Active Heave Compensation

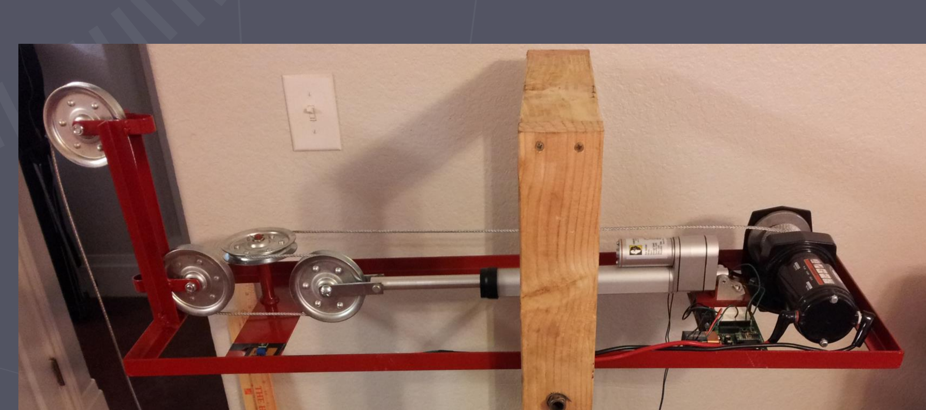
Abstract

The Active Heave Compensation System is a necessary device to secure the deep-ocean production, maintenance, and other sub-sea projects in ocean conditions. The simulation model for the active heave compensation is built by using a one speed two directional winch for general raising and lowering the equipment into the water, an electronic linear actuator for the motion compensation, and a tri-axis accelerometer to measure the motion of the vessel to be compensated.

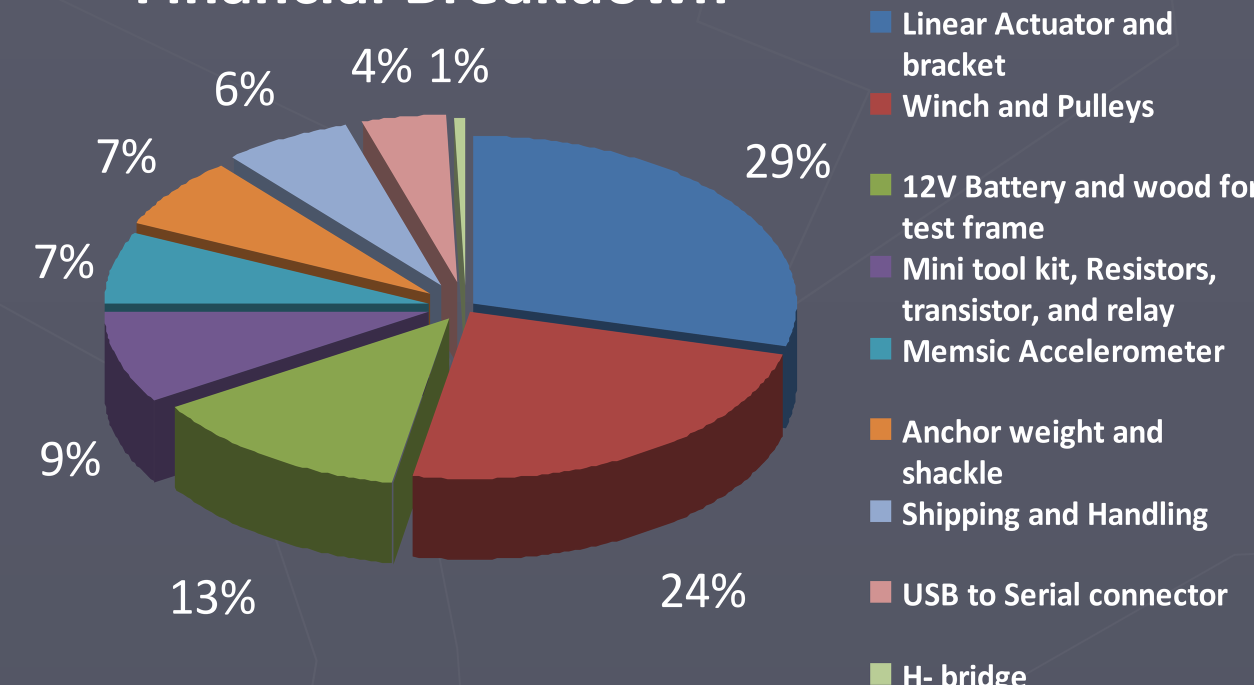
Introduction

As time progresses the world's economies continue to dry up the earth's resources, forcing companies to look to the ocean floor as a source for these necessary resources. In order to ensure safe and efficient operations of drilling or mining, it is essential to have a means of controlling the motion of these systems, and those that support them. One method used to control the horizontal motion of vessels on the water is a Dynamic Positioning (DP) system. DP is a system controlled by a computer program that contains a mathematical model of the vessel that includes information pertaining to the wind and current drag of the vessel and the location of the thrusters. This knowledge, combined with the sensor information, allows the computer to calculate the required steering angle and thruster output for each thruster.

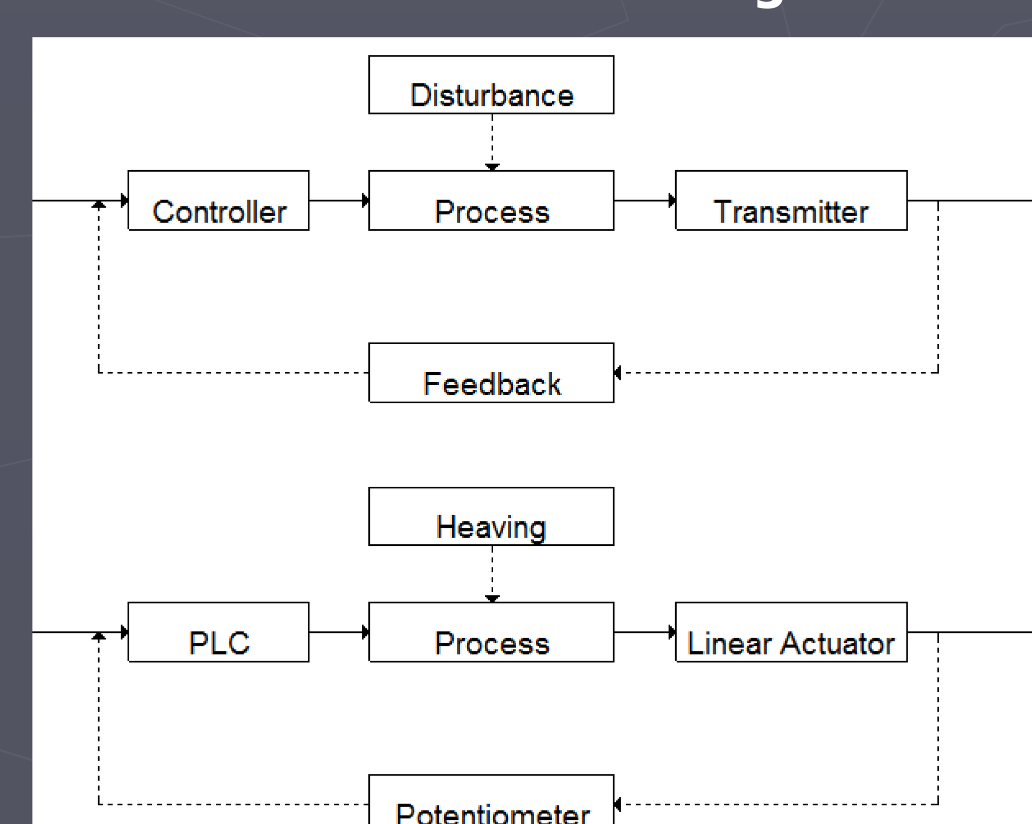
With the horizontal motion accounted for there is still a need to account for the vertical movement of the ocean caused by swells, waves and tides. This is where heave compensation plays an important role. There is passive heave compensation which can either rely on air cushions or springs, but only decrease the effect of heaving. The method that we are utilizing is more complex because it measures the distance the vessel is moving and sends a signal to the PLC to account for this motion by either retracting or extending the actuator, which in turn increases or decreases the length of cable in the water. This type of motion compensation is referred to as Active Heave Compensation.



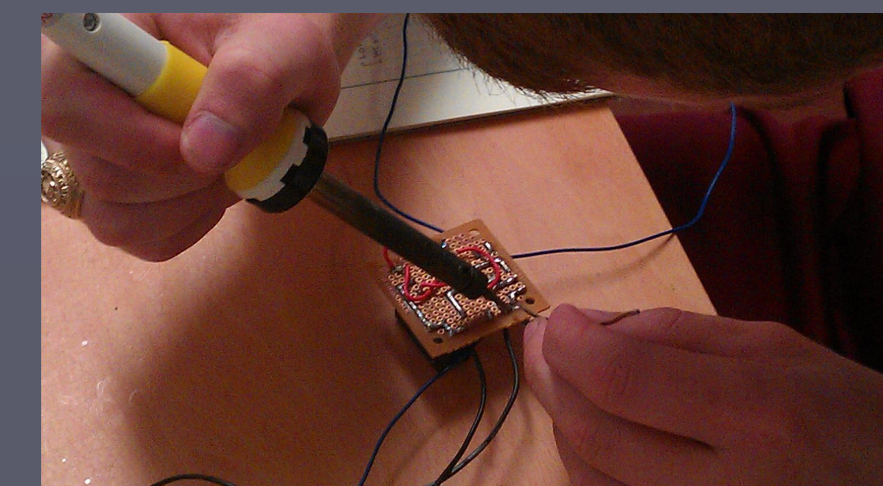
Financial Breakdown



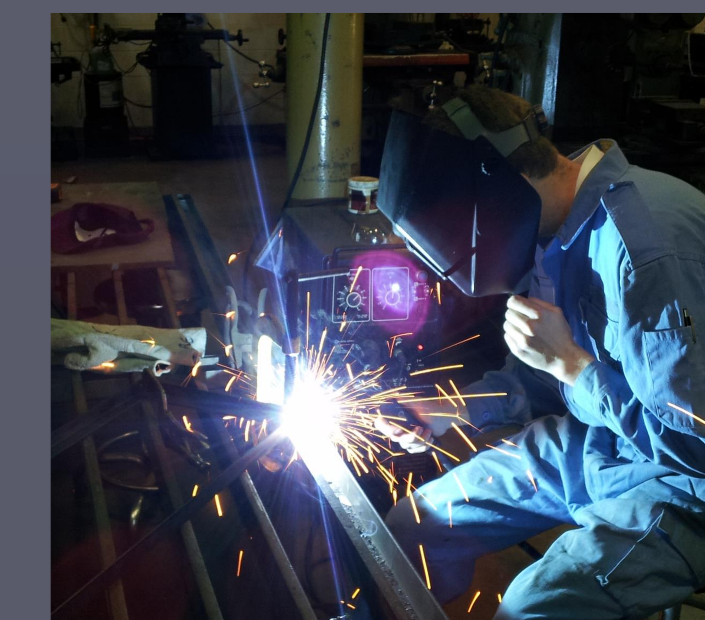
Automation Block Diagram



Team Members



Logan Zandbergen



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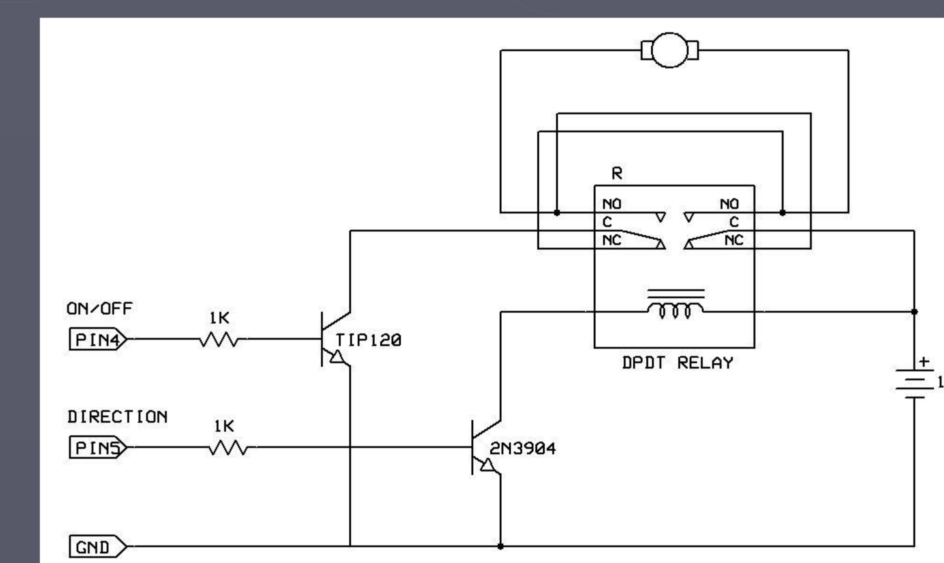

Diagram of the Relay Used

Stresses on the pulley shafts

The weight at the end of the cable will tension the cable which will cause a force on each of the pulleys the cable will be running on. These pulleys therefore need to be analyzed in order to determine what size the shafts that will be supporting them need to be. The distance between the support the shaft will be connected to, the pulley, and the distance from the pulley to the other shaft support play a large role in the shear, bending, and moment diagrams. The following equations were used.

$\sum M = 0$ and $\sum F = 0$

$-FRP(d) + FB(d) = 0$

The force of the pulley multiplied by the distance from support force A plus the support force B multiplied times the distance from support A equals zero. Once the max moment has been determined the flexure equation can be used to determine the minimum shaft size.

I = moment of inertia of area

C = radius.