Pest Alert

Group 22

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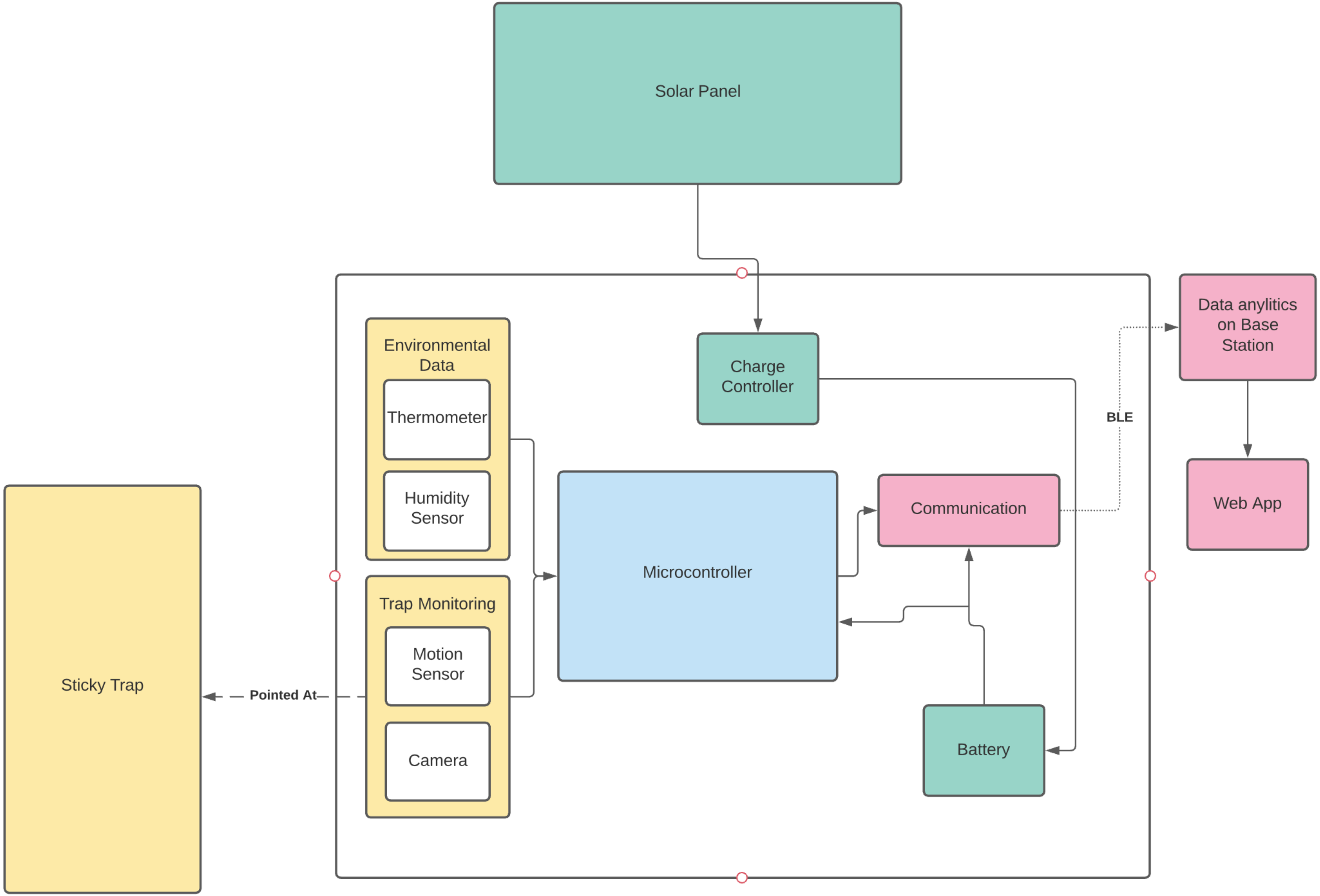
Problem Statement

According to the United Nations Food and Agriculture Organization, between 20 and 40 percent of food crops are lost each year to pests. Integrated Pest Management, or IPM, can help reduce this loss. One of the major problems facing IPM is that it requires a huge labor force to monitor pests.

Our system, Pest Alert, seeks to create an **automated**, **low cost**, **low power**, and **low maintenance** system for monitoring pests in comparison to its competitors. Our system will automatically notify farmers about possible infestations, as well as **managing its own power usage** with a solar panel and battery.


Solar Panel
Environmental Data
Thermometer
Humidity Sensor
Charge Controller
Data anylitics on Base Station
BLE
Web App
Microcontroller
Communication
Trap Monitoring
Motion Sensor
Camera
Sticky Trap
Pointed At
Battery

Competing Solutions - Microsoft/Azure Farm Beats

- Service that uses ML and AI to help farmers
- Uses data-driven techniques to increase agricultural productivity by enabling data collection from sensors, cameras, and drones.
- Weakness: Relies on a big battery or resort to minimal operation during night or extreme weather conditions such as snow and clouds. Farmbeats is also significantly more complex and requires users to have knowledge of Azure web services.

Competing Solutions - Rentokil Digital Pest Control

- Provide customers unrivaled pest data, insights and reporting to help proactively prevent, monitor and manage pests with efficiency and control.
- Uses infrared beams and sensor technology
- Insect light traps that use LED lighting rather than traditional fluorescent tubes, reducing energy uses by up to 70%
- This company focuses more on non-toxic solutions to pests rather than monitoring, whereas our solution is doing more by identifying pests and counting the total

Competing Solutions - Trap View

- This is an energy independent and weather resistant system with pheromone traps that send pictures of lured pests.
- All pictures from pest traps are gathered, processed and securely archived. The pests that are recognized are automatically marked.
- An application with powerful analytical tools allows you to efficiently monitor and successfully respond to the situation in the field.
- This product focuses on simplicity, while ours will also address cost and in turn power efficiency. It also uses pheromone traps which limits the pests.

System Specifications

- System must be operable in the range of 0ºC to 50ºC
- Sensors
  - Low powered camera to capture images of and identify number of pests on sticky trap (<5mW)
  - Motion detection determines beginning of system functionality in order to reduce power consumption
  - Temperature/Humidity sensors to collect surrounding environmental data and observe correlation between environment and pest accumulation
- Power
  - Battery life of 24 hours on full charge: Used to power sensors and should last at least 3 months (with charging) without any interference
  - Solar Panel: Recharge half of the battery with one day of sunlight
  - Reduce monitoring at night and operate in very low power mode by reducing overall operation because energy cannot be harvested in the dark
- Traps should be replaced every two months, when they are full, or when they lose their stickiness.
- Low power communication between sensors and server using Bluetooth Low Energy (<100mW)

Software Design

TensorFlow

MySQL™

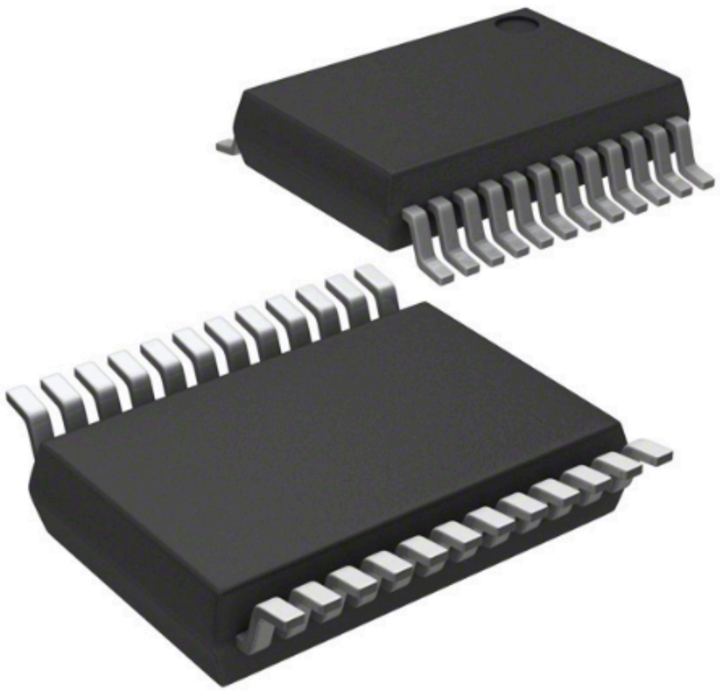
- Web Application Running on Base station
- TensorFlow Lite using IP102 dataset
- MYSQL Database
- Possible User Interface -->
  - Sending sensor data to Base station over BLE
    - Click on desired sensor name
    - Real time sensor data shown
    - Click and data will be sent to server
  - Notifying user when pest count goes over threshold
  - Showcasing images taken from camera

Data Requirements

- Collecting/Storing/Testing Data
  - Temperature
  - Humidity
  - Number of pests
  - Type of pests
- TensorFlow Lite
  - IP102 dataset for training
    - https://github.com/xpwu95/IP102

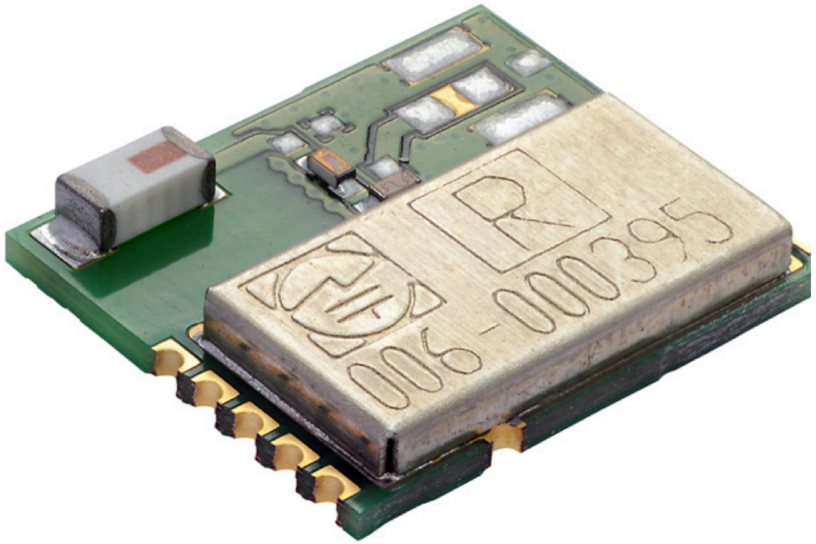
Significant Custom Hardware Design

- Low power microcontroller
  - Microchip SAM L10: ATSAML10D16A-YF
- BLE
  - SPBTLE-RF
- Sensors
  - Temperature: TMP36
  - Humidity: SHTC3
  - Motion Detector: IRA-S210ST01
  - Camera: Arducam 2MP Plus OV2640
  - Solar Panel: Seeed 313070004, 1W Solar Panel
- Rechargeable Battery: 18650 cell @ 2500mAh
- Charge IC: TI BQ2057CSNTR



Low Power Microcontroller

- Microchip SAM L10: ATSAML10D16A-YF
  - 32MHz CPU
  - 64k Flash Memory
- 32-Bit Ultra Low Power Cortex M23 CPU (consumes approx. 2.64 mW)
- 25 uA/MHZ current usage when active, .5uA total when asleep
- SAMl10/11 Evaluation Board for MDR: DM320204

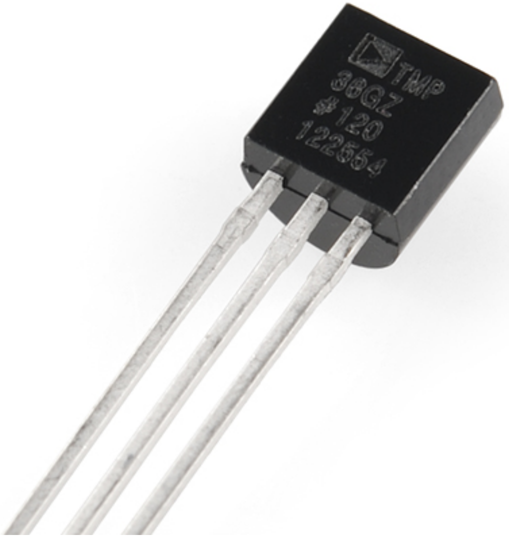


BLE Radio

- Communicates Via SPI
- SPBTLE-RF
- 2 uA standby current
- Max Current 7.1 mA
- +4dBm transmitting power

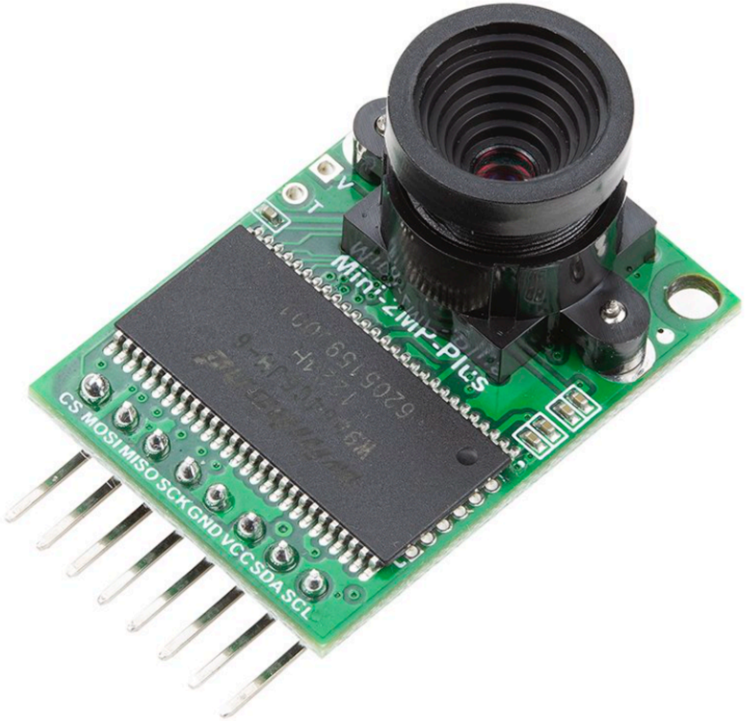
Humidity Sensors

- SHTC3
  - Analog Value Between 20% and 70% of Supply Voltage
  - Maximum power consumed: 3.24 mW
  - Typical accuracy: ±2% in Relative Humidity



Temperature Sensor

- TMP36
  - Analog Value between 0v and Supply Voltage
  - Maximum power consumed: 0.3 mW
  - Typical accuracy: ±2°C in temperature
  - Operates in −40°C to +125°C temp

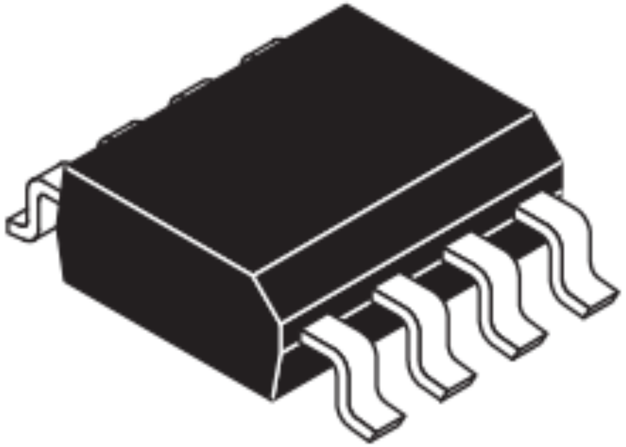


Camera

- Arducam 2MP Plus OV2640
- Maximum power consumed:350 mW
- Low Power Mode: 100mW
- 2MP resolution

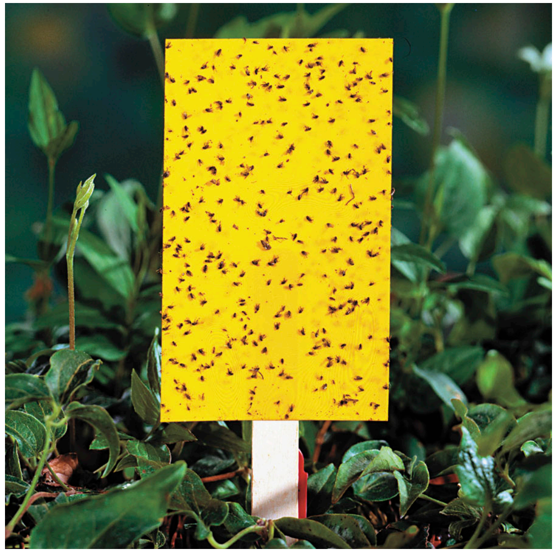
Motion Sensor

- IRA-S210ST01
  - Outputs Analog value between .2v and 1.5v
  - Maximum power consumed: 0.8 mW
  - Horizontal detection area:
    - 10.8 meters
    - 70°
  - Vertical detection area:
    - 5 meters
    - 84°



Charging IC

- TI BQ2057CSNTR
  - Maximum power consumed: 300 mW
  - 4.2v cell voltage
  - Low power Sleep mode
  - Automatic Battery-Recharge Feature



Sticky Trap

- Can last up to 2 months without needing to be changed
- Does not target a specific pest
  - Although it can be put into a pheromone trap if the user wants

Solar Panel and Battery Sizing

Max Possible Power Use: approx. 400mW

Max Possible Energy Use Daily: 24hrs * 400mW = 9.6 Wh/day

The battery needs to be able to run without a solar power for one day, so we need a 9.6Wh battery.

This means for the battery we can use a single 18650 cell, rated at 3.7V and 2500mAh, because it can supply absolute maximum power for one day.

Assuming that the maximum power will not be reached due to the low power design of our system. We can use a 1W solar panel since it can supply enough power for the battery to almost fully recharge daily.

Cost Estimate

Component	Price($)
Microcontroller	2.13
BLE Radio	10.45
Humidity Sensor	1.50
Temperature Sensor	2.98
Camera	9.95
Motion Sensor	3.12
Charging IC	2
Battery	5
Solar Panel	4
Sticky Traps	9.99
Total Cost of Major Assembly Components	51.12
SAM L10 Development Board	60
Total Cost	111.12

Team Responsibilities

- Team Coordinator: Madelyn Wright
- Cost Lead: Angela Wong
- Altium Lead: Owen Boucher

Team Roles

- Communication, PCB, and Data Visualization: Owen Boucher
- Pest Monitoring/Environmental Sensors : Aisha Ben-Neticha
- Data Processing and Conditioning: Angela Wong
- Energy Management: Madelyn Wright

Proposed MDR Deliverables

Owen:

- BLE Communication established
- Framework of visual representation

Aisha:

- Temperature, humidity, and motion detecting sensors configured and functioning (w/ 70% accuracy)
- Camera is configured; can capture images when motion sensor is triggered

Angela:

- Database configured, data conditioning is successful
- 70% accuracy in bug detection

Madelyn:

- Connection between solar panel and battery made
- Code configured to operate in low power modes
- Panel can successfully supply power to sensors

Gantt Chart

Date Start 9/21/20

TASK	START	END	TEAM MEMBER	Week 1 Sept 21-27	Week 2 Sept 28-Oct 4	Week 3 Oct 5-Oct 11	Week 4 Oct 12-Oct 18	Week 5 Oct 19-Oct 25	Week 6 Oct 26-Nov 1	Week 7 Nov 2 - Nov 8	Week 8 Nov 9 - Nov 15	Week 9 Nov 16 - Nov 22
Phase 1												
PDR Week	21-Sep	25-Sep	ALL									
Research/Order Parts	21-Sep	4-Oct	ALL									
Configure Sensors	4-Oct	18-Oct	Aisha									
Checkin #3	19-Oct	22-Oct	ALL									
Set up communication	19-Oct	31-Oct	Owen									
Solar Panel + Batteries	19-Oct	31-Oct	Madelyn									
Low Power Operations	19-Oct	1-Nov	Madelyn									
Testing Computation	1-Nov	15-Nov	ALL									
Build prototype	4-Oct	12-Nov	ALL									
Develop mobile app	12-Oct	12-Nov	Angela									
Mobile User Interface	12-Oct	18-Oct	Angela									
Checkin #4	9-Nov	12-Nov	ALL									
MDR Week	16-Nov	20-Nov	ALL									

Questions?