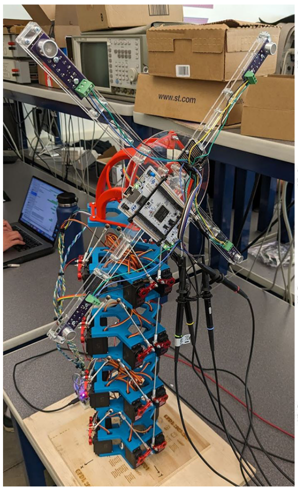
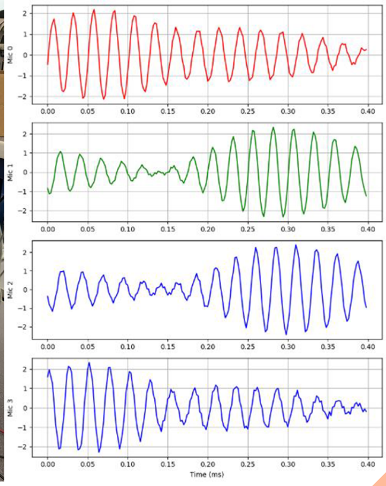
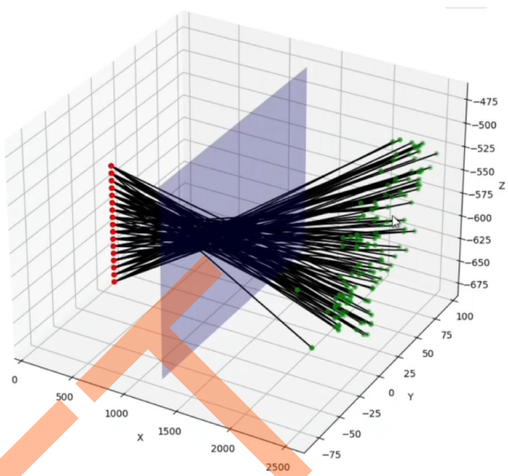
Design and Implementation of an Inverted Short Baseline Acoustic Positioning System

Presented By: Jakob Frabosilio
Committee Members: Dr. John Ridgely (chair), Charlie Refvem, Dr. Siyuan Xing

Autonomous underwater vehicles (AUVs) provide researchers with a bounty of information about our oceans. However, conventional methods for determining the position of AUVs (such as GPS) do not work below the surface of the water.

One common subsea positioning method is acoustic positioning. In this method, a single transmitter sends out a pulse of sound, which is then detected by multiple receivers with known positions. The source of the audio pulse can be determined by analyzing the time-of-arrival at each of the receivers - much like how GPS positioning works.

This thesis presents an implementation of an acoustic positioning system. An above-water prototype is constructed using a single ultrasonic transmitter and an array of acoustic receivers. The ground-truth positioning system, a stacked-hexapod robotic actuator, is used to determine the true position of the receiver array and simulates the motion of an AUV. A transmitter (at a known location) sends a pulse of sound; this pulse is recorded by the microphones and the relative position of the transmitter is estimated. The system's accuracy is evaluated over multiple days of automated testing, comparing the acoustic position estimates to the true location of the receiver array.

The above-water system results are extrapolated to the underwater regime, and recommendations for a full-underwater implementation are discussed. This research provides a wealth of open-source, real-time signal processing and acoustic positioning algorithms (absolute orientation using IMUs, FFT cross-correlation, Kalman filtering, and Hooke-Jeeves search) written in C for STM32/ESP32 microcontrollers.

A Master's Thesis Defense in Mechanical Engineering
California Polytechnic State University, San Luis Obispo

Friday, August 30, 2024, at 1:10pm
Building 192, Room 118 (Engineering IV, Mechatronics Lab)

Zoom Meeting ID: [895 7245 5965]