2016

Dynamic CG Display for Recovery Cranes

Tariq Haddad
Virginia Commonwealth University

Steven LeMasters
Virginia Commonwealth University

Team Members: Tariq Haddad
Steven LeMasters

Faculty Adviser: Michael Cabral

Sponsor: Crane-Masters

Sponsor Mentor: Britt Calloway

ELECTRICAL AND COMPUTER

Dynamic CG Display for Recovery Cranes

CAPSTONE DESIGN EXPO 2016

Introduction

The aim of this project is to improve crane safety by reducing the chance of a crane tipping over. Since recovery cranes often operate on uneven surfaces, there is no assurance that the crane is level with the ground which can make it difficult to ensure the safety of the crane. If the crane were to tip, it could cost millions in damage and put the crane operator in danger.

Project Brief

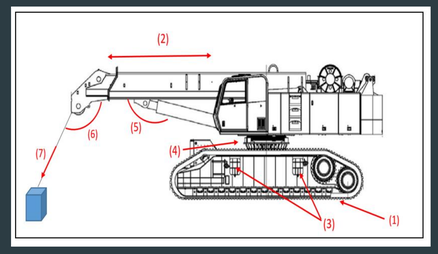
For this project, we created an interface to display the Center of Gravity (CG) for a crane while operating. Giving real-time updates to the crane operator making sure that the crane's Center of Gravity remains in a safe location while the crane rotates, boom changes position, and the weight on the hook changes.

The system developed for this project can be adapted to any Crane. For this specific project are developing the interface for the Cranemasters Mantis 200RS.

Recovery cranes typically tip because the conditions under which the operator must work involves landscapes and loads that aren't "typical". There are usually hills and angles with an offset that standard crane safety systems can't account for. Our dynamic system will make up for these short comings with the addition of several sensors to the system.

Design & Process

Cranes are built to last. running in rough conditions, we had to make sure that the equipment we used in the project won't be affected. The Figure below shows the Mantis 200RS with what values needed to find the CG

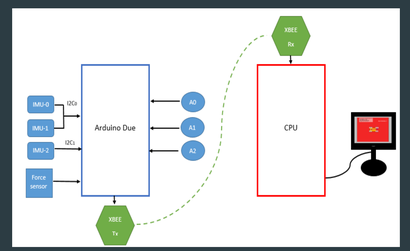


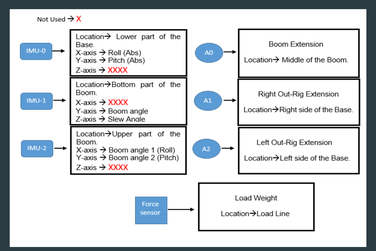
(1) Pitch & roll
(2) Boom extension
(3) Left & right outrigger extension
(4) Slew angle
(5) Boom angle
(6) Load angle
(7) Load weight.

IMU's → Adafruit BNO055 Absolute orientation Sensor. →

Analog → (10,100,1000)K-Ohm Potentiometers →

Transmitter & Receiver → XBee 2mW Wire Antenna →



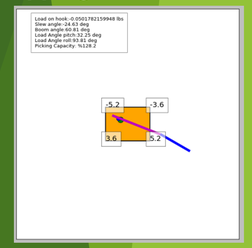


Cranemasters provided us with Python code that has the equations to find the correct values for the list shown above (1-7) using an excel sheet to store the values. The code was modified to take real-time data directly from the sensors and change the display bypassing the excel sheet and storing Data Logs for future reference.

Results

The Sensors were placed on the Model Crane, and connected to the Arduino Due board. Data was transferred from the Arduino to the processing Unit (CPU) through an X-bees (wireless transmitters). The display shows the center of gravity of the crane with a load and warns the operator when the crane is at risk of tipping over.

No risk of tipping



Warning! risk of tipping

The Graphical User Interface (GUI) provides the crane operator with the Real-Time data.
The Top left box → hook load, slew angle, boom angle, the actual load, and the picking capacity.
The Four squares surrounding the crane (Orange box) → pitch and roll (absolute values to gravity).
Purple Line → Slew Angle (360°, CW & CCW).
Blue Line → Load Angles (Pitch & Roll).
Green Dot → Cranes Center of Gravity (CG).
Blue Dot → Cranes Center of Gravity (CG) including Load.
If the crane is at risk of tipping over the Display will turn red and a flashing Warning will appear.

Acknowledgments

- A Special thanks goes to Matt Leccadito for his assistance (Couldn't have done it without you!)
- CraneMasters for building a Crane Model.