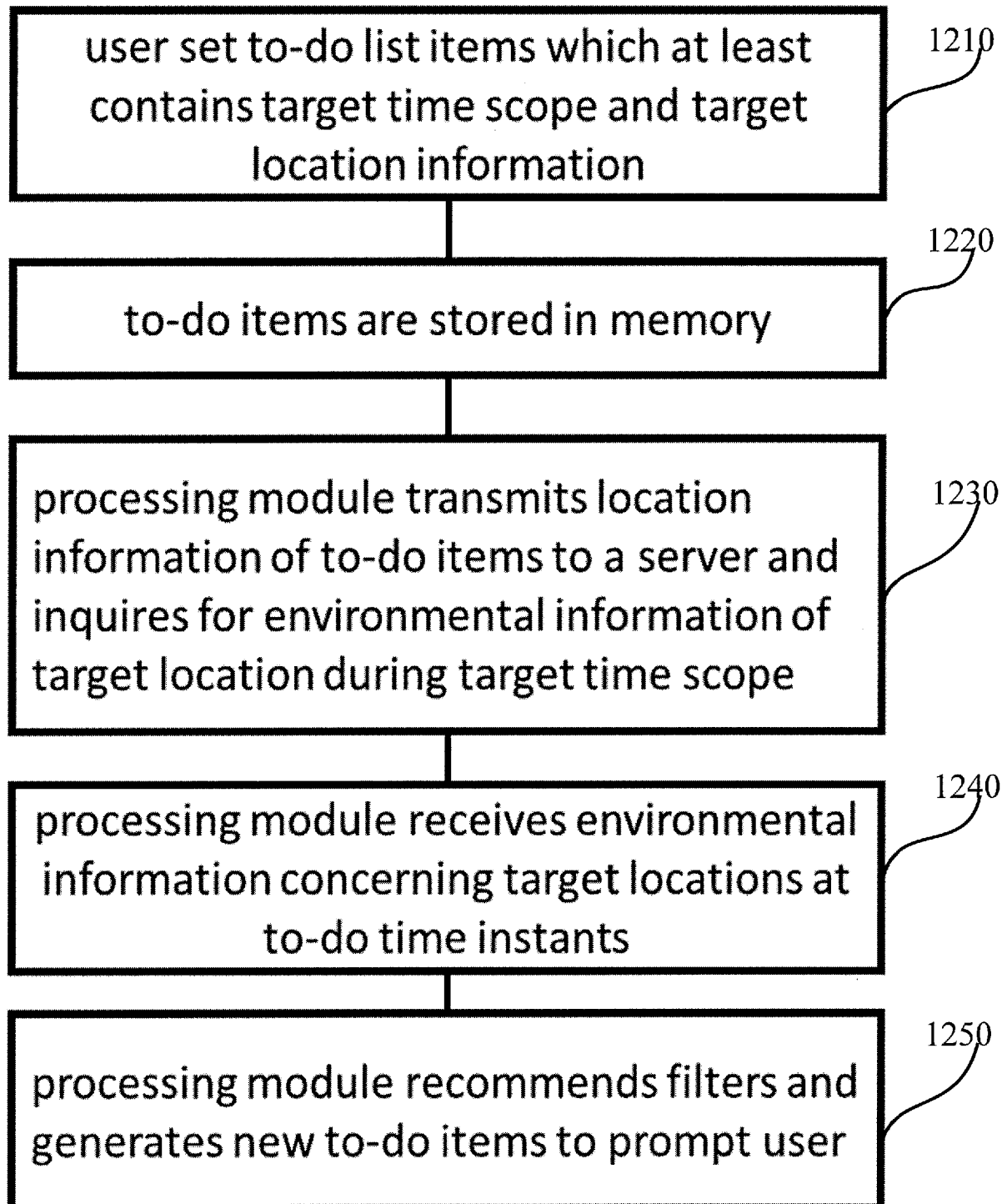


FIGURE 12

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2014/091092

A. CLASSIFICATION OF SUBJECT MATTER

A61M 16/06(2006.01)i; A62B 18/02(2006.01)i; A62B 18/08(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)

A61M; A62B

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

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

CNPAT, EPODOC, WPI, CNKI: NOKIA, sensor???, detect+, sens+, receiv+, environment??. electromyog+, facial, expression, time, location, action, activity, parameter, variable

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 103987427 A (ELWHA LLC.) 13 August 2014 (2014-08-13) description, paragraphs [0023]-[0037], [0044], [0057]-[0072], figures 1-10	1-19, 21, 24, 26-28
A	US 2011240021 A1 (DRAGER MEDICAL GMBH) 06 October 2011 (2011-10-06) description, paragraphs [0007], [0046]-[0047], figures 1-3	20, 23
A	CN 103157206 A (SHANGHAI BAOYA SAFETY EQUIPMENT CO., LTD.) 19 June 2013 (2013-06-19) the whole document	1-28
A	CN 103189089 A (NEXTTEQ LLC.) 03 July 2013 (2013-07-03) the whole document	1-28
A	US 4886056 (SABRE SAFETY LIMITED) 12 December 1989 (1989-12-12) the whole document	1-28

☐ 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	“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
“E”	earlier application or patent but published on or after the international filing date	“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
“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)	“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
“O”	document referring to an oral disclosure, use, exhibition or other means	“&”	document member of the same patent family
“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

08 June 2015

Date of mailing of the international search report

26 June 2015

Name and mailing address of the ISA/CN

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Authorized officer

LIU,Chao

Facsimile No. (86-10)62019451

Telephone No. (86-10)82245601

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] I: Claims 1-19, 22, 25-27 and 28 (partly): receiving environmental information and performing a determination based on the environmental information.
- [2] II: Claims 20, 23 and 28 (partly): storing information characterizing a facial expression, receiving information from at least one electromyographic sensor, and determining whether the received information matches the stored information.
- [3] III: Claims 21, 24 and 28 (partly): obtaining environmental information, physiological information and location information, causing transmitting of the information to a server, receiving a user profile, and authorizing sharing of the user profile.
- [4] Group I, II and III do not have the same or corresponding technical features, or the same or corresponding technical features are: obtaining environmental information, at least one processing core and at least one memory including computer program code. But obtaining environmental information is common practice to control filters in a mask, and the processing core and the memory including computer program code are well known in the art. Thus these inventions do not have the same or corresponding special technical features. Therefore the inventions are not so linked as to form a single general inventive concept, as required by PCT Rule 13.1.

- 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 additional fees, this Authority did not invite payment of 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/CN2014/091092

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
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				EP	2771074	A1	03 September 2014
				US	2013104733	A1	02 May 2013
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				WO	2013063350	A1	02 May 2013
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				EP	2371412	B1	31 July 2013
				EP	2628497	A2	21 August 2013
CN	103157206	A	19 June 2013	CN	103157206	B	21 January 2015
CN	103189089	A	03 July 2013	WO	2012033852	A1	15 March 2012
				CA	2810649	A1	15 March 2012
				JP	2013537812	A	07 October 2013
				EP	2613832	A1	17 July 2013
				US	2014283840	A1	25 September 2014
				US	2012055815	A1	08 March 2012
				US	9044626	B2	02 June 2015
US	4886056	A	12 December 1989	EP	0334555	A2	27 September 1989
				GB	2215615	B	18 December 1991
				GB	2215615	A	27 September 1989