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Stereo+C: An All-Purpose Arrangement of Microphones Using Three Frontal Channels

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ABSTRACT

Until now, considerations for the arrangement of microphones using three frontal channels based on ITU-R BS 755-1 recommendation assume that three frontal speakers are set up in equal height and equal distance in front of a listener. Unfortunately in most home applications the center speaker is not set up as required by the ITU standard. In addition most of these microphone techniques are not compatible with two channel stereo.
Stereo+C is an arrangement that allows to use normal stereo microphone techniques with an additional specially arranged center microphone. The entire arrangement is completely stereo compatible and uncritical in case of a non ideal loudspeaker set up at the consumer's home.

INTRODUCTION

The ITU-R BS 755-1 recommendation for multichannel audio assumes that three frontal speakers are set up in equal height and equal distance in front of a listener [1]. As a result placements of microphones are developed whose signals cause phantom sources only between left and center speaker (L-C) resp. between right and center speaker (R-C) while phantom sources between left and right speaker (L-R) are avoided until now. These are for example INA [2], Double-Stereo [3], OCT [4], Ambisonic [5], [6], [7] and others [8], [9].
The advantages of these pairwise considerations are a bigger hearing zone, a stable middle even outside the central listener position and a better sharpness of localization compared with two channel stereo [3], [10], [11], [12]. But basically there are three serious disadvantages of these microphone arrangements:

- normally 5.1 productions are realized in parallel with two channel recordings. But some of the mentioned techniques are not really compatible with two channel stereo (see point 3), so different microphone setups and different recordings resp. different mixes for 5.1 and two channel stereo have to be made.
- because in most home applications multichannel sound is associated with home cinema the center speaker is not set up as required by the ITU standard. It is mostly positioned above or underneath a TV so that this speaker is not at the same height as the left and right

speaker. In addition, the quality of the center speaker is not equal to the quality of the other frontal speakers due to constructional features and the price structure of the manufacturers (see Fig.1). So one requirement (equal height, distance and quality of the frontal speakers) of the mentioned microphone techniques is not met. But it is out of question to ignore the center speaker for a recording and to produce a simple stereo mixing in the front because consumers who own multichannel equipment want to hear sound coming from the center speaker in case of a 5.1 recording (the same applies to the LFE).

- in some home applications the center speaker is omitted and the damped center signal is reproduced as a so called "phantom center" equally from the left and right frontal speaker like in some multichannel decoders [13]. In that case it comes to crosstalk from the signal of the L-C resp. R-C pair to the other pair so a shifted and blurred localization might occur when using some of the mentioned techniques. This problem exists in case of stereo compatibility, too. Either the principle of the phantom center is used for a stereo downmix of the three frontal channels with the mentioned problems, or the center signal is omitted in the extreme case which might cause a simple left/right localisation ("ping-pong effect", "center-hole").

THE CENTER SUPPORTING MICROPHONE (+C)

Compared with microphone arrangements similar to the extended "Decca Tree" [3] a new powerful and more variable means avoiding these disadvantages is presented whose principle is known from conventional stereo. This arrangement comprises a standard and in its parameters optimized stereo L/R microphone (AB, XY, MS, ORTF, etc.) for the left and the right channel as if the center was omitted. In addition to this L/R arrangement a mono microphone (+C) is located in sufficient distance. It is the goal to cause only phantom sources between L-R and to avoid them between L-C and R-C. This is exactly the opposite approach to the techniques mentioned above. To improve this effect the distance between the +C microphone and the L/R microphone could be increased so that it becomes rather a center supporting microphone. The level of this center microphone could vary from just perceptible - so that the precise location of the stereo microphone is not disturbed - up to the same level in L,C,R as a localization causing center signal. In the last case the center signal provides a bigger hearing zone, a stable middle and a better sharpness of localization compared to two channel stereo. At the same time the signal of the center microphone could be omitted for a stereo mix so that full stereo compatibility is guaranteed. Type and placement of the center loudspeaker are even uncritical at 5.1 because the center signal will only be located at the position of the center speaker if the level of the center signal causes a stimulus. As a rule the localization caused by the left and the right speaker would not be disturbed. Disadvantages of a phantom center do no longer apply because the center signal is mixed as a normal support microphone to left and right in that case.

The question is now what distance between the center supporting microphone and the stereo placement would be sufficient. Here the same rules are applied as in conventional two channel stereo. In practice it is possible to fix the center microphone with an extension onto the stand of the L/R microphone (see Fig. 2). The distance from this microphone to the recorded musical instrument or ensemble is not much larger than the distance between the L/R microphone and the instrument or ensemble so that the distance perception of all three microphones is quite equal. The length of the extension should be more than 2m in practice. Of course there may be points of sound sources which cause phantom sources between L-C and R-C by principle, but in practice this is irrelevant in case of a normal distance to an instrument or to an ensemble because the resulting level and time differences are quite high (think about the "ping-pong-effect" by equally based stereo AB-arrangements So the Stereo+C is something like "big AB" in height).
The independence of the +C microphone allows the usage of a microphone type different to the L/R microphone. It is also possible to place the +C microphone in a completely different position than the L/R microphone. Resulting differences in sound could be adjusted by equalization in both cases. To avoid a middle localization of deep frequencies the center signal can additionally be highpassed at 100 Hz.

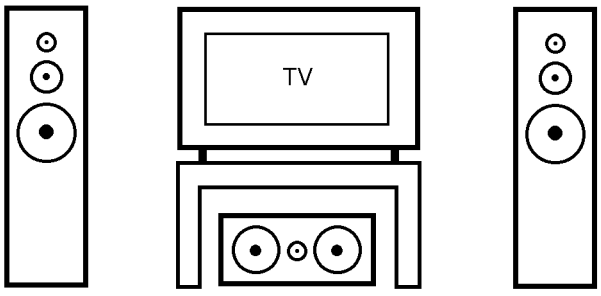

Fig. 1.: Typical frontal speaker settings for multichannel sound in home applications

AN ARTIFICIAL CENTER SIGNAL

The considerations of Stereo+C lead to a sensible way of deriving an artificial electrical center signal from a normal stereo recording for compatible multichannel [14]. Until now, in most cases a simple addition of the damped left and right signal is used [7], [15]. According to Stereo+C this sum signal needs to be additionally delayed to observe the precedence effect. To avoid sound distortions this delay should be quite long. 20 ms and more could be adequate in most cases without observing echoes between the three frontal channels depending of level and programme type of

the artificial center signal. The difference between discrete three frontal signals of a Stereo+C arrangement and three frontal signals with an artificial center signal is that with the addition L+R a correlated signal to L and R is observed. A discrete center signal from Stereo+C is less correlated[1] in all cases and therefore superior to an artificial center signal.
Alternatively, only the delayed and damped left or right signal can be used for the center speaker if the sum signal by itself causes sound distortions (for example AB stereo).

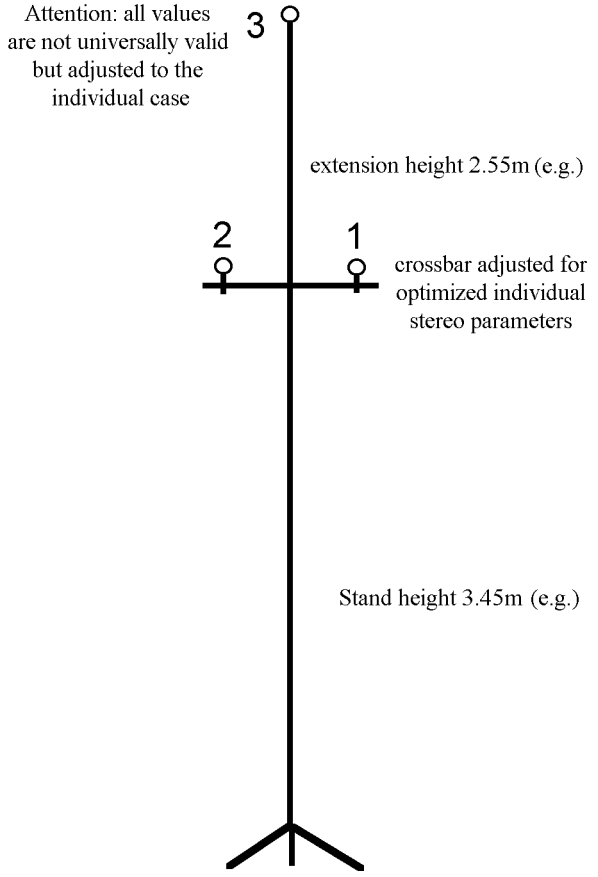

Fig. 2.: The Stereo+C microphone arrangement, example with AB+C (seen from the instrument side)

[1] The lower correlation is not observed due to the resulting (low) time differences between the center microphone and the L/R arrangement caused by the different distance to the instrument resp. ensemble (two signals which are only delayed are correlated) but because of the directional influence of the sound source and because of the influence of the room.

CONCLUSION

Stereo+C is a powerful microphone technique which is completely stereo compatible and which is uncritical in case of a non ideal loudspeaker set up at the consumer's home. It works well in any recording situation even with smaller ensembles or with or with solo instruments (e.g. a piano or an organ) where the possibilities of other arrangements of microphones using three frontal channels are limited[2]. At the same time the considerations of Stereo+C lead to a sensible way of deriving an artificial electrical center signal.

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