(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 859 439 B1

(12) EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent:
30.10.2013 Bulletin 2013/44

(21) Application number: **06716366.7**

(22) Date of filing: **14.03.2006**

(51) Int Cl.:
G10L 19/008 *(2013.01)* *G10L 19/02* *(2013.01)*

(86) International application number:
PCT/KR2006/000916

(87) International publication number:
WO 2006/098583 (21.09.2006 Gazette 2006/38)

(54) MULTICHANNEL AUDIO COMPRESSION AND DECOMPRESSION METHOD USING VIRTUAL SOURCE LOCATION INFORMATION

MULTIKANAL-AUDIOKOMPRESSIONS- UND DEKOMPRESSIONSVERFAHREN ÜBER VIRTUELLE QUELLENFINDUNGSINFORMATIONEN

PROCEDE DE COMPRESSION DECOMPRESSION AUDIO MULTICANAL UTILISANT DES INFORMATIONS DE LOCALISATION SOURCE VIRTUELLES

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI SK TR

(30) Priority: **14.03.2005 KR 20050021104**
14.03.2006 KR 20060023545

(43) Date of publication of application:
28.11.2007 Bulletin 2007/48

(73) Proprietor: **Electronics and Telecommunications Research Institute**
Daejeon-city 305-350 (KR)

(72) Inventors:
- **SEO, Jeong Il**
  Daejeon 305-728 (KR)
- **BEACK, Seung Kwon**
  Dormitory of Info. & Com. Uni.
  Daejeon 305-348 (KR)
- **JANG, In Seon**
  Gunpo-si,
  Gyeonggi 435-040 (KR)
- **KANG, Kyeong Ok**
  Yuseong-gu,
  Daejeon 305-727 (KR)
- **HONG, Jin Woo**
  Daejeon 305-755 (KR)
- **HAHN, Min Soo**
  Daejeon 305-761 (KR)

(74) Representative: **Betten & Resch**
Theatinerstrasse 8
80333 München (DE)

(56) References cited:
US-A1- 2003 035 553 US-A1- 2003 236 583

- **Han-gil Moon: "Multi-channel audio compression method with virtual source location information for MPEG-4 SAC"[Online] February 2005 (2005-02), XP002605438 Seoul National University Retrieved from the Internet: URL:http: //library.snu.ac.kr/Eng/DetailVie w.jsp? uid=1&cid=1198524&ResultType=Multi> [retrieved on 2010-08-16]**
- **James R. West: "Five-Channel Panning Laws: An Analytical and Experimental Comparison - Chapter 3: IID-based Panning Methods"[Online] 1 May 1998 (1998-05-01), page 24PP, XP002605439 University of Miami Music Engineering Retrieved from the Internet: URL: http://mue.music.miami.edu/thesis/jwes t/Chap_ 3/Chap_3_IID_Based_Panning_Methods. html> [retrieved on 2010-08-18]**
- **PULKII V: "VIRTUAL SOUND SOURCE POSITIONING USING VECTOR BASE AMPLITUDE PANNING" JOURNAL OF THE AUDIO ENGINEERING SOCIETY, vol. 45, no. 6, 1 June 1996 (1996-06-01), pages 456-466, XP000695381 AUDIO ENGINEERING SOCIETY, NEW YORK, NY, US ISSN: 1549-4950**

- FALLER C. AND BAUMGARTE F.: 'Binaural Cue Coding: A Novel and Efficient Representation of Spatial Audio' PROCEEDINGS OF IEEE INTERNATIONAL CONFERENCE ON ACOUSTICS, SPEECH, AND SIGNAL PROCESSING vol. 2, 2002, pages 1841 - 1844, XP010804253

Description

[Technical Field]

[0001] The present invention relates to compression and decompression of a multi-channel audio signal, and more particularly, to a method for compressing and decompressing a multi-channel audio signal based on virtual source location information (VSLI) on a semicircular plane.

[Background Art]

[0002] In a conventional binaural cue coding method, an inter-channel level difference (ICLD) is generally used as spatial cue information in compressing spectral information of a multi-channel audio signal. However, the ICLD is subject to a quantization process before being transmitted. Since the quantization process assigns a limited number of bits, resolution is limited. Accordingly, such information loss in the ICLD deteriorates a decompressed audio signal.

[0003] Virtual source location information (VSCI) is known from the Ph.D. dissertation of Han-gil Moon entitled A Multi-Channel Audio Compression Method with Virtual Source Location Information for MPEG-4 SAC, February 2005.

[Disclosure]

[Technical Problem]

[0004] The present invention as claimed in claims 1-13 is directed to methods for compressing and decompressing a multi-channel audio signal using virtual source location information (VSLI) represented on a limited semicircular plane rather than an ICLD, as a spatial cue parameter, thereby minimizing loss caused by quantization of spatial cue information and improving the sound quality of a decompressed audio signal.

[0005] Also only N-1 pieces of virtual source location information are estimated and transmitted according to a location of a global vector in representing and compressing N multi-channel audio signals using a down-mixed audio signal and virtual source location information and transmitting them to a decoder, thereby reducing an amount of transmitted information.

[Technical Solution]

[0006] One aspect of the present invention provides a method for estimating virtual source location information (VSLI) which is used as spatial cue information in compressing a multi-channel audio signal, the method comprising the steps of: (i) virtually assigning channels of the multi-channel audio signal on a semicircular plane; (ii) converting the multi-channel audio signal into a signal in a frequency domain; (iii) dividing the signal in the frequency domain into a plurality of sub-bands and calculating a signal size of each channel in each sub-band; (iv) estimating a global vector represented on the semicircular plane from the calculated signal size of each channel in each sub-band and virtual location information of each virtually assigned channel signal; and (v) determining whether an angle of the global vector in each sub-band is greater than zero, and estimating local vectors in a first set when the angle of the global vector is greater than zero and in a second set when the angle of the global vector is smaller than zero.

[0007] Another aspect of the present invention provides a method for compressing a multi-channel audio signal based on virtual source location information (VSLI), the method comprising the steps of: obtaining angle information of the global vector and the plurality of local vectors which indicate the virtual source location information estimated by performing the above-described method; quantizing the angle information of the global vector and the local vectors; down-mixing and encoding the input multi-channel audio signal; and multiplexing the encoded, down-mixed audio signal with the quantized angle information of the vectors to finally generate a compressed multi-channel audio signal.

[0008] Yet another aspect of the present invention provides a method for decompressing a compressed multi-channel audio signal represented by virtual source location information (VSLI) and an encoded down-mixed audio signal based on spatial cue information, the method comprising the steps of: (i) predicting inverse panning angle information from the VSLI using a constant power panning rule; (ii) obtaining an estimated power component of each channel in each sub-band using the predicted inverse panning angle information; and (iii) finally decompressing a signal of each channel in each sub-band using the estimated power component of each channel and the down-mixed audio signal.

[Advantageous Effects]

[0009] In the method for compressing a multi-channel signal using virtual source location information on a semicircular plane according to the present invention, spatial cue information is represented using virtual sound location information

(VSLI), thereby minimizing loss caused by quantization of spatial cue information and improving the sound quality of a decompressed audio signal.

[Description of Drawings]

[0010]

FIG. 1 schematically illustrates the configuration of a multi-channel audio encoder that the present invention may be employed;
FIG. 2 is a flowchart illustrating a process of estimating virtual sound location information (VSLI) of a multi-channel audio signal according to an exemplary embodiment of the present invention;
FIG. 3 illustrates an example in which respective channels of a multi-channel audio signal are virtually assigned on a semicircular plane structure according to an exemplary embodiment of the present invention;
FIG. 4 illustrates an example of local vectors estimated in respective sections of a semicircular plane structure shown in FIG. 3; and
FIG. 5 is a flowchart illustrating a process of decoding a multi-channel audio signal that has been compressed and represented based on VSLI according to an exemplary embodiment of the present invention.

[Mode for Invention]

[0011] Hereinafter, exemplary embodiments of the present invention will be described in detail. However, the present invention is not limited to the exemplary embodiments disclosed below, but can be implemented in various forms. Therefore, the present exemplary embodiments are provided for complete disclosure of the present invention and to fully convey the scope of the present invention to those of ordinary skill in the art.

[0012] FIG. 1 schematically illustrates the configuration of a multi-channel audio encoder according to the present invention. Referring to FIG. 1, the multi-channel audio encoder includes a down mixer 110 for down-mixing an input multi-channel audio signal to generate a down-mixed audio signal, an advanced audio coding (AAC) encoding unit 120 for encoding the down-mixed audio signal, a virtual source location information (VSLI) estimating unit 130 for estimating virtual source location information from the multi-channel audio signal, a quantizing unit 140 for quantizing the VSLI, and a multiplexing unit 150 for multiplexing the down-mixed audio signal encoded by the AAC encoding unit 120 with the VSLI quantized by the quantizing unit 140 to finally generate a compressed multi-channel audio signal.

[0013] In the present invention, the virtual source location information (VSLI) is represented by an azimuth angle between virtual source location vectors on a semicircular plane, which are estimated from signal magnitude of respective channels in a multi-channel audio signal, and a center channel. Since (N-1) pieces of virtual source location information are used for N multi-channel audio signals, an amount of the virtual source location information is the same as an inter-channel level difference (ICLD).

[0014] In an exemplary embodiment of the present invention, the virtual sound location vectors include a global vector Gv_b, left and right half-plane vectors LHv_b and RHv_b, and left and right subsequent vectors LSv_b and RSv_b. Angles between the respective vectors and the center channel are represented by Ga_b, LHa_b, RHa_b, LSa_b and RSa_b, respectively.

[0015] In the present invention, the channels of the multi-channel audio signal are virtually assigned on the semicircular plane, and the virtual source location vectors represented on the semicircular plane are estimated from signal magnitude of the respective channels. A set of the estimated virtual source location vectors varies with the location of the global vector. Information about an angle between each estimated virtual source location vector and the center channel will be transmitted as the virtual source location information together with the down-mixed audio signal to the decoder.

[0016] FIG. 2 is a flowchart illustrating a process of estimating VSLI of a multi-channel audio signal according to an exemplary embodiment of the present invention.

[0017] In step 210, respective channels of an input multi-channel audio signal are virtually assigned to a two-dimensional semicircular plane. FIG. 3 shows an example of five channels of C, L, R, Ls and Rs of a multi-channel audio signal assigned on the semicircular plane at 45° intervals, and a global vector which is estimated from the channels, according to an exemplary embodiment of the present invention.

[0018] In step 220, the multi-channel audio signal is converted into a signal in a frequency domain. In step 230, the signal in the frequency domain is divided into a plurality of sub-bands and the signal magnitude of each channel in each sub-band is calculated using the following Equation 1:

Equation 1

$$M_{ch,b} = \sum_{n=B_b}^{B_{b+1}-1} \left| S_{ch,n} \right|,$$

where $S_{ch,n}$ denotes a frequency coefficient of the ch-th channel. In an embodiment of the present invention, ch denotes one of a center channel (C), left channel (L), right channel (R), left surround channel (Ls), and right surround channel (Rs). B_b and B_{b+1}-1 denote frequency indexes corresponding to upper and lower boundaries of the sub-band B_b, respectively.

[0019] In step 240, a global vector represented on the semicircular plane assigned the channels is estimated from the signal magnitude of each channel in each sub-band. In the sub-band b, a global vector Gv_b is estimated using the following Equation 2:

Equation 2

$$G_{v_b} = A_1 \times M_{c,b} + A_2 \times M_{L,b} + A_3 \times M_{R,b} + A_4 \times M_{Ls,b} + A_5 \times M_{Rs,b},$$

where A_i denotes virtual location information of each channel signal assigned on the semicircular plane. It may be mapping information of each channel that is assigned on the semicircular plane in step 210. In the embodiment shown in FIG. 3, the virtual location information may be defined as A_1=cos0°+jsin0°, A_2=cos45°-jsin45°, A_3=cos45°+jsin45°, A_4=cos90°-jsin90°, and A_5=cos90°+jsin90° in order of the center, left, right, left surround, and right surround channel signals.

[0020] In step 250, it is determined whether the angle Ga_b of the global vector in each sub-band is greater than zero. In step 260, if the angle of the global vector is greater than zero, a first set of local vectors are estimated. In step 270, if the angle of the global vector is smaller than zero, a second set of local vectors are estimated. In an embodiment, the first set of local vectors includes LHv_b, LSv_b, and RSv_b, and the second set of local vectors includes RHa_b, RSa_b, and LSa_b.

[0021] Local vectors for sections of the semicircular plane are estimated using the following Equations 3. An embodiment thereof is shown in FIG. 4.

Equations 3

$$LHv_b = A_1 \times M_{C,b} + A_2 \times M_{L,b} + A_4 \times M_{Ls,b}$$

$$RHv_b = A_1 \times M_{C,b} + A_3 \times M_{R,b} + A_5 \times M_{Rs,b},$$

$$LSv_b = A_2 \times M_{L,b} + A_4 \times M_{Ls,b}, \text{ and}$$

$$RSv_b = A_3 \times M_{R,b} + A_5 \times M_{Rs,b}.$$

[0022] In step 280, the angle of the global vector and the angles of the local vectors estimated in step 260 or 270 are transmitted as the VSLI to the decoder. That is, if the angle Ga_b of the global vector is smaller than zero, {Ga_b, RHa_b, RSa_b, LSa_b} is transmitted, and otherwise, {Ga_b, LHa_b, LSa_b, RSa_b} is transmitted.

[0023] In this manner, according to the present invention, it can be seen that the spatial cue information for N multi-channel audio signals can be represented by N-1 pieces of virtual source location information.

[0024] FIG. 5 is a flowchart illustrating a process of decoding a multi-channel audio signal that has been compressed and represented based on VSLI according to an exemplary embodiment of the present invention. The decoder estimates vector information of original sound from virtual source location information received together with the encoded down-mixed audio signal. The sound vector is represented by its magnitude and angle. The vector angle can be obtained from the received VSLI, and the vector magnitude can be obtained from the received down-mixed audio signal.

[0025] Specifically, as shown in FIG. 5, an inverse panning angle is predicted from the VSLI using a constant power panning (CPP) rule (S510). In this case, a method for predicting the other inverse panning angles depends on the angle Ga_b of the global vector. The inverse panning angle is predicted using the following Equations 4:

Equations 4

if $Ga_b \geq 0$,

$$\theta_1 = \left(\frac{Ga_b - LHa_b}{RSa_b - LHa_b} \right) \times \frac{\pi}{2}, \quad \theta_2 = \left(\frac{LHa_b - LSa_b}{0 - LSa_b} \right) \times \frac{\pi}{2}$$

$$\theta_3 = \left(\frac{LSa_b + \pi/2}{-\pi/4 + \pi/2} \right) \times \frac{\pi}{2}, \quad \theta_4 = \left(\frac{RSa_b - \pi/2}{\pi/4 - \pi/2} \right) \times \frac{\pi}{2}$$

and, if $Ga_b < 0$,

$$\theta_1 = \left(\frac{Ga_b - RHa_b}{LSa_b - RHa_b} \right) \times \frac{\pi}{2}, \quad \theta_2 = \left(\frac{RHa_b - RSa_b}{0 - RSa_b} \right) \times \frac{\pi}{2}$$

$$\theta_3 = \left(\frac{RSa_b - \pi/2}{\pi/4 - \pi/2} \right) \times \frac{\pi}{2}, \quad \theta_4 = \left(\frac{LSa_b + \pi/2}{-\pi/4 + \pi/2} \right) \times \frac{\pi}{2}$$

[0026] In step 520, an estimated power component for each channel in the sub-band is obtained from the predicted inverse panning angle. The estimated power component for each channel is obtained using the following Equations 5:

Equations 5

$$\text{if } Ga_b \geq 0,$$

$$F_{C,b} = \cos(\theta_1)\sin(\theta_2),$$

$$F_{L,b} = \cos(\theta_1)\cos(\theta_2)\sin(\theta_3),$$

$$F_{Ls,b} = \cos(\theta_1)\cos(\theta_2)\cos(\theta_3),$$

$$F_{R,b} = \sin(\theta_1)\sin(\theta_4), \text{ and}$$

$$F_{Rs,b} = \sin(\theta_1)\cos(\theta_4); \text{ and}$$

$$\text{if } Ga_b < 0,$$

$$F_{C,b} = \cos(\theta_1)\sin(\theta_2),$$

$$F_{L,b} = \sin(\theta_1)\sin(\theta_4),$$

$$F_{Ls,b} = \sin(\theta_1)\cos(\theta_4),$$

$$F_{R,b} = \cos(\theta_1)\cos(\theta_2)\sin(\theta_3), \text{ and}$$

$$F_{Rs,b} = \cos(\theta_1)\cos(\theta_2)\cos(\theta_3).$$

[0027] In step 530, each channel signal in each sub-band can be finally decompressed based on the down-mixed audio signal and the estimated power component for each channel according to the following equation:

Equation 6

$$U_{ch,k} = F_{ch,b} S'_k, \qquad B_b \leq k \leq B_{b+1} - 1$$

where S'_k denotes a frequency component coefficient of the received down-mixed signal, and $U_{ch,k}$ denotes the decompressed audio signal.

[0028] The present invention described above may be provided as one or more computer programs which are implemented on one or more computer-readable mediums. The mediums may include a floppy disc, a hard disc, a CD-ROM, a flash memory card, a programmable read only memory (PROM), a random access memory (RAM), a read only memory (ROM), and a magnetic tape. In general, the computer program may be written in any programming language, such as C, C++, and JAVA.

[0029] While the invention has been shown and described with reference to certain exemplary embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the scope of the invention as defined by the appended claims.

Claims

1. A method for estimating virtual source location information (VSLI) that is used as spatial cue information in compressing a multi-channel audio signal, the method comprising the steps of:

   (i) virtually assigning each channel of the multi-channel audio signal to a semicircular plane, using virtual location information indicating a mapping of each channel on the semicircular plane;
   (ii) converting the multi-channel audio signal into a frequency domain signal;
   (iii) dividing the frequency domain signal into a plurality of sub-bands and calculating signal magnitude of each channel in each sub-band;
   (iv) for each sub-band, estimating a global vector represented on the semicircular plane from the calculated signal magnitude of each channel in the sub-band and from the virtual location information of each virtually assigned channel signal;
   (v) for each sub-band, determining whether an angle between the global vector and a center channel is greater than zero and
   estimating a first set of virtual source location vectors when the angle is greater than zero and
   estimating a second set of virtual source location vectors when the angle is smaller than zero; and
   (vi) using information on an angle between each estimated virtual source location vector and the center channel as virtual source location information.

2. The method of claim 1, wherein step (iii) comprises calculating the signal magnitude of each channel in each sub-band using the following equation:

$$M_{ch,b} = \sum_{n=B_b}^{B_{b+1}-1} \left|S_{ch,n}\right|,$$

   where $S_{Ch,n}$ denotes a frequency coefficient of the ch-th channel, ch denotes one of a center channel (C), left channel (L), right channel (R), left surround channel (Ls), and right surround channel (Rs), and B_b and B_{b+1-1} denote frequency indexes corresponding to upper and lower boundaries of the sub-band B_b, respectively.

3. The method of claim 2, wherein step (iv) comprises estimating the global vector for each sub-band using the following equation:

$$G_{v_b} = A_1 \times M_{c,b} + A_2 \times M_{L,b} + A_3 \times M_{R,b} + A_4 \times M_{Ls,b} + A_5 \times M_{Rs,b},$$

   where A_1 denotes virtual location information of the center channel, A_2 denotes virtual location information of the left channel, A_3 denotes virtual location information of the right channel, A_4 denotes virtual location information of the left surround channel, and A_5 denotes virtual location information of the right surround channel.

4. The method of claim 3, wherein
   A_1=cos0°+jsin0°, A_2=cos45°-jsin45°, A_3=cos45°+jsin45 °, A_4=cos90°-jsin90°, and A_5=cos90° +jsin90°.

5. The method of claim 1, wherein in step (v), the first set of local vectors includes a right half-plane vector RHv_b, a right subsequent vector RSv_b and a left subsequent vector LSv_b, and the second set of local vectors includes a left half-plane vector LHv_b, a left subsequent vector LSv_b and a right subsequent vector RSv_b.

6. The method of claim 5, wherein in step (v), the right half-plane vector RHv_b is estimated using the signal magnitude of center, right, and right surround channels calculated in step (iii); the right subsequent vector RSv_b is estimated using signal magnitude of right and right surround channels calculated in step (iii); the left half-plane vector LHv_b is estimated using signal magnitude of the center, left and left surround channels calculated in step (iii); and the left

subsequent vector LSv_b is estimated using signal magnitude of left and left surround channels calculated in step (iii).

7. The method of claim 6, wherein the right half-plane vector RHv_b, the right subsequent vector RSv_b, the left half-plane vector LHv_b and the left subsequent vector LSv_b are estimated using the following equations:

$$LH_{v_b} = A_1 \times M_{c,b} + A_2 \times M_{L,b} + A_4 \times M_{Ls,b}$$

$$RH_{v_b} = A_1 \times M_{c,b} + A_3 \times M_{R,b} + \quad A_5 \times M_{Rs,b}$$

$$LS_{v_b} = A_2 \times M_{L,b} + A_4 \times M_{Ls,b},$$

and

$$RS_{v_b} = A_3 \times M_{R,b} + + A_5 \times M_{Rs,b}.$$

8. The method of claim 5, wherein when the angle of the global vector Ga_b is greater than zero, angle information of the global vector and the first set of local vectors is transmitted to a decoder, and otherwise, angle information of the global vector and the second set of local vectors is transmitted to the decoder.

9. A method for compressing a multi-channel audio signal based on virtual source location information (VSLI), the method comprising the steps of:

obtaining angle information of a global vector and a plurality of local vectors which represent the virtual source location information estimated by performing the method of any one of claims 1 to 7;
quantizing the angle information of the global vector and the local vectors;
down-mixing and encoding the input multi-channel audio signal; and
multiplexing the encoded, down-mixed audio signal with the quantized angle information of the vectors to finally generate a compressed multi-channel audio signal.

10. A method for decompressing a compressed multi-channel audio signal represented by virtual source location information (VSLI) and an encoded down-mixed audio signal based on spatial cue information, wherein the virtual source location information comprises angle information on an angle between a global vector, estimated from the channels of the multi-channel audio signal, and a center channel of the multi-channel audio signal, the method comprising the steps of:

(i) predicting inverse panning angle information from the VSLI using a constant power panning rule, wherein the prediction scheme of the inverse panning angle information differs depending on the angle information of the global vector;
(ii) obtaining an estimated power component of each channel in each sub-band using the predicted inverse panning angle information; and
(iii) finally decompressing a signal of each channel in each sub-band using the estimated power component of each channel and the down-mixed audio signal, wherein step (i) includes predicting inverse panning angles θ_1, θ_2, θ_3, and θ_4 from the global vector angle Ga_b, the left half-plane vector angle LHa_b, the left subsequent vector angle LSa_b and right subsequent vector angle RSa_b in the virtual source location information when the global vector angle Ga_b in the virtual source location information is greater than zero, and from the global vector angle Ga_b, right half-plane vector angle RHa_b, right subsequent vector angle RSa_b and left subsequent vector angle LSa_b in the virtual source location information when the global vector angle Ga_b is smaller than zero.

11. The method of claim 10, wherein in step (i), the inverse panning angles θ_1, θ_2, θ_3, and θ_4 are estimated using the following equations:

If $Ga_b \geq 0$,

$$\theta_1 = \left(\frac{Ga_b - LHa_b}{RSa_b - LHa_b} \right) \times \frac{\pi}{2}, \quad \theta_2 = \left(\frac{LHa_b - LSa_b}{0 - LSa_b} \right) \times \frac{\pi}{2}$$

$$\theta_3 = \left(\frac{LSa_b + \pi/2}{-\pi/4 + \pi/2} \right) \times \frac{\pi}{2}, \quad \theta_4 = \left(\frac{RSa_b - \pi/2}{\pi/4 - \pi/2} \right) \times \frac{\pi}{2}$$

and, if $Ga_b < 0$,

$$\theta_1 = \left(\frac{Ga_b - RHa_b}{LSa_b - RHa_b} \right) \times \frac{\pi}{2}, \quad \theta_2 = \left(\frac{RHa_b - RSa_b}{0 - RSa_b} \right) \times \frac{\pi}{2}$$

$$\theta_3 = \left(\frac{RSa_b - \pi/2}{\pi/4 - \pi/2} \right) \times \frac{\pi}{2}, \quad \theta_4 = \left(\frac{LSa_b + \pi/2}{-\pi/4 + \pi/2} \right) \times \frac{\pi}{2}.$$

12. The method of claim 11, wherein step (ii) comprises obtaining the estimated power component of each channel in each sub-band using the following equations:

If $Ga_b \geq 0$,

$$F_{C,b} = \cos(\theta_1)\sin(\theta_2),$$

$$F_{L,b} = \cos(\theta_1)\cos(\theta_2)\sin(\theta_3),$$

$$F_{Ls,b} = \cos(\theta_1)\cos(\theta_2)\cos(\theta_3),$$

$$F_{R,b} = \sin(\theta_1)\sin(\theta_4),$$

and

$$F_{Rs,b} = \sin(\theta_1)\cos(\theta_4);$$

and
if $Ga_b < 0$,

$$F_{C,b} = \cos(\theta_1)\sin(\theta_2),$$

$$F_{L,b} = \sin(\theta_1)\sin(\theta_4),$$

$$F_{Ls,b} = \sin(\theta_1)\cos(\theta_4),$$

$$F_{R,b} = \cos(\theta_1)\cos(\theta_2)\sin(\theta_3),$$

and

$$F_{Rs,b} = \cos(\theta_1)\cos(\theta_2)\cos(\theta_3).$$

13. The method of claim 12, wherein step (iii) includes decompressing a signal of each channel in each sub-band using the following equation:

$$U_{ch,k} = F_{ch,b}S'_k, \qquad B_b \leq k \leq B_{b+1} - 1,$$

where S'_k denotes a frequency component coefficient of a received down-mixed signal, and $U_{ch,k}$ denotes a decompressed audio signal.

14. A computer-readable medium having a computer program recorded thereon for performing the method of any of claims 1 to 9.

15. A computer-readable medium having a computer program recorded thereon for performing the method of any one of claims 10 to 13.

Patentansprüche

1. Verfahren zum Schätzen von virtuellen Quellenlokalisierungsinformationen (VSLI), die als räumliche Markierungsinformationen bei der Komprimierung eines Mehrkanal-Audiosignals verwendet werden, wobei das Verfahren die folgenden Schritte umfasst:

(i) virtuelles Zuweisen jedes Kanals des Mehrkanal-Audiosignals zu einer Halbkreisebene unter Verwendung von virtuellen Lokalisierungsinformationen, die eine Abbildung jedes Kanals auf die Halbkreisebene angeben;
(ii) Umsetzen des Mehrkanal-Audiosignals in ein Frequenzbereichssignal;
(iii) Unterteilen des Frequenzbereichssignals in mehrere Unterbänder und Berechnen der Signalgröße jedes Kanals in jedem Unterband;
(iv) für jedes Unterband Schätzen eines globalen Vektors, der auf der Halbkreisebene dargestellt wird, aus der

berechneten Signalgröße jedes Kanals in dem Unterband und aus den virtuellen Lokalisierungsinformationen des Signals jedes virtuell zugewiesenen Kanals;
(v) für jedes Unterband Bestimmen, ob ein Winkel zwischen dem globalen Vektor und einem mittleren Kanal größer als null ist, und
Schätzen einer ersten Menge von virtuellen Quellenlokalisierungsvektoren, wenn der Winkel größer als null ist, und
Schätzen einer zweiten Menge von virtuellen Quellenlokalisierungsvektoren, wenn der Winkel kleiner als null ist; und
(vi) Verwenden von Informationen über einen Winkel zwischen jedem geschätzten virtuellen Quellenlokalisierungsvektor und dem mittleren Kanal als virtuelle Quellenlokalisierungsinformationen.

2. Verfahren nach Anspruch 1, wobei der Schritt (iii) das Berechnen der Signalgröße jedes Kanals in jedem Unterband unter Verwendung der folgenden Gleichung umfasst:

$$M_{ch,b} = \sum_{n=B_b}^{B_{b+1}-1} \left| S_{ch,n} \right|$$

wobei $S_{ch,n}$ einen Frequenzkoeffizienten des *ch-th*-Kanals bezeichnet, *ch* einen mittleren Kanal (C), einen linken Kanal (L), einen rechten Kanal (R), einen linken Surround-Kanal (Ls) oder einen rechten Surround-Kanal (Rs) bezeichnet und B_b und B_{b+1}-1 Frequenzindizes bezeichnen, die einer oberen bzw. einer unteren Grenze des Unterbandes B_b entsprechen.

3. Verfahren nach Anspruch 2, wobei der Schritt (iv) das Schätzen des globalen Vektors für jedes Unterband unter Verwendung der folgenden Gleichung umfasst:

$$Gv_b = A_1 \times M_{c,b} + A_2 \times M_{L,b} + A_3 \times M_{R,b} + A_4 \times M_{Ls,b} + A_5 \times M_{Rs,b}$$

wobei A_1 virtuelle Lokalisierungsinformationen des Mittelkanals bezeichnet, A_2 virtuelle Lokalisierungsinformationen des linken Kanals bezeichnet, A_3 virtuelle Lokalisierungsinformationen des rechten Kanals bezeichnet, A_4 virtuelle Lokalisierungsinformationen des linken Surround-Kanals bezeichnet und A_5 virtuelle Lokalisierungsinformationen des rechten Surround-Kanals bezeichnet.

4. Verfahren nach Anspruch 3, wobei
A_1 = cos0° + jsin0°, A_2 = cos45° - j sin45°, A_3 = cos45° + jsin45°, A_4 = cos90° - jsin90° und A_5 = cos90° + jsin90°.

5. Verfahren nach Anspruch 1, wobei im Schritt (v) die erste Menge lokaler Vektoren einen Vektor RHv_b der rechten Halbebene, einen rechten nachfolgenden Vektor RSv_b und einen linken nachfolgenden Vektor LSv_b enthält und die zweite Menge lokaler Vektoren einen Vektor LHv_b der linken Halbebene, einen linken nachfolgenden Vektor LSv_b und einen rechten nachfolgenden Vektor RSv_b enthält.

6. Verfahren nach Anspruch 5, wobei im Schritt (v) der Vektor RHv_b der rechten Halbebene unter Verwendung der Signalgröße des mittleren, des rechten Kanalsund des rechten Surround-Kanals, die im Schritt (iii) berechnet werden, geschätzt wird; der rechte nachfolgende Vektor RSv_b unter Verwendung der Signalgröße des rechten Kanals und des rechten Surround-Kanals, die im Schritt (iii) berechnet werden, geschätzt wird; der Vektor LHv_b der linken Halbebene unter Verwendung der Signalgröße des mittleren, des linken Kanals und des linken Surround-Kanals, die im Schritt (iii) berechnet werden, geschätzt wird; und der linke nachfolgende Vektor LSv_b unter Verwendung der Signalgröße des linken Kanals und des linken Surround-Kanals, die im Schritt (iii) berechnet werden, geschätzt wird.

7. Verfahren nach Anspruch 6, wobei der Vektor RHv_b der rechten Halbebene, der rechte nachfolgende Vektor RSv_b, der Vektor LHv_b der linken Halbebene und der linke nachfolgende LSv_b unter Verwendung der folgenden Gleichungen geschätzt werden:

$$LHv_b = A_1 \times M_{c,b} + A_2 \times M_{L,b} + A_4 \times M_{Ls,b}$$

$$RHv_b = A_1 \times M_{c,b} + A_3 \times M_{R,b} + A_4 \times M_{Rs,b}$$

$$LSv_b = A_2 \times M_{L,b} + A_4 \times M_{Ls,b}$$

und

$$RSv_b = A_3 \times M_{R,b} + A_5 \times M_{Rs,b} .$$

8. Verfahren nach Anspruch 5, wobei dann, wenn der Winkel des globalen Vektors Ga_b größer als null ist, Winkelinformationen des globalen Vektors und der ersten Menge lokaler Vektoren an einen Decodierer gesendet werden und andernfalls Winkelinformationen des globalen Vektors und der zweiten Menge lokaler Vektoren zu dem Decodierer gesendet werden.

9. Verfahren zum Komprimieren eines Mehrkanal-Audiosignals anhand virtueller Quellenlokalisierungsinformationen (VSLI), wobei das Verfahren die folgenden Schritte umfasst:

Erhalten von Winkelinformationen eines globalen Vektors und mehrerer lokaler Vektoren, die die virtuellen Quellenlokalisierungsinformationen darstellen, die durch Ausführen des Verfahrens nach einem der Ansprüche 1 bis 7 geschätzt werden;
Quantisieren der Winkelinformationen des globalen Vektors und der lokalen Vektoren;
Abwärtsmischen und Codieren des eingehenden Mehrkanal-Audiosignals; und
Multiplexieren des codierten, abwärts gemischten Audiosignals mit den quantisierten Winkelinformationen der Vektoren, um schließlich ein komprimiertes Mehrkanal-Audiosignal zu erzeugen.

10. Verfahren zum Dekomprimieren eines komprimierten Mehrkanal-Audio-signals, das durch virtuelle Quellenlokalisierungsinformationen (VSLI) und ein codiertes abwärts gemischtes Audiosignal dargestellt wird, anhand von räumlichen Markierungsinformationen, wobei die virtuellen Quellenlokalisierungsinformationen Winkelinformationen über einen Winkel zwischen einem globalen Vektor, der aus den Kanälen des Mehrkanal-Audiosignals geschätzt wird, und einem mittleren Kanal des Mehrkanal-Audiosignals umfasst, wobei das Verfahren die folgenden Schritte umfasst:

(i) Vorhersagen inverser Schwenkwinkelinformationen aus den VSLI unter Verwendung einer Konstantleistungs-Schwenkregel, wobei sich das Vorhersageschema der inversen Schwenkwinkelinformationen in Abhängigkeit von den Winkelinformationen des globalen Vektors unterscheidet;
(ii) Erhalten einer geschätzten Leistungskomponente jedes Kanals in jedem Unterband unter Verwendung der vorhergesagten inversen Schwenkwinkelinformationen; und
(iii) schließlich Dekomprimieren eines Signals jedes Kanals in jedem Unterband unter Verwendung der geschätzten Leistungskomponente jedes Kanals und des abwärts gemischten Audiosignals, wobei der Schritt (i) das Vorhersagen inverser Schwenkwinkel θ_1, θ_2, θ_3 und θ_4 aus dem Winkel Ga_b des globalen Vektors, dem Winkel LHa_b des Vektors der linken Halbebene, dem Winkel LSa_b des linken nachfolgenden Vektors und aus dem Winkel RSa_b des rechten nachfolgenden Vektors in den virtuellen Quellenlokalisierungsinformationen umfasst, wenn der Winkel GA_b des globalen Vektors in den virtuellen Quellenlokalisierungsinformationen größer als null ist, und aus dem Winkel Ga_b des globalen Vektors, dem Winkel RHa_b des Vektors der rechten Halbebene, dem Winkel RSa_b des rechten nachfolgenden Vektors und dem Winkel LSa_b des linken nachfolgenden Vektors in den virtuellen Quellenlokalisierungsinformationen, wenn der Winkel GA_b des globalen Vektors kleiner als null ist.

11. Verfahren nach Anspruch 10, wobei im Schritt (i) die inversen Schwenkwinkel θ_1, θ_2, θ_3 und θ_4 unter Verwendung der folgenden Gleichungen geschätzt werden:

falls $Ga_b \geq 0$,

$$\theta_1 = \left(\frac{Ga_b - LHa_b}{RSa_b - LHa_b}\right) \times \frac{\pi}{2}, \quad \theta_2 = \left(\frac{LHa_b - LSa_b}{0 - LSa_b}\right) \times \frac{\pi}{2}$$

$$\theta_3 = \left(\frac{LSa_b + \pi/2}{-\pi/4 + \pi/2}\right) \times \frac{\pi}{2}, \quad \theta_4 = \left(\frac{RSa_b - \pi/2}{\pi/4 - \pi/2}\right) \times \frac{\pi}{2}$$

und falls $Ga_b < 0$,

$$\theta_1 = \left(\frac{Ga_b - RHa_b}{LSa_b - RHa_b}\right) \times \frac{\pi}{2}, \quad \theta_2 = \left(\frac{RHa_b - RSa_b}{0 - RSa_b}\right) \times \frac{\pi}{2}$$

$$\theta_3 = \left(\frac{RSa_b - \pi/2}{\pi/4 - \pi/2}\right) \times \frac{\pi}{2}, \quad \theta_4 = \left(\frac{LSa_b + \pi/2}{-\pi/4 + \pi/2}\right) \times \frac{\pi}{2}.$$

12. Verfahren nach Anspruch 11, wobei der Schritt (ii) das Erhalten der geschätzten Leistungskomponente jedes Kanals in jedem Unterband unter Verwendung der folgenden Gleichungen umfasst:

falls $Ga_b \geq 0$,

$$F_{C,b} = \cos(\theta_1)\sin(\theta_2),$$

$$F_{L,b} = \cos(\theta_1)\cos(\theta_2)\sin(\theta_3),$$

$$F_{Ls,b} = \cos(\theta_1)\cos(\theta_2)\cos(\theta_3),$$

$$F_{R,b} = \sin(\theta_1)\sin(\theta_4),$$

und

$$F_{Rs,b} = \sin(\theta_1)\cos(\theta_4);$$

und
falls $Ga_b < 0$,

$$F_{C,b} = \cos(\theta_1)\sin(\theta_2),$$

$$F_{L,b} = \sin(\theta_1)\sin(\theta_4),$$

$$F_{Ls,b} = \sin(\theta_1)\cos(\theta_4),$$

$$F_{R,b} = \cos(\theta_1)\cos(\theta_2)\sin(\theta_3),$$

und

$$F_{Rs,b} = \cos(\theta_1)\cos(\theta_2)\cos(\theta_3).$$

13. Verfahren nach Anspruch 12, wobei der Schritt (iii) das Dekomprimieren eines Signals jedes Kanals in jedem Unterband unter Verwendung der folgenden Gleichung umfasst:

$$U_{ch,k} = F_{ch,b}S'_k,\ B_b \leq k\ B_{b+1}-1$$

wobei S'_k einen Frequenzkomponentenkoeffizienten eines empfangenen abwärts gemischten Signals bezeichnet und $U_{ch,k}$ ein dekomprimiertes Audiosignal bezeichnet.

14. Computerlesbares Medium, das ein Computerprogramm besitzt, das darauf aufgezeichnet ist, um das Verfahren nach einem der Ansprüche 1 bis 9 auszuführen.

15. Computerlesbares Medium, das ein Computerprogramm besitzt, das darauf aufgezeichnet ist, um das Verfahren nach einem der Ansprüche 10 bis 13 auszuführen.

Revendications

1. Procédé d'estimation d'informations de localisation de source virtuelles (VLSI) qui sont utilisées en qualité d'informations de repérage spatial en vue de compresser un signal audio multicanal, le procédé comprenant les étapes ci-dessous consistant à :

(i) affecter virtuellement chaque canal du signal audio multicanal à un plan semi-circulaire, en utilisant des informations de localisation virtuelles indiquant une mise en concordance de chaque canal sur le plan semi-circulaire ;
(ii) convertir le signal audio multicanal en un signal du domaine fréquentiel ;
(iii) diviser le signal du domaine fréquentiel en une pluralité de sous-bandes et calculer l'amplitude du signal de chaque canal dans chaque sous-bande ;
(iv) pour chaque sous-bande, estimer un vecteur global représenté sur le plan semi-circulaire à partir de l'amplitude de signal calculée de chaque canal dans la sous-bande et à partir des informations de localisation virtuelles de chaque signal de canal affecté virtuellement ;
(v) pour chaque sous-bande, déterminer si un angle entre le vecteur global et un canal central est supérieur à zéro ; et
estimer un premier ensemble de vecteurs de localisation de source virtuels lorsque l'angle est supérieur à zéro ;

et
estimer un second ensemble de vecteurs de localisation de source virtuels lorsque l'angle est inférieur à zéro ; et
(vi) utiliser les informations sur un angle entre chaque vecteur de localisation de source virtuel estimé et le canal central, en qualité d'informations de localisation de source virtuelles.

2. Procédé selon la revendication 1, dans lequel l'étape (iii) consiste à calculer l'amplitude du signal de chaque canal dans chaque sous-bande, en utilisant l'équation ci-dessous :

$$M_{ch,b} = \sum_{n=B_b}^{B_{b+1}-1} \left| S_{ch,n} \right|,$$

où $S_{Ch.n}$ représente un coefficient de fréquence du ch-ième canal, ch représente l'un parmi un canal central (C), un canal gauche (L), un canal droit (R), un canal ambiophonique gauche (Ls), et un canal ambiophonique droit (Rs), et B_b et B_{b+1}-1 représentent des indices de fréquence correspondant aux limites supérieure et inférieure de la sous-bande B_b, respectivement.

3. Procédé selon la revendication 2, dans lequel l'étape (iv) consiste à estimer le vecteur global pour chaque sous-bande, en utilisant l'équation ci-dessous :

$$G_{vb} = A_1 \times M_{c,b} + A_2 \times M_{L,b} + A_3 \times M_{R,b} + A_4 \times M_{Ls,b} + A_5 \times M_{Rs,b} ;$$

où A_1 représente les informations de localisation virtuelles du canal central, A_2 représente les informations de localisation virtuelles du canal gauche, A_3 représente les informations de localisation virtuelles du canal droit, A_4 représente les informations de localisation virtuelles du canal ambiophonique gauche, et A_5 représente les informations de localisation virtuelles du canal ambiophonique droit.

4. Procédé selon la revendication 3, dans lequel
$A_1 = \cos 0° + j\sin 0°$, $A_2 = \cos 45° - j\sin 45°$, $A_3 = \cos 45° + j\sin 45°$, $A_4 = \cos 90° - j\sin 90°$, et $A_5 = \cos 90° + j\sin 90°$.

5. Procédé selon la revendication 1, dans lequel, à l'étape (v), le premier ensemble de vecteurs locaux inclut un vecteur de demi-plan droit RHv_b, un vecteur subséquent droit RSv_b et un vecteur subséquent gauche LSv_b, et le second ensemble de vecteurs locaux inclut un vecteur de demi-plan gauche LHv_b, un vecteur subséquent gauche LSv_b et un vecteur subséquent droit RSv_b.

6. Procédé selon la revendication 5, dans lequel, à l'étape (v), le vecteur de demi-plan droit RH_{vb} est estimé en utilisant l'amplitude du signal des canaux central, droit et ambiophonique droit, calculée à l'étape (iii) ; le vecteur subséquent droit RSv_b est estimé en utilisant l'amplitude du signal des canaux droit et ambiophonique droit, calculée à l'étape (iii) ; le vecteur de demi-plan gauche LH_{Vb} est estimé en utilisant l'amplitude du signal des canaux central, gauche et ambiophonique gauche, calculée à l'étape (iii) ; et le vecteur subséquent gauche LSv_b est estimé en utilisant l'amplitude du signal des canaux gauche et ambiophonique gauche, calculée à l'étape (iii).

7. Procédé selon la revendication 6, dans lequel le vecteur de demi-plan droit RHv_b, le vecteur subséquent droit RS_{Vb}, le vecteur de demi-plan gauche LHv_b et le vecteur subséquent gauche LSv_b sont estimés en utilisant les équations ci-dessous :

$$LH_{vb} = A_1 \times M_{c,b} + A_2 \times M_{L,b} + A_4 \times M_{Ls,b}$$

$$RH_{vb} = A_1 \times M_{c,b} + A_3 \times M_{R,b} + A_5 \times M_{Rs,b}$$

$$LS_{vb} = A_2 \times M_{L,b} + A_4 \times M_{Ls,b},$$

et

$$RS_{vb} = A_3 \times M_{R,b} + A_5 \times M_{Rs,b}.$$

8. Procédé selon la revendication 5, dans lequel, lorsque l'angle du vecteur global Ga_b est supérieur à zéro, les informations d'angle du vecteur global et du premier ensemble de vecteurs locaux sont transmises à un décodeur, et sinon, les informations d'angle du vecteur global et du second ensemble de vecteurs locaux sont transmises au décodeur.

9. Procédé de compression d'un signal audio multicanal sur la base d'informations de localisation de source virtuelles (VLSI), le procédé comprenant les étapes ci-dessous consistant à :

obtenir des informations d'angle d'un vecteur global et d'une pluralité de vecteurs locaux qui représentent les informations de localisation de source virtuelles estimées en mettant en oeuvre le procédé selon l'une quelconque des revendications 1 à 7 ;
quantifier les informations d'angle du vecteur global et des vecteurs locaux ;
réduire par mixage et coder le signal audio multicanal d'entrée ; et
multiplexer le signal audio codé réduit par mixage avec les informations d'angle quantifiées des vecteurs, en vue de générer finalement un signal audio multicanal compressé.

10. Procédé de décompression d'un signal audio multicanal compressé représenté par des informations de localisation de source virtuelles (VLSI), et d'un signal audio codé réduit par mixage, sur la base d'informations de repérage spatial, dans lequel les informations de localisation de source virtuelles comportent des informations d'angle sur un angle entre un vecteur global, estimé à partir des canaux du signal audio multicanal, et un canal central du signal audio multicanal, le procédé comprenant les étapes ci-dessous consistant à :

(i) prédire des informations d'angle de panoramique inverse à partir des informations VLSI, en utilisant une règle de panoramique à puissance constante, dans lequel le schéma de prédiction des informations d'angle de panoramique inverse diffère selon les informations d'angle du vecteur global ;
(ii) obtenir une composante de puissance estimée de chaque canal dans chaque sous-bande, en utilisant les informations d'angle de panoramique inverse prédites ; et
(iii) décompresser finalement un signal de chaque canal dans chaque sous-bande, en utilisant la composante de puissance estimée de chaque canal et le signal audio réduit par mixage, dans lequel l'étape (i) consiste à prédire des angles de panoramique inverse θ_1, θ_2, θ_3, et θ_4 à partir de l'angle de vecteur global Ga_b, de l'angle de vecteur de demi-plan gauche LHa_b, de l'angle de vecteur subséquent gauche LSa_b et de l'angle de vecteur subséquent droit RSa_b dans les informations de localisation source virtuelles, lorsque l'angle de vecteur global Ga_b dans les informations de localisation source virtuelles, est supérieur à zéro, et à partir de l'angle de vecteur global Ga_b, de l'angle de vecteur de demi-plan droit RHa_b, de l'angle de vecteur subséquent droit RSa_b et de l'angle de vecteur subséquent gauche LSa_b dans les informations de localisation source virtuelles, lorsque l'angle de vecteur global Ga_b est inférieur à zéro.

11. Procédé selon la revendication 10, dans lequel, à l'étape (i), les angles de panoramique inverse θ_1, θ_2, θ_3, et θ_4 sont estimés en utilisant les équations ci-dessous :

si $Ga_b \geq 0$,

$$\theta_1 = \left(\frac{Ga_b - LHa_b}{RSa_b - LHa_b}\right) \times \frac{\pi}{2}, \quad \theta_2 = \left(\frac{LHa_b - LSa_b}{0 - LSa_b}\right) \times \frac{\pi}{2}$$

$$\theta_3 = \left(\frac{LSa_b + \pi/2}{-\pi/4 + \pi/2}\right) \times \frac{\pi}{2}, \quad \theta_4 = \left(\frac{RSa_b - \pi/2}{\pi/4 - \pi/2}\right) \times \frac{\pi}{2}$$

et, si $Ga_b < 0$

$$\theta_1 = \left(\frac{Ga_b - RHa_b}{LSa_b - RHa_b}\right) \times \frac{\pi}{2}, \quad \theta_2 = \left(\frac{RHa_b - RSa_b}{0 - RSa_b}\right) \times \frac{\pi}{2}$$

$$\theta_3 = \left(\frac{RSa_b - \pi/2}{\pi/4 - \pi/2}\right) \times \frac{\pi}{2}, \quad \theta_4 = \left(\frac{LSa_b + \pi/2}{-\pi/4 + \pi/2}\right) \times \frac{\pi}{2}.$$

12. Procédé selon la revendication 11, dans lequel l'étape (ii) consiste à obtenir la composante de puissance estimée de chaque canal dans chaque sous-bande, en utilisant les équations ci-dessous :

si $Ga_b \geq 0$,

$$F_{C,b} = \cos(\theta_1)\ \sin(\theta_2),$$

$$F_{L,b} = \cos(\theta_1)\ \cos(\theta_2)\ \sin(\theta_3),$$

$$F_{Ls,b} = \cos(\theta_1)\ \cos(\theta_2)\ \cos(\theta_3),$$

$$F_{R,b} = \sin(\theta_1)\ \sin(\theta_4),$$

et

$$F_{Rs,b} = \sin(\theta_1)\ \cos(\theta_4)\ ;$$

et

si $Ga_b < 0$,

$$F_{C,b} = \cos(\theta_1)\ \sin(\theta_2),$$

$$F_{L,b} = \sin(\theta_1)\ \sin(\theta_4),$$

$$F_{Ls,b} = \sin(\theta_1)\ \cos(\theta_4),$$

$$F_{R,b} = \cos(\theta_1)\ \cos(\theta_2)\ \sin(\theta_3),$$

et

$$F_{Rs,b} = \cos(\theta_1)\ \cos(\theta_2)\ \cos(\theta_3).$$

13. Procédé selon la revendication 12, dans lequel l'étape (iii) consiste à décompresser un signal de chaque canal dans chaque sous-bande, en utilisant l'équation ci-dessous :

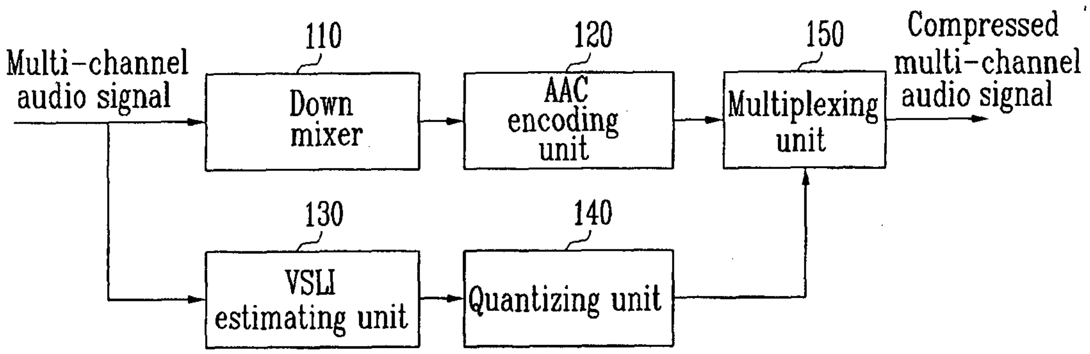
$$U_{ch,k} = F_{ch,b}\ S'_k, \qquad B_b \leq k \leq B_{b+1} - 1,$$

où S'_k représente un coefficient de composante de fréquence d'un signal réduit par mixage reçu, et $U_{ch,k}$ représente un signal audio décompressé.

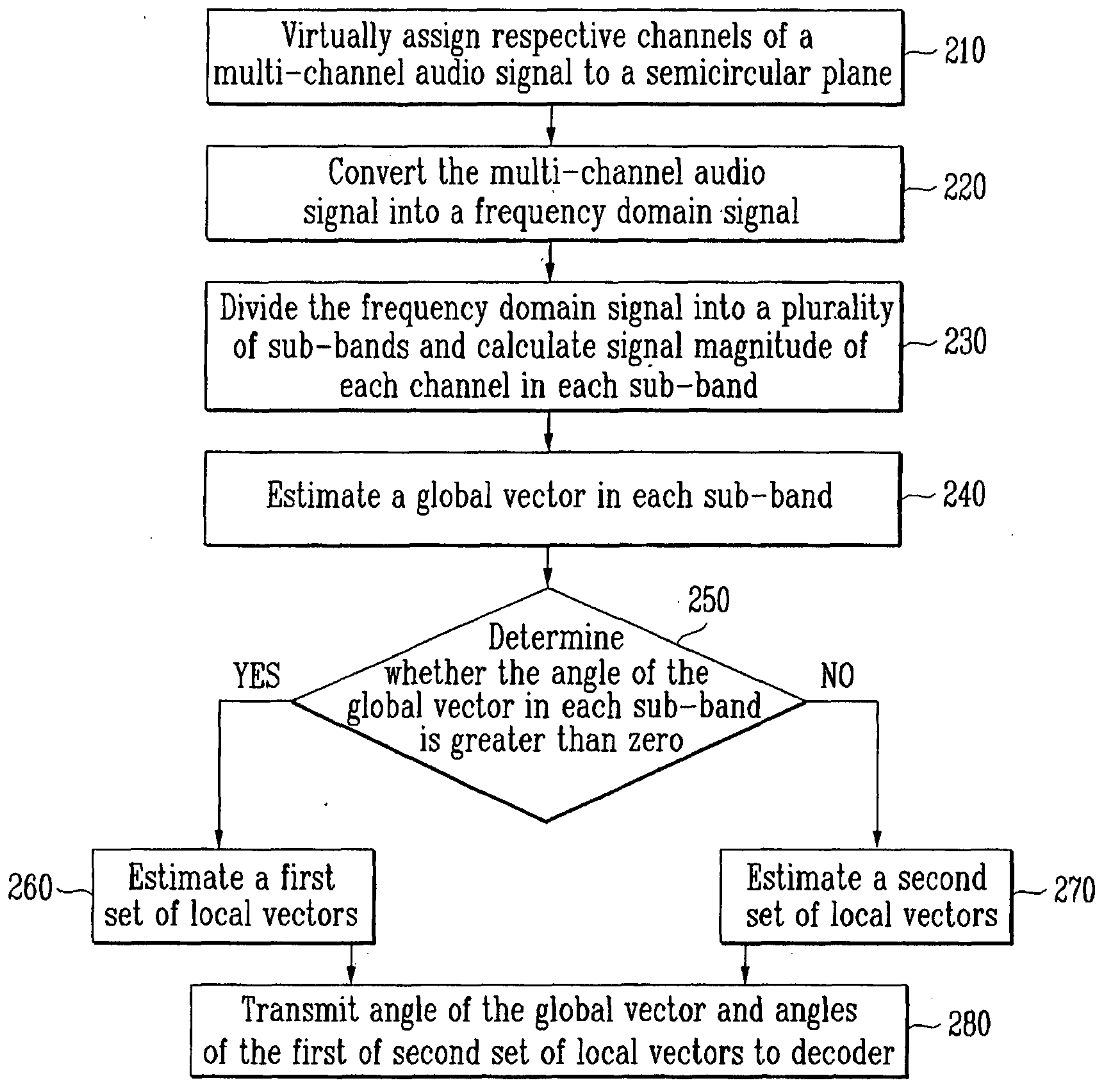
14. Support lisible par ordinateur dans lequel est enregistré un programme informatique destiné à mettre en oeuvre le procédé selon l'une quelconque des revendications 1 à 9.

15. Support lisible par ordinateur dans lequel est enregistré un programme informatique destiné à mettre en oeuvre le procédé selon l'une quelconque des revendications 10 à 13.

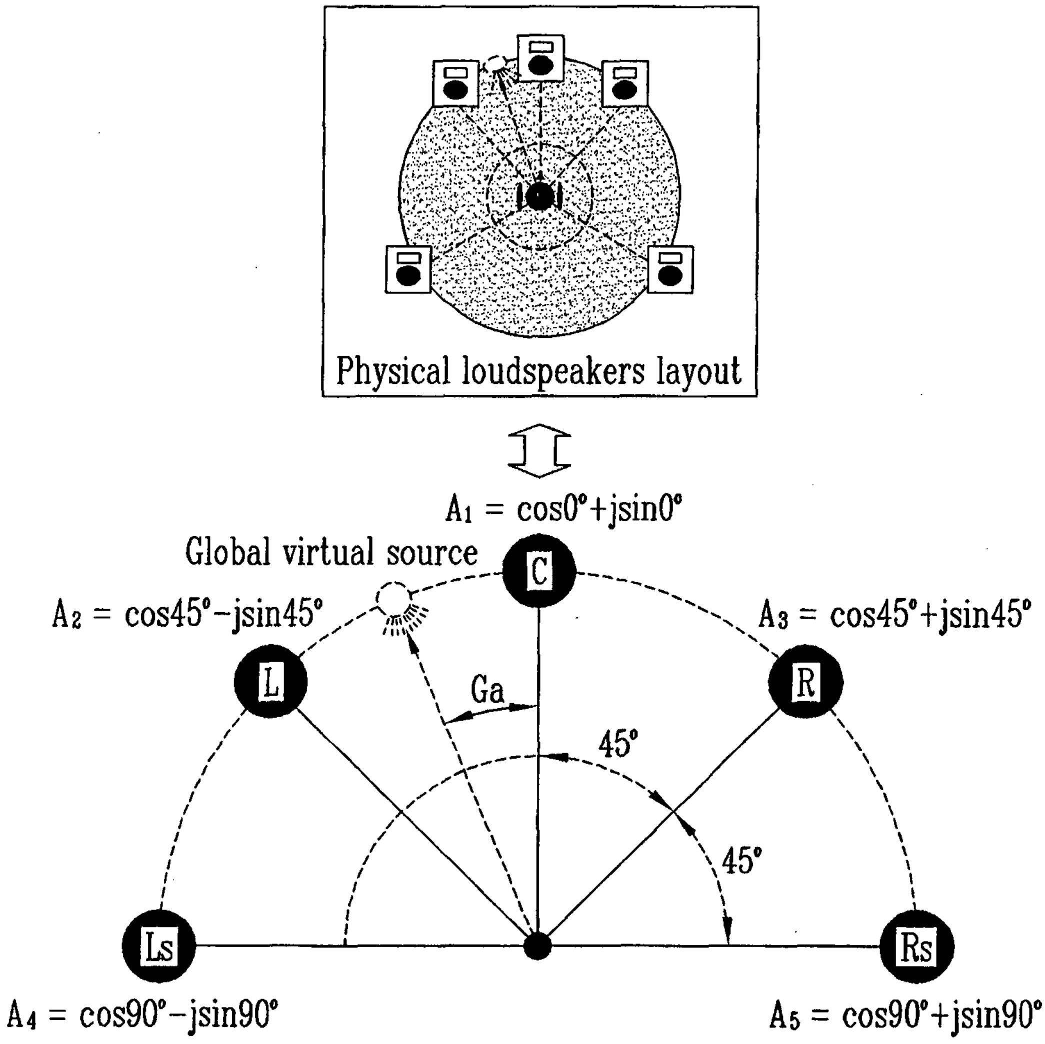
【Figure 1】


Multi-channel audio signal
110
Down mixer
120
AAC encoding unit
150
Multiplexing unit
Compressed multi-channel audio signal
130
VSLI estimating unit
140
Quantizing unit

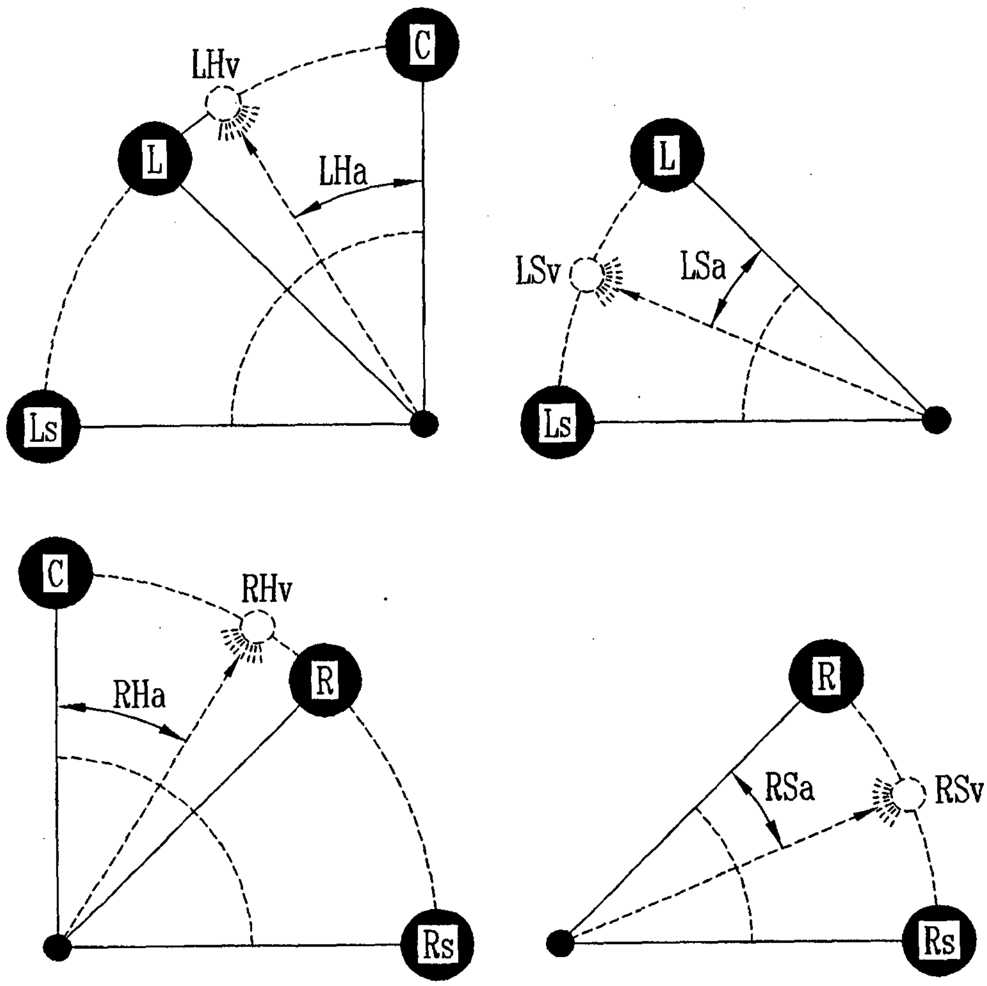
【Figure 2】


Virtually assign respective channels of a multi-channel audio signal to a semicircular plane
210
Convert the multi-channel audio signal into a frequency domain signal
220
Divide the frequency domain signal into a plurality of sub-bands and calculate signal magnitude of each channel in each sub-band
230
Estimate a global vector in each sub-band
240
250
Determine whether the angle of the global vector in each sub-band is greater than zero
YES
NO
260
Estimate a first set of local vectors
Estimate a second set of local vectors
270
Transmit angle of the global vector and angles of the first of second set of local vectors to decoder
280

【Figure 3】


Physical loudspeakers layout
A_1 = cos0°+jsin0°
Global virtual source
A_2 = cos45°−jsin45°
A_3 = cos45°+jsin45°
C
L
R
Ga
45°
45°
Ls
Rs
A_4 = cos90°−jsin90°
A_5 = cos90°+jsin90°

【Figure 4】



【Figure 5】

Predict inverse panning angles from VSLI — 510

↓

Obtain an estimated power component for each channel in each sub-band from the predicted inverse panning angles — 520

↓

Decompress each channel signal in each sub-band based on down-mixed audio signal and the estimated power component for each channel — 530

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Non-patent literature cited in the description

- A Multi-Channel Audio Compression Method with Virtual Source Location Information for MPEG-4 SAC. *Ph.D. dissertation,* February 2005 **[0003]**