Real Time Localization Methods for Calling Frogs using a Wireless Sensor Network

Yasuharu Hirano[1], Daichi Kominami[2], Ikkyu Aihara[3], and Masayuki Murata[1]

[1]*Graduate School of Information Science and Technology, Osaka University, Osaka 565-0871 Japan*
[2]*Graduate School of Economics, Osaka University, Osaka 560-0043 Japan*
[3]*Graduate School of Systems and Information Engineering, University of Tsukuba, Tsukuba 305-8577 Japan*

Keywords: Japanese tree frog, Microphone-array, Localization, Direction of Arrival

Finding animals is important for field experiments, but it is often hard because animals may be small and conceal themselves in their habitat. To localize animal calls, we made a sound localization system using a wireless sensor network, which is composed of a number of sensor devices with wireless communication capability and a microphone array. One of the advantages of a wireless sensor network is ease of deployment of recording equipment. The goal of our system is to achieve the high accuracy of localization (<10 cm) in real time in natural environment. In this study, we implement a localization method using Direction of Arrival (DOA) measurements obtained from a microphone array (Figure 1). We use a Raspberry-Pi 2 for a sensor device connected with an 8ch microphone array (TAMAGO-03, System in Frontier Inc.), which records the sound and calculates DOA by the Multiple Signal Classification (MUSIC) method[1]. Sound source localization is conducted by a localization server that uses a grid-based localization method[2] because the computational complexity of the method is comparatively low. However, in this method, computational time becomes longer as the number of sound sources and microphones increase (Figure 2). Therefore, we propose a distributed localization method. Since sensor devices are connected with each other by wireless communication, they can be easily divided into some groups that are composed of a few sensor devices, respectively. Each group only collects its nearby sound and the localization server merges information received from each group to conducts sound source localization. We show the accuracy and computation time of our system based on the results of simulations and experiments.
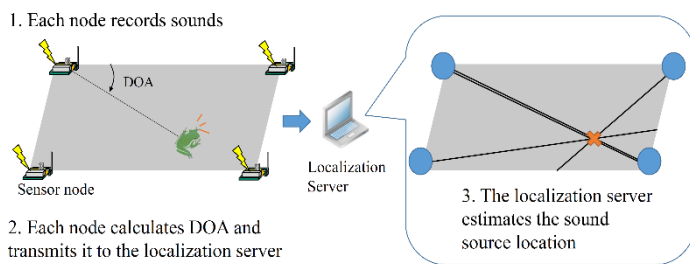

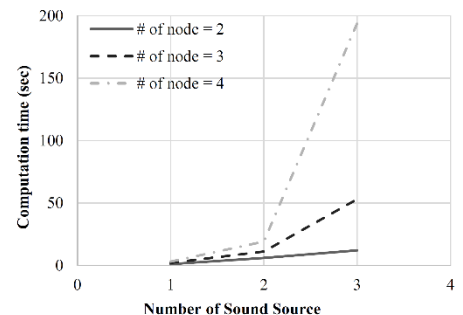Figure. 1 Summary of our localization system

Figure. 2 Computation time for multiple sound sources

[1] R. Schmidt, "Multiple emitter location and signal parameter estimation, "IEEE Transactions on antennas and propagation, vol. 34, no. 3, pp. 276-280, 1986.

[2] A. Griffin, et al., "Real-time localization of multiple audio sources in a wireless acoustic sensor network," in Proceedings of EUSIPCO, pp. 306–310, 2014.