

An Open Hardware and Software Microphone Array System for Robotic Applications

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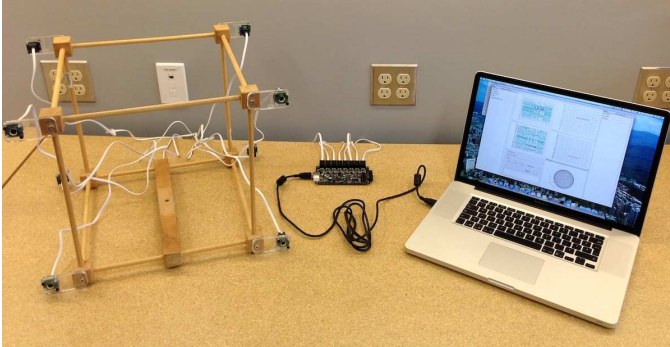


Fig. 1. ManyEars Open Framework

KEYWORDS

Open source – Sound source localization – Sound source separation – Mobile robotics – USB sound card – Open hardware – Microphone array

ABSTRACT

Autonomous robots must be able to perceive sounds from their environment in order to interact naturally with humans. ManyEars is an open framework for microphone array-based audio processing, which allows a robot to localize, track, and separate multiple sound sources, for improved speech and sound recognition in real-world settings [1]. The system runs in real-time on a personal computer and is able to reliably localize and track up to four of the loudest sound sources in reverberant and noisy environments when eight microphones are used [1]. It can also separate up to three sources in an adverse environment with a suitable signal-to-noise ratio improvement for speech recognition [2].

To facilitate maintenance and portability, ManyEars is implemented in C as a modular library, with no dependence on external libraries. The source code is available online [3] under the GNU GPL license. A Graphical User Interface (GUI) (also available online [4]) is a complementary tool used to display in real-time the tracked sound sources and to facilitate configuration and tuning of the parameters of the ManyEars library. ManyEars is also implemented as an open software library with Willow Garage's Robot Operating System (ROS) [4].

ManyEars can be used with commercially available sound cards and microphones. However, these sound cards present limitations when used for embedded robotic applications: they are usually expensive, they have superfluous functionalities, and they also require significant amount of power and size. To facilitate the use of ManyEars on various robotic platforms, customized microphone boards and sound card are distributed as open hardware solutions. The proposed XMOS based sound card is low-cost, compact (12.5 cm × 7.4 cm × 1.5 cm), has eight analog inputs and one stereo output, and can be powered by either the Universal Serial Bus (USB) or an external wide range DC power supply. Audio data are transferred to the computer with the USB 2.0 High-Speed Audio Class 2.0 standard, which makes it compatible with Window, Linux and Mac OS X. The first implementation of ManyEars has been used on the robot Spartacus [5] and the new C version is currently used on the robot IRL-1 [6].

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