APPARATUS AND METHOD FOR THE TIME-ORIENTED EVALUATION AND OPTIMIZATION OF STEREOPHONIC OR PSEUDO-STEREOPHONIC SIGNALS

The invention relates to devices and methods for stereophonizing a mono signal resp. for obtaining pseudostereophonic signals.

In particular, time resp. phase differences between different signals are more closely analyzed, in order on the one hand to be able to draw conclusions as to the acoustic properties of the signals and on the other hand to synthe~~th~~ize stereophonic or pseudostereophonic signals (this term also includes signals with more than two channels) that also exhibit these or other acoustic properties in an ideal form.

In particular, stereophonic or pseudostereophonic signals are analyzed that have been generated according to devices or methods according to EP1850639 or WO2009/138205 or WO2011/009649 or WO2011/009650 or CH01264/10 resp. PCT/EP2011/063322 and that are to be optimized either in terms of their psychoacoustic properties or that are to be matched with existing stereophonic or pseudostereophonic signals in terms of their psychoacoustic properties.

Methods so far in connection with EP1850639 or WO2009/138205 optimize the parameters exclusively in terms of an angle-dependent virtualisation of a classic MS array. According to the invention, this arrangement is additionally subjected to a time-dependent virtualization.

The present invention not only explores all possibilities of such a virtualization - partly through the radical simplification of the systems existing with

EP1850639 or WO2009/138205 or WO2011/009649 or WO2011/009650 or CH01264/10 resp. PCT/EP2011/063322 - but even achieves their automatization through the unexpected reformulation of the so-called inverse problem ~~known for noise filters and interference filters~~.

Hereinafter, the state of the art will be described, in particular with respect to devices or methods for obtaining, improving or optimizing stereophonic or pseudostereophonic audio signals.

EP0825800 (Thomson Brandt GmbH) proposes the generation of different kinds of signals from a mono input signal by means of filtering, said signals being used - for example by using a method proposed by Lauridsen based on amplitude and time difference corrections, depending on the recording situation - to generate virtual single-band stereo signals separately, which are then subsequently combined to form two output signals.

WO/2009/138205 as well as EP1850639 describe among others a method for methodically evaluating the angle of incidence for the sound event that is to be mapped, said angle of incidence being enclosed by the main axis of the microphone and the directional axis for the sound source, this being achieved by applying time differences and amplitude corrections which are functionally dependent on the original recording situation (which may be interpolated by using the system). The contents of WO/2009/138205 as well as of EP1850639 are hereby incorporated as a reference.

US5173944 (Begault Durand) applies HRTFs (Head Related Transfer Functions), which correlate with 90, 120, 240 and 270 degrees azimuth respectively, to the differently delayed but uniformly amplified monophonic

According to Hilbert's famous theorem on invariants (Hilbert, page 291, § 2), in our system, the linear combination

$$\boxminus\,[1,\ 1,\ -2]\ *\ [1,\ 1,\ -1]^2\ +$$
$$\Theta\ [1,\ 1,\ -2]\ *\ [1,\ 1,\ 1]^2\ =\ 0$$

in turn represents an invariant. Thus, for example, any piercing straight lines of $f\hat{}(t_1)$ and $f\hat{}(t_2)$, considered on the plane spanned by the vectors (1, 1, -2) and (1, 1, 1), ξ_1 and ξ_2, correspond to an infinite number of invariants of S and S′ resp. of S and $\sum'$.

When considering the standard cone reflected on the complex number plane, the change of opening angle of the cone yields the cone equation

$$-x_1^2 - x_2^2 + (1/g^{*2}) * x_3$$

resp. the coefficients $[-1\ \ -1\ \ 1/g^{*2}]$. Two cone equations are then considered:

$$S := a_x^2 := -1 * x_1^2 - 1 * x_2^2 + (1/g^2) * x_3^2 = 0$$

and

$$S' := a'_{x}{}^2 := -1 * x_1^2 - 1 * x_2^2 + (1/g'^2) * x_3^2$$

$$= 0.$$

It is well known that one invariant is thus:

$$a_{a'}{}^2 := -1 * (-1)^2 - 1 * (-1)^2 + (1/g^2) * (1/g'^4).$$

Both cones S, S′ are non polar if

$$S' = -1 * x_1^2 - 1 * x_2^2 + 1 * x_3^2 = 0$$

thus simultaneously enables the consideration of identical vanishing invariants relative to S

$$S = -1 * x_1^2 - 1 * x_2^2 + 2 * x_3^2 = 0$$

resp.

$$\sum' = 1 * u_1^2 + 1 * u_2^2 + 1 * u_3^2 + 2 * 1 * u_2u_3 + 2 * 1 * u_3u_1 + 2 * 1 * u_1u_2 = 0.$$

The relation

$$a_{a'}^2 := -1 * (-1)^2 - 1 * (-1)^2 + 2 * 1^2 = -1 * 1 - 1 * 1 + 2 * 1 = 0$$

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According to Hilbert's theorem on invariants (Hilbert, page 291, § 2), in our system, the linear combination

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