$$R_{fm,cs}=\frac{R_{fm,cm}R_{cm,cs}}{R_{cm,cm}},R_{fs,cm}=\frac{R_{fm,fs}R_{fm,cm}}{R_{fm,fm}},R_{fs,cs}=\frac{R_{fm,fs}R_{fm,cm}R_{cm,cs}}{R_{fm,fm}R_{cm,cm}}$$

[0075] These quantities can therefore be extrapolated quite easily from the available data. Finally, the complete extrapolated covariance matrix Γ a simple matrix multiplication, is needed;

$$\begin{bmatrix} R_{lf,lf} & R_{lf,rf} & R_{lf,c} & R_{lf,lfe} \\ R_{lf,rf} & R_{rf,rf} & R_{rf,c} & R_{rf,lfe} \\ R_{lf,c} & R_{rf,c} & R_{c,c} & R_{c,lfe} \\ R_{lf,lfe} & R_{rf,lfe} & R_{c,lfe} & R_{lfe,lfe} \end{bmatrix}=\frac{1}{4}\begin{bmatrix} 1 & 1 & 0 & 0 \\ 1 & -1 & 0 & 0 \\ 0 & 0 & 1 & 1 \\ 0 & 0 & 1 & -1 \end{bmatrix}\begin{bmatrix} R_{fm,fm} & R_{fm,fs} & R_{fm,cm} & R_{fm,cs} \\ R_{fm,fs} & R_{fs,fs} & R_{fs,cm} & R_{fs,cs} \\ R_{fm,cm} & R_{fs,cm} & R_{cm,cm} & R_{cm,cs} \\ R_{fs,cs} & R_{rf,lfe} & R_{cm,cs} & R_{cs,cs} \end{bmatrix}\begin{bmatrix} 1 & 1 & 0 & 0 \\ 1 & -1 & 0 & 0 \\ 0 & 0 & 1 & 1 \\ 0 & 0 & 1 & -1 \end{bmatrix}$$

[0076] These steps are also be applied in order to extrapolate the total covariance matrix of the additional two channels, i,e, LS and RS. Leading to the total extrapolated covariance matrix:

$$\operatorname{Re}E\left[\begin{bmatrix} lf \\ rf \\ c \\ lfe \\ ls \\ rs \end{bmatrix}\begin{bmatrix} lf^* & rf^* & c^* & lfe^* & ls^* & rs^* \end{bmatrix}\right]\begin{bmatrix} R_{lf,lf} & R_{lf,rf} & R_{lf,c} & R_{lf,lfe} & R_{lf,ls} & R_{lf,rs} \\ R_{lf,rf} & R_{rf,rf} & R_{rf,c} & R_{rf,lfe} & R_{rf,ls} & R_{rf,rs} \\ R_{lf,c} & R_{rf,c} & R_{c,c} & R_{c,lfe} & R_{c,ls} & R_{c,rs} \\ R_{lf,lfe} & R_{rf,lfe} & R_{c,lfe} & R_{lfe,lfe} & R_{lfe,ls} & R_{lfe,rs} \\ R_{lf,ls} & R_{rf,ls} & R_{c,ls} & R_{lfe,ls} & R_{ls,ls} & R_{ls,rs} \\ R_{lf,rs} & R_{rf,rs} & R_{c,rs} & R_{lfe,rs} & R_{ls,rs} & R_{rs,rs} \end{bmatrix}$$

[0077] By using the same approach, i.e. converting the channels to virtual mono and side channels, it is quite easy to derive closed form formulas for the extrapolated covariance matrices.

[0078] So far, what has presented is a two step approach where the partial covariance matrix of the channels [*lf rf c lfe*] is first extrapolated and then the total covariance matrix of all channels is then extrapolated. However, another approach would consist in computing the total incomplete covariance matrix and then to globally extrapolate all correlations. The two approaches are conceptually equivalent. The second approach is however more effective since it globally extrapolates all possible correlations while the former implies a two step approach.

[0079] Both approaches are similar in implementation and are based on the maximum entropy (i.e. determinant maximization) approach.

[0080] It should be noted that all quantities depend both on time and frequency. The indexing was omitted for sake of clarity. The time index corresponds to the parameter time-slot l, while the frequency index to the processing band index m. Finally it should also be pointed out that all the resulting correlations will be defined relatively to the energy of the mono down mix signal, which is represented by $\sigma^2_{OTT_0}$. This is in fact true for any OTT_X box, due to the presence of the term $\sigma^2_{OTT_X}$.

[0081] In the following, in order to simplify the notation the mono downmix energy normalized extrapolated covariance matrix is defined as