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(54) CONSUMER ELECTRONICS DEVICE AND METHOD OF OPERATION

(57) A consumer electronics device (100) is configured to enhance an audio signal output by the consumer electronics device (100). The consumer electronics device (100) determines a volume level of the audio signal output by the consumer electronics device (100). The consumer electronics device (100) applies a gain to at least one frequency band of the audio signal so as to enhance a speech portion of the audio signal. The applied gain is a function of the determined volume level. This allows the speech portion of the audio signal to be boosted to make the speech portion more distinguishable.

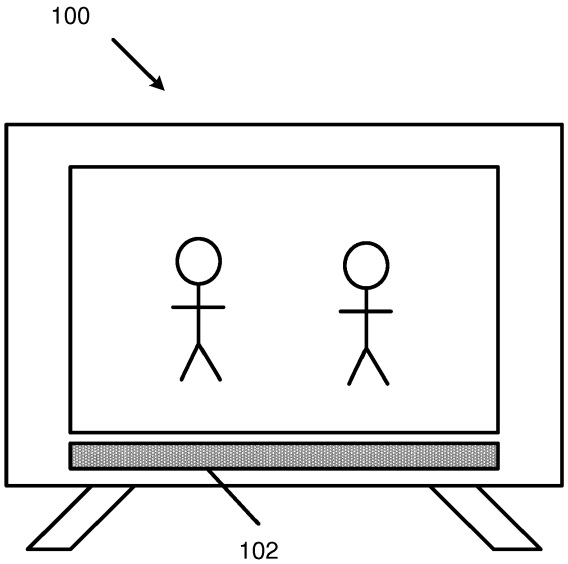

Figure 1

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Description

Technical Field

[0001] The present disclosure relates to a consumer electronics device and a method of operating a consumer electronics device to enhance an audio signal output by the consumer electronics device.

Background

[0002] Consumer electronics devices, such as television sets, home audio systems, etc., typically output audio signals at a volume level set by a user of the device. If the consumer electronics device is playing out audio signals that contain human speech (for example, the audio signals of a television programme), the human speech will be output by the consumer electronics device at the same volume as any other sounds contained in the audio signal, e.g. background sounds and music. This can make it difficult for a user of the consumer electronics device to distinguish between the human speech and the other sounds played out by the consumer electronics device. This typically results in the user increasing the volume level of played out audio signals, which may result in distortion of the audio signal, making distinguishing the human speech even more difficult.

Summary

[0003] According to a first aspect disclosed herein, there is provided a method of operating a consumer electronics device to enhance an audio signal output by the consumer electronics device, the method comprising: the consumer electronics device determining a volume level of an audio signal output by the consumer electronics device; and the consumer electronics device applying a gain to at least one frequency band of the audio signal so as to enhance a speech portion of the audio signal, wherein the applied gain is a function of the determined volume level.

[0004] In examples, the function of the determined volume level is such that: if the determined volume level is within a first volume band, a first gain is applied to the at least one frequency band of the audio signal; and if the determined volume level is within a second, different volume band, a second, different gain is applied to the at least one frequency band of the audio signal.

[0005] In examples, the method comprises repeating the determining and applying in response to detecting a change in the volume level.

[0006] In examples, the gain applied to the at least one frequency band decreases as the volume level of the audio signal increases.

[0007] Alternatively, the gain applied to the at least one frequency band only changes when the volume changes from one volume band to another.

[0008] In examples, the volume level is set by a user by setting a volume control of the consumer electronics device.

[0009] In examples, the frequency band is between 300 hertz and 3 kilohertz.

[0010] According to a second aspect disclosed herein, there is provided a consumer electronics device configured to enhance an audio signal output by the consumer electronics device, the consumer electronics device being configured to: determine a volume level of an audio signal output by the consumer electronics device; and apply a gain to at least one frequency band of the audio signal so as to enhance a speech portion of the audio signal, wherein the applied gain is a function of the determined volume level.

[0011] In examples, the consumer electronic device is configured to: apply a first gain to the at least one frequency band of the audio signal if the determined volume level is within a first volume band; and apply a second, different gain to the at least one frequency band of the audio signal if the determined volume level is within a second, different volume band.

[0012] In examples, the consumer electronic device is configured to repeat the determining and applying in response to detecting a change in the volume level.

[0013] In examples, the consumer electronic device is configured such that the gain applied to the at least one frequency band of the audio signal decreases as the volume level of the audio signal increases.

[0014] In examples, the consumer electronics device is configured such that the gain is applied to a frequency band between 300 hertz and 3000 hertz.

[0015] According to a third aspect disclosed herein, there is provided a computer program comprising instructions such that when the computer program is executed on a computing device, the computing device is arranged to carry out a method according to any of the method steps disclosed herein.

Brief Description of the Drawings

[0016] To assist understanding of the present disclosure and to show how embodiments may be put into effect, reference is made by way of example to the accompanying drawings in which:

Figure 1 shows schematically an example consumer electronics device configured to enhance an audio signal output by the consumer electronics device; and

Figure 2 shows schematically an example control system of a consumer electronics device configured to enhance an audio signal output by the consumer electronics device.

Detailed Description

[0017] A consumer electronics device is able to output

audio signals that contain various different components depending on the contents of the media associated with the audio signals. For example, a television programme output from a television set may contain human speech and the sounds of road traffic, weather, animals, backing music, sound effects and so on. In another example, a music recording output by a home audio system may contain human speech and instrument sounds.

[0018] The volume level of each component of the audio signal (e.g. speech, music, etc.) output from a consumer electronics device will depend on the volumes in the recorded or live content. For example, in a recorded television programme, the speech component and a background component, such as a sound effect, may have been recorded at different volumes. For example, the sound effect may be louder than the speech component. This may make it difficult for a user of the consumer electronics device to hear and understand the speech component. In any event, users often find it difficult to hear speech in content that is output by a consumer electronics device, especially in television programmes, films (movies), etc. The human speech is usually considered to be the most important component of the audio signal. That is, the user would most like to be able to hear the human speech above the other components of the audio signal.

[0019] The user may increase or decrease the volume level of the consumer electronics device in an attempt to make the speech component more accessible. However, increasing the volume level results in the volume of each component of the audio signal increasing. Similarly, decreasing the volume level results in the volume of each component of the audio signal decreasing. Changing the volume level does not result in a relative change in volume between the speech component and the other components of the audio signal. Indeed, increasing the overall volume may lead to distortion of the whole sound which is played back, resulting in the speech component becoming even more difficult to discern for the user. In addition, simply increasing the overall volume may not be acceptable or appropriate in the environment in which the consumer electronics device is being used.

[0020] In examples described herein, a consumer electronics device is configured to enhance an audio signal output by the consumer electronics device to boost the speech portion of the audio signal. That is, a gain is applied to at least one frequency band of an audio signal, e.g. a frequency band corresponding to human speech. The applied gain is a function of a determined volume level of the audio signal output by the consumer electronics device. For example, the applied gain may decrease monotonically with an increase in the volume level of the audio signal output by the consumer electronics device. As a specific example, the applied gain may be inversely proportional to the determined volume level, or at least generally inversely proportional to the determined volume level.

[0021] Enhancing the speech portion of the audio signal advantageously allows the user of the consumer electronics device to more easily distinguish between the speech portion and other portions or components of the audio signal and therefore hear the speech portion more clearly.

[0022] Figure 1 shows schematically an example consumer electronics device 100. The consumer electronics device 100 may be for example a media device such as a television set, a set top box, a DVD player, an audio amplifier, an audio processor, including for example a surround sound audio processor/amplifier, a personal computing device such as a laptop or desktop or tablet computer, a video game console, a cellular phone (including a so-called "smart phone"), etc.

[0023] The consumer electronics device 100 has at least one loudspeaker 102 for outputting an audio signal into an environment as sound. For example, the at least one speaker 102 may be built-in to the consumer electronics device 100 or the speaker(s) 102 may be connected to the consumer electronics device 100 by a wired or wireless connection.

[0024] Figure 2 shows schematically an example control system 200 of a consumer electronics device 100 configured to enhance an audio signal output by the consumer electronics device 100.

[0025] The control system 200 and its components as shown in Figure 2 are represented as a schematic block diagram for the purposes of explaining the functionality of the control system only. Hence, it is understood that each component of the control system is a functional block for performing the functionality ascribed to it herein. Each component may be implemented in hardware, software, firmware, or a combination thereof. Additionally, although described as separate components of the control system, some or all of the functionality may be performed by a single piece of hardware, software, or firmware.

[0026] The control system has a controller 202 or processor operatively coupled to a user interface 204 and at least one loudspeaker 208. The user interface 204 for example may be a display in the form of a screen for receiving inputs from the user. For example, the user interface 204 may comprise a touch screen, or a point-and-click user interface 204 comprising a mouse, track pad, or tracker ball or the like. Alternatively or additionally, the user interface 204 may comprise a dedicated actuator or control panel for controlling the consumer electronics device 100. For example, the user interface 204 may comprise one or more buttons, sliders, switches and/or dials. The user interface 204 is configured to receive inputs from a user of the consumer electronics device 100. For example, a user may provide a command to change the volume level of the audio signals output by the consumer electronics device 100.

[0027] The controller 202 is also operatively coupled to a gain circuit 206 configured to apply a gain to at least one frequency band of an audio signal output by the consumer electronics device 100. For example, the gain cir-

cuit 206 may comprise one or more amplifiers.

[0028] In examples, the consumer electronics device 100 determines a volume level of an audio signal output by the consumer electronics device 100. For example, the volume level of the audio signal may be any value between a minimum volume level (e.g. 0) and a maximum volume level (e.g. 100). The volume level may be representative of the power or amplitude of the sound emitted by the speaker(s) 102. That is, the volume level is a setting of the consumer electronics device 100 rather than a physical quantity. A lower volume level is representative of quieter sounds, whereas a higher volume level is representative of louder sounds.

[0029] In examples, the consumer electronics device 100 is configured to apply a gain to at least one frequency band of the audio signal so as to enhance a speech portion of the audio signal. For example, the at least one frequency band may contain audio of frequencies corresponding to those of human speech. The audio signal may also contain frequencies that do not correspond to those of human speech. In examples, the gain is only applied to the at least one frequency band and is not applied to other frequency bands. In one specific example, the consumer electronics device 100 may be configured to apply a gain to a single frequency band which contains audio of frequencies corresponding to those of human speech.

[0030] In examples, the applied gain is a function of the determined volume level. For example, the applied gain may decrease monotonically with an increase in the volume level of the audio signal output by the consumer electronics device. That is, at higher volume levels of the audio signal, the gain that is applied is less and vice versa. In one simple example, the applied gain may be inversely proportional to the volume level. Other examples are described below.

[0031] The function may be continuous such that as the volume changes the gain applied to the at least one frequency continuously changes. Alternatively, the function may be discrete such that the gain applied to the at least one frequency band changes only as the volume level changes to certain discrete levels or changes by a specific amount.

[0032] In a specific example, the function of the determined volume level is such that: if the determined volume level is within a first volume band, a first gain is applied to the at least one frequency band of the audio signal; and if the determined volume level is within a second, different volume band, a second, different gain is applied to the at least one frequency band of the audio signal. That is, the function may be discontinuous such that a different gain is only applied if the volume level changes such that the volume level enters into a different volume band.

[0033] In another example, the range of volume levels between the minimum volume level and the maximum volume level may consist of more than two volume bands. For example, the volume range may consist of ten volume bands with ten volume levels in each band. In this example, the bands may be 0-10, 11-20, 21-30, 31-40, 41-50, 51-60, 61-70, 71-80, 81-90 and 91-100. The volume range may consist of a different number of volume bands with different numbers of volume levels in each band. The volume bands may be set by a user of the consumer electronics device 100. The gain that is applied may differ between some or all of the volume bands. Again, in an example, the gain that is applied for volumes falling within a volume band is less as the volume of the audio is greater.

[0034] In examples, the consumer electronics device 100 is configured to detect a change in the volume level. The volume level may be set by a user setting a volume control of the consumer electronics device 100. For example, a user may operate a user interface 204 of the consumer electronics device 100 to trigger a change in the volume level. Additionally or alternatively, the user may operate a control device, such as a remote control, that is configured to change the volume level of the audio signal output by the consumer electronics device 100.

[0035] In examples, the consumer electronics device 100 is configured to determine the volume level of the audio signal and apply a gain to the at least one frequency response in response to detecting a change in the volume level. That is, the gain may be applied dynamically to the at least one frequency band of the audio signal.

[0036] In examples, the gain applied to the at least one frequency band decreases monotonically as the volume level of the audio signal increases. Table 1 shows example gains applied to the at least one frequency band for different example volume bands.

Table 1

Volume Band	Applied Gain
1-10	6 dBr
11-20	5 dBr
21-30	4 dBr
31-40	3 dBr
41-50	2.5 dBr
51-60	2 dBr
61-70	1.5 dBr
71-80	1 dBr
81-90	0.5 dBr
91-100	0 dBr

[0037] Here, dBr is a relative difference in signal strength between the volume of the speech portion before the gain is applied and the volume of the speech portion after the gain is applied. That is, it is the relative difference between the volume of the at least one frequency band of the audio signal before and after the gain

is applied to the at least one frequency band.

[0038] The volume bands and applied gains given here are merely examples. In examples, the applied gains are selected according to the type of consumer electronics device 100. That is, the applied gains used for a television set may be different from the applied gains used for a laptop computer for example.

[0039] In examples, the volume bands and associated applied gain values are stored as data at the consumer electronics device 100 on data storage. Alternatively, the data may be stored remotely across one or more servers.

[0040] In examples, the amount of gain to be applied changes dynamically according to the volume level, with the applied gains of the lower volume levels being greater than the applied gains of the higher volume levels. That is, at lower volume levels, a larger gain may be needed to ensure the user can sufficiently hear the speech portion of the audio signal.

[0041] In examples, no gain is applied to the frequency bands other than the at least one frequency band. That is, no gain is applied to the portions of the audio signal not corresponding to human speech. In this way, the background noise/sounds are all held at a constant volume whilst the speech portion in the played out audio signals is boosted (i.e. amplified). That is, the user can hear the speech portion more clearly whilst still being able to hear the background sounds.

[0042] In examples, no gain is applied to the largest volume band because applying a gain in this range may cause distortion of the audio signal output by the consumer electronics device 100 (because of for example distortion caused by the amplifier circuit in the consumer device 100 and/or in the speaker(s) 102, etc).

[0043] In examples, the at least one frequency band may be between 300 hertz (Hz) and 3000 Hz. In alternative examples, the at least one frequency band may be between 300 Hz and 3400 Hz.

[0044] In alternative examples, the at least one frequency band may span a user or manufacturer defined range of frequencies. The consumer device 100 may be provided with functionality that allows the user to set the frequencies for the one or more frequency bands for which a gain is selectively applied.

[0045] It will be understood that the processor 202 or processing system or circuitry referred to herein may in practice be provided by a single chip or integrated circuit or plural chips or integrated circuits, optionally provided as a chipset, an application-specific integrated circuit (ASIC), field-programmable gate array (FPGA), digital signal processor (DSP), graphics processing units (GPUs), etc. The chip or chips may comprise circuitry (as well as possibly firmware) for embodying at least one or more of a data processor or processors, a digital signal processor or processors, baseband circuitry and radio frequency circuitry, which are configurable so as to operate in accordance with the exemplary embodiments. In this regard, the exemplary embodiments may be implemented at least in part by computer software stored in (non-transitory) memory and executable by the processor, or by hardware, or by a combination of tangibly stored software and hardware (and tangibly stored firmware).

[0046] Reference is made herein to data storage for storing data. This may be provided by a single device or by plural devices. Suitable devices include for example a hard disk and non-volatile semiconductor memory.

[0047] Although at least some aspects of the embodiments described herein with reference to the drawings comprise computer processes performed in processing systems or processors, the invention also extends to computer programs, particularly computer programs on or in a carrier, adapted for putting the invention into practice. The program may be in the form of non-transitory source code, object code, a code intermediate source and object code such as in partially compiled form, or in any other non-transitory form suitable for use in the implementation of processes according to the invention. The carrier may be any entity or device capable of carrying the program. For example, the carrier may comprise a storage medium, such as a solid-state drive (SSD) or other semiconductor-based RAM; a ROM, for example a CD ROM or a semiconductor ROM; a magnetic recording medium, for example a floppy disk or hard disk; optical memory devices in general; etc.

[0048] The examples described herein are to be understood as illustrative examples of embodiments of the invention. Further embodiments and examples are envisaged. Any feature described in relation to any one example or embodiment may be used alone or in combination with other features. In addition, any feature described in relation to any one example or embodiment may also be used in combination with one or more features of any other of the examples or embodiments, or any combination of any other of the examples or embodiments. Furthermore, equivalents and modifications not described herein may also be employed within the scope of the invention, which is defined in the claims.

Claims

1. A method of operating a consumer electronics device (100) to enhance an audio signal output by the consumer electronics device (100), the method comprising:

   the consumer electronics device (100) determining a volume level of an audio signal output by the consumer electronics device (100); and
   the consumer electronics device (100) applying a gain to at least one frequency band of the audio signal so as to enhance a speech portion of the audio signal, wherein the applied gain is a function of the determined volume level.

2. A method according to claim 1, wherein the function

of the determined volume level is such that:

if the determined volume level is within a first volume band, a first gain is applied to the at least one frequency band of the audio signal; and
if the determined volume level is within a second, different volume band, a second, different gain is applied to the at least one frequency band of the audio signal.

3. A method according to claim 1 or claim 2, comprising repeating the determining and applying in response to detecting a change in the volume level.

4. A method according to any of claims 1 to 3, wherein the gain applied to the at least one frequency band decreases as the volume level of the audio signal increases.

5. A method according to any of claims 1 to 4, wherein the volume level is set by a user by setting a volume control of the consumer electronics device (100).

6. A method according to any of claims 1 to 5, wherein the frequency band is between 300 hertz and 3000 hertz.

7. A consumer electronics device (100) configured to enhance an audio signal output by the consumer electronics device (100), the consumer electronics device (100) being configured to:

determine a volume level of an audio signal output by the consumer electronics device (100); and
apply a gain to at least one frequency band of the audio signal so as to enhance a speech portion of the audio signal, wherein the applied gain is a function of the determined volume level.

8. A consumer electronics device (100) according to claim 7, the consumer electronics device (100) being configured to:

apply a first gain to the at least one frequency band of the audio signal if the determined volume level is within a first volume band; and
apply a second, different gain to the at least one frequency band of the audio signal if the determined volume level is within a second, different volume band.

9. A consumer electronics device (100) according to claim 7 or claim 8, the consumer electronics device (100) being configured to repeat the determining and applying in response to detecting a change in the volume level.

10. A consumer electronics device (100) according to any of claims 7 to 9, the consumer electronics device (100) being configured such that the gain applied to the at least one frequency band of the audio signal decreases as the volume level of the audio signal increases.

11. A consumer electronics device (100) according to any of claims 7 to 10, the consumer electronics device (100) being configured such that the gain is applied to a frequency band between 300 hertz and 3000 hertz.

12. A computer program comprising instructions such that when the computer program is executed on a computing device, the computing device is arranged to carry out a method according to any of claims 1 to 6.

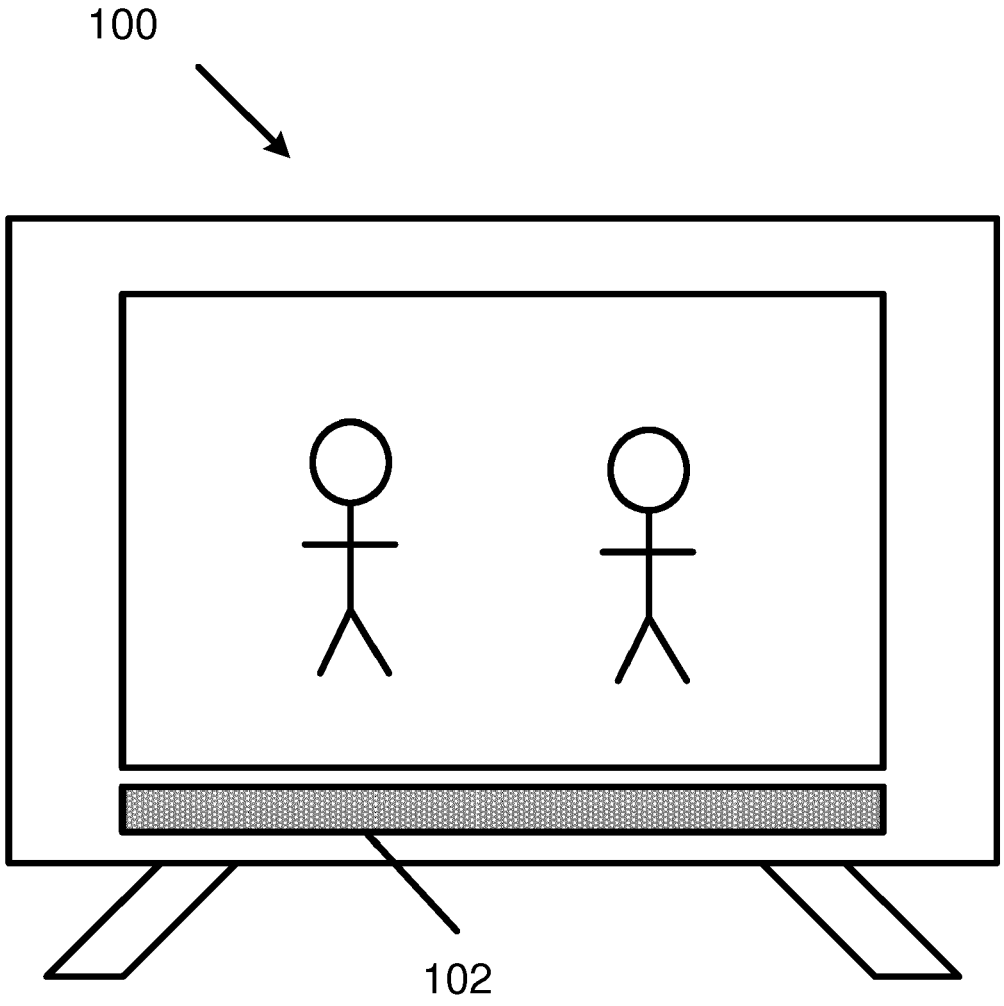

Figure 1

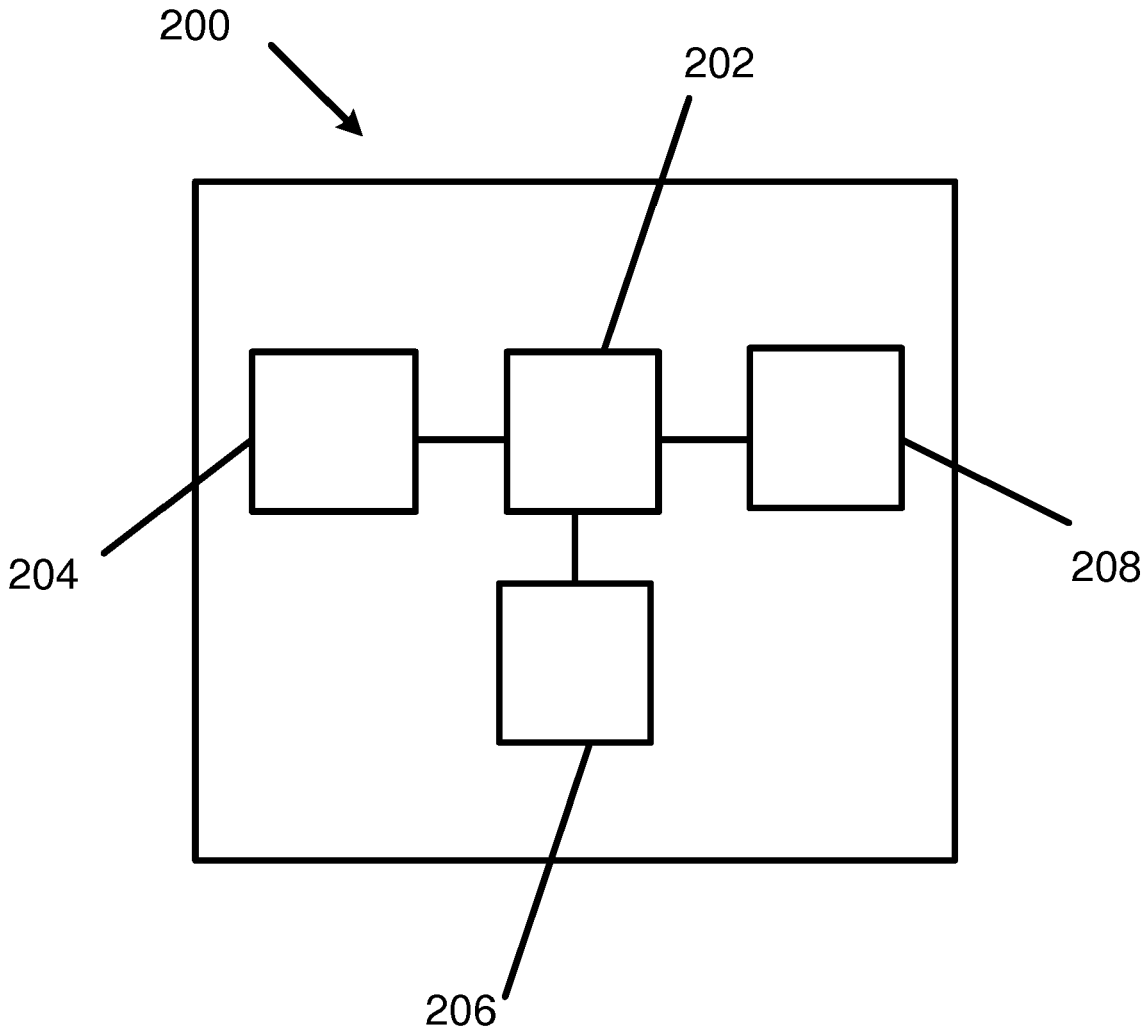

Figure 2

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EUROPEAN SEARCH REPORT

Application Number
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	22 December 2017	Müller, Achim

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. EP 17 19 8600

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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