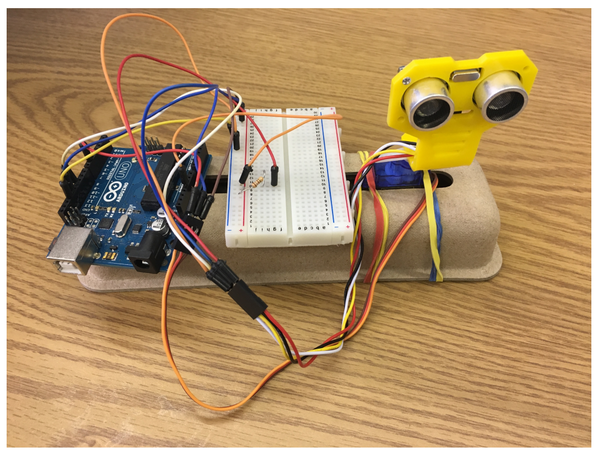
Ultrasonic User Localization and Tracking Based on Mechanical Beamforming

Department of Computer Science

Introduction

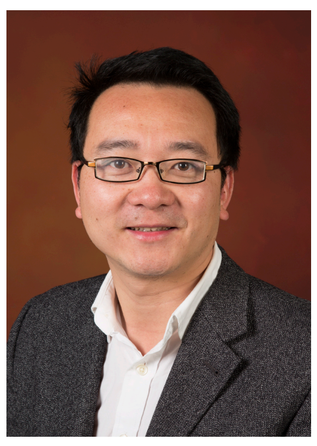
Smart Noninvasive Environments

This work proposes a novel solution that collects data by using commodity off-the-shelf ultrasonic sensors for minimal invasion. With a dedicatedly designed ultrasonic sensing instrument, the proposed solution collects, preprocesses and analyzes dynamic-rich data to determine the occupancy of a space and track any motion of the occupants

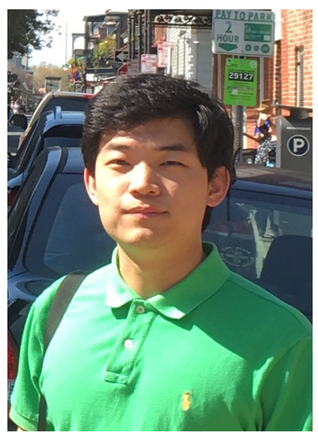


Authors

Advisor
Prof. Shaoen Wu



Graduate Student
Shangyue Zhu



Research Objectives

- Identify occupants in smart homes
- Tracking occupants' location in room
- Recognize users daily life activities

Methodologies and System Design

Collect Background data

Ultrasonic sensor scans the whole home, detecting the static objects such as doors, computers, tables and so on, and storing the distances between each object and the sensor as environment background information.

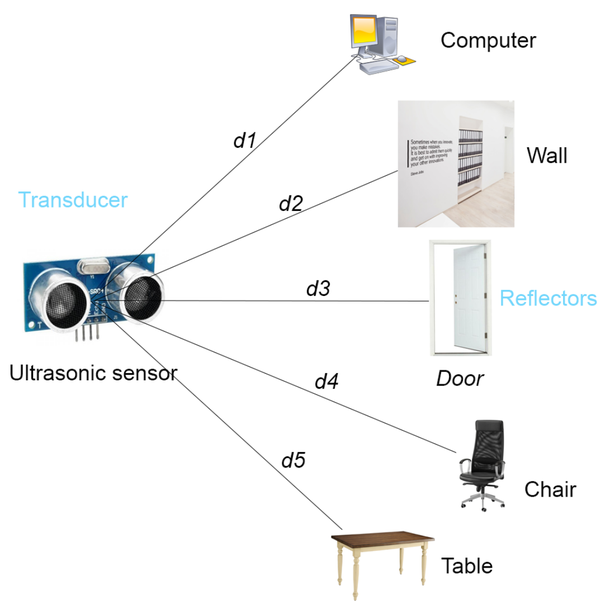


Fig.1 Ultrasonic scan smart home

Methodologies and System Design

Data Preprocessing

Keep the valid data (the blue dots), which in the range of the ultrasonic sensor, and remove the exceptional data (the red dots) from the environment background data list. (see Figure 2)

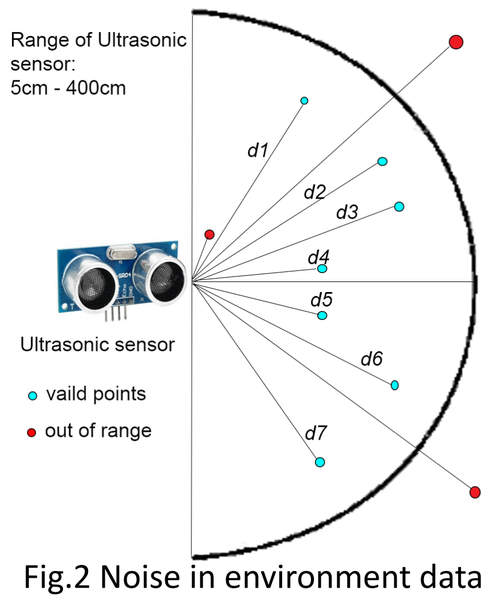


Fig.2 Noise in environment data

Mobile Object Recognition

Start new scan and segregate target data from a noisy environment by using **contrastive divergence learning** method.
As shown on Fig.3, green line presents environment data collected at previous. Red line presents newly scanned data, where exists a significantly prominent part presenting target location degree interval.

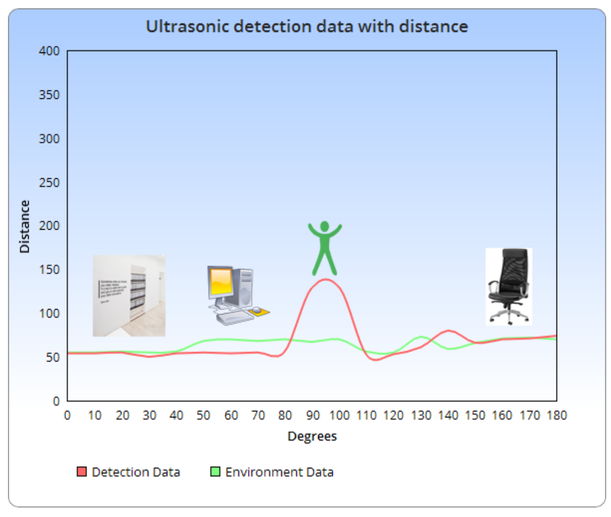


Fig.3 Example for tracking users location

User Location Tracking

After getting the users' location range, ultrasonic get rescan to collect dynamic data to recognize status of activities. To identify the approximately location range, the program will calculate the scan interval by trigonometric function. Fig.4 is describing the data obtained by re-scanning the target range with three consecutive times. The prominent parts reflect an approximately movement trajectory.

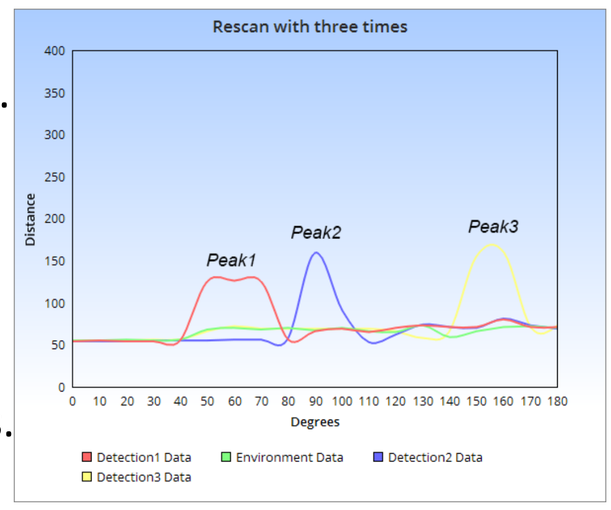


Fig.4 Output for rescan

Recognized Activities

As shown on Fig.4, there are three peaks marked target activities range. We use deep learn method, such as Fourier Transform, to extract the features of activities to identify the motion status.

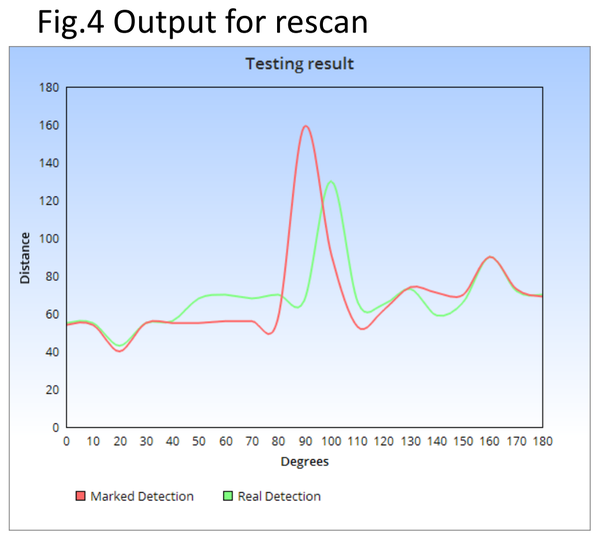


Fig.5 (a) Detection Results

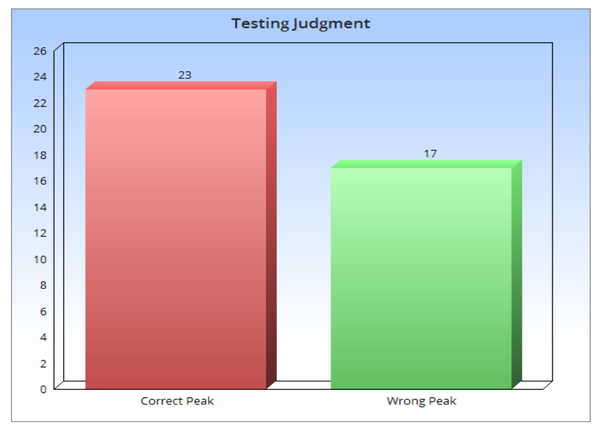


Fig.5(b) Accuracy Results

Testing Result

As shown on Fig.5a, we have marked points in detection area. The red line in fig.5 denotes marked and green line presents real testing data. The accuracy result reflects in Fig5(b), we have 40 times testaments, which own 23 correct results.

Contact us Dr. Shaoen Wu swu@bsu.edu Shangyue Zhu szhu@bsu.edu