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IoT Based Crop Monitoring System

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Abstract

The IoT-Based crop monitoring System is a cutting-edge solution designed to enhance agricultural productivity and efficiency by utilizing sensor technology and automation. The core objective is to automate the irrigation process based on real-time soil moisture data. The systememploysanESP8266 module to facilitate the seamless exchange of data between various sensors and Firebase, a real-time cloud database. This interconnected system comprises two primary fields, each equipped with soil and soil moisture sensors, temperature sensors, smoke detectors, UV light, buzzer, solenoid valves, and mini water pump. The ESP8266 module serves as the central hub for collecting data from the sensors and transmitting it to the Firebase database. The data includes crucial information such as soil moisture levels, temperature, smoke detection, and UV light intensity. Furthermore, the system integrates alarm functionality through the buzzer and precise irrigation control via the solenoid valve and mini water pump. The data stored in Firebase is accessible through a web application built using React.js and Node.js. This web interface provides users with a graphical representation of the gathered data, allowing them to monitor the agricultural conditions in real-time. The main key features are Data Visualization in which users can remotely monitor soil moisture levels and receive real-time updates on crop conditions through a web application. Resource Efficiency by automating irrigation, this model optimizes water usage, reducing waste and improving water conservation. This paper not only showcases the integration of IoT technology in agriculture but also serves as a practical and environmentally responsible solution for modern farming practices.

Keywords: *Automation Sensor; Data Visualization; IoT (Internet of Things).*

1. Introduction

Agriculture has been the backbone of human civilization for millennia, and its sustainability and efficiency are critical for ensuring food security in an ever-growing global population. To address the challenges faced by modern agriculture, there is a pressing need to integrate cutting-edge technology and data-driven approaches. The "IoT-Based Agriculture Management System with ESP8266 and Firebase Integration" project emerges as a groundbreaking solution to enhance agricultural productivity and resource management. The ESP8266 module serves as the central hub for collecting data from the sensors and transmitting it to the Firebase database. The data includes crucial information such as soil moisture levels, temperature, smoke detection, and UV light intensity. Furthermore, the system integrates alarm functionality through the buzzer and precise irrigation control via the solenoid valve and mini water pump. This project focuses on harnessing the power of the Internet of Things (IoT) to create a smart and efficient agricultural ecosystem [1]. At its core, the system utilizes the ESP8266 module as a bridge between various sensors and Firebase, a real-time cloud database. The integration of multiple sensors, including soil moisture, temperature, smoke, and UV light, along with actuators like buzzers, solenoid valves, and mini water pump, forms the foundation of an intelligent agricultural infrastructure [2]. The system operates in two distinct agricultural fields, each equipped with a suite of sensors and actuators tailored to the specific needs of the crops grown. By continuously monitoring key environmental parameters such as soil moisture, temperature, and UV light intensity, the system enables precision agriculture practices. This includes automated irrigation control, real-time alerts for adverse conditions, and the ability to take immediate corrective actions. The heart of this project lies in the seamless connectivity between the ESP8266 module and Firebase. All data collected by the sensors is transmitted in real-time to the Firebase database, which serves as the central repository for agricultural information. This data is then made accessible through a web application developed using React.js and Node.js. The web application provides an intuitive graphical interface for users to visualize and analyze the data, enabling informed decision-making and proactive management.

2. Method

2.1.Data Collection

For data visualization, the data collecting from sensors by ESP8266 module which is a central hub of the hardware, transmits the data to the firebase database [3]. The data includes crucial information such as soil moisture levels, temperature, smoke detection, and UV light intensity. The first and important step for data collection is to have the perfect reading of soil moisture levels by which further process can be carried out. It collects real time data from the sensors.

2.2.Data Pre-Processing

Data preprocessing is a critical step in any data visualization process as it helps to prepare the dataset for the visualization process [4]. In this paper of IOT based crop management system, a real-time dataset is used which not increases workload in data visualization as it works on updated data which includes insight data of all sensors which is transmitting through ESP module. Overall, by performing these data preprocessing techniques, it is ensured that our model could show effective visualization from the dataset and that it could generalize well to read the data. Proper data preprocessing can significantly impact the model's performance and accuracy, and therefore it is essential to consider these techniques during the initial stages of any project.

2.3.Model Selection

The previous work in this crop management system has mainly focused on sensors and the data collecting from that sensor to be accurate. However, the proposed system on Iot based crop management system, we aim to achieve better accuracy of data visualization and therefore opted for Chartjs library, a type of library commonly used in data visualization tasks. One of the key features of Chartjs is that it can give a fully functional dynamic data visualization. JavaScript package called Chart.js is used to create HTML-based charts. Among the most basic JavaScript visualization libraries, it includes all types of pre-built chart. A selection of commonly used chart types, plugins, and customization options are offered by Chart.js. [5] A mixed chart can also be created by combining other chart types. It has several customization options, including the ability to add custom plugins for zoom, drag-and-drop functionality, and annotations. Large datasets are a great fit for Chart.js. You can avoid data processing and normalization by utilizing the internal format to rapidly consume such datasets.

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Overall, Charts library is worthy choice as it strikes the right balance between offering new capabilities.

2.4.Model Deployment

Model deployment involves making the fully functional model available. In the proposed system, the functional model of crop management system needs to be deployed to farmers that they can use this technology in their farms to make their farming digital. The Chartjs library is a popular Javascript library used to create chart types, plugins, customizable options. It provides a set of tools that can be used to develop dynamic data visualization carts. Html & css provides dynamic web page where all data can be integrated. Figure 5 shows the output of the webpage

3. Results and Discussion

3.1.Results

Working and results of our system is displayed here. Several screenshots with their explanation and how they will work is shown here.

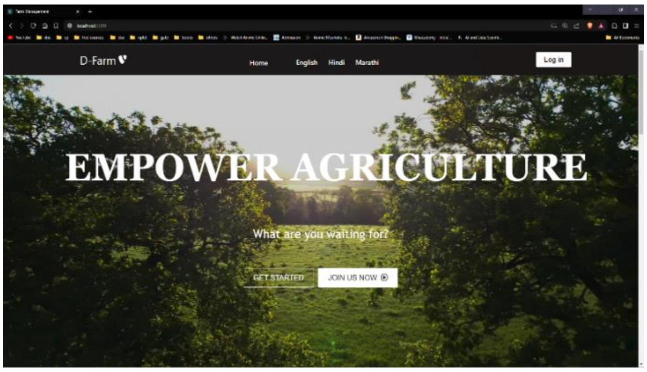

Figure 1 Website

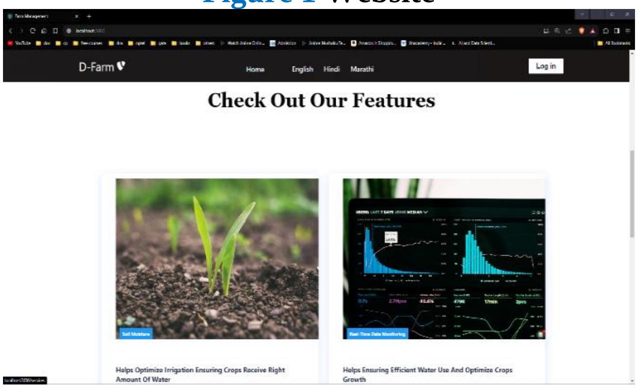

Figure 2 Home Page

This is the first page of our website (Figure 1, 2). Here the users will log in or sign up which will take them to the landing page of our website. Below given is the footer page of our website which provides all the basic functionalities to users providing them a very good user experience in Figure 3 & 4.

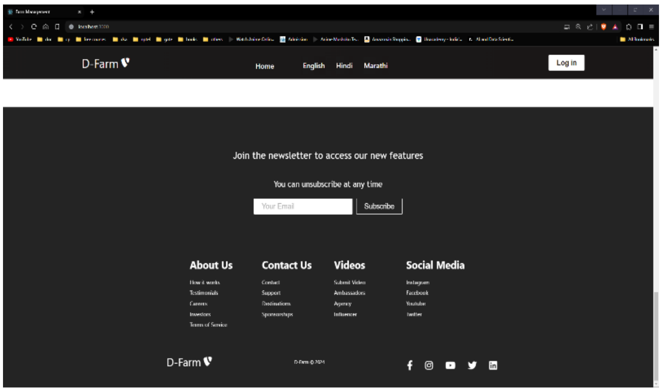

Figure 3 Basic Functionalities

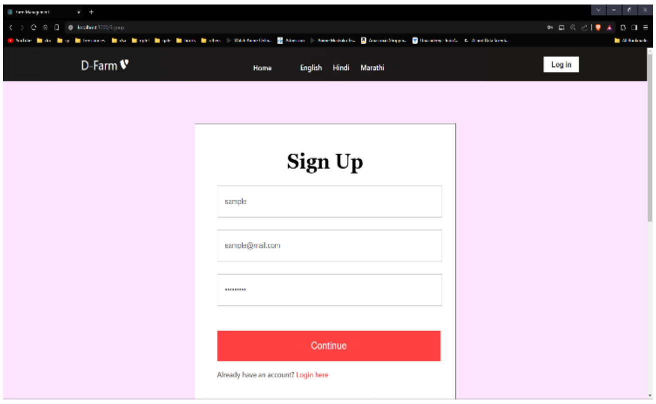

Figure 4 Sign Up

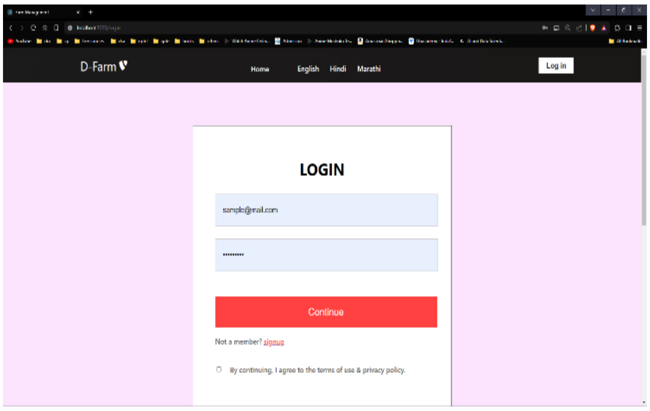

Figure 5 Login

As soon as the users click on the ‘Login’ button in Figure 1 they will be redirected to the page shown in Figure 5 which consists of different fields to enter the credentials of the user.

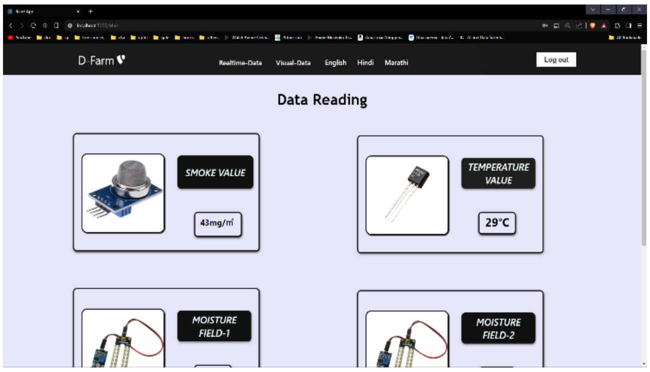

Figure 6 Data Reading

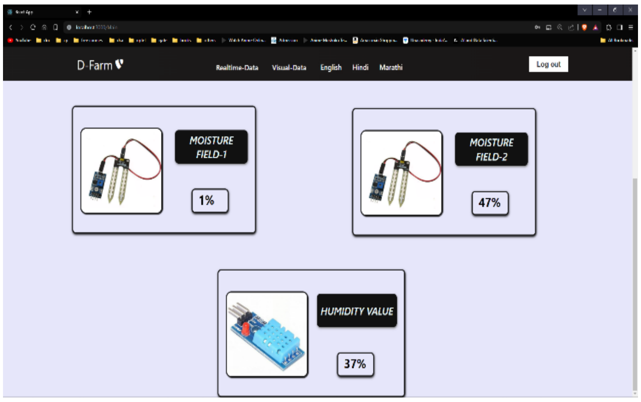

Figure 7 Sensors Data

After successful login, the user will have all the sensors data on the home page shown in Figure 6 & Figure 7.

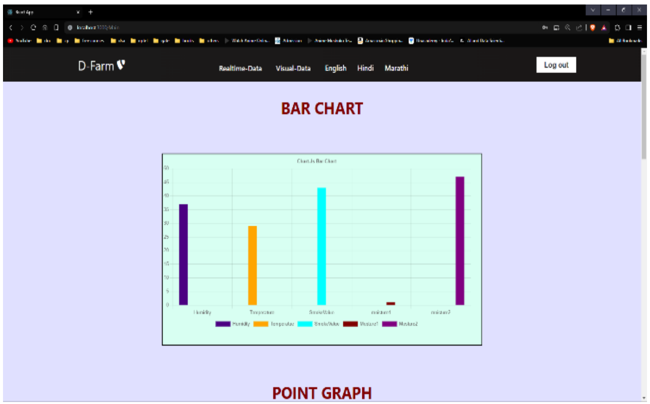

Figure 8 Bar Chart

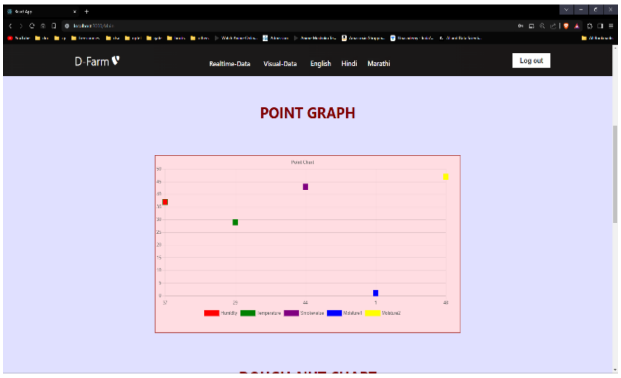

Figure 9 Point Graph

Let’s say in case of data visualization the user clicks on Visual-Data section. The user will be redirected to the page shown in Figure 8 & Figure 9 which will include Bar graph and point graph.

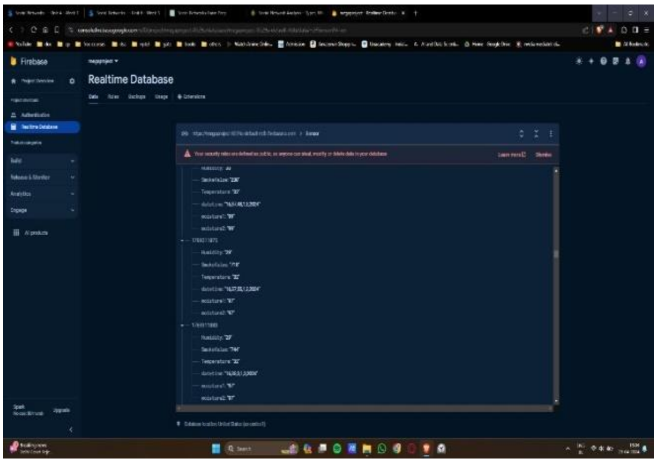

Figure 10 Firebase

The real time data which is reading from ESP8266 through sensors is transmitting to the firebase as shown in Figure 10.

Figure 11 ESP8266 Sensor

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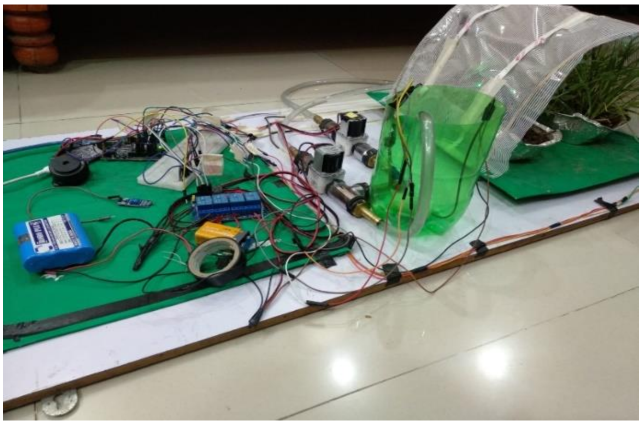

Figure 12 Smart Irrigation System

Figure 13 Output

3.2. Discussion

Based on the data above, we can conclude that offering these kinds of websites can help everyone who aspires to become a self-sufficient farmer and an authority in their industry [Figure 11]. Because everything that is required will already be provided automatically by Arduino and its code, it can save a significant amount of time and work [Figure 12]. The user finds it challenging to read the large papers that are available online, but our smart irrigation system and user interface make it easier by visualizing the essential data, making it easier for the user to read and comprehend [Figure 13].

Conclusion

An IoT-based crop management system with a website, data visualization capabilities, and language change support offers a comprehensive solution for farmers to monitor, analyze, and optimize agricultural practices. By integrating IoT sensors, data visualization tools, and multilingual support, the system empowers farmers to make informed decisions, enhance crop productivity, and promote sustainable farming practices.

- **Real-Time Insights:** Farmers can access real-time data on soil moisture levels, environmental conditions, and crop health through intuitive data visualization interfaces. This enables timely decision-making and proactive management of crop-related activities.
- **Optimized Resource Allocation:** With data-driven insights provided by the system, farmers can optimize resource allocation, including water usage, fertilizer application, and pest control measures. This leads to improved efficiency and reduced input costs.
- **Enhanced Accessibility:** Multilingual support ensures that farmers from diverse linguistic backgrounds can effectively utilize the system. Language change support promotes inclusivity and facilitates knowledge sharing among farmers worldwide.
- **Improved Crop Yield and Quality:** By leveraging IoT sensors and data visualization tools, farmers can closely monitor crop conditions and implement targeted interventions to maximize yield and quality. This results in higher profitability and competitiveness in the agricultural market.
- **Sustainable Agriculture Practices:** The system supports sustainable agriculture practices by enabling precise irrigation scheduling, minimizing water waste, and reducing environmental impacts. By promoting resource conservation and environmental stewardship, the system contributes to long-term agricultural sustainability.

In summary, an IoT-based crop management system with website integration, data visualization capabilities, and language change support represents a transformative approach to modern agriculture. By harnessing the power of

IoT technologies and data analytics, farmers can overcome challenges, optimize productivity, and cultivate a more resilient and sustainable agricultural sector.

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