Enabling Intentional Sound for Construction Cobots

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SHARE Lab

Objective

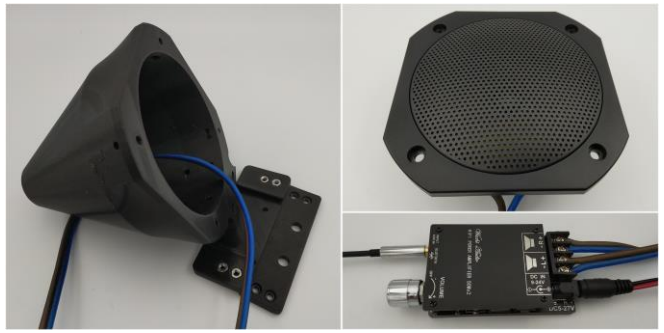
To design an adaptable audio system that can be easily integrated into cobots working in construction

Motivation

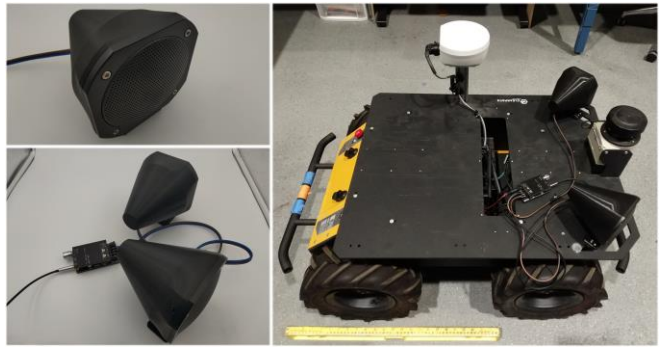
- Collaborative robots (cobots) require strong communication abilities to safely and capably work alongside people [1]
- Sound cues such as back-up warning alarms and horns are required by regulatory agencies for construction vehicles and machinery [2] [3]
- Robots intended for construction sites often lack speakers or other audio systems [4-6]
- Broadband sounds may act as better audible alerts to humans than typical tonal sounds (e.g., the typical truck back-up warning) [7]
- An adaptable audio system capable of being heard on construction sites and enabling intentional sounds could address this disparity

Robotic Platform

We tested the proposed speaker hardware on a Husky robot, a platform currently used in construction robotics research



Left: the speaker enclosure and mount plate
Top Right: the FRS 10 WP speaker driver
Bottom Right: the TPA3116D2 amplifier module



Top Left: a single speaker
Bottom Left: the prototype audio system, unmounted
Right: the prototype mounted on the Husky robot

Speaker Components

We designed or selected each of the following:

- Speaker driver: converts electrical audio signals into sound
- Speaker enclosure: affects loudness and frequency response
- Amplifier: increases power of audio signals

Speaker Specifications

Based on construction site conditions, the speaker must:

- Withstand the environmental conditions (i.e., having an Ingress Protection rating of at least 55)
- Be audible on the worksite. In the U.S., this means being audible at above 90 dBA
- Interface successfully with the hardware of construction robots of interest

Initial Validation

- The prototype produced sound of sufficient intensity (107.8 dB) in front of the robot while mounted on the Husky
- Intensity was slightly lower to the side (101.0 dB) and behind (97.7 dB) the robot due to numerous acoustic factors
- We will design additional mounts and open-source our hardware to help others benefit from this work

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