Virtual Surround Sound from a Dolby Digital Source
6.111 Final Project Abstract

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My 6.111 final project is a Dolby Digital decoder for any source which is capable of outputting a Dolby Digital compliant bit stream on an optical TOSLink cable, then using this decoded signal to simulate surround sound on a pair of standard headphones or, with some careful placement, any pair of standard 2.0 speakers. Specifically the system will be comprised of 3 components: a Dolby Digital decoder, a Head-Relation Transfer Function(HRTF) module, and a visual locator module.

The backbone of the system will be the decoder module which provides the rest of the system with the appropriate streams of information to perform the HRTF functions and combine the outputs to provide signal to the AC97 module. The specification for Dolby decoding is a well defined industry standard that appears on a multitude of products in the consumer electronics field. It supports the film standard of the typical of 320 kbits per second to the digital television standard of 448 kbps and the standard maximum of 640 kbps of bit length ranging from 16 to 24 bits each. The input will come from a pre-made TOSLink receiver module which transfers the optical signals to a serial digital data stream for the module to decode. After examining the frame information and making sure it meets the Dolby Digital specification, it will compute the PCMs described by the stream . This will then go to the HRTF module as the 6 streams of PCM data, representing the 5 speakers and the subwoofer for processing.

The visual locator module will be a GUI that allows the user to change his location and orientation relative to the movie screen and still maintain the same audio effects of being in the actual surround sound environment. The locative and orientation data output by this module is also passed to the HRTF module so that we can use it to calculate exactly how the sound should be modified for the user's current placement.

The HRTF module will then take these PCM streams and location data and perform what amounts to some FFT processing on the PCM stream combined with some linear algebra to simulate that each of the 6 speakers in the virtual surround sound setup are in their ideal location. Essentially, what happens is by delaying the signal some period of time, typically a few microseconds and modifying the frequency and phase of a sound, given a known location to broadcast from and a know destination for the sound, we can make it appear as if there is a speaker producing the sound in any location in the space around the user. The effectiveness of the method is limited simulating sounds that are less than approximately 2 meters away from the subject, and shifts in elevation are also difficult to recreate, but no current recording takes that altitude information into account. Yet, for a contrived setup, similar to the headphones I am planing to use, the model works exceedingly well. The summed output of this module will be 2 PCM streams, one for each earpiece, that can be fed to the AC97 module and out to the headphones.

The team will consist of Harrison Hall. As modules go for the project, the order of importance is the Dolby decoding and then the HRTF module followed by the GUI. Harrison will be implementing all of the modules himself.