Owlsat - PDR

Team

Vijay Shah: Senior, EE, CanSat team leader

Eugene Pidlaoan: Senior, EE

Elisha Tigah: Senior, EE

Faculty Advisor:

Dr. Chang-Hee Won

Presentation Outline

- Team Roster Overview
- CanSat Overview
- Mechanical/Structural Overview
- Electrical Overview
- "Flight" Software Overview
- Integration and Test Overview
- Ground System Overview
- Mission Operations
- Cost Estimates
- Schedule Overview
- Summary

Team Roster and Responsibilities

Subsystem Name	Person(s) Responsible	Collaboration
Data Handling Subsystem	Vijay, Eugene	Jed-Justin, Lonnie
Communications Subsystem	Eugene	Jed-Justin, Lonnie
Sensor Subsystem	Elisha	Lonnie
Landing Subsystem	Vijay, Eugene, Elisha	
Imaging Subsystem	Vijay, Eugene	
Structure Subsystem	Vijay, Eugene	
Power Subsystem	Eugene	Jed-Justin
Ground Station	Elisha	Lonnie

- Jed-Justin Imperial and Lonnie Sweet are members of the other Temple University CanSat Team that we are collaborating with.

CanSat Overview

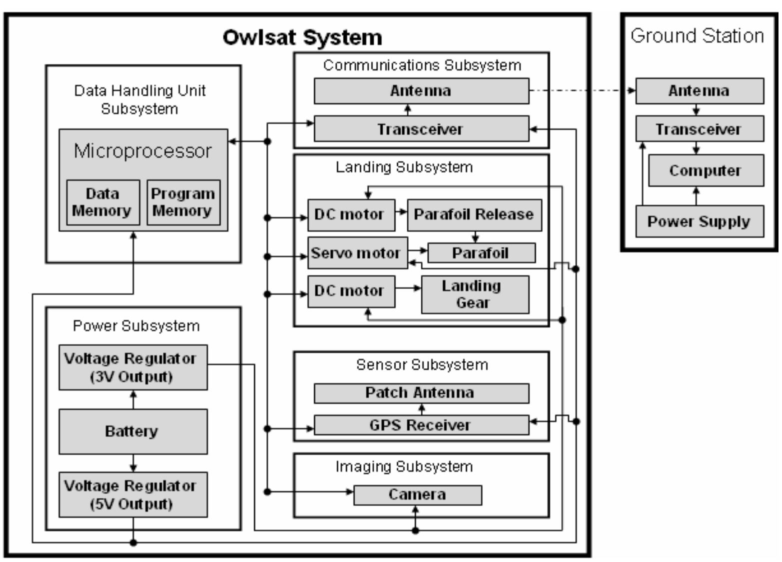
The mission of Owlsat is to satisfy the following requirement:

- Main requirements:
  - To send altitude data during descent every 5 seconds
  - To land in an upright position
  - Upon landing, release parachute from CanSat
- Bonus Requirements:
  - Take a 360 degree panoramic picture
  - Land near given coordinates

Structural Requirements

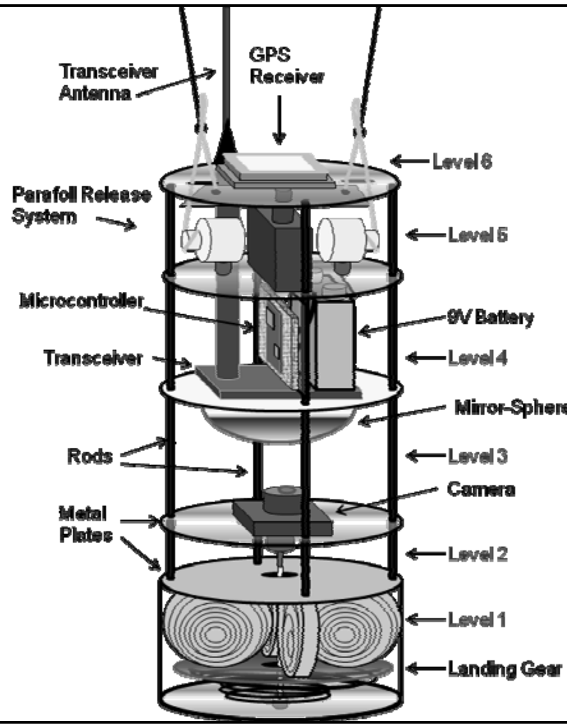
- No protrusions before deployment of CanSat from Rocket
- Shall not exceed 500 grams of mass
- No more than 2.6 inches (66.04 mm) in diameter
- No more than 8 inches (203.2 mm) in height.
- No Attachments to the rocket.
- Cost of the CanSat should be no more then $1000.

System Overview



Mechanical Overview - structural layout

- Owlsat consist of 6 levels, each separated by a circular metal plate held up by four rods.
- Figure shows a general layout of all components within Owlsat



Structural Layout I

- 1st level - Landing Gear
  - Measuring tape strips attached to the base of Owlsat
  - Used to land Owlsat in an upright position
- 2nd level - DC motor
  - DC motor will be used to release cover of the landing gear when signaled
- 3rd level - Imaging subsystem
  - Aiptek Mini Pencam digital camera
  - Mirrored surface ball
- 4th level – Components
  - 9V battery to supply power to the whole system
  - Circuit Board to wire all the piece
  - Microcontroller to program all the components
  - Transceiver for sending data to ground station
  - Antenna is needed with the transceiver to transmit data

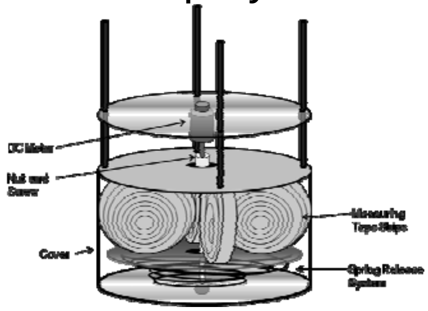
Structural Layout II

- 5th level – Descent control
  - Servo Motor
  - Parafoil strings
  - DC motors(2)
  - Parafoil strings will be attached to a servomotor
  - Decision will be made whether to steer left or right based on GPS coordinates
- 6th level – Sensor
  - GPS receiver will provide altitude, position, longitude and latitude data to microcontroller
  - Patch antenna is used to receive the data from global satellites

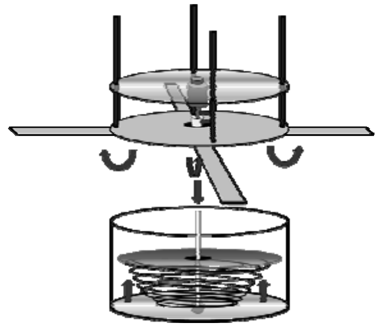
Landing Gear

- Consists of measuring tape strips rolled up before deployment
- When signaled, DC motor will turn counter-clockwise to unscrew cover and deploy landing gear

Before Deployment



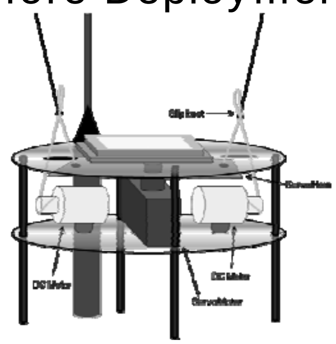
After Deployment



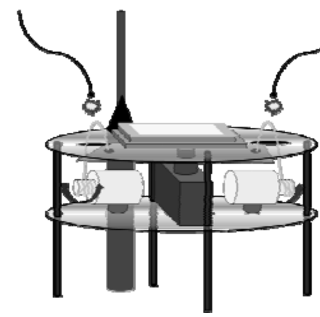
Parafoil Release System

- Consists of four strings
- Two strings will be attached to servo-horn and DC motor spindles and will have slip-knots tied in the middle
- The second string will be tied to slip-knot securing the parafoil
- When signaled, DC motor will turn and pull both strings to untie the slip-knot and release the parafoil

Before Deployment

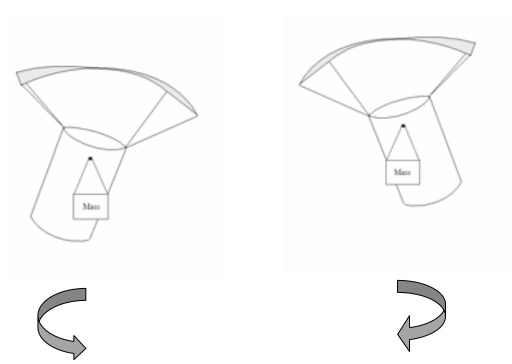


After Deployment



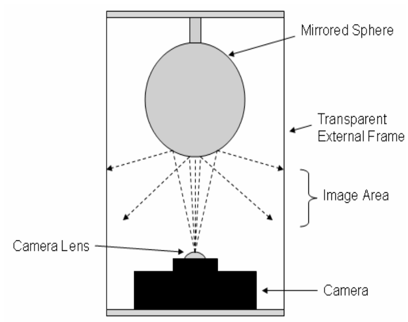
Parafoil Steering System

- Two control lines used to steer parafoil
- Controlled by servo motor
- 1.5 ms pulse rotates servo horn by 90 degrees



Imaging Subsystem

- Needs to take a 360 degree panoramic picture of horizon
- Consists of a 1.3 Megapixel camera placed at a certain distance from a convex mirror sphere
- When signaled, camera will take picture of mirror sphere producing an Omni-directional photo and store it in on-board memory
- Omni-directional photo will be converted to a 360 degree panoramic picture through Adobe Photoshop

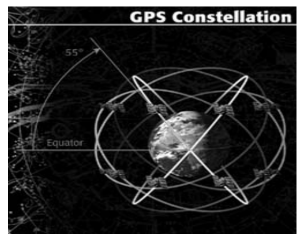


Preliminary mass budget

Subsystem Name	Components	Total Mass (g)
Data Handling Subsystem	Microcontroller	9
Communications Subsystem	Transceiver	20
	Antenna	23
Sensor Subsystem	GPS receiver	90
Landing Subsystem	DC Motor (3)	60
	Parafoil	TBD
	Servo motor	27
	Measuring Tape Strips (3)	12
Imaging Subsystem	Camera	25
	Mirror Sphere	5
Structure Subsystem	Rods (4)	TBD
	Metal Plates (5)	TBD
	Nuts and Screws	TBD
Power Subsystem	9V Battery	46
	Voltage Regulator (2)	10
Total	-	327
Maximum Requirement	-	500

Recovery system overview

- GPS receiver is able to give altitude, position, longitude and latitude data
  - One GPS receiver in Owlsat
  - Second GPS receiver connected to Laptop
  - Once the final coordinates are transmitted from Owlsat, second GPS receiver will be used to track Owlsat



Electrical Overview

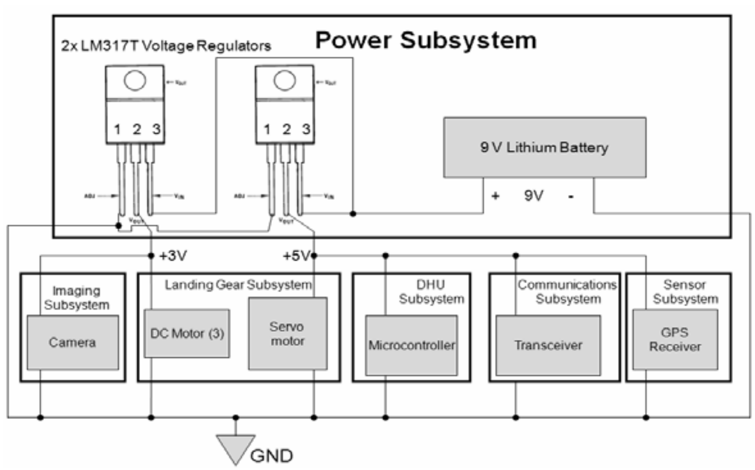
- Power system design overview
  - 9V lithium battery - 1200mAh rating
  - Voltage regulator - LM317T
- How long the battery lasts with a certain load?

$$T_{Battery-Life} = \frac{Power\_Rating\ (mAh)}{Current\_Load\ (mA)} = \frac{1200\ mAh}{1146\ mA} = 1.047$$

- As long as battery life time is greater than one, the battery should last at least one hour
- Meaning the battery is able to last for an hour at the minimum satisfying the competition requirement.
- A second battery is in consideration pending final mass budget of Owlsat

Power Interface

- **Two voltage regulators will interface with Owlsat system**
  - 5v and 3v

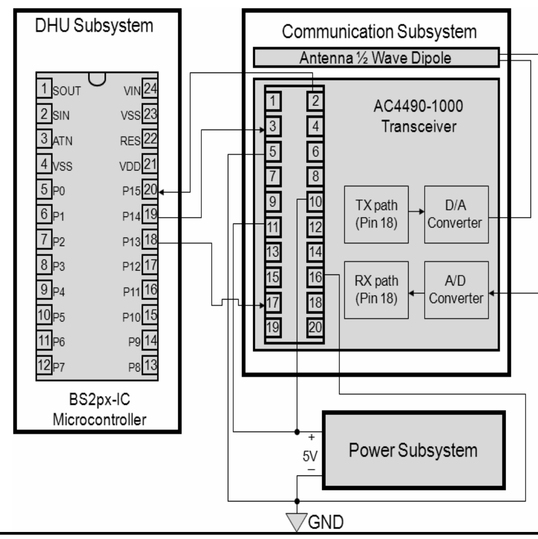


Power budget

Subsystem Name	Component(s)	Voltage	Current
Data Handling Subsystem	Microcontroller	5V	55mA
Communications Subsystem	Transceiver	5V	106mA
	Antenna	-	-
Sensor Subsystem	GPS receiver	5V	115mA
Landing Subsystem	DC Motor (3)	3V	3x250mA
	Parafoil	-	-
	Servo motor	5V	TBD
	Measuring Tape Strips	-	-
Imaging Subsystem	Camera	3V	120mA
	Mirror Sphere	-	-
Structure Subsystem	Rods	-	-
	Metal Plates	-	-
	Nuts and Screws	-	-
Power Subsystem	9V Battery	-	-
	Voltage Regulator (2)	-	-
Total	-	-	1146mA
Maximum Requirement	-	-	1200mA

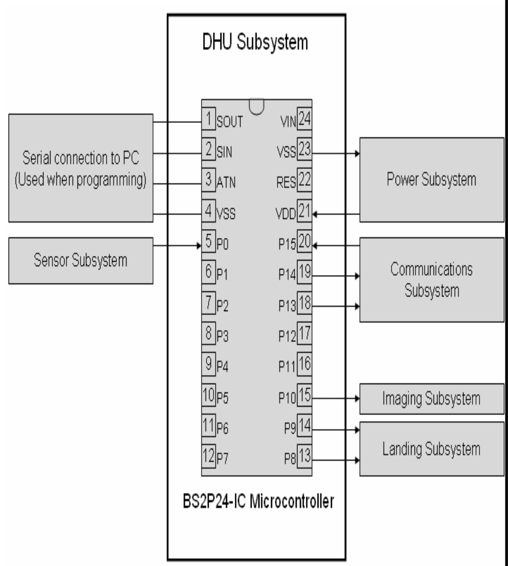
Communications system and Interface

- Transceiver
  - Aerocomm AC4490-200 module with ½ wave dipole antenna of power gain 2.5dBi
  - Operates in a frequency band of 902-928 MHz
  - Range of 21,120 ft
- Transceiver will use a 20 pin TTL asynchronous serial port interface to connect with microcontroller



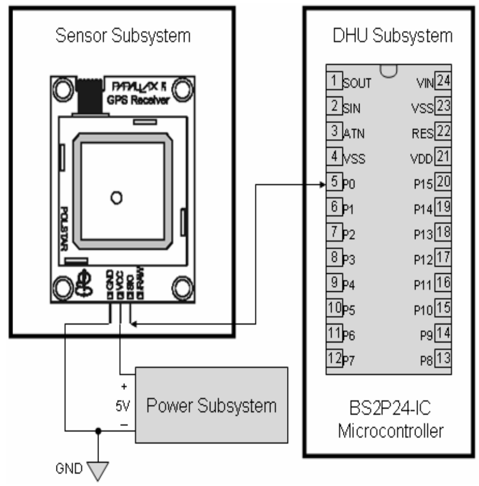
Processor and Interface

- Parallax BS2p24-IC BASIC Stamp
  - Best choice in terms of size, processing speed, instruction speed and memory sizes.
- Basic I/O pins - pins 5-20 (P0-P15)
- Power subsystem - pins 21-24



Sensor and Interface

- Parallax GPS receiver module
  - Determines longitude, latitude, altitude, current time, and velocity
  - Microcontroller will send current altitude values to transceiver via DHU
- GPS receiver will be interfaced to the microcontroller using one pin while the other two pins are required for its power

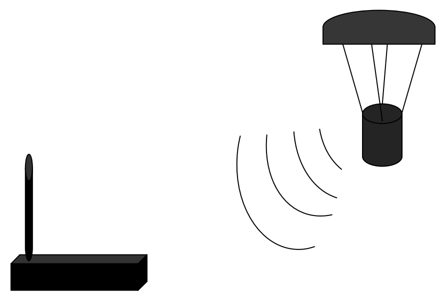


"Flight" Software Overview

- The programming for the microcontroller will be done in Basic
- The software has not been implemented and tested yet, but we have a brief outline of what we will program for each subsystem

Communications Subsystem Software Overview

- The program will have access to the most updated altitude data acquired from GPS receiver
- Will be programmed to send the altitude data to the ground station in five second intervals or less



Sensor Subsystem Software Overview

- GPS module will yield digital output in the form of an ASCII data string
- Microcontroller will access altitude data from the stored GPS position memory for transmission to the ground station
- To satisfy the bonus requirement, the current altitude, location, time, and heading will be compared to the transmitted target coordinates which will be used to control the servomotor to steer the parafoil

Imaging Subsystem Software Overview

- The program will send a signal to trigger camera to take picture
- Signal programmed to be sent at a certain time or altitude indicated by the GPS receiver
- The microcontroller will be programmed to send multiple signals to take multiple pictures at different altitudes

Landing Subsystem Software Overview

- The microcontroller will send a signal to trigger the landing subsystem when the most recent coordinates from the GPS receiver match the ones pre-specified in the program.
- The signal from the microcontroller will deploy the landing gear at the appropriate altitude.

Integration and Test Overview

- Each subsystem must be tested in order to ensure each component works to its best ability
- So far we have only done tests to the mechanical portions of the project, but we have developed an outline for the electrical portions

Communications Subsystem Integration and Test Overview

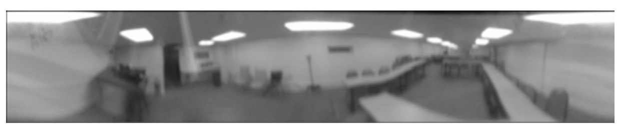
- We will have to determine if the ground station will be able to receive signals from the CanSat transceiver 3,000 feet away
- We will have to determine if the CanSat transceiver will be able to transmit data to ground station in five second intervals or less

Sensor Subsystem Integration and Test Overview

- Tests include walking around with the GPS receiver to ensure it give correct position data
- It will be dropped from a building in order to ensure that it gives us a descent rate.

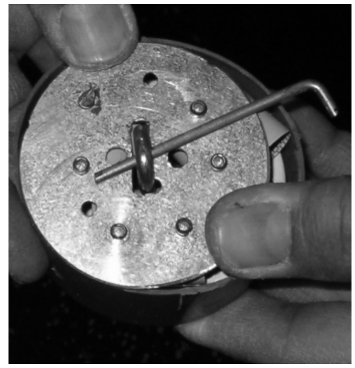
Imaging Subsystem Integration and Test Overview

- Pictures will be taken to determine if the camera is correct distance from the mirror-sphere
- Adjust focal point to ensure best image quality
- Omni-directional picture will be transformed to rectangular 360 degree panoramic picture



Landing Subsystem Integration and Test Overview

- A can with a 500 gram mass will be mounted on landing gear
- Can with landing gear will be dropped from tables length to determine is landing is upright
- Landing gear release system will be tested with measuring strips to ensure it will deploy upon landing

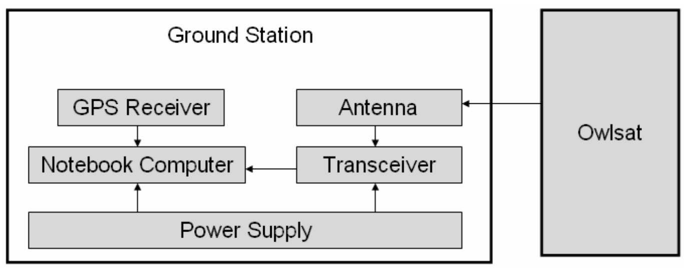


Ground System Overview

- Design considerations and requirements
  - Used to receive and store data the CanSat will be transmitting during launch time
  - Includes transceiver with antenna interfaced with a laptop
  - GPS receiver is used for the recovery system

Ground System Architecture

- Owlsat communicates directly with antenna of ground station to be able to receive altitude data
- GPS receiver is used once final coordinates are transmitted to locate Owlsat



Ground Hardware Selection

- Laptop: Asus A8Js
- Transceiver: CL4490-1000
- Antenna: ½ Wave Dipole
- GPS receiver: Parallax GPS receiver module

Mission Operations: Concept of Operations

Owlsat Mission		
Mission Phase	**Task**	**Subsystem Component**
Launch	Launch Owlsat to about 3,000 ft	None
	At apogee, deploy Owlsat and Parafoil	Microcontroller, Servo motor
Descent	Must transmit altitude data to ground station in 5 second intervals or less	GPS receiver, Microcontroller, Transceiver
	Owlsat must steer itself to the intended longitude/ latitude coordinates given prior to launch	GPS receiver, Microcontroller, Servo motor
	A 360 degree panoramic picture must be taken of the horizon	GPS receiver, Microcontroller, Camera
Landing	Owlsat must deploy its base landing gear and detach itself from the Parafoil	GPS receiver, Microcontroller, Landing gear
	Owlsat must land in an upright position as close to the intended latitude/longitude coordinates as possible	Landing gear, parafoil, servomotor

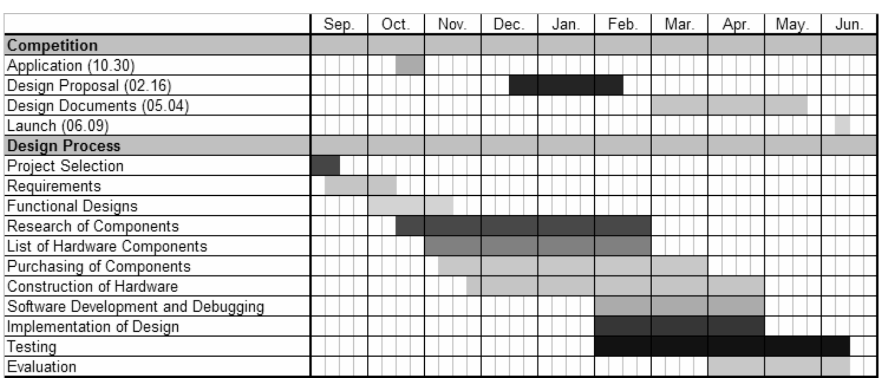
Mission Operations: Data Analysis Design

- Altitude data from the GPS receiver is to be analyzed by the microcontroller to be sent to communications subsystem for transmission to ground station
- Altitude data from GPS receiver will be used to compare with pre-programmed altitude data to release landing gear and to take images
- Longitude and latitude coordinates from the GPS receiver are to be analyzed when comparing the current coordinates with the intended coordinates for landing the CanSat

Cost Estimates

Subsystem Name	Component(s)	Vendor	Quantity	Cost (Each)
Data Handling Subsystem	Microcontroller	Parallax	1	$79.00
Communications Subsystem	Antenna	Aerocomm	1	Development kit $100.00
	Transceiver	Aerocomm	1	Development kit
Sensor Subsystem	GPS receiver	Parallax	2	$79.95
Landing Subsystem	DC Motor	Radio Shack	3	$3.29
	Parafoil	TBD	1	TBD
	Servo motor	Parallax	1	$15.00
	Measuring Tape Strips	Home Depot	1	$7.00
Imaging Subsystem	Camera	Aiptek	1	$10.00
	Mirror Sphere	Christmas Ornament	1	$3.00
Structure Subsystem	Rods	Home Depot	4	TBD
	Metal Plates	Home Depot	5	$0.52
	Nuts and Screws	Radio Shack	TBD	TBD
Power Subsystem	9V	Radio Shack	1	$10.99
	Voltage Regulator	Radio Shack	2	$2.29
Ground Station	Laptop	Donated	1	Donated
	Antenna	Aerocomm	1	Development kit
	Transceiver	Aerocomm	1	Development kit
Total				$401.94

Schedule Overview



- Currently we are in the implementation of design and programming process
- We are also testing on various parts of Owlsat

Summary

- All components are decided upon except parafoil
- Structural design is complete
- Electrical interface design is complete
- The Mechanical/Structural part is being currently being worked on
- Electrical part is pending as we are waiting for our components to arrive
- Software testing not completed yet