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TOPIC PRESENTATION

Topic No. 1

I. General Subject Area

IoT-based Smart Plant Monitoring

II. Specific Topic

The Development of Cropify: IoT-Based Smart Plant Monitoring with Wi-Fi Module for Sanctuario Nature Farms.

III. Specifics of Research

A. Introduction

Technological innovation greatly shaped the agricultural field throughout time. It innovates the traditional practices of agriculture. One of these innovations is smart plant monitoring using the Internet of Things. The Internet of Things (IoT) refers to the physical objects or things that are set with sensors, software, and hardware that are interconnected to each other and communicate through the Internet, enabling them to send and receive data. In fact, according to Lewis (2024), the use of IoT in smart plant monitoring involves combining connected devices and sensors. These include the soil moisture, temperature, and humidity sensors. Smart Plant Monitoring is designed to monitor the crops by collecting data. The sensor gives and provides the real-time environmental status of the plants such as if the soil is extremely dry or wet or if the temperature and humidity are high or low, alerting the farmers if any issues are detected with the functionality of an alert notification that notifies users on their phones. These enable the farmers to make decisions and take actions regarding the information they get.

The Arduino platform is used to implement smart plant monitoring. The Arduino is an open-source electronics platform that is built on hardware, such as the microcontroller boards, and a software known as the Arduino Integrated Development Environment or Arduino IDE. The Arduino IDE is used to write codes and upload programs to a microcontroller board. The researchers will use Arduino IDE to program into the ESP32 microcontroller. The ESP32 microcontroller will act as the brain of the prototype, in this way, it can interact with the sensors and process data. In addition, the ESP32 microcontroller has built-in Wi-Fi and Bluetooth capabilities. With the use of Wi-Fi connectivity, the ESP32 establishes a connection to a Wi-Fi network and sends the collected data to Firebase in real-time. To provide a user interface for the user to monitor the crops, the researcher will use the Android Studio and flutter as a framework to develop an Android mobile application, using the Dart programming language.

B. Background of the Study

The Sanctuario Nature Farms was established by people who share the same passion for the environment and healthy living. It is located at Sitio Italaro, Brgy. Kayquit, Indang, Cavite. The Sanctuario Nature Farms was registered as a non-stock and a non-profit corporation. They are dedicated to natural farming and their main crop is Lettuce and a vast assortment of medical and culinary herbs. The Sanctuario Nature Farms' vision is to develop techno-centric organic farms that focus on finding new technologies and economical ways of farming. Its mission is to see a healthier Philippines by increasing awareness of the benefits of organic products through training and education of individuals in the area of scientific and modern organic farming.

The Sanctuario Nature Farms currently relies on manual drip irrigation to water the crops, placing the tubes with emitters above the soil and the emitters slowly drip water into the soil directly in the plant's roots. When it comes to monitoring, they depend on the weather station and manually observe the crops to monitor them. With this current kind of method, the Sanctuario Nature Farms still faces some challenges. Some of the drip lines are broken causing leakage or blockage of water, which leaves farmers unaware, distributes water unevenly, and worse, the water doesn’t reach certain crops—also relying on weather stations that provide environmental data covering a large area where it can’t monitor the crops individually. While manually observing the crops requires a lot of labor from the farmers. Lastly, due to Climate Change recently, the Sanctuario Nature Farms is facing a challenge to understand what is happening to their crops, some of their crops just die and they are left clueless as to the reason behind it.

Recognizing the challenges that Sanctuario Nature Farms faces when it comes to monitoring its crops, the researchers came up with a study entitled “The Development of Cropify: IoT-based Smart Plant Monitoring with Wi-Fi Module for Sanctuario Nature Farms”. It aims to monitor the environmental status of the crops, allow the user to be notified early if any issues are detected and take action immediately, reduce crop losses, prevent the farmer salary deductions, and lessen the labor on the farms. Also, the researchers aim to promote technology and use it as a support tool in the agricultural industry.

C. Research Description

The general objective is to construct a prototype called “The Development of Cropify: IoT-based Smart Plant Monitoring with Wi-Fi Module for Sanctuario Nature Farms”. It aims to monitor and notify regarding the environmental status of the Sanctuario Nature Farms’ crops.

Specifically, it aims to:

1. Identify the needed requirements through observations and interviews with the Sanctuario Nature Farms’ staff.

2. Analyze the problem through the use of the fishbone diagram to distinguish its cause and effect, conceptual model of the study, theoretical diagram, context diagram, and use-case diagram.

3. Design and develop a prototype entitled “The Development of Cropify: IoT-based Smart Plant Monitoring with Wi-Fi Module for Sanctuario Nature Farms” which will be capable of:

a. Detecting the soil moisture, temperature, and humidity

b. Monitoring real-time data provided by the sensors via mobile phone with Wi-Fi.

c. Providing an alert notification based on the standard range given for the sensors.

d. Providing a setting where the user can select a specific crop to monitor.

4. Test the performance of the system using unit testing, integration testing, and device testing;

5. Evaluate the system if it complies with the ISO 25010 standards.

6. Implement the study to the organization by providing a letter to be handed over to the manager of the Sanctuario Nature Farms after the prototype is built and ready.

- **Manageability (Scope and Limitations)**

The study focuses on the Development of an IoT-based Smart Plant Monitoring and Notification System with a Wi-Fi Module for Sanctuario Nature Farms.

The study provides two (2) levels of access which are the Administrator and Users (Plot Assigned Farmer),

Administrator

The Administrator is responsible for managing the farmer account, such as creating a username and password for the user and deleting an account. The administrator can gain access to the mobile application by obtaining the provided QR code and logging in with the provided google account of Sanctuario Nature Farms, so it can retrieve if the administrator forgot password. They can also monitor the real-time status of crops such as the soil moisture, temperature, and humidity.

User

The User (Plot Assigned Farmer) can monitor and receive notifications regarding the real-time status of crops such as the soil moisture, temperature, and humidity. The user can gain access to the mobile application by obtaining the provided QR code and logging in using the administrator's provided username and password.

The System consists of a different Module which are the Hardware Module, Wi-Fi Module, Notification Module, Settings Module, and User Guidance Module.

Hardware Module

The prototype will use sensors such as soil moisture, temperature, and humidity sensors. These sensors provide data regarding the crop’s environmental status. The soil sensor measures the soil moisture level, the temperature sensor measures whether the surrounding area is extremely hot or cold, and the humidity sensor is used to measure the amount of moisture in the air, identifying whether the soil has high or low humidity. These sensors provide data that can be used to display the real-time status of the environment of the crops.

Wi-Fi Module

The Arduino IDE is programmed to the ESP32 microcontroller. The ESP32 provides Wi-Fi connectivity, enabling real-time data to be sent to the Firebase. The Firebase stores and retrieves the data. To display these collected data, the flutter framework is used to provide a user interface for the user to monitor the real-time status of soil moisture, temperature, and humidity on their mobile phone if the Wi-Fi is turned on.

Notification Module

The Notification Module can able to alert the user about the certain status of the crops. Notification will be sent to the user’s mobile phone if any issue is detected such as if the soil is excessively dry or wet or if the temperature and humidity are high or low.

Settings Module

The settings module allows the user to select which type of crops they want to monitor. The user can only choose from Five Common Crops of the Sanctuario Nature Farms which are Lettuce, Bukchoy, Cucumber, Tomato, and Eggplant. This provides the user an option to customize monitoring based on their selected crops such as the specific soil moisture, temperature, and humidity requirements level.

User Guidance Module

The User Guide Module provides the user a helpful assistance in using the Smart Plant Monitoring. It contains Helper message, In-app instructions, FAQ section, and Contact details of the developers. The Helper message display a certain message in monitoring page, it will display a certain conditions if the plants needs water or overwatered or displays disconnection. The In-app instruction provides information to the user on the steps on how to use the Smart Plant Monitoring. The FAQ section assesses the users to address common questions and provide a quick solution. Lastly, the Contact details allow the user to reach out to the developers to seek assistance and feedback.

However, despite its functionalities, the prototype faces limitations, such as it is only available to android and it is Wi-Fi dependent. When the Wi-Fi is turned off, the user cannot see the real-time status of soil moisture, temperature, and humidity. The prototype is specifically designed only for Five Common Crops of the Sanctuario Nature Farms, it can only monitor a one 14 meters plot, can’t irrigate the crops automatically, the one soil moisture sensor can’t detect longer ranges, and also the prototype cannot store the previous records and reports of the environmental status of the crops. And there are no special indicators specific to the plant such as pH or nutrients.

- **Importance of the Study**

This study aims to construct a prototype called “The Development of Cropify: IoT-based Smart Plant Monitoring with Wi-Fi Module for Sanctuario Nature Farms” to monitor and notify regarding the environmental status of the Sanctuario Nature Farms’ crops.

The implementation of this study will be deemed important to the following:

Sanctuario Nature Farms Workers

The Sanctuario Nature Farms workers will gain benefits from this research. It will lessen their workload, prevent the deduction of salary, and allow them to do other important tasks on the farms. In addition, with the use of smart plant monitoring, they can monitor and respond quickly to take care of the plants they need which will make their work efficient.

Researchers

Developing a smart plant monitoring system can bring an opportunity to enhance the researchers' technical and soft skills that they can apply in their future careers in the development, engineering, automation, robotics, and agricultural industries.

Future Researchers

The documentation of this study can serve as a valuable reference and broaden or enhance the study.

- **Research Design**

The researchers will use a prototyping approach consisting of cycles of the requirements gathering, design, building a prototype, evaluate, refining the prototype, testing, validation, and implementation. In requirement gathering, the researchers will gather data through observation and interviews with the beneficiary which is the Sanctuario Nature Farms. In design, brainstorming sessions with Sanctuario Nature Farm workers to the prototype. In evaluation, the prototype will test in field trials, gathering feedback from farm workers, and monitoring system performance. In refinement, improving the prototype model based on the feedback and performance evaluation. In validation, the beneficiary will evaluate the performance of the prototype. After the prototype is satisfied the researchers will continue in development and it will test the final development and will undergo The Last stage which is implementation. In Implement, engaging with the beneficiaries in the implementing planning process, seeking input, and addressing concerns to ensure the successful adoption and integration of the smart plant monitoring into Santuario Nature Farms operations.

- Schedule of Activities (Activities and Timelines)

Activity	**M1**	**M2**	**M3**	**M4**	**M5**	**M6**
1. Data Gathering and Analysis						
2. Designing of the System						
3. Testing and Improvement						
4. Evaluation						
5. Documentation						

- **Resource Requirement**

Hardware:

- Sensors
  - Capacitive Soil Moisture Sensor
  - DHT22 Temperature and Humidity Sensor
- Breadboard
- ESP32
- Power Supply (Battery Lithium-ion Cell)
- Jumper Wires/Wires

Software:

- Arduino IDE Software
- C/C++
- Windows 11
- VS Code/Android Studio IDE

- **Expected Output**

1. Fully functional prototype

The prototype should be fully functional where it can display and alert the user regarding the real-time environmental status of the plants given by the sensors.

2. Test result of the prototype

The test result of the prototype should have a positive outcome where all components are functional and working accurately.

3. Evaluation result of the proposed prototype

The Evaluation result should have accurate and good reviews from the beneficiary and the evaluators.

4. Complete project documentation

The complete documentation should include the process of building the system, such as showing the functionalities of the prototype, and the hardware and software used.

- **Reference**

Lewis, A. (2024, February 12). What is a Smart Plant Monitoring System Using IoT? *Medium*. Retrieved from https://lewisashley2121.medium.com/what-is-a-smart-plant-monitoring-system-using-iot-96b279513b32

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