Senior Design Project in Electrical Engineering

Dynamic Positioning System

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Sponsor: CG Marine Safety Center

Project Background

Following the Deepwater Horizon incident in 2010, U.S. citizens realized the importance of regulating DP systems and emergency procedures used in U.S. waters as well as the need to more fully understand the operations of DP systems. There were regulations pertaining to vessels that employ DP systems established by the International Maritime Organization (IMO) that all vessels must comply with. However, there were few regulations and little policy established by the United States in regards to Mobile Offshore Drilling Units (MODUs) specific to U.S. waters. The DPS project was created to assist in developing policy and increased understanding of DP systems, particularly on MODUS, within the Coast Guard.

Objectives

Goals:

- Build a vessel platform that employs a DP system similar to that of MODUs
- Design a control algorithm for the platform that will be used to control platform's heading and position

2012-2013 Goals:

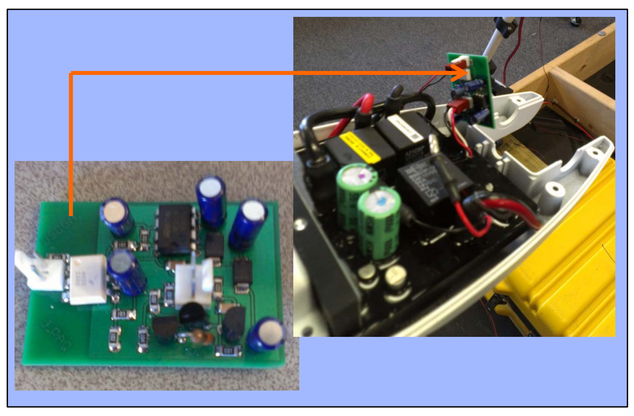
- Develop and deploy systems on the vessel platform
  - Data collection system
  - Power distribution system
  - Motor control system
- Collect data from vessel while it is underway for system identification controller development

Requirements

The following requirements were developed through research of MODU operations and accuracy of our sensor:

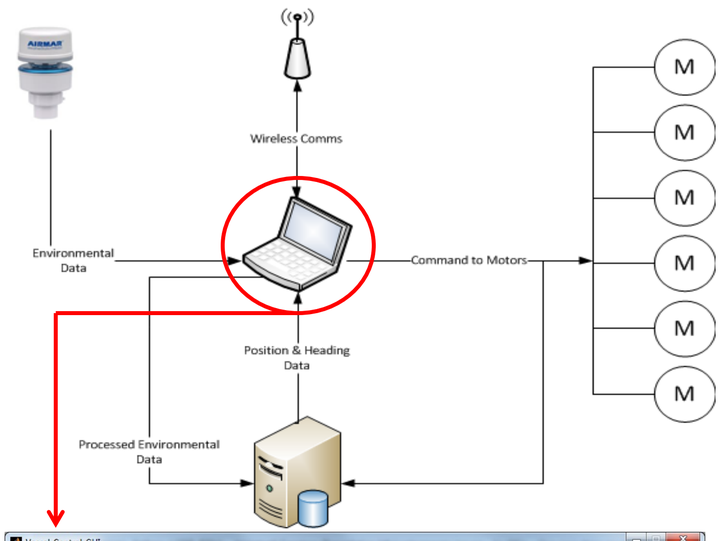
- Vessel will stay within a 10m radius of a specified geographic position
- Vessel heading will not deviate more than ± 20° of desired heading
- Vessel will maintain position in up to 5kts of wind and 2kts of current

Motor Control Circuit Design



The Motor control circuit was designed to mimic the function of a potentiometer in the motor handle that would normally control the motor thrust. The circuit outputs a pulse width modulated signal, controlled by the microcontroller. The signal corresponds to a voltage at the motor head which controls the motor output.

System Diagram



Results

The DPS Team was able to meet the objectives set forth at the beginning of the year. The team developed a power distribution system that supplies six trolling motors with power to generate sufficient thrust to maneuver the vessel. The trolling motors, which are available in the civilian market, were modified to receive a signal from an Arduino micro controller to control the thrust of each motor (bottom left). The system operator controls the thrust via a user interface on the vessel's computer.

The vessel receives position, heading and environmental data via the AIRMAR PB200 (top left). The vessel computer stores this data, along with motor control commands, in a local database to be utilized by the autonomous controller as well as used for system identification.

Over several tests on the water, the team was able to implement a proportional heading controller. In addition, some of the data collected could be used for initial system identification.

Future Work

Areas for future Senior design groups to focus on:

- System identification
- Integration of motor sensor
  - Water current sensor
  - Multiple position and heading sensors
  - Apply H_∞ PID control
- System redundancy
- Continued testing
- Increased system protection such as watertight integrity