The HPS Autopilot Capstone is an ongoing project to develop a roll control module that will:
- Keep the submarine stable at high and low speeds
- Improve the handling experience of the submarine

**Phase Three Requirements**
- Test design for implementation readiness
  - Investigate the hardware's functionality, performance, and reliability
  - Evaluate the control design's calculations and performance
- Document suggestions for design revisions
- Record test data and outcomes

**Prototype Autopilot Module**
- Completed by previous year's team
- Two-board system to measure fixture rotation relative to a point

**Three phase test plan:**
- Functionality: Does the device function at a baseline level
- Performance: Does the device function according to specifications
- Reliability: Does the device maintain accurate results under real-world conditions

**Also required:** methodology to translate rotation of gimbal to rotation of a reference point
- Calculated using homogeneous transforms

**Attitude and Heading Reference System:**
- Utilizes sensor fusion to estimate roll, pitch, and yaw
- Three sensors need to each be tested in the IMU (Internal Measurement Unit)
  - Gyroscope
  - Accelerometer
  - Magnetometer

**Hardware Test Plan**
- Testing revealed significant error in yaw measurement
- Magnetometer calibration was determined the most likely cause

**Hardware Test Results**
- Testing revealed significant error in yaw measurement
- Magnetometer calibration was determined the most likely cause

**Hardware Test Plan**
- Prototype Autopilot Module completed by previous year's team
- Two-board system to measure fixture rotation relative to a point

**HARDWARE / SOFTWARE**
- Module is not ready for implementation in a submarine setting
- Module cannot accurately measure yaw angles
- Physical device is prone to pins breaking off in headers and the battery pack is cumbersome to remove

**Future teams will need to perform:**
- Partial redesign of PCB
- Redesign of battery casing

**Multiple options for AHRS redesign:**
- Correct magnetometer error
  - Fix magnetometer calibration procedure to obtain better raw data
  - Utilize specialized calibration software and integrate code libraries for the IMU (Internal Measurement Unit)
- Use alternate methods to obtain yaw values
  - Position second module's roll/pitch axis to line up with main module's yaw axis and feed in data

**Discussion and Future Work**
- Controller does decrease roll error but struggles to reach steady state in under 20 seconds with normal use case body velocities (under about 2.5 m/s). There is room for improvement in controller design.

**Future teams may want to look into:**
- Simulink's PID tuner
- Linear quadratic regulator controls (LQR)
- Further refining hydrodynamic equations
- Automating force and moment calculations using Computational Fluid Dynamics (CFD)

**CONTROLS**
- Module is not ready for implementation in a submarine setting.
- Module cannot accurately measure yaw angles.
- Physical device is prone to pins breaking off in headers and the battery pack is cumbersome to remove.

**Future teams will need to perform:**
- Partial redesign of PCB
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**MULTIPLE OPTIONS FOR AHRS REDESIGN:**
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