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Localization of phantom sources derived from contradicting signal differences

The effect of interchannel time and level differences on the perceived localization of a phantom source has already been well investigated, and for the center region (shift in the range of 0% to 75%), a linear relationship can be seen between time difference and shift, and also between level difference and shift. Therefore, for this center region, the effect of time and level differences upon phantom source shift can be described thus:

	Interchannel Difference		Resultant Phantom Source Shift
Time...	0,1 ms	=	13%
Level...	1 dB	=	7,5%

It has also been shown, that when both time and level differences are present, that the resultant phantom source shift will be approximately equivalent to the sum of the separate time and level shifts. The knowledge of these relationships is used by the "Image Assistant" to calculate localization curves. However, in order to be able to calculate data for non sweet spot listening positions, it was required to know how (and if) a phantom source is localized with both time and intensity cues which are in conflict. This means that the time difference cue relates to the opposite direction of the level difference cue.

Therefore, a short investigation was carried out at the IRT, and initial results are published here.

A standard 2 loudspeaker stereo setup was used, with the speakers at +/- 30°, and with a listening distance of 2 meters. Test subjects were asked to record where they localized a sound source, using a directional scale with 5° increments. (-30°, -25°, ... 0, +5°, +10°.......+30°).

The sound source used was a mono female voice, and this was fed to both loudspeakers. A delay ranging from 0 to 1.2ms (0.2ms increments) was introduced to one channel, and a level difference between the channels ranging from 0 to +12dB (3dB increments) was introduced, making the delayed channel higher in level than the other. Therefore 35 different combinations of level and time differences were used, with each one being played twice, resulting in 70 excerpts for the subject to localize. These excerpts were presented to the subject in a random order.

Below is a contour plot showing the perceived localizations of the combinations of opposing time and level cues:
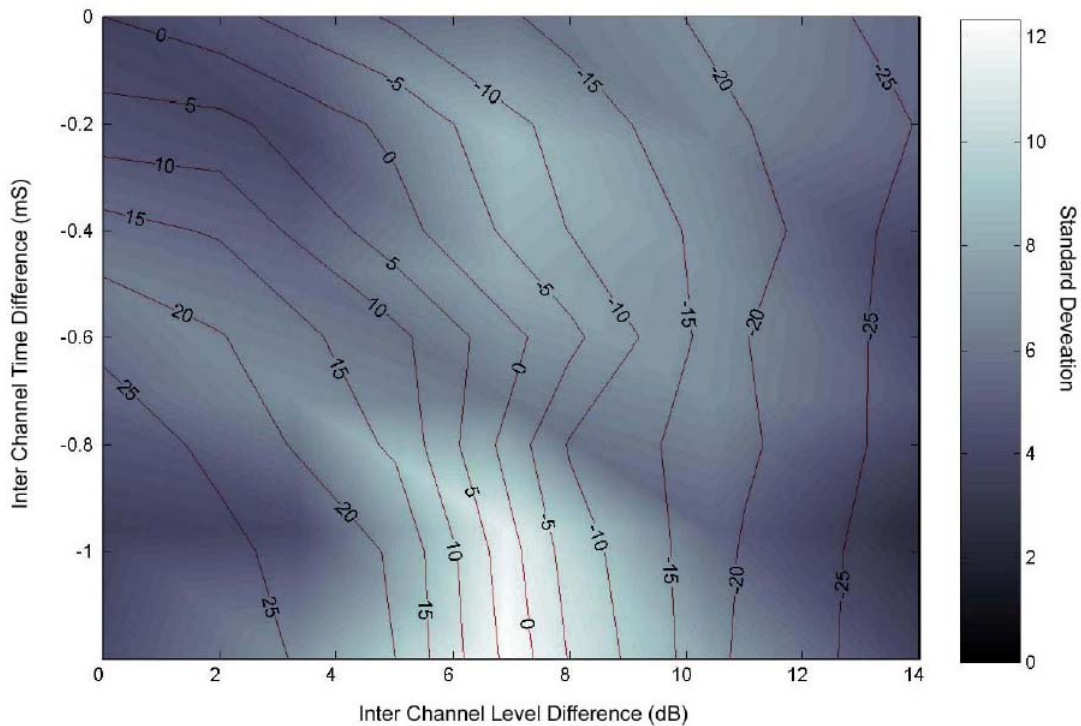
Figure: Perceived Localization of a phantom source derived from contradicting signal differences. (in degrees in a Standard Stereo configuration +/- 30°, with Standard deviation of the mean value in degrees)

The shading represents the standard deviation of the perceived directions. As can be seen, the accuracy of the phantom source localization is poor, unless:

- the level difference cue is completely dominant (> 12 dB), resulting in the phantom source being localized at the speaker.
- the level difference cue is below 3 dB. In this region it appears possible to counteract the level difference with a timing difference.
- only one of the cues are present.

As the difference between the shift due to time cues and that due to level cues increased, two distinctly separate phantom sources were said to have been localized by the subjects, one containing the high frequency content of the source signal (from the time difference shift position), and the other containing the low frequency content (from the level difference shift position). However, the subjects were only allowed to record one single localization position, based on which phantom source they thought was the more dominant. This explains why the resulting localization accuracy of the phantom sources when the two cues are distinctly in conflict is so poor, as the subjects did not always record the same perceived localization of an excerpt upon their second hearing.

For the above reason, more detailed investigations should be made taking into account the presence of two individual phantom sources, before looking for further meaning in the results obtained so far.