Not "The Sound of Silence"
Acoustic Communication for the SPL

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I. Motivation

One long term goal of RoboCup is to raise robotic soccer to a human like level in terms of quality and robustness. Therefore, several challenges exist that have to be overcome. The one our team has focused on is that of robust communication. Previous RoboCup tournaments have clearly shown that communication by WLAN definitively is a show stopper under real world conditions like the world cup. This is mainly caused by radio interference with other leagues, undisciplined usage of the WLAN resource by several individuals (e.g., video streaming, file sharing, etc.), but also by bad hardware design w.r.t. wireless communication of the NAO robot. Hence, our contribution for this year's SPL Open Challenge introduces robust acoustic communication without the need of radio signals.

II. Methodology

Various approaches to digital acoustic communication have been proposed in literature. The main field of application so far is communication at submarine vessels and underwater sensor networks as sound is much better propagated in water compared to radio signals. However, as radio communication channels at RoboCup tournaments are completely overloaded, some times even jammed, we transpose underwater communication methodologies to over-the-air acoustic communication for the SPL. Limits that have to be overcome are: poor hardware like microphones and speakers of the NAO robot, unfeasible design decisions like direction and position of built-in microphones, and finally lots of noise coming from the NAO's hardware as much as from environment. To tackle these issues acoustic communication has to be robust to noise, and adaptive to changes in environmental condition. Main goal for our team in this year's challenge is robustness. Hence, our base implementation for acoustic communication is based on Frequency Shift Keying (FSK) with error correction. The default throughput highly depends on chosen base frequencies and will be 8 bps for the demonstration.

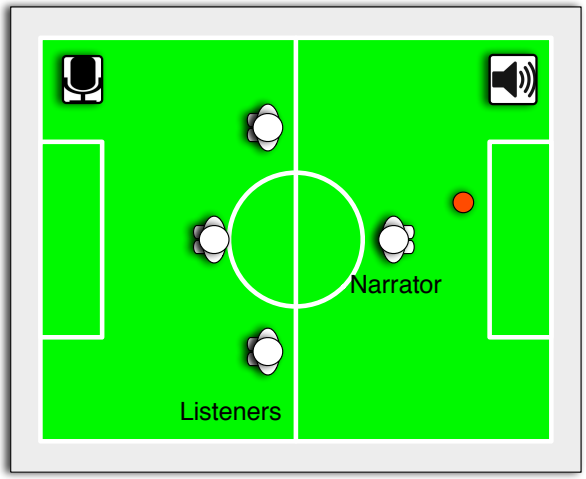

Figure 1: Setup for Acoustic Communication Demo

III. Demonstration

We will demonstrate the robots' ability to "talk to each other" by sharing information via acoustic communication. An exemplary setup is shown in Figure 1: one robot, the narrator, is placed at the field surrounded by other NAOs, the listeners, who will be turned away from the narrator (no visual contact). The demonstration starts by presenting an object and its properties to the narrator. This object, for example a ball, can not be seen by the listeners. The narrator tells the object's properties, relative position and object type, to the listeners, which subsequently indicate this information to the SPL audience.

IV. Results and Expectations

Our work shows that acoustic communication can successfully be integrated into a soccer playing SPL robot. Data throughput is far away from radio communication due to physical as much as information theoretical limits, but can be tweaked to get close to human "bandwidth". Experiments at laboratory conditions show good robustness even with presence of music and chatting students. Although bandwidth is very limited, we think our contribution can help to overcome WLAN issues for the SPL.