Senior Design 1
Group A

Divide and Conquer, Version 2

Farming Assistance & Solar Tracking (F.A.S.T.)

Group A

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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.

Project goals:

The F.A.S.T device will assist farmers with measuring air and soil temperature, soil humidity, and ultraviolet light, in a solar powered, remote connected weather station. The F.A.S.T device is lightweight, portable, and easy to use . The device sends data directly to an android app where the owner of the device can see the device's measurements. Using a rotating solar panel, it will track the sun and rotate accordingly. The device can assist in crop growth and livestock well being. Optimum temperature is required at the time of sowing and all life stages of crops. Excess or deficiency of moisture can lead to defective germination, growth, and maturation. High UV light can damage the DNA of some organisms. Certain UV intensity can also help plants grow. **Table 3: Milestone Senior Design I** and **Table 4: Milestone Senior Design II** outline the projected dates that this device will be produced.

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Project objectives:

The objectives for this project are defined in **Figure 8: The House of Quality**. From this figure it is easy to see that price along with weight will provide the most limitations in terms of performance. The estimated budget has been outlined in **Table 2: Budget and Parts** to make sure that the cost objective is realistic.

Function:

The main function of the F.A.S.T device is to provide farmers with real time crop data without extensive maintenance required. Some of the devices functionality include, being able to run without a grid connected power source, the ability to connect to a mesh network, and to send accurate real time data to I/O devices. The specific requirements and specification are further referenced on **Table 1: Specification and Requirements.**

Specification and Requirements

Description	Value	Unit
User Interface		
Product must be able to send data in real time to an Android app (C# or java) to be viewed at a specified time interval.	5	Mins
Product must be able to alert user via app of any abnormal readings	-	-
Application must present historical data to user	-	-
Application must be able to poll the product and request a current reading	-	-
Microcontroller		
I2C address width	>= 7	bits
Low voltage	<=7	Volts
Low power draw	-	-
Bluetooth 5.2 with Mesh Network capability	-	-
SPI support	-	-
Sensors		
Lux sensor measurement range	.1-30,000	lux
Air humidity measurement range	10%-90%	rH
Relative Soil humidity measurement range	10%-90%	rH
Wind speed measurement range	0-50	m/s
UV light intensity measurement range	0-12	mW/cm^2
Temperature Sensor Hook up temp sensor (TMP006)	32 - 120	F

Table 1: Specification and Requirements (I)

Description	Value	Unit
Structure		
Servo motor with specified torque	21-25	kg/cm
Be able position PV panel to the azimuth during peak sunlight hours	-	-
Power system		
PV module with specified max production	20	Watt
Charge Controller	120	Watt
Battery with specified max capacity	84	Watt
Completely self-sufficient from PV module	-	-

Table 1: Specification and Requirements (II)

Project Constraints

- Aside from the requirements outlined in Table 2 there are also other limitations for the project.
- Each station must draw an amount of power less than or equal to the power that each station can individually generate.
- Sensors with a relatively high degree of precision must be used to ensure that data is usable.
- Weather stations must be positioned such that they can communicate between each other through Bluetooth.
- Station must be able to endure typical outdoor weather conditions, including, but not limited to, rain, direct sunlight, cold weather, hot weather, wind, light hail.

Block Diagrams

Shown in **Figure 1** is the overall block diagram.The overall system consists of five subsystems logging, sensor, mechanical, communication, and power sub systems.

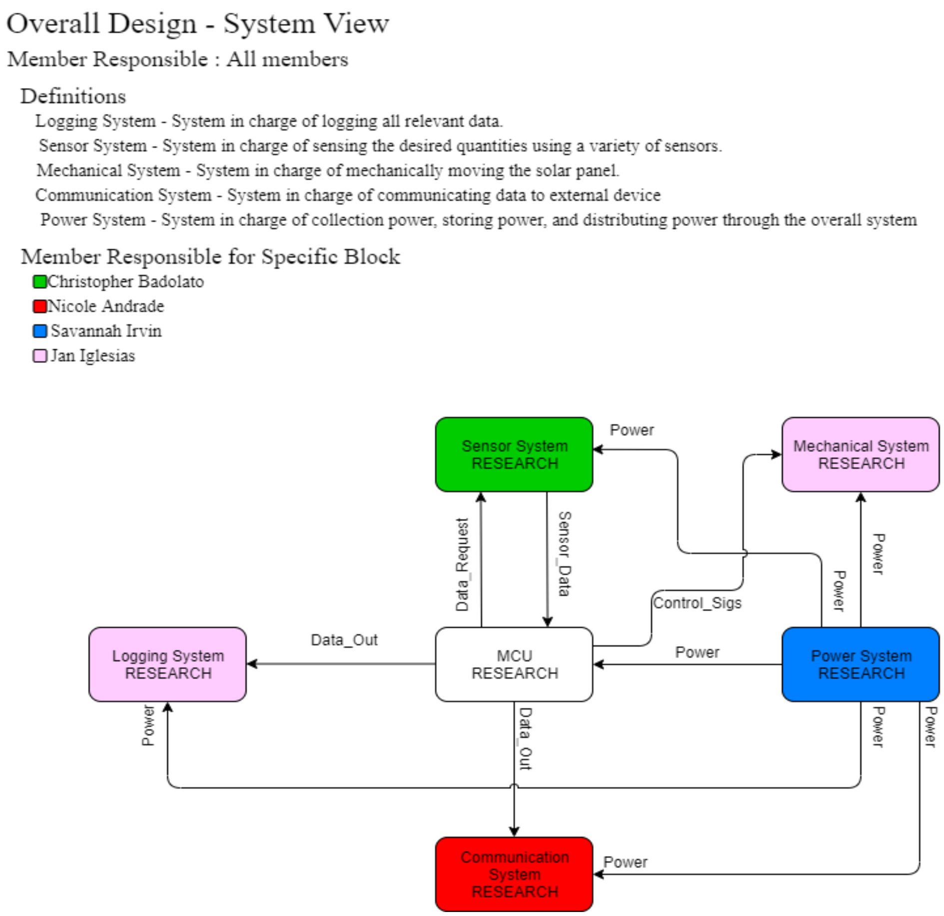


Figure 1: Overall Block Design

Shown in **Figure 2** is the sensor connection system. Each sensor has two lines, a serial data line (SDA) which sends data to or from the main processor and a serial clock (SCL) which ensures each sensor is synchronized with the master clock. Uart will be used to ensure the data from each sensor is reading correctly.

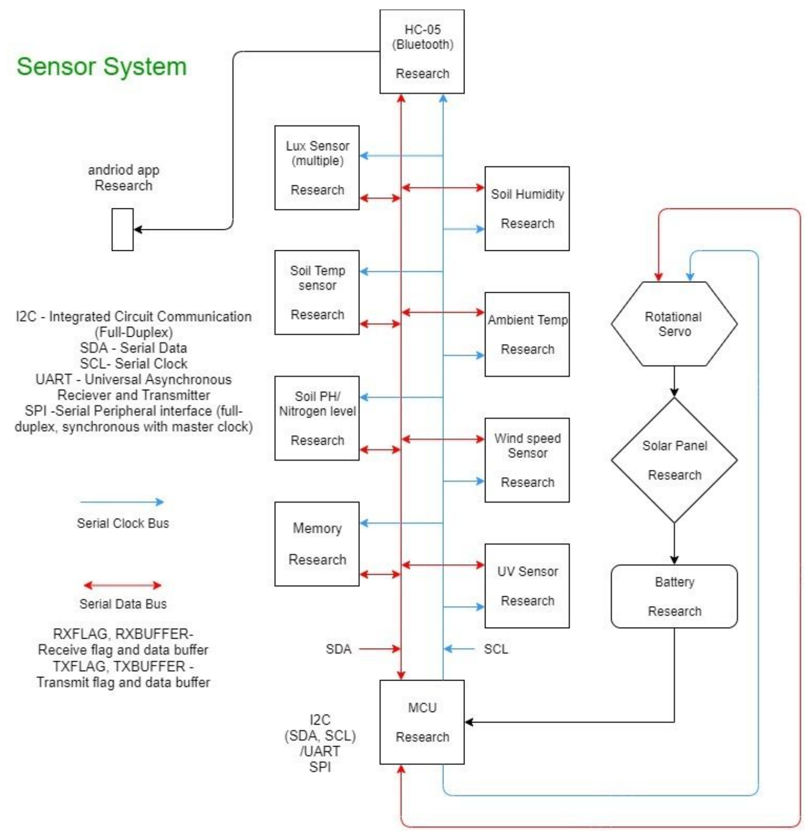


Figure 2: Sensor System Block Design

Shown in **Figure 3** is the logging system that will be implemented for this project. The logging system will be used to save measurements made by the sensor subsystem in local non-volatile memory.

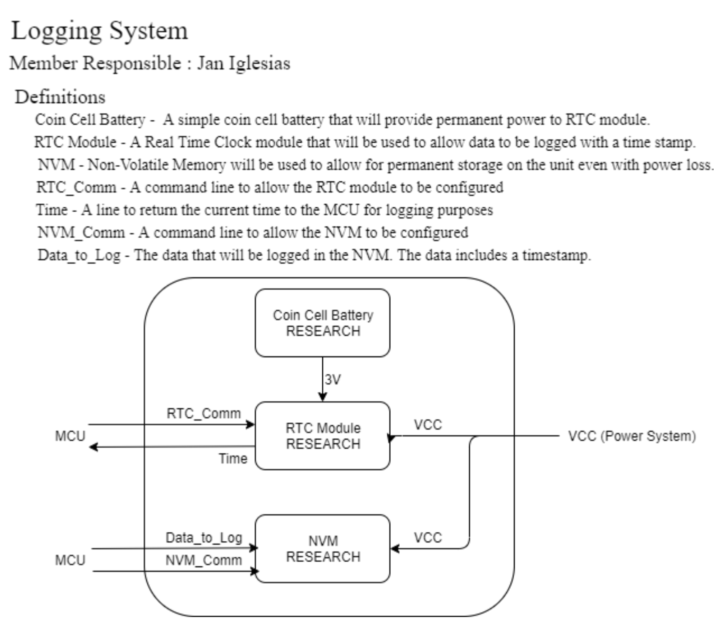


Figure 3: Logging System Block Design

Shown in **Figure 4** is the mechanical systems. This system is responsible for the structure of the weather station as well as the physical angling of the PV. The position and PV of the power will be inputs which allow the motor to change the position of the PV to azimuth.

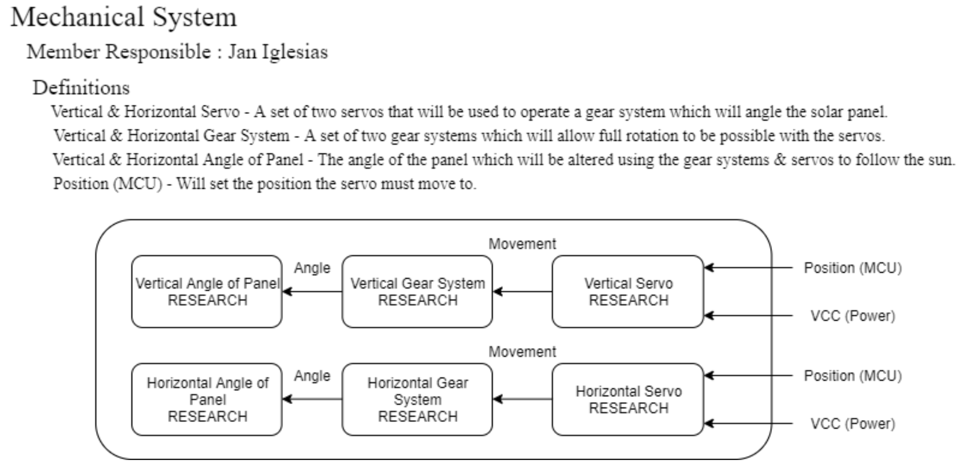


Figure 4: Mechanical System Block Design

Shown in **Figure 5** is the communication system. The communication system will consist of a display module and a Bluetooth module. The display module will receive data and commands from the MCU and will display output. The Bluetooth module will also receive data and commands from the MCU and will output data and commands.

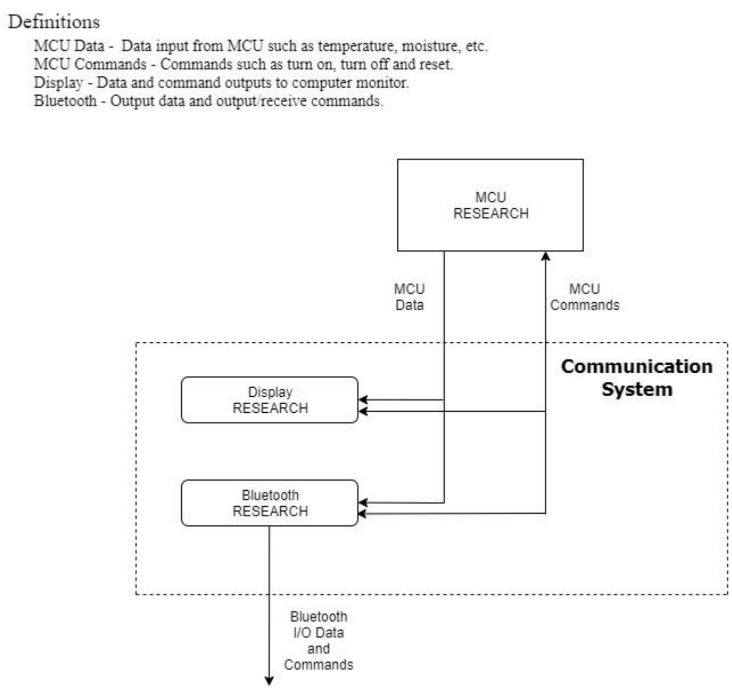


Figure 5: Communication System Block Design

Shown in **Figure 6** is the power system. The PV module will act as a current source when adequate sunlight is applied. A charge controller is needed to check if the battery can accept current, if it can the PV will charge the battery and then the battery will go through a voltage regulator to supply power to the weather station. If the battery is full the pV will go directly to the voltage regulator and supply the weather station.

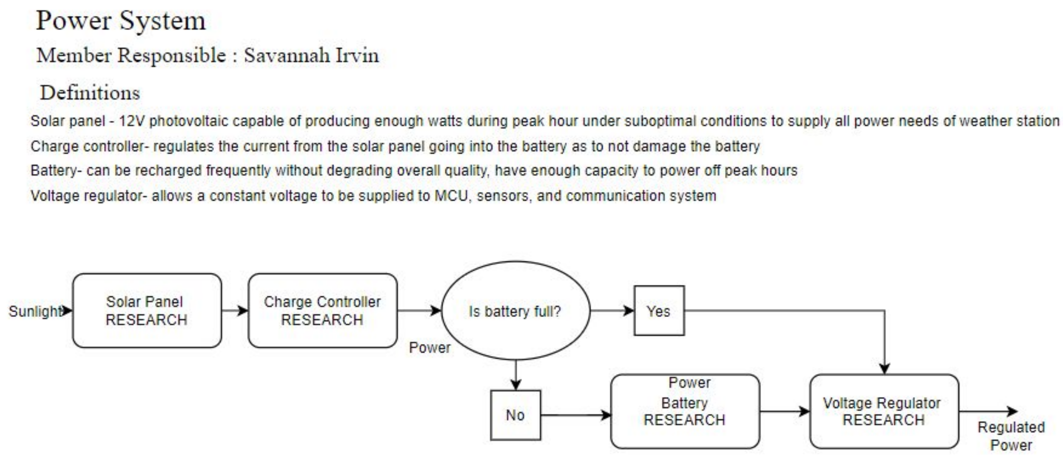


Figure 6: Power System Block Design

Shown in **Figure 7** is a software flow diagram. The MCU is in a waiting state until the data from the sensors is ready to be sent back to the MCU. Each minute the MCU will ask each sensor for the current data. If the data is legitimate the system will take appropriate action.

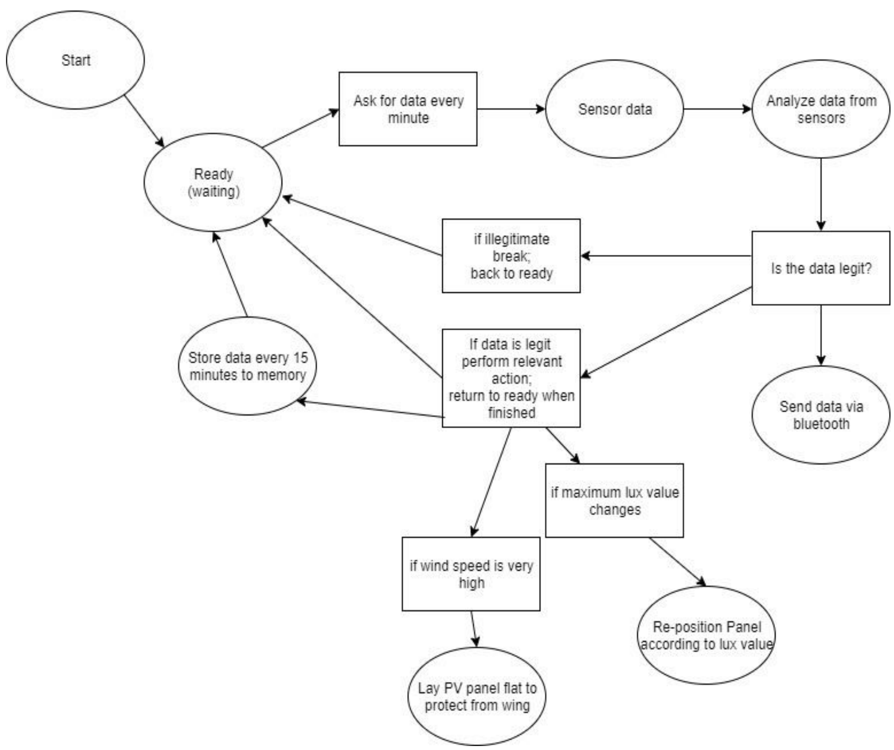


Figure 7: Software Flow Block Diagram

Estimated Project Budget

Component	Price	Status
An MCU which has I2C capabilities as well as SPI & UART.	~ $10 / IC	Research
Solar Panel (14.4 x 13.4 x 0.9 inch) (3.45 lb) (20W, 12V)	$30.50	Research
Rechargeable Lead Acid battery (12V 7A)	$20.97	Research
Solar charge controller	$11.99	Research
Adafruit lux sensor	$5.00 * 5 = $25	Research
UV sensor	$6.50	Research
Servo for angling the panel.	$20.00 * 2 = $40	Research
Building materials	$50.00	Research
Soil Sensor (moisture)	$7.50	Research
Wind Speed Sensor	$45.00	Research
AM2320 Digital Temp and Humidity	$3.95	Research
HC-05 (bluetooth)	$10.57	Research
WRL-13678 (dataSheet)	$6.95	Research
Misc costs	$100	Research
Tentative total:	$368.93	

Table 2: Budget and Parts

Financing

- This project will be entirely self-funded by its team.

Spring 2020 timeline: Senior Design I

Task	**Due Date**
Get project approval.	January 31st
Begin code design.	January 31st
Begin first draft of project design.	January 31st
Finalize parts list.	TBD
Begin basic PCB design.	TBD
Begin embedded/firmware development.	TBD
Order essential parts.	TBD
Build breadboard prototype.	TBD
Ensure functionality of prototype and perform design revisions as necessary.	TBD
Manufacture PCB.	TBD
Assemble the first PCB based prototype and test.	TBD
Ensure functionality of prototype and perform design revisions as necessary.	TBD

Table 3: Milestone Senior Design I

Fall 2020 timeline: Senior Design II

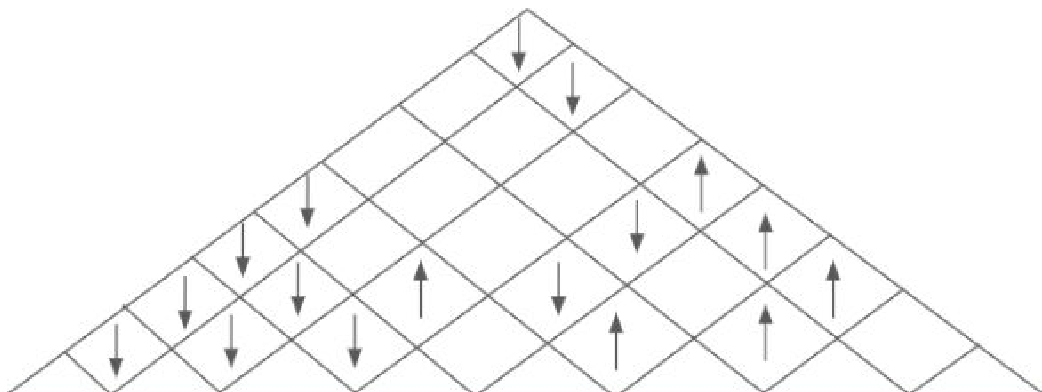
Task	**Due Date**
Make any PCB corrections or revisions.	TBD
Fix any remaining issues available.	TBD
Lock in scope of project as well as design.	TBD
Manufacture final PCB used for the project.	TBD

Table 4: Milestone Senior Design II (I)

Task	Due Date
Finalize code and code documentation.	TBD
Assemble the final project unit.	TBD
Test project unit and make any repairs or corrections as necessary.	TBD

Table 4: Milestone Senior Design II (II)

House of Quality



	Cost	Weight	Tracker torque	Battery Storage	High precision sensor	Data retrieval frequency	Status update interval	Solar output
Low cost	↑↑↑	↓↓↓	↓↓↓	↓↓↓	↓↓↓	-	-	↓↓↓
Easy reproduction	↑	-	-	-	↓↓	-	-	↓↓
Light weight	↓↓	↑↑↑	↑	↓↓↓	-	-	-	↓↓↓
Portable	↓↓↓	↑↑↑	-	↓↓↓	-	-	-	↓↓↓
Low Maintenance	↓↓↓	-	-	↑↑↑	↓	-	-	↑↑↑
Easy user Interface	↓	-	-	-	↑	↑↑↑	↑↑↑	-
Real time display	↓	-	-	-	↑↑	↑↑↑	↑↑↑	-
Targets for Engineering Requirements	<$1000	<30lb	>21 kg/cm	>60 Watts	5% error	<1 min	<5 mins	>100 Watts

Figure 8: House of Quality