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60/776,724 2006 02 27 (US)

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60/787,516 2006 03 31 (US)

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HRTF

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HRTF .

[0001] , .

[0002] .

[0003] , , . , , . , , .

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[0005] , .

[0006]

[0007] , ; , .

[0008] , , ; , .

[0009] , , ; , .

[0010] , , ; , .

[0011] . , . , . , .

[0012]

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[0249] ,

HRTF

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[0014] 1 .

[0015] 2 .

[0016] 3 .

[0017] 4 5 .

[0018] 6 7 .

[0019] 8 9 .

[0020] 10 11 .

[0021] 12 1 .

[0022] 13 2 .

[0023] 14 3 .

[0024] 15 4 .

[0025] 16 5 .

[0026] 17 .

[0027] 18 1 .

[0028] 19 2 .

[0029] 20 3 .

[0030] 21

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[0031] 22 1 .

[0032] 23 2 .

[0033] 24 .

[0034] 25 .

[0035] 26 .

[0036] 27 .

[0037] 28

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[0038] 29

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[0039] 30 1 .

[0040] 31 2 .

[0041] * *

[0042] 10: 20:

[0043] 100: 200:

[0044] 300: 400:

[0045] 500: 600:

[0046] 700: 800:

[0047] 900: 1000:

[0048] 1010: 1020:

[0049] 1030: 1040:

[0050] 1041: 1042:

[0051] 1043: 1050:

[0052] 1060: 1100:

[0053] 1200: 1300:

[0054] 1400: 1500:

[0055]

[0056] 1 .
(10) (100), (200), (300), (400)
(500) .

[0057] 1 , (X1, X2,...,Xn) (100) , (10
0) . ,
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. ,
. , (10)
. (200)
. .
(300) (400) , (500) .

[0058] " (spatial information)" (down-mix)
, (up-mix)
. .
CLD(channel level difference),
(correlation) ICC(inter channel coherences),
CPC(channel prediction coefficients) .

[0059] " " " "
.
. , MP3, AC-3, DTS
AAC .
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[0060] (500) ,
(20) . 2 .

[0061] (20) (600), (700), (800), (900) (1000) . (600) , . , (700) , (800) . (1000) . .

[0062] , (10) OTT (One-To-Two box) TTT (Two-To-Three box) . , . (20) , (20) . , , . , , HRTF(head-related transfer functions, 'HRTF' .) .

[0063] , (hybrid domain) . .

[0064] (hybrid filterbank) , (hybrid domain) . , .

[0065] (time domain) . HRTF FIR(Finite Inverse Response) IIR(Infinite Inverse Response) , .

[0066] . , DFT(Ddiscrete Fourier Transform) . . , , .

[0067] , . . (proto-type filter information) , GL_L . (converted filter information) , GL_L' . (sub-randering information) , FL_L1 . , HL_L . / / , HL_L' . , . HRTF , HRTF .

[0068] , (900) , . . .

[0069] 2 . . 2 , (audio payload) 1 (frame) (ancillary data field) . . , 48 128kbps , 5 32kbps , .

[0070] 3 . (1000) (1010), (1020), (1030), (1040), (1050) .

[0071] 3 , (1010) ,
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4 5 .

[0072] (1020)
. , (900) HRTF , (1020) HRTF
.

[0073] (1030) (integration)
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. , (1042) .
(1042) (1041) / (1042) .
(1041) / (1042) / . ,
(105) (900)
. (105) 3 . ,
(900) , (1050)
. (900) .

[0074] , (1000) (1060) . 3 , (1060)
(1000) , (1000) .
(1060) , HRTF
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[0075] , .
, . , HRTF
DFT, QMF .

[0076] , HRTF ,
. , HRTF ( ) , 5.1 10
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. ,
. , HRTF
. , .

[0077] (900) (1100) /
(1200) . (1100) ,
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[0078] (1200) .
, ,
. (1200)
. , (1200) ,
. 3 , , , ,
QMF DFT ,
. ,
. (1100) (1200) .
IIR (FIR) .

[0079] , (900) ,
. ,
. 6 9 .
(1300) . ,

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[0080] 4 5 . . , , 4 5 . . , , CLD1 CLD5, ICC1 ICC5 , . $D\_L(=D_L)$,$D\_R(=D_R)$, $D\_C(=D_C)$, $D\_LFE(=D_{LFE})$, $D\_Ls(=D_{Ls})$, $D\_Rs(=D_{Rs})$. , (tree structure) . , .

[0081] (900) [1] .

[0082] 1

$$Lo = L*GL\_L' + C*GC\_L' + R*GR\_L' + Ls*GLs\_L' + Rs*GRs\_L'$$

[0083] $$Ro = L*GL\_R' + C*GC\_R' + R*GR\_R' + Ls*GLs\_R' + Rs*GRs\_R'$$

[0084] , * DFT , QMF (convolution) . L, C, R, Ls, Rs , . , CLD , CLD ICC . CLD . (tree structure) 4 , CLD 1 [2] .

[0085] 2

$$\begin{bmatrix} L \\ R \\ C \\ LFE \\ Ls \\ Rs \end{bmatrix} = \begin{bmatrix} D_L \\ D_R \\ D_C \\ D_{LFE} \\ D_{Ls} \\ D_{Rs} \end{bmatrix} m = \begin{bmatrix} c_{1,OTT3}c_{1,OTT1}c_{1,OTT0} \\ c_{2,OTT3}c_{1,OTT1}c_{1,OTT0} \\ c_{1,OTT4}c_{2,OTT1}c_{1,OTT0} \\ c_{2,OTT4}c_{2,OTT1}c_{1,OTT0} \\ c_{1,OTT2}c_{2,OTT0} \\ c_{2,OTT2}c_{2,OTT0} \end{bmatrix} m$$

[0086]

[0087] ,

$$c_{1,OTT_x}^{l,m} = \sqrt{\frac{10^{\frac{CLD_x^{l,m}}{10}}}{1+10^{\frac{CLD_x^{l,m}}{10}}}}$$

[0088]

[0089] ,

$$c_{2,OTT_x}^{l,m} = \sqrt{\frac{1}{1+10^{\frac{CLD_x^{l,m}}{10}}}}$$

[0090]

[0091] , m .

[0092] * (tree structure) 5 , CLD 2 [3] .

[0093] 3

$$\begin{bmatrix} L \\ Ls \\ R \\ Rs \\ C \\ LFE \end{bmatrix} = \begin{bmatrix} D_L \\ D_{Ls} \\ D_R \\ D_{Rs} \\ D_C \\ D_{LFE} \end{bmatrix} m = \begin{bmatrix} c_{1,OTT3}c_{1,OTT1}c_{1,OTT0} \\ c_{2,OTT3}c_{1,OTT1}c_{1,OTT0} \\ c_{1,OTT4}c_{2,OTT1}c_{1,OTT0} \\ c_{2,OTT4}c_{2,OTT1}c_{1,OTT0} \\ c_{1,OTT2}c_{2,OTT0} \\ c_{2,OTT2}c_{2,OTT0} \end{bmatrix} m$$

[0094]

[0095] CLD , . ICC / . dx(m) [4] .

[0096] 4

$$\begin{bmatrix} L \\ R \\ C \\ LFE \\ Ls \\ Rs \end{bmatrix} = \begin{bmatrix} A_{L1}m + B_{L0}d_0(m) + B_{L1}d_1(C_{L1}m) + B_{L3}d_3(C_{L3}m) \\ A_{R1}m + B_{R0}d_0(m) + B_{R1}d_1(C_{R1}m) + B_{R3}d_3(C_{R3}m) \\ A_{C1}m + B_{C0}d_0(m) + B_{C1}d_1(C_{C1}m) \\ c_{2,OTT4}c_{2,OTT1}c_{1,OTT0}m \\ A_{LS1}m + B_{LS0}d_0(m) + B_{LS2}d_2(C_{LS2}m) \\ A_{RS1}m + B_{RS0}d_0(m) + B_{RS2}d_2(C_{RS2}m) \end{bmatrix}$$

[0097]

[0098] , A, B, C CLD ICC , d_0 d_3 , m . D_L, D_R .

[0099] , CLD, ICC / 1 dx(m)(x=0, 1, 2) . , dx [5] .

[0100] 5

```
FL_L_M = d_L_M * GL_L' (mono 입력 -> Left 출력)
FL_R_M = d_L_M * GL_R' (mono 입력 -> Right 출력)
FL_L_Dx = d_L_Dx * GL_L' (Dx 출력 -> Left 출력)
```

[0101]

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FL_R_Dx = d_L_Dx * GL_R' (Dx 출력 -> Right 출력)
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[0102] [5] [6] .

[0103] 6

```
HM_L = FL_L_M + FR_L_M + FC_L_M + FLS_L_M + FRS_L_M + FLFE_L_M
HM_R = FL_R_M + FR_R_M + FC_R_M + FLS_R_M + FRS_R_M + FLFE_R_M
HDx_L = FL_L_Dx + FR_L_Dx + FC_L_Dx + FLS_L_Dx + FRS_L_Dx + FLFE_L_Dx
HDx_R = FL_R_Dx + FR_R_Dx + FC_R_Dx + FLS_R_Dx + FRS_R_Dx + FLFE_R_Dx
```

[0104]

[0105] . CLD, ICC / 1 dx , dx(m) .

[0106] CLD, ICC / 2 . , [7] .

[0107] 7

$$\begin{bmatrix} L \\ R \\ C \\ LFE \\ Ls \\ Rs \end{bmatrix} = \begin{bmatrix} A_{L1}m + B_{L0}d_0m + B_{L1}d_1C_{L1}m + B_{L3}d_3C_{L3}m \\ A_{R1}m + B_{R0}d_0m + B_{R1}d_1C_{R1}m + B_{R3}d_3C_{R3}m \\ A_{C1}m + B_{C0}d_0m + B_{C1}d_1C_{C1}m \\ c_{2,OTT4}c_{2,OTT1}c_{1,OTT0}m \\ A_{LS1}m + B_{LS0}d_0m + B_{LS2}d_2C_{LS2}m \\ A_{RS1}m + B_{RS0}d_0m + B_{RS2}d_2C_{RS2}m \end{bmatrix}$$

$$= \begin{bmatrix} A_{L1} + B_{L0}d_0 + B_{L1}d_1C_{L1} + B_{L3}d_3C_{L3} \\ A_{R1} + B_{R0}d_0 + B_{R1}d_1C_{R1} + B_{R3}d_3C_{R3} \\ A_{C1} + B_{C0}d_0 + B_{C1}d_1C_{C1} \\ c_{2,OTT4}c_{2,OTT1}c_{1,OTT0} \\ A_{LS1} + B_{LS0}d_0 + B_{LS2}d_2C_{LS2} \\ A_{RS1} + B_{RS0}D_0 + B_{RS2}D_2C_{RS2} \end{bmatrix} m$$

[0108]

[0109] , , D_L, D_R , .

[0110] CLD, ICC / 3 2 - . - . , 1 - .

[0111] CLD, ICC / 4 2 d_0 d_3 , (, L, R, C, Ls, Rs) . , [8] .

[0112] 8

$$\begin{bmatrix} L \\ R \\ C \\ LFE \\ Ls \\ Rs \end{bmatrix} = \begin{bmatrix} A_{L1} + K_L d_L \\ A_{R1} + K_R d_R \\ A_{C1} + K_C d_C \\ c_{2,OTT4}c_{2,OTT1}c_{1,OTT0} \\ A_{LS1} + K_{Ls} d_{Ls} \\ A_{RS1} + K_{Rs} d_{Rs} \end{bmatrix} m$$

[0113]

[0114] , K CLD ICC , d_L, d_R, d_C, d_Ls d_Rs .

[0115] CLD, ICC / 5 , 4 d_L d_R , d_Ls d_Rs . , d_R=f(d_L), d_Rs=f(d_Ls) , d_L, d_C d_Ls .

[0116] CLD, ICC / 6 , 5 d_L d_Ls . , d_L d_C .

[0117] CLD, ICC / 7 , 3 - (nested) . 7 - - , - . , (Phase

response) , .

[0118] CLD, ICC / 8 2 . [9] .

[0119] 9

$$\begin{bmatrix} L \\ R \\ C \\ LFE \\ Ls \\ Rs \end{bmatrix} = \begin{bmatrix} A_{L1}+K_L d_L \\ A_{R1}+K_R d_R \\ A_{C1}+K_C d_C \\ c_{2,OTT4}c_{2,OTT1}c_{1,OTT0} \\ A_{LS1}+K_{Ls} d_{Ls} \\ A_{RS1}+K_{Rs} d_{Rs} \end{bmatrix} m + \begin{bmatrix} P_{L0}d_{new0}(m)+P_{L1}d_{new1}(m)+\cdots \\ P_{R0}d_{new0}(m)+P_{R1}d_{new1}(m)+\cdots \\ P_{C0}d_{new0}(m)+P_{C1}d_{new1}(m)+\cdots \\ 0 \\ P_{Ls0}d_{new0}(m)+P_{Ls1}d_{new1}(m)+\cdots \\ P_{Rs0}d_{new0}(m)+P_{Rs1}d_{new1}(m)+\cdots \end{bmatrix}$$

[0120]

[0121] , 1 A A+Kd .

[0122] CLD, ICC / 9 , . , , .

[0123] CLD, ICC / 4 [10] .

[0124] 10

$$\begin{bmatrix} L \\ R \\ C \\ LFE \\ Ls \\ Rs \end{bmatrix} = \begin{bmatrix} A_{L1}m+K_L d_L(m) \\ A_{R1}m+K_R d_R(m) \\ A_{C1}m+K_C d_C(m) \\ c_{2,OTT4}c_{2,OTT1}c_{1,OTT0}m \\ A_{LS1}m+K_{Ls} d_{Ls}(m) \\ A_{RS1}m+K_{Rs} d_{Rs}(m) \end{bmatrix}$$

[0125]

[0126] di_(m)(i=L, R, C, Ls, Rs) i , , , QMF . , , . , d_L, d_R, d_C, d_Ls, d_Rs d , [1 0] .

[0127] [10] [1] , [1] [11] .

[0128] 11

$$Lo = HM\_L*m + HMD\_L*d(m)$$

$$Ro = HM\_R*R + HMD\_R*d(m)$$

[0129]

[0130] , HM_L m Lo , HM_R m Ro . d(m) . HMD_L d(m) , Lo , . HMD_R d(m) Ro .

[0131] , (, HRTF) . . , d(m) d*m( ) , [11] [12] .

[0132] 12

$$Lo = HM\_L*m + HMD\_L*d*m = HMoverall\_L*m$$

[0133] $$Ro = HM\_R*m + HMD\_R*d*m = HMoverall\_R*m$$

[0134] , , , .

[0135] 6 7 . 6 , (900) A (910) B (920) . , (1000) (left) (right) . A (910) , . B (920) , . , .

[0136] , . , (1000) (HL_L) , (HL_R) . , (1000) (HR_R) , (HR_L) .

[0137] 7 , (900) 1A (911), 2A (912), 1B (921) 2B (922) . (900) , (1000) . , (900) , .

[0138] , 1A (911) (HL_L) , 2A (912) (HL_R) . , 1B (921) (HR_R) , 2B (922) (HR_L) . , " " . HL_R HR_L , . , HL_R / HR_L 0 . HL_R / HR_L 0 , .

[0139] 6 7 . , x, D, G, p, y , [13] .

[0140] 13

$$\mathbf{x}=\begin{bmatrix} Li \\ Ri \end{bmatrix},\quad \mathbf{p}=\begin{bmatrix} L \\ Ls \\ R \\ Rs \\ C \\ LFE \end{bmatrix},\quad \mathbf{D}=\begin{bmatrix} D\_L1 & D\_L2 \\ D\_Ls1 & D\_Ls2 \\ D\_R1 & D\_R2 \\ D\_Rs1 & D\_Rs2 \\ D\_C1 & D\_C2 \\ D\_LFE1 & D\_LFE2 \end{bmatrix}$$

$$\mathbf{G}=\begin{bmatrix} GL\_L & GLs\_L & GR\_L & GRs\_L & GC\_L & GLFE\_L \\ GL\_R & GLs\_R & GR\_R & GRs\_R & GC\_R & GLFE\_R \end{bmatrix}\quad \mathbf{y}=\begin{bmatrix} Lo \\ Ro \end{bmatrix}$$

[0141] ,

[0142] , , . (p) [14] (D) (x) .

[0143] 14

$$\mathbf{p}=\mathbf{D}\cdot\mathbf{x},\quad \begin{bmatrix} L \\ Ls \\ R \\ Rs \\ C \\ LFE \end{bmatrix}=\begin{bmatrix} D\_L1 & D\_L2 \\ D\_Ls1 & D\_Ls2 \\ D\_R1 & D\_R2 \\ D\_Rs1 & D\_Rs2 \\ D\_C1 & D\_C2 \\ D\_LFE1 & D\_LFE2 \end{bmatrix}\begin{bmatrix} Li \\ Ri \end{bmatrix}$$

[0144]

[0145] , (y) [15] (p) (G) .

[0146] 15

$$\mathbf{y}=\mathbf{G}\cdot\mathbf{p}$$

[0147]

[0148] , p [14] [16] .

[0149] 16

$$\mathbf{y}=\mathbf{GDx}$$

[0150]

[0151] , H

$$\mathbf{H}=\mathbf{GD}$$

[0152]

[0153] , (y) (x) [17] .

[0154] 17

$$\mathbf{H}=\begin{bmatrix} HL\_L & HR\_L \\ HL\_R & HR\_R \end{bmatrix},\quad \mathbf{y}=\mathbf{Hx}$$

[0155]

[0156] , (H) , (x) (H) (y) .

[0157] (H) , (H) [18]

.

[0158] 18

$$\mathbf{H} = \mathbf{GD}$$

$$\begin{bmatrix} GL\_L & GLs\_L & GR\_L & GRs\_L & GC\_L & GLFE\_L \\ GL\_R & GLs\_R & GR\_R & GRs\_R & GC\_R & GLFE\_R \end{bmatrix} \begin{bmatrix} D\_L1 & D\_L2 \\ D\_Ls1 & D\_Ls2 \\ D\_R1 & D\_R2 \\ D\_Rs1 & D\_Rs2 \\ D\_C1 & D\_C2 \\ D\_LFE1 & D\_LFE2 \end{bmatrix}$$

[0159]

[0160] 8 9 . 8 , (900) A (930) B (940) . , (1000) (HM_L) (HM_R) . A (930) (HM_L) , B (940) (HM_R) . (900) , A (930) B (940) [12] HMoverall_R HMoverall_L , .

[0161] , . , (900) , . , 3 . , , (step) .

[0162] 9 , (900) , [11] . (900) 1A (931), 2A (932), 1B (941) 2B (942) . (900) (941, 942) , . , HL_L, HL_R . , 1A (931) HM_L , 2A (932) HM_R . , 1B (941) HMD_R , 2B (942) HMD_L .

[0163] , x, D, G, p, y , [19] .

[0164] 19

$$\mathbf{x}=[Mi],\quad \mathbf{p}=\begin{bmatrix} L \\ Ls \\ R \\ Rs \\ C \\ LFE \end{bmatrix},\quad \mathbf{D}=\begin{bmatrix} D\_L \\ D\_Ls \\ D\_R \\ D\_Rs \\ D\_C \\ D\_LFE \end{bmatrix}$$

$$\mathbf{G}=\begin{bmatrix} GL\_L & GLs\_L & GR\_L & GRs\_L & GC\_L & GLFE\_L \\ GL\_R & GLs\_R & GR\_R & GRs\_R & GC\_R & GLFE\_R \end{bmatrix},\quad \mathbf{y}=\begin{bmatrix} Lo \\ Ro \end{bmatrix}$$

[0165]

[0166] ,
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[0167] * 4 5 /
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/ ,
. /
(smoothing) . (frequency domain smoothing) /
(time domain smoothing) , . ,
/ (gain) .

[0168] 10 11 . 10
11 , / ,
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[0169] 10 11 , (1042) /
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(1042) / ,
(1043) . , (1020)
(, HRTF) (
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[0170] 12 1 . 1
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[0171] 13 2 . 2
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, (log scale)/ (bark scale) ,
, .

[0172] 14 3 . 3
(,) . , 3
, IIR (FIR)
(Low pass filtering) .

[0173] 15 4 . 4
(Random noise) (contour) .
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[0174] 16 5 . 5 2 4 . , , , . , . 5 , . 1 5 (, CLD) (power) . , , (power normalization) . , , [20] .

[0175] 20

[0176] D_L(pb) + D_R(pb) + D_C(pb) + D_Ls(pb) + D_Rs(pb) + D_Lfe(pb) = C

[0177] , pb = 0 -1 , C .

[0178] 17 . , (left channel source) GL_L , GL_R . , (, Lo) (, Ro) . , / [21] .

[0179] 21

[0180] Lo = L * GL_L + C * GC_L + R * GR_L + Ls * GLs_L + Rs * GRs_L

Ro = L * GL_R + C * GC_R + R * GR_R + Ls * GLs_R + Rs * GRs_R

[0181] L, R, C, Ls, Rs / , L, R, C, Ls, Rs / . 18 20 .

[0182] 18 (900) 1 . , (900) (1010), (1020), (1030), (1040) (1050) . (900) 3 . , (1020) (1 , 2 ,..., N) .

[0183] 18 , (1020) . , , 1 . D_L (GL_L' GL_R') [22] .

[0184] 22

[0185] FL_L = D_L * GL_L' (모노 입력 --> 왼쪽 출력 채널로의 필터 계수)

FL_R = D_L * GL_R' (모노 입력 --> 오른쪽 출력 채널로의 필터 계수)

[0186] , D_L (1010) . , D_L (tree structure) . 2 (FR_L FR_R) , N (FRs_L FRs_R) .

[0187] , 1

. D_L1, D_L2 [
23] .

[0188] 23

FL_L1 = D_L1 * GL_L' (왼쪽 입력 ---> 왼쪽 출력채널로의 필터 계수)

FL_L2 = D_L2 * GL_L' (오른쪽 입력 --> 왼쪽 출력채널로의 필터 계수)
FL_R1 = D_L1 * GL_R' (왼쪽 입력 --> 오른쪽 출력채널로의 필터 계수)
FL_R2 = D_L2 * GL_R' (오른쪽 입력 --> 오른쪽 출력채널로의 필터 계수)

[0189]

[0190] , FL_R1 [23] , FL_R1 L , R
, 1 . ,
. D_L1, D_L2
(1010) . ,

.
, .

[0191] (1020) (1030), (1040)
(1050) (900) . (1030)
(, HL_L, HL_R, HR_L, HR_R) . (1030)
.
, [24] .

[0192] 24

HM_L = FL_L + FR_L + FC_L + FLs_L + FRs_L + FLFE_L
[0193] HM_R = FL_R + FR_R + FC_R + FLs_R + FRs_R + FLFE_R

[0194] , [25] .

[0195] 25

HL_L = FL_L1 + FR_L1 + FC_L1 + FLs_L1 + FRs_L1 + FLFE_L1
HR_L = FL_L2 + FR_L2 + FC_L2 + FLs_L2 + FRs_L2 + FLFE_L2
HL_R = FL_R1 + FR_R1 + FC_R1 + FLs_R1 + FRs_R1 + FLFE_R1
HR_R = FL_R2 + FR_R2 + FC_R2 + FLs_R2 + FRs_R2 + FLFE_R2

[0196]

[0197] , (1040) (1041) / (1042) ,
. ,
QMF . ,
.

[0198] ,
. , n n+k
(k 1), (, HL_L, HR_L, HL_R, HR_R)
.
.
, [26] .

[0199] 26

$$HM\_L(n+j) = HM\_L(n) *(1-a) + HM\_L(n+k) * a$$

[0200] $$HM\_R(n+j) = HM\_R(n) *(1-a) + HM\_R(n+k) * a$$

[0201] , [27] .

[0202] 27

$$HL\_L(n+j) = HL\_L(n) *(1-a) + HL\_L(n+k) * a$$

$$HR\_L(n+j) = HR\_L(n) *(1-a) + HR\_L(n+k) * a$$

$$HL\_R(n+j) = HL\_R(n) *(1-a) + HL\_R(n+k) * a$$

[0203] $$HR\_R(n+j) = HR\_R(n) *(1-a) + HR\_R(n+k) * a$$

[0204] , 0 j k , j, k , a 0 a 1 [28] .

[0205] 28

[0206] $$a = j/k$$

[0207] [27] [28] . 22 23 .

[0208] (1042) , . 12 16 . , , . , [29] .

[0209] 29

$$HM\_L(n)' = HM\_L(n)*b + HM\_L(n-1)'*(1-b)$$

[0210] $$HM\_R(n)' = HM\_R(n)*b + HM\_R(n-1)'*(1-b)$$

[0211] , (n-1) (HM_L(n-1)' HM_R(n-1)') (1-b) , (n) (HM_L(n) HM_R(n)) b 1-pole IIR . , b 0 b 1 , b , b . , .

[0212] [29] , [30] .

[0213] 30

$$HM\_L(n+j)' = (HM\_L(n)*(1-a) + HM\_L(n+k)*a) * b + HM\_L(n+j-1)' * (1-b)$$

[0214] $$HM\_R(n+j)' = (HM\_R(n)*(1-a) + HM\_R(n+k)*a) * b + HM\_R(n+j-1)' * (1-b)$$

[0215] (1041) / (1042) / , . .

[0216] (1050) .

, . , (900) .

[0217] 19 (900) 2 . 2 (1000) (1010), (1020), (1030), (1040) (1050) , (1020) , 1 .

[0218] 19 , 2 1 (1040) . , (1020) (, FL_L, FL_R , FL_L1, FL_L2 ,FL_R1, FL_R2) / . , (1030) / . (1050) (900) .

[0219] 20 (1000) 3 . 3 (1000) (1010), (1020), (1030), (1040) (1050) , (1020) , 1 2 .

[0220] 120 , 3 1 2 (1040) (1010) . , (1010) / . , (1020) / . (1030) , (11050) (900) .

[0221] 21 . 21 DFT , . , 21 , .

[0222] 21 , (OL) (windowing) . 21 50 , . (window function) (discontinuity) (seamless) , DFT (selectivity) . (sine square window function) . , OL*2 (HL_L') (-1) (ZL) , DFT . 20 k DFT .

[0223] . . IDFT(Invers Discrete Fourier Transform) , (20 , k-1) OL . , .

[0224] 22 1 . . , 18 20 , . , , , . , . , . .

[0225] 22 , , . (, 21 n, n+1) , . , . , 21 (K-1, K, K+1, K+2) , . 21 (linear interpolation) , . , , .

[0226] 23 2 . 22 , 2 , . , , . , .

[0227] 24 . 24 (a) , , (, 24 n, n+1) . , , . , .

[0228] , . , 24 (b) , . , . , . , . , . , , . , , . , 24 (b) , , . , .

[0229] 25 . 25 , (1400) . (1010), (1030), (1040), (1050, 1100), (1300) . 25 , . , (zero padding) . , .

[0230] 26 . , , . . (, (reverberation) (diffuse)) (truncation) . , , .

[0231] 26 , 4 . 4 DFT

, DFT . N1 (FL)
(2*OL) . N2 N1
(FL) (2*OL') .
N3 N1 (FL') ,
(2*OL) . N4 N1 (FL') ,
(2*OL') . , ,
. 4
. ,
.

[0232] 27 .
,
. , ,
, . ,
HRTF ,
. DFT , DFT
.

[0233] 27 , (FL) ,
(A B) . , A
B . , A B
(Inverse Discrete Fourier Transform, IDFT)
, . , B A FL'
.
. , B
. , ,
, .

[0234] ( ) ,
. ,
, ,
. 26 2 ,
.

[0235] 28
. 28 ,
. 28 , 27 A 1 HM_L_A ,
27 B 2 HM_L_B . 28
, .
(1000) HM_L (1500) . HRTF
, .
. , HM_L_A
, HM_L_B
.

[0236] , DFT QMF
. , A B QMF
. (900) 1 (950) 2
(960) , 1 (950) HM_L_A , 2
(960) HM_L_B .

[0237] 27 , A B ,
. 28 ,
B ,

.

[0238] 29
. 29 (1000)
, HRTF (1500)
28 . 28 , B L/R
. , (1500) A 1 , 2
B 3 . , 3 L/R
. 29 ,
(900) 1 (970), 2 (980) 3 (990) . 3
3 (990) L/R .
, 1 (970) 2 (980) A1 A2
L/R . , 3 (990)
. 29 L/R
.

[0239] 30 1 . DFT
. DFT
, 30 DFT . (1100) QMF
DFT , (1300) IDFT IQMF . 30
, .

[0240] 30 , P QMF P
. W , M- DFT(FFT) .
DFT . M- DFT
M/2 P M/2*P- DFT
. , M/2*P- DFT
, DFT .

[0241] , QMF (leakage), , (aliasing)
. ,
. QMF QMF
,
. , (1100) QMF
DFT (leakage minimize butterfly, B) ,
(1300) IDFT (C) .

[0242] , (1000
, M/2*P- DFT , QMF DFT
. QMF .

[0243] 31 2 . 30 QMF
. (1100) QMF ,
(1300) IQMF . 31 QMF DFT
. , QMF QMF QMF .
DFT M(3012) QMF ,
QMF , DFT
.

[0244] QMF B , B ( )
. 1 (,), B
DFT . [31] HM_L
, QMF (b)
.

[0245] 31

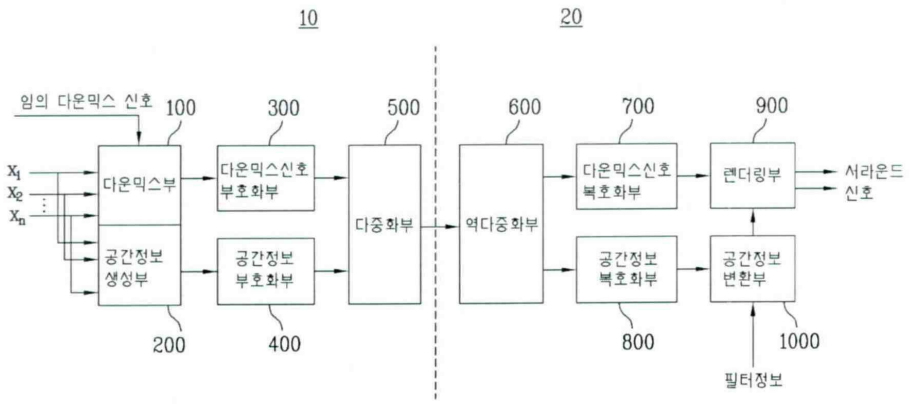
$$Lo\_m_b(k) = HM\_L_b * m = \sum_{i=0}^{filter\_order-1} hm\_l_b(i)m_b(k-i)$$

[0246]

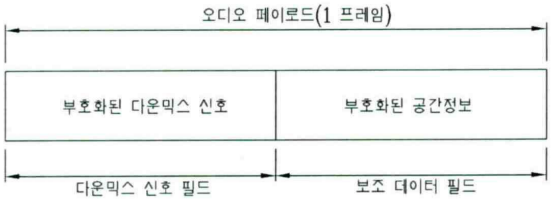
[0247] , k QMF (time order), . QMF
QMF ,
. , (
, HRTF) QMF ,
. , HRTF
.

[0248] ,
, .
,
.

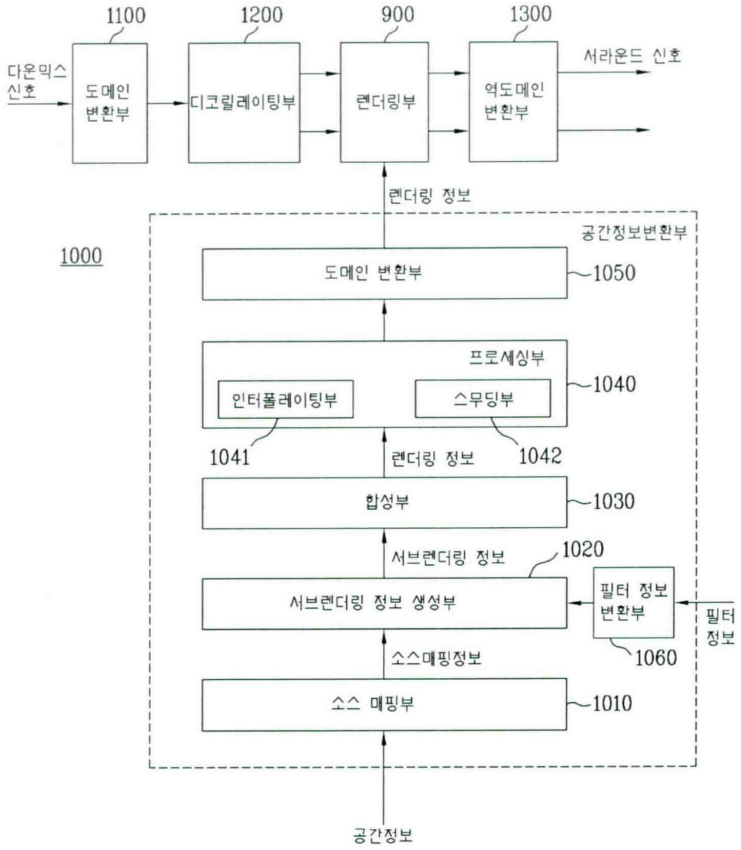
1



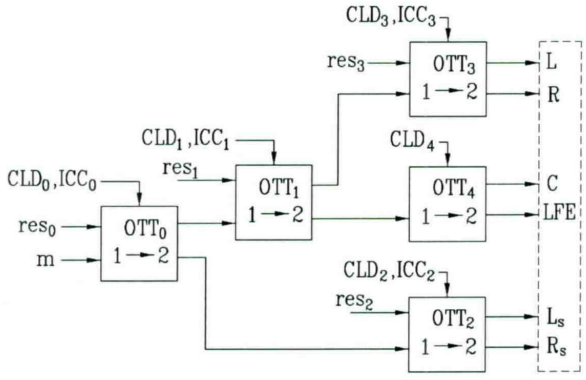
2



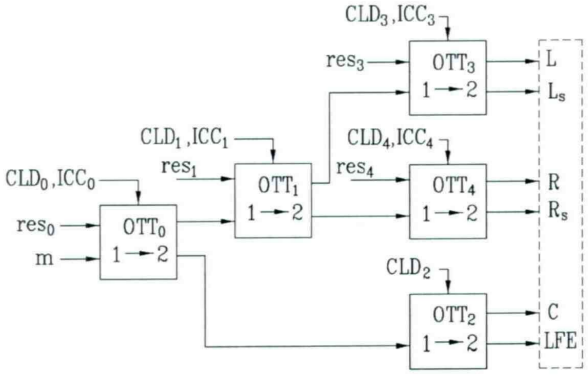
3


1100
1200
900
1300
다운믹스 신호
도메인 변환부
디코릴레이팅부
렌더링부
역도메인 변환부
서라운드 신호
렌더링 정보
공간정보변환부
1000
도메인 변환부
1050
프로세싱부
인터폴레이팅부
스무딩부
1040
1041
1042
렌더링 정보
합성부
1030
서브렌더링 정보
1020
서브렌더링 정보 생성부
필터 정보 변환부
필터 정보
1060
소스매핑정보
소스 매핑부
1010
공간정보

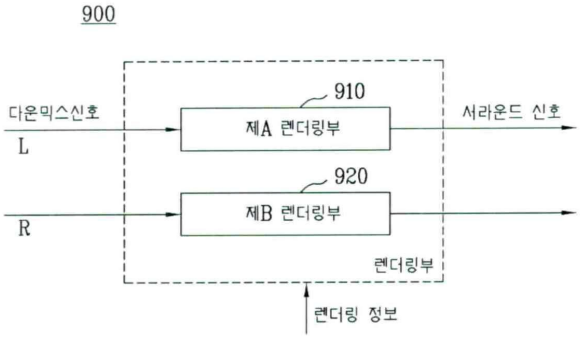
4


CLD3,ICC3
res3
OTT3
1→2
L
R
CLD1,ICC1
res1
CLD4
CLD0,ICC0
OTT1
1→2
OTT4
1→2
C
LFE
res0
OTT0
1→2
m
CLD2,ICC2
res2
OTT2
1→2
Ls
Rs

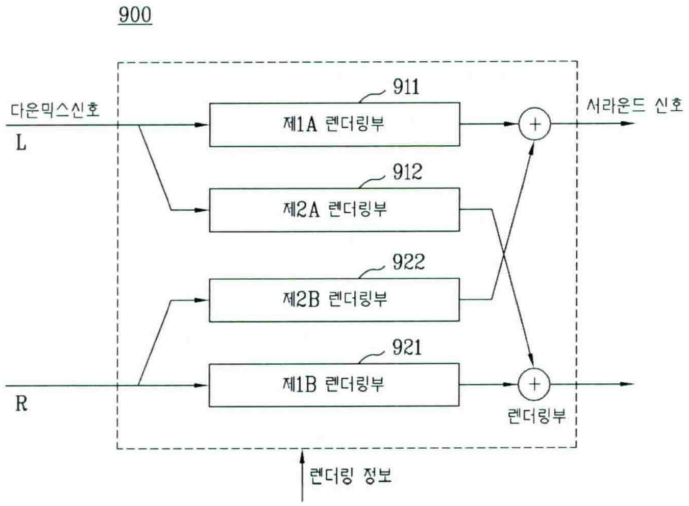
5


CLD3,ICC3
res3
OTT3
1→2
L
Ls
CLD1,ICC1
res1
CLD4,ICC4
res4
CLD0,ICC0
OTT1
1→2
OTT4
1→2
R
Rs
res0
OTT0
1→2
m
CLD2
OTT2
1→2
C
LFE

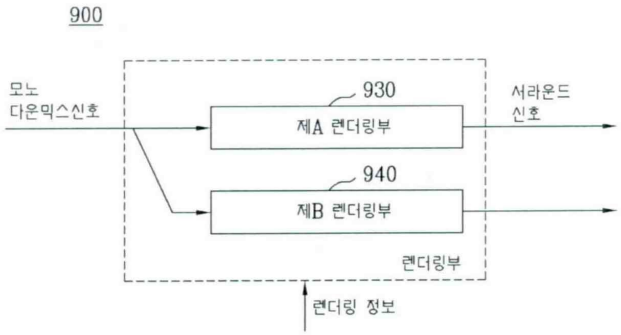
6


900
910
다운믹스신호
L
제A 렌더링부
서라운드 신호
920
R
제B 렌더링부
렌더링부
렌더링 정보

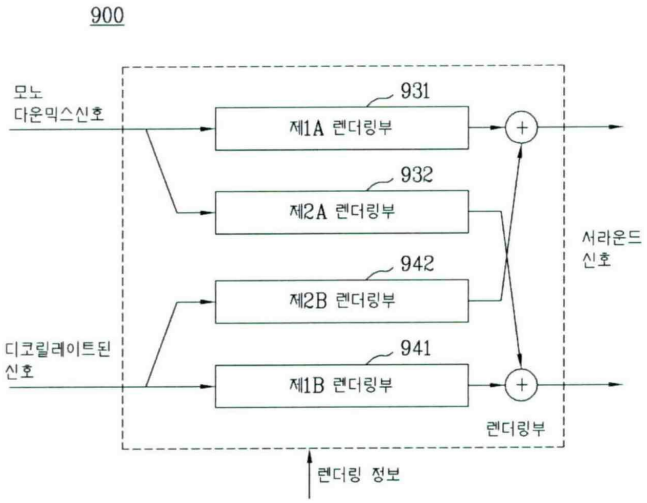
7


900
911
다운믹스신호
L
제1A 렌더링부
서라운드 신호
912
제2A 렌더링부
922
제2B 렌더링부
921
R
제1B 렌더링부
렌더링부
렌더링 정보

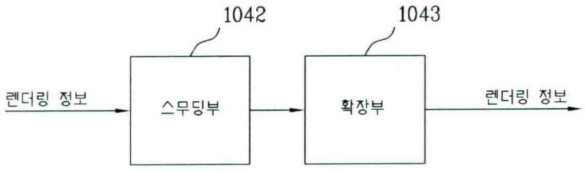
8


900
모노
다운믹스신호
930
제A 렌더링부
서라운드
신호
940
제B 렌더링부
렌더링부
렌더링 정보

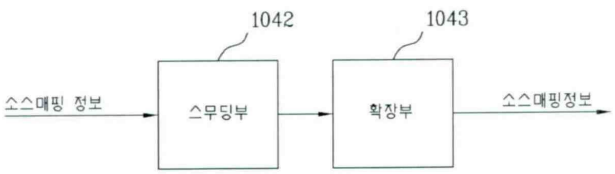
9


900
모노
다운믹스신호
931
제1A 렌더링부
932
제2A 렌더링부
서라운드
신호
942
제2B 렌더링부
디코릴레이트된
신호
941
제1B 렌더링부
렌더링부
렌더링 정보

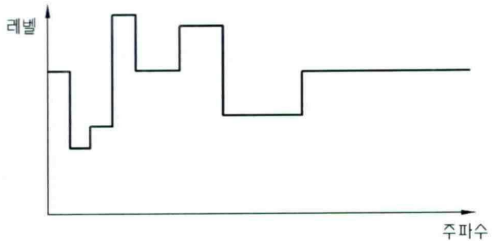
10


1042
1043
렌더링 정보
스무딩부
확장부
렌더링 정보

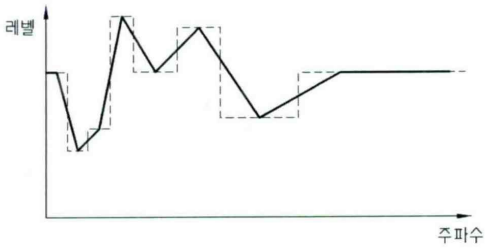
11


1042
1043
소스매핑 정보
스무딩부
확장부
소스매핑정보

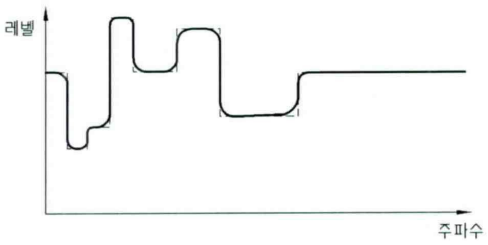
12



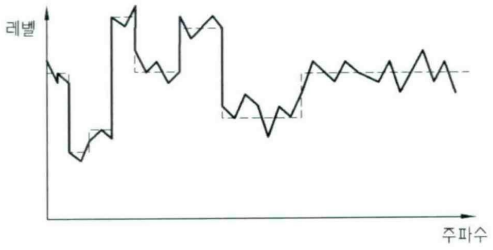
13



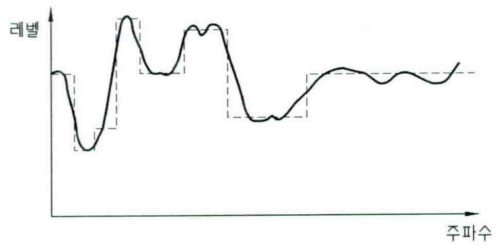
14



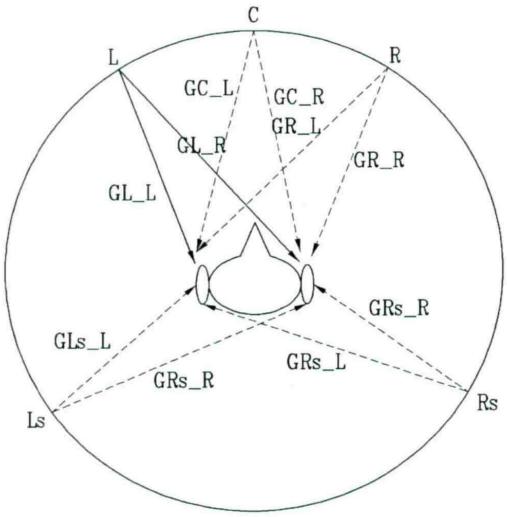
15



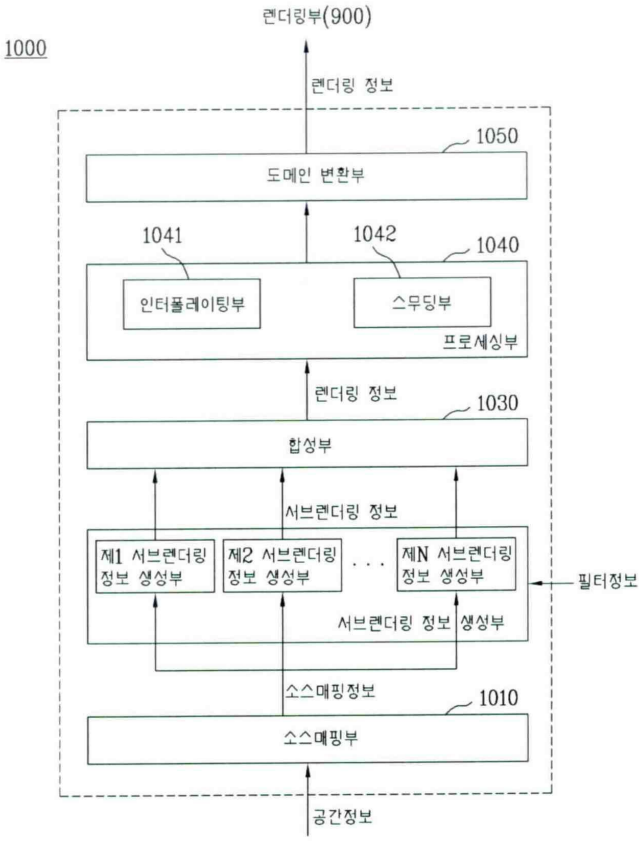
16



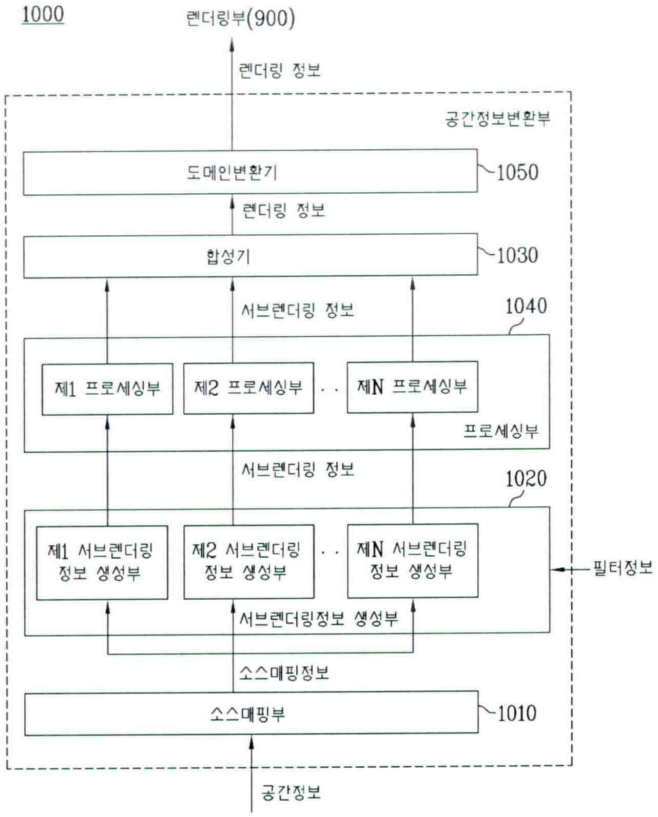
17



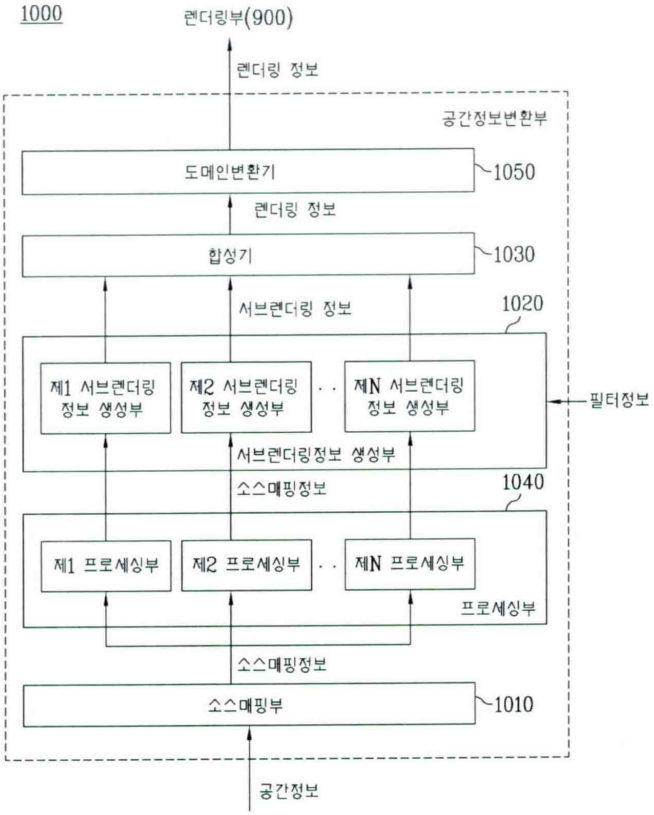
18


렌더링부(900)
1000
렌더링 정보
1050
도메인 변환부
1041
1042
1040
인터폴레이팅부
스무딩부
프로세싱부
렌더링 정보
1030
합성부
서브렌더링 정보
제1 서브렌더링 정보 생성부
제2 서브렌더링 정보 생성부
. . .
제N 서브렌더링 정보 생성부
필터정보
서브렌더링 정보 생성부
소스매핑정보
1010
소스매핑부
공간정보

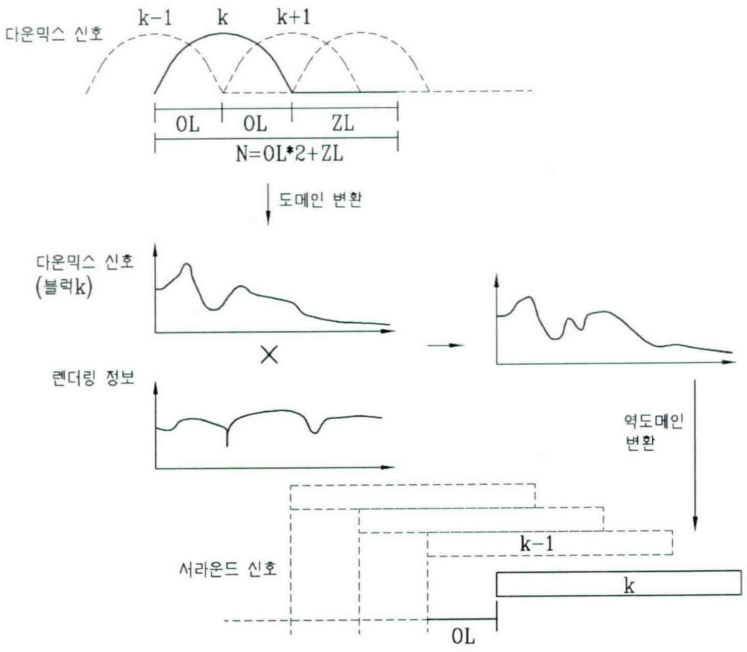
19


1000
렌더링부(900)
렌더링 정보
공간정보변환부
도메인변환기
1050
렌더링 정보
합성기
1030
서브렌더링 정보
1040
제1 프로세싱부
제2 프로세싱부
제N 프로세싱부
프로세싱부
서브렌더링 정보
1020
제1 서브렌더링 정보 생성부
제2 서브렌더링 정보 생성부
제N 서브렌더링 정보 생성부
필터정보
서브렌더링정보 생성부
소스매핑정보
소스매핑부
1010
공간정보

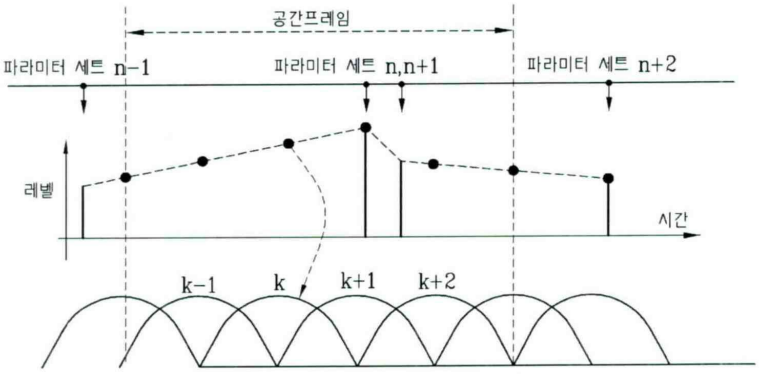
20


1000
렌더링부(900)
렌더링 정보
공간정보변환부
도메인변환기
1050
렌더링 정보
합성기
1030
서브렌더링 정보
1020
제1 서브렌더링 정보 생성부
제2 서브렌더링 정보 생성부
제N 서브렌더링 정보 생성부
필터정보
서브렌더링정보 생성부
소스매핑정보
1040
제1 프로세싱부
제2 프로세싱부
제N 프로세싱부
프로세싱부
소스매핑정보
소스매핑부
1010
공간정보

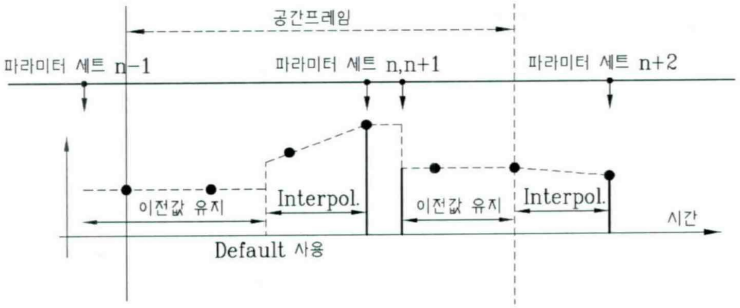
21


다운믹스 신호
k-1
k
k+1
OL
OL
ZL
N=OL*2+ZL
도메인 변환
다운믹스 신호
(블럭k)
렌더링 정보
역도메인
변환
서라운드 신호
k-1
k
OL

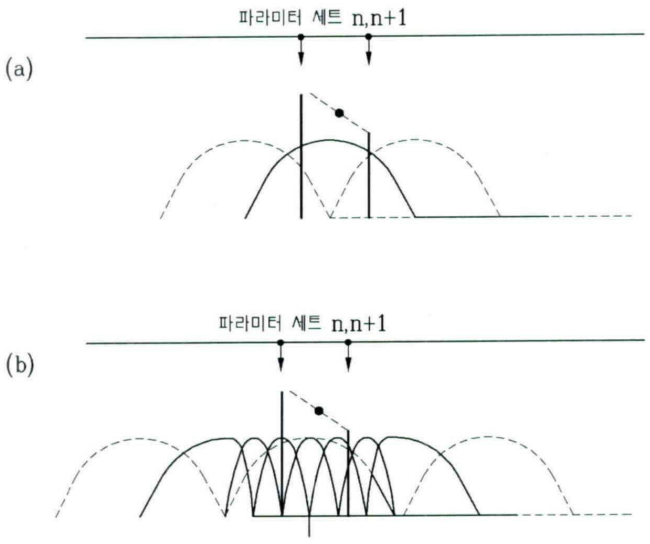
22


공간프레임
파라미터 세트 n-1
파라미터 세트 n,n+1
파라미터 세트 n+2
레벨
시간
k-1
k
k+1
k+2

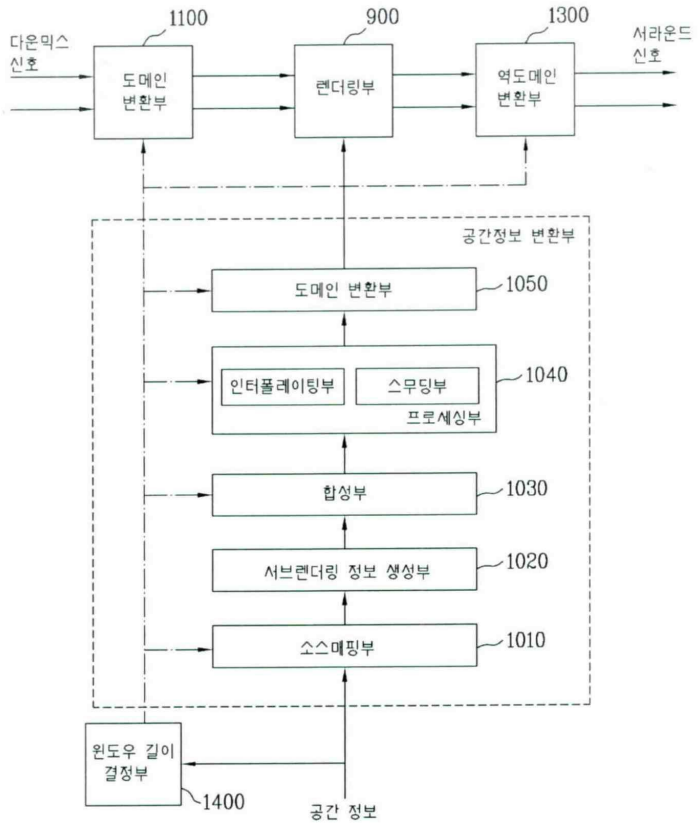
23


공간프레임
파라미터 세트 n-1
파라미터 세트 n,n+1
파라미터 세트 n+2
이전값 유지
Interpol.
이전값 유지
Interpol.
시간
Default 사용

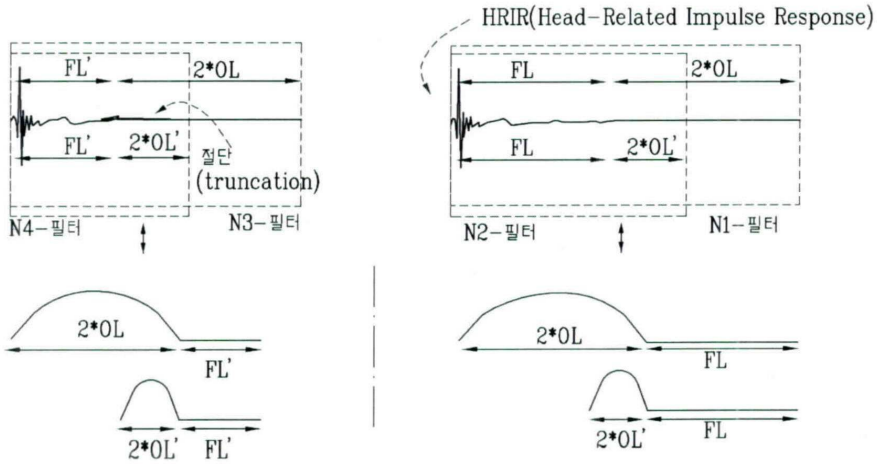
24


파라미터 세트 n,n+1
(a)
파라미터 세트 n,n+1
(b)

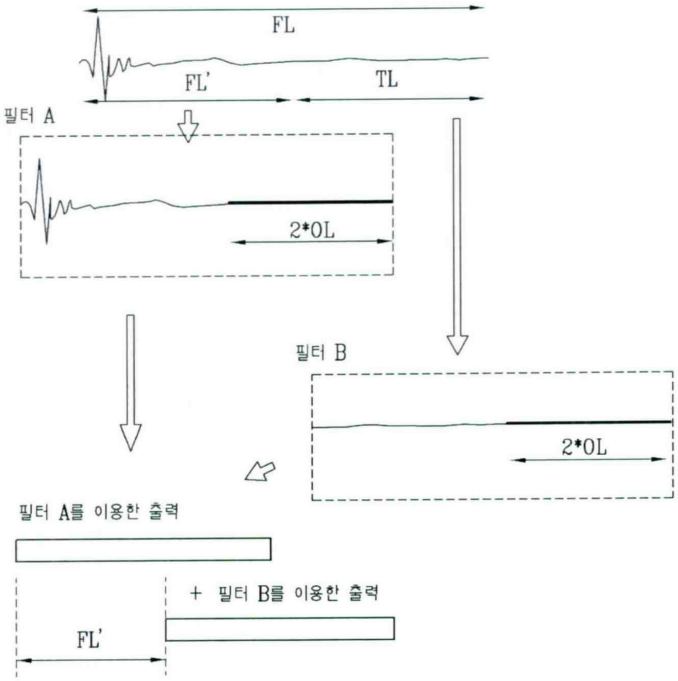
25


다운믹스 신호
1100
도메인 변환부
900
렌더링부
1300
역도메인 변환부
서라운드 신호
공간정보 변환부
도메인 변환부
1050
인터폴레이팅부
스무딩부
1040
프로세싱부
합성부
1030
서브렌더링 정보 생성부
1020
소스매핑부
1010
윈도우 길이 결정부
1400
공간 정보

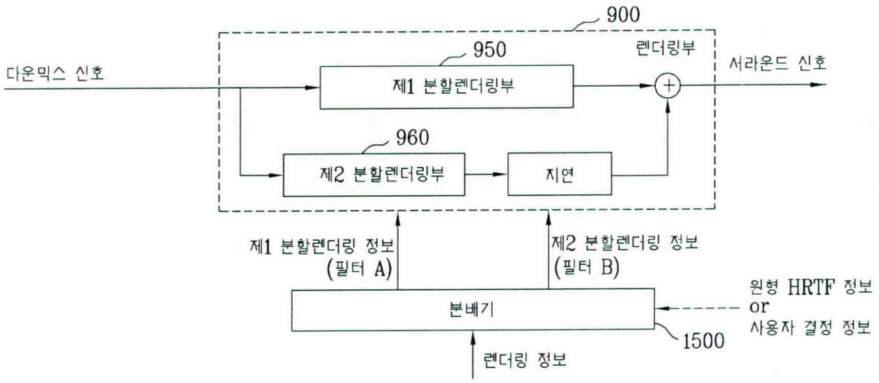
26


HRIR(Head-Related Impulse Response)
FL'
2*0L
FL'
2*0L'
절단
(truncation)
N4-필터
N3-필터
FL
2*0L
FL
2*0L'
N2-필터
N1-필터
2*0L
FL'
2*0L'
FL'
2*0L
FL
2*0L'
FL

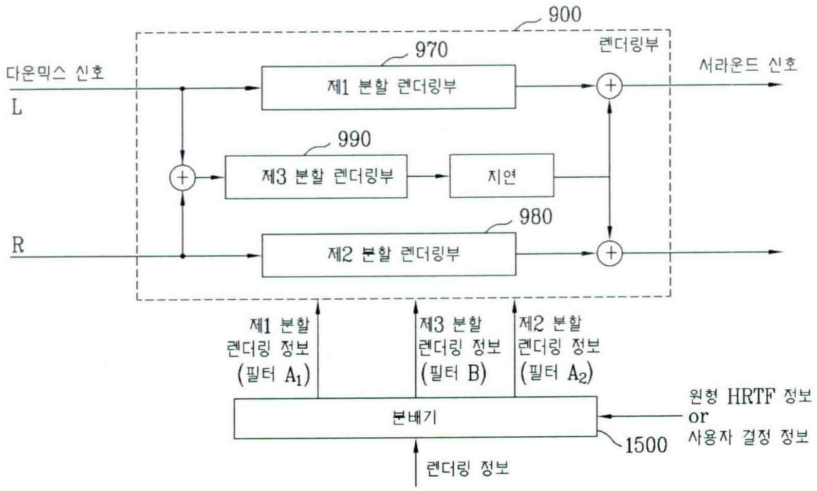
27


FL
FL'
TL
필터 A
2*OL
필터 B
2*OL
필터 A를 이용한 출력
+ 필터 B를 이용한 출력
FL'

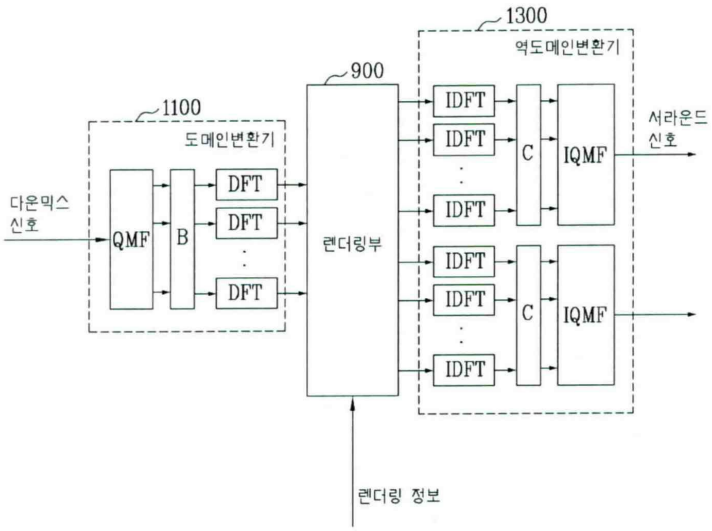
28


900
렌더링부
950
제1 분할렌더링부
다운믹스 신호
서라운드 신호
960
제2 분할렌더링부
지연
제1 분할렌더링 정보
(필터 A)
제2 분할렌더링 정보
(필터 B)
분배기
원형 HRTF 정보
or
사용자 결정 정보
1500
렌더링 정보

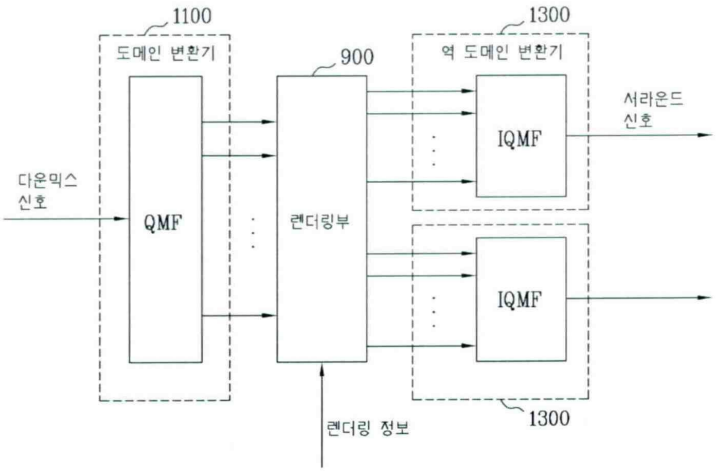
29


900
렌더링부
970
제1 분할 렌더링부
다운믹스 신호
L
서라운드 신호
990
제3 분할 렌더링부
지연
980
제2 분할 렌더링부
R
제1 분할
렌더링 정보
(필터 A_1)
제3 분할
렌더링 정보
(필터 B)
제2 분할
렌더링 정보
(필터 A_2)
분배기
원형 HRTF 정보
or
사용자 결정 정보
1500
렌더링 정보

30


1300
역도메인변환기
900
1100
도메인변환기
다운믹스
신호
QMF
B
DFT
DFT
DFT
렌더링부
IDFT
IDFT
IDFT
C
IQMF
서라운드
신호
IDFT
IDFT
IDFT
C
IQMF
렌더링 정보

31


1100
도메인 변환기
900
1300
역 도메인 변환기
서라운드
신호
다운믹스
신호
QMF
렌더링부
IQMF
IQMF
렌더링 정보
1300