A Capstone Project on Robust Dynamic Positioning and Data Acquisition Systems

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The United States Coast Guard is responsible for enforcing Dynamic Positioning Systems (DPS) standards in the maritime industry. It is important for the members of the U. S. Coast Guard to understand how these systems work. Students have gained a much greater understanding of how DPS works and what might be required to maintain them by building one from scratch. Aside from this, the project has served as a great opportunity to work on a one year term project that may resemble engineering or acquisitions project that might be encountered in their future career.

The overall goal of this project is to prototype a dynamic positioning system similar to the ones on buoy tenders in the fleet. The primary goal is to maintain a desired heading and position within a certain range. The secondary goals include robust capabilities (the ability to continue functioning despite motor failures) and data acquisition (to analyze system effectiveness post testing). Students build a vessel from scratch out of an oil drum and an inner tube for buoyancy. The internal construction consists of tiered layering containing batteries at the lowest level, an onboard computer at the second level, and control hardware at the top level (micro controllers, H-bridges, and fuse boxes). Students successfully use a light detection and ranging (LIDAR) device to determine the relative position to two stationary poles. They are able to communicate with the onboard computer via either wired connection or Remote Desktop through an ad-hoc wireless network. Students have accomplished this project all through the application of past courses they have taken in computer control systems, network communication, and digital signal processing at the U.S. Coast Guard Academy.

First milestone of this project is to focus on constructing the vessel and installing the hardware. One of the challenges for students is the communication lines that must fully function between the various pieces of software, hardware, and the working power distribution system. The LIDAR sensor determines the relative position to two stationary poles. Using the location detection algorithm, students conduct a set of system identification tests in an indoor tank test to determine how the system reacts to various thrusts from the motors. This allows students to accomplish an “Open-Loop” system tests. Using the data acquisition system, students able to identify the system and calculate coefficients for the controller and comprehend a “Closed-Loop” system. Students have implemented a proportional derivative (PD) controller. All of the programming has been done in Matlab®. The recent challenge is to characterize the robust functionality of the system. Currently, most of the milestones for the project have accomplished and the focus is on improving the more robust system.