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1. The Subject and Aims of Research  
The goal of immersion system is to create the illusion of proximity for people physically in different areas. To achieve this, it is essential to pick-up and regenerate all the crucially visual and aural information that is perceptible by human senses. The major research directions would be the development of multimedia system with emphases on immersive audio techniques and their applications:  
- audio-visual fusion by machine learning,  
- image retrieval using graph modeling,  
- application of virtual technology to the Internet,  
- modeling of immersive system,  
- multichannel audio rendering,  
- virtual acoustics for high-definition audio delivery,  
- room acoustics/ equalization/ calibration,  
- adaptive signal processing for application involving hand-free microphones,  
- and their consumer electronics applications.

Applications of immersive audio include teleconferencing, home entertainment, air traffic control, pilot warning and guidance, distance learning, professional sound editing, and assisting people who are visually or aurally impaired.

2. Related Recent Research Topics  
(1) Modeling of immersive audio system:  
In this project, the fuzzy cerebellar model articulation controller (FCMAC) is adopted to train a system on real data collected from recordings in a concert hall and then use the model to synthesize microphone signals from other recordings. The reference signal that we use is one of the two microphones used in the ORTF configuration above the conductor’s head in classical music recordings. The training signals come from another microphone placed near the tympani during the same recording. We should note here that this is not a problem of source separation or instrument tracking. Our goal is not to eliminate all but the single instrument sound. It is to synthesize the signal that a microphone would have picked up if it were present near the instrument during the recording. This approach is effective for synthesizing signals in virtual microphone that are placed beside an individual instrument. We are currently investigating how to generalize this approach to cover a broader variety of instruments and microphone positions.
(2) Multichannel audio rendering.

Multichannel audio is rapidly becoming the next step in the evolution of musical reproduction. Increasing the number of channels produces a more pleasing and immersive experience for listeners. However, only a relatively small number of multichannel musical recordings have been made. Furthermore, many older or historical recordings are seemingly destined to remain as one or two-channel renditions. One approach to up-converting these recordings to multichannel versions is to synthesize the necessary microphone signals that would normally be used to make a multichannel recording. As shown in Fig. 1, we propose a morphing algorithm to synthesize signals based on the pair-wise reference signals. This approach is similar to the graphic morphing that allows signal not only being transformed from one to another, but incorporating with the appropriately acoustic characteristics.

![Fig. 1. Multichannel recording synthesis by spectrogram morphing.](image)

3. Selected Publications and Project*


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