IoT-Based Smart Control System for Monitoring Agriculture

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Abstract— ***Farming is a complex yet important process that has been on the course in townlets since mortal civilization. There are numerous aspects that growers need to take into consideration while farming. Cultivating factors involve soil, irrigational installations, temperature, rainfall, water level, etc. To produce successful crop growth, an agronomist needs to be well set and be conscious of the accurate or absolute values for these factors, rainfall conditions, or climate changes because the overall affair of the crop is largely dependent upon these factors. This article presents an automated experimental strategy using the Internet of Things to intelligently operate systems for monitoring agriculture.***

Keywords— Smart Control Systems, Agriculture, Weather monitoring, Agricultural factors, Automatic Roof Shading, Irrigation System, and Water Conservation.

I. INTRODUCTION

An IoT-based smart agricultural monitoring system is being developed to create a model that can predict the weather, soil temperature, moisture, and water level with accuracy as well as include extra features like automated roof shading. Because weather and agriculture interact, accurate weather forecasting is necessary for agriculturalists to make informed decisions that would not lead to losses.

The various agriculture monitoring systems have important ramifications for predicting the weather and tracking agricultural variables including moisture, temperature, and soil level. The farmers would benefit from having a basic grasp of their land and the yields they should cultivate in the proper places. They would even be able to identify the elements influencing crop ripening and receive early alerts about climatic changes. It is affordable to improve water resource preservation tactics and optimize them for agricultural systems with an automated Smart irrigation system that makes use of the Internet of Things. It helps the farmer by intelligently and seamlessly identifying the right stretch of land to receive water by embedding multiple sensors in the soil. As a result, the development of an IoT-based Smart agricultural model may have a positive impact on society, the economy, and the environment.The purpose of the study in [1] is to monitor and control various problems in the soil to sustain agriculture. In this study, the root zone of the plant is covered with a wireless network of soil moisture sensors measuring temperature. To incorporate modern technology into important activities such as agriculture, [2] developed a revolutionary IoT-based smart agricultural monitoring device. Features such as affordable prices, low labor and easy maintenance can help farmers avoid problems. In addition, the system reduces the need for workers, simplifies farming and supports smart agriculture. The case study in [3] focused on the use of rain devices to alert rescuers and was set up in an agricultural setting. Rain measuring devices were installed in the project, which is designed to keep important information that rain will not cause job loss, especially in agriculture. An automatic sprinkler and automatic drying system has been developed in [4] to prevent product loss from falling. To do this, the system uses a smart microcontroller roof sensor, a DC motor, and a smart microprocessor that detects rain and wraps a protective layer against it. [5]- [7], sensors (light, relative humidity, temperature, soil moisture content, etc.). In the context of agriculture, IoT (Internet of Things) refers to systems that use sensors in their design and make smart decisions using a wireless sensor network that controls various farm activities and provides useful information about agriculture. Farmers are using various sensors, wireless connections, etc. to increase yields and overall growth. And using the dynamics of the control environment [9]-[11] many projects and solutions have been developed over time. IoT is used in agricultural science to improve crops, reduce costs and improve quality. The article [12] examines several strategies that can be used to generate our farmer's income over time, as doubling the income is so difficult. The use of server analytics and its application in agriculture is described in [13]. The project was developed in [14] to identify insufficient soil, the best result of self-management system is to irrigate only when soil moisture is below a certain point. A built-in project at [15] at the center of agricultural research is a network that senses water using Arduino UNO and a rain gauge. The model outlined in [16] involves collecting data and making data-based decisions. Farmers can benefit as the environmental information it collects can be used to predict new agricultural jobs. As the IoT-based smart irrigation system was reviewed and presented in [17], the framework was developed using a remote sensing system in WSN that includes temperature and humidity sensors. The aim of IoT-based water conservation in [18] is to reduce water waste in the industrial environment. Despite water scarcity, future water demand must be met and therefore managed in every possible way. Using web technology, smart farming can be managed from anywhere. To address issues in the field, the Internet of Impact (IOT) has transformed the agriculture industry by involving producers [19] through a greater integration of the fourth, negative and conservation success chart. In [20], a weather-based and IoT-based weather monitoring system is proposed. The weather overlay system is used to find and record the apparent precipitation in various locations for research or precipitation forecasting. The mission is accomplished through the use of technologies such as the Internet of Things (IoT).

In this work IoT-based smart control system for monitoring agriculture is developed. The complete paper is primarily fractionalized into six sections. Section 1 discusses the introduction and the literature review. Section 2 describes the project's software as well as hardware requirements; Section 3 contains the key characteristics of the proposed agricultural system; Section 4 depicts the project's execution; and Section 5 informs us of the results and the paper is concluded in Section 6.

II. COMPONENTS AND MODULE

A. Hardware Requirements

(a) *Soil Sensor*

The soil moisture sensor shown in Fig. 1 is used to measure the amount of water in the soil horizon as well as to keep track of the water content of the soil. Water in the soil cannot be detected instantly by soil moisture sensors. Instead, they keep an eye on a different soil element that is thought to be connected to water concentration.

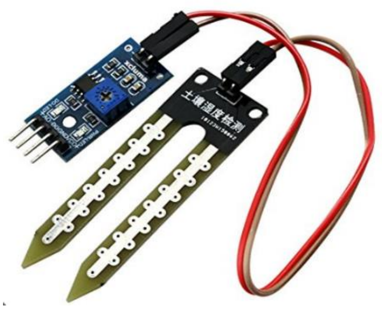

Fig. 1 Soil Sensor used for measuring soil moisture

(b) *DHT11 Sensor*

The DHT11 is a simple, incredibly affordable digital temperature as well as humidity sensor, as seen in Fig. 2. It delivers a signal that is digital on the data port without the need for analogue input pins by monitoring the air's humidity using a heating element and a capacitance humidity sensor.

Fig. 2 DHT11 Sensor used for measuring humidity

(c) *Rain Sensor*

A rain sensor or rain switch, as depicted in Fig. 3, is a detecting device that is activated by rainfall. The air's moisture is measured using a thermistor and a moisture sensor that is capacitive, and it does so without the usage of analogue input ports by generating a digital signal that is sent on the data pin.

Fig. 3 Rain Sensor used for sensing Rainfall

(d) *DS18B20 Waterproof Temperature Sensor*

The DS18B20 digital thermometer, as shown in Fig. 4, provides temperature measurements in the 9-bit to 12-bit Celsius range. It also has an alarm function with upper and lower trigger points which are user programmable and more stable.

Fig. 4 Temperature Sensor used for measuring temperature

(e) *180º Rotation Servo Motor*

The servo motor, such as the 180-degree servo in Fig. 5, may rotate to a certain angle in response to the signal. This capability allows for the direction and positioning of this kind to be controlled in several remote-controlled vehicles, robotics, and other sectors.

Fig. 5 Rotating servo motor used for rotating roof

B. Software Requirements

(a) Open Weather API

The OpenWeather Ltd.-owned webservice Utilizing its API, Open Weather Map provides access to weather data from all around the world, including predictions, now casts, and historical data for each location. The company provides a minute-by-minute hyper local precipitation forecast for any location.

(b) Adafruit IO

With Adafruit IO, devices can be linked using unique WipperSnapper firmware without writing a single line of code. Just add credentials, load the WipperSnapper firmware onto your board, and connect it to power. The board will immediately sign up for an account with Adafruit IO.

III. PROPOSED SYSTEM

IoT-based Smart agriculture monitoring system is to devise a model that can accurately harbinger the weather forecast, soil temperature, moisture, and water level, also with additional attributes such as automatic roof shading. This model is designed to predict every aspect required for a perfect agricultural environment in real-time or for forthcoming periods, facilitating users to recede costs and save time. As a result of the interaction between weather and agriculture, precise weather forecasting is required for agriculturalists to make knowledgeable determinations that will not result in losses. The model has significant implications for weather forecasting and monitoring agriculture factors such as water level, soil temperature, and moisture.

This would help the farmers to have a brief understanding of their grounds and the yields they should grow at appropriate locations. They even would be able to pinpoint the factors concerning the ripening of crops and would also get preceding warnings about climate differences. This automated Smart irrigation system using the Internet of Things is cost-effective for enhancing water resource preservation strategies and optimizing them for agricultural systems that aid farmers in that water can only be supplied to the necessary area of land by using a system of several embedded sensors that runs automatically and intelligently. Therefore, the successful development of an IoT-based Smart agricultural model can have far-reaching benefits for society, the economy, and the environment.

A. *Weather Forecasting Using Open Weather API*

The prediction of atmospheric conditions based on location and time is known as weather soothsaying. Growing professionals in farming will be able to reasonably easily determine when and how to move because each position will have its own rainfall protrusions. Because of the relationship between rainfall and farming, it is essential to accurately predict the amount of precipitation in order to provide growers the information they need to make decisions that are unlikely to result in losses. Because rainfall and agriculture are intertwined, accurate rainfall forecasting is necessary for growers to come up with selections that will not result in losses.

B. *Automatic Roof Shading*

When excessive rain falls on the harvested crops, which have been allowed to dry out, they decay and are destroyed, forcing the growers to solve a conundrum. Some crops need to dry before being offered for sale at the agriculture request yard, a space that the majority of growers don't have and takes a long time to do. The planters' resources and time are wasted because they committed approximately three to four months of their labor and an enormous sum of capital in the yield, which is then destroyed by failure. In order to protect growers from extreme loss when they encounter loss, this piece of equipment has been constructed.

C. Smart Irrigation and Water Conservation System

Irrigation is the process of applying water to land instinctively to increase agriculture product and farming. Irrigation, as we all know, is the process of providing stores with predetermined intervals of controlled water supply. In dry locations and during periods of below-average precipitation, it aids in the growth of agricultural crops, the maintenance of geography, soil, and connections, and the revegetation of disturbed soils.

D. Monitoring Agriculture Factors

The goal of this design is to support producers in obtaining real-time data (temperature, moisture, soil humidity, and soil temperature) for efficient terrain evaluation, allowing them to improve both yield and quality of the product.

IV. IMPLEMENTATION

A. *Implementation of Weather Forecasting*

First an account is created on the Open Weather API using the gmail account and a password has been created. Then logged in using the same credentials as shown in Fig. 8(a) and after that a free plan for weather data has been selected and a key is created for the project as shown in Fig. 8(b). The data is collected for the required city using the key as shown in Fig. 8(c) and later on it is kept in code using ArduinoJson Assistant as shown in Fig. 8(d) and at last it is linked to adafruit to directly see the weather. In Fig. 8(a,b,c,d), API for weather forecasting is displayed.

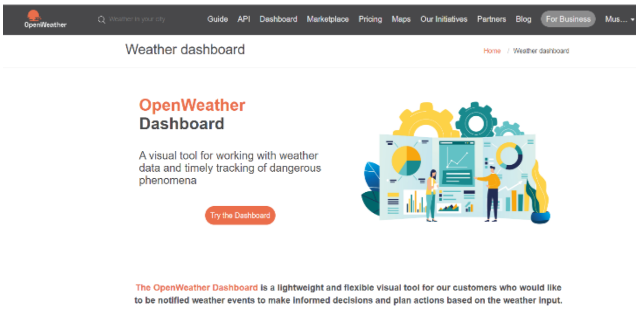

Fig. 8(a) Open weather API screen

Key	Name	Status	Actions
9410b1d5951018a9696eb3daa288656f	Default	Active	
d51ae37484decec79445fda11aff8069	WEATHER FORECASTING	Active	

Fig. 8(b) API Key created

{"cod":"200","message":0,"cnt":40,"list":[{"dt":1682521200,"main":
{"temp":304.97,"feels_like":302.87,"temp_min":301.2,"temp_max":304.97,"pressure":1006,"sea_lev
_kf":3.77},"weather":[{"id":804,"main":"Clouds","description":"overcast clouds","icon":"04n"}
{"speed":2.46,"deg":38,"gust":2.39},"visibility":10000,"pop":0,"sys":{"pod":"n"},"dt_txt":"20
{"temp":301.85,"feels_like":300.48,"temp_min":299.35,"temp_max":301.85,"pressure":1006,"sea_le
p_kf":2.5},"weather":[{"id":804,"main":"Clouds","description":"overcast clouds","icon":"04n"}
{"speed":2.38,"deg":75,"gust":2.41},"visibility":10000,"pop":0,"sys":{"pod":"n"},"dt_txt":"20
{"temp":297.86,"feels_like":297.2,"temp_min":297.86,"temp_max":297.86,"pressure":1007,"sea_lev
_kf":0},"weather":[{"id":804,"main":"Clouds","description":"overcast clouds","icon":"04n"}],"
{"speed":2.64,"deg":86,"gust":2.67},"visibility":10000,"pop":0,"sys":{"pod":"n"},"dt_txt":"20
{"temp":297.53,"feels_like":296.86,"temp_min":297.53,"temp_max":297.53,"pressure":1007,"sea_le
p_kf":0},"weather":[{"id":804,"main":"Clouds","description":"overcast clouds","icon":"04n"}],"

Fig. 8(c) Collection of weather data of Chandigarh city using created key

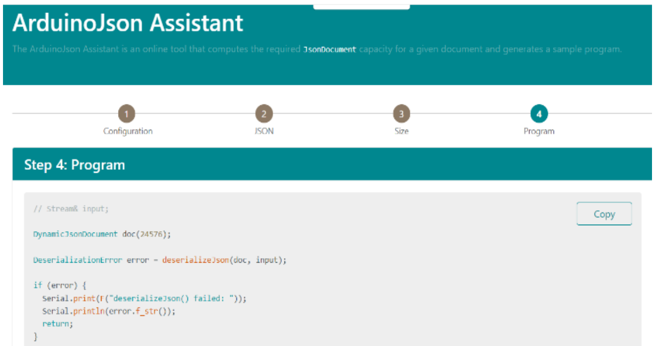

Fig. 8(d) Use of ArduinoJson Assistant to get the program code to implement the collected weather data

B. *Implementation On Adafruit IO*

In this Online service first an account is created using gmail account and a password is created.Then using the same credentials it is logged in and username and key is checked which is created by the system itself as shown in Fig. 9(a) and account status is as shown in Fig. 9(b). Later a dashboard is created for project as shown in Fig. 9(c) and feeds have been added as per requirement as shown in Fig. 9(d) and then blocks are added for each feed as shown in Fig. 9(e) and then output screen is seen and edited according to creativity as shown in Fig. 9(f). Adafruit's implementation is depicted in Fig. 9(a,b,c,d,e,f) :

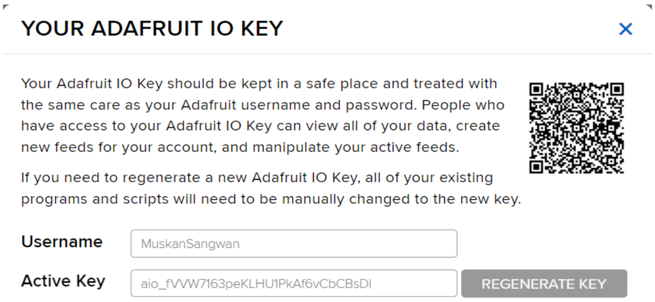

Fig. 9(a) Key generated

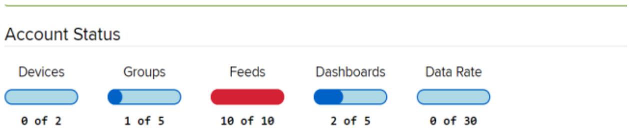

Fig. 9(b) Account status on service

Dashboards

Name	Key	Created At
SMART AGRICULTURE	smart-agriculture	April 25, 2023
Welcome Dashboard	welcome-dashboard	April 25, 2023

Fig. 9(c) Creation of dashboard

New Feed New Group

Default

Feed Name	Key
HUMIDITY	humidity
LED	led
MOISTURE	moisture
MOISTURE DATA	moisture-data
SOIL TEMP	soil-temp
SOIL TEMPERATURE DATA	soil-temperature-data
TEMPERATURE	temperature
WEATHER DATA	weather-data
Water pump	water-pump
Welcome Feed	welcome-feed

Fig. 9(d) Creation of feeds

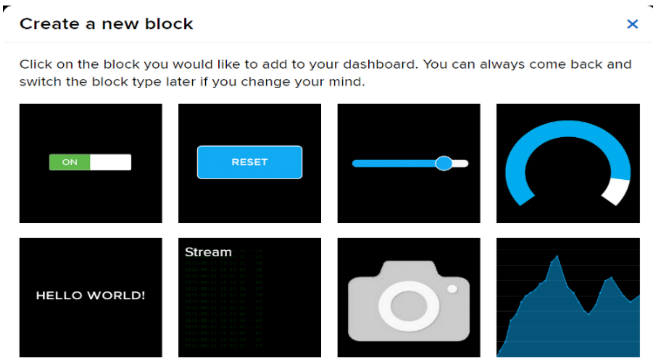

Fig. 9(e) Creation of blocks

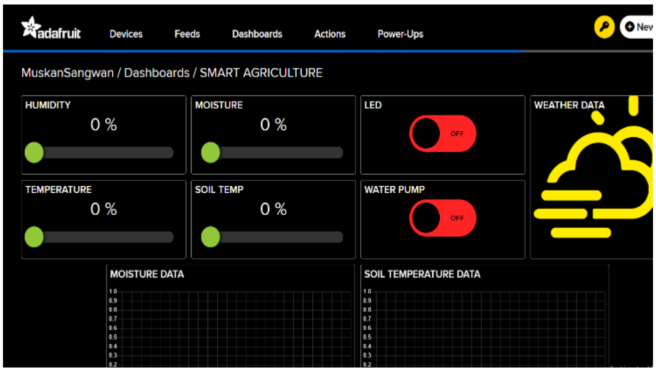

Fig. 9(f) Output screen on Adafruit IO for monitoring factors and weather

C. *Automatic Roof Shading Using Servo Motor*

Further, an automated roof is created using 180^0 servo motor which has three connections to rotate the roof. When roof senses the rainfall it rotates motor which is connected to roof means will expand the roof in 180^0 direction over crops which will save them from destroying as shown in Fig. 10.

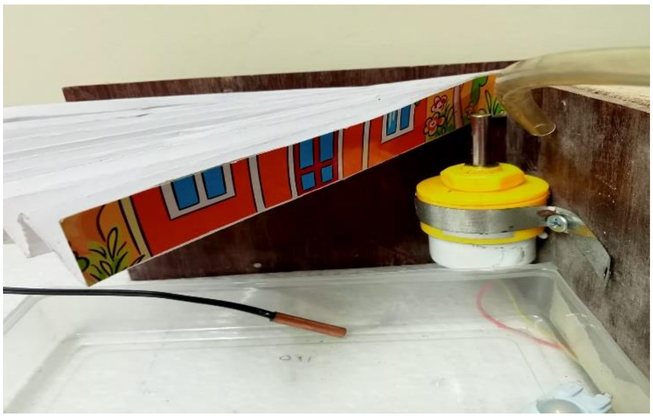

Fig. 10 Automatic Roof Using Servo Motor

D. *Hardware Connections*

All the hardware connections are done as shown in Fig. 11 circuit diagram for smart irrigation, monitoring factors and automatic roof shading and all these connections on PCB board are shown in Fig. 12.

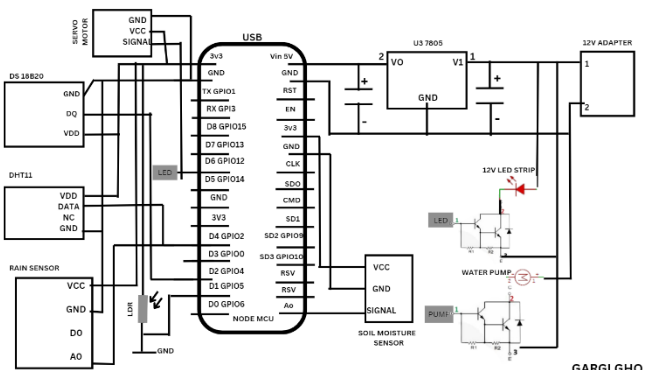

Fig. 11 Circuit diagram for hardware connections

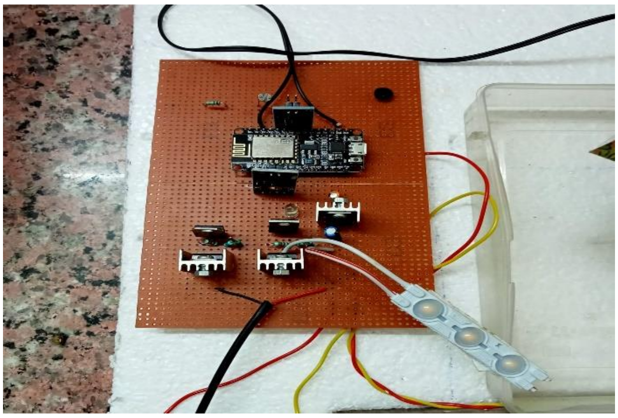

Fig. 12 Hardware connections on PCB

V. RESULTS AND DISCUSSIONS

As seen in Fig 13, the effective layout of an IoT-based smart control system reduces the time and resources required when monitoring agricultural manually. This system makes use of a technology called the Internet of Things. This device measures soil pressure, temperature, and humidity in addition to automating rood shading. The numerous measurements made for weather forecasting and agriculture are shown on the screen as in Fig 14. Additionally, it regulates the irrigation system and makes weather forecasts. Under ideal conditions, this approach works well, but when those criteria fail to meet requirements, as when there is not enough lighting or lightning, additional improvement may be accomplished.

Fig. 13 Proposed system

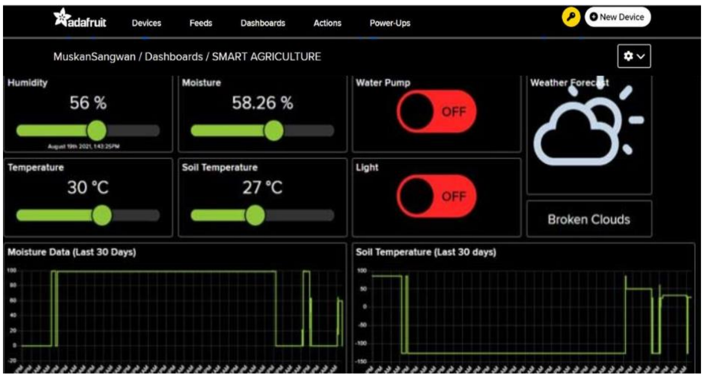

Fig. 14 Output of proposed system on Adafruit IO

VI. CONCLUSION

The proposed system is intended to offer a new element to the agricultural backdrop for farming in order to help farmers produce better-quality and higher-yielding crops. The data used to construct the proposed system makes it clear that there are number of steps that must be performed to create a completely IoT-based smart control system for monitoring agriculture that was successfully created and deployed. This approach will reduce the farmers' demand for labour as well as save them money and time. Although this policy would have an impact on the economy, it would ultimately be a significant step in the direction of a more sustainable and healthy national economy.

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