Project and Group Identification Document

Updated Divide and Conquer (D&C V2)

Senior Design I
EEL4914 – 0001

Zip line Inspection Tool

Group 9

Friedrich Schulte (CpE)
Ellis Curry (EE)
Paul Jenny (CpE)

Sponsor: United Launch Alliance

Project Narrative Description

United Launch Alliance (ULA) has installed a 1,350-foot-long (410m)-zip line on its Atlas V Launchpad in Cape Canaveral, Florida. The zip line is intended to give astronauts a quick and safe way to escape during a Launchpad emergency, and hopefully will never have to be used. The system was installed in April of 2017 and has been subject to the coastal Florida environment as well as the powerful forceful rocket launching events. Intense heat in the summer, high volumes of rain and wind from storms, and possibly even some lightning will have no doubt caused strain and potential damages to the zip line system. Currently the most common inspection method of steel cables used in zip lines is just a visual check for frays and corrosion. The current method presents an array of problems to the United Launch Alliance. The first being that the steel rope system is so long and so high up that the procedure to visually check the entire length of the rope is cumbersome and time-consuming. Secondly that the visual inspection will fail to identify any possible damage that has occurred on the inside of the steel zip line rope, underneath the several outer windings. United Launch Alliance has therefore commissioned the design of a tool that can inspect the cables to the Emergency Egress System zip lines at the Crew Access Tower.

By creating a controllable inspection tool that can traverse along the zip line cable recording valuable data we can hope to save the ULA time and money. The inspection tool can obviously have no lasting impacts or cause any damage during the inspection process. This steel rope inspection tool should make the job of evaluating the condition of the zip line faster while also being easy to use and portable due to the relatively hard to access nature of the zip line. The data obtained from the inspection tool should be accurate while also remaining reasonably easy to interpret and follow by the inspection team. The ultimate goal is to create a unique, effective, and low cost inspection tool, that can be applied to not only the emergency egress system of the Atlas V Launchpad but other zip lines as well. While similar products have been in development they mostly occur overseas and deal with high voltage power lines, suspension bridges, cranes, ski lifts and other products that incorporate steel suspended wires. The scope of the project is to design a tool that can inspect the cables to the Emergency Egress System zip lines at the Crew Access Tower and flag likely spots for damage requiring further inspection.

This project is a multi-disciplinary project where we are working in conjunction with three separate mechanical engineering senior design teams. A hall-effect sensor will be designed in order to detect flux leakage in the metal wire; additionally cameras will be incorporated to provide a visual inspection of the cable as the unit traverses the wire. The mechanical engineering teams are working separately and will design three various chassis to which the sensor will be attachable. Our scope in the project is to provide a sensor to the mechanical teams as well as programming modular controls for the motors and sensors in addition to handling battery and power requirements as well as data storage and interpretation. Because we are one group and there are three separate mechanical groups working on three various chassis, the sensors and controls will be modular and contained in a transferable control and sensor box that is to be under 15lbs.

Specifications and Requirements

Project Constraints

- Insufficient memory storage for acquired Data
- Testing on actual ULA Egress System (access to the Launchpad)
- RC Transmitter, transmission Distance, Signal Distance limitation
- Power Consumption
- Ability to operate in Florida temperatures (high heat, high humidity)
- Sensors and control box are modular and can be removed and attached from differing chassis.

Related Standards

- Ability to identify localized cracks/flaws
- RC Controllable
- Ability to record visual data
- Ability to record and identify structural data through use of Hall Sensor(s).
- Ability to store data for easy access and further review
- Ability to recall test instrument from any point on wire when needed (in case of malfunctions)
- Ability for Motor to record distance travelled

Quantitative Specifications

- Ability to traverse and inspect full length of Cable (410m)
- Ability to inspect entire cable length in reasonable time (approx. 2hrs)
- Battery life of at least 2hrs

- Ability to record 2hrs of video footage
- Sensor and controls modular and removable to be contained in a control box of size 15x8x8 inches, and under 15lbs.

Electrical Components

Motor

- Motor Controller
- Motor Driver Card
- Gear Encoder
- Batteries
- Heat Sink

Sensors

Cameras

- Data Storage Card
- LED (for consistent lighting)
- Video Compression Card
- Battery

Hall Sensor

- Magnets
- Arduino Microcontroller
- Battery

Controls

- Data antenna linked to RF card
- Microcontroller
- Ground Control Unit (RC Controller)

House of Quality Figure

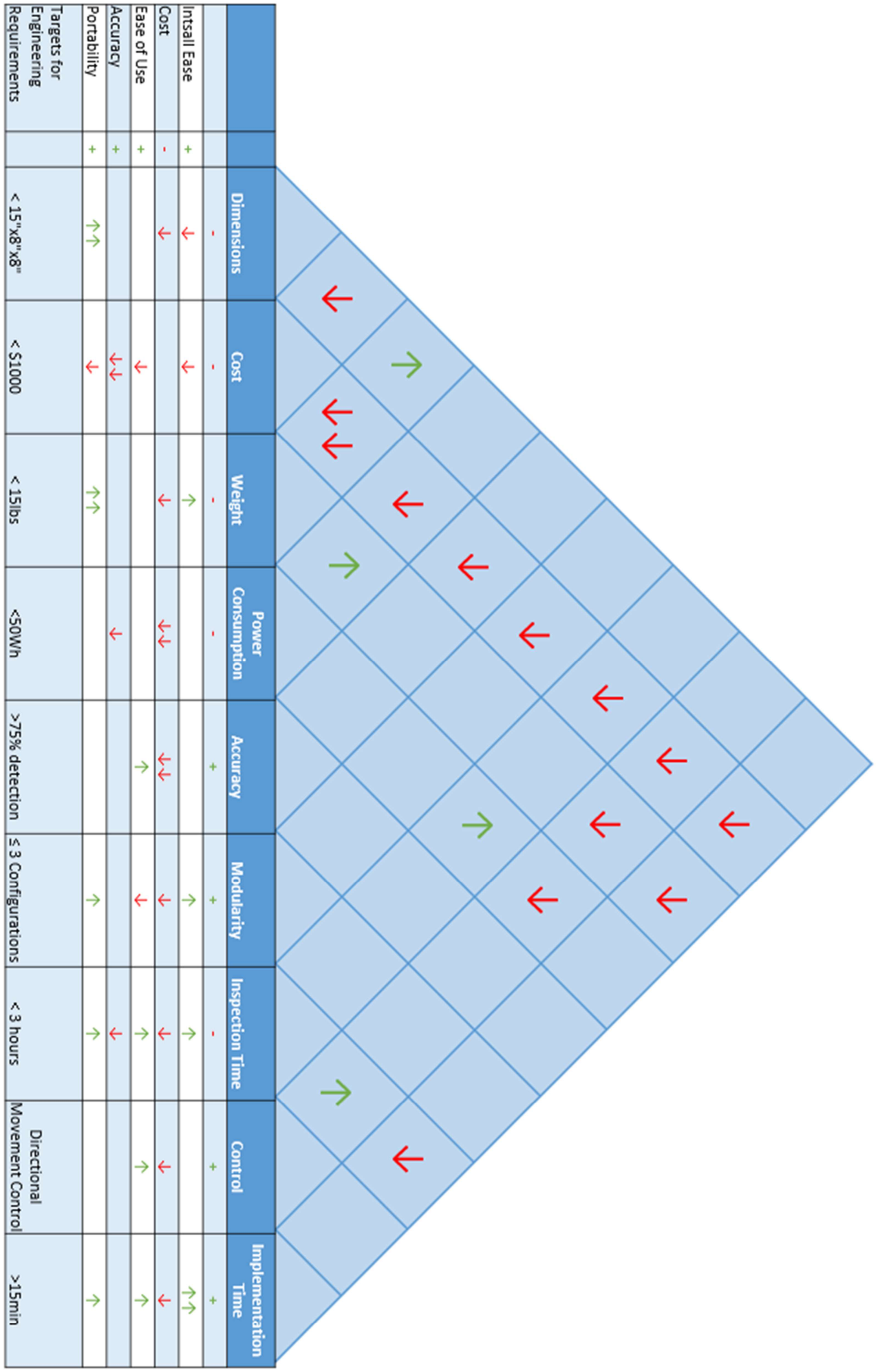

Figure 1: House of Quality

Component Block Diagram

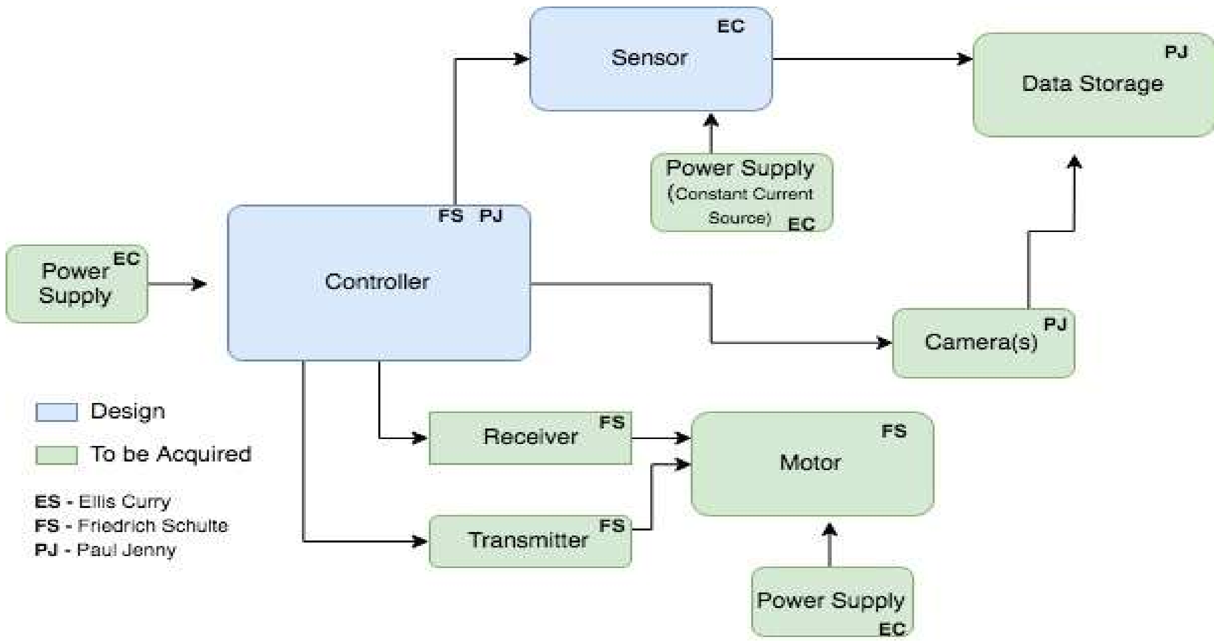

Figure 2: Block Diagram

Estimated Project Budget

Item	**Cost**
Controller components	$50
Motor	$50
Magnets (flux production system)	$25
Hall sensors	$25
Data storage	$30
Circuit board and components	$150
Battery and power system	$300
Component housing	$50
Cable gripping mechanism	$150
RC Transmitter/Receiver	$40
Cameras	$40
Additional Expenses	$90
Estimated Total	**$1000**

Table 1: Estimated Project Budget

Initial Project Milestone

Spring 2018 Semester:

I. Project Proposal (3-4wks)

- Initial Project idea and group identification
- General Design Concept
- Initial Block Diagrams
- Supervisor Approval

II. Research and Documentation (9wks)

III. Complete Design of Project (14wks, end of Semester)

- Includes final documentation consisting of:
  - Formal technical document outlining research, design, theory of operation, construction, and testing.

Summer 2018 Semester:

I. Begin Prototype (3-4wks)

- Acquire Parts B
- Begin initial testing/assembly of individual system components

II. Complete V1 Prototype

- Test
- Debug
- Improve

III. Complete fully functional working V2 Prototype (9wks, end of Semester)

- Final documentation and Presentation