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(54) Configuring a sound field

Konfigurierung eines Schallfeldes

Configuration d'un champ sonore

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EP 2 161 950 B1

Description**Field of the Invention**

5 **[0001]** The present invention relates to a method and system for dynamic reconfiguring an audio reproduction system comprising two or more sound channels. The premises of the reconfiguring are being based on the position of one or more listeners and the one or more sound channels in the reproduction system. The feature obtained is a sound distribution into individual zones of sound fields.

10 **[0002]** The invention includes digital signal processing, sound transducers, filters and amplifier configurations to be applied in surround sound systems and traditional stereophonic system, and to be applied in any domain like a home, in a vehicle, in a boat, in an airplane, in an office or in any other private or public domain, this being airports, shopping centres, sports arenas and theatres, i.e. in a PA system.

Background of the Invention

15 **[0003]** It is a well known problem in prior art loudspeaker systems operating in closed rooms/spaces e.g. a car, that the sound expired by the user may vary according to the listeners position in a space relative to the loudspeaker system transducers.

20 **[0004]** Furthermore systems have been developed for simplistic sound distribution, for example for use inside rooms or cars. The systems detect the configuration of the space and the presence of listeners, and reconfigure the sound output according to the number of listeners and their position relative to the loudspeakers. Such systems are disclosed in US2007/0211908, and DE102004022379.

25 **[0005]** Document US2004/0240676 A1 describes that a wide frequency range signal from a test sound source is reproduced successively by a plurality of speakers, and the reproduced sound is detected by a plurality of microphones, after which the frequency characteristics thereof are obtained at FFTs, while obtaining the frequency characteristics of the wide frequency range signal at an FFT. A high frequency range level is normalized with a low frequency range level, and a determination section compares the normalized value with a reference value stored in a reference value storage section to determine the number and positions of people in the sound field. At the same time, the transfer functions between the speakers and the microphones are calculated at transfer function calculators, and impulse responses are obtained at IFFTs, after which a reverberation time calculator calculates the reverberation time based on the impulse responses. An audio signal is adjusted based on the results obtained from the determination section and the reverberation time calculator, whereby it is possible to optimize the audio reproduction according to changes in the sound field. In WO2007/016527 test signals are generated and received. The received (distorted) signal is then used in order to adjust the output of the of the sound reproduction system (audio tuning system).

35 **[0006]** Further prior art documents are WO 2005/115050 A1, DE 10 2005 033238 A1, and David Hand ET AL: "Principles of Data Mining", 31 December 2001 (2001-12-31), pages 1-322, Cambridge, Massachusetts, USA, ISBN: 978-0-26-208290-7.

Object of the Invention

40 **[0007]** Thus to obtain a certain perceived quality level of a loudspeaker system, e.g. in a car, the individual sound channels incorporating one or more loudspeaker modules must be calibrated and adjusted individually and according to the number of persons in the car, and their position in the space e.g. their seated positions.

45 **[0008]** This principle may be applied in any type of room like airplanes, boats, theatres, arenas, and shopping centres and alike.

[0009] In the public domain applications it would be a huge advantage to direct the sound fields primarily into zones where people are located and /or seated, this to avoid acoustical reflections from distributed speakers in areas where no people are located.

Description of the Invention

50 **[0010]** The invention discloses a surround sound system where different sound settings may be enabled via digital signal processing means controlling the individual sound channels parameters e.g. the equalization (filters), the delay, the gain (amplification). The premise for the control is based upon the listener's position in the listening room/space.

55 In a more advanced embodiment of the invention the control and sound setting may work in a contextual mode of operation to accommodate for:

- the position of the one or more listeners;

- a functional mode of operation, e.g. adjust the sound system settings to be in movie mode;
- the type of music, e.g. rock;
- the time of the day; e.g. morning/day/night/Christmas etc.

5 **[0011]** The invention discloses a solution that in an automatically mode of operation may fulfil the stated requirements and solve the related technical problems.

[0012] In summary embodiments of the invention include:

- sensor means to detect a listener position;
- 10 • a mode of operation related to a user position or a required function;
- Information available according to context (place, time and music content);
- multi channel sound system, e.g. two channels stereo, a 5.1 surround sound system;
- digital controlled sound system e.g. digital control of gain, equalization and delay;
- 15 • active speakers including amplifiers and filters for each loudspeaker transducer.

The digital control of the sound system is based on standard means for:

- gain: adjust the signal by a certain level, i.e. + /- xx dB, e.g. +0.1 dB;
- delay: the signal is delayed by a specific time, i.e. yy ms, e.g. 100 ms;
- 20 • EQ: the signal is filtered according to the Finite Impulse Response principle (FIR) or the signal is filtered according to the Infinite Impulse Response principle (iIR); a number of coefficients are specified; the number of parameters typically to be from 1 -> 1000.

25 **[0013]** The invention may be implemented in different embodiments. An example not claimed of the reconfiguring procedure may be implemented as:

- a traditional algorithm in terms of a sequential software program in which the values of the resulting adjustment parameters are embedded in the code itself; the algorithm validates according to a specified system structure of an actual loudspeaker configuration.

30 **[0014]** According to the invention, the reconfiguring procedure is implemented as:

- a table based concept in which one or more tables defines the attributes to be applied per loudspeaker channel versus the mode of operation, the listener position and other context related information (e.g. time).

35 **[0015]** In a first aspect of the invention a method for dynamic and automatic reconfiguring an audio reproduction system comprising two or more sound channels comprises the set of features defined in independent claim 1.

[0016] The fundamental goal of the invention is to enhance the perceived sound quality seen from a listener perspective. Regardless of the physical position of the loudspeakers, a virtual sound field may be generated and directed so it appears to be anywhere the listener may desire. This is obtained by adjusting the gain, the delay and the equalization parameters of the individual sound channels in a multichannel sound system.

40 In another aspect the reconfiguring process validates the position of the one or more users, and/or functional premises and/or context related premises and or content related premises as part of the reconfiguring of the one or more sound channels that constitutes the configured loudspeaker system, and where the validation prioritizes the position of one or more listeners.

45 According to specific requirements of a sound providing system miscellaneous features may be offered and controlled automatically and/or commanded by the user. The features may be used individually and/or mixed in a way that accommodates the user's demands. A predefined combination of sound settings per channel and the functional options supports the processing. Examples of functional options are:

- seat priority: driver, all, back, front, centre, left, right etc.;
- a persons physical position: in a room, in a car, in a PA domain etc.;
- zone priority: a zone includes one or more specific sound channels;
- mode priority: movie, music, speech;
- 50 • channel mode: stereo, surround sound 5.1, or other multi channel system of any order;
- group of people: one or more listeners in a zone;
- the time of an event.

[0017] The reconfiguring process is provided as one or more algorithms to provide the calculation of each of the values of the sound channel adjustment variables.

In a preferred embodiment the reconfiguring process is provided as a table with relations provided to be accessed by the digital signal processor to provide each of the values of the sound channel adjustment with variables.

The saved attributes and key parameters are loaded into the reconfiguring means supported by electronic means, means that is connected wirelessly or connected by wire to the audio reproduction system.

[0018] In a third aspect of the invention the reconfiguring process provides the settings of the sound parameters; gain, equalization and delay for one sound channel, to be applied in one sound field zone related to the physical position of first group of people including one or more listeners.

To accommodate for the handling of more zones including different groups of people the reconfiguring process provides the settings of the sound parameters; gain, equalization and delay for one sound channel, to be applied in one sound field zone related to the physical position of one or more other groups of people including one or more listeners.

[0019] In yet another aspect a listener position is detected via standard sensor means like switches or infrared detectors or strain gauges or temperature sensitive detectors.

The configuring process is to be automatically executed and/or controlled by the audio amplifier means, including a digital signal processor, which drives the loudspeaker system. The reconfiguring means is embedded into an audio reproduction system.

[0020] In an embodiment, the reconfiguring is controlled via a table mapping the mode of operation to adjustment parameters for each speaker in every channel or just relevant channels. The adjustment parameters are e.g. but not limited to: equalization, delay and gain.

[0021] The table may be represented as one or more data set as most appropriate to the digital controller unit. E.g. one data set may contain the relations among:

- listener position,
- loud speaker channel #,
- parameter settings (EQ, delay, and gain).

[0022] Another data set may contain the functional/mode related information like:

- functional settings (movie, audio only),
- loud speaker channel #,
- parameter settings (EQ, delay, and gain).

[0023] This table concept is considered to be a data driven control systems, and enables for easy updates of the functional behaviour of a specific system simply by loading alternative data set into the controller.

[0024] In addition, the invention includes a constraint Solver, which comprises a table with digital data representing the constraints of the passenger(s) position(s) and related acoustical adjustment, attributes and corresponding variable values.

The constraint solver processing enables an arbitrary access mode to information with no order of sequences required.

This is an important advantage over prior art tree-like programming structure, where the starting point is given by the root of the tree. Especially, when finding ways from nodes within the tree-like program to a specific target location in the tree, it may be obscure with regard to which way to chose, whether backwards or forwards, and the final solution may be a new start from the root.

[0025] According to the invention, the product configuration domain table is organized as relations among variables in the general mathematical notation of 'Disjunctive Form':

AttribVariable 1.1 and AttribVariable 1.2 and AttribVariable 1.3 and AttribVariable 1.n
 Or AttribVariable 2.1 and AttribVariable 2.2 and AttribVariable 2.3 and AttribVariable 2.n
 Or
 Or
 Or AttribVariable m.1 and AttribVariable m.2 and AttribVariable m.3 and AttribVariable m.n

[0026] For example, AttribVariable 1.1 may be defining a passenger seat position, AttribVariable 1.1 a speaker transducer unit, AttribVariable 1.3 a speaker system/subsystem and AttribVariable 1.n gain value for the transducer unit. In another example, AttribVariable 2.n may be a reference to another table.

[0027] An alternatively definition term is the 'Conjunctive Form':

AttribVariable 1.1 or AttribVariable 1.2 or AttribVariable 1.3 or AttribVariable 1.n

And AttribVariable 2.1 or AttribVariable 2.2 or AttribVariable 2.3 or AttribVariable 2.n

And

And

And AttribVariable m.1 or AttribVariable m.2 or AttribVariable m.3 or AttribVariable m.n

[0028] With this method of defining the problem domain, it becomes a multi-dimensional state space enabling equal and direct access to any point in the defined set of solutions. The term multidimensional has to be understood as a contrast to a tree-like programming structure, which is two-dimensional.

[0029] According to the invention, the product configuration function proceeds by finding the result of the interrogation in the set of allowed and possible combinations in one or more Configuration Constraint Tables. According to definitions made in the configuration constraint tables, the result might be:

- a list of variables useful in the application e.g. gain, and filter setting i.e. equalization, for the one or more transducers;
- a list of variables useful in the application e.g. delay for the one or more transducers;
- a list of variables useful in the application to configure individual sound domains to related to zone of sound of targeted to one or more users.

[0030] Alternative configurations may be evaluated by the constraint solver, the alternatives being one or more of the defined set of legal combination in the constraint table.

The example illustrates alternative solutions for x, y when y is given:

The: If x Then y may be represented as $x \rightarrow y$

[0031] With the truth table:

x	y	$x \rightarrow y$
0	0	1
0	1	1
1	0	0
1	1	1

[0032] Given the premise x is '1' the conclusion y is '1'.

Given the conclusion y is '1' the premises for x may be '1' or '0'.

Thus, when y is '1' the alternatives for x are '1' or '0'.

[0033] Represented in a constraint table the $x \rightarrow y$ has the legal combinations of x, y:

x	y
0	0
0	1
1	1

[0034] Table entries in a constraint table may be combined into legal/illegal combination such that all the well known logical operators known from the Boolean algebra will be included as required. The logical operators being: AND, OR, NOT, XOR, Logical Implication ($\rightarrow$), Logical Bi-implication ($=$).

[0035] An example of a table definition is displayed below:

Mode or position	Speaker channel #	Other (e.g. time, content)	Equalization EQ	Delay	Gain
Driver	1		p-val-d1	q-val-d1	r-val-d1
	2		p-val-d2	q-val-d2	r-val-d2
					
	n		p-val-dn	q-val-dn	r-val-dn
Front	1		p-val-f1	q-val-f1	r-val-f1
	2		p-val-f2	q-val-f2	r-val-f2

(continued)

Mode or position	Speaker channel #	Other (e.g. time, content)	Equalization EQ	Delay	Gain
5					
	n		p-val-fn	q-val-fn	r-val-fn
Rear	1		p-val-r1	q-val-r1	r-val-r1
10	2		p-val-r2	q-val-r2	r-val-r2
	n		p-val-rn	q-val-rn	r-val-rn
15	All	1	p-val-a1	q-val-a1	r-val-a1
	2		p-val-a2	q-val-a2	r-val-a2
					
20	n		p-val-an	q-val-an	r-val-an
Movie	1		p-val-m1	q-val-m1	r-val-m1
25	2		p-val-m2	q-val-m2	r-val-m2
					
	n		p-val-mn	q-val-mn	r-val-mn
					
30	Other	1	p-val-ol	q-val-ol	r-val-ol
	2		p-val-o2	q-val-o2	r-val-o2
					
35	n		p-val-on	q-val-on	r-val-on

[0036] Thus in an aspect of the invention the reconfiguring means is embedded into an audio reproduction system as defined in claim 12. Thus the system becomes the controller of the re- configuring process that provides a reconfiguration of the system itself.

Description of the Drawing

[0037] In the following, preferred embodiments of the invention will be described with reference to the drawings wherein:

Figure 1 displays components that constitute examples of loudspeaker module configurations, that represent one sound channel configuration;

Figure 2 displays an example of an embodiment of the invention displaying a plurality of sound channels;

[0038] Figure 1 display components that constitute examples of loudspeaker module configurations related to one sound channel.

A loudspeaker transducer unit (1) is the fundamental means that transforms the electrical signal to the sound waves produced by movements of the membrane of the transducer unit. Any standard transducer unit may be applied in the invention.

[0039] The characteristics of each loudspeaker transducer unit are determined by measurement and/or from specifications delivered by the supplier of the unit.

[0040] In the preferred embodiment an audio reproduction system comprising active sound transducers including an amplifier (2) is provided for each transducer unit (1). This type of amplifier is e.g. the technology ICEpower from Bang & Olufsen DK.

[0041] In a high quality audio reproduction system a dedicated filter means, an equalizer, (3) is provided per amplifier (2). The means (3) provides a frequency dependent amplification to control the overall gain, which may be regulated up or down as required. Means for down regulation may be as simple as adjustment of a resistive means serial connected to the loudspeaker module.

[0042] To control the sound distribution into individual zones of sound fields the sound delay among channels must be controlled. In a preferred embodiment the delay (4) is controlled individually per sound channel.

[0043] Figure 2 displays the example of an audio reproduction system comprising loudspeaker modules configured in a multi channel concept e.g. a 5.1 surround sound system.

In fact any number of channels (22) may be handled; having a corresponding table complex related according to the actual functional system requirements.

[0044] The audio reproduction system may be an audio amplifier (20), including a digital signal processor, for controlling and driving the loudspeaker channels (22), and to provide a signal (21) that's amplified and filtered and delayed accordingly.

[0045] Input from sensor means (23) determines the mode and functional operation of the control system and may be of a different nature e.g. but not limited to: simple switch, accelerometer, infrared detection, thermal sensing etc.

In the preferred embodiment the sensors primarily detects the position of a user in a room/space, the position to be related to the sound field that's relevant for the one or more users /listeners.

[0046] E.g. in a vehicle the detection of a user's position is where the individual user is seated. The detection in this system may be via a simple switch in every seat, or via switches related to the security belts.

[0047] Additional control signals may be received as user commands (24), e.g. a command to 'enable automatic sound control' and a context related information (25), e.g. information about the time of the day and/or the type of music actual in play. The additional control signal information to be used as input into the digital signal processor to control mode and functional operation of the sound system.

[0048] In a preferred embodiment the reconfigure means is imbedded into the controller of the audio sound system. Thus the audio sound system is the master having the digital signal processor means (20) that initiates, controls and applies the reconfiguring process. Alternative table definitions may be loaded into the digital signal processor (20) from external means e.g. a laptop/PC (26).

[0049] The invention may be applied in relation to automatically adjusting an audio sound system to a maximum level of quality taking into account the position of individual listeners in dedicated zone of sound fields.

[0050] The invention includes sound channel configurations to be applied in surround sound systems and traditional stereophonic system, and to be applied in any domain like a home, in a vehicle, in an airplane in a boat, in an office or in any other public domain and alike.

Claims

1. A method for dynamic and automatic reconfiguring an audio reproduction system comprising two or more sound channels, where each sound channel comprises a loudspeaker transducer, and where the reconfiguring has the steps:

- determining the physical position of one or more listeners,
- supplying the physical position as information to the audio reproduction system in order to select a set of predefined or calculated sound parameters, the set of sound parameters to include settings for equalization, gain, and delay per sound channel and/or per loudspeaker transducer,
- using a constraint solver, selecting one or more legal sets among defined legal sets of sound parameters predefined in a constraint table, where the constraint table is configured as a multi-dimensional state space, defining relations among variables in either disjunctive form or conjunctive form, based on the information supplied to the audio reproduction system, and
- providing the one or more selected legal sets of sound parameters to the respective sound channel and/or per loudspeaker transducer accordingly.

2. A method according to claim 1, wherein the step of selecting a set of predefined sound parameters comprises applying user commanded information.

3. A method according to claim 1 or 2, where the reconfiguring process validates the position of the one or more listeners as part of the reconfiguring of the audio reproduction system.

4. A method according to any preceding claim where the reconfiguring process provides the settings of the sound

parameters gain, equalization, and delay for one sound channel, to be applied in one sound field zone related to the physical position of a first subset of the one or more listeners.

5 5. A method according to claim 4 where the reconfiguring process provides the settings of the sound parameters gain, equalization, and delay for one sound channel, to be applied in one sound field zone related to the physical position of one or more second subsets of the one or more listeners.

6. A method according to claim 1, where the physical position of the one or more listeners is detected via sensor means.

10 7. A method according to claim 6, wherein the sensor means comprise at least one of infrared detectors, strain gauges, and temperature sensitive detectors.

8. A method according to claim 3, wherein the one or more listeners are passengers in a vehicle, and where the constraint table comprises digital data representing the constraints of at least one of

- 15
- 1) the physical position of the one or more listeners, and related acoustical adjustment, attributes and corresponding related variable values,
 - 2) the physical position of the one or more listeners, loud speaker channel number, parameter settings of equalization, delay, and gain, and
 - 20 3) Functional settings.

9. A method according to claim 8, wherein the functional settings comprise at least one of a movie, audio only, a loudspeaker channel number, and parameter settings.

25 10. A method according to claim 9, wherein the parameter settings of the functional settings comprise at least one of equalization, delay, and gain.

30 11. A method according to any preceding claim, wherein the reconfiguring process is configured to take into account a predefined combination of sound settings per sound channel and at least one functional option, wherein the at least one functional option includes at least one of

- a seat priority;
- a zone priority;
- a mode priority;
- a channel mode;
- 35 a number of listeners in a zone; and
- a time of the event.

12. An audio sound system comprising

- 40
- reconfigure means for carrying out the method according to any of claims 1 to 11, and
 - an audio reproduction system comprising two or more sound channels, each channel comprising a loudspeaker transducer, and individual means for equalization and amplification, the audio reproduction system constituting an audio reproduction equipment in a room, in a vehicle, in an airplane, in a boat, in a PA system,

45 wherein the reconfigure means are configured to apply the automatic reconfiguring on the audio reproduction system.

Patentansprüche

50 1. Verfahren zum dynamischen und automatischen Rekonfigurieren eines Audiowiedergabesystems, das zwei oder mehr Schallkanäle umfasst, wobei jeder Schallkanal einen Lautsprecherwandler umfasst, und wobei das Rekonfigurieren die folgenden Schritte aufweist:

- 55
- Bestimmen der physischen Position von einem oder mehreren Hörern,
 - Zurverfügungstellen der physischen Position als Information an das Audiowiedergabesystem, um einen Satz von vordefinierten oder berechneten Schallparametern auszuwählen, wobei der Satz von Schallparametern Einstellungen zum Entzerren, Verstärken und Verzögern je Schallkanal und/oder je Lautsprecherwandler beinhaltet.

- Verwenden einer Beschränkungsberechnung, die einen oder mehrere erlaubte Sätze aus definierten erlaubten Sätzen von Schallparametern auswählt, die in einer Beschränkungstabelle vordefiniert sind, wobei die Beschränkungstabelle als ein multidimensionaler Zustandsraum konfiguriert ist, der Beziehungen zwischen Variablen entweder in disjunktiver Form oder in konjunktiver Form definiert, basierend auf den dem Audiowiedergabesystem zur Verfügung gestellten Informationen, und

• entsprechendes Bereitstellen des einen oder der mehreren ausgewählten erlaubten Sätze von Schallparametern an den jeweiligen Schallkanal und/oder den jeweiligen Lautsprecherwandler.
- 2. Verfahren nach Anspruch 1, wobei der Schritt des Auswählens eines Satzes von vordefinierten Schallparametern, das Anwenden von Benutzerbefehlsinformationen umfasst.
- 3. Verfahren nach Anspruch 1 oder 2, wobei der Rekonfigurationsprozess die Position des einen oder der mehreren Hörer als Teil des Rekonfigurierens des Audiowiedergabesystems bestätigt.
- 4. Verfahren nach einem der vorstehenden Ansprüche, wobei der Rekonfigurationsprozess die Einstellungen der Schallparameter Verstärken, Entzerren und Verzögern für einen Schallkanal bereitstellt, um in einem Schallfeldbereich angewendet zu werden, der in Beziehung zu der physischen Position einer ersten Teilmenge des einen oder der mehreren Hörer steht.
- 5. Verfahren nach Anspruch 4, wobei der Rekonfigurationsprozess die Einstellungen der Schallparameter Verstärken, Entzerren und Verzögern für einen Schallkanal bereitstellt, um in einem Schallfeldbereich angewendet zu werden, der in Beziehung zu der physischen Position der einen oder mehreren zweiten Teilmengen des einen oder der mehreren Hörer steht.
- 6. Verfahren nach Anspruch 1, wobei die physische Position des einen oder der mehreren Hörer durch Sensormittel erkannt wird.
- 7. Verfahren nach Anspruch 6, wobei die Sensormittel mindestens eines von Infrarotdetektoren, Dehnungsmessern und temperaturempfindlichen Detektoren umfassen.
- 8. Verfahren nach Anspruch 3, wobei der eine oder die mehreren Hörer Passagiere in einem Fahrzeug sind und wobei die Beschränkungstabelle digitale Daten umfasst, die die Beschränkungen mindestens eines des Folgenden umfasst:
 - 1) die physische Position des einen oder der mehreren Hörer und die damit in Beziehung stehende akustische Anpassung, die Attribute und die zugehörigen damit in Beziehung stehenden Variabelwerte,
 - 2) die physische Position des einen oder der mehreren Hörer, die Lautsprecherkanalnummer, die Parametereinstellungen von Verzerren, Verzögern und Verstärken, und
 - 3) funktionale Einstellungen.
- 9. Verfahren nach Anspruch 8, wobei die funktionalen Einstellungen mindestens eines von einem Film, nur Audio, einer Lautsprecherkanalnummer und Parametereinstellungen umfassen.
- 10. Verfahren nach Anspruch 9, wobei die Parametereinstellungen der funktionalen Einstellungen mindestens eines von Entzerren, Verzögern und Verstärken umfassen.
- 11. Verfahren nach einem der vorstehenden Ansprüche, wobei der Rekonfigurationsprozess dazu konfiguriert ist, eine vordefinierte Kombination aus Schalleinstellungen je Schallkanal und mindestens eine funktionale Option zu berücksichtigen, wobei die mindestens eine funktionale Option mindestens eines des Folgenden beinhaltet:
 - eine Sitzpriorität;
 - eine Bereichspriorität;
 - eine Moduspriorität;
 - einen Kanalmodus;
 - eine Anzahl von Hörern in einem Bereich; und
 - einem Zeitpunkt des Ereignisses.
- 12. Audioschallsystem, das Folgendes umfasst:

- Rekonfigurationsmittel zum Durchführen des Verfahrens nach einem der Ansprüche 1 bis 11, und
- ein Audiowiedergabesystem, das zwei oder mehrere Schallkanäle umfasst, wobei jeder Schallkanal einen Lautsprecherwandler und individuelle Mittel zum Entzerren und Amplifizieren umfasst, wobei das Audiowiedergabesystem eine Audiowiedergabeausrüstung in einem Raum, in einem Fahrzeug, in einem Flugzeug, in einem Boot, in einem PA-System darstellt,

wobei die Rekonfigurationsmittel dazu konfiguriert sind, automatisches Rekonfigurieren an dem Audiowiedergabesystem anzuwenden.

Revendications

1. Procédé de reconfiguration dynamique et automatique d'un système de reproduction audio comprenant deux canaux sonores ou plus, dans lequel chaque canal sonore comprend un transducteur de haut-parleur, et dans lequel la reconfiguration comporte les étapes :

- de détermination de la position physique d'un ou de plusieurs auditeurs,
- de fourniture de la position physique en tant qu'information au système de reproduction audio afin de sélectionner un ensemble de paramètres sonores prédéfinis ou calculés, l'ensemble de paramètres sonores servant à inclure des réglages pour l'égalisation, le gain et le retard par canal sonore et/ou par transducteur de haut-parleur,
- à l'aide d'un résolveur de contrainte, de sélection d'un ou de plusieurs ensembles légaux parmi des ensembles légaux définis de paramètres sonores prédéfinis dans une table de contrainte, dans lequel la table de contrainte est configurée en tant qu'espace d'état multidimensionnel, définissant des relations entre des variables soit sous forme disjonctive soit sous forme conjonctive, sur la base des informations fournies au système de reproduction audio, et
- de fourniture des un ou plusieurs ensembles légaux sélectionnés de paramètres sonores au canal sonore respectif et/ou par transducteur de haut-parleur en conséquence.

2. Procédé selon la revendication 1, dans lequel l'étape de sélection d'un ensemble de paramètres sonores prédéfinis comprend l'application d'informations commandées par l'utilisateur.

3. Procédé selon la revendication 1 ou 2, dans lequel le processus de reconfiguration valide la position des un ou plusieurs auditeurs dans le cadre de la reconfiguration du système de reproduction audio.

4. Procédé selon une quelconque revendication précédente, dans lequel le processus de reconfiguration fournit les réglages de gain, d'égalisation et de retard des paramètres sonores pour un canal sonore à appliquer dans une zone de champ sonore liée à la position physique d'un premier sous-ensemble des un ou plusieurs auditeurs.

5. Procédé selon la revendication 4, dans lequel le processus de reconfiguration fournit les réglages de gain, d'égalisation et de retard des paramètres sonores pour un canal sonore à appliquer dans une zone de champ sonore liée à la position physique d'un ou de plusieurs seconds sous-ensembles des un ou plusieurs auditeurs.

6. Procédé selon la revendication 1, dans lequel la position physique des un ou plusieurs auditeurs est détectée par l'intermédiaire de moyens de détection.

7. Procédé selon la revendication 6, dans lequel les moyens de détection comprennent au moins l'un de détecteurs à infrarouge, d'extensomètres et de détecteurs sensibles à la température.

8. Procédé selon la revendication 3, dans lequel les un ou plusieurs auditeurs sont des passagers dans un véhicule, et dans lequel la table de contrainte comprend des données numériques représentant les contraintes d'au moins l'un

- 1) de la position physique des un ou plusieurs auditeurs, et d'un ajustement acoustique associé, d'attributs et de valeurs variables associées correspondantes,
- 2) de la position physique des un ou plusieurs auditeurs, du numéro de canal de haut-parleur, de réglages de paramètre d'égalisation, de retard et de gain, et
- 3) de réglages fonctionnels.

9. Procédé selon la revendication 8, dans lequel les réglages fonctionnels comprennent au moins l'un d'un film, audio uniquement, d'un numéro de canal de haut-parleur et de réglages de paramètre.

10. Procédé selon la revendication 9, dans lequel les réglages de paramètre des réglages fonctionnels comprennent au moins l'un d'une égalisation, d'un retard et d'un gain.

11. Procédé selon une quelconque revendication précédente, dans lequel le processus de reconfiguration est configuré pour prendre en compte une combinaison prédéfinie de réglages sonores par canal sonore et au moins une option fonctionnelle, dans lequel l'au moins une option fonctionnelle inclut au moins l'un

d'une priorité de siège ;

d'une priorité de zone ;

d'une priorité de mode ;

d'un mode de canal ;

d'un nombre d'auditeurs dans une zone ; et

d'un temps de l'événement.

12. Système sonore audio comprenant

- des moyens de reconfiguration pour mettre en oeuvre le procédé selon l'une quelconque des revendications 1 à 11, et

- un système de reproduction audio comprenant deux canaux sonores ou plus, chaque canal comprenant un transducteur de haut-parleur, et des moyens individuels pour l'égalisation et l'amplification, le système de reproduction audio constituant un équipement de reproduction audio dans une pièce, dans un véhicule, dans un avion, dans un bateau, dans un système PA,

dans lequel les moyens de reconfiguration sont configurés pour appliquer la reconfiguration automatique sur le système de reproduction audio.

Figure 1

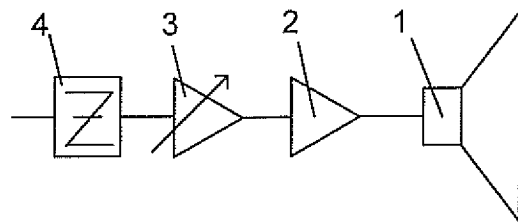
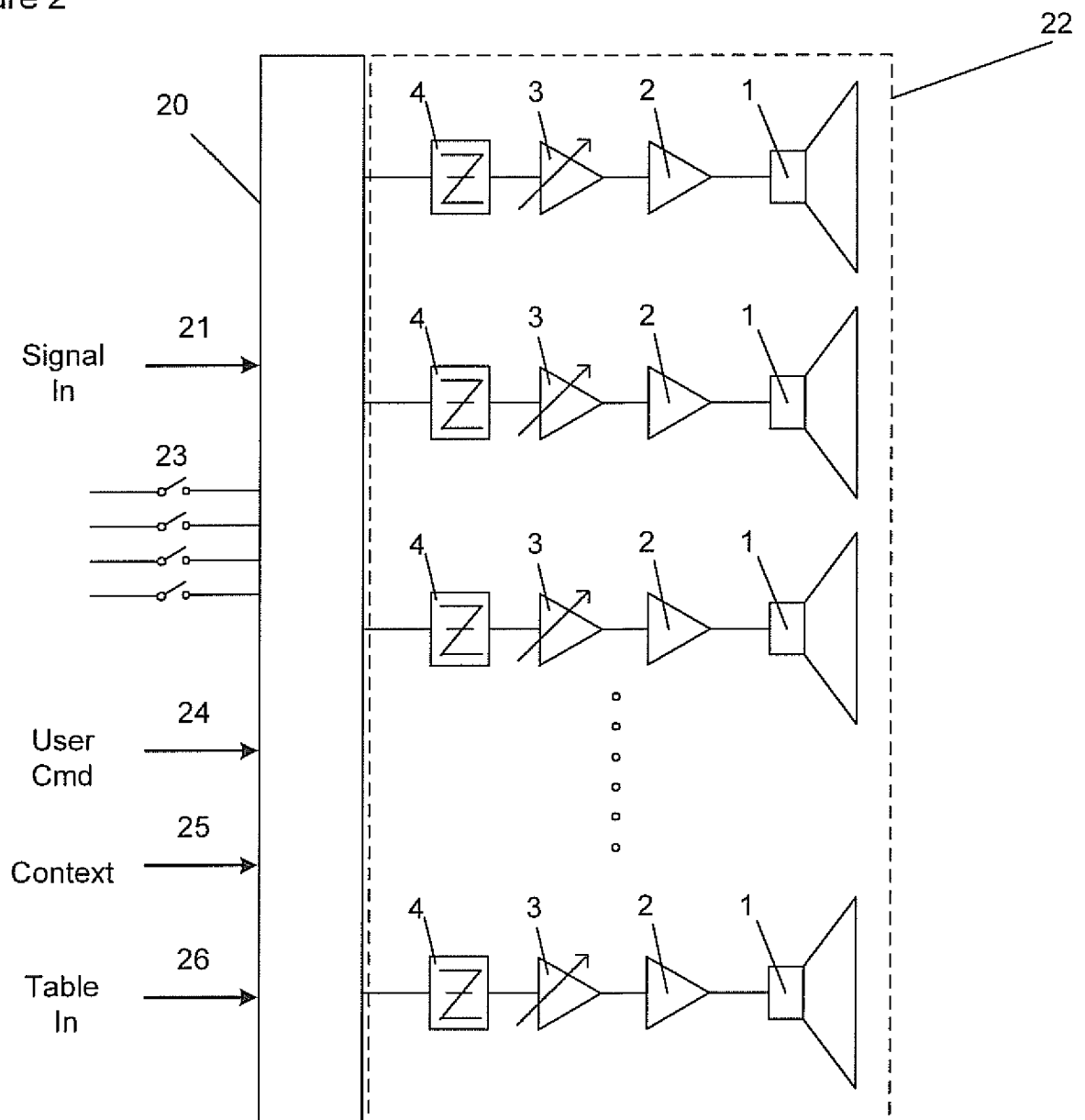


Figure 2



REFERENCES CITED IN THE DESCRIPTION

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