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Smart Crop-Field Monitoring and Automation Irrigation System

Prinsi Bhuva¹, Jainny Patni², Yash Ranpariya³, Dr. Warish Patel⁴

Dept. of Computer Engineering (PIET), Parul University, Vadodara, India¹

Dept. of Computer Engineering (PIET), Parul University, Vadodara, India²

Dept. of Computer Engineering (PIET), Parul University, Vadodara, India³

Asst. Professor, Dept. of Computer Engineering (PIET), Parul University, Vadodara, India⁴

ABSTRACT: A Smart Irrigation System is a software and hardware solution designed to automatically water plants using sensors and is also used to scan for plant diseases. India's main source of income comes from the agricultural sector and 70 percent of farmers and people depend on agriculture. There is an urgent need to change the manual method to automation to increase the productivity of the factory. Smart irrigation system should help the farmer who supplies water for a low harvest time and quantity. The smart irrigation system monitors humidity sensors and temperature fluctuations in the crop area, giving the exact time when the engine starts and stops. In this way, the automatic person avoids human errors and controls the moisture of the soil. The smart irrigation system running on low cost mobile application to allow any user to capture images of infected leaves and get the disease name, plant name, cure. The major advantage of smart irrigation system is to remotely monitor field conditions. Farmers can remotely monitor and control their irrigation systems, making it easier to manage large farms and respond quickly to changing weather conditions or unexpected problems. A smart irrigation system using a mobile application refers to a technology-based approach to effectively control and manage the watering of plants, crops or lawns using a mobile application.

KEYWORDS: Smart Crop-Field Monitoring And Automation Irrigation System , Irrigation, Soil moisture, Plant Disease Detector, Arduino Device, javascript ,Android Studio, google collab, User Experience.

I. INTRODUCTION

India's major source of income is from agriculture sector and 70% of farmers and general people depend on the agriculture [3]. Indian irrigation system, the farmers are chosen most of the methods manually such as drip, terraced, ditch irrigation system of them. In order to improve to the crop productivity there is an urgent need to change manual method to automation [3]. Smart agriculture is a deep integration of modern technology and agriculture, involving agronomy, physics, information, automation and other multidisciplinary knowledge, and is a necessary path for the development of modern agriculture [1]. Internet of things (IOT) is allowing controls the systems from remote area over an internet. It can controls the sensors which are used at various areas at water control systems [3]. Smart irrigation system based on portable prototypes using capacitive soil sensors based on qualitative designs and sensory data collection methods from agricultural fields. Sensors are connected to the Internet via wirelessly in this case [5]. Through wireless sensor nodes, data from the sensors is sent to the cloud. The IoT frameworks analyze and process the collected data [5]. Irrigation is one of the essential aspects of farming. Overwatering causes as many problems as under watering can cause. It also leads to the wastage of water resources [11]. This paper proposes a low-cost, sustainable irrigation system that helps smallholder farmers manage irrigation more efficiently by providing a low-cost, open-source, autonomous, and easy-to-use smart irrigation control system. This is followed by regular notifications being sent to the farmer's mobile phones or Application Programming Interfaces (API) application [5]. Automatic irrigation systems can be expensive to install, making it difficult for some farmers to afford. So we develop a low cost irrigation system that helps farmers to manage irrigation. The primary contribution of this paper are as follows:

- This irrigation system propose is to develop a soil moisture sensor that can be used for smart irrigation. In this, soil moisture sensor is integrated with the Arduino microcontroller with Wi-Fi connectivity.

- The 'C' programming syntax has been used to write the code using Arduino software to compile and load it into the Node MCU. The following problems have been identified in the existing soil irrigation system: water management, involvement of humans, increasing labor costs, and time to sense and supply water in required conditions.
- The goal of this work is to supply water for the plants automatically with an Arduino microcontroller. As crop needs fresh water and energy production, it is essential need for the crops.
- The use of irrigation is to water the plants to yield good results.
- Plant growth and crop yield can be hampered with the infection of fungal diseases through leaves. However, there are no solutions for quick disease and cure identification for farmers and regular people. This paper aims at developing a low-cost mobile application to allow any user to capture images of infected leaves and get the disease name, plant name, cure, and a contact for further help.

II. LITERATURE SURVEY

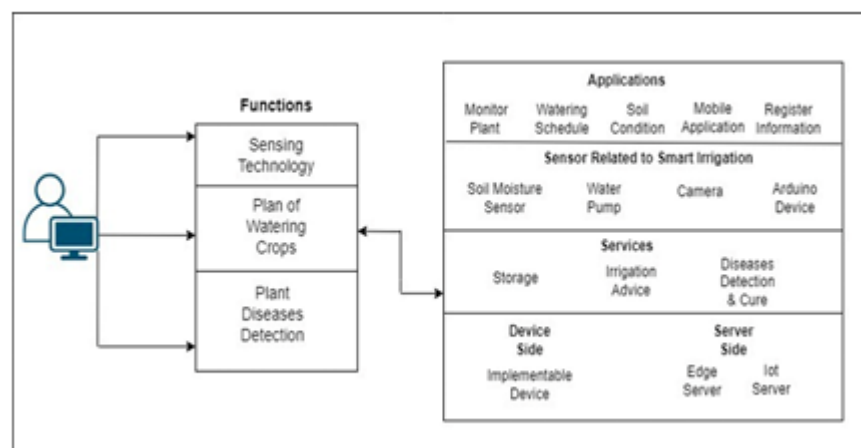
Dweepayan Mishra (2018) proposed a paper in which agriculture is a crucial part of India's economy, and enhancing crop yield and quality is essential. Traditional irrigation methods often result in uneven moisture distribution, which can affect crop production. To address this issue, the paper proposes an automated irrigation system designed to optimize water usage and reduce manual labor, thereby increasing crop productivity [2].

Dr Raj Kishen Moloo (2022) proposed paper in which the application leverages the location of captured images to provide historical weather data and facilitates contact with the Food and Agriculture Research Extension Institute (FAREI) for further assistance. Additionally, images are stored in the Firestore Database, and the app includes a chat feature for expert consultation, including the ability to send and receive images. A Convolutional Neural Network (CNN) model, trained with 3000 images over 25 epochs using Python on Kaggle, achieved an overall accuracy of 75.5%. Specific accuracies were 30.0% for Black Rot and 60.0% for Rust, based on a training set of 10 images per disease. The application demonstrated an overall accuracy of 68.3% in tests conducted with 60 users [6].

Amine Dahane (2024) proposed paper in which the agricultural sector faces significant challenges in ensuring food safety, but the Internet of Things (IoT) has emerged as a promising solution for smart farming. This study details the design and development of a cost-effective, comprehensive fog-IoT/AI system, utilizing open-source platforms to monitor agro-field data in real-time. Despite the advantages, smallholder farmers are often reluctant to adopt technology-based solutions. The PRIMA INTEL-IRRIS project seeks to make digital and smart agricultural technologies more appealing and accessible to these communities by introducing the concept of intelligent irrigation "in-the box." [4].

III. METHODOLOGY

This diagram provides an overview of a smart irrigation system, highlighting its main functions, applications, sensors, services, and involved devices. Here's a summarized explanation:



Functions :

1. Sensing Technology: Employs sensors to collect environmental data, such as soil moisture.
2. Watering Plan for Crops: Develops a watering schedule based on sensor data.
3. Plant Disease Detection: Identifies and detects diseases in plants using various sensors and technologies.

Applications

- Plant Monitoring: Tracks the health and growth of plants.
- Watering Schedule: Manages the timing and amount of water for crops.
- Soil Condition Monitoring: Analyzes soil moisture levels.
- Mobile Application: Uses a mobile app for controlling the irrigation system.
- Information Registration: Manages and stores irrigation system data. Sensors for Smart Irrigation

HARDWARE MODULES

- Soil Moisture Sensor: Monitors soil moisture content.
- Water Pump: Regulates water flow to plants.
- Camera: Captures images for monitoring plant health and detecting diseases.
- Arduino Device: A microcontroller used for creating devices that sense and control physical systems. Services
- Data Storage: Stores information from sensors and devices.
- Irrigation Advice: Provides recommendations based on collected data.
- Disease Detection and Treatment: Identifies plant diseases and suggests treatments.

The diagram illustrates the integration of these components, demonstrating how they work together to create an efficient smart irrigation system. This system aims to optimize water usage, monitor plant health, and improve crop yields through advanced technology and data analysis.

Soil moisture sensor: The soil moisture sensor estimates the soil volumetric water content. Volumetric water content represents the portion of the total volume of soil occupied by water. The controllers can be adjusted to open the valves and start irrigation once the volumetric water content reaches a user-defined threshold.

5V relay module: 5V relay module and take a 9V battery. Connect the positive wire of the battery to the COM terminal of the relay module. Take a water pump and connect the positive wire of the water pump to the NO pin of the relay module. Connect the negative wire of the battery to the negative wire of the motor.

IV. DIAGRAMS

➤ FLOWCHART

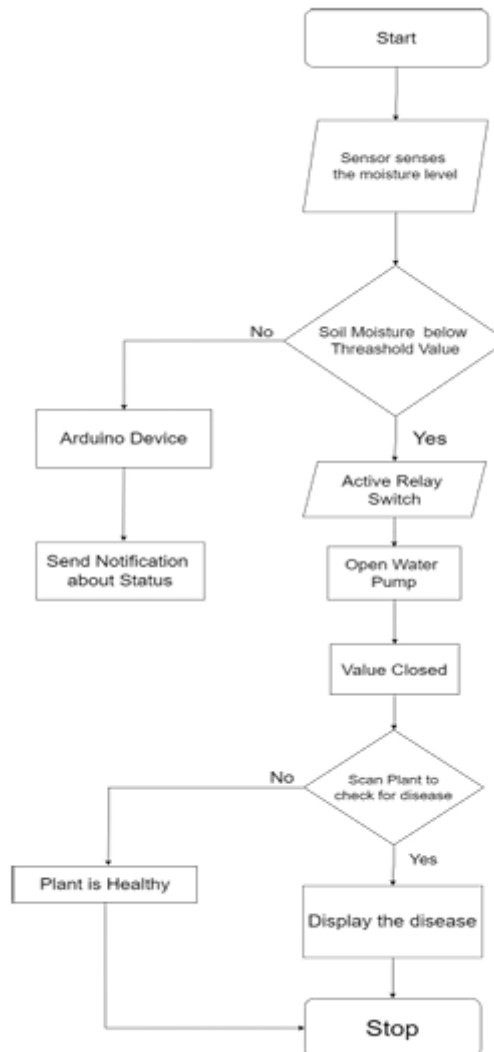


Fig 4.1: Flowchart of the application

➤ SEQUENCE DIAGRAM

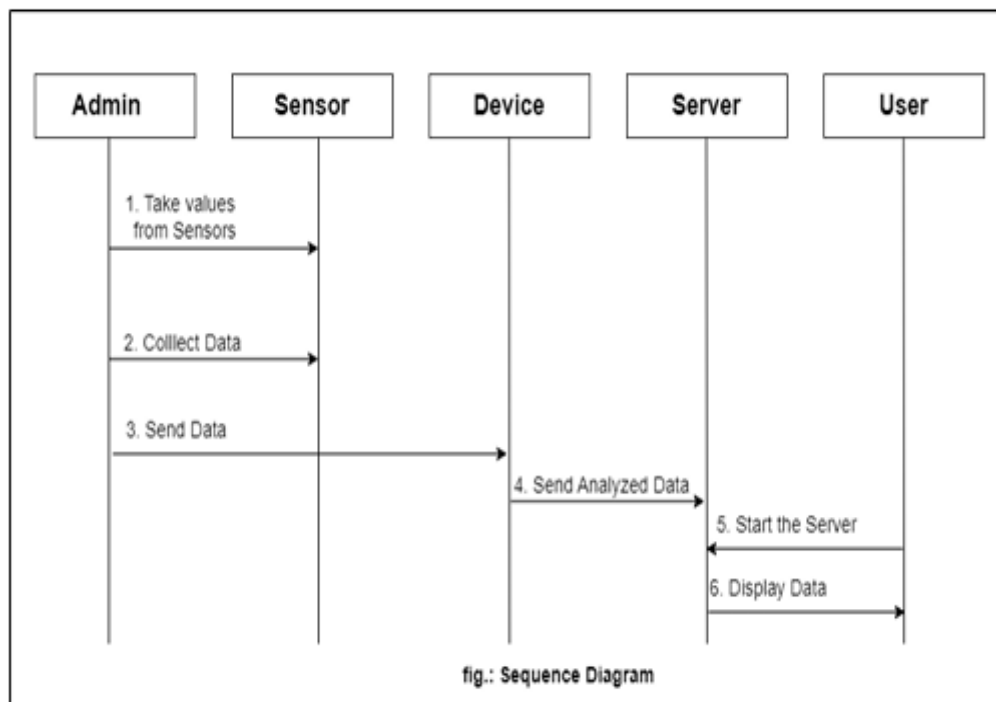


FIG 4.2: SEQUENNCE DIAGRAM

V. IMPLEMENTATION

Water Efficiency : The smart irrigation system was designed to optimize water usage by closely monitoring soil moisture levels in real-time. Traditional irrigation systems often rely on fixed schedules, which may not account for the actual water needs of the soil and plants at any given time. This can lead to over watering or under-watering, both of which can negatively impact plant health and waste water. In contrast, the smart irrigation system uses sensors placed in the soil to continuously measure moisture levels. These sensors feed data into a central control system, which processes the information and determines the exact amount of water needed at specific times. The system can adjust the watering schedule dynamically, delivering water only when the soil moisture falls below a predefined threshold. This precision ensures that plants receive the optimal amount of water to maintain their health and growth, without wasting excess water. By preventing over-watering, the system also reduces the risk of waterlogging, which can lead to root diseases and other issues.

Disease Detection Accuracy The integrated plant disease detector is a crucial component of the smart irrigation system, designed to monitor plant health continuously and identify diseases at an early stage. Traditional methods of disease detection in agriculture often rely on visual inspections by farmers, which can be time consuming and may miss early signs of disease, leading to delayed interventions and significant crop damage.

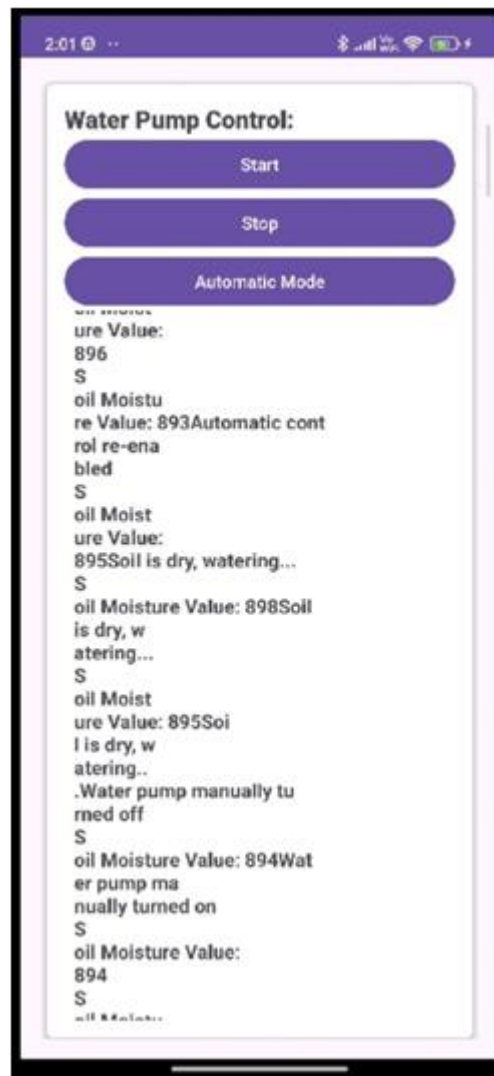
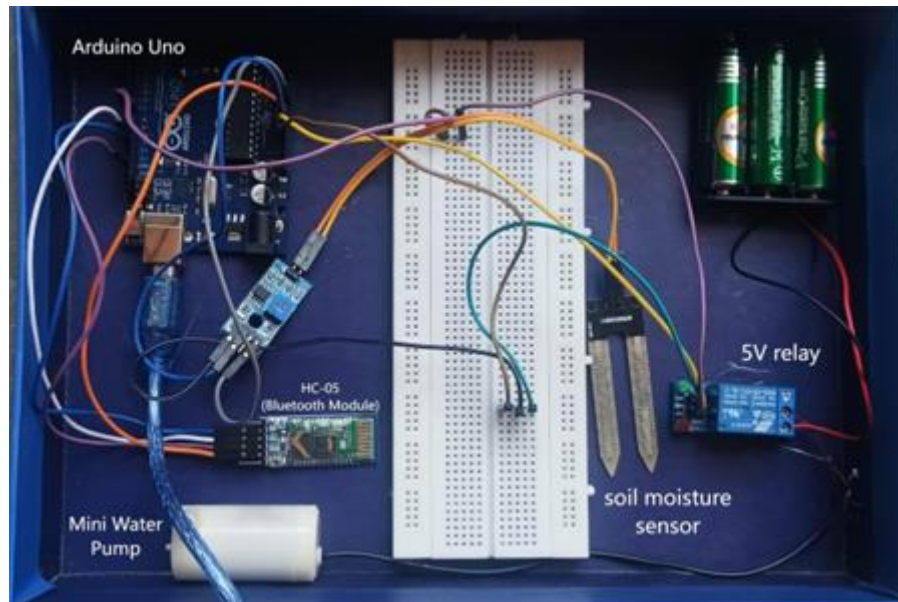


Fig 5.1: Implementation of proposed work.



5.2 Implementation of hardware work

VI. CONCLUSION

With this approach, a fully automatic irrigation system also provides real-time information about soil and crops, helping farmers make the right decisions. Live disease detection can also be used for faster detection of diseases. The developed prototypes are useful for farmers and work cost-effectively in agricultural operations, significantly reducing water consumption. It follows that this system is easy to implement and takes time, money and labor saving solution for field irrigation. With IOT, we can control our farm from anywhere, not only by hard work, but by smart work (technology), we can irrigate crops.

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