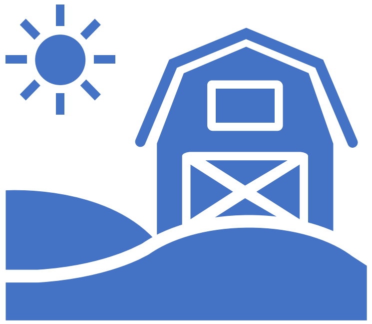
F.A.S.T.
Critical Design Review

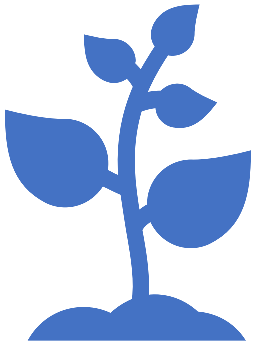
- Group A:
  - Nicole Andrade : (CpE)
  - Christopher Badolato (Cpe)
  - Jan Iglesias Morales (CpE)
  - Savannah Irvin (CpE)

F.A.S.T.
Farming Assistant Solar Tracker

Project Goals & Motivation



Weather accounts for 85% of crop loss for farmers. If farmers could more accurately predict the weather it would lead to a reduction in crop loss, in turn could yield greater profits, and in certain areas could provide food to those in need.



Providing farmers with a straightforward way of determining the status of their fields would allow them to make more informed decisions with regards to their fields.

The Team

Nicole Andrade

- Software Development

Christopher Badolato

- Software Development

Jan Iglesias Morales

- Embedded HW/SW Development

Savannah Irvin

- Power

Member Responsibilities

NAME	POWER	SENSOR SYSTEM	APPLICATION	COMMUNICATION	HOUSING
Christopher Badolato		Primary	Primary		
Jan Iglesias Morales	Secondary	Secondary		Primary	
Nicole Andrade			Secondary		Primary
Savannah Irvin	Primary				Secondary

Project Objectives

- Help farmers maximize the efficiency of their farms as well as minimize crop loss.
- Create a “portable” device that farmers will be able to place around their fields to obtain useful data.
- Through an app

Project Specifications and Requirements

Mechanical (Housing)

Can house all components

Durable filament

Dual Axis movement

Power System

Runs solely from PV

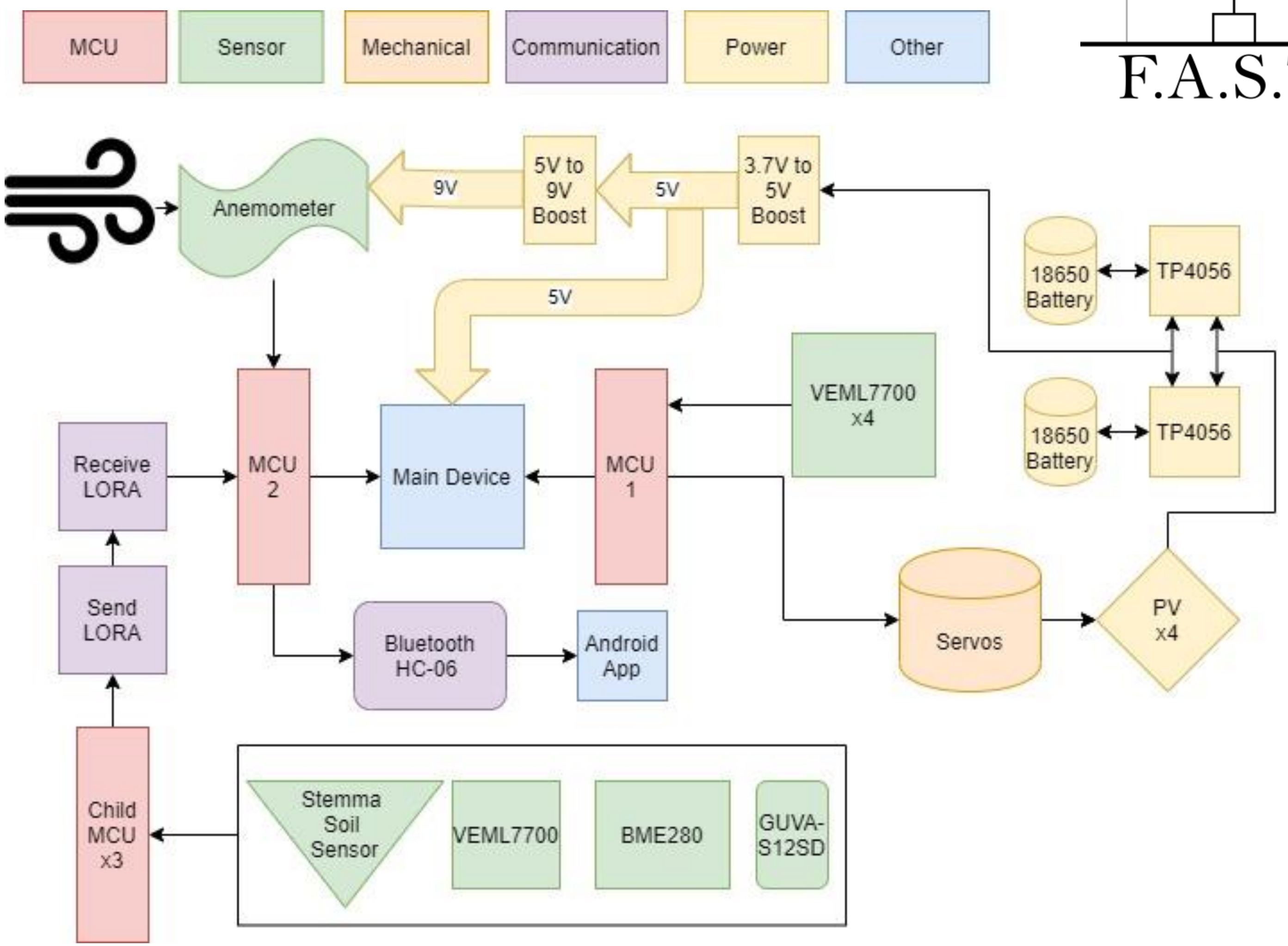
Battery capacity to power for 24hour

5V VCC and 9V VCC

Project Specifications and Requirements

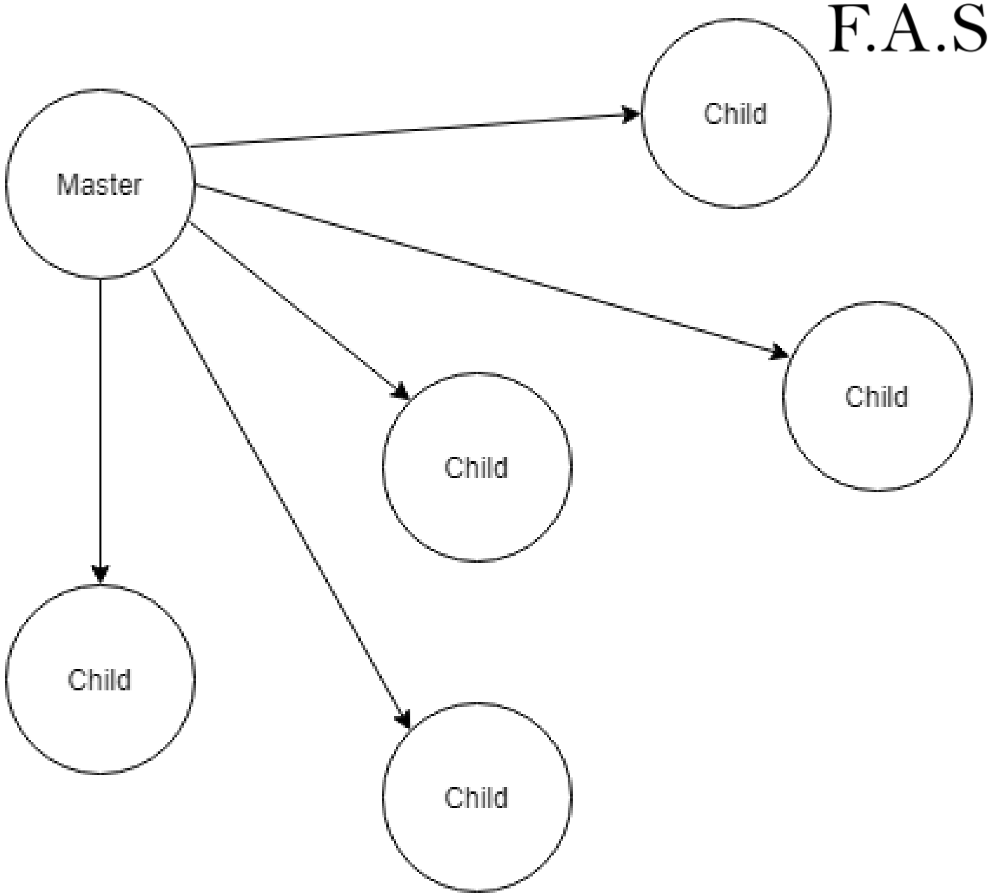
- Communication
  - Provide communication between F.A.S.T units
  - Allow for communication with user through phone app.
- Sensor System
  - Provide accurate lux, temperature, pressure, humidity, soil temperature and soil moisture to the main fast unit.
  - Wind speed for main unit
  - Accurate lux sensing for main unit solar tracking.
- MCU
  - Must have at least 1 serial communication module.
  - Provide I2C and SPI support.
  - At least 5 digital pins and 3 analog pins
  - Low power consumption

Overall Project Block Diagram



F.A.S.T Network

- A star network.
- Child units send measurements to master unit.
- Extremely long range with tuned antennas
- Arrays of measurements are sent to the main unit.
- An android app connects to main unit to see all measurements.



Transmissions

- Each transmission sends a string of bytes to a listener.
- In this application, an array of floats was converted to an array of bytes before being transmitted using a union.
- Upon a transmission being received, the array of bytes is converted to an array of floats.

Payload

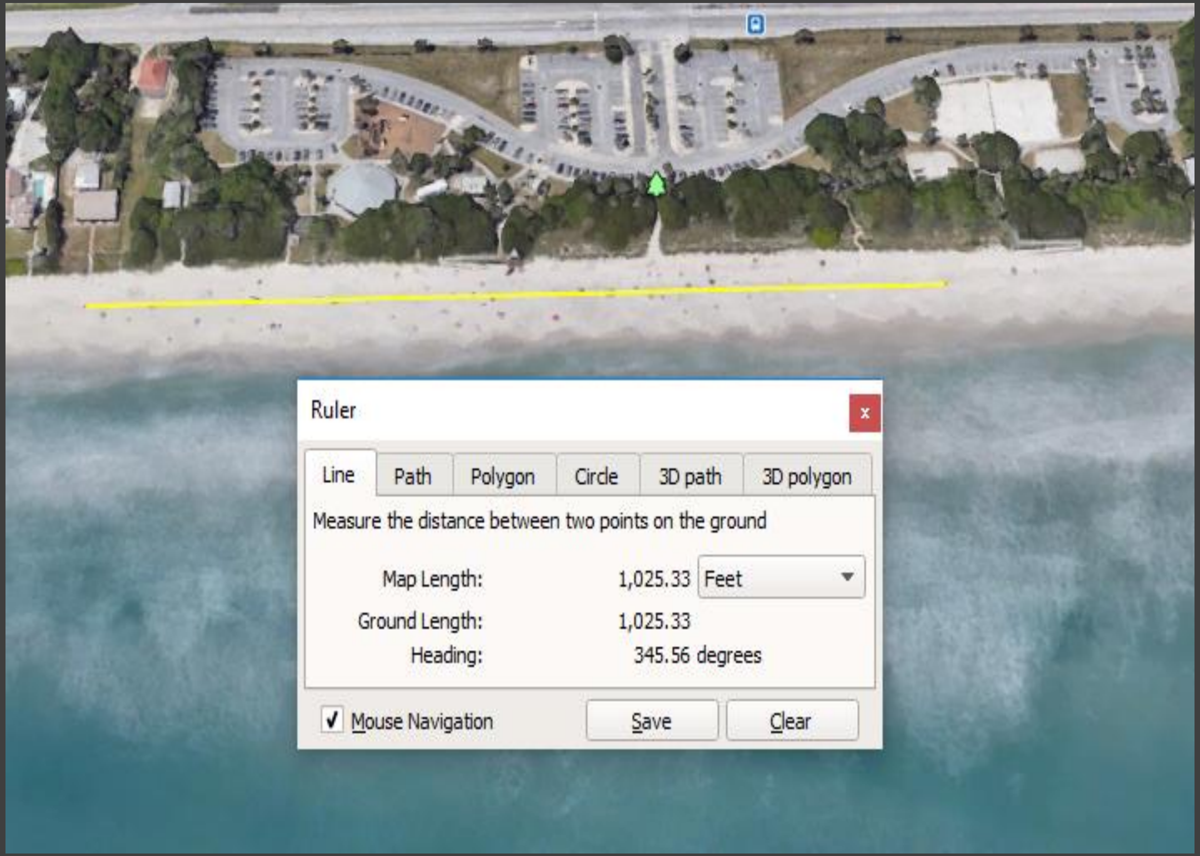
2.00	Machine ID
24.60	Temp (Celsius)
45.98	Humidity (%)
101434.70	Pressure (Pa)
44.95	Brightness (Lux)
25.96	Soil Temp (Celsius)
368.00	Soil Moisture
0.00	UV
0.00	Wind Speed (m/s)
-1	Delimiter

- The payload sent with every transmission is an array of floats.
- Each float in the array represents a different measurement.
- Delimited at the end of the payload

Wireless LoRa System

F.A.S.T

- The wireless transmission between the units is done using the LoRa (Long Range) technology.
- Operates in the 900MHz frequency.
- Relatively low powered.
- Up to 20km with directional tuned antennas and tuned settings.
- RFM95W module will be used.

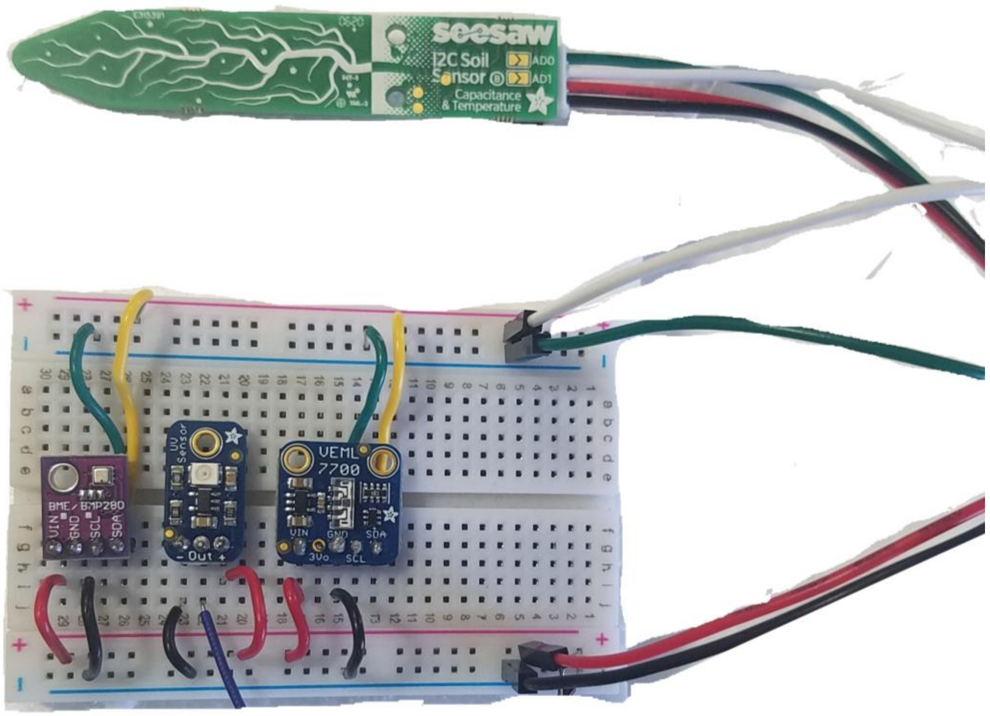


LoRa Range test

- Under non-ideal conditions with non-calibrated antenna, a range of 1000ft was observed using breadboard prototypes.
- No data was lost.
- Consistent measurements were observed by the master

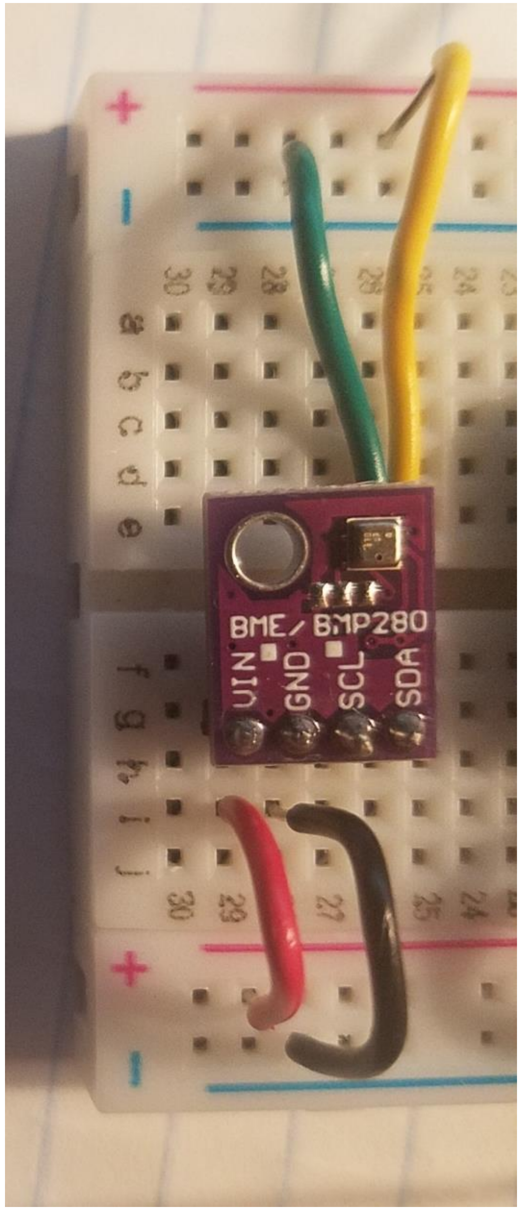
Sensor System

- Each child unit contains the sensor system
- Main unit contains sensor system plus anemometer
- I2C and Analog inputs
- Each unit contains 4 sensors and a LORA transceiver.



BME280

- Pressure
- Humidity
- Ambient Temperature
- I2C



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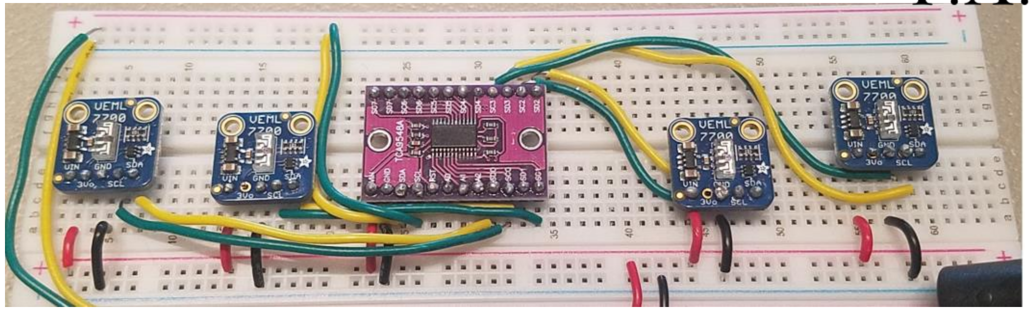
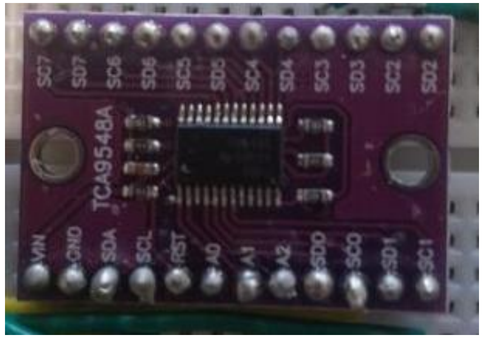
VEML7700

- Lux Sensor
- I2C multiplexer (TCA9548A)
- Each lux sensor has the same I2C address therefore the multiplexer was needed



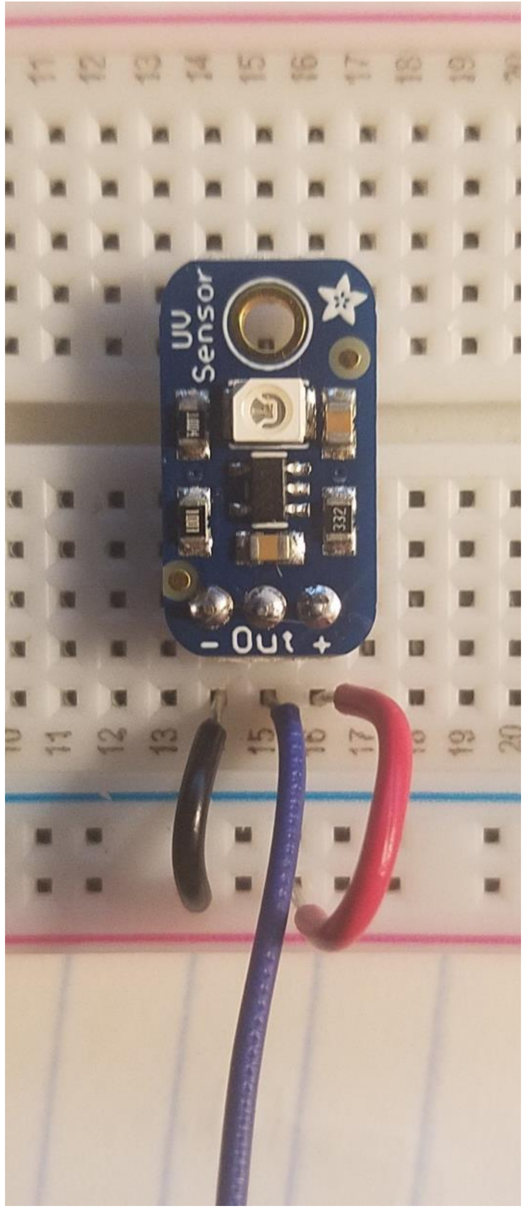


Stemma Soil Sensor

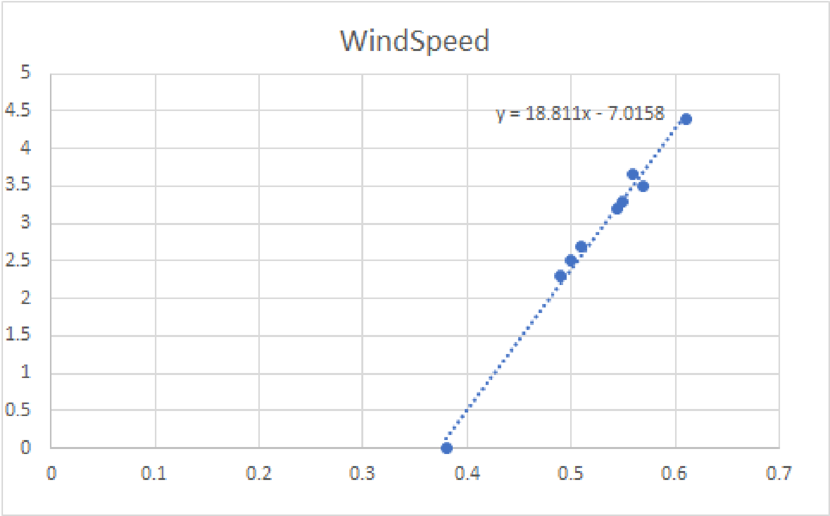
- Soil Moisture
- Soil Temperature
- Data received by MCU via I2C

GUVA-S12SD (UV Sensor)

- UV Index
- Analog Output
- 5V input



Anemometer



- Wind Speed Sensor
- Analog output
- 9V input
- Main device only

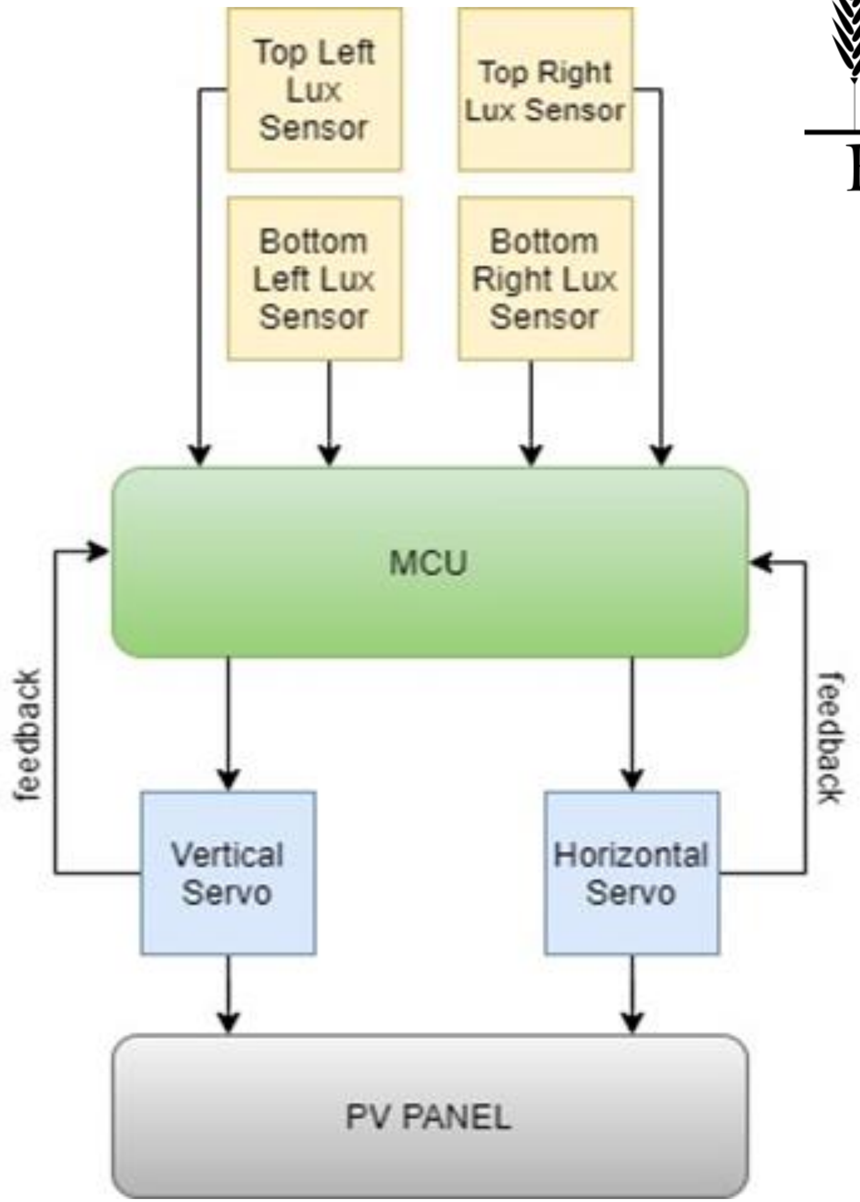
Solar Tracking System

- Subsystem of F.A.S.T.
- Main purpose is to point panels towards the sun for maximum light intensity throughout the day.
- Measures light intensity from 4 lux sensors.
- Dual axis servo motor system combined with dual gears are used to provide freedom to follow the light intensity.

Solar Tracking System

Embedded Processor is issued to:

- Capture light intensity signals for the light sensors.
- Process light data to find needed change in position as light source moves.
- Control the servo motors to position the panel in the direction of the sun.



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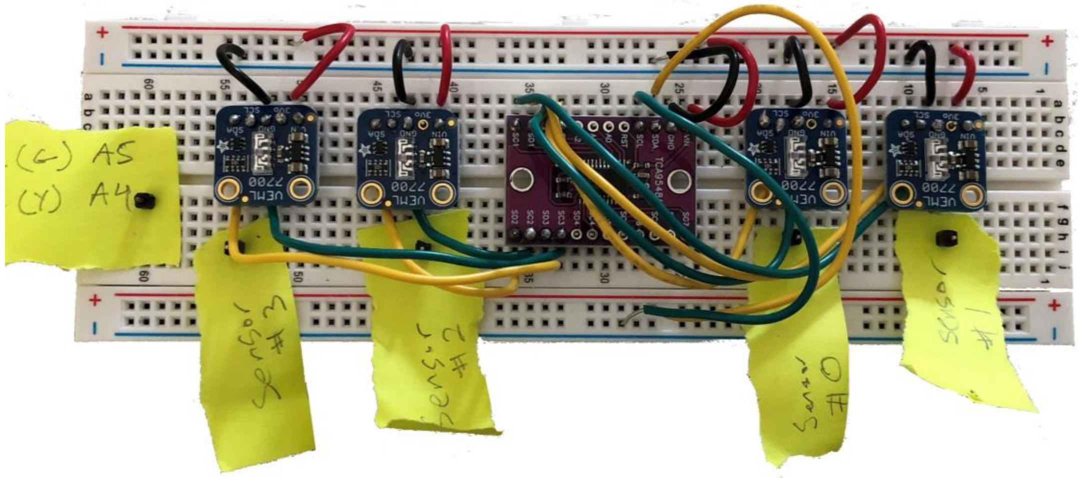
Solar Tracking Mechanical Design

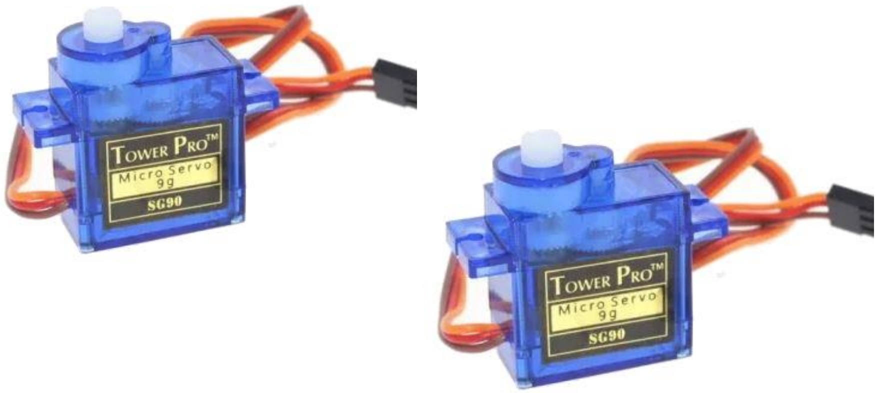
- 3D printed
- Dual Axis
- Material selection - PETG

	PLA	ABS	PETG
Strength (MPa)	65	40	53
Stiffness	7.5/10	5/10	5/10
Durability	4/10	8/10	8/10
Cost (per kg)	$10 - $40	$10 -$40	$20 - $60
Impact Resistant	No	Yes	No
UV Resistant	No	No	No
Water Resistant	No	No	Yes

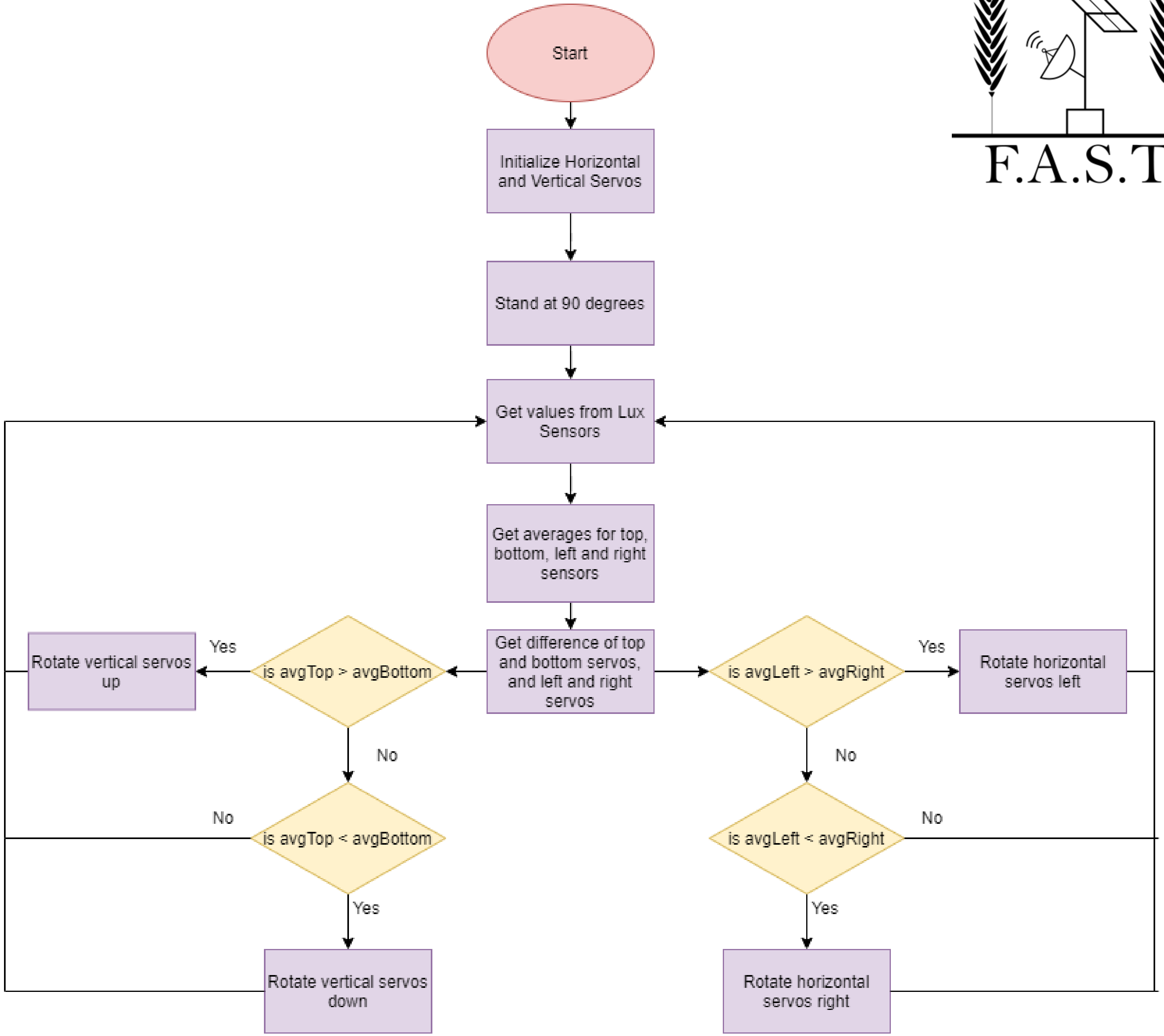
Solar Tracking Components

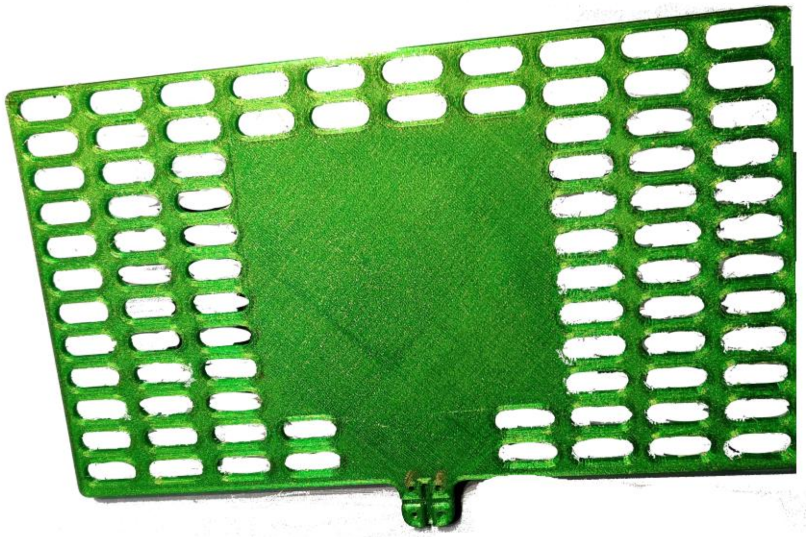
- Lux Sensors
  - ➢ Need shielding to give more isolation for directionality.
- Servos
  - ➢ Need to be strong enough to power the gimbals and the solar panel weight.
  - ➢ 180-degree servos

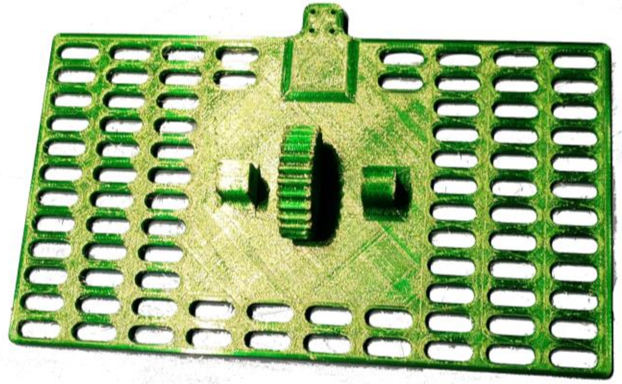




Solar Tracking System Software







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Housing Modification

Power System Components

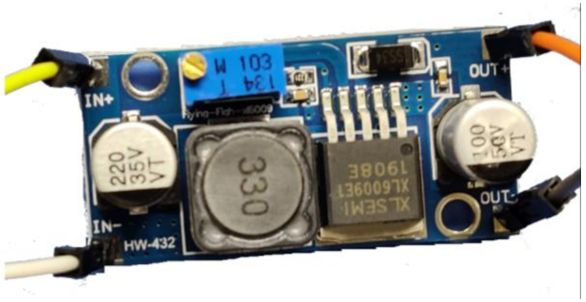
(4) 5-Watt Polycrystalline Solar Cells

(2) TP 4056 Charging Module

(2) 18650 Batteries

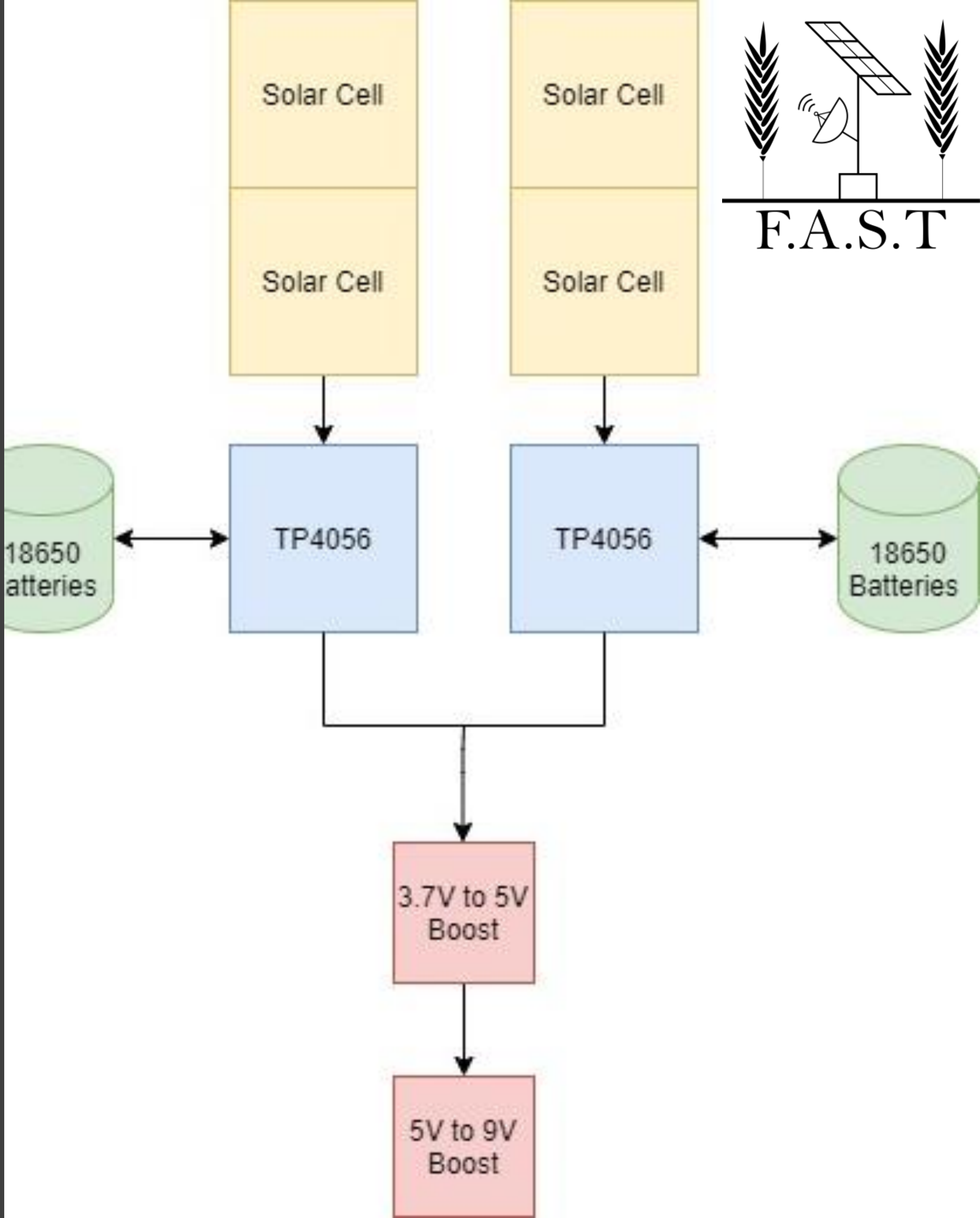
(1) 3.7V to 5V Boost Converter

(1) 5V to 9V Boost Converter



Power System

- Using Solar, and batteries cells allows us to scale supply in design phase
- TP 4056 module chosen to keep cost low and design safe and simple (concerns of placing)
- 9V VCC line from 5
- Current load draws max average .23A combined batteries have 6A capacity so theoretically 26



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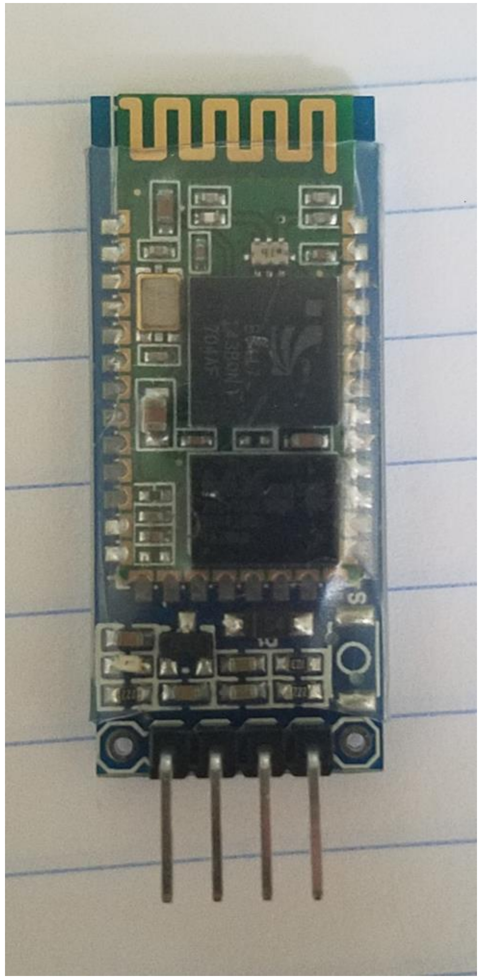
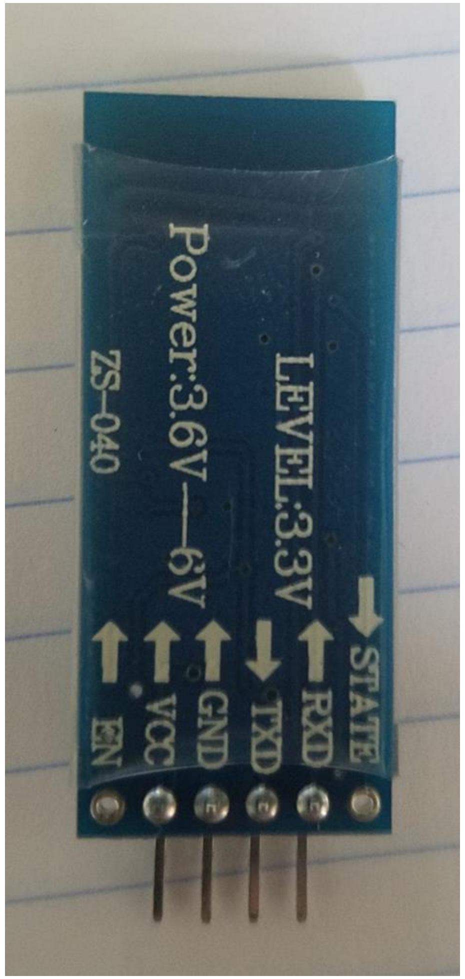
HC-06

- Communication via Bluetooth is possible with UART serial transmission and an HC-06 module
- Data from each device is sent via LORA and displayed on the application previously described
- Only the master device has Bluetooth capabilities.





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Application

- The android application will serve as an information nexus and will provide the measurements obtained by all the units.
- The application will require a Bluetooth connection to the Master unit.
- Analytics and information processions may be implemented in the application using live data and historical recorded measurements.

Constraints

01

Working within the budget.

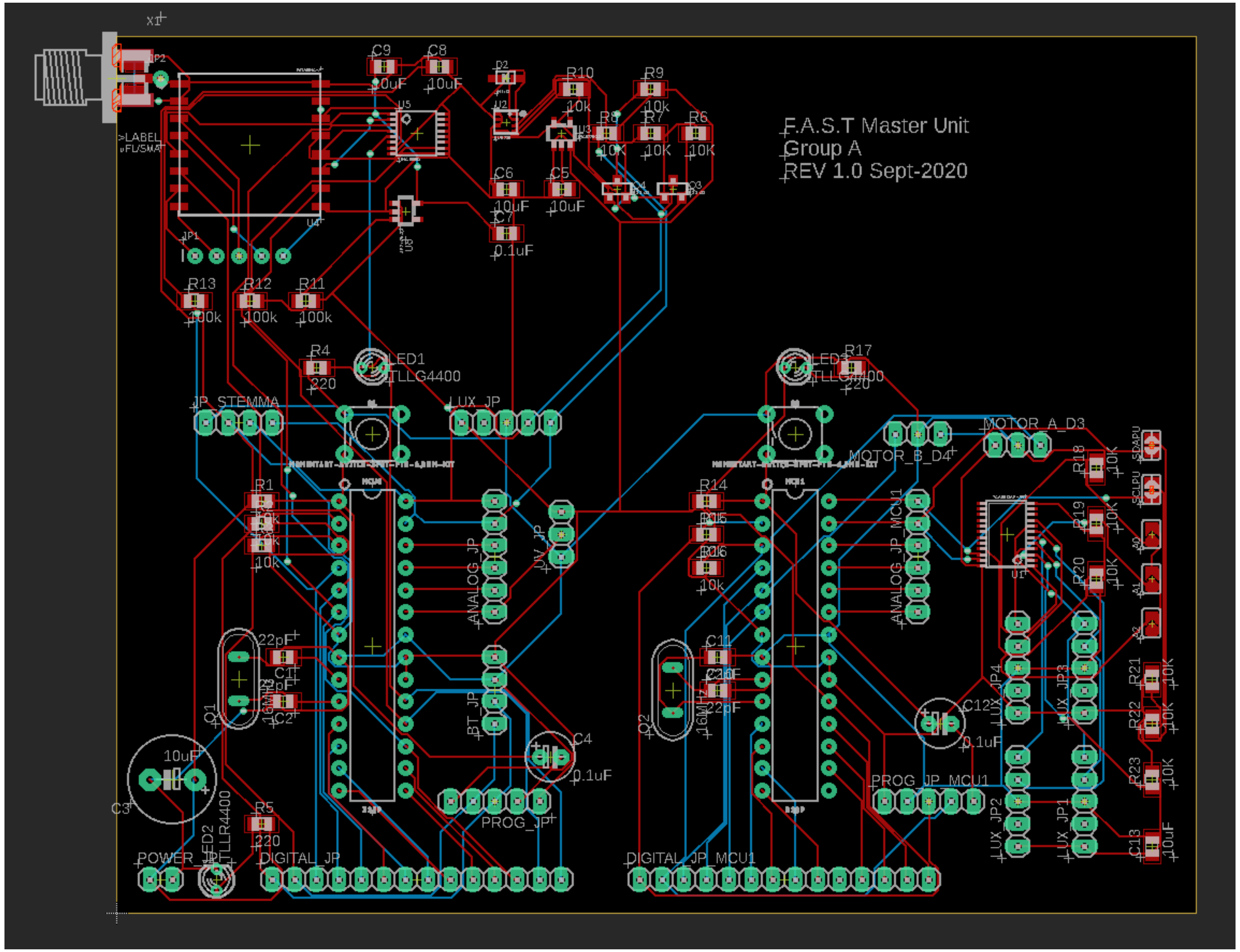
02

Finding ways to effectively work together while still maintaining a safe environment due to COVID-19.

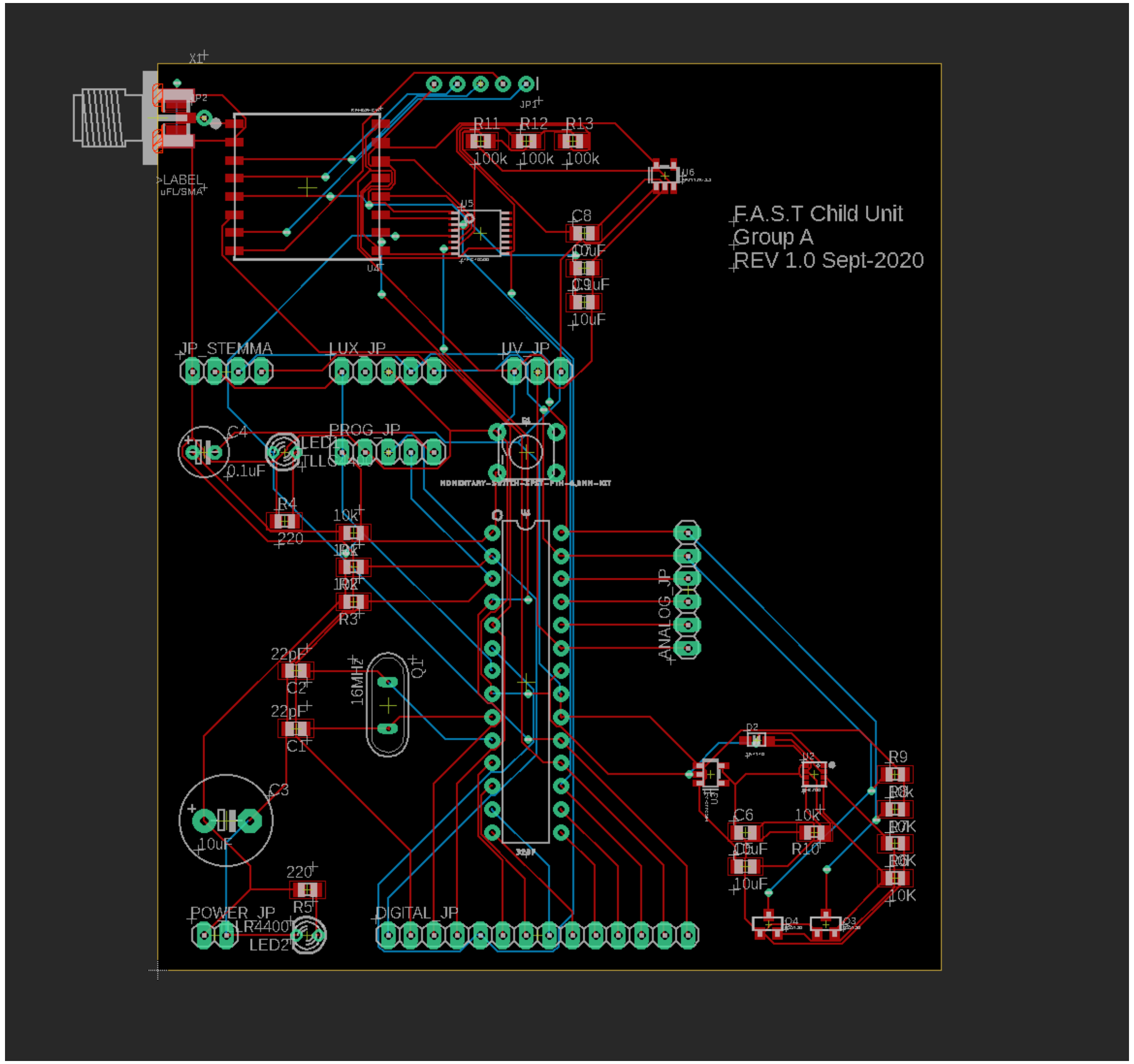
03

Learning how to use new equipment remotely.

Master PCB



Child PCB



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Overall Successes

- Effective meetings were planned and occurred at a consistent pace (Twice a week minimum).
- All members worked hard and provided a positive attitude while contributing to the project despite current circumstances.
- Logic breadboard prototypes were successfully implemented and verified.
- Costs were distributed.
- Communication between team members was constant and effective.

Overall Difficulties

Designing a power system along with a charging module that can charge both batteries safely.

Main logic system will be finalized before power system. This will require the logic and power PCBs to be split to accelerate development time.

Financing has proven difficult due to the cost of the sensors as well as the cost of the associated R&D.

Project Financing

Project is currently being funded entirely from members.

Members purchase materials as needed and are reimbursed to distribute costs.

Currently trying to obtain partial funding assistance from a generous benefactor.

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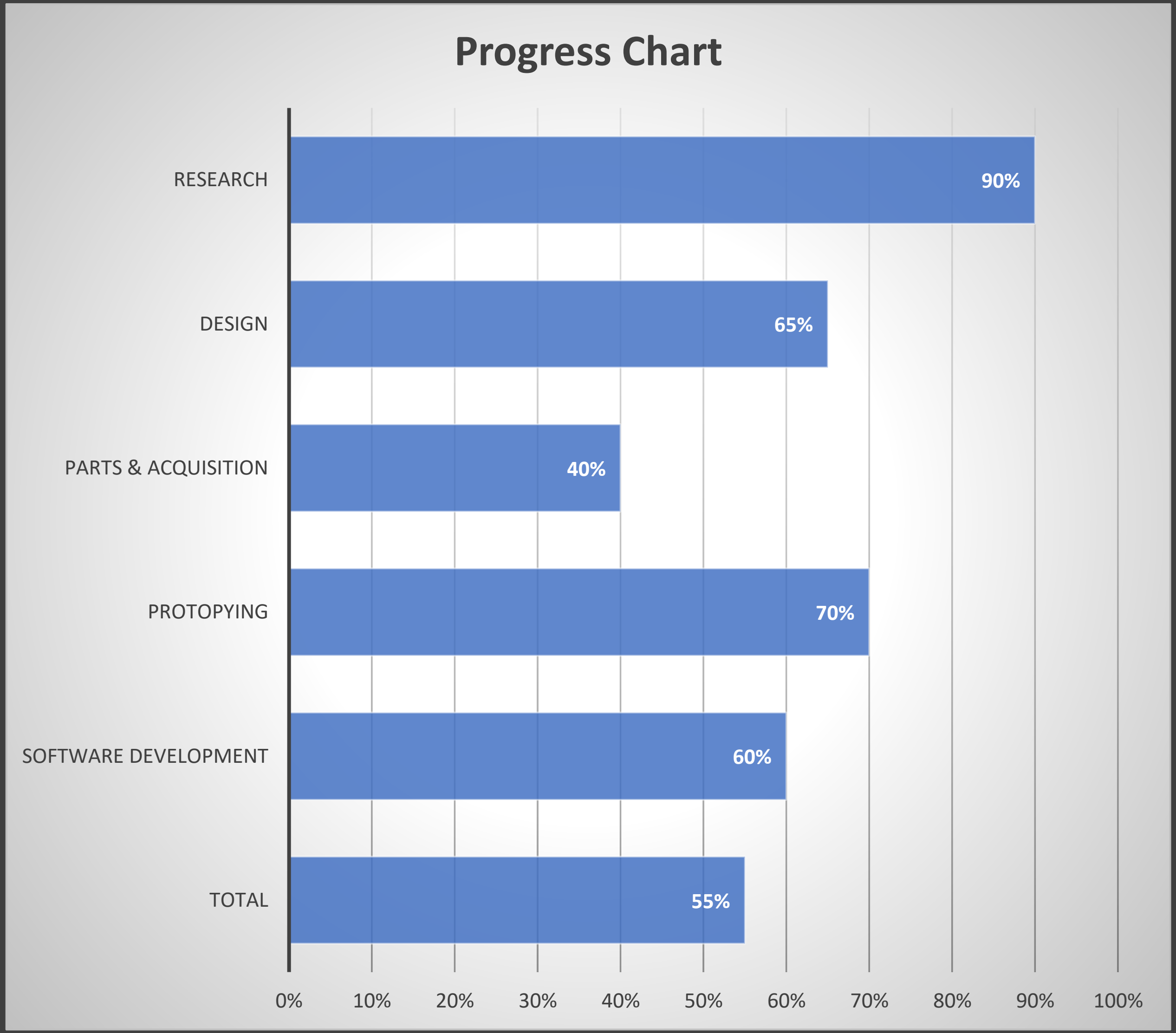
Budget

Quantity	Item	Supplier	Price/Unit	Total price
1	Anemometer	Adafruit	$ 49.95	$ 49.95
2	SG90 Servo	Amazon	$ 7.50	$ 15.00
5	TCA9548APWR multiplexer	Digikey	$ 1.58	$ 7.90
10	16MHz Quartz Crystal	Digikey	$ 0.29	$ 2.90
4	Solar Cells	Amazon	$ 6.50	$ 26.00
2	TP 4056	Amazon	$ 2.00	$ 4.00
2	18659 Battery	Amazon	$ 6.75	$ 13.50
1	Filament PETG 1kg spool	Amazon	$ 20.99	$ 20.99
10	Green LEDs 3mm	Digikey	$ 0.36	$ 3.60
10	Red LEDs 3mm	Digikey	$ 0.36	$ 3.60
1	TPS61022RWUR	Digikey	$ 1.69	$ 1.69
1	Assorted push buttons	Amazon	$ 8.99	$ 8.99
1	TPS61088RHLR	Digikey	$ 3.73	$ 3.73
1	HC-06 Surface Mount	Mouser	$ 9.94	$ 9.94
1	Ten pack of flashed ATMega328ps	Amazon	$ 25.99	$ 25.99
5	STEMMA soil sensor	Adafruit	$ 7.50	$ 37.50
10	VEML7700 Lux Sensor	Digikey	$ 1.38	$ 13.80
5	BME280 Sensor	Digikey	$ 5.95	$ 29.75
5	GUVA-S12SD Sensor	Digikey	$ 6.00	$ 30.00
5	RFM95W Lora	Digikey	$ 13.57	$ 67.85
5	915 MHz antenna	Amazon	$ 7.50	$ 37.50
1	Ten pack of SMA RF connectors	Amazon	$ 7.99	$ 7.99
1	Assorted pack of female headers	Amazon	$ 10.00	$ 10.00
1	Assorted pack of male headers	Amazon	$ 4.59	$ 4.59
1	Assorted electrical components	Digikey/Mouser/Amazon	$ 30.00	$ 30.00
Total	================================	===================	========	$ 466.76

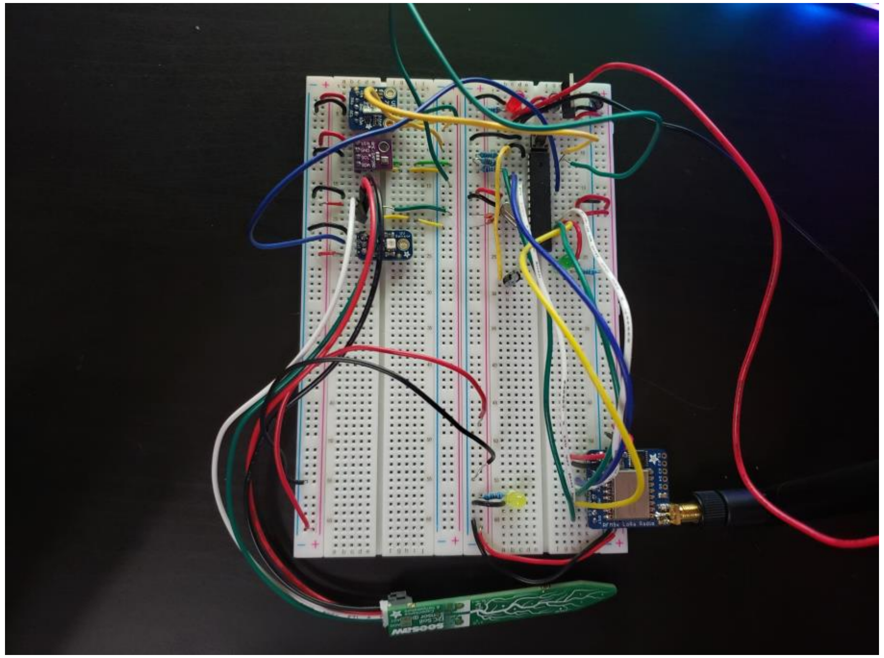
Project Progress

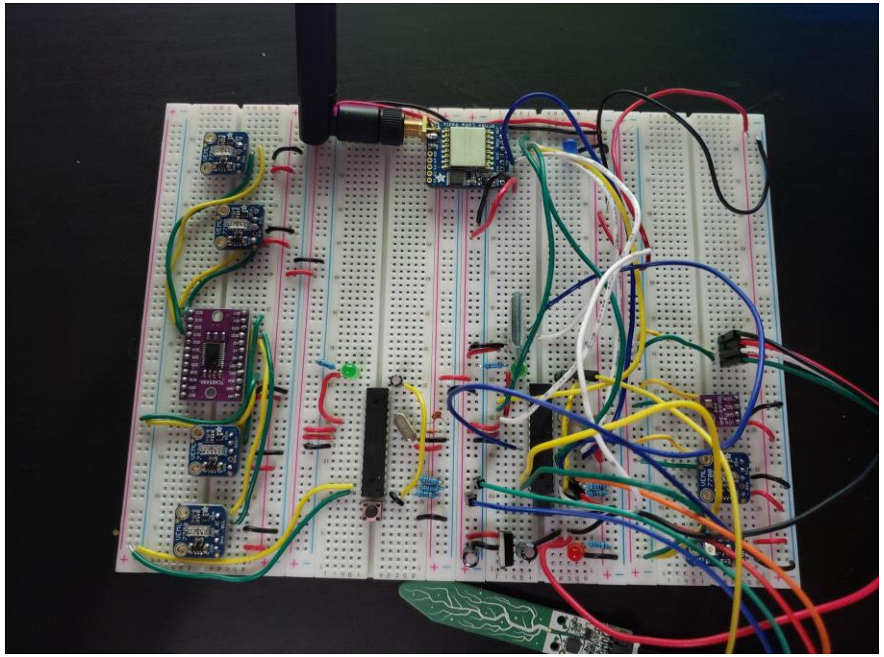


Progress Details

- Logic system is almost entirely completed. All major design decisions have been completed, implemented, and validated.
- Several logic prototypes have been implemented in breadboards for child and master units.
- Power system fulfills capacity
- PCB for the logic board is completed and is currently under review.
- Application view of Bluetooth data

Logic Breadboard Prototypes





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Next Steps

- Finish the power system.
- Finalize the power PCB.
- Send out our first logic PCB revision to be printed.
- Assemble first revision units.
- Test first revision units.