

Implementation of 3d hrtf interpolation in synthesizing virtual 3d moving sound

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Abstrak

3D sound is a new trend in various media, such as movies, video games, and musicals. Interpolated head-related transfer functions (HRTFs) are a key factor in its production, due to real-time system limitations in storing measured HRTFs. In addition, the interpolation of HRTFs can reduce the need to measure a large amount of HRTFs and the associated effort. In this research, we used the PKU-IOA HRTF Database and covered three interpolation techniques, namely bilinear rectangular, bilinear triangular, and tetrahedral. Bilinear interpolations can be used to compute weights in interpolating measured HRTFs in a linear fashion, with respect to azimuth and elevation angles. Such interpolations have been proposed for three measurement points that form a triangle or for four measurement points that form a rectangle, surrounding the HRTF at a desired point. These geometrical approaches compute weights from a distance of the desired point from each measurement point. Tetrahedral interpolation, meanwhile, is a technique for HRTF measurements in 3D (i.e. azimuth, elevation, and distance) using barycentric weights. Based on our experiments, 3D tetrahedral interpolation results in the best average mean square error (MSE) of 3.72% for minimum phase head related impulse responses (HRIRs) and best average spectral distortion (SD) of 2.79 dB for magnitude HRTFs, compared to 2D bilinear interpolations (i.e. rectangular and triangular interpolation). Regarding the latter, bilinear rectangular interpolation generally performs better than the triangular variety. Additionally, the use of minimum phase HRIRs as input data results in more optimal interpolated data than magnitude HRTFs. We therefore propose an optimal framework for obtaining estimated HRIRs by interpolating minimum phase HRIRs using tetrahedral interpolation. Such HRIRs have been simulated to produce virtual 3D moving sound in a horizontal plane with a difference of 2.5° of azimuth angle. The simulated moving sound that is heard moves naturally in a clockwise direction from an azimuth angle of 0° to 360°.