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(54) **LIGHTING DEVICE WITH VOICE CONTROL**

(57) The present invention relates to a lighting device comprising a receiver (6) for receiving a voice input, a voice recognition circuit (13) configured to recognize at least one predetermined voice command in the voice input and to output a command code assigned to the predetermined voice command in response to the recognized predetermined voice command and a control circuit (11) configured to control the lighting device based on the command code.

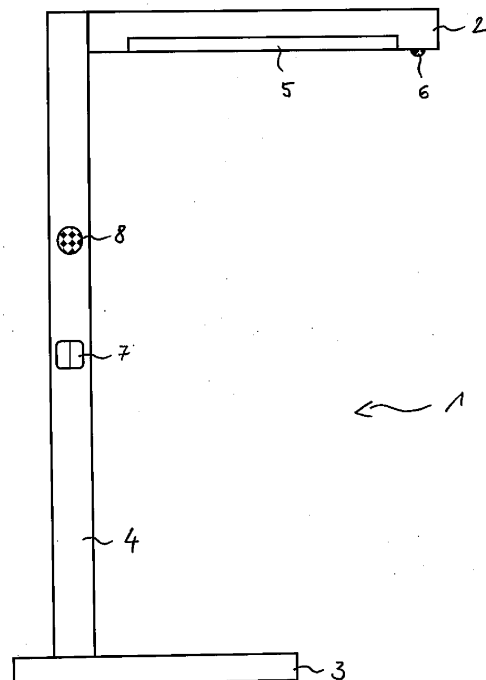


Fig. 1

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Description

[0001] The invention is in the field of lighting equipment. In particular, the invention relates to a lighting device and a method for controlling the lighting device.

[0002] In lighting systems, a person usually controls luminaires by operating a switch. Alternatively, or for activating special functions that cannot be easily set with a single switch, luminaires can be controlled by voice commands.

[0003] However, this often requires additional devices, such as a smartphone, for voice input and an Internet connection or central components that are connected to a network. This connection may be local for controlling lighting devices connected in the same network, but in most cases the component for voice command recognition is also connected to the internet.

[0004] It is an object of the present invention to provide an apparatus and a method, which reduce the above problems. In particular, an object of the present invention is to provide a lighting device and a method, with which voice control can be provided with low effort and cost.

[0005] This object is achieved by a lighting device and a method for controlling a lighting device according to the enclosed independent claims. Advantageous features of the present invention are defined in the corresponding dependent claims.

[0006] According to the present invention, the lighting device comprising a receiver for receiving a voice input, a voice recognition circuit configured to recognize at least one predetermined voice command in the voice input and to output a command code assigned to the predetermined voice command in response to the recognized predetermined voice command and a control circuit configured to control the lighting device based on the command code.

[0007] The voice recognition circuit and the receiver for receiving the voice input are part of the lighting device, eliminating the need for an external voice input device or Internet connection. Since voice input is processed within the lighting device, no special data protection measures or measures to prevent unauthorized access from outside are necessary. Further, such integration has the advantage that spoken voice command does not need to reach a central component to execute command recognition and a spatial limitation can be achieved. In a scenario where a plurality of devices are in a close spatial relation, this avoids misinterpretation of voice command. An example is an office with a plurality of voice controlled luminaires, for which the invention enables control from a limited area around the position of the luminaire.

[0008] The voice recognition circuitry and the control circuitry can be separate modules, interconnected via a Universal Serial Bus (USB) or universal asynchronous receiver-transmitter (UART) interface. Preferably, the control circuit acts as USB host and the voice recognition circuit acts as USB device preferably as USB Human Interface Device. In addition, the voice recognition cir-

cuitry can be powered via the USB interface.

[0009] According to a preferred embodiment, the control circuit is DALI-2 application controller, wherein the lighting device comprises at least one converter circuit configured to provide a supply voltage and/or current to a light source of the lighting device and a DALI-2 bus configured to interconnect the at least one converter device and the control circuit.

[0010] The voice command and thus the command code can contain a command for configuration (setting parameters, such as dimming speed, color temperature) and/or for control (switching on/off, dimming) of the lighting device. Only a single voice command, such as "light", could be used/stored to control the lighting device, with the voice command turning the lighting device on or off depending on the current operating state of the lighting device. In addition, the voice recognition circuitry can be configured to recognize the command even if it is spoken in different languages.

[0011] The voice command can include one or more words. To increase the accuracy of voice recognition, the number of words/commands to be recognized can be reduced by language selection and/or adaptation to the current state of the lighting device in which only certain commands can be processed/executed. For this, the voice recognition circuit can be configured to recognize each of a plurality of predetermined voice commands, wherein a part of the plurality of predetermined voice commands is assigned to a predetermined state of the lighting device and the control circuit is configured to detect the predetermined state and to control the voice recognition circuit to restrict the recognition of the voice commands to the part when the predetermined state is detected. The state can be an operating state of the lighting device (e.g., light on or off, configuration mode, emergency mode) or a user/device-activated menu (e.g., language selection menu, menu for selecting color temperature and/or intensity) in which only certain settings can be made by predetermined voice commands.

[0012] Language can be set in the language selection menu activated by a voice command and/or can be set automatically by the lighting device by analyzing/determining the language of the voice commands received by the receiver (microphone).

[0013] In addition or alternatively, an error signal can be issued to the user if a voice command is received that cannot be executed in the current/detected state or if the voice input cannot be recognized (unknown command, wrong language). For this, the control circuit is configured to output an error signal if the predetermined state is detected and the voice recognition circuit recognizes a voice command that does not belong to the part of the plurality of predetermined voice commands or if the voice recognition circuit does not recognize a voice command in the voice input.

[0014] The error signal can be output by an indicator light of the lighting device and/or a loudspeaker of the lighting device. In addition or alternatively, the voice com-

mands expected/accepted in the current state can be output by the loudspeaker to inform the user, wherein the control circuit is configured to control the loudspeaker to output the voice commands of the part of the plurality of predetermined voice commands one by one, when the predetermined state is detected and/or instead of the error signal.

[0015] The control circuit can be configured to classify a plurality of states of the lighting device, such as different operating states (on, off, $x\% < \text{dim level} > y\%$) but also different menu stages, and to determine the expected/accepted commands assigned to each class (stage). In particular, the control circuit can be configured to detect at least a first and second state of the lighting device, wherein the first state corresponds to a main menu and the second state corresponds to a sub menu of the main menu and a first part of the plurality of voice commands is assigned to the main menu and a second part of the plurality of voice commands is assigned to the sub menu. In this way, the voice recognition circuit can be controlled to restrict/focus recognition on the voice commands expected/accepted for the respective menu.

[0016] If there are several persons and/or lighting devices in the same room, lighting device may be controlled unintentionally. To prevent such malfunction, the lighting device can comprise a detecting means configured to detect a person in an area, wherein the control circuit is configured to control the lighting device based on the command code only when the person is detected. The detecting means can comprise a directional microphone, a camera and/or a motion detector directed to the area and/or a microphone array configured to locate the person in the area.

[0017] The receiver can comprise the directional microphone or the microphone array to receive the person's voice input when the person is in the area.

[0018] The lighting device can be a pendant luminaire, a wall luminaire or ceiling luminaire. According to a preferred embodiment, the lighting device is a free-standing luminaire having a head, wherein the head comprises an optical element configured to direct, by refraction and/or reflection, light of a light source to at least a part of the area and the detecting means is located in or on the luminaire head.

[0019] Alternatively or in addition, the person can address the desired lighting device to prevent control of another lighting device. For this, the voice recognition circuit is configured to recognize the at least one predetermined voice command including a name assigned to the lighting device and the control circuit is configured to control the lighting device based on the command code only when the name is included in the at least one predetermined voice command.

[0020] If several parameters of the lighting device are controllable, the voice command can name a parameter and specify how to change/set the parameter, wherein the voice recognition circuit is configured to recognize a voice command including the name of a parameter to be

set and an indication of how to set/change the parameter and the control circuit is configured to set/change the parameter.

[0021] The lighting device can comprise a housing, in which at least one of the receiver, the voice recognition circuit, the control circuit and the detecting means is arranged.

[0022] According to the present invention, a method for controlling a lighting device comprises the steps of:

- receiving a voice input;
- recognizing at least one predetermined voice command in the voice input to output a command code assigned to the predetermined voice command in response to the recognized predetermined voice command; and
- controlling the lighting device based on the command code.

[0023] Embodiments of the invention are discussed in detail with reference to the enclosed figures, in which

FIG. 1 shows a lighting device according to an embodiment of the present invention in side view,

FIG. 2 shows a simplified block diagram of parts of the lighting device shown in FIG. 1,

FIG. 3 shows a table of parameters to be set for the USB Human Interface Device communication,

FIG. 4 shows a table of instruction groups and the corresponding first byte of the HID report data packet,

FIG. 5 shows a table of instructions to be recognized,

FIG. 6 shows a table of voice recognition results and the respective feedback to the user,

FIG. 7 shows a table of menu options and the corresponding command, and

FIG. 8 shows a flowchart of a menu selection operation.

[0024] In the figures, same reference numbers denote same or equivalent structures. The explanation of structures with same reference numbers in different figures is avoided where deemed possible for sake of conciseness.

[0025] FIG. 1 shows a lighting device 1 according to an embodiment of the present invention in a side view. The lighting device 1 is a free-standing luminaire (floor lamp) formed by a head 2, a base 3 and a stand 4 which is mounted on the base 3 and to which head 2 is attached. The head 2 comprises an optical element 5 configured

to direct light from a light source (not shown) to an area below the head 2 and a microphone 6 to receive voice commands. A switch 7 to turn the light on and off and a loudspeaker 8 is attached to the stand 4. It is to be noted that the switch is optional and the lighting device may be controlled by voice control only. The height of the lighting device 1 is about two meters.

[0026] As shown in FIG. 2 the lighting device 1 comprises a light source 9, a converter circuit 10 configured to provide a supply voltage and/or current to the light source 9, a control circuit 11 configured to control the converter circuit 10 based on a signal received from the switch 7 and based on a voice command received by the microphone 6, a DALI bus 12, to which the converter circuit 10, the switch 7 and the control circuit 11 are connected, a voice recognition circuit 13 connected to the microphone 6 and the control circuit 11, a power supply 14 for the voice recognition circuit 13 and a power supply 15 for the control circuit 11.

[0027] The control circuit 11 is a DALI application controller that transmits and receives signals to/from the converter circuit 10 and the switch 7 via the DALI bus 12 and transmits and receives signals to/from the voice recognition circuit 13 via a USB interface/connection 16. In FIG. 2, the voice recognition circuit 13 is powered by the power supply 14. Alternatively, the voice recognition circuit 13 can be powered by the USB interface (5V, 500mA).

[0028] The voice recognition circuit 13 acts as USB 2.0 device and the control circuit 11 acts as USB host. Table 1 in FIG. 3 shows parameters to be set for the Human Interface Device (HID) communication.

[0029] The voice recognition circuit 13 is programmed by the manufacturer of the lighting device 1 or the voice recognition circuit 13 to generally recognize a specific set of voice commands in specific languages. The commands (command codes) transmitted from the voice recognition circuit 13 to the control circuit 11 via the USB interface 16 can be classified in different instruction groups, wherein the respective instruction group is indicated by the first byte of the possible 64 bytes in the HID report data packet. Table 2 in FIG. 4 shows the first byte assigned to different instruction groups.

[0030] The control circuit 11 controls the converter circuit 10 based on the command received from the voice recognition circuit 13. The command can be an instruction to set the light intensity or the color temperature. In addition, the command can be an instruction to activate/deactivate a settings menu or to select a menu item. To simplify speech recognition, numbers can be assigned to the menu items, wherein the control circuit 11 controls the loudspeaker 8 to list the menu items with the corresponding number so that the user knows which number to call to select the desired menu item. In addition, the control circuit 11 can be configured to provide feedback to the user regarding the result of the voice recognition and/or to list all commands/instructions if the lighting device 1 is powered with for the first time, a certain

switch is operated, or a corresponding voice command is received.

[0031] Table 3 in FIG. 5 shows a set of 16 instructions that can be recognized by the voice recognition circuit 13 in English and German, wherein the instructions of columns 12 to 16 are numbers for selecting menu items in a menu activated by the instruction "Start Menu" and "Starte Menu" of column 12. In this way, the instructions of columns 11 to 16 can be executed only when the menu is activated and the instructions of columns 1 to 10 can be executed only when the menu is deactivated. To increase the accuracy of voice recognition, the control circuit 10 can control the voice recognition circuit 13 to focus/restrict the voice recognition to the instructions of columns 1 to 10 when the menu is deactivated and to focus/restrict the voice recognition to the instructions of columns 11 to 16 when the menu is activated. When the instruction of column 9 is received, the control circuit 10 requests information about the weather from an external server (not shown), for example, via Internet, and controls the loudspeaker 8 to output the information using Text-to-Speech software/module.

[0032] Table 4 in FIG. 6 shows results of the voice recognition and the respective feedback output by the loudspeaker 8. The language of the feedback can be adapted to the language of the instruction.

[0033] FIG. 7 shows in table 5 the selection options with the corresponding instruction for the menu and sub-menus (different menu stages), and FIG. 8 shows a flow-chart of the menu selection operation. As shown in FIG. 7 and 8, when the menu is activated by the command "Start Menu" or "Starte Menü", the control circuit 11 controls the loudspeaker 8 to list the menu items "Language speaker output", "Low light level", ..., "Speaker volume" with the corresponding number "One"/"Eins", "Two"/"Zwei", ..., "Five"/"Fünf" and list the sub menu items "Deutsch" and "English" with the corresponding number "Eins" and "Two" when the menu item "Language speaker output" is activated by the instruction "One" or "Eins".

Claims

1. Lighting device comprising

a receiver (6) for receiving a voice input;
a voice recognition circuit (13) configured to recognize at least one predetermined voice command in the voice input and to output a command code assigned to the predetermined voice command in response to the recognized predetermined voice command; and
a control circuit (11) configured to control the lighting device based on the command code.

2. The lighting device according to claim 1, further comprising

a serial interface, preferably USB or UART interface (16), configured to connect the voice recognition circuit (13) to the control circuit (11).

3. The lighting device according to claim 2, wherein the control circuit (11) acts as USB host and the voice recognition circuit (13) acts as USB device or as USB Human Interface Device.

4. The lighting device according to any one of the preceding claims, further comprising

at least one converter circuit (10) configured to provide a supply voltage and/or current to a light source (9); and
a DALI-2 bus (12) configured to connect the at least one converter device (109) to the control circuit (11), wherein
the control circuit (11) is an application controller.

5. The lighting device according to any one of the preceding claims, wherein

the voice recognition circuit (13) is configured to recognize each of a plurality of predetermined voice commands; and
a part of the plurality of predetermined voice commands is assigned to a predetermined state of the lighting device; and
the control circuit (11) is configured to detect the predetermined state and is configured to control the voice recognition circuit (13) to restrict the recognition of the voice commands to the part when the predetermined state is detected and/or is configured to output an error signal when the predetermined state is detected and a voice command that does not belong to the part is recognized by the voice recognition circuit (13).

6. The lighting device according to claim 5, further comprising

a loudspeaker (8); wherein
the control circuit (11) is configured to control the loudspeaker to output the error signal and/or is configured to control the loudspeaker to output the voice commands of the part one by one when the predetermined state is detected.

7. The lighting device according to claim 5 or 6, wherein

the control circuit (11) is configured to detect a first state of the lighting device and a second state of the lighting device;
the first state corresponds to a main menu and the second state corresponds to a sub menu of the main menu; and

a first part of the plurality of voice commands is assigned to the main menu and a second part of the plurality of voice commands is assigned to the sub menu.

8. The lighting device according to any one of the preceding claims, further comprising

a detecting means configured to detect a person in an area; wherein
the control circuit (11) is configured to control the lighting device based on the command code only when the person is detected.

9. The lighting device according to claim 8, wherein the detecting means is a directional microphone, a microphone array, a camera or a motion detector.

10. The lighting device according to claim 9, wherein the receiver (6) comprises the directional microphone or the microphone array.

11. The lighting device according to any one of claims 8 to 10, wherein

the lighting device is a free-standing luminaire comprising a head (2);
the head (2) comprises an optical element (5) configured to direct, by refraction and/or reflection, light of a light source (9) to at least a part of the area; and
the detecting means is located in or on the luminaire head (2).

12. The lighting device according to any one of the preceding claims, wherein

the voice recognition circuit (13) is configured to recognize the at least one predetermined voice command including a name assigned to the lighting device; and
the control circuit (11) is configured to control the lighting device based on the command code only when the name is included in the at least one predetermined voice command.

13. The lighting device according to any one of the preceding claims, wherein

the voice recognition circuit (13) is configured to recognize the at least one predetermined voice command including a name of a parameter to be set and an indication of how to set the parameter.

14. The lighting device according to any one of the preceding claims, further comprising

a housing, in which at least one of the receiver (6), the voice recognition circuit (13) and the control circuit (11) is arranged.

15. A method for controlling a lighting device (1) comprising the steps of:

receiving a voice input;
recognizing at least one predetermined voice 5
command in the voice input to output a command code assigned to the predetermined voice
command in response to the recognized predetermined voice command; and
controlling the lighting device (1) based on the 10
command code.

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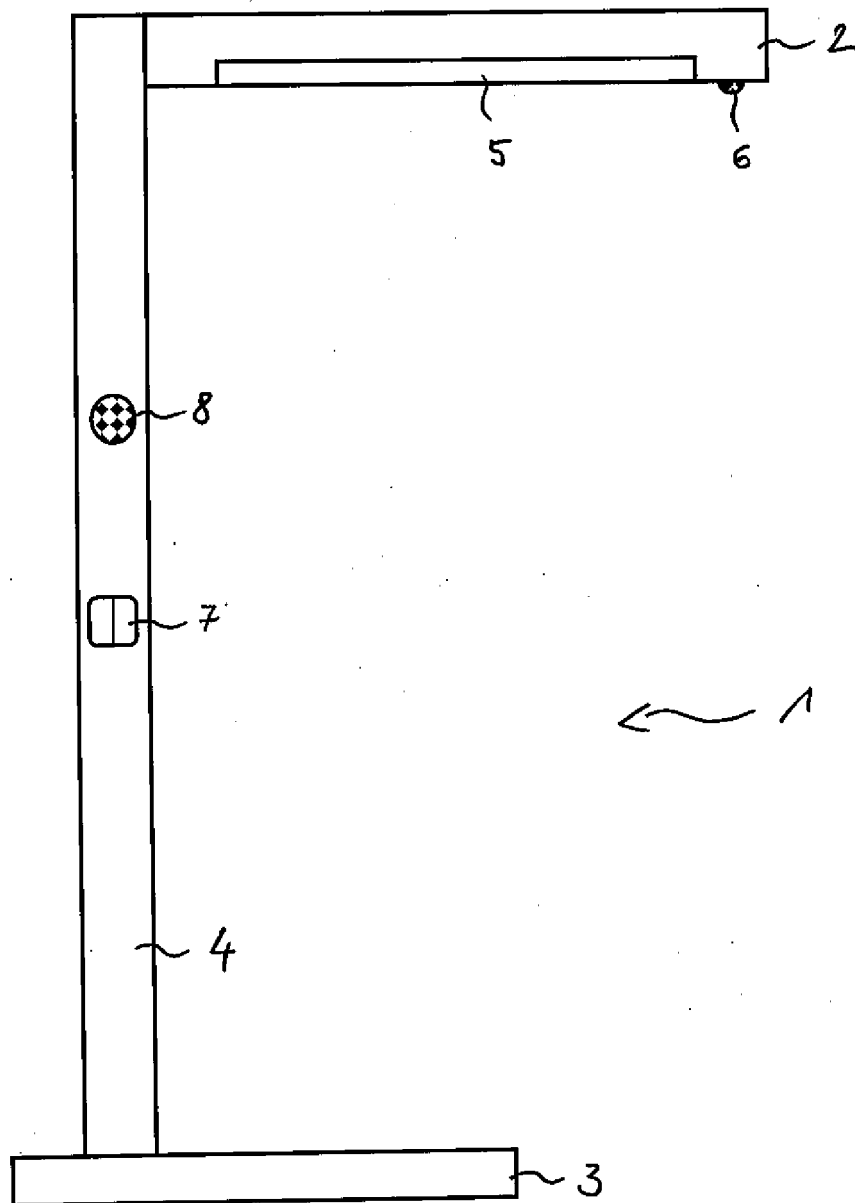


Fig. 1

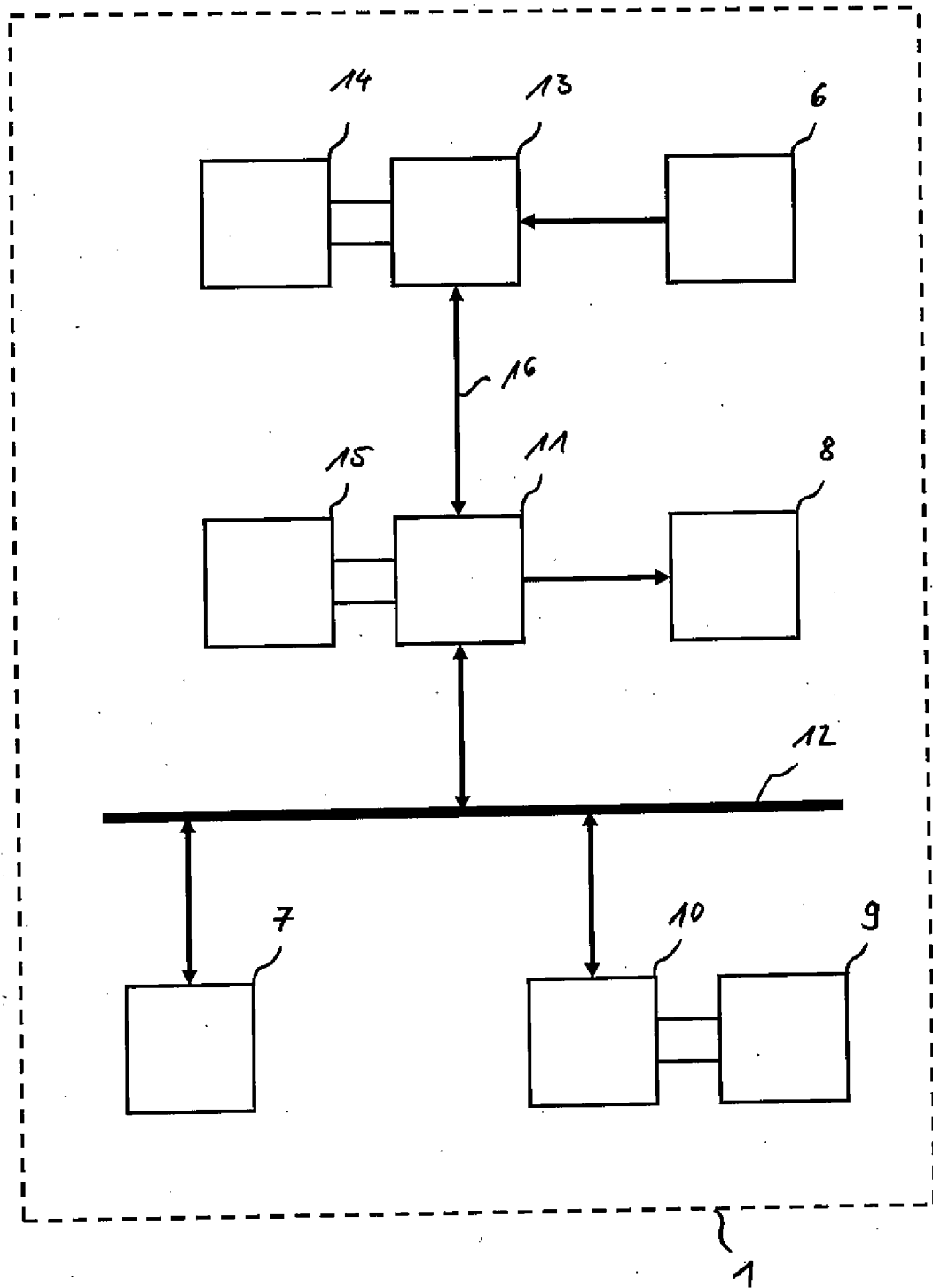


Fig. 2

Parameter	Value
Configuration Number	0x00
Interface Number	0x00
Input Endpoint Number	0x81
Output Endpoint Number	0x02
Maximum Data Size	64 Bytes

Table 1: HID Configuration Parameters

Fig. 3

Device to Host:

Instruction group	First data byte
Voice command for configuration	0x00 .. 0x0f
Voice command for light control	0x10 .. 0x1f
Voice command for other control	0x20 .. 0x2f
Reserved for future use	0x30 .. 0xff

Table 2: Instruction Groups

Fig. 4

#	Instruction in English	Instruction in German	Data of USB Packet (Device to Host)	Possible Feedback via Speaker
1	Intensity Low	Helligkeit Niedrig	0x11	1, 2
2	Intensity Medium	Helligkeit Mittel	0x12	1, 2
3	Intensity High	Helligkeit Hoch	0x13	1, 2
4	Intensity Off	Helligkeit Aus	0x10	1, 2
5	Color Low	Lichtfarbe Niedrig	0x14	1, 2
6	Color Medium	Lichtfarbe Mittel	0x15	1, 2
7	Color High	Lichtfarbe Hoch	0x16	1, 2
8	Bye	Tschüss	0x20	2, 4
9	Weather	Wetter	0x21	1, 2
10	Start Menu	Starte Menü	0x0a	1, 2
11	Exit Menu	Exit Menü	0x0b	1, 2
12	One	Eins	0x01	1, 2
13	Two	Zwei	0x02	1, 2
14	Three	Drei	0x03	1, 2
15	Four	Vier	0x04	1, 2
16	Five	Fünf	0x05	1, 2

Table 3: Instruction Set Overview

Fig. 5

Condition	Speaker Feedback English	Speaker Feedback German	Feedback ID
Voice Recognition was successful and an instruction from Table 1 understood	"OK"	"OK"	1
As voice recognized but no instruction from Table 1 understood	"Unknown instruction. Please repeat."	"Unbekannter Befehl. Bitte wiederholen."	2
Noise was recognized	No feedback	No feedback	3
Instruction #8 recognized	"Goodbye"	"Auf Wiedersehen"	4
Silence	No feedback	No feedback	-/-

Table 4: Feedback

Fig. 6

Configuration	Menu Position	Instruction English/German	Sub. Configuration	Instruction
Call configuration menu	-	"Start Menu"/"Starte Menü"	-	-
Language speaker output	1	"One"/"Eins"	1: Deutsch 2: English	"One"/"Eins" for German "Two"/"Zwei" for English
Low light level	2	"Two"/"Zwei"	1: 10% light level 2: 20% light level 3: 30% light level	"One"/"Eins" for 10% "Two"/"Zwei" for 20% "Three"/"Drei" for 30%
Medium light level	3	"Three"/"Drei"	1: 40% light level 2: 50% light level 3: 60% light level	"One"/"Eins" for 40% "Two"/"Zwei" for 50% "Three"/"Drei" for 60%
High light level	4	"Four"/"Vier"	1: 70% light level 2: 80% light level 3: 90% light level 4: 100% light level	"One"/"Eins" for 70% "Two"/"Zwei" for 80% "Three"/"Drei" for 90% "Four"/"Vier" for 100%
Speaker volume	5	"Five"/"Fünf"	1: Low 2: Medium 3: High	"One"/"Eins" for Low "Two"/"Zwei" for Medium "Three"/"Drei" for High

Table 5: Configuration Menu

Fig. 7

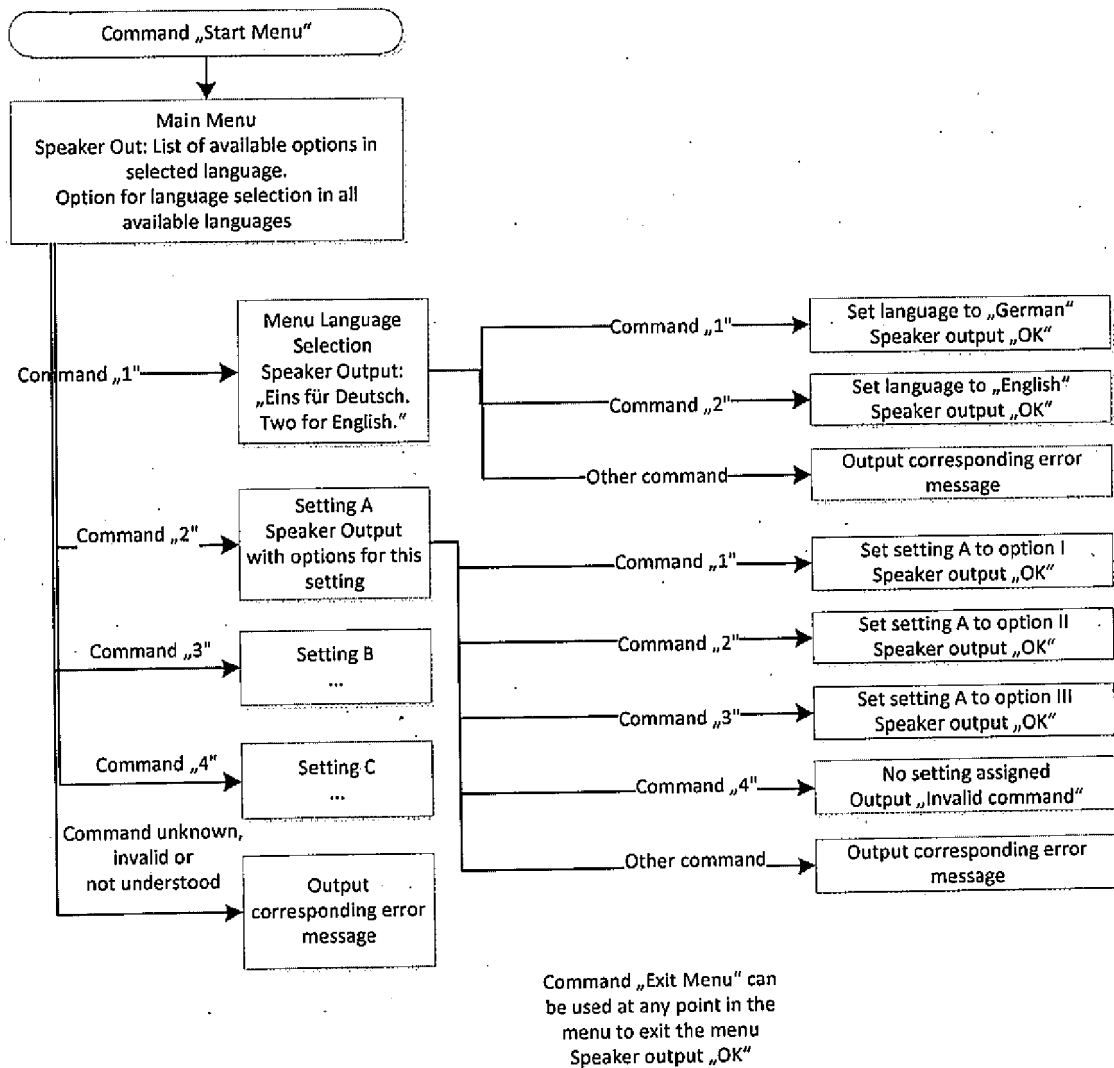


Fig. 8



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Application Number

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The present search report has been drawn up for all claims			

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EPO FORM 1503 03:82 (P04C01)

Place of search

Munich

Date of completion of the search

29 September 2023

Examiner

Henderson, Richard

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

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