Machine Learning Techniques for HRTF Personalization

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Abstract

Head related transfer function (HRTF) is a key factor in the three dimensional sounds (3d sound) generations over headphones. The main goal of 3d sound applications is the reproduction of the spatial properties of a sound by filtering the sound source with appropriate head related impulse response (HRIR) of the listener which is the time domain equivalent of an HRTF. Accurate reproduction of the spatial properties of sound remains a challenge. There are several methods to obtain HRTFs. The most important of these methods is the direct measurements because it guarantees that the filtering of 3d sound systems will be with the appropriate impulse response of the ear of the listener corresponding to his anthropometric specifications. This helps to give the listener the impression of the real sound and improve the virtual reality applications. Since, each listener has his peculiar HRTF related to the physical features of the listener. Several research efforts have been exerted on developing personalized HRTF functions suitable for general purpose 3d sound applications. A key function of these HRTF personalization approaches is their ability to the adapt the HRTFs measurements to the listener without any need for direct measurements that is time-consuming, efforts-demanding and requires special tools and equipments. HRTF personalization aims to solve this problem by the standardization of the available measurements of HRTF for wide range of subjects. Machine learning plays important role in this aspect. Since the HRIR have evident characteristics relating to anthropometric parameters and the relation between them is very complex, and it cannot be exactly expressed by an explicit linear formula. This thesis presents personalization model based on establishing non-linear relationship between the anthropometric parameters and HRIRs. The HRTF personalization model based on the back-propagation artificial neural networks (BPANN), principle components analysis tools (PCA) and the current HRIRs measurements database. The results of this study have produced considerable performance improvements over the recently developed related systems have been obtained.