

netLabs!UG Internship 2023

Capstone Project

July 31st, 2023

Introduction

netLabs!UG has been engaged by Precision AgriTech, a forward-thinking farm to develop a cutting-edge Smart Irrigation System. The farm is committed to sustainable agriculture and aims to optimize water usage, increase crop yield, and reduce operational costs. To achieve these objectives, you are tasked to design an advanced system integrating an ESP32 microcontroller board, soil moisture, temperature, and light intensity sensors, Machine Learning (ML) algorithms, a web application for real-time visualizations, Bluetooth for remote control, and actuators.

Part 1: Embedded System Design

With the knowledge obtained from the embedded systems module, you will set up a Microcontroller circuit using the following key components:

- *ESP32 Development Board*
- *Resistive Soil Moisture Sensor Module*
- *Submersible Digital Temperature Sensor*
- *LDR Light Dependent Resistor GL5506*
- *20x4 Display LCD Module*
- *Water Pump*

Sensor and Actuator Interfacing:

You will configure the ESP32 microcontroller board, to collect soil moisture, temperature and light intensity readings using Resistive Soil Moisture Sensor Module, Submersible Digital Temperature Sensor and LDR Light Dependent Resistor GL5506 respectively. The incoming sensor readings should be displayed on a 20x4 Display LCD Module and a water pump should be configured for actuation purposes.



ESP32



Soil Moisture
Sensor



Submersible
Digital
Temperature
Sensor



Cloud Data Logging and Autonomous Irrigation:

You will set up communication with a real-time database e.g. Firebase to log sensor data and develop logic on the ESP32 to autonomously control the actuators (water pump and irrigation valves) based on the ML model's irrigation predictions.

Remote Control:

You will implement Bluetooth communication on the ESP32 to enable remote control capabilities and allow authorized users to adjust irrigation schedules and settings via Bluetooth-enabled devices.

Deliverables

1. A microcontroller based system
 - Collecting soil moisture, temperature and light intensity readings
 - Logging sensor readings to a real-time database
 - Autonomously controlling irrigation based on ML model's predictions and authorized users' triggers.

Part 2: Machine Learning Model Development

With the knowledge acquired from the Python module, you are required to develop an ML model to predict optimal irrigation timings using a custom dataset that will be provided.

Data Preprocessing and Feature Selection:

You will be required to process the provided dataset, ensuring data integrity and handling any missing values or outliers as well as select relevant features for ML model training.

Model Training:

You will be required to train an ML model to predict optimal irrigation timings based on historical sensor data and crop requirements.

Model Integration and Deployment:

You will be required to convert the trained ML model to a format compatible with the ESP32 and deploy it on the ESP32 to enable on-device predictions.

Deliverables:

1. You will be required to develop an ML model to predict optimal irrigation timings
2. You will be required to deploy the trained model on the ESP32 for on-device predictions.

Part 3: Web Application

With the knowledge obtained from the Python module, you are required to develop a web application using the Flask framework.

Real-Time Visualization and ML Model Deployment:

You will be required to develop a user-friendly web application and implement functionalities to visualize real-time sensor data and ML model predictions on the web application. The developed ML model should also alternatively be deployed on the web application.

User Authentication and Authorization:

You will be required to implement secure user authentication and authorization mechanisms to ensure only authorized users can access the web application.

Data Interaction with Real-Time Database:

The web application should be integrated with the real-time database to fetch and display the latest sensor data and ML model predictions.

Responsive Design and User Experience:

The web application should have a responsive layout to ensure compatibility with various devices (e.g., smartphones, tablets, and computers) and should have an optimized user interface for a seamless and intuitive user experience.

Deliverables

1. A responsive and secure web application
 - Housing the trained ML model
 - Providing real-time visualizations of sensor data and ML model predictions.

General Project Guidelines:

- You are expected to have a MOCK presentation of the project on 16th August 2023, and the final presentation will be 18th August 2023.
- Follow the appropriate principles that govern project management to accomplish the project objectives in the set timelines.