SENIOR DESIGN PROJECT IN ELECTRICAL ENGINEERING

ROBUST DYNAMIC POSITIONING & DATA ACQUISITION SYSTEM

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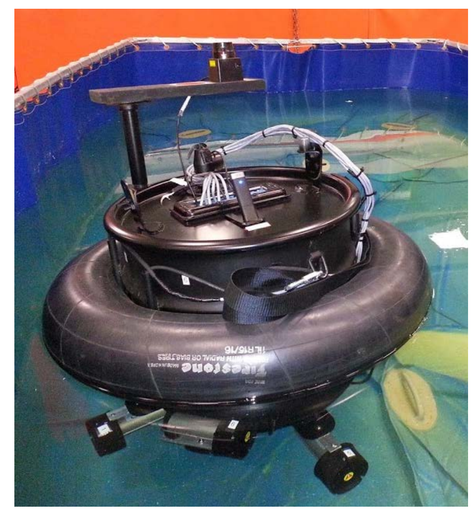
PROJECT BACKGROUND

Dynamic Positioning Systems (DPS) are used in the maritime industry to allow vessels to maintain a desired heading and position while underway. Specifically in the Coast Guard, these systems are used for buoy tending where maintaining a precise location while tending a buoy is vital to ensuring safe maritime navigation. In the commercial industry, DPS is heavily relied upon by oil rigs and large commercial vessels to maintain a very precise heading and position.

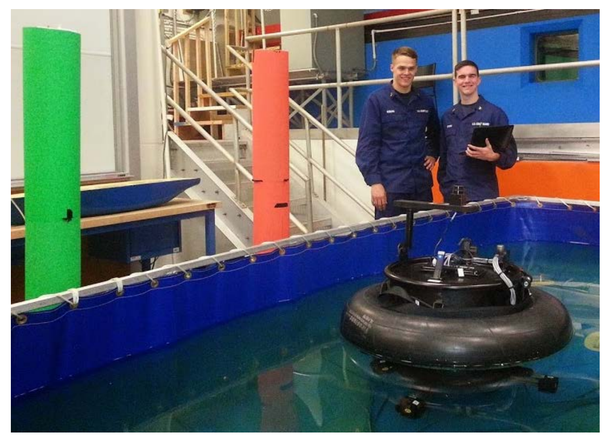
Since DPS is depended on in high risk situations in the maritime industry such as drilling for oil, it is imperative that these systems have the ability to adjust for system failures and still maintain position. Additionally, the Coast Guard has the responsibility to regulate these complex systems so it is very important that Coast Guard officers have an understanding of how these systems operate. It is the goal of this project to improve on these robust capabilities and provide Coast Guard Officers with hands on experience learning how a DPS operates.

Coast Guard Buoy Tender utilizing DPS during buoy operations

Offshore oil rig which relies on DPS so safely extract oil from the ocean floor



Final construction of prototype vessel.



Testing environment and design team.

PROJECT REQUIREMENTS

Five major requirements were identified for the project:

- Maintain both heading and position
- Ease of use, portable, and aesthetically pleasing
- Robust – maintain functionality despite partial system failure
- Data acquisition – data can be stored and easily accessed for analysis

DATA FLOW DIAGRAM

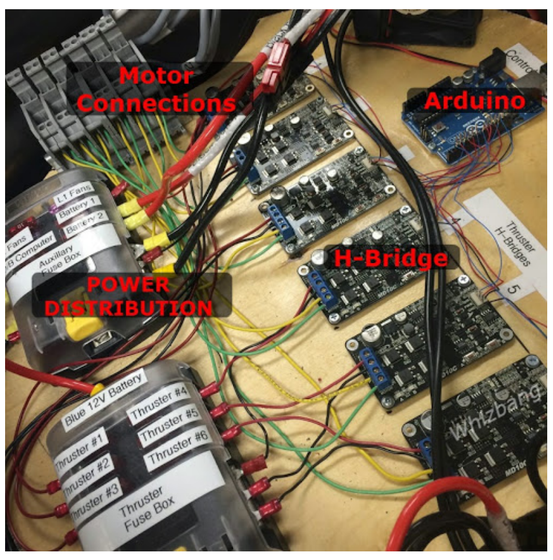
The Light Detection and Ranging (LIDAR) sensor outputs the range and bearing of a stationary reference point to MATLAB. MATLAB then compares this data to the desired location. Any error between the actual and desired location is passed through a control algorithm which calculates the required motor output. Motor commands are then sent via the arduino microcontroller to one of six h-bridges. The H-bridge translates the motor command into a percentage of the maximum 12 volt output. This voltage is then sent to the corresponding motor to produce thrust.

PROJECT DELIVERABLES

The project goals are as follows:

- Data acquisition system that collects position and heading data for analysis
- Functional control algorithm that autonomously uses motors to correct position and heading error
- Reliable vessel platform to demonstrate system functionality

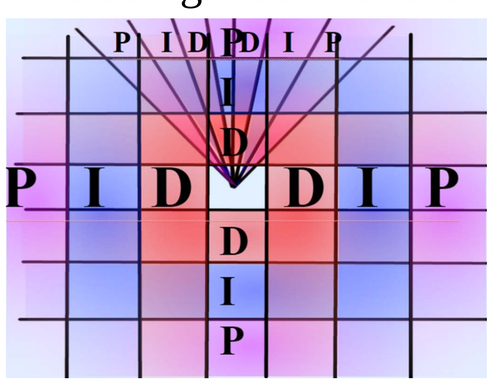
INTERNAL CONSTRUCTION



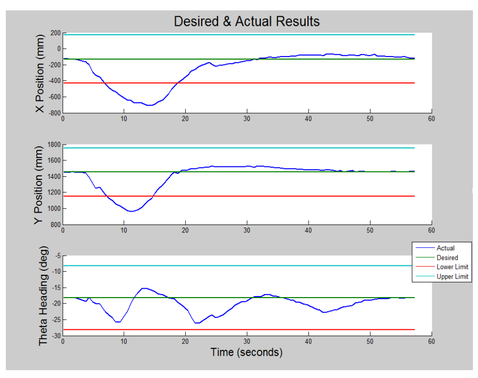
Internal components of the prototype vessel include: power distribution system, control hardware and an onboard computer.

FINAL RESULTS

After performing a thorough system identification based upon open loop data, the system was initially implemented using a proportional derivative (PD) controller. Testing revealed that this controller was unstable and it was decided to perform system identification again and design a proportional integral derivative (PID) controller. The PID controller was implemented in stages based upon the margin of error. After tuning the PID coefficients, the system was able to meet all design requirements including robust functionality.

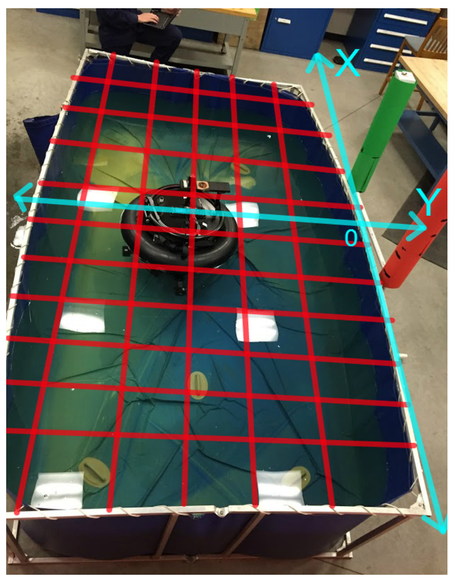


Visual representation of the margin implementation of the PID controller. Split into X, Y, and Theta controllers.



Final PID controller results show vessel is able to correct position and heading after manual error is induced into the system (X,Y, and Theta controllers).

DATA ACQUISITION SYSTEM



LIDAR sensor determines the range and bearing to two aids to navigation and converts that data into a position and heading of the vessel which is stored for analysis.