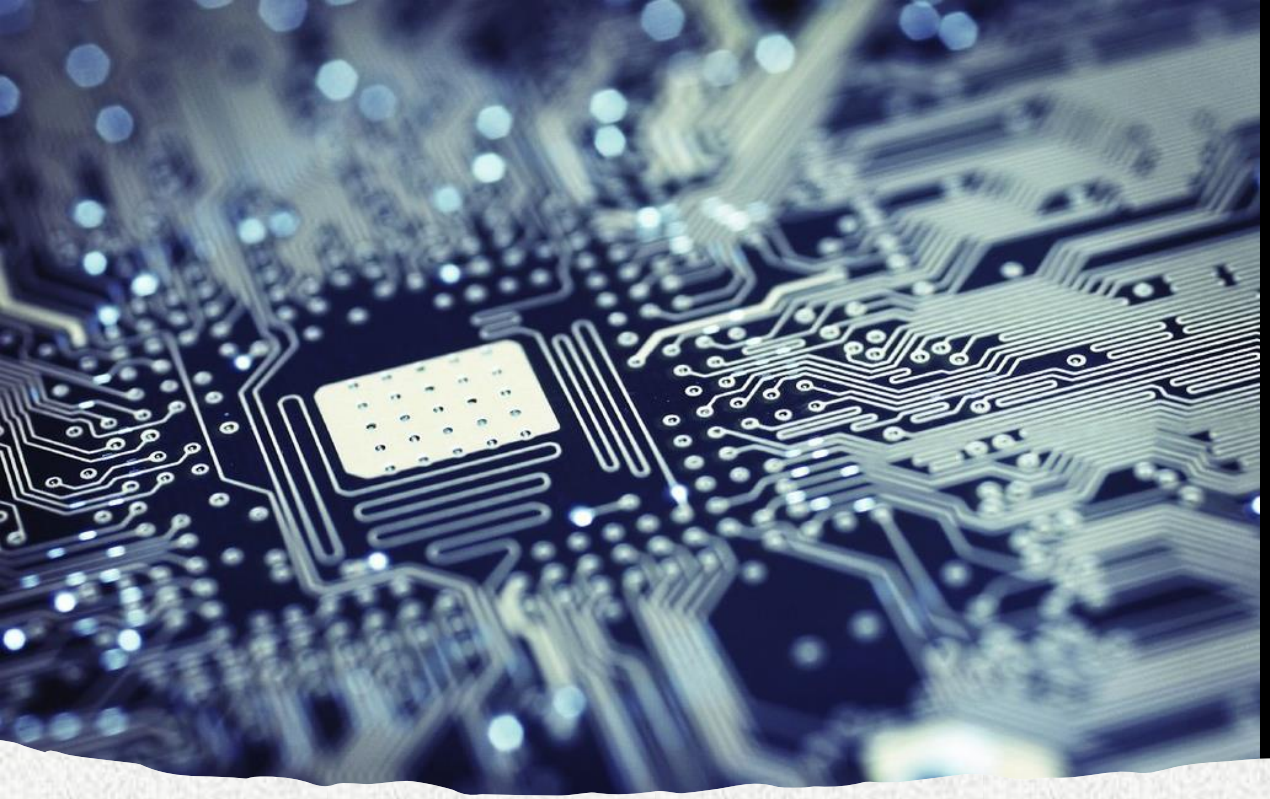


Wireless Microclimate System for Agrivoltaics

By: Da Boyz

Team – Da Boyz

Team Members

- Alex Campbell – campb4ja@mail.uc.edu
- Anthony Napolitano – napoliaj@mail.uc.edu
- Rose Saalman – saalmark@mail.uc.edu
- Keith Springs – springkh@mail.uc.edu
- Yulia Martinez – martinyg@mail.uc.edu
- Will Hopkins – hopkinwe@mail.uc.edu

Advisors

- Dr. Mohsen Rezayat – mohsen.rezayat@omid-usa.org
- Dr. Je-Hyeong Bahk – bahkjg@ucmail.uc.edu

Project Abstract

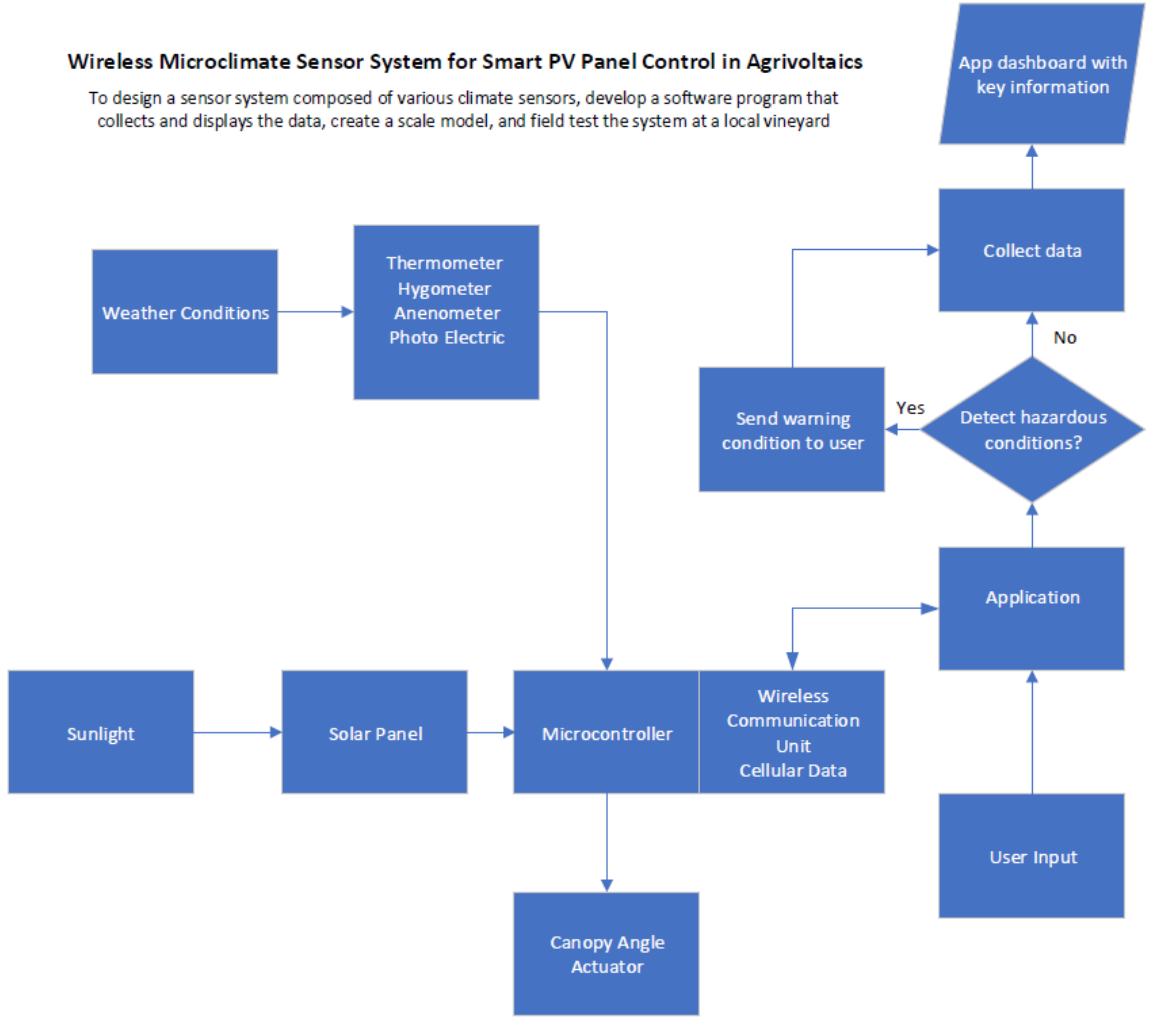
In this project, we will develop a wireless microclimate sensor system that is capable of sensing local climate components such as air temperature, humidity, light intensity, and wind at an agricultural site as well as the soil conditions such as soil temperature and moisture level. These sensing data will be collected remotely into an application, made accessible to the user, and will be used to make automatic decisions on the adjustment of the PV panel angle and other operations. Some extreme weather events such as hails may not be easily detected or predicted from the microclimate sensing; these will instead be reported from public alert sources.

User Stories & Design Diagram

As an App User, I want to track the weather and environmental hazards and automatically receive notifications from the app when conditions become hazardous for the plants, so that I can plan in advanced ways to protect them.

As an App User, I want to monitor real-time graphs of sensor data from the fields through a dashboard, so that I can track weather and growth patterns of the plants.

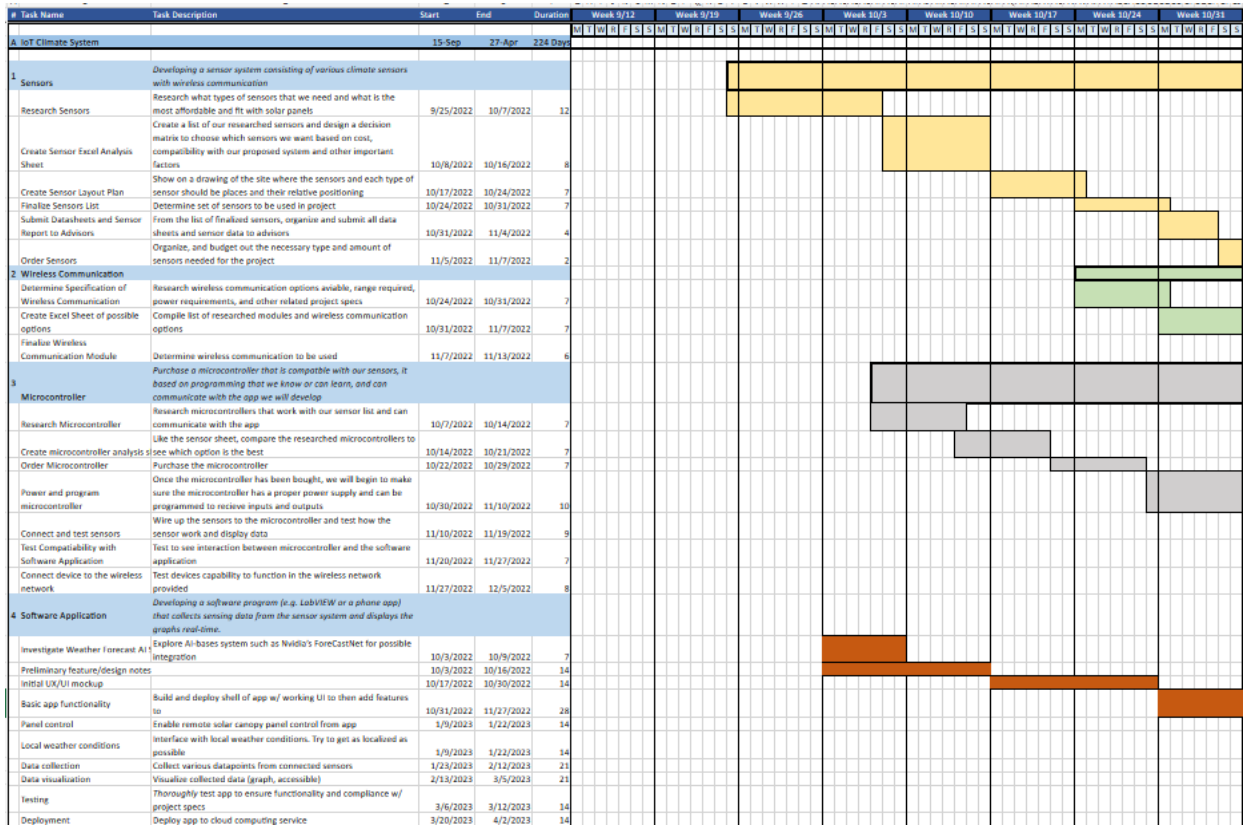
As an App User, I want to control the angle of the solar panels in the canopy, so that I provide optimal conditions to the plants below while continuing to produce solar energy in the canopy above.



Major Project Constraints

- Economic
  - $3,250 budget
  - Purchase of microcontroller, sensors, wireless communication components
  - Cloud hosting costs
- Social
  - Generalizing use for potential application around the globe
- Environmental
  - Physical location of the vineyard
  - Difficult to accurately report localized extreme weather conditions
- Security
  - Authentication

Review of Project Progress

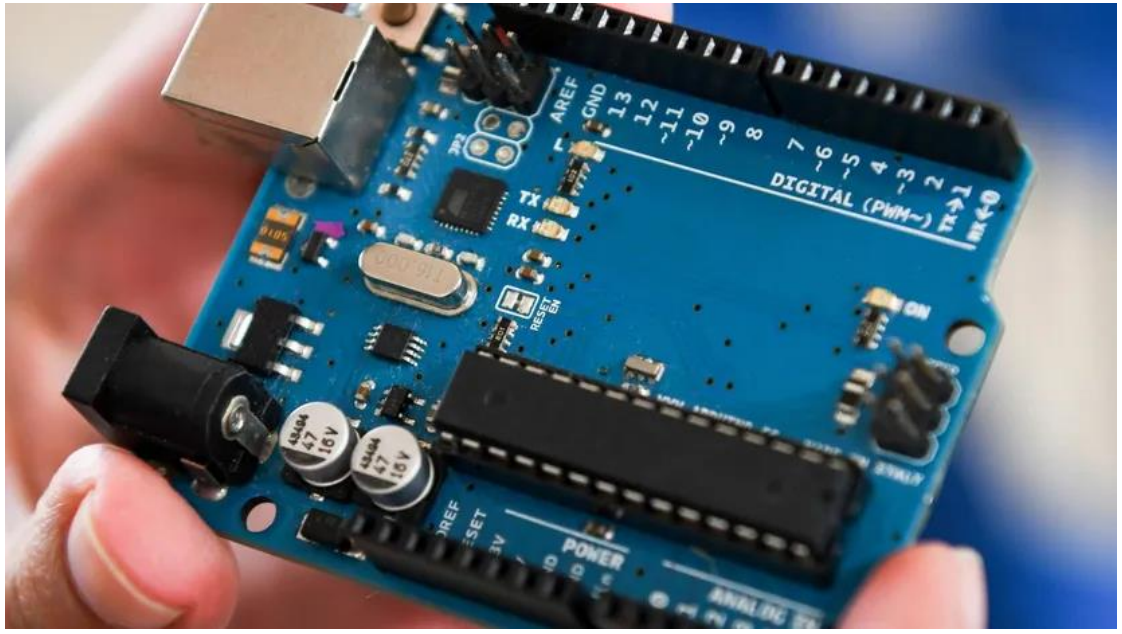


#	Task Name	Task Description	Start	End	Duration
0					
4	IoT Climate System		15-Sep	27-Apr	224 Days
1	Sensors	*Developing a sensor system consisting of various climate sensors with wireless communication*			
	Research Sensors	Research what types of sensors that we need and what is the most affordable and fit with solar panels	9/25/2022	10/7/2022	12
	Create Sensor Excel Analysis Sheet	Create a list of our researched sensors and design a decision matrix to choose which sensors we want based on cost, compatibility with our proposed system and other important factors	10/8/2022	10/16/2022	8
	Create Sensor Layout Plan	Show on a drawing of the site where the sensors and each type of sensor should be places and their relative positioning	10/17/2022	10/24/2022	7
	Finalize Sensors List	Determine set of sensors to be used in project	10/24/2022	10/31/2022	7
	Submit Datasheets and Sensor Report to Advisors	From the list of finalized sensors, organize and submit all data sheets and sensor data to advisors	10/31/2022	11/4/2022	4
	Order Sensors	Organize, and budget out the necessary type and amount of sensors needed for the project	11/5/2022	11/7/2022	2
2	Wireless Communication				
	Determine Specification of Wireless Communication	Research wireless communication options aviable, range required, power requirements, and other related project specs	10/24/2022	10/31/2022	7
	Create Excel Sheet of possible options	Compile list of researched modules and wireless communication options	10/31/2022	11/7/2022	7
	Finalize Wireless Communication Module	Determine wireless communication to be used	11/7/2022	11/13/2022	6
3	Microcontroller	*Purchase a microcontroller that is compatible with our sensors, it based on programming that we know or can learn, and can communicate with the app we will develop*			
	Research Microcontroller	Research microcontrollers that work with our sensor list and can communicate with the app	10/7/2022	10/14/2022	7
	Create microcontroller analysis s	Like the sensor sheet, compare the researched microcontrollers to see which option is the best	10/14/2022	10/21/2022	7
	Order Microcontroller	Purchase the microcontroller	10/22/2022	10/29/2022	7
	Power and program microcontroller	Once the microcontroller has been bought, we will begin to make sure the microcontroller has a proper power supply and can be programmed to recieve inputs and outputs	10/30/2022	11/10/2022	10
	Connect and test sensors	Wire up the sensors to the microcontroller and test how the sensor work and display data	11/10/2022	11/19/2022	9
	Test Compatiability with Software Application	Test to see interaction between microcontroller and the software application	11/20/2022	11/27/2022	7
	Connect device to the wireless network	Test devices capability to function in the wireless network provided	11/27/2022	12/5/2022	8
4	Software Application	*Developing a software program (e.g. LabVIEW or a phone app) that collects sensing data from the sensor system and displays the graphs real-time.*			
	Investigate Weather Forecast AI	Explore AI-bases system such as Nvidia's ForeCastNet for possible integration	10/3/2022	10/9/2022	7
	Preliminary feature/design notes		10/3/2022	10/16/2022	14
	Initial UX/UI mockup		10/17/2022	10/30/2022	14
	Basic app functionality	Build and deploy shell of app w/ working UI to then add features to	10/31/2022	11/27/2022	28
	Panel control	Enable remote solar canopy panel control from app	1/9/2023	1/22/2023	14
	Local weather conditions	Interface with local weather conditions. Try to get as localized as possible	1/9/2023	1/22/2023	14
	Data collection	Collect various datapoints from connected sensors	1/23/2023	2/12/2023	21
	Data visualization	Visualize collected data (graph, accessible)	2/13/2023	3/5/2023	21
	Testing	*Thoroughly test app to ensure functionality and compliance w/* project specs	3/6/2023	3/12/2023	14
	Deployment	Deploy app to cloud computing service	3/20/2023	4/2/2023	14

- Choosing hardware
  - Microcontroller, sensors, wireless communication
- Application Mockups
- Collaborate with Environmental Engineers team with solar canopy

Expected Accomplishments by End of Fall

- Analyze sensor list and order them
- Create microcontroller list and analyze which one we want and order one
- Design how to do wireless communication with the app whether cellular or Wi-Fi
- Application mockups and early application prototype



Division of Work

Electrical Engineering (2):

Develop a sensor system consisting of various climate sensors with wireless communication

Sensors
- Determine type of sensors needed
- Determine range, position, and power requirements of sensor

Power
- Coordinate with Solar Team to determine power requirements

Computer Engineering (2):

Develop a sensor system consisting of various climate sensors with wireless communication

Microcontroller
- Determine appropriate controller based on number of sensors, wireless communication, power constraints

Wireless Communication
- Integrate communication between software application and microcontrollers
- Determine appropriate Wireless Communication protocols and modules based on constraints

Computer Science (2):

Develop a software program that collects sensing data from the sensor system and displays the graphs real-time.

Work included in Software Application:
- Panel control
- Interface with local weather conditions
- Weather forecast system
- Data collection
- Data visualization
- Software Testing
- Deployment to AWS

Expected Demo at the Expo

- A scale model of the PV panel and angle controller that can be operated remotely by the software program.
- Application complete with User Interface and functionality
- Data from on-site testing

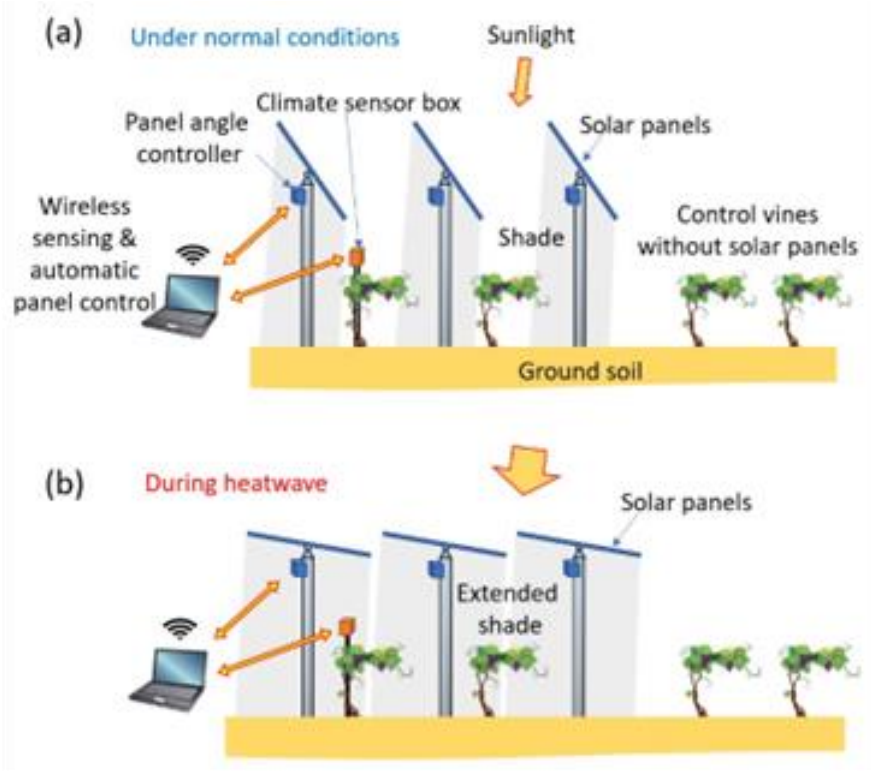


Fig. 1. Illustration of the agrivoltaic system at a small vineyard with smart panel control and climate monitoring system