Experiment Design to Measure Perceived Error in Simulated Acoustic Environments

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Simulated acoustic environments are used in fields such as the automotive industry to help predict what conceptual spaces, such as car cabins, would sound like without having to build actual working prototypes. These acoustic environments save time and money by allowing for key changes to be made to designs before significant investment is made. To be immersed in an acoustic environment, a person wears a pair of headphones equipped with a head tracking device. This allows the person to move around in the simulated space and hear the noises that would be present in all parts of the final space.

As associated with all simulated models, acoustic environments have a large amount of error in the precision of the created sound sources and their locations. It is necessary to determine how much of this error is acceptable to a listener inside the environment so that adequate adjustments to the simulation can be made. In this project, an experiment was designed in LabVIEW to quantify the allowable amount of perceivable error in simulated acoustic environments.

Measuring any perceived subject is a difficult task because of the wide range of differences in human perception. In this experiment, to determine the amount of acceptable error in an acoustic environment, listeners will be asked to compare two given sounds and answer yes or no to the question "do you hear a difference?" The listener is given a number of simulated sounds at different qualities which are compared to control sounds. Using a "smart" algorithm that constantly adjusts what comparison it will give next based on the answer to the last, it can be determined at what quality level the simulated sound can distinguish from a control sound. With this method, the exact level, or threshold, of acceptable perceived error is found and quantified. The amount of acceptable error is dependent on the frequency of the sound, the sound's location around the head, and the specific parameters used to generate the simulated sound sources.

A large degree of error may be acceptable to a listener in one situation while the smallest amount may not be acceptable in another situation depending on the exact characteristics of the sound and simulation models used. It is important to determine the acceptable levels of error as this knowledge can be used to reduce computation time in real-time simulations. If a high degree of error is acceptable to a listener, the model used to simulate the sound field can be made more coarse and therefore require less computation time. Using the LabVIEW program that was developed in this project, it will be possible to quantify the amount of acceptable perceived error in acoustic environments and therefore greatly improve the quality of these environments.