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A METHOD OF FITTING A HEARING DEVICE AND FITTING DEVICE

TECHNICAL FIELD

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The present invention is related to a method of fitting a hearing device as well as a fitting device for performing such a method.

10 BACKGROUND OF THE INVENTION

Hearing devices are typically used to improve the hearing capability or communication capability of a user. A hearing device may pick up the surrounding sound with a microphone
15 of the hearing device, process the microphone signal thereby taking into account the hearing preferences of the user of the hearing device and providing the processed sound signal into an ear canal of the user via a miniature loudspeaker, commonly referred to as a receiver. A hearing
20 device may also receive sound from an alternative input such as an induction coil or a wireless interface.

A commonly known procedure in a fitting session is a sequential processing of single fitting tasks. The fitting
25 session is defined as a session performed in order to find the best parameter settings for a user. However, a fitting

software does hardly support the fitter in a trade-off management. In other words, the fitting software does not indicate or even prevents the fitter from applying actions, which may have unwanted effects. This contradicts

5 previously applied modifications or even worsens settings for any other sound or sound class. This can result in an increased number of necessary fitting sessions required to be performed by the user which in turn delimits user satisfaction.

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In the prior art, one approach to solve this problem is to simply collect all fitting actions before being applied.

This provides a better overview over what shall be modified. However, this approach does not completely solve
15 the problem. Nevertheless, the fitter has to determine and to decide, which "final" actions need to be applied,

without knowing what the consequences are. Commonly, it is possible, that a fitter applies several (contradicting) modifications resulting in a kind of oscillating hearing

20 aid settings. In the state of the art, an optimization for a hearing situation A can degrade a hearing situation B and vice versa, if the behavioural part of the hearing device, which is modified, is relevant for both hearing situations but is modified based on different targets.

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It is therefore an object of the present invention to provide a method which allows improved fitting actions for hearing devices. It is a further object of the invention to

propose a fitting device for performing such a method for improved fitting actions.

SUMMARY OF THE INVENTION

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It is pointed out that the term "hearing device" must not only be understood as a device that is used to improve the hearing of hearing impaired patients, but also as a communication device to improve communication between
10 individuals. In addition, the term "hearing device" comprises hearing device types currently available, as for example behind the ear (BTE), in the ear (ITE), in the canal (ITC) and completely in the canal (CIC) hearing devices. Furthermore, hearing devices may also be fully or
15 partially implantable.

The present invention is directed to a method of fitting a hearing device, wherein the hearing device being adapted to amplify an audio signal according to a gain model, said
20 gain model and said audio signal being associated with a sound class. The method comprises the steps of: selecting the sound class, and providing fine tuning data, said fine tuning data describing a modification of the gain model associated with the selected sound class. The method
25 further comprises the steps of providing a data base of sound types, and providing a psychoacoustic model, said psychoacoustic model determining an expected effect of the

modification to a group of sound types based on the fine tuning data and the psychoacoustic model.

In this way, the proposed invention supports the hearing
5 device user/fitter in trade-off management for fitting
actions, which the hearing device user/fitter wants to
apply. The hearing device user/fitter gets a tool, which
provides a better insight into the consequences resulting
from the fitting actions. In other words, the hearing
10 device user/fitter gets indications, which behavioural part
of the hearing instrument becomes affected by a fitting
action and also which sounds and sound classes will be
affected by a fitting action. This advantageously results
in the number of necessary fitting sessions can be reduced
15 which in turn raises user satisfaction.

In an embodiment of the proposed method the step of
providing fine tuning data comprises retrieving said fine
tuning data from a fitting software, an external device or
20 an external server. In an example, the external server can
comprise a central server in the cloud based on a cloud-
technology.

In an embodiment of the proposed method the step of
25 retrieving the fine tuning data from the fitting software
comprises fine tuning modifications by a fitter by means of
the fitting software executed on a computer operated by the
fitter. It is to be noted that the term "fitter" is defined

to also comprise an automated expert system. The psychoacoustic model is used to evaluate and validate hearing device settings. The hearing device settings can be delivered from a fine tuning by means of a fitting software
5 running on a PC and operated by a fitter, and directly transmitted to the hearing device or transmitted via internet connection to the hearing device, which is connected to the fitting software via internet connection.

10 In an embodiment of the proposed method the step of retrieving the fine tuning data from the external device comprises self-fitting of modifications performed by the hearing device user. Hence, provided is a fitting functionality, that improves hearing device settings
15 without extensive manual trade-off management. The present invention further provides significant improvements for any kind of fitting, e.g. conventional fitting in the fitter's office, self-fitting in the field by the end user or fitting via an internet connection.

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In an embodiment of the proposed method the external device is a mobile device, in particular a smartphone, comprising a processor for executing a mobile fitting application. The method is configured to, when running on a mobile fitting
25 device, e.g. a smartphone with fitting functionality, support end users in applying a self-fitting procedure.

In an embodiment the proposed method further comprises the step of providing data about an individual hearing ability and feeding said data about the individual hearing ability into the psychoacoustic model.

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In an embodiment of the proposed method the psychoacoustic model is adapted to at least one of a hearing loss and an individual perception of the hearing device user. The psychoacoustic model can be integrated into the fitting
10 software or run on a central server in the cloud. In further examples, the psychoacoustic model can be performed on a mobile device, on a self-fitting device or on the hearing device itself. The psychoacoustic model can be tuned to better fit the individual hearing loss and hearing
15 needs of the hearing device user by providing its estimations and verifying these estimations by judgments or ratings of the hearing device user or automatically by considering all previous (up to now) proposed and applied modifications over time.

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In an embodiment the proposed method further comprises the step of providing the psychoacoustic model with at least one of: predefined sounds, meta-data of sounds, and sounds which are recorded from the hearing device user or the
25 fitter.

In an embodiment of the proposed method the predefined sounds are retrievable from a data base.

In an embodiment of the proposed method the expected effect determined by the psychoacoustic model is a value indicating how one or more sounds, sound types and/or sound
5 classes are affected by the modification.

In an embodiment of the proposed method the step of providing the psychoacoustic model comprises: accessing a plurality of relevant and/or representative sound examples
10 or meta-data of sound examples, and calculating a perceptual effect of the setting or modification on each of the sounds examples. The psychoacoustic model can be adapted to general hearing losses or to the individual hearing loss and hearing demands of a customer. Each of
15 sounds, sound types and/or sound classes, as mentioned above, can be defined as perceptual effect. In other words, the perceptual effect can describe how sounds, sound types and/or sound classes are affected by the modification.

20 In an embodiment the proposed method further comprises the step of determining data representing perceptual dimensions for each of the sound examples or meta-data of sound examples. In an aspect, the psychoacoustic model can use pre-defined sounds or meta-data of sounds or sounds which
25 are recorded from the hearing device user.

In an embodiment of the proposed method the perceptual dimensions comprise at least one of loudness, sharpness,

dullness, intelligibility, annoyance, listening effort, familiarity, naturalness and clarity.

Moreover, the present invention is directed to a fitting
5 device comprising a processor and a computer-readable
medium for storing a computer program comprising
instructions for executing the method according to one of
claims 1 to 13. The fitting device allows to, during
fitting of the hearing device, determine the most
10 appropriate trade-off for the configuration of the hearing
device settings, wherein said most appropriate trade-off
involves less disturbing disadvantages for a plurality of
relevant sounds or is depending on a weighting of sounds
according to an importance for the user or preference of
15 the user.

In an embodiment the proposed fitting device is a remote
server, a fitting-computer, a personal computer, a mobile
device, in particular a smartphone, or the hearing device
20 itself.

It is expressly pointed out that any combination of the
above-mentioned embodiments is subject of further possible
embodiments. Only those embodiments are excluded that would
25 result in a contradiction.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention is further described with reference to the accompanying drawings jointly illustrating various exemplary embodiments which are to be considered in connection with the following detailed description. What is shown in the figures is the following:

Fig. 1 schematically depicts a method for fitting a hearing device; and

Fig. 2 schematically depicts a modification performed on several sound types and resulting effects.

DETAILED DESCRIPTION OF THE INVENTION

Fig. 1 is a schematic view illustrating a method for fitting a hearing device (not shown). The hearing device being adapted to amplify an audio signal according to a gain model, said gain model and said audio signal being associated with a sound class. The method comprises selecting the sound class. The method further comprises, in a step S1, retrieving fine tuning data 14 from a fitting software 10. The step of retrieving the fine tuning data 14 from the fitting software 10 comprises fine tuning modifications by a fitter by means of the fitting software 10 executed on a computer operated by the fitter.

- 10 -

Additionally or as an option to retrieving the fine tuning data 14 from the fitting software 10, in a step S2, said fine tuning data 14 can be retrieved from an external device 12, generated by means of self-fitting of
5 modifications performed by the hearing device user on said external device 12.

Additionally or as an option, the fine tuning data 14 can be retrieved from an external memory, e.g. from the cloud.
10 In the shown example, the external device is a smartphone 12. The modification results in the fine tuning data 14. Therefore, said fine tuning data 14 describe a modification of the gain model associated with the selected sound class.

15 In a step S3, said fine tuning data 14 is fed into at least one psychoacoustic model 16, schematically depicted in Fig. 1 as a cloud. Said psychoacoustic model 16 is used to evaluate and validate hearing device settings and is adapted to a hearing loss, but can additionally be adapted
20 to an individual perception of a certain hearing device user. The psychoacoustic model 16 can deliver data for determining:

- how specific modification take effect on sounds,
25 sound types, or sound classes,
- which behavioral part of the hearing device provides a perceivable change in hearing,

- 11 -

- which sounds, sound types, or sound classes are affected by a modification,
- how sounds, sound types, or sound classes are affected by a modification,
- 5 • which hearing issues for sounds, sound types, or sound classes have to be expected, if a modification is applied,
- which wanted or unwanted side-effects could occur for sounds, sound types, or sound classes, if a
10 particular modification is applied,
- how a modification has to be modified in order to avoid unwanted side-effects for other sounds, sound types, or sound classes, if a modification is applied,
- 15 • how an optimal modification has to look like, in order to avoid unwanted side-effects for other sounds, sound types, or sound classes

In a step S4, the psychoacoustic model 16 is further
20 supplied with data about an individual hearing ability.
Said individual hearing ability data can be retrieved from an individual hearing loss database, schematically depicted by reference sign 18. In an option, said individual hearing loss database 18 can be supplied with data resulting from
25 executing programs included in the fitting software 10, as schematically depicted by a dashed arrow labelled with S4'.

The method comprises the step of providing a data base of sound types. In a step S5, the psychoacoustic model 16 is further supplied with data/meta-data about sound types comprising representative sound types 20. The

5 psychoacoustic model 16 has access to a plurality of relevant and representative sound examples or meta-data of sound examples and calculates the perceptual effect of the setting/modification on each of these sounds examples. The psychoacoustic model 16 is configured to determine data
10 indicating perceptual dimensions, e.g. loudness, sharpness, dullness, intelligibility, annoyance, listening effort, familiarity, etc., for each of received sound examples or meta-data of sound examples.

15 In a further step S6, the at least one psychoacoustic model is applied to data fed into an array 22 comprising several expected-effects-determination means, schematically depicted by an array of graphic boxes. Said array 22 is comprised by or part of the psychoacoustic model 16. Said
20 means are used to determine one or more expected effects of the modification to a group of sound types based on the fine tuning data and the psychoacoustic model 16. As shown, each of said graphic boxes can be assigned a number providing the fitter or hearing device user a notification
25 about which consequences for representative sound classes and/or sound types have to be expected (or rather to be considered) by a certain modification. For example, the assigned number "0" can indicate that the modification has (almost) no effect on the sound type. The number "-1" can

indicate that the modification has an undesirable effect on the sound type, while the number "1" can indicate that the modification has a desirable effect on the sound type. As schematically shown, a sound type 2 relating to a sound
5 class 1 is determined to show best effects as compared to the remaining modifications.

In a step S7, an optimized modification 24 is derived. Said step S7 can be followed by a step S8 comprising feeding
10 back adjusted modification to the fitting software 10. Additionally or as an option, step S7 can be followed by a step S9 comprising feeding back adjusted modification to the external device, e.g. the smartphone 12.

15 Fig. 2 is a schematic view illustrating the array 22 comprising the several expected-effects-determination means (graphic boxes, refer to Fig. 1). As mentioned above, said array 22 is comprised by or part of the psychoacoustic model 16. In particular, Fig. 2 shows modification on
20 several sound types and resulting effects in an exemplary view. As schematically depicted, the psychoacoustic model 16 is provided with data about the modification and/or sound class (also refer to Fig. 1). While the frequency ranges are shown as sharply defined areas, said ranges can
25 comprise smooth transitions. The psychoacoustic model 16 is further provided with data about individual hearing ability of the hearing device user as well as data about sound types.

The psychoacoustic model 16 is applied to said data about the sound types and determines expected effects (refer to Fig. 1). The psychoacoustic model 16 determines how sound types are affected by the modification. While not shown, the psychoacoustic model 16 can be configured to determine how sounds and/or sound classes might be affected by the modification. The determining result is provided to the hearing device fitter and/or the user of the hearing device.

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The procedure mentioned above can also be applied for several consecutive modifications and shows better the effect of each modification on several sound types. Each of said graphic boxes can be assigned a number providing the fitter or hearing device user a notification about which consequences for representative sound classes and/or sound types have to be expected by a certain modification. In the shown example, the assigned number "0" can indicate that the modification has (almost) no effect on the sound type. The number "-1" can indicate that the modification has a slight undesirable effect on the sound type. The number "-2" can indicate that the modification has a moderate undesirable effect on the sound type. Further, the number "-3" can indicate that the modification has an increased undesirable effect on the sound type. It is to be noted that the shown range of numbers from 0 to -3 is only for illustrative purposes. The range of numbers can be represented in different (reasonable) ranges, for example [-1,0,1], [-3,-2,-1,0,1,2,3] or [-3,-2,-1,0,1], as well. As

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an alternative, the representation can be graphically, for example in the form of a traffic light. In another alternative, the representation can be textural, for example "good", "neutral", "bad".

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In the example shown in Fig. 2, Sound Type 1 is impaired by all modifications, i.e. Mod. 1 to Mod. 3. The worst scenario results from Mod. 1 imposed on Sound Type 1.

Further, in the shown example, Sound Type n is impaired by
10 modifications Mod. 2 and Mod. 3. Otherwise, Sound Types 2 and 3 are both affected beneficially when modified by all modifications Mod. 1 to Mod. 3. Further, Sound Type n is affected beneficially when modified by only modification Mod. 1.

15

Advantageously, the psychoacoustic model can use pre-defined sounds or meta-data of sounds or sounds, which are recorded from the hearing device user. A notification can be provided to the fitter or end user, which consequences
20 for representative sound classes or sound types have to be considered or expected by a certain modification. Further, an automatic limitation of modification can be provided based on the result of the calculation. An automatic optimization of a degree or shape of modifications can be
25 provided based on the result of the calculation. The psychoacoustic model can be tuned to better fit the individual hearing loss and hearing needs of a hearing device user by providing its estimations and verifying these estimations by judgments or ratings of the user.

Hence, provided is a fitting functionality, that improves hearing device settings without extensive manual trade-off management. The present invention allows significant
5 improvement for any kind of fittings, resulting in higher user acceptance.

CLAIMS

1. A method of fitting a hearing device, the hearing
5 device being adapted to amplify an audio signal according
to a gain model, said gain model and said audio signal
being associated with a sound class, said method comprising
the steps of:
- selecting the sound class,
 - 10 - providing fine tuning data (14), said fine tuning data
(14) describing a modification of the gain model associated
with the selected sound class,
 - providing a data base of sound types,
 - providing a psychoacoustic model (16), said
15 psychoacoustic model (16) determining an expected effect of
the modification to a group of sound types based on the
fine tuning data and the psychoacoustic model (16).
2. The method according to claim 1, wherein the step of
20 providing fine tuning data (14) comprises retrieving said
fine tuning data (14) from a fitting software (10), an
external device (12) or an external server.
3. The method according to claim 2, wherein the step of
25 retrieving the fine tuning data (14) from the fitting
software (10) comprises fine tuning modifications by a

fitter by means of the fitting software (10) executed on a computer operated by the fitter.

4. The method according to claim 2, wherein the step of
5 retrieving the fine tuning data (14) from the external device (12) comprises self-fitting of modifications performed by the hearing device user.

5. The method according to claim 4, wherein the external
10 device is a mobile device (12), in particular a smartphone, comprising a processor for executing a mobile fitting application.

6. The method according to one of the preceding claims,
15 further comprising the step of providing data (18) about an individual hearing ability and feeding said data (18) about the individual hearing ability into the psychoacoustic model (16).

20 7. The method according to one of the preceding claims, wherein the psychoacoustic model (16) is adapted to at least one of a hearing loss and an individual perception of the hearing device user.

25 8. The method according to one of the preceding claims, comprising the step of providing the psychoacoustic model (16) with at least one of: predefined sounds, meta-data of

sounds, and sounds which are recorded from the hearing device user or the fitter.

9. The method according to claim 8, wherein the
5 predefined sounds are retrievable from a data base.

10. The method according to one of the preceding claims,
wherein the expected effect determined by the
psychoacoustic model (16) is a value indicating how one or
10 more sounds, sound types and/or sound classes are affected
by the modification.

11. The method according to one of the preceding claims,
wherein the step of providing the psychoacoustic model (16)
15 comprises:

- accessing a plurality of relevant and/or
representative sound examples or meta-data of sound
examples, and
- calculating a perceptual effect of the setting or
20 modification on each of the sounds examples.

12. The method according to claim 11, further comprising
determining data representing perceptual dimensions for
each of the sound examples or meta-data of sound examples.

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13. The method according to claim 12, wherein the perceptual dimensions comprise at least one of loudness, sharpness, dullness, intelligibility, annoyance, listening effort, familiarity, naturalness and clarity.

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14. A fitting device comprising a processor and a computer-readable medium for storing a computer program comprising instructions for executing the method according to one of claims 1 to 13.

10

15. The fitting device according to claim 14, wherein the fitting device is a remote server, a fitting-computer, a personal computer, a mobile device (12), in particular a smartphone, or the hearing device itself.

15

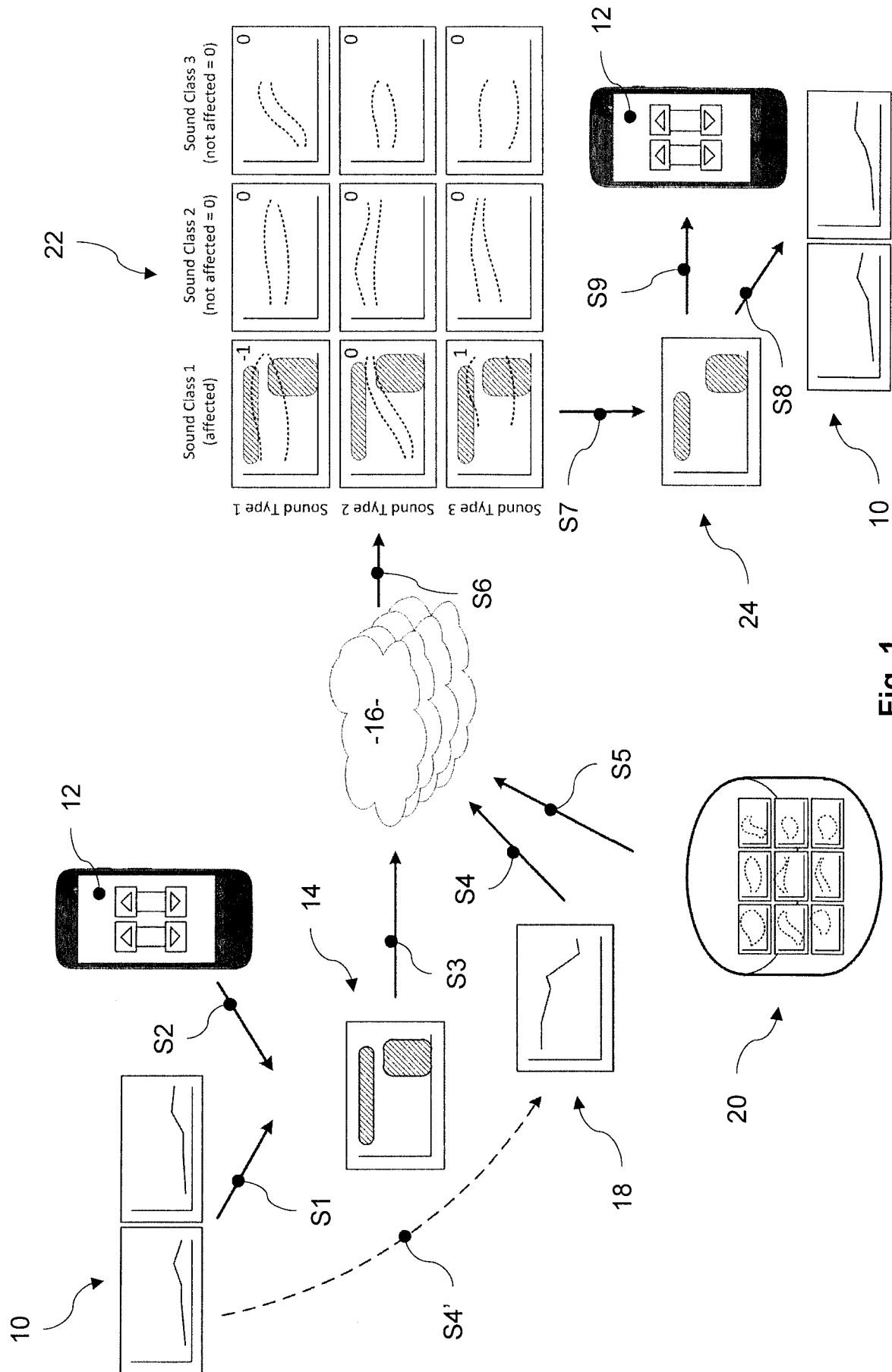


Fig. 1

22

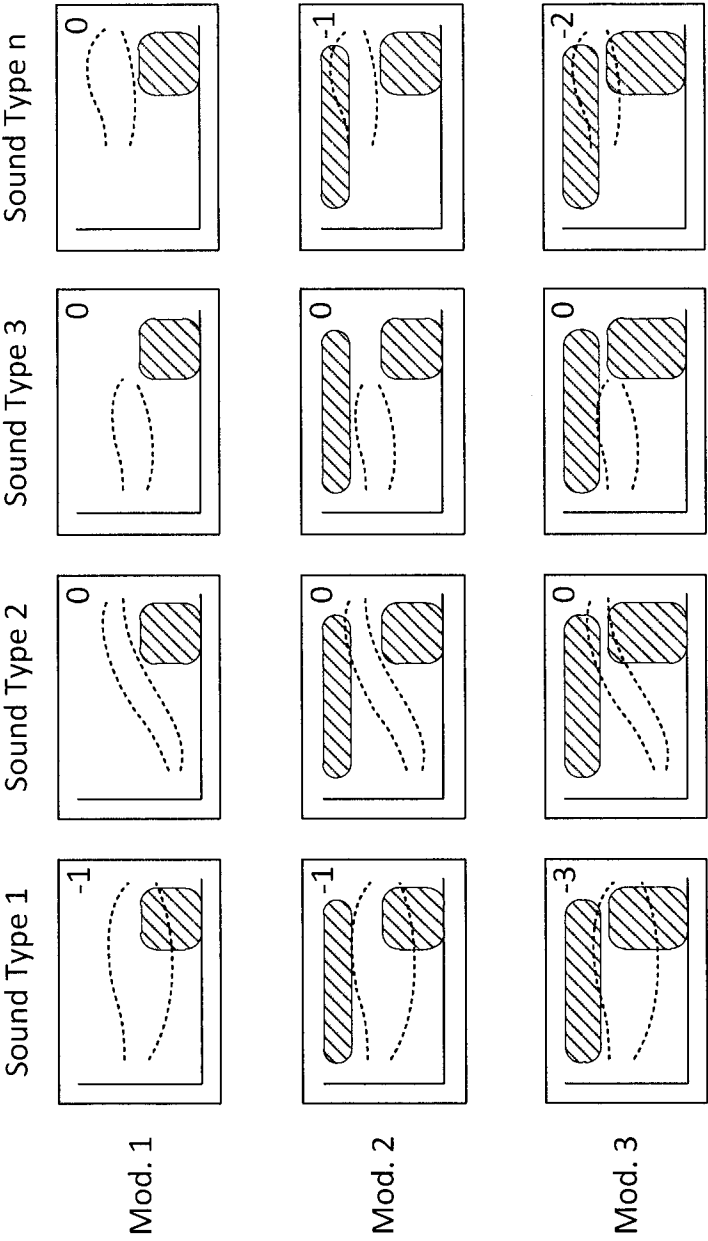


Fig. 2

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2016/066313

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04R25/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04R

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2010/202636 A1 (FROEHLICH MATTHIAS [CN] ET AL) 12 August 2010 (2010-08-12) paragraph [0008] - paragraph [0016] paragraph [0022] - paragraph [0030] figure 3	1-15
A	----- WO 2008/028484 A1 (GN RESOUND AS [DK]; KATES JAMES MITCHELL [US]) 13 March 2008 (2008-03-13) page 1, line 5 - page 2, line 8 figure 1	1,14
A	----- US 2015/023534 A1 (SHENNIB ADNAN [US]) 22 January 2015 (2015-01-22) paragraphs [0009], [0029], [0032], [0036] figures 1-3, 5-7 ----- -/--	2-5



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/066313

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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