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A Novel Approach to Design Dolby Headphone

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Abstract*—The Dolby Surround process involves encoding four channels of information--Front Left, Center, Front Right, and Rear Surround into a two-channel signal. A decoding chip then decodes the four channels and sends them to the appropriate destination, the Left, Right, Rear, and Phantom Center (center channel is derived from the L/R front channels).This Paper describes work carried out to develop a specification to allow Dolby sound system in headphone by inserting two virtual speakers.*

Keywords-Dolby,3dsound,surround;

1. INTRODUCTION

The Emergence Of Dolby Surround

In the mid-70's Dolby Labs, with breakthrough film soundtracks such as Tommy, Star Wars, and Close Encounters of the Third Kind, unveiled a new surround sound process that was more easily adaptable for home use. Also, with the advent of the Hi-Fi Stereo VCR and Stereo TV Broadcasting in the 1980's, there was an additional avenue for which to gain public acceptance of surround sound: Home Theater. Up to that point, listening to the sound portion of a TV Broadcast or VCR tape was like listening to a tabletop AM radio. That is the point, initialized me to insert indirect communication in this protocol.

What is Dolby Headphone technology?

Dolby Headphone technology gives you the sound of a five-speaker surround playback system through any pair of headphones. It accurately models the surround sound listening experience of a properly set up and calibrated 5.1-channel speaker system as shown in figure 1, making it ideal for personal and portable surround listening. Dolby Headphone reproduces the audio signal's entire sonic signature, from the initial impulse to the final decay, and every reflection in between. It uses a highly sophisticated room-modeling algorithm that places images accurately, so you hear a multi-channel soundtrack the way its producers intended it to be heard. Dolby Headphone can also simulate a two-speaker stereo system and can be featured in PCs, portable DVD players, A/V receivers, digital TV sets, and wireless headsets.

Benefits of Dolby Headphone?

To understand the benefits associated with this virtual surround headphone technology, one needs to first understand the major limitation associated with the use of an ordinary pair of stereo-headphones. Normal headphones produce a rather unnatural in-the-head sound effect. Sound appears to be coming from within rather than from in front and around. The mind knows very well that sound cannot be coming from inside the head

and therefore no longer believes the sound the ears are hearing. Exposure to this unnatural sound effect for an extended period may eventually lead to what is referred to as 'listener fatigue'. This is a state of mental fatigue caused by the cognitive dissonance the mind experiences. In other words, this creates a feeling of uncomfortable tension in the mind as a result of the conflict between what the mind knows and what instead appears to be.

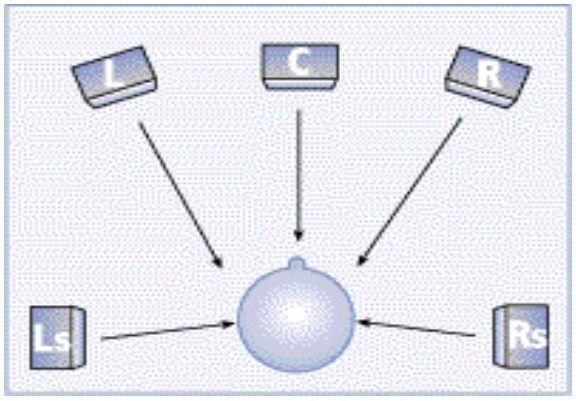

Figure 1 :Position of speaker to listener

In contrast to this headphone listening experience, when we listen to sound originating from a set of speakers, we hear sound coming from the speakers' positions as well as sound reflected off any side or rear of the room. The combined effect of direct and reflected sound is unique for each speaker in the system, and is dependent on the speaker and the listener's position, as well as the room acoustic characteristics This means that by the time sound from a specific speaker reaches the ear, it acquires a unique acoustical signature. These direct and reflected sounds provide spatial information to the brain about the speaker location, room dimensions, as well as other ambient information. A correct speaker placement can provide enough spatial cues to the brain as a result of direct and reflected sounds, to enable the exact location of sounds in the horizontal and vertical planes.

This creates what is referred to as a three-dimensional soundstage. In other words, when we listen to a system of home theater loudspeakers, we hear the sound coming from various directions: front, from the left, from the right, from either side, or from somewhere in the middle of the room. This contrasts heavily with the in-the-head effect produced by ordinary stereo headphones.

How does Dolby Headphone work?

It takes a multi-channel audio source (up to 5-channels), and adds to it the necessary spatial and ambient information effects through simulated direct and reflected sounds, and outputs a special two-channel encoded audio signal that is reproduced through a pair of conventional stereo headphones as shown in figure 2, 3. The Dolby surround sound headphone process is based on the fact that sound emanating from different sources in a room would reach the ears at slightly different volumes and in different times. This applies to both direct and reflected sounds.

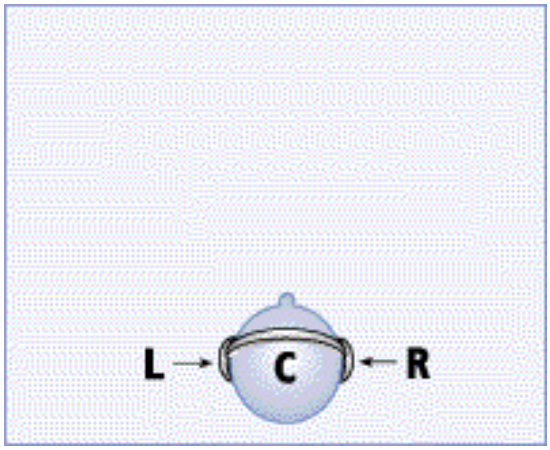

Figure 2 :Adjustment of center point of speaker

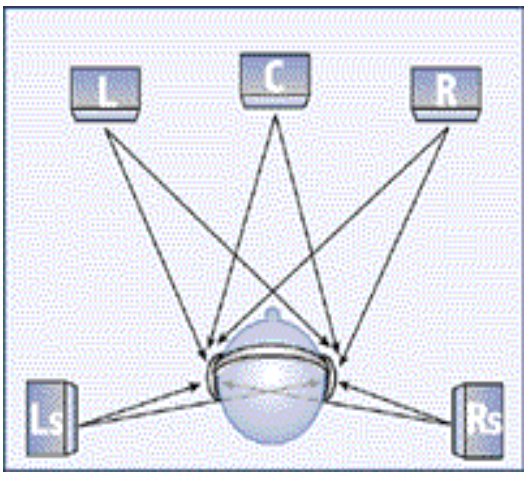

Figure 3: Position of speaker to listener

Does Dolby Headphone have any limitations?

One limitation of Dolby Headphone is its inability to re-create the surround back channels of Extended Surround sound formats such as THX Surround EX (Dolby Digital EX) or DTS Extended Surround (DTS-ES). Remember that 5.1-channel surround sound formats call for surround sound channel speakers to be placed beside the primary listening location, as shown in the figure above. In the 6.1-channel Extended Surround formats, the additional surround sound speakers (two are usually recommended) are placed behind the primary listening location, for complete 360-degree envelopment. So Dolby Headphone, if it were to ever support these 6.1-channel surround sound formats, would have to re-create sounds coming from behind the listener. The front-to-back imaging is tricky when all you've got to work with are two headphone mini-speakers that are placed side-by-side.

The best way to realize what we mean is to take your Dolby Headphone program and listen to it with your headphones on backwards. Wear them reversed, with the right-sideear cup/mini-speaker on your left ear and vice versa. With the headphones on backwards, where do you now hear the sounds that originally came from the front? Sure, right-to-left imaging is reversed as can be expected, but forget that for a moment. Try closing your eyes or turning off your TV. What you may notice is that the front-to-back imaging is not so clearly placed anymore. That is, you're probably not as sure whether the sound is coming from in front of you or from behind you. When we're facing the TV screen and our eyes are open, our brains help our ears interpret where sounds should be coming from. Without the visual cues, Dolby Headphone loses some of its ability to image front-to-back. This limitation is easily explained by physics and the classic geometric triangulation problem, and should not be misunderstood as a fundamental deficiency in the Dolby Headphone algorithm. To be fair, Dolby Headphone was never meant to simulate any of the 6.1-channel Extended Surround sound formats, with their back surround channels.

2. PROPOSED WORK

Design of Dolby SoundX.

What is Dolby SoundX ?

Here we propose an extension of current dolby headphone technology. In this technology physically we will use 3 speakers at left ear and 3 speakers at right ear as shown in figure 4.

- Speakers at left ear cup are named L, Lx and Ly.
- Speakers at right ear cup are named R, Rx and Ry.

By setting the loudness of these speakers at different level we get the sound effect similar to Dolby 6.1 channel Extended Surround sound, with their back surround channels.

1. When Loudness of L=1 and R=0, this gives sound effect of Front left (FL) speaker.
2. When Loudness of R=0 and L=1, this gives sound effect of Front right (FR) speaker.
3. When Loudness of L=1 and R=1, this gives sound effect of Center (C) Speaker.
4. Loudness of Lx=0.775 and Rx=.25, this gives sound effect of Rear left (RL) speaker.
5. Loudness of Ly=0.25 and Ry=0.75, this gives sound effect of Rear right (RR) speaker.

Sound effects no 1, 2 & 3 are already present in the current headphones, we have proposed new effect for Rear Left and Rear Right.

Table 1: Intensity of Different Channels

Sr No.	Actual Speakers Intensity (in %)						Virtual Speaker Effect
	L	Lx	Ly	R	Rx	Ry	
1)	100	-	-	0	-	-	Front Left
2)	0	-	-	100	-	-	Front Right
3)	100	-	-	100	-	-	Center
4)	-	75	-	-	25	-	Rear Left
5)	-	-	25	-	-	75	Rear Right

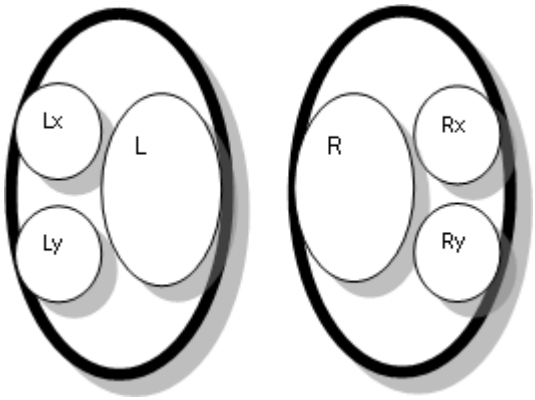

Figure 4. Design of Speaker

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