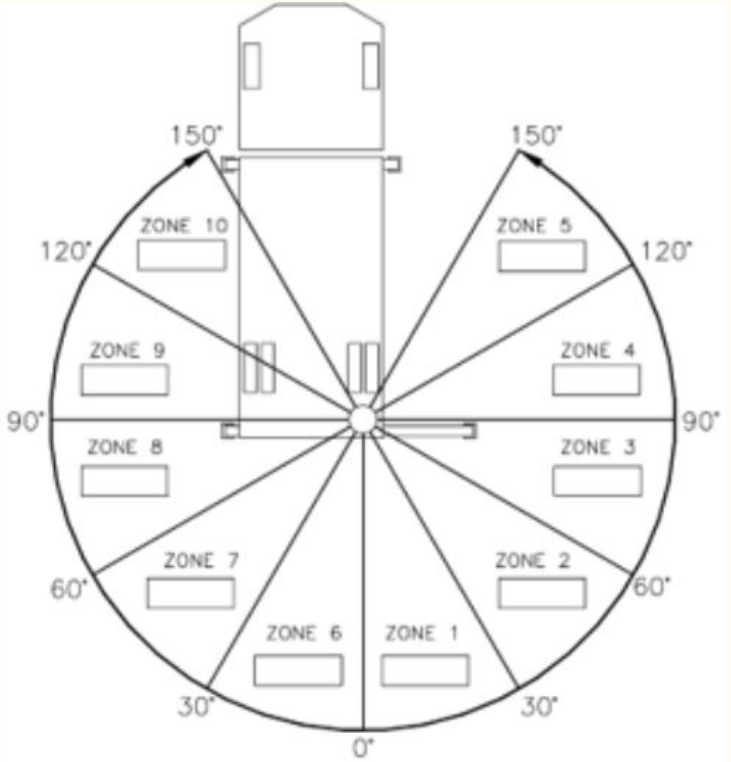
Crane Positional Sensor

Team Name: sdmay21-20
Website URL: file://sdweb.ece.iastate.edu/sdmay21-20/www/team.html
Client: Stellar Industries

Problem Statement

Stellar Industries needs a rotational sensor to calculate the angle at which their crane is positioned according to their truck base. The sensor is needed to provide that information to their operators so they can uphold their safety standards.



Functional Requirements

- Compute the exact angle
- Send data to CAN bus using J1939 or Open Can protocol
- Operate between -40°F to +160°F
- Receive power from 24V DC
- Mountable to crane
- Weather resistant housing

Non-functional Requirements

- Cost efficient
- Follows IEEE standards

Technical/Other Constraints/Considerations

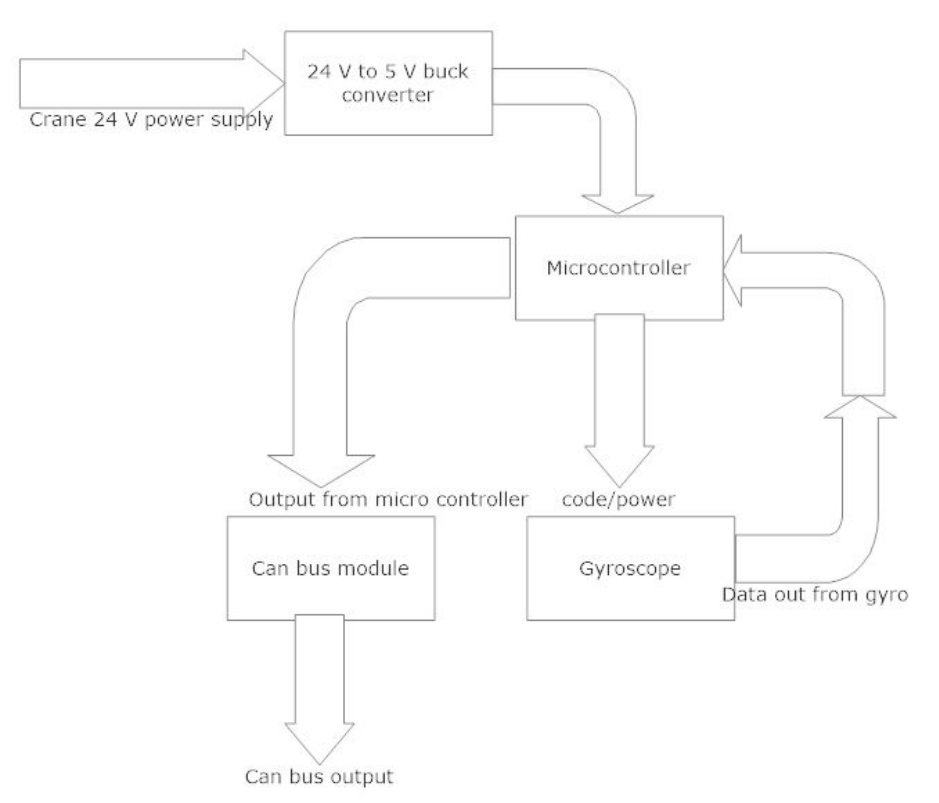
Technical constraints include:

- The design must not use a mechanical gear for the rotational sensor

Technical considerations include:

- The sensor design should be easily mountable/attachable to the crane to avoid having to take any parts of the crane off

Conceptual Sketch



Market survey

Many consumer products such as smartphones, videogames and aircraft implement gyroscopes into their designs.

- Smartphones use gyroscopes to get the orientation of the device, this can be used in applications such as the measure app on the iPhone or motion control games such as Temple Run.
- Aircraft use gyroscopes as attitude indicators, heading indicators and turn coordinators.

Our design will differ from these marketplace examples as we are using a gyroscope to only read the rotational angle instead of orientation of the crane.

Potential Risks & Mitigation

- Gyroscopic Drift
  - Filtering
- Wire Connection Issues
  - Solder wires
- Faulty sensors
  - Testing Sensors before implementation

Resource/Cost Estimate

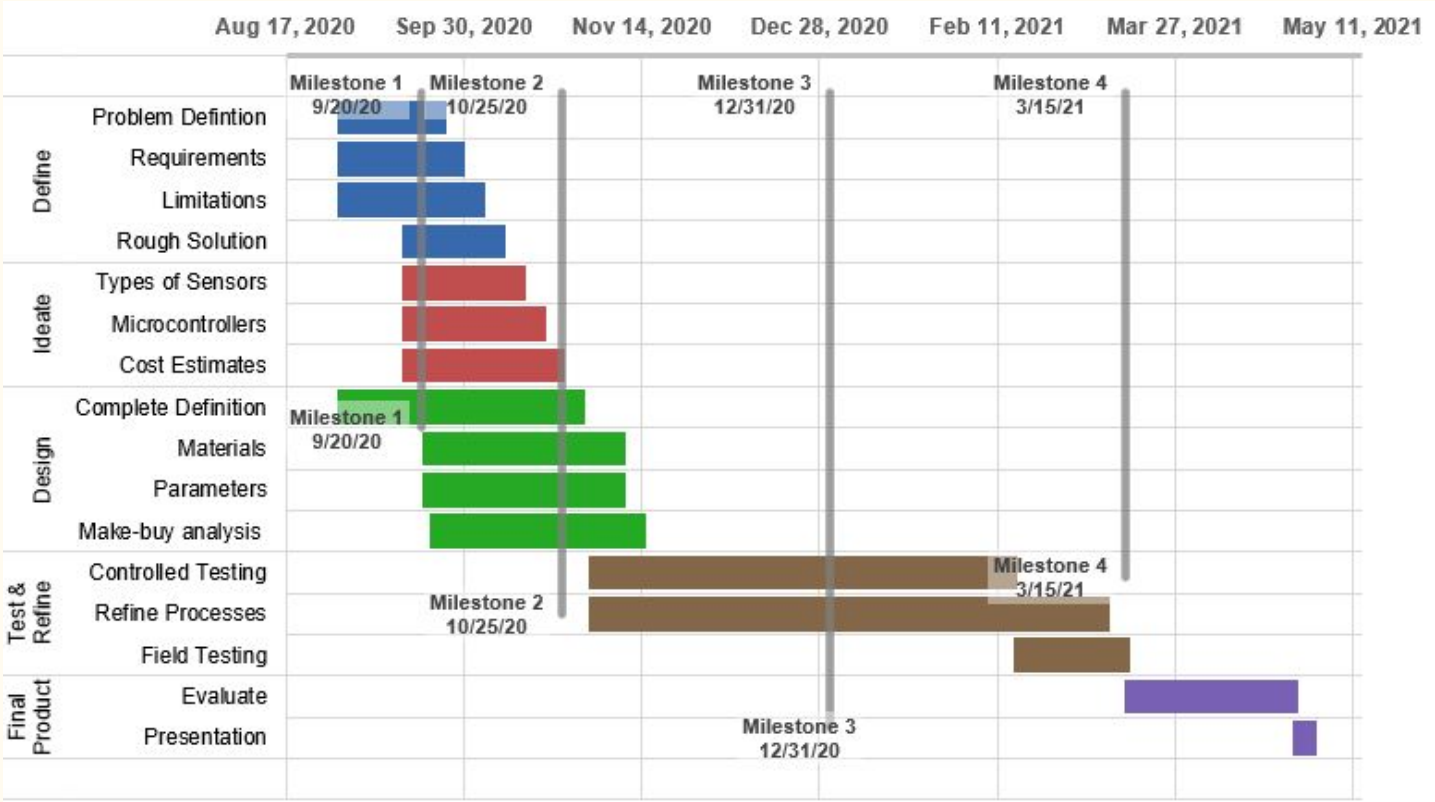
- Microcontroller - Arduino Uno Rev3 SMD: $17.52
- MPU-6050 - Accelerometer, Gyroscope, 3 Axis Sensor Evaluation Board: $10.00
- Buck Converter - PDS1-S24-S5-S: $4.31
- ABS Plastic Waterproof Enclosure - IP65: $20.00
- 3M Heavy Duty Waterproof Tape: $10.86

Total cost is $62.69 for an individual unit

Possible Solution

- IME18-08NPSZC0S: $53.90
- YF2A14-020VB3XLEAX: $20.12

Project Milestones & Schedule



Functional Decomposition

- Detect rotational movement
  - Providing power
- Convert to angle
  - Input from sensor
  - Derive ratio/formula
- Communicate with crane controller
  - CAN Bus

Detailed Design (functional modules design, interface definition, user interfaces, etc.)

- 24V - 5V DC Step-Down Converter
- Horizontally-mounted Gyro Sensor
- Calculations through MCU
- Transmit data in Open CAN or J1939 protocol
- Mounting with electrical control box and 3M waterproof mounting tape

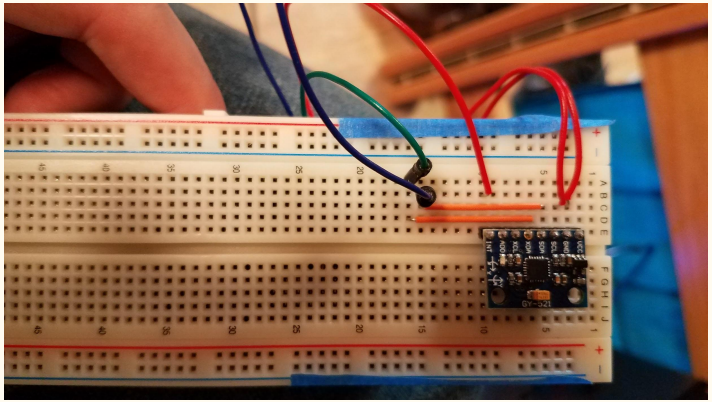
HW/SW/Technology Platforms used

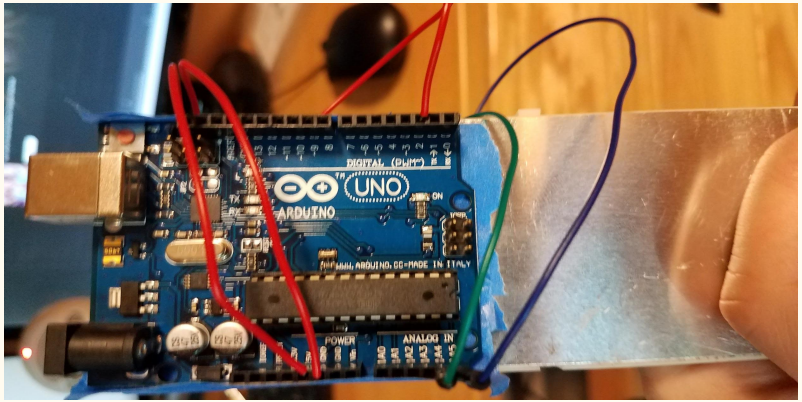
- Made use of Arduino IDE Software
- Using an Arduino Uno along with an MPU-6050 component for testing.

Test Plan – simulation, what tests, what metrics, hypothesis, etc.

- Unit Testing
  - Working Sensor
  - Accurate Angle Measurements
- Interface Testing
  - Output to CAN Bus Format (J1939, Open Can)
- Acceptance Testing
  - Weather/Environmental
  - Vibration Testing

Prototype Implementations or basic building block implementations





Demonstration

Current Project Status

1. Defining the Problem and Research
2. Ideation
3. Designing a Solution and Preliminary Testing
4. Additional Testing
5. Final Deliverable

Task responsibility/contributions of each project member

- Eli Davidson
  - Test Engineer & Report Manager
- Andrew Jacobson
  - Chief Engineer
- Nikhil Sharma
  - Meeting Facilitator
- Wyatt Syhlman
  - Meeting Scribe & Parts Facilitator

Plan for next semester

- Continue testing
- Re-visit Stellar
- Additional Implementation