(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
20 January 2022 (20.01.2022)

WIPO | PCT

(10) International Publication Number
WO 2022/013603 A1

(51) International Patent Classification:
H04R 25/00 (2006.01)

(21) International Application Number:
PCT/IB2020/056701

(22) International Filing Date:
16 July 2020 (16.07.2020)

(25) Filing Language: English

(26) Publication Language: English

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(81) **Designated States** *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, IT, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) **Designated States** *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report (Art. 21(3))*

WO 2022/013603 A1

(54) **Title:** HEARING ALERT

(57) **Abstract:** The invention, in one embodiment, is a single unit that operates on a WUW system and alerts the wearer that someone is talking to them via an aural, visual or tactile signal. This arrangement does not have the directionality. More preferably, a second embodiment of the invention alerts the wearer to the directionality of a person who is addressing them. The device is ideally worn bilaterally on the body e.g. bracelets, independent of the hearing aids or may be incorporated into the hearing aids themselves or into clothing. The devices are initially paired together and operate in unison and are programmed to recognise the WUW through a single input or multiple inputs to provide improved accuracy of recognition of the WUW e.g. the person's name. The hearing alert device may also be programmed to recognise additional alarms that safeguard the individual and improve quality of life.

HEARING ALERT

BACKGROUND OF THE INVENTION

Typically hearing aids do not have directionality. They collect sound only based on the orientation of the individual wearing the aids. Hearing aids with two (dual) microphones are, in principle, able to detect the directions of sounds based on the principle that sounds arriving from behind will reach the back microphone before the front one, and vice-versa. As a result, the hearing aid can then focus on speech and away from noise (if they are arriving from different directions). Hearing aids are therefore available in a variety of formats with an associated degree of complexity and relevent cost. These are fixed directionality devices; when the hearing aid only picks up all sounds directly in front of you. It will only help when noise is directly behind you and speech is directly in front of you.

Adaptive directionality; is when the hearing aid continuously monitors the listening environment in search of speech before focusing in that direction and away from noise (again if they are arriving from different directions).

Narrow directionality; compared to fixed and adaptive directionality, narrow directionality devices use a much more focused beam with directional beamforming. It suppresses sounds at angles outside of the very narrow beam and by doing so provides additional focus on speech.

Directionality in hearing aids is therefore designed to maximise signal-to-noise ratio for speech coming from a particular direction without respect for the intent of the listener and can be an intrusion on the intensions of the person wearing the hearing aids. Directionality

in hearing aids is best suited to those with signal-to-noise ratio (SNR) losses in the mild-to-moderate (4-8dB SNR loss) range. For those with greater SNR losses, directionality can still provide the benefit of listening comfort and can help with the understanding of speech in a noisy environment as long as contextual and speech cues are available. Individuals with hearing loss do not rely solely on the use of hearing aids. They like to be able to see the person clearly and combine the audio signals they receive with elements of lip reading and contextualisation.

Technological developments, enable us to address the issues of speech cues and directionality in a different way. Wake-up-word (WUW) speech recognition can be incorporated into a hearing aid system that would enable the person being addressed to identify quickly the direction of the speech and face the person addressing them to improve their understanding and communication.

SUMMARY OF THE INVENTION

The unique requirement of the system is that it should recognise a single word, such as the person's name when spoken as an alert, while rejecting all other sounds with virtually 100% accuracy including the phrase or word of interest spoken in a non-alerting (i.e. reference) context.

The system comprises two devices that may be incorporated into the hearing aids or may be worn independently of the hearing aids on either side of the body, for example as bracelets or other body adornments. The devices are paired to each other and will process the signal of the WUW to alert the wearer to the direction of the sound i.e. that they are being addressed. This communicable alert may be in the form of an aural signal to the person

wearing the hearing aids, a visual signal on the device or a tactile signal e.g. a series of vibrations that has a directional context such as a single vibration for 'forward', a double vibration for 'rear', a triple vibration for 'left' and a quadruple vibration for 'right' or similar or even the left device alone emits a signal for 'left' and similarly the right device alone emits a signal for 'right'.

Such a device would result in the wearer recognising that they were being addressed and turn to face the speaker, taking in the other visual cues to enable them to interact better in the conversation. WUW speech recognition has previously been described by Kepuska (2011) and have been incorporated into home entertainment and information systems. Never before has the technology been incorporated into a directional modality for personal use. This is different to binaural processing that is currently incorporated into directional microphones in hearing aids that allow the listener to orientate themselves optimally in noisy environments in order that they can receive the best signal from the person talking to them.

DESCRIPTION OF THE INVENTION

The inventors recognise that individuals with impaired hearing can be frustrated by current hearing aid technologies because they either do not incorporate directionality or where directionality is incorporated, it addresses only the SNR to improve the quality of the signal. This can leave the individual unaware sometimes that they are being addressed by someone approaching them other than face on and/or resulting in the individual asking the person speaking to start again now that they have their attention.

In one embodiment the device is a single unit that operates on a WUW system and alerts the wearer that someone is talking to them via an aural, visual or tactile signal. The inventors are aware that this is a suboptimal embodiment of the invention since directionality cannot be obtained from a single sensor. More preferably, the inventors have created a second embodiment of the WUW device that alerts the wearer to the directionality of a person who is addressing them. The device is ideally worn bilaterally on the body e.g. bracelets, rings, independent of the hearing aids or may be incorporated into the hearing aids themselves or into clothing. The bilateral nature of the device renders to it the directional functionality. The device comprises of a signal detector means, a WUW detector means, a device pairing means, for example Bluetooth, and a signal processing means resulting in a directional alert to the wearer. Said alert signal may be aural, visual or tactile - that may not be mutually exclusive.

The devices are initially paired together and operate in unison via a wireless means. The devices are programmed to recognise the WUW through a single input or multiple inputs to provide improved accuracy of recognition of the WUW e.g. the person's name. The WUW, once detected, enables the devices to process the signal and through the bilateral configuration, determine if the WUW has originated from a source to the front, rear, or to the left or right side of the wearer. The signal processing for the WUW is designed to recognise multiple accents and dialects to provide an accurate interpretation of when the individual is being addressed (Kepuska 2011).

The device may comprise a power indicator and be powered by a replaceable battery power supply or may be rechargeable.

The hearing alert device may also be programmed to recognise additional alarms that safeguard the individual and improve quality of life. For example, the device may be programmed to alert to a doorbell ring, a telephone call or a smoke/fire alarm and other systems that are used in everyday life.

REFERENCES

Veton Kepuska (2011). Wake-Up-Word Speech Recognition, Speech Technologies, Prof. Ivo Ipsic (Ed.), ISBN: 978-953-307-996-7, InTech, Available from: http://www.intechopen.com/books/speech-technologies/wake-upword-speech-recognition

CLAIMS

1. A wearable hearing alert device that operates on a wake up word (or phrase) and indicates to the wearer via an aural, visual or tactile signal that they are being addressed.
2. A device according to claim 1 that indicates the direction of the addressor.
3. A device according to claim 1 and 2 that comprises at least two units that are linked wirelessly.
4. A device according to claim 2 that may be incorporated into a hearing aid.
5. A device according to claim 2 that may be a personal wearable accessory.
6. A device according to claim 2 that may be an item of clothing.
7. A device according to claim 2 where the wake up word or phase is programmable and customisable by the wearer.
8. A device according to claim 2 where the wake up word recognises different dialects or accents.
9. A device according to claim 1 and 2 that can alert the wearer to predetermined alarms and sounds.
10. A device according to claim 1 and 2 where the device is battery operated.
11. A device according to claim 1 and 2 that has a rechargeable power supply.

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2020/056701

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 2020/054490 A1 (DIERENBACH KARL ALLEN [US]) 20 February 2020 (2020-02-20)	1-7,9-11
Y	abstract paragraph [0011] - paragraph [0013] paragraph [0137] paragraph [0143] paragraph [0211] - paragraph [0212] paragraph [0272]	8

X	EP 2 472 907 A1 (OTICON AS [DK]) 4 July 2012 (2012-07-04)	1-7,9-11
Y	abstract paragraph [0008] paragraph [0025] paragraph [0064] figures 1-3	8

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
19 February 2021	01/03/2021

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INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2020/056701

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	LI CHENXING ET AL: "Recurrent Neural Network Based Small-footprint Wake-up-word Speech Recognition System with a Score Calibration Method", 2018 24TH INTERNATIONAL CONFERENCE ON PATTERN RECOGNITION (ICPR), IEEE, 20 August 2018 (2018-08-20), pages 3222-3227, XP033457368, DOI: 10.1109/ICPR.2018.8546063 [retrieved on 2018-11-26] page 3224 - page 3225 -----	8

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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