Optimal Design of Microphone Array for Humanoid-Robot Audition

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Abstract

One of the important components of a humanoid robot is its auditory system. The system is mainly aimed at increasing the robot's awareness of its surroundings and at enabling natural human-robot interaction using speech. The auditory system is usually based on a microphone array which constitutes the front end for sound acquisition. Configuration of this array plays a central role in the performance of the system as a whole. There are robot-audition related publications concerned with the optimization of the array configuration for enhancing the spatial information acquired by the array [1] and for improving the sound localisation performance [2]. However, spatial aliasing, which is one of the major problems in array design, remains largely untreated in the humanoid-robot audition literature. The current work presents a method for microphone positioning optimisation that extends the aliasing-free frequency range of the array. The method can be used to complement the existing techniques for aliasing cancellation by signal processing [3]. The efficacy of the proposed method to reduce aliasing is demonstrated by showing a significant performance improvement, when compared to using the efficient nearly-uniform microphone distribution. The proposed method is applied to the design of a new 12-microphone array for the NAO robot. This design is subject to the real constraints on microphone positioning due to the robot's cameras, loudspeakers, and other components. An initial evaluation of the new prototype head manufactured by Aldebaran Robotics according to the design is discussed and an example is presented showing its efficacy for reducing the speech-recognition error rates in real-world environments.

Keywords

Microphone array, humanoid robot, robot audition, aliasing cancellation, array optimization, human-robot interaction, speech recognition.

References

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