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(54) Title: VISUAL COMMUNICATION OF HEARING AID PATIENT-SPECIFIC CODED INFORMATION
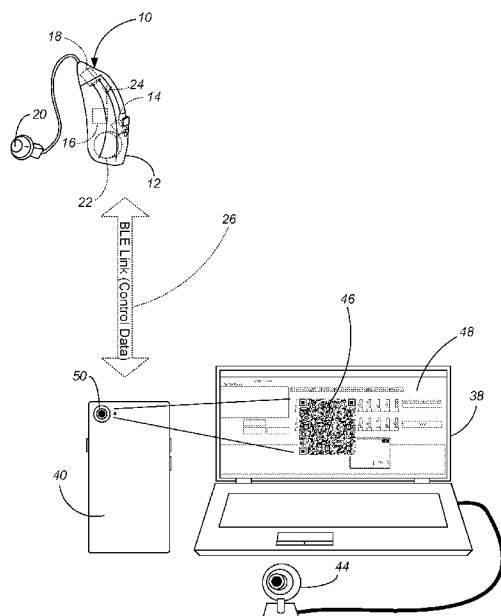
FIG. 3

(57) Abstract: A method and system visually communicates hearing aid information between a patient's smartphone and an audiologist's computer system by using a QR code captured by a camera. When the audiologist's computer system takes a picture of the QR code on the display of the patient's smartphone, the QR code contains at least one piece of audiological data representing historical or current patient-specific usage of the hearing aid. When the patient's smartphone takes a picture of the QR code on the display of the audiologist's computer system, the QR code contains audiological data, which the patient's smartphone extracts to transmit instructions or information to adjust at least one audiological parameter setting on the patient's hearing aid. The patient may transmit or receive an image file of either QR code over a network, thereby communicating the same information with the audiologist.

VISUAL COMMUNICATION OF HEARING AID PATIENT-SPECIFIC CODED INFORMATION

CROSS-REFERENCE TO RELATED APPLICATION(S)

The present application claims the benefit of U.S. provisional patent application Ser. No. 62/745,085, filed October 12, 2018. The contents of U.S. provisional patent application Ser. No. 62/745,085 is hereby incorporated by reference in entirety.

BACKGROUND OF THE INVENTION

Many people have some sort of hearing impairment, and are willing to wear a hearing aid or similar body-worn, battery-operated hearing assist device to address their hearing impairment. Such hearing aids not only amplify sound sensed from a microphone which is part of the device, but also are commonly modified to adjust or personalize the hearing aid audio output for the particular hearing profile of the patient. Being body-worn, typically in an exposed location on the head or ear of the patient, many hearing aid patients want their hearing aid to be relatively small and inconspicuous. In part due to size constraints, hearing aids typically do not include any visual display.

Many hearing aids, in addition to having a microphone to receive audible sound, also have an antenna or similar transceiver device/chipset to receive (and in many instances send) wireless signals. The wireless signals may include a) instructions about hearing aid settings, adjusting the way the hearing aid audio output is personalized for the hearing abilities/loss of that particular patient; and b) an audio stream to play audio from a source other than the microphone, such as playing a telephone call, a television program, or from a remote microphone. For example, U.S. Pat. No. 9,832,578 discloses a hearing aid which can receive audio streaming over a wireless proprietary audio streaming link and can also receive control data over a Bluetooth Low Energy ("BLE") link. U.S. Pat. No. 9,832,578 is owned by the assignee of the present invention and incorporated by reference, and summarized with reference to FIG. 1. As shown in FIG. 1, the hearing assist device 10, in this case depicted as a behind-the-ear hearing aid, has a housing 12 and includes a microphone 14, a digital signal processor ("DSP") 16 and a speaker (receiver) 18 with a sound outlet 20 directed into the patient's ear canal (not shown), powered by a replaceable or rechargeable battery 22, such as the hearing aids further disclosed in U.S. Pat. Nos. 7,519,193, 8,355,517, 8,358,797 and 8,767,987, all assigned to the assignee of the present invention and each incorporated by reference. The hearing aid 10 also includes an antenna

/chipset 24 for receiving a wireless signal, which can preferably include control data 26, 28 and/or audio data 30 (such as from an audio streaming device) 32, and/or may alternatively receive control data 34 over a wired connection 36 or directly programmed or burned into the DSP 16.

5   As disclosed in U.S. Pat. No. 9,832,578, one source of the control data can be an audiologist's computer system 38, while an alternative source of control data can be the patient's computing device such as a smartphone 40. Smartphones have become ubiquitous in today's society, with many hearing aid owners also owning a smartphone. Assuming the smartphone and the hearing aid are so equipped, patients can wirelessly communicate with their hearing aids

10   using their smartphone, such as using a Bluetooth or BLE signal, providing several advantages. The smartphone may have a touchscreen and control buttons which are larger than the switches or controls on the hearing aid itself, and the smartphone may be used to more easily enable patients, particularly elderly patients, to have the physical dexterity to adjust the hearing aid controls. The smartphone will have a display that the hearing aid lacks, so information from the

15   hearing aid or control settings for the hearing aid can be presented on the smartphone display and be read by the patient. The smartphone will be connectable to one or more wide area networks, such as either or both of its cellphone network and the internet (including WiFi), enabling either the hearing aid manufacturer and/or an audiologist, remote from the hearing aid itself (but usually with the permission and participation of the hearing aid patient), to communicate

20   information from or to the hearing aid. The audiologist thus may be able to remotely and timely perform services such as adjusting digital signal processor ("DSP") parameters so the hearing aid more properly adjusts the sound output for the hearing deficiency of that particular patient at that particular time and environmental location.

          A perceived or actual shortcoming of many such systems is that they do not allow

25   adequate protection over the hearing aid data of the patient. Possibilities exist for nefarious hacking into the system (possibly changing DSP parameters to the detriment of the patient), and/or for sensitive personalized data to be used or leaked outside the knowledge and/or permission of the patient. In Europe, for instance, stringent GDPR regulations have been put in place to allow citizens more control over their personalized data. Additionally, virus and

30   malware problems run rampant when transmitting information over wide area networks such as the internet.

Owners of smartphones know that most smartphones include a camera, and that the camera can be used to input coded information to the smartphone, such as reading a bar code or a QR code (from Quick Response code). QR codes are commonly used on product packaging and promotional literature to direct consumers to a desired webpage. Bar codes and QR codes are limited in size. For instance, a QR code is limited to the number of bits in the QR display, such as a version 10 QR code, limited to exactly 57 x 57 pixels, e.g., about 1kB or 3kB of data are limits of common QR code sizes.

Hearing aid manufacturers are familiar with QR codes and their use on smartphones. For instance, hearing aid manufacturers may use a QR code on the packaging for a hearing aid, to quickly identify the type of hearing aid being purchased into the smartphone and/or for directing the patient's smartphone to a desired webpage for downloading of the correctly corresponding control software into the smartphone.

SUMMARY OF THE INVENTION

The present invention is method and system for communicating information between a computing device controlled by a hearing assist device patient and a different computer system controlled by a different party such as an audiologist, by using a visual computer code such as a bar code or more preferably a QR code. When the audiologist's computer system takes a picture of the QR code on the display of the patient's computing device, the QR code contains at least one piece of audiological data representing historical or current patient-specific usage of the hearing assist device. When the patient's computing device (such as a smartphone) takes a picture of the QR code on the display of the audiologist's computer system, the QR code contains audiological data, which the patient's computing device extracts to transmit instructions or information to adjust at least one audiological parameter setting on the patient's hearing assist device. Because the QR code is communicated visually, the patient can retain stringent control of his or her own audiological data. For certain patients, the QR code can be printed on paper and mailed from the audiologist to the patient. Alternatively, the patient in appropriate situations may transmit an image file of a QR code over a network, thereby communicating the same information with the audiologist. Because the QR code is limited in size, transmission of a virus or similar malware is impossible.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic view showing prior art communication with a hearing aid in a system including a patient's smartphone and an audiologist's computer, such as disclosed in U.S.

Pat. No. 9,832,578.

FIG. 2 is a schematic view of a preferred system in accordance with the present invention, using a QR code generated on a patient's smartphone to communicate hearing aid patient-personalized information to an audiologist's computer.-

5   FIG. 3. is a schematic view of the preferred system of the present invention, using a QR code generated on an audiologist's computer to communicate hearing aid patient-personalized information to a patient's smartphone.-

FIG. 4 is a schematic view of the preferred system of the present invention, showing two way communication between an audiologist datacenter and a patient's smartphone, using

10   internet-transmitted QR codes.

While the above-identified drawing figures set forth a preferred embodiment, other embodiments of the present invention are also contemplated, some of which are noted in the discussion.   In all cases, this disclosure presents the illustrated embodiments of the present invention by way of representation and not limitation. Numerous other minor modifications and

15   embodiments can be devised by those skilled in the art which fall within the scope and spirit of the principles of this invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

The present invention involves two different software applications running on two different computing systems, in conjunction with a patient's hearing assist device(s) 10 such as

20   one or a pair of hearing aids. Typically, one of the software applications will run on a patient's computing device such as a patient's smartphone 40. (As used herein, the possessive term "patient's" is not necessarily intended to mean ownership of the device, but rather use and control of the device regardless of actual ownership.) The patient's smartphone 40 can communicate with the patient's hearing aid(s) 10 over a wired connection or local area network

25   (such as, most commonly, Bluetooth or BLE). Typically the other software application will run on a computer 38 controlled either by a hearing assist device manufacturer or audiologist. (As used herein, the possessive term "audiologist's" is not necessarily intended to mean ownership of the device, and is not limited to licensed audiologists, but rather use and control of the device by a desired person or entity (including fitting experts, manufacturers, etc.) other than the patient

30   and regardless of actual ownership). The invention involves the way information from one software application is transmitted and/or imported into the other software application. The two related software apps can communicate patient-specific usage and/or hearing aid parameter

setting information by a computer readable code such as a bar code or more preferably a QR code.

In the most secure application, the patient-specific hearing assist device audiological data is transmitted optically, from one display to the camera of the other computing device. FIGS. 2 and 3 thus show differing aspects of the present invention, which can be used alone or in conjunction with each other. In FIG. 2, a patient's smartphone 40, which either is currently or was previously in communication with the hearing aid 10, communicates information to the audiologist's computer system 38 using a visual code such as a QR code 42 or a bar code. The smartphone 40 generates a QR code 42 and displays the QR code 42 on its screen. At least part of the data in the generated QR code 42 is patient-specific audiological usage data for the hearing aid 10. The patient-specific audiological usage data could be originally derived within the hearing aid 10 and transmitted to the smartphone 40, or could be originally derived within the smartphone 40 during use of the hearing aid 10. The audiologist's computer system 38 uses a camera 44 to visually capture the code 42, with a processor (not separately shown) in the audiologist's computer 38 analyzing the captured image to interpret the QR code 42.

In FIG. 3, the audiologist's computer system 38 communicates information to the patient's computing device 40 using a visual code such as a QR code 46 or a bar code. The audiologist's computer system 38 generates a QR code 46 and displays the QR code 46 on its screen 48. At least part of the data in the generated QR code 46 is patient-specific audiological control data for adjusting the parameter settings within the hearing aid 10. The patient uses their smartphone camera 50 to take a photo or video of the QR code 46, visually importing the captured image of the QR code 46 so it can be analyzed with a processor (not separately shown) in the patient's smartphone 40 to interpret the QR code 46. The patient-specific audiological control data in the QR code 46 can then be converted into commands from the smartphone 40 to the hearing aid 10 to initially set up the hearing aid 10 for that particular patient, or to make adjustments at a later time to improve the hearing aid performance for that particular patient.

While the present invention is primarily expected to be used with the patient's smartphone 40, that is only because of their ubiquity and how commonly smartphone devices 40 include an acceptable camera 50 as well as the ability to download and use QR code reading and/or generating software. The patient's computing device could alternatively be a desktop, laptop or tablet computer, similarly equipped with a camera as part of the system and having the ability to interpret a QR code 46 visually captured by the camera and/or generate a QR code.

By communicating patient-specific audiological data optically, there is no possibility of intercepting or manipulation of any of the data by any third party, such as might occur via a transmission via the internet, or might even occur via a long range or short range wireless transmission. The patient and/or audiologist knows exactly when and where they are aiming the camera 44, 50 and taking a photo or video, and knows that the only data being communicated is information from the photo or video received by the camera 44, 50. With patient-specific audiological data being communicated only optically, the patient can maintain tight and stringent control over their own personal hearing aid data.

The QR code transfer scheme also very clearly limits the size of the transmission. Unlike virtually any other transmission scheme in use today, a QR code is limited to the number of bits in the QR display, such as about 1kB or 3kB of data in common QR code sizes. Once the size of the QR code is selected (such as a version 10 QR code, limited to exactly 57 x 57 pixels), no more data can be possibly transmitted. The use of a QR code is not only secure but is very transparent to the patient when information is being communicated with the fitting professional.

In the most preferred embodiment, communication between the smartphone 40 and the hearing aid 10 still occurs via a short range wireless transmission 26, such as using a BLE protocol. Because there is such a wireless transmission 26 in the system, there remains a possibility of some third party intercepting the wireless transmission 26 or of a third party device impersonating the smartphone 40 to deliver false setting parameter information or steal the usage data coming from the hearing aid 10. In general, this risk is considered remote and insignificant, because appropriate secure pairing between the smartphone 40 and the hearing aid 10 can be required, with the patient selecting a secure location and time to initiate such communication between the smartphone 40 and the hearing device 10. Additionally, the QR codes 42, 46 can be encrypted, greatly increasing the difficulty of tampering with the QR code. For even more secure control of patient data, communications between the smartphone 40 and the hearing device 10 could be restricted to wired communications.

FIG. 4 depicts situations where the benefits of a longer distance transmission outweigh the need for absolute security. An extremely secure transfer of information can be achieved by transmitting a photo or computer-generated image file (such as a .jpg file) of an encrypted QR code, such as through an email or text message. FIG. 4 thus shows the smartphone 40 transmitting an image file 52 of an encrypted QR code 42 through the internet 54, which QR code 42 includes patient-specific audiological usage data for the hearing aid 10. FIG. 4 also

shows the audiologist's computer 38a, 38b, 38n transmitting an image file 56 of an encrypted QR code 46 through the internet 54, which QR code 46 includes patient-specific audiological control data for adjusting the DSP parameter settings within the hearing aid 10. The smartphone 40 receives the image file 56 and interprets the QR code 46, thereafter transmitting the DSP

5   parameter setting adjustment to the hearing device 10. The embodiment shown in FIG. 4 allows the patient to determine whether and when to accept the risk of .jpg file transmission versus the need to bring the patient's computing device 40 within the several feet of the audiologist's computing device 38 required for optical/camera transmission of the QR code information. The use of a QR code 42, 46 to transmit information between the audiologist's software application

10   and the patient's software application, whether by limited distance optical (taking a photo or video, as shown in FIGS. 2 and 3) or longer distance other (email or text message, as shown in FIG. 4) means that in all cases the information imported into the application is limited to the size of the QR code 42, 46, making transmission of a virus or similar malware impossible.

FIG. 4 also demonstrates another aspect of the preferred embodiment, that when

15   transmitting the QR code image file 52, 56 over a wide area network 54 to a remote location, the audiologist's computer 38 can be any one of numerous audiologist's computers 38a, 38b, 38n, such as at a central datacenter connected to either a secure server 58 or a secure cloud database. Such an arrangement allows a patient, at any time (day or night, 24/7), to transmit usage information and/or receive hearing aid parameter setting adjustments for a professional solution

20   to combat any emergency problem being faced by the patient and correct hearing aid performance in any particular environment at any particular time.

One of the pieces of information which is within the QR code 42, 46 is identifying information for the particular hearing aid 10. For instance, "MDA" information which is manufacturer specific information, including a device serial number, can be transmitted in a 288

25   byte section of the QR code 42, 46. The two applications perform a confirmation that sender and receiver are both correspondingly matched to the particular hearing device 10. For example, a wife with the same type of hearing aid as her husband is not able to mistakenly use the software application to connect with her husband's hearing aid(s) by accident. Such wrong connections are also prevented in larger groups, such as if multiple students in a class or multiple people in a

30   home or apartment have similarly programmable hearing assist devices.

Another section of information transmitted by QR code 42, 46 is programming information for the hearing device 10. For example, the data (not including the English language

portions) of a file known as a "PGM" file is used for hearing aids from IntriCon Corporation, assignee of the present invention, can be sent in a 528 byte section of the QR code 42, 46. When included in the QR code 42 from the patient's smartphone 40, the programming information is usage information, telling the audiologist the current or previous DSP parameter settings for the

5   hearing aid 10. When included in the QR code 46 from the audiologist's computer 38, the programming information is future DSP parameter settings for the hearing aid 10, telling the smartphone 40 how to adjust the hearing aid 10 for better audio output for a particular patient/time/environment.

An important aspect of the preferred software applications is that that the patient is in

10   control of his or her own data. There is no linkage or hidden push notifications or responses from the patient's software application to either the cloud server or to the audiologist's software application. The only way in which the patient software application outputs information is through generation of a QR code 42. It is then the patient's sole decision as to whether and when to provide the patient-generated QR code 42 to a professional, vendor, etc.

15   Visually transferring data from the audiologist to the patient's computing device 40 via QR code ensures there is no possibility of tampering with the data values. It is again the patient's sole decision as to whether and when to acquire (i.e., take a photo or video of) the audiologist-generated QR code 46 and make changes to the DSP parameter settings of his or her own hearing aid(s) 10. The patent-specific QR code 46 could be printed, and delivered to the

20   patient by hand, by mail or by other common carrier, with the patient taking a photo or video of the QR code 46 at a later time after generation and printing. An image file of the QR code 46 could alternatively be transmitted via email, text message or other electronic transfer, which provides similar security benefits but is not quite as absolutely-tamper-proof as visual transmission into the patient's computing device camera 50. Mail delivery of the printed patient-

25   specific QR code 46 is considered less tamper-proof than an image file transmission, and is particularly beneficial for remote patients who may not have access to email, text message or other electronic transfer.

The present invention allows the patient to store multiple QR codes 46 from the audiologist as image files within the memory of the smartphone 40. For instance, a patient may

30   recall a prior problematic acoustic environment (such as eating in a particular restaurant), when the patient reported a problem to the audiologist and the audiologist provided a set of DSP parameter settings customized for that particular patient when in that particular acoustic

environment. The patient can then search the photos stored on the smartphone 40 (organized according to the image file metadata), looking for a photo of a QR code from that remembered date or looking for a photo of a QR code recorded at that remembered location. Once identifying the image file with the desired QR code, the patient can, within the software app, have the smartphone 40 initiate appropriate changes to the DSP parameter settings within the hearing aid(s) 10 for use on returning to the restaurant.

In some embodiments, the preferred QR code generators, used in both the patient's smartphone 40 and in the audiologist's computer system 38, can adaptively select the size of the QR code 42, 46 based upon the amount of data that is desired to be transmitted.

The QR code data preferably includes information to adjust hearing aid functions, settings and adjustments. For instance, the most preferred QR-code 46 generated by the audiologist transfers up to 3kB of data to the patient's smartphone 40, including fields of information for:

a) Deprivation (points);

b) serial number or similar identifying information of the patient's hearing assist device(s) 10 (for the patient's smartphone 40 to verify and ensure that the programming settings are not input into the wrong hearing assist device);

c) a simplified set of instructions for DSP parameter settings, such as one of any of twenty-four or thirty-two common DSP parameter setting categories that adequately cover the vast majority of hearing deficiencies, each category having its own value known by either the smartphone 40 or hearing aid 10 for overall pre-amplifier gain, compression ratios, thresholds and output compression limiter (MPO) settings for each of eight channels, time constants, noise reduction, matrix gain, equalization filter band gain settings for each of twelve different frequency bands, and adaptive feedback canceller on/off. Other embodiments can include a full set of parameter settings for the particular DSP amplifier and hearing aid being used.

In more particularity, when used in conjunction with a hearing aid using an AUDION 16 DSP with sixteen frequency bands from IntriCon Corporation, the QR code can include the following fields and relative sizes of data:

EXAMPLE 1

```
{
  "id":"<string>",
  "version":"1",
```

```
      "right": {
        "serial":"<string>",
        "configuration":"<base64>",
        "program0":"<base64>",
 5      "program1":"<base64>",
        "program2":"<base64>",
        "program3":"<base64>",
        "program4":"<base64>",
        "program5":"<base64>",
10      "mda7":"<base64>",
        "mda8":"<base64>",
        "mda9":"<base64>",
        "mda10":"<base64>",
        "biquad11":"<base64>",
15      "biquad12":"<base64>"
      },
      "left":
      {
        "serial":"<string>",
20      "configuration":"<base64>",
        "program0":"<base64>",
        "program1":"<base64>",
        "program2":"<base64>",
        "program3":"<base64>",
25      "program4":"<base64>",
        "program5":"<base64>",
        "mda7":"<base64>",
        "mda8":"<base64>",
        "mda9":"<base64>",
30      "mda10":"<base64>",
        "biquad11":"<base64>",
        "biquad12":"<base64>"
      }
    }
```

35   **Table 1**

Key Name	Value Length (characters)	Description
[Header]		
id	variable	Identifier for the data.
version	variable	Format version.
left	102-482	The data for the left hearing aid.
right	102-482	The data for the right hearing aid.
[left/right]		
serial	10	The serial number of the hearing aid.

configuration	16	Parameters that apply to the entire hearing aid. 64-bit encoded.
program0	76	Program specific parameters. 64-bit encoded.
program1	76	Program specific parameters. 64-bit encoded.
program2	76	Program specific parameters. 64-bit encoded.
program3	76	Program specific parameters. 64-bit encoded.
program4	76	Program specific parameters. 64-bit encoded.
program5	76	Program specific parameters. 64-bit encoded.
mda7	80	Parameters that apply to the entire hearing aid. 64-bit encoded.
mda8	80	Parameters that apply to the entire hearing aid. 64-bit encoded.
mda9	80	Parameters that apply to the entire hearing aid. 64-bit encoded.
mda10	80	Parameters that apply to the entire hearing aid. 64-bit encoded.
biquad11	56	Parameters that apply to the entire hearing aid. 64-bit encoded.
biquad12	56	Parameters that apply to the entire hearing aid. 64-bit encoded.
[configuration]		
SW Mode	2	Configures the physical type of program change switch used by the instrument.
VC_Mode	2	Configures the physical volume control type used by the instrument.
VC EN	1	Enables and disables the physical volume control on the instrument.
VC Prompt mode	3	Sets the type of prompts are to be sounded when the volume control is changed.
PGM Prmpt	2	Sets the type of prompts are to be sounded when the program is changed.
WRN Prmpt	2	What type of prompts are to be sounded when for warnings, such as low battery.
VC_Startup	5	The default VC level at start up
PGM_Startup	3	Sets the program to start up in when the instrument powers on.
VC NumSteps	3	Configures how many steps the volume control range is to have.
VC Step Size	3	Configures the decibel size each volume control change will change.
VC_Analog_Range	3	Configures the volume control range when VC_Mode is set to Analog VC. For Analog VC, the number of steps is always 31 (32 VC positions: 0 to 31). Divide VC_Analog_Range by 31 to get the step size.
Nbr_of_Prgms	3	Configures how many programs the instrument will have.

Tone Level	3	N/A
Tone Frequency	3	Frequency to use by any prompts set to tones.
T Ref	1	N/A
Dir Spacing	3	The physical acoustic distance between the two microphones when the instrument input mux is set to a directional mode.
Dir Mic Calibration	5	Mic calibration adjustment for directional microphone options when 2 microphones are used. Use in conjunction with Dir_Mic_Cal_Input.
Cal_Input	1	Selects which microphone input to apply the Dir_Mic_Cal adjustment to.
AD Sens	2	Adaptive Directional Sensitivity
ATC	1	Auto Telecoil
Tap Mode	2	ACOUSTAP™ Mode
Tap Sensitivity	2	Adjusts the sensitivity of the ACOUSTAP™ acoustic program change switch. This will generally be used in "normal" mode. Only set on "High" when using microphones that have a built-in low frequency roll-off.
Power On Level	2	This sets the volume level the instrument will be at until the Power On Delay finishes.
Power On Delay	2	Power On Delay sets how long the instrument remains at Power_On_Level before it changes to normal volume.
Noise Level	3	Level of the noise generator when input mux is set to noise generator.
HP Enable	1	High Power Mode parallels two output stages to provide more output power to aids with lower impedance.
A. Save	1	Auto Save: If the Volume Control Power on Position and Power On Program should be automatically saved or depend on the configuration settings.
Noise_Fit_1_preset	3	Noise Filter 1
Noise_Fit_2_preset	3	Noise Filter 2
Out_Fit_2_index	3	Output Filter 2
Out_Fit_1_index	3	Output Filter 1
O_F_EN	1	Output Filter Enable
N_Ref	1	This sets the noise generator to be input referred or output referred. When the Noise Generator is output referred, the Noise Generator shape is only affected by the Noise Filters below. When the Noise Generator is input referred, the Noise Generator Filters are disabled and all other program parameters (BEQs, compression, etc.) affect the shape of the noise.
Reserved	18	N/A
[program0-5]		
IN_MODE_P1	4	Input Mux
PAG_P0	4	Analog Preamp Gain
PAG_P1	4	Analog Preamp Gain

PADG_P1	2	Digital Preamp Gain
PADG_P2	2	Digital Preamp Gain
MGMAN_P1	3	Matrix Gain Mantissa
MGEXP_P1	3	Matrix Gain Exponent
FB	2	Feedback Canceller
NR	3	Noise Reduction
LL EXP	1	Low Level Expansion
Wind	1	Wind Suppression
Reserved	3	N/A
BEQ1	5	Band Gain
BEQ2	5	Band Gain
BEQ3	5	Band Gain
BEQ4	5	Band Gain
BEQ5	5	Band Gain
BEQ6	5	Band Gain
Reserved	2	N/A
BEQ7	5	Band Gain
BEQ8	5	Band Gain
BEQ9	5	Band Gain
BEQ10	5	Band Gain
BEQ11	5	Band Gain
BEQ12	5	Band Gain
Reserved	2	N/A
BEQ13	5	Band Gain
BEQ14	5	Band Gain
BEQ15	5	Band Gain
BEQ16	5	Band Gain
CR1	6	Compression Ratio
CR2	6	Compression Ratio
CR3	6	Compression Ratio
CR4	6	Compression Ratio
CR5	6	Compression Ratio
CR6	6	Compression Ratio
CR7	6	Compression Ratio
Reserved	2	N/A
CR8	6	Compression Ratio
CR9	6	Compression Ratio
CR10	6	Compression Ratio
CR11	6	Compression Ratio
CR12	6	Compression Ratio
Reserved	2	N/A
CR13	6	Compression Ratio
CR14	6	Compression Ratio

CR15	6	Compression Ratio
CR16	6	Compression Ratio
compress_consts_1	4	Compression Time Constants
compress_consts_2	4	Compression Time Constants
compress_consts_3	4	Compression Time Constants
compress_consts_4	4	Compression Time Constants
compress_consts_5	4	Compression Time Constants
compress_consts_6	4	Compression Time Constants
compress_consts_7	4	Compression Time Constants
compress_consts_8	4	Compression Time Constants
compress_consts_9	4	Compression Time Constants
compress_consts_10	4	Compression Time Constants
compress_consts_11	4	Compression Time Constants
compress_consts_12	4	Compression Time Constants
compress_consts_13	4	Compression Time Constants
compress_consts_14	4	Compression Time Constants
compress_consts_15	4	Compression Time Constants
compress_consts_16	4	Compression Time Constants
Comp_TK_1	5	Compression Threshold
Reserved	3	N/A
Comp_TK_2	5	Compression Threshold
Comp_TK_3	5	Compression Threshold
Comp_TK_4	5	Compression Threshold
Comp_TK_5	5	Compression Threshold
Comp_TK_6	5	Compression Threshold
Comp_TK_7	5	Compression Threshold
Reserved	2	N/A
Comp_TK_8	5	Compression Threshold
Comp_TK_9	5	Compression Threshold
Comp_TK_10	5	Compression Threshold
Comp_TK_11	5	Compression Threshold
Comp_TK_12	5	Compression Threshold
Comp_TK_13	5	Compression Threshold
Reserved	2	N/A
Comp_TK_14	5	Compression Threshold
Comp_TK_15	5	Compression Threshold
Comp_TK_16	5	Compression Threshold
MPO_TK_1	4	Maximum Power Output Threshold
MPO_TK_2	4	Maximum Power Output Threshold
MPO_TK_3	4	Maximum Power Output Threshold
MPO_TK_4	4	Maximum Power Output Threshold
Reserved	1	N/A
MPO_TK_5	4	Maximum Power Output Threshold

MPO_TK_6	4	Maximum Power Output Threshold
MPO_TK_7	4	Maximum Power Output Threshold
MPO_TK_8	4	Maximum Power Output Threshold
MPO_TK_9	4	Maximum Power Output Threshold
MPO_TK_10	4	Maximum Power Output Threshold
MPO_TK_11	4	Maximum Power Output Threshold
MPO_TK_12	4	Maximum Power Output Threshold
MPO_TK_13	4	Maximum Power Output Threshold
MPO_TK_14	4	Maximum Power Output Threshold
MPO_TK_15	4	Maximum Power Output Threshold
MPO_TK_16	4	Maximum Power Output Threshold
MPO_atk_1	3	Maximum Power Output Attack
MPO_Rel_1	3	Maximum Power Output Release
Reserved	1	N/A
remote mix ratio	4	When the Input is set to a Streaming input, this parameter controls the volume of the microphone on the hearing instrument in relation to the level of the Companion Microphone Accessory.
Low Cut Input Filter	4	This is a low-cut filter offering a selection of 3 dB down cutoff frequencies.
[biquad11]		
Noise_Filter1_A0	24	These are biQuad coefficients for the first noise filter.
Reserved	8	N/A
Noise_Filter1_A1	24	These are biQuad coefficients for the first noise filter.
Reserved	8	N/A
Noise_Filter1_A2	24	These are biQuad coefficients for the first noise filter.
Reserved	8	N/A
Noise_Filter1_B1	24	These are biQuad coefficients for the first noise filter.
Reserved	8	N/A
Noise_Filter1_B2	24	These are biQuad coefficients for the first noise filter.
Reserved	8	N/A
Noise_Filter2_A0	24	These are biQuad coefficients for the second noise filter.
Reserved	8	N/A
Noise_Filter2_A1	24	These are biQuad coefficients for the second noise filter.
Reserved	8	N/A
Noise_Filter2_A2	24	These are biQuad coefficients for the second noise filter.
Reserved	8	N/A
Noise_Filter2_B1	24	These are biQuad coefficients for the second noise filter.
Reserved	8	N/A
Noise_Filter2_B2	24	These are biQuad coefficients for the second noise filter.
Reserved	8	N/A
[biquad12]		
Output_Filter1_A0	24	These are biQuad coefficients for the first output filter.
Reserved	8	N/A
Output_Filter1_A1	24	These are biQuad coefficients for the first output filter.

Reserved	8	N/A
Output_Filter1_A2	24	These are biQuad coefficients for the first output filter.
Reserved	8	N/A
Output_Filter1_B1	24	These are biQuad coefficients for the first output filter.
Reserved	8	N/A
Output_Filter1_B2	24	These are biQuad coefficients for the first output filter.
Reserved	8	N/A
Output_Filter2_A0	24	These are biQuad coefficients for the second output filter.
Reserved	8	N/A
Output_Filter2_A1	24	These are biQuad coefficients for the second output filter.
Reserved	8	N/A
Output_Filter2_A2	24	These are biQuad coefficients for the second output filter.
Reserved	8	N/A
Output_Filter2_B1	24	These are biQuad coefficients for the second output filter.
Reserved	8	N/A
Output_Filter2_B2	24	These are biQuad coefficients for the second output filter.
Reserved	8	N/A
[mda7]		
Platform ID	16	Platform Identification differentiates DSP hybrids from each other. The Generic Driver provides an amp type differentiator that simplifies this. Platform ID remains useful for determining if different amp types are under the same platform.
Reserved	16	N/A
Reserved	8	N/A
Reserved	8	N/A
Reserved	8	N/A
Ear	2	Left/right side.
Reserved	6	N/A
MANF ID	12	Manufacturer Identification is a security feature. If this is set to a non-zero value the amplifier cannot be read or written by any software unless the pass code to activate the manufacturer ID has been entered in the security section of the software.
LayoutVersion	4	Layout Version is meant to track the Structure of the MDA_x memory space. Use as desired. This allows upgrades of this memory without complicated decoding algorithms. If you change the layout of this memory your software can simply read this version and act accordingly.
Model ID	16	Used to store the Model Identification number (Model

		ID). Hardware options are specific to a Model ID. Options include microphone, receiver, and volume control. The Model ID allows software applications to know which hardware options to display.
SN	8	Two characters of the serial number.
SN	8	Two characters of the serial number.
SN	8	Two characters of the serial number.
SN	8	Two characters of the serial number.
SN	8	Two characters of the serial number.
MDA	8	Manufacture's Data
MDA	8	Manufacture's Data
MDA	8	Manufacture's Data
MDA	8	Manufacture's Data
MDA	8	Manufacture's Data
MDA	8	Manufacture's Data
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MDA	8	Manufacture's Data
MDA	8	Manufacture's Data
MDA	8	Manufacture's Data
[mda8/9/10]		
Reserved	1920	N/A

In preferred embodiments, the order of the key-value pairs in this data is not important. While these data fields and lengths are appropriate for transmitting DSP parameter values to IntriCon's hearing aids using AUDION 16 DSP amplifiers, other data lengths and potentially other sets of parameters could be sent to a hearing aid using a different DSP.

d) map settings for adaptive finetuning of the DSP parameter settings listed in c) above;

e) Date and time of creating the QR code 46 (this enables the patient's smartphone 40 to compare the date and/or time information from the newly received QR code 46 to date and/or time information of existing audiological parameter settings on the patient's hearing assist device, allowing the patient to keep the most updated DSP parameter settings in the hearing aid 10 and/or consciously and knowingly return to an earlier set of DSP parameter settings);

f) Software version; and

g) recommended max input levels (real time).

In alternative embodiments, the data contained in the audiologist-generated QR code 46 includes different fields and different information, including both additional information and subsets of this information.

The most preferred QR code 42 generated by the patient's application for transferring information to the audiologist's computing device 38 includes information (up to 3 kb or more) for transferring:

a) customer number and/or serial number or similar identifying information of the patient's hearing assist device(s) 10 (for the audiologist to verify which customer and which hearing aid is at issue, possibly referencing a database showing that patient's hearing test results and that patient's history of making DSP parameter setting changes and/or that patient's history of performing cognitive training exercises);

b) Time stamp of program settings (training sessions) with time and action like a log file, advising the audiologist of whether the patient performed various sessions prescribed by the audiologist for the patient's cognitive development using the hearing aid;

c) Connection time, advising the audiologist of when the hearing aid was used and the source of audio content during that time period;

d) Acoustic environment levels over time (exceeding recommendation) of the microphone audio input, with time and date (this could alternative include more detailed historical acoustic information, such as noise, frequency, etc., such as percentile weighted input noise and speech levels per Channel);

e) Percentile Real time analyses data (sum signal or recorded period of time);

f) Date and time of using the "complain button" including acoustic environment data, i.e., patient can mark/record different acoustic situations where the hearing aid is not adequately performing, so the audiologist can program a set of DSP parameter settings better suited for similar acoustic situations;

g) a simplified set of currently-being-used DSP parameter settings, such as one of any of twenty-four or thirty-two common DSP parameter setting categories that adequately cover the vast majority of hearing deficiencies, each category having its own value known by the audiologist or the audiologist's computer 38 for overall pre-amplifier gain, compression ratios, thresholds and output compression limiter (MPO) settings for each of eight channels, time

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constants, noise reduction, matrix gain, equalization filter band gain settings for each of twelve different frequency bands, and adaptive feedback canceller on/off. This can include any or all of the DSP parameters listed above in Example 1 and Table 1, or additional information. This can also include a log file of adjustments to audiological parameter settings on the patient's hearing assist device 10 made by the patient using his or her smartphone 40; and

h) map settings for adaptive finetuning of the DSP parameter settings listed in g) above;

The audiologist can thus read the usage data pertaining to the hearing aid 10 from the patient's smart device 40. With this information, the audiologist can better adjust hearing device settings to gain better results. In alternative embodiments, the data contained in the patient-generated QR code 42 includes different fields and different information, including both additional information and subsets of this information.

Although the present invention has been described with reference to preferred embodiments, workers skilled in the art will recognize that changes may be made in form and detail without departing from the spirit and scope of the invention.

CLAIMS:

1. A method for fitting a hearing assist device for a patient, comprising:

    displaying patient-specific hearing assist device audiological data in a computer readable code;

    with a camera on a patient's computing device, acquiring an image of the displayed computer readable code;

    processing the image on the patient's computing device to extract at least one piece of audiological data; and

    transmitting instructions or information from the patient's computing device to the patient's hearing assist device based on the extracted audiological data, thereby adjusting at least one audiological parameter setting on the patient's hearing assist device.

2. The method of claim 1, wherein the computer readable code is a QR code.

3. The method of claim 1, wherein the computer readable code comprises identifying information for the patient's hearing assist device, and further comprising:

    verifying that the identifying information in the computer readable code matches the particular hearing assist device.

4. The method of claim 1, wherein the computer readable code comprises date and/or time information for when the computer readable code was generated, and further comprising:

    comparing the date and/or time information from the computer readable code to date and/or time information of existing audiological parameter settings on the patient's hearing assist device.

5. The method of claim 4, comprising comparing the date and/or time information from two different computer readable codes, and alerting the patient if the adjustment involves replacing newer audiological parameter settings with older audiological parameter settings.

6. The method of claim 1, further comprising:

    at a separate time on a patient's computing device, acquiring a digital image file of a second computer readable code over a wide area network connection;

    processing the digital image file on the patient's computing device to extract at least one piece of second audiological data; and

    transmitting instructions or information from the patient's computing device to the patient's hearing assist device based on the extracted second audiological data,

thereby making a second adjustment of at least one audiological parameter setting on the patient's hearing assist device.

7. The method of claim 1, further comprising:

storing a plurality of images of computer readable codes on the patient's computing device.

8. The method of claim 1, further comprising:

with a display on a patient's computing device, displaying patient-specific hearing assist device audiological usage data in a computer readable code.

9. A method for assessing usage of a hearing assist device for a patient, comprising:

displaying patient-specific hearing assist device audiological usage data in a computer readable code on a patient's computing device;

with a camera, acquiring an image of the displayed computer readable code;

processing the image to extract at least one piece of audiological data representing patient-specific usage of the hearing assist device.

10. The method of claim 9, wherein the computer readable code is a QR code.

11. The method of claim 9, wherein the computer readable code comprises identifying information for the patient and/or patient's hearing assist device.

12. The method of claim 11, wherein the audiological data representing patient-specific usage comprises a log file of training sessions performed by the patient.

13. The method of claim 11, wherein the audiological data representing patient-specific usage comprises a log file of adjustments to audiological parameter settings on the patient's hearing assist device made by the patient.

14. The method of claim 11, wherein the audiological data representing patient-specific usage comprises a file of audio environmental data associated with complaint instances.

15. The method of claim 9, further comprising:

at a separate time on a patient's computing device, transmitting a digital image file of a second computer readable code over a wide area network connection;

processing the transmitted digital image file to extract at least one second piece of audiological data representing patient-specific usage of the hearing assist device.

16. A system for communicating patient-specific hearing assist device audiological data, comprising:

a hearing assist device worn by a patient;

a patient's computing device having a patient's camera and a patient's display both
controlled by a patient's computing device processor, the patient's computing
device being configured to transmit patient-specific hearing assist device
audiological data to and/or from the patient's hearing assist device, the patient's
computing device processor being programmed to generate and/or read a
computer readable visual code with patient-specific hearing assist device
audiological data therein; and

an audiologist's computing system having an audiologist's display controlled by a system
processor, the audiologist's computing system not being able to remotely
configure the patient's hearing assist device without the permission of the patient,
the system processor being programmed to generate and/or read the computer
readable visual code with patient-specific hearing assist device audiological data
therein.

17. The system of claim 16, wherein the computer readable visual code is acquired by the
patient's computing device using the patient's camera.

18. The system of claim 16, wherein the audiologist's computing system comprises an
audiologist's camera, wherein the computer readable visual code is acquired by the audiologist's
computing system using the audiologist's camera.

19. The system of claim 16, wherein the computer readable code is transmitted as a digital
image over a wide area network connection between the patient's computing device and the
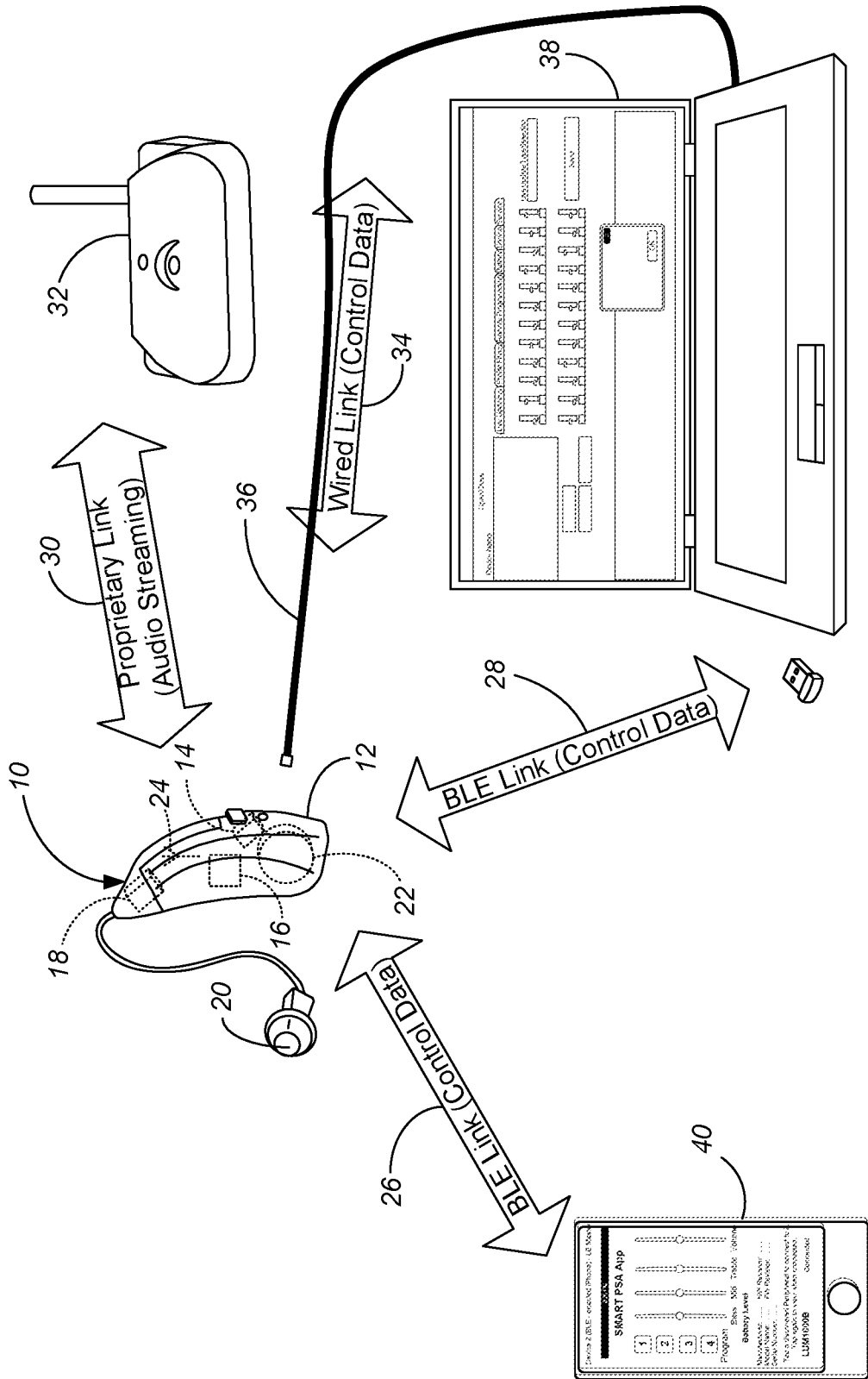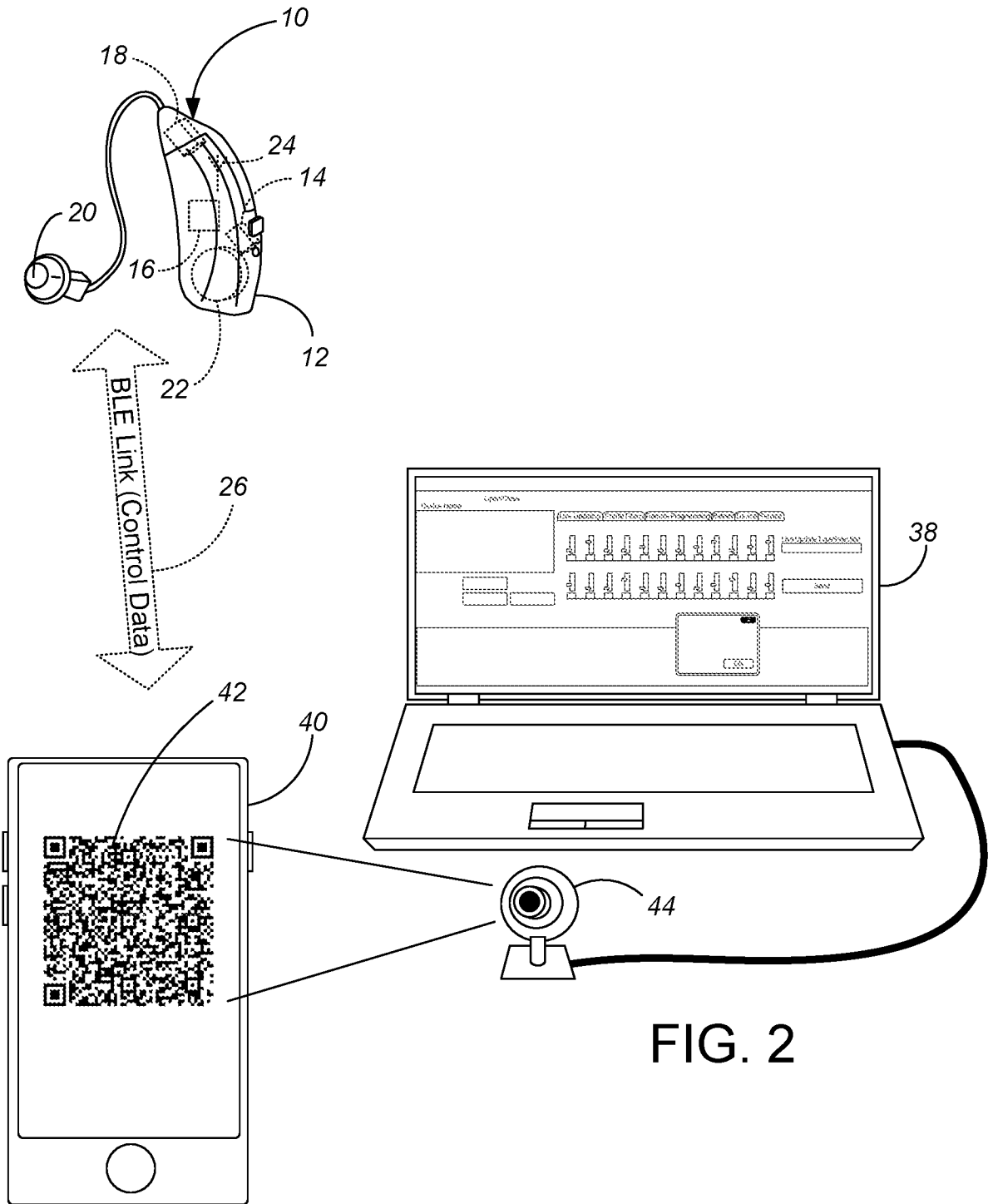audiologist's computing system.
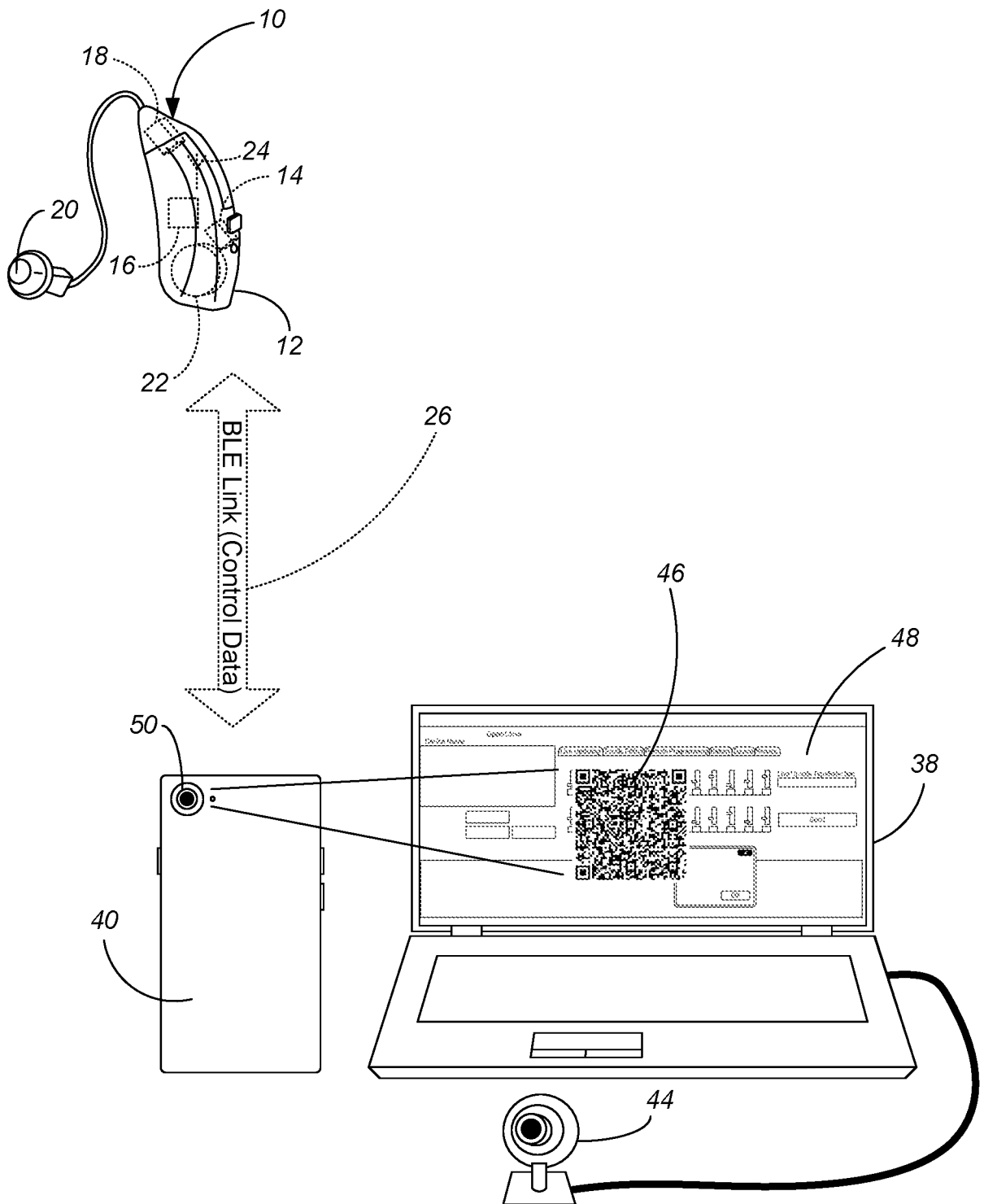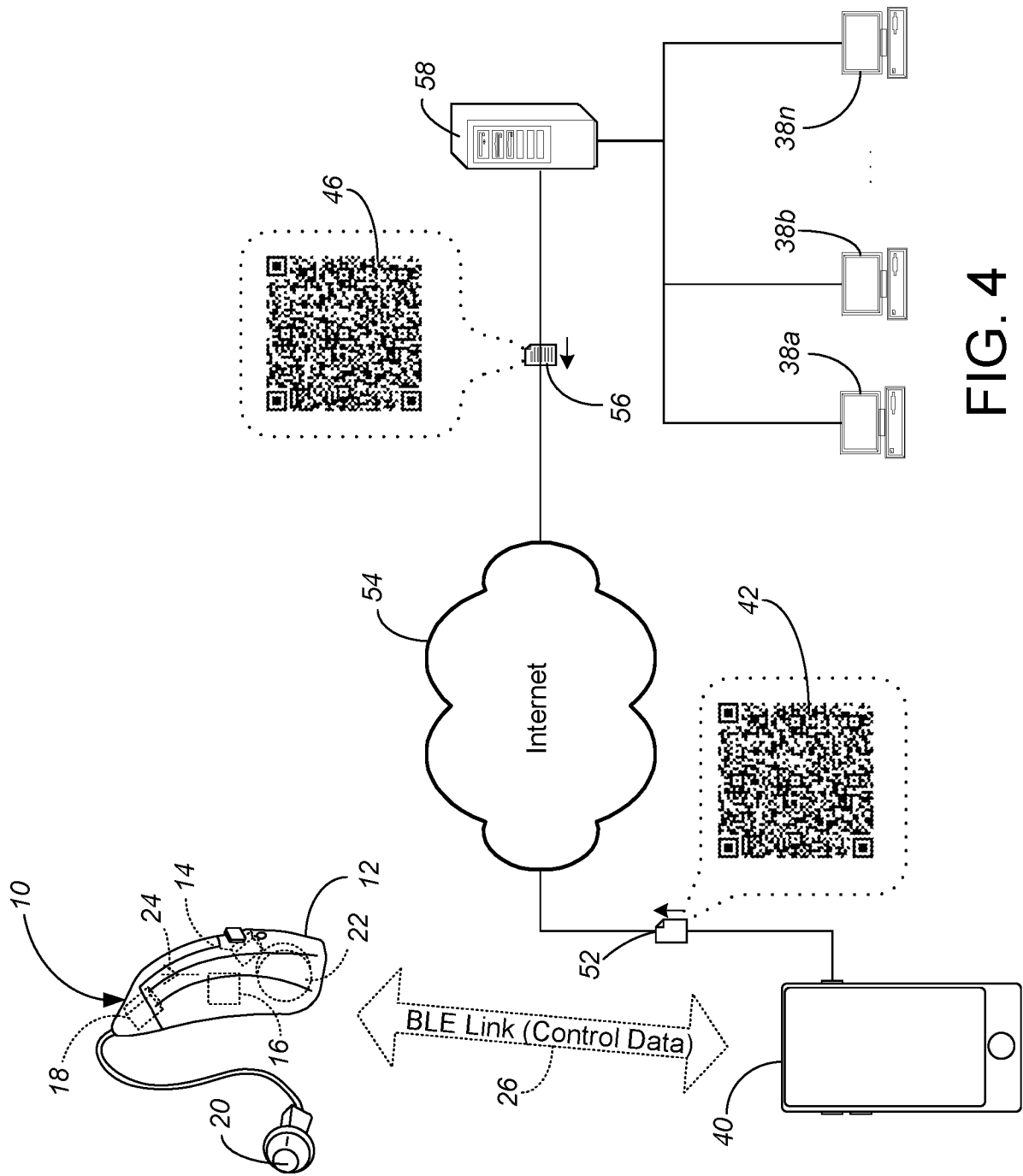
FIG. 1 (Prior Art)

FIG. 2

FIG. 3

FIG. 4

INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

IPC -   H04R 25/00, G10L 13/02 (2020.01)

CPC -   H04R 25/558, H04R 2225/55, H04R 29/004, H04R 25/55, H04R 2460/07, H04L 67/12, H04L 67/06, G10L 13/02, H04R 25/505

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)
See Search History document

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

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

C.   DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	DE 10,147,811 C1 (SIEMENS AUDIOLOGISCHE TECHNIK), 18 June 2003 (18.06.2003), entire document, especially Abstract; page 3-4, 5-6	1-8
Y	US 2016/0212552 A1 (SONOVA AG), 21 July 2016 (21.07.2016), entire document, especially Abstract; para [0080], [0083]-[0084]	1-8
Y	US 2017/0006389 A1 (GN ReSound A/S), 05 January 2017 (05.01.2017), entire document, especially Abstract; para [0046]-[0048], [0085]-[0089]	4-5
A	US 2015/0163585 A1 (Samsung Electronics Co., Ltd.), 11 June 2015 (11.06.2015), entire document	1-8
A	US 2017/0111950 A1 (SONOVA AG), 20 April 2017 (20.04.2017), entire document	1-8

☐ 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
"D"   document cited by the applicant in the international application
"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
04 February 2020	26 FEB 2020

Name and mailing address of the ISA/US	Authorized officer
Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450	Lee Young
Facsimile No. 571-273-8300	Telephone No. PCT Helpdesk: 571-272-4300

Form PCT/ISA/210 (second sheet) (July 2019)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 19/56065

Box No. II	Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
   because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
   because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
   because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III	Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

--- (See Continuation in Supplemental Box) ---

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:
   Claims 1-8

Remark on Protest
☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
☐ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (continuation of first sheet (2)) (July 2019)

Continuation of:
Box III. Observations where unity of invention is lacking

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be searched, the appropriate additional search fees must be paid.

Group I - Claims 1-8 method for customizing a hearing assist device for a patient using computer readable code encoded audiological parameter settings.

Group II - Claims 9-15 method for assessing usage data of patient training sessions using a hearing assist device.

Group III - Claims 16-19 system for communicating patient-specific hearing assist device audiological data.

The inventions listed as Groups I though III do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons:

Special Technical Features

Group I require the special technical features of displaying patient-specific hearing assist device audiological data in a computer readable code; processing the image on the patient's computing device to extract at least one piece of audiological data; transmitting instructions or information from the patient's computing device to the patient's hearing assist device based on the extracted audiological data, thereby adjusting at least one audiological parameter setting on the patient's hearing assist device, not required by any other group.

Group II require the special technical features of displaying patient-specific hearing assist device audiological usage data in a computer readable code on a patient's computing device; extract at least one piece of audiological data representing patient-specific usage of the hearing assist device, not required by any other group.

Group III require the special technical features of a patient's computing device having a patient's display controlled by a patient's computing device processor, the patient's computing device processor being programmed to generate a computer readable visual code with patient-specific hearing assist device audiological data therein; and an audiologist's computing system having an audiologist's display controlled by a system processor, the audiologist's computing system not being able to remotely configure the patient's hearing assist device without the permission of the patient, the system processor being programmed to generate and/or read the computer readable visual code with patient-specific hearing assist device audiological data therein, not required by any other group.

Common Technical Features

Groups I-II shares the feature of displaying a computer readable code.

Groups II-III share the features of the patient's computing device being configured to transmit patient-specific hearing assist device audiological data to and/or from the patient's hearing assist device.

Groups I-III share the feature of with a camera, acquiring an image of the displayed computer readable code; a hearing assist device worn by a patient; a patient's computing device having a patient's camera.

However, this shared technical feature does not represent a contribution over prior art, because the shared technical feature is being anticipated by US 2016/0212552 A1 (SONOVA AG), 21 July 2016 (21.07.2016).

SONOVA AG teaches displaying a computer readable code (para [0083]- QR code or a bar code, located on the hearing device 4 or a packaging); with a camera, acquiring an image of the displayed computer readable code (para [0083]- the user 6 can take a picture of or scan a visual code, such as a QR code or a bar code); a hearing assist device worn by a patient (para [0079]- hearing system 3); a patient's computing device having a patient's camera (para [0079]-[0080]- communication device such as the mobile device 2, e.g. a smartphone, PDA or tablet computer is also connected to the network 7); a patient's computing device being configured to transmit patient-specific hearing assist device audiological data to and/or from the patient's hearing assist device (para [0012]-[0013], [0081] - determining and/or selecting at the computing and/or communication device control data and/or configuration data using the hearing system control and/or configuration service; [0013] sending the control and/or configuration data from the computing and/or communication device to the hearing system).

As the common features were known in the art at the time of the invention, this cannot be considered a common technical feature that would otherwise unify the groups. Therefore, Groups I-III lack unity under PCT Rule 13.