Development Team

Benigno Ortega
Project Lead
Motor Functionality

Ryan Levy
System Architecture
Solar Integration

Winston Lee
GPS and IMU Integration

Corey Zhou
Control System
Cellular Communication

Tahereh Mahjerdy
Cellular Communication
Project Overview

- Spotter buoy is a data collection aquatic system that provides real-time measurements for Oceanography research.
- Maintenance and repositioning requires more time and resources.
- Design a system to autonomously keep a buoy near the desired location.
Design Overview

- Low-power system capable of repositioning to new location
- Send command for vessel to move to desired location
- Vessel takes the target location then uses current location and orientation to calculate rudder angle and thruster power needed to navigate to the new point
- Once system reaches destination, go into idle state
- When buoy drifts away from specified radius, it will automatically detect and move back to the central location
Idle State
Boat thruster requires a lot of power when running. To account for this, we have a large 25W solar panel to continuously charge our 2 batteries from sunrise to sunset.

- Solar charge controller connects to panel, 12V battery, and thruster.
- Powerboost connects to USB, charging 3.7V battery and powering Raspberry Pi.
- Fuel gauge measures battery level and sends to Pi.
- Lasts over 72 hours.
Raspberry Pi Zero W

Our main microcontroller

1GHz single core CPU

Low power consumption

Plenty of configurable I/O ports without being overkill for the operations needed

Connects to our digital compass, GPS, servo motor, speed controller, cellular modem, fuel gauge, and power boost
GPS: Adafruit Ultimate GPS

- 10 Hz update
- Accuracy within 50 feet in our system

IMU: CMPS12

- Returns bearing with 4 significant digits
- 100 Hz update
Navigation & Propulsion

- T200 Thruster propels system towards destination
- Servo: 8 kg/cm stall torque, 0° - 180° hand rotation
- Navigate with changes in rudder angle with pushrod connected to servo motor

Blue Robotics
T200 Thruster

Tower Pro SG90
Analog Servo

HH Aluminum
Alloy Rudder
Cellular Communication

- Hologram Nova R410 (LTE Cat-M1) - 75 Kb/s Upload/Download
- USB 2.0 at 480 Mb/s
- Low Power Consumption
- Import anchorless.py on home computer
- HTTP Requests from Desktop PC through Hologram.io Cloud to modem
Control System

- Calculates rudder and thruster control signals from GPS and IMU
- Piecewise linear function from haversine distance to thruster control
- PID controller for IMU and Haversine bearing to rudder control
Turn off rudder and thruster

Calculate haversine distance from desired location

Outside radius?

IMU: get absolute orientation

Calculate rudder direction and thruster power

Send rudder direction to servo motor

Send thruster power to motor

Send thruster power to motor
Final Product:

Connection to Website
Final Product:

Marine vehicle: replace typical anchorage system with an autonomously repositioning vessel that tethers a buoy to a designated zone.
Final Product:

- Software Implementation

- `cell_comm_pi.py`
- `fuel_gauge.py`
- `controller.py`
- `esc_controller.py`
- `Servo.py`
- `navigation.py`

- `main.py`
Final Product:

- Hardware Implementation

- Two batteries
- Solar Controller
- Solar Panel Cable
- PowerBoost
- ESC
- Raspberry Pi
- Modem
- Fuel Gauge
- Servo Motor
- Compass
- GPS
Anchorless
A Self-Positioning Ocean Tether

Demo Video
Acknowledgements

- UCSB Coast Lab
  - Nick Nidzieko
  - Christopher Moran

- Professor Yogananda Isukapalli

- TAs
  - Trenton Rochelle
  - Boning Dong
Thank you!

Any Questions?