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(54) **DEVICE AND METHOD FOR DETECTING REMOVAL OF AN IN-THE-EAR HEADPHONE FROM A USER'S EAR**

(57) A user device (102) can detect an ear-fitting headphone (100) being removed from an ear of a user wearing the ear-fitting headphone (100) by determining that a capacitance of a capacitive sensor (106) of the ear-fitting headphone (100) has changed. The user device (102) can notify the user that the ear-fitting headphone (100) has been removed from the ear if it is determined that the capacitance of the capacitive sensor (106) has changed over a time period by an amount greater than a threshold.

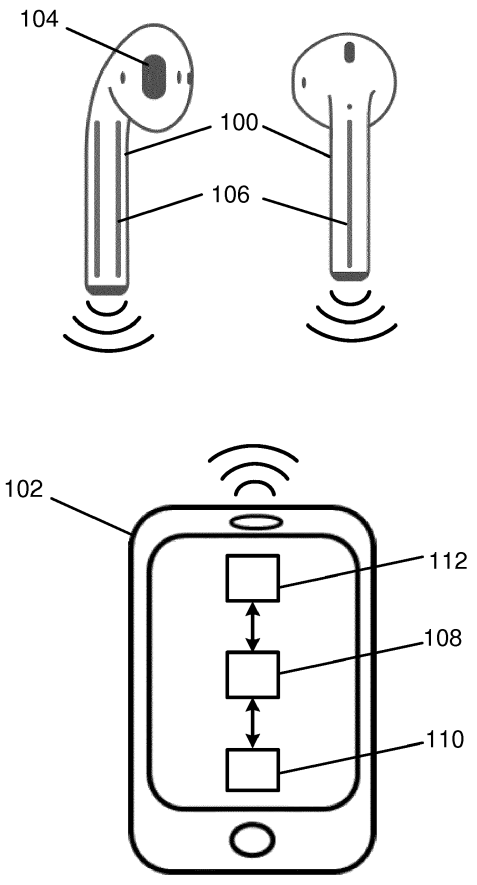

Figure 1

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Description

Technical Field

[0001] The present disclosure relates to a device and method for detecting an ear-fitting headphone being removed from an ear of a user wearing the ear-fitting headphone.

Background

[0002] Ear-fitting headphones (also known as earbuds, earphones or in-ear headphones) are known to fall out of a wearer's ear from time to time. For example, ear-fitting headphones are particularly susceptible to fall out of the wearer's ear(s) when exercising, dancing, or in crowded places where they may be accidently knocked out of the ear by another person. Another cause of ear-fitting headphones being accidentally removed from a wearer's ear is when the wearer has fallen asleep whilst using the ear-fitting headphone. The problem is particularly undesirable when wearing wireless headphones as a single ear-fitting headphone is neither attached to the other headphone or to a user device that provides the audio, such as a mobile phone or music player. This can result in the wearer losing the ear-fitting headphone.

Summary

[0003] According to a first aspect disclosed herein, there is provided a method of detecting an ear-fitting headphone being removed from an ear of a user wearing the ear-fitting headphone, the method comprising: determining that a capacitance of a capacitive sensor of the ear-fitting headphone has changed; and if it is determined that the capacitance of the capacitive sensor has changed over a time period by an amount greater than a threshold, notifying the user that the ear-fitting headphone has been removed from the ear.

[0004] In an example, determining that the capacitance of the capacitive sensor of the ear-fitting headphone has changed comprises determining an amount of change in capacitance of the capacitive sensor from one time instant to another time instant.

[0005] In an example, determining that the capacitance of the capacitive sensor of the ear-fitting headphone has changed comprises determining an amount of change in capacitance of the capacitive sensor relative to a capacitance of a capacitance sensor of a second ear-fitting headphone in the user's other ear.

[0006] In an example, the method comprises: determining that a capacitance of a second capacitive sensor of the ear-fitting headphone has changed; and if it is determined that the capacitance of the second capacitive sensor has changed over a time period by an amount less than a threshold, notifying the user that the ear-fitting headphone has been removed from the ear.

[0007] In an example, determining that the capacitance of the second capacitive sensor of the ear-fitting headphone has changed comprises determining an amount of change in capacitance of the second capacitive sensor from one time instant to another time instant.

[0008] In an example, the method comprises notifying the user that the ear-fitting headphone that has been removed from the ear is a left-hand ear-fitting headphone or a right-hand ear-fitting headphone.

[0009] In an example, notifying the user that the ear-fitting headphone has been removed from the ear comprises displaying a notification on a user device connected to the ear-fitting headphone.

[0010] In an example, notifying the user that the headphone has been removed from the ear comprises playing out a notification through the ear-fitting headphone that has been removed.

[0011] In an example, notifying the user that the ear-fitting headphone has been removed from the ear comprises playing out a notification through an ear-fitting headphone that has not been removed from the wearer's ear.

[0012] According to a second aspect disclosed herein, there is provided a computer program comprising instructions such that when the computer program is executed on a computing device, the computing device is arranged to carry out a method as described above.

[0013] According to a third aspect disclosed herein, there is provided a user device constructed and arranged to detect an ear-fitting headphone being removed from an ear of a user wearing the ear-fitting headphone, the user device being configured to: determine whether a capacitance of a capacitive sensor of the ear-fitting headphone has changed; and cause a notification to be presented to notify the user that the ear-fitting headphone has been removed from the ear if it is determined that the capacitance of the capacitive sensor has changed over a time period by an amount greater than a threshold.

[0014] In an example, the user device is configured to determine whether a capacitance of a capacitive sensor of the ear-fitting headphone has changed by determining an amount of change in capacitance of the capacitive sensor from one time instant to another time instant.

[0015] In an example, the user device is configured to determine whether a capacitance of a capacitive sensor of the ear-fitting headphone has changed by determining an amount of change in capacitance of the capacitive sensor relative to a capacitance of a capacitance sensor of a second ear-fitting headphone.

[0016] In an example, the user device is configured to: determine whether a capacitance of a second capacitive sensor of the ear-fitting headphone has changed; and cause a notification to be presented to the user to notify the user that the ear-fitting headphone has been removed from the ear if it is determined that the capacitance of the second capacitive sensor has changed over a time period by an amount less than a threshold.

[0017] In an example, the user device is configured to notify the user that the ear-fitting headphone that has

been removed from the ear is a left-hand ear-fitting headphone or a right-hand ear-fitting headphone.

[0018] In an example, wherein the user device is connected to the ear-fitting headphone over a wireless connection, the user device is configured to receive a notification notifying the user that the ear-fitting headphone has been removed from the ear.

[0019] In an example, the user device is the ear-fitting headphone and is configured to cause a notification to be presented by a second user device to notify the user that the ear-fitting headphone has been removed from the ear.

[0020] According to a fourth aspect disclosed herein, there is provided a user device constructed and arranged to detect a ear-fitting headphone connected to the user device being removed from an ear of a user wearing the ear-fitting headphone, the user device being configured to:

receive information associated with a capacitance of a capacitive sensor of the ear-fitting headphone;
determine, using the received information, that the capacitance of the capacitive sensor of the ear-fitting headphone has changed; and
notify the user that the ear-fitting headphone has been removed from the ear if the determined change in capacitance of the capacitive sensor over a time period is greater than a threshold.

[0021] According to a fifth aspect disclosed herein, there is provided an ear-fitting headphone constructed and arranged to detect if the ear-fitting headphone has been removed from an ear of a user wearing the ear-fitting headphone, the ear-fitting headphone comprising:

a capacitive sensor configured to detect a change in capacitance of the capacitive sensor, wherein the ear-fitting headphone is configured to:

(i) determine that a capacitance of the capacitive sensor of the ear-fitting headphone has changed and/or (ii) transmit information associated with the capacitance of the capacitive sensor of the ear-fitting headphone to a user device connected to the ear-fitting headphone; and

cause a notification to be present to a user to notify the user that the ear-fitting headphone has been removed from the ear if the determined change in capacitance of the capacitive sensor over a time period is greater than a threshold.

Brief Description of the Drawings

[0022] To assist understanding of the present disclosure and to show how embodiments may be put into effect, reference is made by way of example to the accompanying drawings in which:

Figure 1 shows schematically an example of a pair of ear-fitting headphones connected to a user device.

Detailed Description

[0023] Whilst the terms are used somewhat inconsistently in the art, the following terms will be used herein to mean the following, unless the context requires otherwise.

[0024] The term "headphone" as used herein is used as a generic term for a small loudspeaker driver worn on or around the head over a user's ear or directly within the user's ear. The term headphone covers on the one hand, "circumaural headphones" and "supra-aural headphones", and on the other hand, "ear-fitting" headphones.

[0025] The terms "circumaural" and "supra-aural" headphones are used herein to mean headphones that use a band over the top of or around the side of the user's head to hold the loudspeakers in place.

[0026] The term "ear-fitting headphone" is used herein to mean a headphone that does not use a band to hold the loudspeakers in place. Ear-fitting headphones as used herein are individual loudspeakers that are connected by a wire or by a wireless connection to each other and/or a user device. Ear-fitting headphones as used herein include "earphones" and "earbuds".

[0027] The term "earphones" (or "in-ear headphones") is used herein to mean headphones that are inserted directly into the ear canal. The term "earbuds" is used herein to mean headphones that are placed into the (outer) ear and rest outside of the ear canal, typically being held in place by the concha ridge at the centre of the outer ear.

[0028] Ear-fitting headphones, including in-ear headphones, earbuds, earphones, etc. are often small and discreet. Ear-fitting headphones can be connected to an audio source device over a wired or wireless connection. Due to their small nature, and for wireless ear-fitting headphones in particular, such headphones are likely to become lost if they are accidentally removed from a wearer's ear(s) without the wearer noticing. The likelihood of the user not realising that an ear-fitting headphone has been accidentally removed from their ear is increased if the headphone is not outputting sound at the time the ear-fitting headphone is removed. In that situation, there is no change from sound being played out to the ear to sound not being played out to the ear for the user to notice.

[0029] Examples described herein notify the wearer when an ear-fitting headphone is removed from the ear, which helps to prevent the loss of an ear-fitting headphone.

[0030] In addition, the wearer will of course deliberately remove an ear-fitting headphone from his/her ear during use. Informing the wearer each and every time an ear-fitting headphone is removed from the ear may cause

annoyance to the wearer. Some examples described herein help to avoid informing the wearer of the removable of an ear-fitting headphone when the removal is intentional or likely to have been intentional.

[0031] Figure 1 shows schematically an example of a first ear-fitting headphone 100 and a second ear-fitting headphone 100 (collectively a pair of ear-fitting headphones 100) connected to a user device 102. Each headphone 100 may be any type of ear-fitting headphone that can be placed in a user's (outer) ear. For example, each ear-fitting headphone 100 may be an earbud that sits directly outside the user's ear canal. In another example, each headphone 100 may be an earphone that is placed directly into the user's ear canal. Each ear-fitting headphone 100 has a loudspeaker or other driver 104 for outputting sound to the user. The ear-fitting headphone 100 also has at least one capacitive sensor 106. In Figure 1, the ear-fitting headphone 100 to the left has two capacitive sensors 106 and the second ear-fitting headphone 100 to the right 100 has a single capacitive sensor 106.

[0032] The capacitive sensor(s) 106 may generate an electric field and detect nearby objects by sensing whether the field has been disrupted.

[0033] For example, the capacitive sensor 106 may have two "plates" and detect an object that is conductive or that has a different dielectric property from air, like a human ear or finger. That is, a change in capacitance occurs when an object interacts with the material between the plates. The object does not have to intrude into the capacitive sensor 106 itself to cause a change in capacitance since the capacitive sensor's electric field extends into the environment surrounding the capacitive sensor 106.

[0034] Alternatively, the capacitive sensor 106 may have a single plate. In that case, an object (such as a finger or ear) acts as a second plate. A change in capacitance of the capacitive sensor 106 will be caused when a finger or ear comes into contact with (or close proximity to) the capacitive sensor 106. Such an arrangement is common in capacitive touch sensors as used in for example many touch screen devices.

[0035] The capacitive sensor 106 may be made from a metal, including for example copper or indium tin oxide. The capacitive sensor 106 may appear (relatively) transparent to the human eye. The ear-fitting headphone 100 may optionally have additional capacitive sensors. For example, the ear-fitting headphone 100 may have two, three, four, or more capacitive sensors.

[0036] Each headphone 100 may be connected to a user device 102. The user device 102 may be for example a media device such as a television set, a set top box, a DVD player, a Blu-Ray player, a personal computing device such as a laptop or desktop or tablet computer, a video game console, a cellular phone (including a so-called "smart phone"), a dedicated media player (e.g. an MP3 or similar player), a wearable communication device (including so-called "smart watches"), etc. The ear-fitting headphone(s) 100 may each be (logically and optionally physically) connected to the user device 102 over a wired or wireless connection. In other examples, only one ear-fitting headphone 100 is (logically and optionally physically) connected to the user device 102, with the other ear-fitting headphone 100 being (logically and optionally physically) connected to the first ear-fitting headphone 100 which is connected to the user device 102.

[0037] The user device 102 has a controller 108, such as a processor, operatively coupled to a user interface 110 of the user device 102. The user interface 110 may be for example a display in the form of a screen for receiving inputs from the user. For example, the user interface 110 may comprise a touch screen, or a point-and-click user interface 110 comprising a mouse, track pad, or tracker ball or the like. The user interface 110 is configured to present information to a user of the user device 102.

[0038] The controller 108 is also operatively coupled to a wireless transceiver 112 for communicating via any suitable wireless medium, e.g. a radio transceiver for communicating via a radio channel (though other forms are not excluded, e.g. an infrared transceiver). The wireless transceiver 112 may comprise a Wi-Fi, Bluetooth, etc. interface for enabling the user device 102 to communicate wirelessly with a different user device 102. Additionally or alternatively, the wireless transceiver 112 may communicate with a different user device 102 via a wireless router or a server (not shown), for example, over a local area network such as a WLAN or a wide area network such as the internet.

[0039] The user device 102 has an interface for connecting to the headphones 100. There may be a wired interface and/or a wireless interface for connecting to the headphones 100. Examples described herein are particularly useful in the case that the headphones 100 connect wirelessly to the user device 102.

[0040] In one configuration, the or each ear-fitting headphone 100 transmits a signal representative of the capacitance of the capacitive sensor 106 to the user device 102. The user device 102 (specifically the controller 108) determines that there has been a change in capacitance of the capacitive sensor 106. The user device 102 then causes a notification to be presented at the user device 102 (e.g. a visible a notification displayed on a display screen and/or an audible a notification played out through a loudspeaker). The user device 102 may also transmit an audible notification to be played out through the first ear-fitting headphone 100 and/or the second ear-fitting headphone 100.

[0041] In an alternative configuration, the ear-fitting headphone 100 may itself determine that there has been a change in capacitance of the capacitive sensor 106. The ear-fitting headphone 100 may also transmit a notification to the user device 102 to be presented at the user device 102. Alternatively or additionally, the ear-fitting headphone 100 may cause the notification to be played out of either ear-fitting headphone 100.

[0042] In examples described herein, an ear-fitting

headphone 100 is detected as being removed from an ear of a user. A change in capacitance of a capacitive sensor 106 of the ear-fitting headphone 100 may be determined. The change may be, for example, due to the ear-fitting headphone 100 no longer being in contact with the user's ear.. If the capacitance of the capacitive sensor 106 has changed over a time period by an amount greater than a threshold, the user is notified that the ear-fitting headphone 100 has been removed from the ear. That is, when the ear-fitting headphone 100 is worn by the user, the capacitive sensor 106 will have a first capacitive value and, when the ear-fitting headphone 100 is removed from the ear, the capacitive sensor 106 will have a second capacitive value. The change in capacitance of the capacitive sensor 106 may be caused by the change in the dielectric constant of the material between the plates of the capacitive sensor 106. For example, human skin has different dielectric characteristics from air. Therefore when the ear-fitting headphone 100 is in the ear of the user, the dielectric constant of the capacitive sensor 106 is influenced by human skin. When the ear-fitting headphone 100 is removed from the ear of the user, the dielectric constant of the capacitive sensor 106 is no longer influenced by human skin and therefore the capacitance of the capacitive sensor 106 will change.

[0043] By determining if the capacitance of the capacitive sensor 106 has changed over a time period by an amount greater than a threshold, the user may only be notified if the ear-fitting headphone 100 has been accidentally removed from the ear (that is, not deliberately by the user). For example, if within the time period, the user removes the ear-fitting headphone 100 from the ear (e.g. to readjust the position of the ear-fitting headphone 100 in the ear) but subsequently returns the ear-fitting headphone 100 to the ear, the capacitance of the capacitive sensor 106 will not have changed by an amount greater than a threshold.

[0044] Similarly, if the user touches the capacitive sensor 106 with their finger, for example, the capacitance of the capacitive sensor 106 will not change by an amount greater than the threshold and therefore the user will needlessly not be notified that the ear-fitting headphone 100 has been removed from the ear.

[0045] The time period for determining if the change in capacitance of the capacitive sensor 106 breaches the threshold may be user defined. For example, the time period may be set to ensure the user has enough time to remove an ear-fitting headphone 100 from the ear and replace the ear-fitting headphone 100 in order to readjust the ear-fitting headphone's position. The time period may also be set to ensure the user has enough time to return the ear-fitting headphone 100 to the ear upon realising that the ear-fitting headphone 100 has been accidentally removed from the ear. For example, the time period may be a few seconds, such as in the range of three to five or ten seconds or so.

[0046] In some examples, the threshold may be set (e.g. by the user or the manufacturer) such that a change in capacitance due to the capacitive sensor 106 going from being in contact with human skin to air will change by an amount greater than the threshold. An advantage of this is that the user will not be notified if there is a small change in capacitance not caused by an air to skin difference. This threshold may be changed at a later time, e.g. via the user device 102.

[0047] The capacitive sensor 106 may be placed on the side of the ear-fitting headphone 100 that faces the user when the ear-fitting headphone 100 is worn by the user. An advantage of the capacitive sensor 106 being on the inner side of the ear-fitting headphone 100 is that it increases the likelihood of a change in capacitance when the ear-fitting headphone 100 is removed from the ear, e.g. due to the change in contact with skin to air. That is, it is more likely that the capacitive sensor 106 is in contact with user's the ear during use.

[0048] As an option, when looking for a change in capacitance of the capacitive sensor 106, the change may be determined by comparing the capacitance at different times, i.e. from one time instant to another. That is, the capacitance of the capacitive sensor 106 at the first time instant (e.g. at the start of the time period) is compared to the capacitance of the capacitive sensor 106 at the second time instant (e.g. at the end of the time period). The user will be notified that the ear-fitting headphone has fallen out of the ear if the difference in capacitance between the two time instants is greater than the threshold. For example, at one time instant the ear-fitting headphone 100 may be in the user's ear (with a capacitance value determined at least in part by human skin) and at another time instant the ear-fitting headphone 100 may have fallen to the ground (with a capacitance value at least in part determined by air). An advantage of this is that the difference in capacitance at the two time instances will be relatively large and likely to breach the threshold.

[0049] As another option, when looking for a change in capacitance of the capacitive sensor 106, in the change may be determined by comparing the capacitance of the capacitive sensor 106 with a capacitance of a capacitance sensor 106 of a second ear-fitting headphone 100 in the user's other ear. If the two ear-fitting headphones are in the user's ears, their capacitance values would be similar (or within a small threshold of each other). If the first ear-fitting headphone 100 is removed from the user's ear, the capacitance of the ear-fitting headphone 100 will differ from that that of the second ear-fitting headphone 106. For example, when the ear-fitting headphones are placed in the user's ears, the (inner) capacitive sensor 106 will come into contact with (or very close proximity to) the user's skin. The capacitance of the two ear-fitting headphones 100 will be similar. When the first ear-fitting headphone 100 is removed from the ear, the capacitance will change from the initial value due to no longer being in contact with the user's skin. The user may therefore be notified that the ear-fitting headphone 100 has been removed. An advantage of this is that the change in ca-

pacitance will only be greater than the threshold if something happens to one ear-fitting headphone 100 but not the other. Therefore the user will not be unnecessarily notified if they intentionally take both headphones 100 out of their ear.

[0050] As mentioned, the ear-fitting headphone(s) 100 may have a second capacitive sensor 106. For example, the second capacitive sensor 106 may be placed on the side of the ear-fitting headphone 100 that faces away from the user when the ear-fitting headphone 100 is worn by the user. In this example, the second capacitive sensor 106 may be on the opposite side of the ear-fitting headphone 100 compared to the (first) capacitive sensor 106. In other examples, the second capacitive sensor 106 may be on either side of the ear-fitting headphone 100, i.e. between the inner and outer facing sides of the ear-fitting headphone 100.

[0051] Some examples may include determining a change in capacitance of the second capacitive sensor 106 of the ear-fitting headphone 100. Rather than notifying the user if the change in capacitance is greater than a threshold, the user will only be notified if the change in capacitance is less than a threshold. An option for determining the change in capacitance may involve comparing the capacitance of the second capacitive sensor 106 at one time instance and another time instance. For example, when the ear-fitting headphone 100 is in use in the wearer's ear, the capacitance of the second capacitive sensor 106 will be influenced by air. When the ear-fitting headphone 100 is accidentally removed from the user's ear, the capacitance of the second capacitive sensor 106 will still be influenced by air. That is, the change in capacitance over the time period will be relatively small or negligible, i.e. an amount less than a threshold. If the change is greater than the threshold due to, for example, a finger touching the capacitive sensor 106, the user will not be notified. An advantage with this is that the user will not be notified if the user intentionally removes the ear-fitting headphone 100.

[0052] As an example of notifying the user of the removal of a headphone, the user device 102 may display a notification on a display screen of the user interface 110. That is, the user interface 110 of the user device 102 is configured to present a textual or graphical notification to the user of the user device 102. The notification may be transmitted from the ear-fitting headphone 100 or generated and presented directly at the user device 102. The notification may be automatically displayed on the user device 102 in response to detecting that the ear-fitting headphone 100 has been removed. An advantage of this is that the displayed notification will alert the user of the accidental removal of the ear-fitting headphone 100 without the need to pause or stop the second ear-fitting headphone 100 playing out the sound that it may have been playing out at the time of removal of the first ear-fitting headphone 100.

[0053] As an option, the user may be notified that the ear-fitting headphone 100 has been removed or fallen out by playing out a notification through the ear-fitting headphone 100 that has been removed. For example, the ear-fitting headphone 100 may emit a notification sound (e.g. an alarm) at a volume loud enough for the user to hear the sound when the ear-fitting headphone 100 is not in the user's ear. As well as informing the user of the headphone removal, the sound can also help the user to locate the removed ear-fitting headphone 100.

[0054] Alternatively or additionally, the user may be notified that the ear-fitting headphone 100 has been removed or fallen out by playing out a notification through the ear-fitting headphone 100 that has not been removed, i.e. the second ear-fitting headphone 100 that is still in the user's ear 106. For example, the notification may be spoken words or an alarm or jingle indicative of an accidental removal of the other ear-fitting headphone 100. An advantage of this is that the user will be made aware of the removal without having to look at the user device 102 and this is made in a discreet manner via the ear-fitting headphone 100 that has not been removed.

[0055] In some examples, as part of the notification, the sound (e.g. a song) that was previously being played out of the ear-fitting headphone(s) 100 may be paused whilst the notification is being presented or until the ear-fitting headphone 100 has been inserted back into the user's ear. The sound may also be paused until the user selects to continue playing the sound, e.g. via the user device 102. An advantage of this is that the abrupt stoppage may serve to quickly alert the user that an ear-fitting headphone 100 has been accidentally removed.

[0056] In some options, the user is told which ear-fitting headphone 100 has been removed or fallen from the ear. That is, the notification displayed on the display screen or played out through either ear-fitting headphone 100 to the user may contain information indicating that the ear-fitting headphone 100 that has been removed is a left or right ear-fitting headphone.

[0057] In examples, the user device 102 determines whether a capacitance of a capacitive sensor 106 of the ear-fitting headphone 100 has changed. If the capacitance of the capacitive sensor 106 has changed over a time period by an amount greater than a threshold, the user device 102 causes a notification to be presented to the user. For example, the notification may be displayed on a display screen or played out through the (first) or second ear-fitting headphone 100.

[0058] The controller 108 and its components as shown in Figure 1 are represented as a schematic block diagram for the purposes of explaining the functionality of the controller 108 only. Hence, it is understood that each component of the controller 108 is a functional block for performing the functionality ascribed to it herein. Each component may be implemented in hardware, software, firmware, or a combination thereof. Additionally, although described as separate components of the controller 108, some or all of the functionality may be performed by a single piece of hardware, software, or firmware.

[0059] It will be understood that the processor or

processing system or circuitry referred to herein may in practice be provided by a single chip or integrated circuit or plural chips or integrated circuits, optionally provided as a chipset, an application-specific integrated circuit (ASIC), field-programmable gate array (FPGA), digital signal processor (DSP), graphics processing units (GPUs), etc. The chip or chips may comprise circuitry (as well as possibly firmware) for embodying at least one or more of a data processor or processors, a digital signal processor or processors, baseband circuitry and radio frequency circuitry, which are configurable so as to operate in accordance with the exemplary embodiments. In this regard, the exemplary embodiments may be implemented at least in part by computer software stored in (non-transitory) memory and executable by the processor, or by hardware, or by a combination of tangibly stored software and hardware (and tangibly stored firmware).

[0060] Reference is made herein to data storage for storing data. This may be provided by a single device or by plural devices. Suitable devices include for example a hard disk and non-volatile semiconductor memory.

[0061] Although at least some aspects of the embodiments described herein with reference to the drawings comprise computer processes performed in processing systems or processors, the invention also extends to computer programs, particularly computer programs on or in a carrier, adapted for putting the invention into practice. The program may be in the form of non-transitory source code, object code, a code intermediate source and object code such as in partially compiled form, or in any other non-transitory form suitable for use in the implementation of processes according to the invention. The carrier may be any entity or device capable of carrying the program. For example, the carrier may comprise a storage medium, such as a solid-state drive (SSD) or other semiconductor-based RAM; a ROM, for example a CD ROM or a semiconductor ROM; a magnetic recording medium, for example a floppy disk or hard disk; optical memory devices in general; etc.

[0062] The examples described herein are to be understood as illustrative examples of embodiments of the invention. Further embodiments and examples are envisaged. Any feature described in relation to any one example or embodiment may be used alone or in combination with other features. In addition, any feature described in relation to any one example or embodiment may also be used in combination with one or more features of any other of the examples or embodiments, or any combination of any other of the examples or embodiments. Furthermore, equivalents and modifications not described herein may also be employed within the scope of the invention, which is defined in the claims.

Claims

1. A method of detecting an ear-fitting headphone (100) being removed from an ear of a user wearing the ear-fitting headphone (100), the method comprising:

determining that a capacitance of a capacitive sensor (106) of the ear-fitting headphone (100) has changed; and
if it is determined that the capacitance of the capacitive sensor (106) has changed over a time period by an amount greater than a threshold, notifying the user that the ear-fitting headphone (100) has been removed from the ear.

2. A method according to claim 1, wherein determining that the capacitance of the capacitive sensor (106) of the ear-fitting headphone (100) has changed comprises determining an amount of change in capacitance of the capacitive sensor (106) from one time instant to another time instant.

3. A method according to claim 1, wherein determining that the capacitance of the capacitive sensor (106) of the ear-fitting headphone (100) has changed comprises determining an amount of change in capacitance of the capacitive sensor (106) relative to a capacitance of a capacitive sensor (106) of a second ear-fitting headphone (100) in the user's other ear.

4. A method according to any of claims 1 to 3, comprising:

determining that a capacitance of a second capacitive sensor (106) of the ear-fitting headphone (100) has changed; and
if it is determined that the capacitance of the second capacitive sensor (106) has changed over a time period by an amount less than a threshold, notifying the user that the ear-fitting headphone (100) has been removed from the ear.

5. A method according to any of claims 1 to 4, comprising:

notifying the user that the ear-fitting headphone (100) that has been removed from the ear is a left-hand ear-fitting headphone or a right-hand ear-fitting headphone.

6. A method according to any of claims 1 to 5, wherein notifying the user that the ear-fitting headphone (100) has been removed from the ear comprises displaying a notification on a user device (102) connected to the ear-fitting headphone (100).

7. A method according to any of claims 1 to 6, wherein notifying the user that the ear-fitting headphone (100) has been removed from the ear comprises playing out a notification through the ear-fitting head-

phone (100) that has been removed.

8. A computer program comprising instructions such that when the computer program is executed on a computing device, the computing device is arranged to carry out a method according to any of claims 1 to 7.

9. A user device (102) constructed and arranged to detect an ear-fitting headphone (100) being removed from an ear of a user wearing the ear-fitting headphone (100), the user device (102) being configured to:

determine whether a capacitance of a capacitive sensor (106) of the ear-fitting headphone (100) has changed; and
cause a notification to be presented to notify the user that the ear-fitting headphone (100) has been removed from the ear if it is determined that the capacitance of the capacitive sensor (106) has changed over a time period by an amount greater than a threshold.

10. A user device (102) according to claim 9, the user device (102) being configured to determine whether a capacitance of a capacitive sensor (106) of the ear-fitting headphone (100) has changed by determining an amount of change in capacitance of the capacitive sensor (106) from one time instant to another time instant.

11. A user device (102) according to claim 9, the user device (102) being configured to determine whether a capacitance of a capacitive sensor (106) of the ear-fitting headphone (100) has changed by determining an amount of change in capacitance of the capacitive sensor (106) relative to a capacitance of a capacitive sensor (106) of a second ear-fitting headphone (100).

12. A user device (102) according to any of claims 9 to 11, the user device (102) being configured to:

determine whether a capacitance of a second capacitive sensor (106) of the ear-fitting headphone (100) has changed; and
cause a notification to be presented to the user to notify the user that the ear-fitting headphone (100) has been removed from the ear if it is determined that the capacitance of the second capacitive sensor (106) has changed over a time period by an amount less than a threshold.

13. A user device (102) according to any of claims 9 to 12, the user device (102) being configured to notify the user that the ear-fitting headphone (100) that has been removed from the ear is a left-hand ear-fitting headphone or a right-hand ear-fitting headphone.

14. A user device (102) constructed and arranged to detect an ear-fitting headphone (100) connected to the user device (102) being removed from an ear of a user wearing the ear-fitting headphone (100), the user device (102) being configured to:

receive information associated with a capacitance of a capacitive sensor (106) of the ear-fitting headphone (100);
determine, using the received information, that the capacitance of the capacitive sensor (106) of the ear-fitting headphone (100) has changed; and
notify the user that the ear-fitting headphone (100) has been removed from the ear if the determined change in capacitance of the capacitive sensor (106) over a time period is greater than a threshold.

15. An ear-fitting headphone (100) constructed and arranged to detect if the ear-fitting headphone (100) has been removed from an ear of a user wearing the ear-fitting headphone (100), the ear-fitting headphone (100) comprising:

a capacitive sensor (106) configured to detect a change in capacitance of the capacitive sensor (106), wherein the ear-fitting headphone (100) is configured to:

(i) determine that a capacitance of the capacitive sensor (106) of the ear-fitting headphone (100) has changed and/or (ii) transmit information associated with the capacitance of the capacitive sensor (106) of the ear-fitting headphone (100) to a user device (102) connected to the ear-fitting headphone (100); and

cause a notification to be present to a user to notify the user that the ear-fitting headphone (100) has been removed from the ear if the determined change in capacitance of the capacitive sensor (106) over a time period is greater than a threshold.

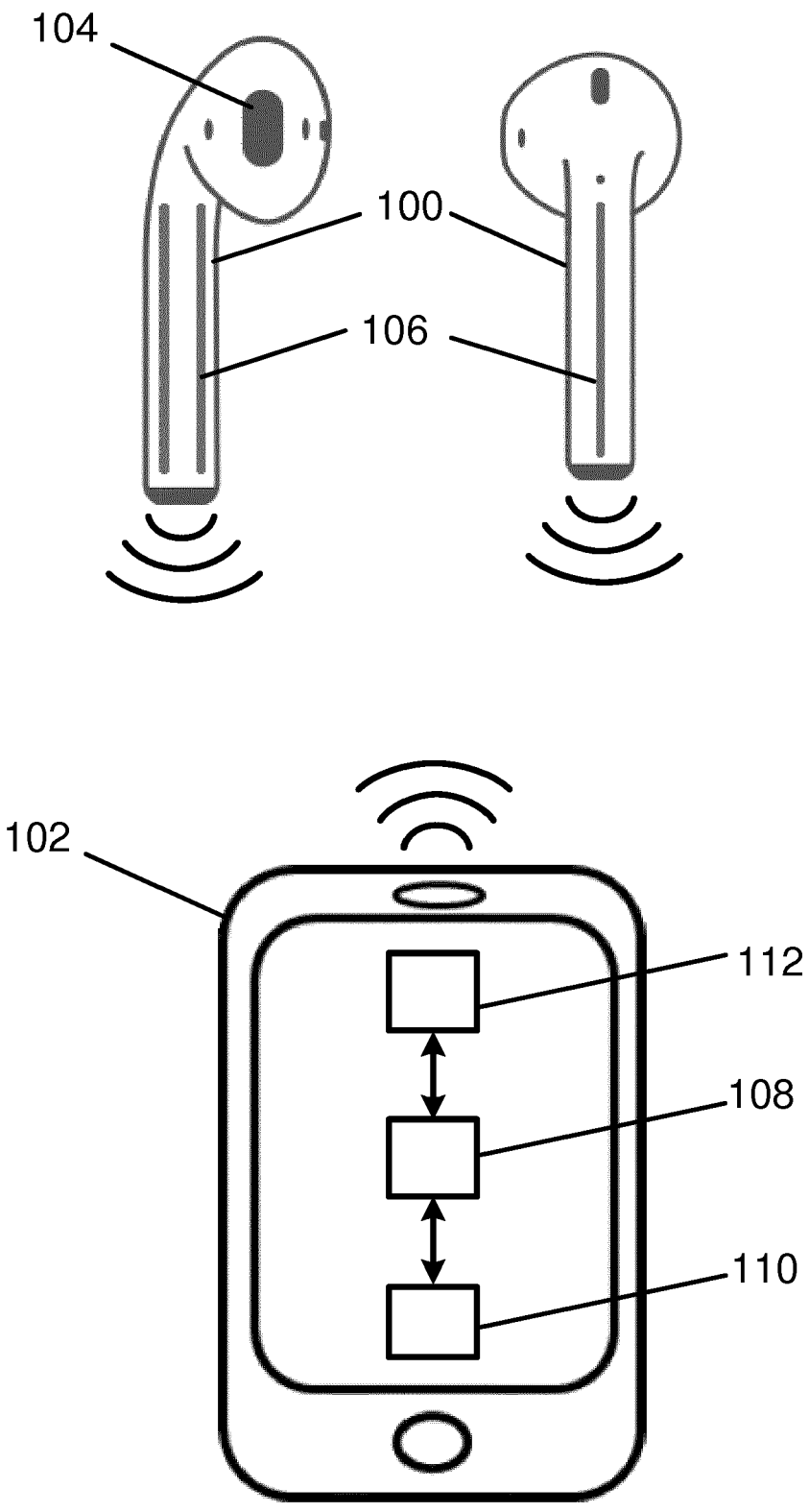

Figure 1

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EUROPEAN SEARCH REPORT

Application Number
EP 17 20 7463

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	22 May 2018	Fobel, Oliver

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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L : document cited for other reasons

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