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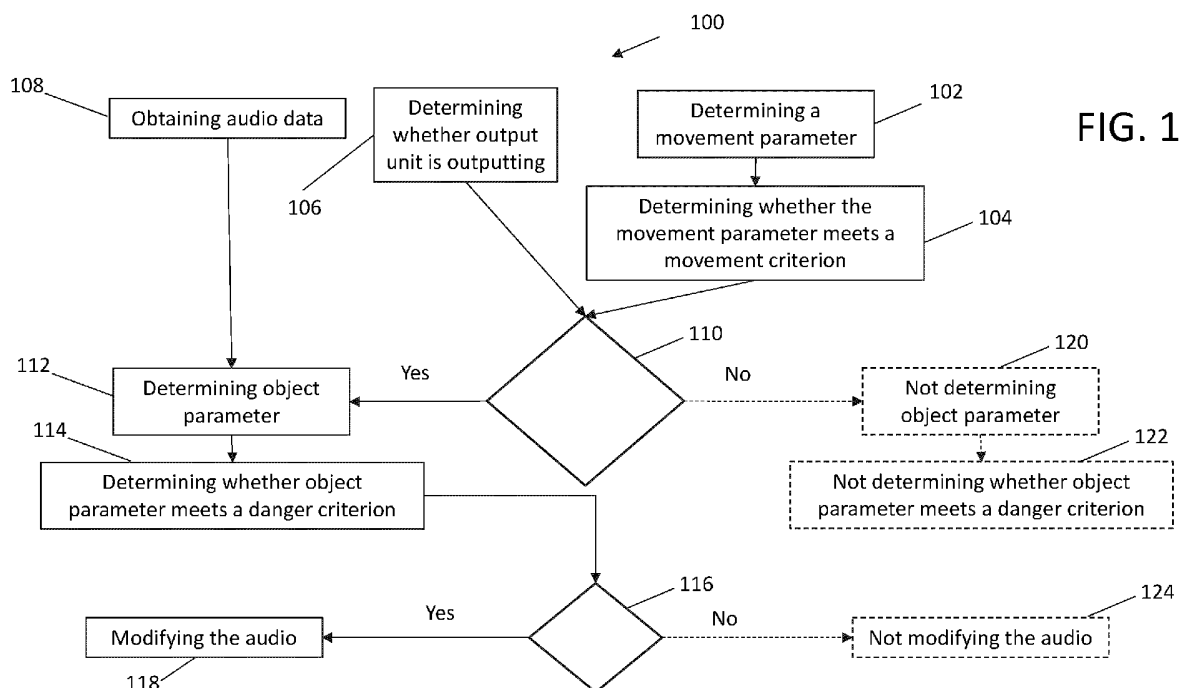
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(54) **HEARING AID HAVING ENVIRONMENTAL AWARENESS**

(57) A method of improving environmental awareness in a hearing aid is disclosed. The method includes determining, based on movement data, a movement parameter indicative of a movement of the hearing aid, determining whether the movement parameter meets a movement criterion, determining whether an output unit of the hearing aid is outputting an audio, and obtaining, by at least one microphone of the hearing aid, audio data indicative of an environment around the hearing aid. In

accordance with a determination that the movement parameter meets the movement criterion and that the output unit is outputting audio, the method includes determining, based on the audio data, an object parameter indicative of a moving object in the environment, determining whether the object parameter meets a danger criterion, and in accordance with a determination that the object parameter meeting a danger criterion, modifying the audio being output by the output unit.



Description

TECHNICAL FIELD

[0001] The present application relates to the field of hearing aids.

SUMMARY

[0002] In an aspect of the present application, a method of improving environmental awareness in a hearing aid is provided. The method can comprise determining, based on movement data, a movement parameter indicative of a movement of the hearing aid. The method can comprise determining whether the movement parameter meets a movement criterion. The method can comprise determining whether an output unit of the hearing aid is outputting an audio. The method can comprise obtaining, by at least one microphone of the hearing aid, audio data indicative of an environment around the hearing aid. In accordance with a determination that the movement parameter meets the movement criterion and that the output unit is outputting audio, the method can comprise determining, based on the audio data, an object parameter indicative of a moving object in the environment. In accordance with a determination that the movement parameter meets the movement criterion and that the output unit is outputting audio, the method can comprise determining whether the object parameter meets a danger criterion. In accordance with a determination that the object parameter meeting a danger criterion, the method can include modifying the audio being output by the output unit.

[0003] In accordance with a determination that the movement parameter does not meet the movement criterion or that the output unit is outputting audio, the method can comprise not determining, based on the audio data, an object parameter indicative of a moving object in the environment. In accordance with a determination that the movement parameter does not meet the movement criterion or that the output unit is outputting audio, the method can comprise not determining whether the object parameter meets a danger criterion. In accordance with a determination that the object parameter does not meet a danger criterion, the method can include not modifying the audio being output by the output unit.

[0004] Embodiments of the disclosed methods can improve environmental awareness for a user of a hearing aid. Embodiments of the disclosed methods can improve safety for a user of a hearing aid. For example, embodiments of the disclosed methods can aim to grab a user's attention (e.g., signal to a user), such as by providing a change in stream/microphone mix ratio, to ensure environmental awareness when streaming on the move. In one or more embodiments, the disclosed method will not disrupt the streaming experience unnecessarily when in a busy environment.

[0005] More and more people listen to music, pod-

casts, and audiobooks while in transit or out enjoying nature. For most hearing aid users, their main focus is on the streamed content, while environmental sound is attenuated due to factors such as a negative ratio of mic to streamed input, occluding acoustics and raised hearing thresholds. As the user is on the move, their eyes are usually trained in front, entailing a loss of awareness to either side. This is a perfect storm which presents a risk in situations where more environmental awareness is needed, e.g. biking in traffic. Advantageously, embodiments of the disclosed method can be used to improve the environmental awareness of a hearing aid user. Further, embodiments of the disclosed method can improve safety of a hearing aid user. For example, embodiments of the disclosed method can alleviate dampening in the environment caused by streaming.

[0006] In particular, embodiments of the disclosed methods can provide signaling to a user of a hearing aid about a potentially dangerous situation, or another situation which may require the user's awareness. A potentially dangerous situation can be, for example, the approach of a vehicle and/or bicycle. The method can utilize different cues from the hearing aid to provide an alert to a user upon meeting certain criteria.

[0007] Embodiments of the disclosed method can be performed by a hearing aid. For example, a hearing aid can include a processor and/or algorithm configured to perform the disclosed method. Embodiments of the disclosed method can be performed by a processor, such as in a mobile telephone, in communication with the hearing aid. Embodiments of the disclosed method can be performed by a server, such as a cloud server, in communication with the hearing aid and/or an intermediate device in communication with the hearing aid.

[0008] In one or more example methods, the method can be performed by a hearing aid in part and a mobile telephone in part. For example, determining the movement parameter can be performed in a mobile telephone. In other words, the mobile telephone may have an accelerometer, whereas the hearing aid may not.

[0009] In one or more example methods, the method can include obtaining movement data. For example, the method can include obtaining the movement data from one or more sensors. The one or more sensors can be integrated into the hearing aid. The one or more sensors can be in communication with the hearing aid. The one or more sensors can be in communication with an intermediate electronic device, which in turn is in communication with the hearing aid. In one or more example methods, the method can include determining movement data.

[0010] In one or more example methods, the movement data is accelerometer data and/or global positioning system (GPS) data and/or sound scene analysis. The method can include obtaining and/or determining the movement data from one or more sensors. The one or more sensors can include, for example, one or more of an accelerometer, a global positioning system, and a mo-

tion sensor (e.g., motion detector).

[0011] In one or more example methods, the method further comprises obtaining the movement data from the hearing aid. In one or more example methods, the method further comprises obtaining the movement data from another electronic device. The another electronic device can be a mobile phone, a cloud server, or a physical server.

[0012] The movement data can be indicative of the movement of the hearing aid. The movement data can be indicative of the movement of a user of the hearing aid.

[0013] Based on the movement data, the method can include determining a movement parameter. The movement parameter is indicative of a movement of the hearing aid. The movement parameter can be indicative of whether the hearing aid is moving or is stationary (e.g., not moving). For example, the movement parameter can be a "true" if the movement data indicates that the hearing aid is moving or a "false" if the movement data indicates that the hearing aid is stationary (e.g., not moving).

[0014] The method can include determining whether the movement parameter meets the movement criterion. In accordance with the movement parameter being indicative of the hearing aid moving, the method determines that the movement parameter meets the movement criterion. In accordance with the movement parameter being indicative of the hearing aid is not moving, the method determines that the movement parameter does not meet the movement criterion. In other words, the movement parameter can be used to determine whether the hearing aid is moving or not. The method can include certain actions when the hearing aid is moving and other actions when the hearing aid is not moving.

[0015] In one or more example methods, determining whether the movement parameter meets the movement criterion comprises determining whether the movement parameter is indicative of the hearing aid moving. In accordance with the determination that the movement parameter is indicative of the hearing aid moving, the method comprises determining that the movement parameter meets the movement criterion. In accordance with the determination that the movement parameter is not indicative of the hearing aid moving, the method comprises determining that the movement parameter does not meet the movement criterion.

[0016] In other words, the method can determine that the movement parameter meets the movement criterion if the movement parameter is indicative of the hearing aid moving. However, if the movement parameter is indicative of the hearing aid not moving (e.g., being stationary), the method can determine that the movement parameter does not meet the movement criterion.

[0017] In one or more example methods, determining whether the movement parameter meets the movement criterion comprises determining whether the audio data is indicative of the hearing aid being outdoors. In accordance with the determination that audio data is indicative of the hearing aid being outdoors, the method includes

determining that the movement parameter meets the movement criterion. In accordance with the determination that audio data is not indicative of the hearing aid being outdoors, the method includes determining that the movement parameter does not meet the movement criterion.

[0018] The embodiments of the disclosed method may not be necessary for indoor use as there is less potential for harm to a user of the hearing aid. Further, by not using the disclosed method indoors, battery life can be improved by the hearing aid.

[0019] For example, determining whether the audio data is indicative of the hearing aid being outdoors can include determining the echo (e.g., reverberation, reverb) levels in the audio data. Indoor audio data can have a higher level of echo, due to the enclosed space, than an outdoor location. In one or more examples, determining whether the audio data is indicative of the hearing aid being outdoors includes determining whether the audio data is equal to or below an echo threshold. In accordance with the determination that the audio data is equal to or below an echo threshold, the method includes determining that the audio data is indicative of the hearing aid being outdoors. In accordance with the determination that the audio data is above an echo threshold, the method includes determining that the audio data is indicative of the hearing aid being not outdoors. The echo threshold can be a preset threshold.

[0020] In one or more example methods, determining whether the audio data is indicative of the hearing aid being outdoors can include determining whether outdoor noises are found in the audio data. For example, in accordance with the determination that the audio data includes one or more of: wind sounds, bird sounds, vehicle sounds, and nature sounds, the method can include determining that the audio data is indicative of the hearing aid being outdoors. In accordance with the determination that the audio data does not include one or more of: wind sounds, bird sounds, vehicle sounds, and nature sounds, the method can include determining that the audio data is indicative of the hearing aid being not outdoors. Other audio data cues indicative of the hearing aid being outdoors can be used as well.

[0021] In one or more example methods, determining whether the audio data is indicative of the hearing aid being outdoors can include applying one or more algorithm using acoustic spatial clues to determine whether the audio data is indicative of the hearing aid being outdoors.

[0022] In one or more example methods, determining whether the audio data is indicative of the hearing aid being outdoors can include obtaining global positioning system (GPS) data. For example, in accordance with the determination that the GPS data is indicative of the user being outside, the method can include determining that the audio data is indicative of the hearing aid being outdoors. In accordance with the determination that the GPS data is indicative of the user not being outside, the meth-

od can include determining that the audio data is not indicative of the hearing aid being outdoors.

[0023] In one or more example methods, determining whether the audio data is indicative of the hearing aid being outdoors can include obtaining temperature data. For example, in accordance with the determination that the temperature data is indicative of a change in temperature, the method can include determining that the audio data is indicative of the hearing aid being outdoors. In accordance with the determination that the temperature data is not indicative of a change in temperature, the method can include determining that the audio data is not indicative of the hearing aid being outdoors.

[0024] In other words, the method can include at least two criteria for meeting the movement criterion in certain embodiments. First, the hearing aid is moving. Second, the hearing aid is outdoors.

[0025] In one or more example methods, determining whether the movement parameter meets the movement criterion comprises determining whether the movement data is indicative of the hearing aid moving within a time threshold. In accordance with the determination that the movement data is indicative of the hearing aid moving within the time threshold, the method includes determining that the movement parameter meets the movement criterion. In accordance with the determination that the movement data is not indicative of the hearing aid moving within the time threshold, the method includes determining that the movement parameter does not meet the movement criterion.

[0026] For example, it can be advantageous for the method to take into account that a person may be stopped temporarily, such as at an intersection, while continuing to monitor the surroundings. The user of the hearing aid may quickly start moving at a dangerous location after being stopped for a period of time.

[0027] The time threshold may be set for a particular time. Different locations may have different time thresholds. Example time thresholds include 10 seconds, 30 seconds, 60 seconds, 90 seconds, and/or 120 seconds.

[0028] In one or more examples, the method includes determining whether the movement data is indicative of the hearing aid throughout the time threshold. In other words, until the method determines that the movement data is indicative of the hearing aid not moving for the entire time threshold, the method can determine that the movement parameter meets the movement parameter.

[0029] The method can begin using the time threshold when the movement data is indicative of the hearing aid not moving. Advantageously, each time the hearing aid stops moving the method can utilize the time threshold as a timer and continue monitoring the environment around the hearing aid.

[0030] The method can include determining whether an output unit of the hearing aid is outputting an audio. The audio can include, for example, music, speech, streaming, etc. In one or more example methods, determining whether the output unit of the hearing aid is out-

putting an audio includes determining whether the output unit (e.g., speaker) of the hearing aid is outputting an audio not from the at least one microphone. In other words, the method may only take action if audio outside of the hearing aid forward path is being used. For example, determining whether an output unit of the hearing aid is outputting an audio can include determining whether the hearing aid is receiving audio data from another device. For example, determining whether an output unit of the hearing aid is outputting an audio can include determining whether the hearing aid is receiving audio data using Bluetooth Low Energy (BLE). In accordance with the determination that the hearing aid is receiving audio data using BLE, the method includes determining that the output unit of the hearing aid is outputting an audio.

[0031] The method can include obtaining audio data indicative of an environment around the hearing aid. In one or more example methods, the method can include obtaining, by at least one microphone of the hearing aid, audio data indicative of an environment around the hearing aid. The method can include obtaining, by at least one input unit of the hearing aid, audio data indicative of an environment around the hearing aid.

[0032] The method can determine whether the hearing aid is moving and whether the hearing aid is playing an audio to a user. The method can determine whether the hearing aid is moving and whether the hearing aid is playing a streaming audio to a user. In one or more example embodiments, the method can include determining whether the movement parameter meets the movement criterion and whether the output unit is outputting audio. In accordance with a determination that the movement parameter meets the movement criterion and that the output unit is outputting audio, the method includes determining, based on the audio data, an object parameter indicative of a moving object in the environment.

[0033] For example, the audio data can be indicative of certain object sounds in the environment. The audio data can be indicative of an object that can potentially move in the environment.

[0034] The audio data can be indicative of a vehicle (e.g., a car, scooter, truck, motorcycle) in the environment. The audio data can be indicative of a bicycle in the environment. The method can determine that the object parameter is indicative of a moving object in the environment in accordance with the audio data being indicative of certain objects in the environment that are capable of movement. In one or more example methods, the method can include obtaining a plurality of audio data indicative of the environment around the hearing aid. Based on the plurality of audio data, the method can include determining an object parameter indicative of a moving object in the environment. By obtaining a plurality of audio data, it may provide more audio data for the determination the object parameter.

[0035] The method can include determining whether the object parameter meets a danger criterion. The danger criterion may also be known as an awareness crite-

tion. For example, the method determines that the object parameter meets the danger criterion in accordance with the object parameter being indicative of the moving object travelling towards the hearing aid. For example, the method determines that the object parameter meets the danger criterion in accordance with the object parameter being indicative of the moving object's path intersecting with the path of the hearing aid. In other words, the method can be used to avoid dangerous situations (e.g., via the danger criterion) or to make the user of the hearing aid aware of a potential interaction.

[0036] For example, the method determines that the object parameter does not meet the danger criterion in accordance with the object parameter not being indicative of the moving object travelling towards the hearing aid. For example, the method determines that the object parameter does not meet the danger criterion in accordance with the object parameter being indicative of the moving object's path not intersecting with the path of the hearing aid.

[0037] In one or more example methods, determining whether the object parameter meets the danger criterion comprises determining whether the object parameter is indicative of the moving object moving towards the hearing aid. In accordance with the determination that the object parameter is indicative of the moving object moving towards the hearing aid, the method includes determining that the object parameter meets the danger criterion. In accordance with the determination that the object parameter is not indicative of the moving object moving towards the hearing aid, the method includes determining that the object parameter does not meet the danger criterion.

[0038] In other words, the method is only concerned with a moving object moving towards a hearing aid. If the moving object were moving away from the hearing aid, there would be no potential danger and no need to alert the user.

[0039] In one or more examples, determining whether the object parameter is indicative of the moving object moving towards the hearing aid from the sides of the user. In some situations, it can be assumed that a moving object moving towards the hearing aid from the front of the user of the hearing aid would be noticed by the user. However, moving objects moving toward the users from the sides can be much more problematic, and therefore it can be advantageous to alert the user via the hearing aid.

[0040] In one or more example methods, determining whether the object parameter meets the danger criterion further comprises determining whether the object parameter is indicative of the moving object moving at or above a velocity threshold. In accordance with the determination that the object parameter is indicative of the moving object moving at or above the velocity threshold, the method includes determining that the object parameter meets the danger criterion. In accordance with the determination that the object parameter is indicative of the

moving object not moving at or above the velocity threshold, the method includes determining that the object parameter does not meet the danger criterion.

[0041] The velocity threshold can be, for example, 10 km/h, 20 km/h, or 38 km/h. The velocity threshold can be a velocity in which the user would be harmed by interacting with the moving object.

[0042] In one or more example methods, determining whether the object parameter meets the danger criterion further comprises determining whether the object parameter is indicative of the moving object moving at a zero or positive acceleration. In accordance with the determination that the object parameter is indicative of the moving object moving at a zero or positive acceleration, the method includes determining that the object parameter meets the danger criterion. In accordance with the determination that the object parameter is indicative of the moving object not moving at a negative acceleration, the method includes determining that the object parameter does not meet the danger criterion.

[0043] In other words, if the moving object is slowing down the method does not have to alert the user of the hearing aid.

[0044] In one or more example methods, determining whether the object parameter meets the danger criterion comprises inputting the audio data into a neural network. In one or more example methods, determining whether the object parameter meets the danger criterion comprises determining, by the neural network, the object parameter. In one or more example methods, determining whether the object parameter meets the danger criterion comprises outputting, by the neural network, whether the object parameter meets the danger criterion.

[0045] In other words, the method can utilize a neural network (such as artificial intelligence, machine learning, etc.) for determination of whether the object parameter meets the danger criteria. The neural network can include one or more algorithms for interpretation of audio data to determine whether the object parameter meets the danger criterion.

[0046] In one or more example methods, determining, by the neural network, the object parameter comprises classifying, by the neural network, the moving object.

[0047] For example, the neural network can be configured to output a classification of the moving object. Classification can include one or more of vehicle, bicycle, animal, pedestrian, and non-factor. The method can be configured to determine, based on the classification output by the neural network, whether the object parameter meets the danger criterion.

[0048] In accordance with the object parameter meeting a danger criterion, the method includes modifying the audio being output by the output unit. Modifying can include attenuating the audio. Modifying can include reducing the volume of the audio. Modifying can include turning off noise cancellation. Modifying can include any change to the audio that can provide some sort of signalling to the user of the hearing aid.

[0049] In certain examples, a user may be wearing two hearing aids (e.g., a binaural system). For example, a user may be wearing a first hearing aid and a second hearing aid. Modifying the audio being output by the output unit can include modifying the audio being output by the output unit of the first hearing aid and/or modifying the audio being output by the output unit of the second hearing aid. This may allow for directional alert to a user of the hearing aid (e.g., modifying the audio of the hearing aid in the direction of the approaching object).

[0050] In one or more example methods, modifying the audio comprises attenuating the audio. In other words, the method can include reducing the loudness of the audio data, providing an audio clue to the user of the hearing aid. Modifying the audio can include fully attenuating the audio. Modifying the audio can include attenuating the audio by, for example, 1, 2, 3, 4, or 5 dBs. Modifying the audio can include attenuating the audio to create awareness for a hearing aid user without fundamentally changing the streaming experience.

[0051] In one or more example methods, modifying the audio comprises adjusting a mix ratio of the audio. In other words, the method includes changing the parameters of the audio, providing an audio clue to the user.

[0052] In one or more example methods, modifying the audio comprises outputting an audio tone. In other words, the method can include adding further audio to alert the user. The audio tone can include a chime, a tone, or any audio separate from the audio data currently being output.

[0053] In one or more example methods, in accordance with the object parameter meeting the danger criterion, the method comprises vibrating the hearing aid. In one or more example methods, in accordance with the object parameter not meeting the danger criterion, the method comprises not vibrating the hearing aid. In other words, the method can include providing a physical cue to the user of the hearing aid.

[0054] Further disclosed herein are example hearing aids having a memory and a processor configured to perform any and/or all of the method steps disclosed herein.

A hearing aid:

[0055] The above-disclosed method(s) can be performed partially or fully by a hearing aid.

[0056] The hearing aid may be adapted to provide a frequency dependent gain and/or a level dependent compression and/or a transposition (with or without frequency compression) of one or more frequency ranges to one or more other frequency ranges, e.g. to compensate for a hearing impairment of a user. The hearing aid may comprise a signal processor for enhancing the input signals and providing a processed output signal.

[0057] The hearing aid may comprise an output unit for providing a stimulus perceived by the user as an acoustic signal based on a processed electric signal. The output unit may comprise a number of electrodes of a

cochlear implant (for a CI type hearing aid) or a vibrator of a bone conducting hearing aid. The output unit may comprise an output transducer. The output transducer may comprise a receiver (loudspeaker) for providing the stimulus as an acoustic signal to the user (e.g. in an acoustic (air conduction based) hearing aid). The output transducer may comprise a vibrator for providing the stimulus as mechanical vibration of a skull bone to the user (e.g. in a bone-attached or bone-anchored hearing aid). The output unit may (additionally or alternatively) comprise a (e.g. wireless) transmitter for transmitting sound picked up by the hearing aid to another device, e.g. a far-end communication partner (e.g. via a network, e.g. in a telephone mode of operation, or in a headset configuration).

[0058] The hearing aid may comprise an input unit (e.g., at least one microphone) for providing an electric input signal representing sound. The input unit may comprise an input transducer, e.g. a microphone, for converting an input sound to an electric input signal. The input unit may comprise a wireless receiver for receiving a wireless signal comprising or representing sound and for providing an electric input signal representing said sound.

[0059] The wireless receiver and/or transmitter may e.g. be configured to receive and/or transmit an electromagnetic signal in the radio frequency range (3 kHz to 300 GHz). The wireless receiver and/or transmitter may e.g. be configured to receive and/or transmit an electromagnetic signal in a frequency range of light (e.g. infrared light 300 GHz to 430 THz, or visible light, e.g. 430 THz to 770 THz).

[0060] The hearing aid may comprise a directional microphone system adapted to spatially filter sounds from the environment, and thereby enhance a target acoustic source among a multitude of acoustic sources in the local environment of the user wearing the hearing aid. The directional system may be adapted to detect (such as adaptively detect) from which direction a particular part of the microphone signal originates. This can be achieved in various different ways as e.g. described in the prior art. In hearing aids, a microphone array beamformer is often used for spatially attenuating background noise sources. The beamformer may comprise a linear constraint minimum variance (LCMV) beamformer. Many beamformer variants can be found in literature. The minimum variance distortionless response (MVDR) beamformer is widely used in microphone array signal processing. Ideally the MVDR beamformer keeps the signals from the target direction (also referred to as the look direction) unchanged, while attenuating sound signals from other directions maximally. The generalized sidelobe canceller (GSC) structure is an equivalent representation of the MVDR beamformer offering computational and numerical advantages over a direct implementation in its original form.

[0061] The hearing aid may comprise antenna and transceiver circuitry allowing a wireless link to an entertainment device (e.g. a TV-set), a communication device

(e.g. a telephone), a wireless microphone, a separate (external) processing device, or another hearing aid, etc. The hearing aid may thus be configured to wirelessly receive a direct electric input signal from another device. Likewise, the hearing aid may be configured to wirelessly transmit a direct electric output signal to another device. The direct electric input or output signal may represent or comprise an audio signal and/or a control signal and/or an information signal.

[0062] In general, a wireless link established by antenna and transceiver circuitry of the hearing aid can be of any type. The wireless link may be a link based on near-field communication, e.g. an inductive link based on an inductive coupling between antenna coils of transmitter and receiver parts. The wireless link may be based on far-field, electromagnetic radiation. Preferably, frequencies used to establish a communication link between the hearing aid and the other device is below 70 GHz, e.g. located in a range from 50 MHz to 70 GHz, e.g. above 300 MHz, e.g. in an ISM range above 300 MHz, e.g. in the 900 MHz range or in the 2.4 GHz range or in the 5.8 GHz range or in the 60 GHz range (ISM=Industrial, Scientific and Medical, such standardized ranges being e.g. defined by the International Telecommunication Union, ITU). The wireless link may be based on a standardized or proprietary technology. The wireless link may be based on Bluetooth technology (e.g. Bluetooth Low-Energy technology, e.g. LE audio), or Ultra WideBand (UWB) technology.

[0063] The hearing aid may be constituted by or form part of a portable (i.e. configured to be wearable) device, e.g. a device comprising a local energy source, e.g. a battery, e.g. a rechargeable battery. The hearing aid may e.g. be a low weight, easily wearable, device, e.g. having a total weight less than 100 g, such as less than 20 g, such as less than 5 g.

[0064] The hearing aid may comprise a 'forward' (or 'signal') path for processing an audio signal between an input and an output of the hearing aid. A signal processor may be located in the forward path. The signal processor may be adapted to provide a frequency dependent gain according to a user's particular needs (e.g. hearing impairment). The hearing aid may comprise an 'analysis' path comprising functional components for analyzing signals and/or controlling processing of the forward path. Some or all signal processing of the analysis path and/or the forward path may be conducted in the frequency domain, in which case the hearing aid comprises appropriate analysis and synthesis filter banks. Some or all signal processing of the analysis path and/or the forward path may be conducted in the time domain.

[0065] An analogue electric signal representing an acoustic signal may be converted to a digital audio signal in an analogue-to-digital (AD) conversion process, where the analogue signal is sampled with a predefined sampling frequency or rate f_s , f_s being e.g. in the range from 8 kHz to 48 kHz (adapted to the particular needs of the application) to provide digital samples x_n (or $x[n]$) at dis-

crete points in time t_n (or n), each audio sample representing the value of the acoustic signal at t_n by a predefined number N_b of bits, N_b being e.g. in the range from 1 to 48 bits, e.g. 24 bits. Each audio sample is hence quantized using N_b bits (resulting in 2^{N_b} different possible values of the audio sample). A digital sample x has a length in time of $1/f_s$, e.g. 50 μ s, for $f_s = 20$ kHz. A number of audio samples may be arranged in a time frame. A time frame may comprise 64 or 128 audio data samples. Other frame lengths may be used depending on the practical application.

[0066] The hearing aid may comprise an analogue-to-digital (AD) converter to digitize an analogue input (e.g. from an input transducer, such as a microphone) with a predefined sampling rate, e.g. 20 kHz. The hearing aids may comprise a digital-to-analogue (DA) converter to convert a digital signal to an analogue output signal, e.g. for being presented to a user via an output transducer.

[0067] The hearing aid may comprise a number of detectors configured to provide status signals relating to a current physical environment of the hearing aid (e.g. the current acoustic environment), and/or to a current state of the user wearing the hearing aid, and/or to a current state or mode of operation of the hearing aid. Alternatively or additionally, one or more detectors may form part of an *external* device in communication (e.g. wirelessly) with the hearing aid. An external device may e.g. comprise another hearing aid, a remote control, and audio delivery device, a telephone (e.g. a smartphone), an external sensor, etc.

[0068] One or more of the number of detectors may operate on the full band signal (time domain). One or more of the number of detectors may operate on band split signals ((time-) frequency domain), e.g. in a limited number of frequency bands.

[0069] The number of detectors may comprise a movement detector, e.g. an acceleration sensor. The movement detector may be configured to detect movement of the user's facial muscles and/or bones, e.g. due to speech or chewing (e.g. jaw movement) and to provide a detector signal indicative thereof.

[0070] The hearing aid may comprise a classification unit configured to classify the current situation based on input signals from (at least some of) the detectors, and possibly other inputs as well. In the present context 'a current situation' may be taken to be defined by one or more of

- a) the physical environment (e.g. including the current electromagnetic environment, e.g. the occurrence of electromagnetic signals (e.g. comprising audio and/or control signals) intended or not intended for reception by the hearing aid, or other properties of the current environment than acoustic);
- b) the current acoustic situation (input level, feedback, etc.), and
- c) the current mode or state of the user (movement, temperature, cognitive load, etc.);

d) the current mode or state of the hearing aid (program selected, time elapsed since last user interaction, etc.) and/or of another device in communication with the hearing aid.

[0071] The classification unit may be based on or comprise a neural network, e.g. a recurrent neural network, e.g. a trained neural network.

[0072] The hearing aid may further comprise other relevant functionality for the application in question, e.g. compression, noise reduction, etc.

[0073] The hearing aid may comprise a hearing instrument, e.g. a hearing instrument adapted for being located at the ear or fully or partially in the ear canal of a user, e.g. a headset, an earphone, an ear protection device or a combination thereof. A hearing system may comprise a speakerphone (comprising a number of input transducers (e.g. a microphone array) and a number of output transducers, e.g. one or more loudspeakers, and one or more audio (and possibly video) transmitters e.g. for use in an audio conference situation), e.g. comprising a beamformer filtering unit, e.g. providing multiple beamforming capabilities.

[0074] It is intended that some or all of the structural features of the hearing aid described above, in the 'detailed description of embodiments' or in the claims can be combined with embodiments of the method(s), when appropriately substituted by a corresponding process and vice versa. Embodiments of the method have the same advantages as the corresponding devices.

A computer readable medium or data carrier:

[0075] In an aspect, a tangible computer-readable medium (a data carrier) storing a computer program comprising program code means (instructions) for causing a data processing system (a computer) to perform (carry out) at least some (such as a majority or all) of the (steps of the) method described above, in the 'detailed description of embodiments' and in the claims, when said computer program is executed on the data processing system is furthermore provided by the present application.

[0076] By way of example, and not limitation, such computer-readable media can comprise RAM, ROM, EEPROM, CD-ROM or other optical disk storage, magnetic disk storage or other magnetic storage devices, or any other medium that can be used to carry or store desired program code in the form of instructions or data structures and that can be accessed by a computer. Disk and disc, as used herein, includes compact disc (CD), laser disc, optical disc, digital versatile disc (DVD), floppy disk and Blu-ray disc where disks usually reproduce data magnetically, while discs reproduce data optically with lasers. Other storage media include storage in DNA (e.g. in synthesized DNA strands). Combinations of the above should also be included within the scope of computer-readable media. In addition to being stored on a tangible medium, the computer program can also be transmitted

via a transmission medium such as a wired or wireless link or a network, e.g. the Internet, and loaded into a data processing system for being executed at a location different from that of the tangible medium.

5 **[0077]** In an aspect of the present application, a method of improving environmental awareness in a hearing aid via a tangible computer-readable medium is provided. The a tangible computer-readable medium (a data carrier) storing a computer program can comprise program code means (instructions) for causing a data processing system (a computer) to perform (carry out) determining, based on movement data, a movement parameter indicative of a movement of the hearing aid. The tangible computer-readable medium (a data carrier) storing a computer program can comprise program code means (instructions) for causing a data processing system (a computer) to perform (carry out) determining whether the movement parameter meets a movement criterion. The tangible computer-readable medium (a data carrier) storing a computer program can comprise program code means (instructions) for determining whether an output unit of the hearing aid is outputting an audio. The tangible computer-readable medium (a data carrier) storing a computer program can comprise program code means (instructions) for obtaining, by at least one microphone of the hearing aid, audio data indicative of an environment around the hearing aid. In accordance with a determination that the movement parameter meets the movement criterion and that the output unit is outputting audio, the tangible computer-readable medium (a data carrier) storing a computer program can comprise program code means (instructions) for determining, based on the audio data, an object parameter indicative of a moving object in the environment. In accordance with a determination that the movement parameter meets the movement criterion and that the output unit is outputting audio, the tangible computer-readable medium (a data carrier) storing a computer program can comprise program code means (instructions) for determining whether the object parameter meets a danger criterion.

A computer program:

45 **[0078]** A computer program (product) comprising instructions which, when the program is executed by a computer, cause the computer to carry out (steps of) the method described above, in the 'detailed description of embodiments' and in the claims is furthermore provided by the present application.

50 **[0079]** In an aspect of the present application, a method of improving environmental awareness in a hearing aid is provided. The method can comprise determining, based on movement data, a movement parameter indicative of a movement of the hearing aid. The method can comprise determining whether the movement parameter meets a movement criterion. The method can comprise determining whether an output unit of the hearing aid is outputting an audio. The method can comprise obtaining,

by at least one microphone of the hearing aid, audio data indicative of an environment around the hearing aid. In accordance with a determination that the movement parameter meets the movement criterion and that the output unit is outputting audio, the method can comprise determining, based on the audio data, an object parameter indicative of a moving object in the environment. In accordance with a determination that the movement parameter meets the movement criterion and that the output unit is outputting audio, the method can comprise determining whether the object parameter meets a danger criterion.

A data processing system:

[0080] In an aspect, a data processing system comprising a processor and program code means for causing the processor to perform at least some (such as a majority or all) of the steps of the method described above, in the 'detailed description of embodiments' and in the claims is furthermore provided by the present application.

A hearing system:

[0081] In a further aspect, a hearing system comprising a hearing aid as described above, in the 'detailed description of embodiments', and in the claims, AND an auxiliary device is moreover provided.

[0082] The hearing system may be adapted to establish a communication link between the hearing aid and the auxiliary device to provide that information (e.g. control and status signals, possibly audio signals) can be exchanged or forwarded from one to the other.

[0083] The auxiliary device may be constituted by or comprise a remote control, a smartphone, or other portable or wearable electronic device, such as a smartwatch or the like.

[0084] The auxiliary device may be constituted by or comprise a remote control for controlling functionality and operation of the hearing aid(s). The function of a remote control may be implemented in a smartphone, the smartphone possibly running an APP allowing to control the functionality of the audio processing device via the smartphone (the hearing aid(s) comprising an appropriate wireless interface to the smartphone, e.g. based on Bluetooth or some other standardized or proprietary scheme).

[0085] The auxiliary device may be constituted by or comprise an audio gateway device adapted for receiving a multitude of audio signals (e.g. from an entertainment device, e.g. a TV or a music player, a telephone apparatus, e.g. a mobile telephone or a computer, e.g. a PC, a wireless microphone, etc.) and adapted for selecting and/or combining an appropriate one of the received audio signals (or combination of signals) for transmission to the hearing aid.

[0086] The auxiliary device may be constituted by or comprise another hearing aid. The hearing system may comprise two hearing aids adapted to implement a bin-

aural hearing system, e.g. a binaural hearing aid system.

Definitions:

[0087] In the present context, a hearing aid, e.g. a hearing instrument, refers to a device, which is adapted to improve, augment and/or protect the hearing capability of a user by receiving acoustic signals from the user's surroundings, generating corresponding audio signals, possibly modifying the audio signals and providing the possibly modified audio signals as audible signals to at least one of the user's ears. Such audible signals may e.g. be provided in the form of acoustic signals radiated into the user's outer ears, acoustic signals transferred as mechanical vibrations to the user's inner ears through the bone structure of the user's head and/or through parts of the middle ear as well as electric signals transferred directly or indirectly to the cochlear nerve of the user.

[0088] The hearing aid may be configured to be worn in any known way, e.g. as a unit arranged behind the ear with a tube leading radiated acoustic signals into the ear canal or with an output transducer, e.g. a loudspeaker, arranged close to or in the ear canal, as a unit entirely or partly arranged in the pinna and/or in the ear canal, as a unit, e.g. a vibrator, attached to a fixture implanted into the skull bone, as an attachable, or entirely or partly implanted, unit, etc. The hearing aid may comprise a single unit or several units communicating (e.g. acoustically, electrically or optically) with each other. The loudspeaker may be arranged in a housing together with other components of the hearing aid, or may be an external unit in itself (possibly in combination with a flexible guiding element, e.g. a dome-like element).

[0089] A hearing aid may be adapted to a particular user's needs, e.g. a hearing impairment. A configurable signal processing circuit of the hearing aid may be adapted to apply a frequency and level dependent compressive amplification of an input signal. A customized frequency and level dependent gain (amplification or compression) may be determined in a fitting process by a fitting system based on a user's hearing data, e.g. an audiogram, using a fitting rationale (e.g. adapted to speech). The frequency and level dependent gain may e.g. be embodied in processing parameters, e.g. uploaded to the hearing aid via an interface to a programming device (fitting system), and used by a processing algorithm executed by the configurable signal processing circuit of the hearing aid.

[0090] A 'hearing system' refers to a system comprising one or two hearing aids, and a 'binaural hearing system' refers to a system comprising two hearing aids and being adapted to cooperatively provide audible signals to both of the user's ears. Hearing systems or binaural hearing systems may further comprise one or more 'auxiliary devices', which communicate with the hearing aid(s) and affect and/or benefit from the function of the hearing aid(s). Such auxiliary devices may include at least one of a remote control, a remote microphone, an audio gate-

way device, an entertainment device, e.g. a music player, a wireless communication device, e.g. a mobile phone (such as a smartphone) or a tablet or another device, e.g. comprising a graphical interface. Hearing aids, hearing systems or binaural hearing systems may e.g. be used for compensating for a hearing-impaired person's loss of hearing capability, augmenting or protecting a normal-hearing person's hearing capability and/or conveying electronic audio signals to a person. Hearing aids or hearing systems may e.g. form part of or interact with public-address systems, active ear protection systems, handsfree telephone systems, car audio systems, entertainment (e.g. TV, music playing or karaoke) systems, teleconferencing systems, classroom amplification systems, etc.

[0091] The invention is set out in the appended set of claims.

BRIEF DESCRIPTION OF DRAWINGS

[0092] The aspects of the disclosure may be best understood from the following detailed description taken in conjunction with the accompanying figures. The figures are schematic and simplified for clarity, and they just show details to improve the understanding of the claims, while other details are left out. Throughout, the same reference numerals are used for identical or corresponding parts. The individual features of each aspect may each be combined with any or all features of the other aspects. These and other aspects, features and/or technical effect will be apparent from and elucidated with reference to the illustrations described hereinafter in which:

FIG. 1 shows an example flowchart of one or more embodiments of the disclosed method,

FIG. 2 illustrates an example situation according one or more embodiments of the disclosed method,

FIG. 3 illustrates an example situation according one or more embodiments of the disclosed method, and

FIG. 4 shows an example hearing aid incorporating one or more elements of the disclosed method.

[0093] The figures are schematic and simplified for clarity, and they just show details which are essential to the understanding of the disclosure, while other details are left out. Throughout, the same reference signs are used for identical or corresponding parts.

[0094] Further scope of applicability of the present disclosure will become apparent from the detailed description given hereinafter. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the disclosure, are given by way of illustration only. Other embodiments may become apparent to those skilled in the art from the following detailed description.

DETAILED DESCRIPTION OF EMBODIMENTS

[0095] The detailed description set forth below in connection with the appended drawings is intended as a description of various configurations. The detailed description includes specific details for the purpose of providing a thorough understanding of various concepts. However, it will be apparent to those skilled in the art that these concepts may be practiced without these specific details. Several aspects of the apparatus and methods are described by various blocks, functional units, modules, components, circuits, steps, processes, algorithms, etc. (collectively referred to as "elements"). Depending upon particular application, design constraints or other reasons, these elements may be implemented using electronic hardware, computer program, or any combination thereof.

[0096] The electronic hardware may include micro-electronic-mechanical systems (MEMS), integrated circuits (e.g. application specific), microprocessors, micro-controllers, digital signal processors (DSPs), field programmable gate arrays (FPGAs), programmable logic devices (PLDs), gated logic, discrete hardware circuits, printed circuit boards (PCB) (e.g. flexible PCBs), and other suitable hardware configured to perform the various functionality described throughout this disclosure, e.g. sensors, e.g. for sensing and/or registering physical properties of the environment, the device, the user, etc. Computer program shall be construed broadly to mean instructions, instruction sets, code, code segments, program code, programs, subprograms, software modules, applications, software applications, software packages, routines, subroutines, objects, executables, threads of execution, procedures, functions, etc., whether referred to as software, firmware, middleware, microcode, hardware description language, or otherwise.

[0097] The present application relates to the field of hearing aids.

[0098] FIG. 1 shows an example flowchart of one or more embodiments of the disclosed method. As shown, the method 100 is for improving environmental awareness in a hearing aid, such as the hearing aid 400 shown in FIG. 4.

[0099] The method 100 includes determining 102, based on movement data, a movement parameter indicative of a movement of the hearing aid. The method 100 includes determining 104 whether the movement parameter meets a movement criterion. The method 100 includes determining 106 whether an output unit of the hearing aid is outputting an audio. The method 100 includes obtaining 108, by at least one microphone of the hearing aid, audio data indicative of an environment around the hearing aid.

[0100] In accordance with a determination 110 that the movement parameter meets the movement criterion and that the output unit is outputting audio, the method 100 includes determining 112, based on the audio data, an object parameter indicative of a moving object in the en-

vironment and determining 114 whether the object parameter meets a danger criterion.

[0101] In accordance with a determination 116 that the object parameter meeting a danger criterion, the method 100 includes modifying 118 the audio being output by the output unit.

[0102] In accordance with a determination 110 that the movement parameter does not meet the movement criterion or that the output unit is outputting audio, the method 100 includes not determining 120, based on the audio data, an object parameter indicative of a moving object in the environment and not determining 122 whether the object parameter meets a danger criterion.

[0103] In accordance with a determination 116 that the object parameter does not meet a danger criterion, the method 100 includes not modifying 124 the audio being output by the output unit.

[0104] In one or more example methods determining 104 whether the movement parameter meets the movement criterion includes determining whether the movement parameter is indicative of the hearing aid moving, and in accordance with the determination that the movement parameter is indicative of the hearing aid moving, determining that the movement parameter meets the movement criterion. In accordance with the determination that the movement parameter is indicative of the hearing aid not moving, the method 100 includes determining that the movement parameter does not meet the movement criterion.

[0105] In one or more example methods, determining 104 whether the movement parameter meets the movement criterion includes determining whether the audio data is indicative of the hearing aid being outdoors, and in accordance with the determination that audio data is indicative of the hearing aid being outdoors, determining that the movement parameter meets the movement criterion. In accordance with the determination that audio data is indicative of the hearing aid being not being outdoors, the method 100 includes determining that the movement parameter does not meet the movement criterion.

[0106] The method 100 can further include obtaining the movement data from the hearing aid. The movement data can be accelerometer data and/or global positioning system (GPS) data and/or sound scene analysis.

[0107] In one or more example methods, modifying 118 the audio comprises one or more of attenuating the audio, adjusting a mix ratio of the audio, and outputting an audio tone. In accordance with the object parameter meeting the danger criterion, the method comprises vibrating the hearing aid. In accordance with the object parameter not meeting the danger criterion, the method comprises not vibrating the hearing aid.

[0108] Determining 114 whether the object parameter meets the danger criterion includes determining whether the object parameter is indicative of the moving object moving towards the hearing aid, and in accordance with the determination that the object parameter is indicative

of the moving object moving towards the hearing aid, determining that the object parameter meets the danger criterion. In accordance with the determination that the object parameter is not indicative of the moving object moving towards the hearing aid, the method 100 includes determining that the object parameter does not meet the danger criterion.

[0109] Determining 114 whether the object parameter meets the danger criterion further includes determining whether the object parameter is indicative of the moving object moving at or above a velocity threshold, and in accordance with the determination that the object parameter is indicative of the moving object moving at or above the velocity threshold, determining that the object parameter meets the danger criterion. In accordance with the determination that the object parameter is indicative of the moving object moving at or above the velocity threshold, the method 100 includes determining that the object parameter does not meet the danger criterion.

[0110] Determining 114 whether the object parameter meets the danger criterion can include inputting the audio data into a neural network, determining, by the neural network, the object parameter, and outputting, by the neural network, whether the object parameter meets the danger criterion. Determining, by the neural network, the object parameter can include classifying, by the neural network, the moving object.

[0111] Determining 114 whether the movement parameter meets the movement criterion includes whether the movement data is indicative of the hearing aid moving within a time threshold, and in accordance with the determination that the movement data is indicative of the hearing aid moving within the time threshold, determining that the movement parameter meets the movement criterion. In accordance with the determination that the movement data is indicative of the hearing aid not moving within the time threshold, determining that the movement parameter does not meet the movement criterion.

[0112] Further disclosed herein is a hearing aid, such as hearing aid 400, having a memory and a processor configured to perform the method 100 of any one of the previous claims.

[0113] Further disclosed is a data processing system comprising a processor and program code means for causing the processor to perform at least some of the steps of the method 100 disclosed herein.

[0114] Further disclosed is a computer program product comprising instructions which, when the program is executed by a computer, cause the computer to carry out the steps of the method 100 disclosed herein.

[0115] FIG. 2 illustrates an example situation 200 according to one or more embodiments of the disclosed method, such as method 100 discussed with respect to FIG. 1.

[0116] As shown, a user 202 of a hearing aid is walking outside (e.g., the movement parameter is indicative of movement of the hearing aid). The hearing aid of the user 202 is also connected to their mobile telephone via BLE in order to stream music 204 (e.g., the output unit of the

hearing aid is outputting an audio).

[0117] Further, the hearing aid of user 202 is configured to obtain, by at least one microphone, audio data 206 indicative of the environment around the hearing aid. Accordingly, the movement parameter meets the movement criterion and the output unit is outputting the audio, so further steps are taken. If the user 202 was not moving, or if the hearing aid was not outputting audio, no further steps would be taken.

[0118] In the situation 200 shown in FIG. 2, the user 202 of the hearing aid is approaching an intersection 208. In this particular intersection 208, a vehicle 210 is travelling towards the user 202 of the hearing aid. Based on the audio data 206, the object parameter indicative of a moving object in the environment can be determined (e.g., the moving vehicle 210).

[0119] Further, it can be determined that the object parameter meets a danger criterion (e.g., the vehicle 210 will hit the user 202 of the hearing aid when crossing the intersection 208). Accordingly, the hearing aid can modify the audio being output which, as shown in FIG. 2, is fully attenuating the audio. This provides an audio clue to the user 202 of the hearing aid to be aware of their surroundings to avoid being hit by the vehicle 210.

[0120] FIG. 3 illustrates an example situation according one or more embodiments of the disclosed method.

[0121] In particular, FIG. 3 illustrates the dB levels of sound being produced by the hearing aid. In the situation shown in FIG. 3, the streamed audio level 302 has a higher dB output than the microphone output 304.

[0122] Time 306 illustrates a moment where, according to the disclosed method, it is determined that an object parameter meets a danger criterion. Accordingly, the method modifies the audio being output by the output unit of the hearing aid. This is shown in FIG. 3 as slight reduction of the dB level of the streamed audio level 302 and a slight increase in the dB level of the microphone output 304. Even a minor change in the input ratio and/or the output ratio can create awareness to a user of the hearing aid. For example, only a few dBs of change (e.g., not enough to change the streaming experience, but enough to create awareness) could cause a hearing aid user's head turn. At time 308, the situation has been resolved the dB levels can return to what they were previously.

[0123] FIG. 4 shows an example embodiment of a hearing aid according to the disclosure. As shown, the hearing aid 400 includes the housing 414. The hearing aid 400 is configured to be worn behind the user's ears and comprises a behind-the-ear part 402 and an in-the-ear part 404. The behind-the-ear part 402 is connected to the in-the-ear part 404 via connecting member 406. However, the hearing aid 400 may be configured in other ways e.g., as completely-in-the-ear hearing aids. In some examples, the hearing aid 300 is in communication with another hearing aid via a short-range wireless link, e.g., an inductive wireless link.

[0124] It is intended that the structural features of the

devices described above, either in the detailed description and/or in the claims, may be combined with steps of the method, when appropriately substituted by a corresponding process.

[0125] As used, the singular forms "a," "an," and "the" are intended to include the plural forms as well (i.e. to have the meaning "at least one"), unless expressly stated otherwise. It will be further understood that the terms "includes," "comprises," "including," and/or "comprising," when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof. It will also be understood that when an element is referred to as being "connected" or "coupled" to another element, it can be directly connected or coupled to the other element, but an intervening element may also be present, unless expressly stated otherwise. Furthermore, "connected" or "coupled" as used herein may include wirelessly connected or coupled. As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items. The steps of any disclosed method are not limited to the exact order stated herein, unless expressly stated otherwise.

[0126] It should be appreciated that reference throughout this specification to "one embodiment" or "an embodiment" or "an aspect" or features included as "may" means that a particular feature, structure or characteristic described in connection with the embodiment is included in at least one embodiment of the disclosure. Furthermore, the particular features, structures or characteristics may be combined as suitable in one or more embodiments of the disclosure. The previous description is provided to enable any person skilled in the art to practice the various aspects described herein. Various modifications to these aspects will be readily apparent to those skilled in the art.

[0127] The claims are not intended to be limited to the aspects shown herein but are to be accorded the full scope consistent with the language of the claims, wherein reference to an element in the singular is not intended to mean "one and only one" unless specifically so stated, but rather "one or more." Unless specifically stated otherwise, the term "some" refers to one or more.

Claims

1. A method (100) of improving environmental awareness in a hearing aid, the method comprising:
 - determining (102), based on movement data, a movement parameter indicative of a movement of the hearing aid;
 - determining (104) whether the movement parameter meets a movement criterion;
 - determining (106) whether an output unit of the

- hearing aid is outputting an audio;
obtaining (108), by at least one microphone of the hearing aid, audio data indicative of an environment around the hearing aid;
in accordance with a determination (110) that the movement parameter meets the movement criterion and that the output unit is outputting audio;
- determining (112), based on the audio data, an object parameter indicative of a moving object in the environment;
determining (114) whether the object parameter meets a danger criterion; and
in accordance with a determination (116) that the object parameter meeting a danger criterion, modifying (118) the audio being output by the output unit.
2. The method (100) of claim 1, wherein determining (104) whether the movement parameter meets the movement criterion comprises:
- determining whether the movement parameter is indicative of the hearing aid moving; and
in accordance with the determination that the movement parameter is indicative of the hearing aid moving, determining that the movement parameter meets the movement criterion.
3. The method (100) of any one of the previous claims, wherein determining (104) whether the movement parameter meets the movement criterion comprises:
- determining whether the audio data is indicative of the hearing aid being outdoors; and
in accordance with the determination that audio data is indicative of the hearing aid being outdoors, determining that the movement parameter meets the movement criterion.
4. The method (100) of any one of the previous claims, wherein the method further comprises obtaining the movement data from the hearing aid.
5. The method (100) of any one of the previous claims, wherein the movement data is accelerometer data and/or global positioning system (GPS) data and/or sound scene analysis.
6. The method (100) of any one of the previous claims, wherein modifying (118) the audio comprises one or more of attenuating the audio, adjusting a mix ratio of the audio, and outputting an audio tone.
7. The method (100) of any one of the previous claims, wherein, in accordance with the object parameter meeting the danger criterion, the method comprises
- vibrating the hearing aid.
8. The method (100) of any one of the previous claims, wherein determining (114) whether the object parameter meets the danger criterion comprises:
- determining whether the object parameter is indicative of the moving object moving towards the hearing aid; and
in accordance with the determination that the object parameter is indicative of the moving object moving towards the hearing aid, determining that the object parameter meets the danger criterion.
9. The method (100) of claim 8, wherein determining (114) whether the object parameter meets the danger criterion further comprises:
- determining whether the object parameter is indicative of the moving object moving at or above a velocity threshold; and
in accordance with the determination that the object parameter is indicative of the moving object moving at or above the velocity threshold, determining that the object parameter meets the danger criterion.
10. The method (100) of any one of the previous claims, wherein determining (114) whether the object parameter meets the danger criterion comprises:
- inputting the audio data into a neural network;
determining, by the neural network, the object parameter; and
outputting, by the neural network, whether the object parameter meets the danger criterion.
11. The method (100) of claim 10, wherein determining, by the neural network, the object parameter comprises classifying, by the neural network, the moving object.
12. The method (100) of any one of the previous claims, wherein determining (114) whether the movement parameter meets the movement criterion comprises:
- determining whether the movement data is indicative of the hearing aid moving within a time threshold; and
in accordance with the determination that the movement data is indicative of the hearing aid moving within the time threshold, determining that the movement parameter meets the movement criterion.
13. A hearing aid (400) having a memory and a processor configured to perform the method (100) of any one

of the previous claims.

14. A data processing system comprising a processor and program code means for causing the processor to perform at least some of the steps of the method (100) of any one of claims 1-13. 5
15. A computer program product comprising instructions which, when the program is executed by a computer, cause the computer to carry out the steps of the method (100) of any one of claims 1-13. 10

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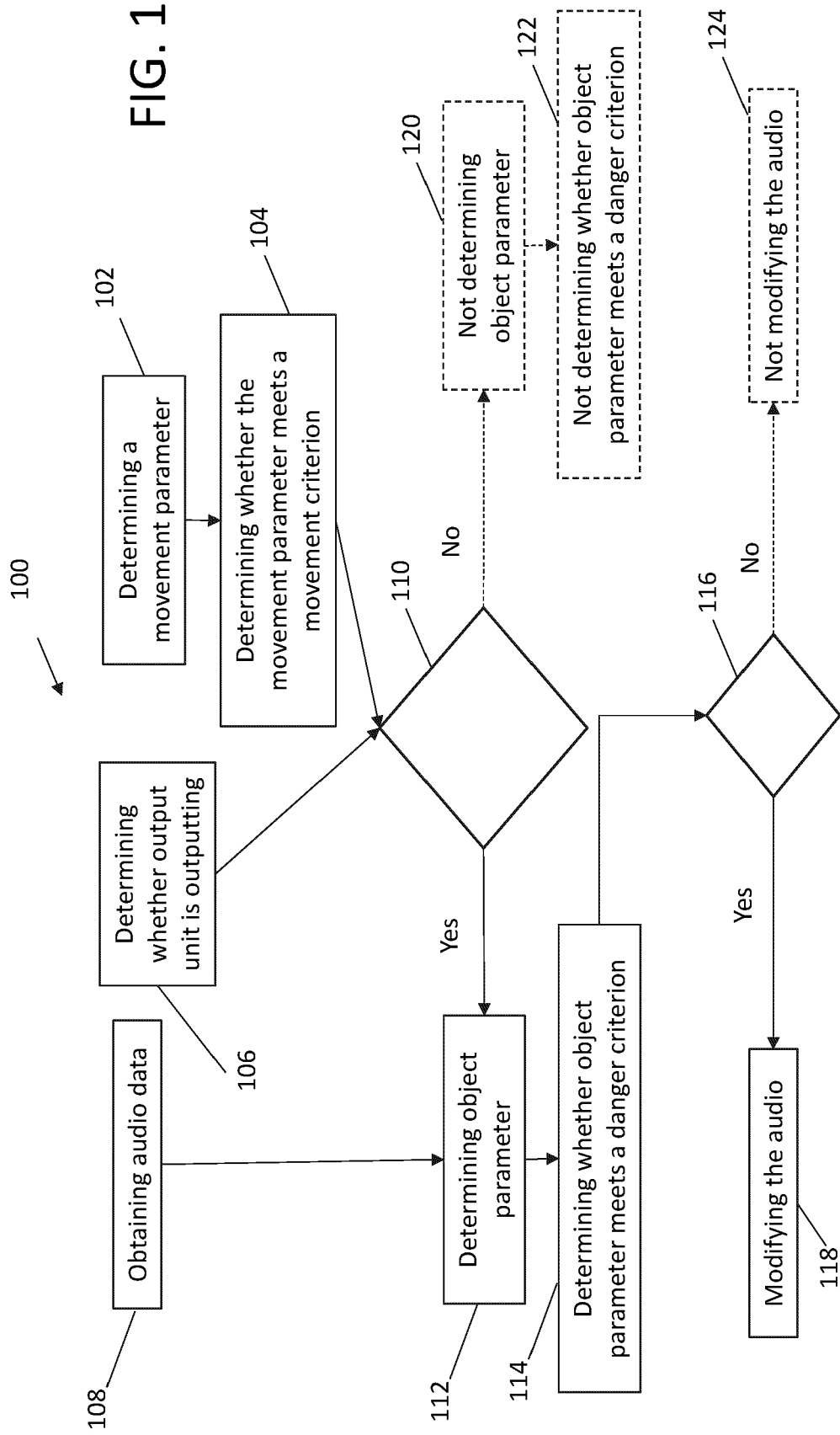
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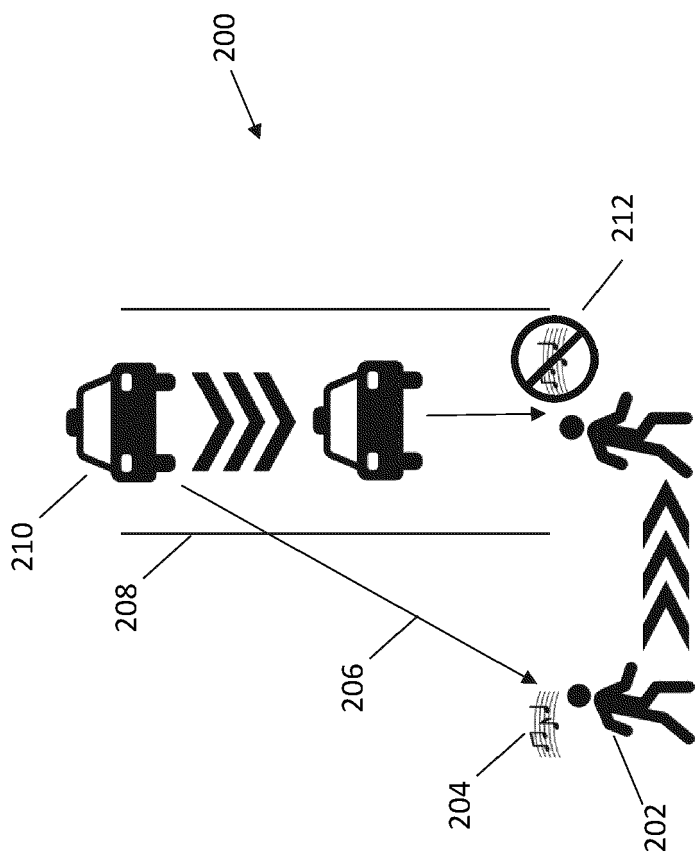


FIG. 2

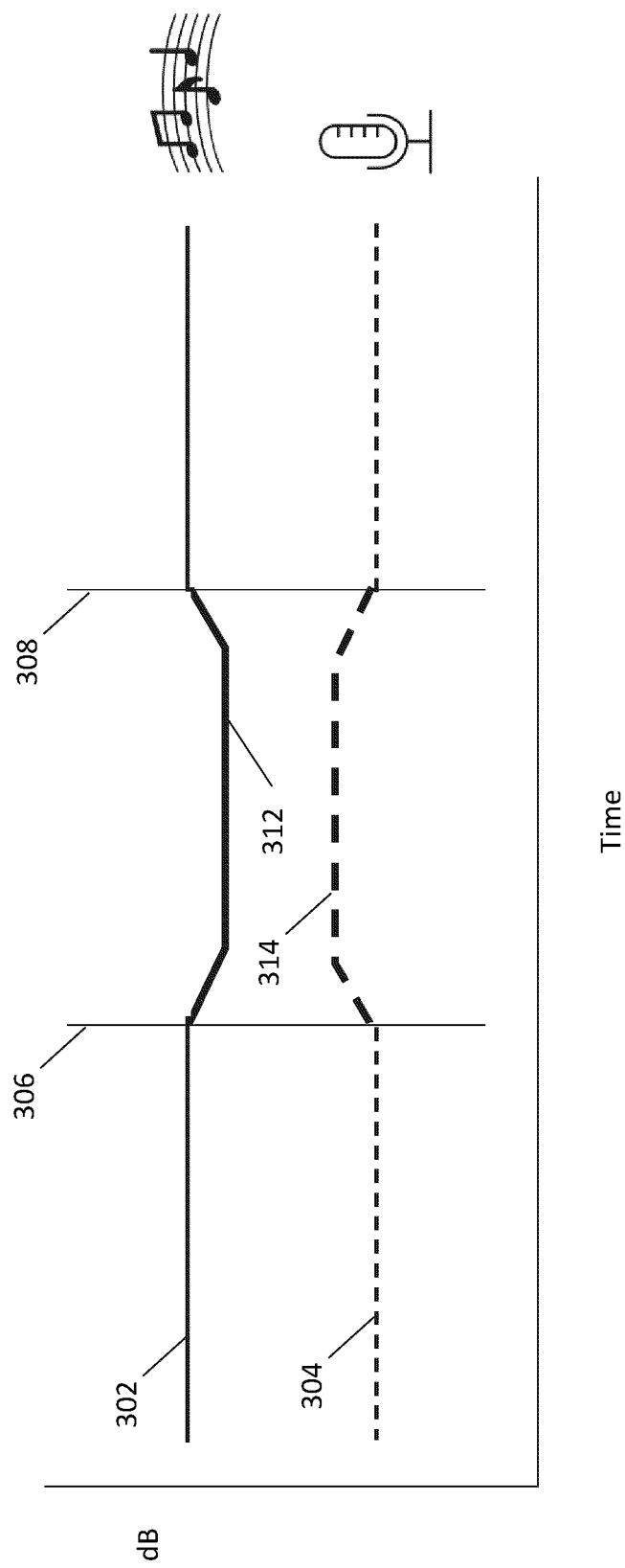


FIG. 3

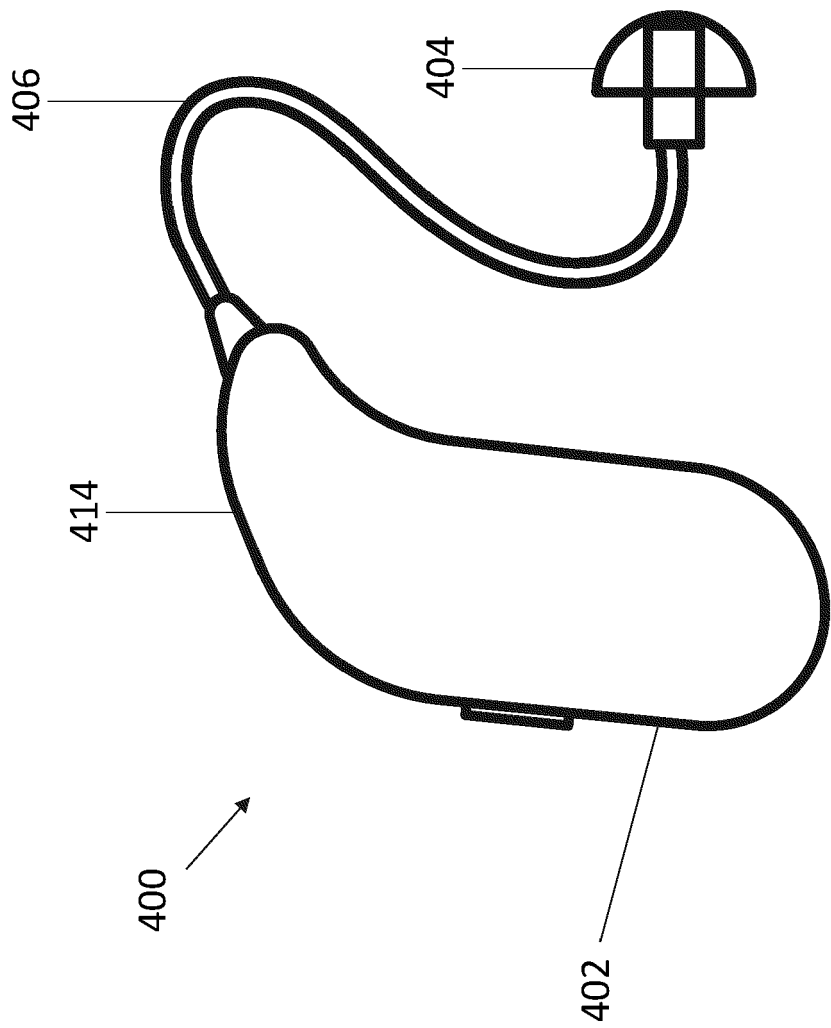


FIG. 4



EUROPEAN SEARCH REPORT

Application Number

EP 23 18 9928

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The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (IPC)
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Place of search		Date of completion of the search	Examiner
Munich		16 January 2024	Righetti, Marco
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons	
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		& : member of the same patent family, corresponding document	

**ANNEX TO THE EUROPEAN SEARCH REPORT
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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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