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Automated Irrigation Management System using IoT

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***Abstract*—Agriculture spread to a great extent in the Indian economy above 60%, as the population is increasing, which also increases the need for modern technology for the increased production of crops. The Stereotyped methods of irrigation like sprinkler and inflow types are not much effective. As they out-turn in water loss and fungus-related issues because of overwatering. In the future, there may be a situation of demanding more water resources for agriculture. These circumstances can be avoided by using an Automated Irrigation System using IoT. IoT is a highly emerging technology that lets objects communicate through Internet, IoT has been used in a large set of applications like traffic management, smart cities, etc. The major application of IoT is a smart irrigation system, through this smart irrigation there is an advantage of the increase in crop production and decreased use of fertilizers. Using this smart irrigation, the condition of soil like humidity and moisture can be determined by fixing different sensors and these aspects increase the crop and this precise agriculture benefits the farmer. The data from the sensors is wirelessly transmitted to the server database. When the field's moisture and temperature are reduced, the irrigation will be automated. Periodically, the farmer receives information about the field's status by mobile**.

***Keywords*—Mobile Controlled agriculture, IoT, NodeMCU, Sensors, DC motor.**

I. INTRODUCTION

Agriculture spread to a great extent in the Indian economy above 60%, as the population is increasing, which also increases the need for modern technology for the increased production of crops. The agricultural lands are getting reduced in large proportions due to some reasons like industrialization, commercial markets, etc these affect agricultural production. but to meet the needs of the people one must use modern technology for agriculture.

Modern technology includes IoT, Clouds, etc. Precision agriculture is completely different from traditional agriculture. In the present scenario, we have several issues of insects and diseases of plants due to many more reasons that affect the crop in quantity and quality, we can overcome all these problems through precision agriculture. In this way, farming does not need the total attention of the farmer but works through technology. This helps to yield better quality fruits and vegetables and also helps in large-scale production.

This smart irrigation uses sensors and Regulates the moisture content by taking the weather into consideration. This weather can be tracked through temperature and humidity sensors. Smart irrigation makes farming simple and economical for the farmer. this decreases the labor expenses and this whole process is done through wireless communication.This method can also be used for gardening purposes Which can be operated through the phone application. Though there were similar works that are reported by many scholars as well as professors, the work differs in the comparison of the comprehensive sentences. This article is a detailed survey of the electromagnetic technique of operating the cropped framing. This work also varies at both the international level and in India particularly.

The automation technique in agriculture is largely required for the volumed areas, the reason behind this is to reduce the complexity while the manual work is difficult to manage for larger areas. The complexity is reduced by segmenting the field into different sectors and these segments may be worked separately. The water supply can be done according to the segment separations.

to the farmer is noticed and notified to the farmer for further requirements and maintenances.

II. Literature Survey

"Wireless Monitoring of Soil Moisture, Temperature, and Humidity using Zigbee in Agriculture" published by prof. Chavan C H and Karnade P V; [1] use ZigBee for monitoring environmental parameters using a smart wireless sensor network system. This approach explains Nodes will submit values to a server that stores and processes the values before displaying them. Using Zigbee is an advantage as it is low in cost. The GDP per capita may increase in the future. Their suggested approach's disadvantage is that it does not determine weather forecasts and ZigBee doesn't support high data rates.

"Sensor-Based Automated Irrigation System with IOT" by Karan Kansara, and Vishal Zaweri [2] includes a technique for sending the status to the user about the process. The GSM is used. The GSM and microcontroller are connected using MAX232. The advantage of this System is Gps locations have been placed in the field and information about areas near Gps is sent to GSM. The drawback of this process is that it does not identify the nutrient value of soil and also this system is used in parks and stadiums but is not much effective for wide areas.

"A study on smart irrigation system using IoT" published by Bobby Shingla, Abhishek Singh, Shashank Yadav [3]. determines the moisture value of the soil using different sensors like temperature and soil sensors and sends signals to Arduino. Arduino decides whether to on/off the motor. The advantage is that maintenance is easy and the cost is low. The Arduino UNO R3 which is the latest microcontroller version is used. The drawback of this can be they didn't find the ph value of the soil and there is a need to add other contents can be added for high accuracy.

"Design and Implementation of Automatic Plant Watering System" published by Archana, Priya [4] identifies the value of soil, and then on and off of the motor is controlled by the temperature sensor. The disadvantage of this paper is that its did not include a method for sending the current situation of the field to the user.

"A Handhelding testing system for Irrigation System Management" by Jiachun et al [5]., used handhelds irrigation detection devices to develop the need for saving water irrigation for crops planted near the karst slope area using an L8051F microcontroller. Merits of this system are it has simple operation, is easy to carry up, least cost, wireless control. Demerits are since this is a handheld technique more labor is invested and water requirements may vary modern techniques should be implemented.

"Mobile Integrated smart irrigation Management" by Vaishali.s, Uday Kumar.s, Suraj.s [6]. is a system developed automated irrigation system without any manual intervention. This system checks the moisture level at the respective plant irrespective of the current supply. The merit of the system is Blue term android application is used as a communication between hardware and software components by using Bluetooth media. This system is similar to other proposed systems and does not provide any other extensions for accuracy.

"Drip Irrigation Control using Mobile Phone" by prof Salokhe B T, Ms.Shilpa; [7]. This system's central monitoring is a computer whereas remote monitoring is done by mobile phone. Android application implements hardware of drip irrigation using broadband and control drips remotely. There will be a range of problems with the system to manage the database, and isolated servers. The disadvantage of this drip system is not possible to operate it based on decisions, it can operate only a single condition at a time.

"Automated Intelligent Wireless Drip Irrigation using Linear Programming" by Manish Giri [8]. He used WSN along with linear programming to automate the information valves and pull on the system in case of an intense need for water. The disadvantage is working range of the system is limited to 150 mt. Thus it doesn't provide water for large areas.

"Impact of Climate Change on Agricultural Productivity and Food Security Resulting in Poverty in India" published by Japneet Kaur. [9] In this scenario, Parallel Layer Regression (PLR) apart from Deep Belief Network (DBN) is introduced 5to improve the productivity of plants. This strategy has great potential for accurate crop productivity prediction in terms of accuracy (ACY), sensitivity (SN), and specificity (SP). The disadvantage is that PLR leads to overfitting and underfitting of data and causes over assumptions.

"Measuring the effects of extreme weather events on yields" published by Powell J P,Reinhard S. [10] here we learn how optic fiber benefits a variety of applications following cable applications. These fibers are thinner and lighter and information exchange is done through this to get data from the sensors. OTDR theory and its operations are applied here. But this makes the system complicated as we use uncountable fibers and optic connections. It's difficult to handle them for a longer time.

III. Limitations of Existing System

In the Existing System, more manual work is done. The farmer has to check the land continuously and provide the requirements as per land type. Watering the plants individually is a difficult daily activity. This leads to over Consumption of Time and Energy. Moreover, there are chances of watering the crops more than they require which leads to fungal infections.

IV. Proposed System

This System is a combination of both the hardware as well as software components. Development in cropping systems results in better irrigation.

A. Components

a) NodeMCU

NodeMCU in Fig.1. has great processing and also storage eligibility to cope with sensors and application-related devices using general-purpose input/output with a minimal improvement of up-front and loading during runtime.it is mostly popular for the Wi-Fi Internet chip of Espress if, i.e, ESP8266 which uses Lua-based language to run user programs. The Node MCU board contains the ESP-12E module, CP2102, and also the USB connector.ESP-12E contains pins that are designed to make it breadboard-friendly.

Fig.1. NodeMCU

b) Moisture Sensor

A moisture sensor is an easy instrument for detecting moisture levels in the soil. various crops require a distinct level of moisture to increase productivity. Farmers can determine the water level present in the field by using these values. Hence, no human work is involved. This sensor is low-cost as well as low-power equipment operated in 3.3V-5V. The soil moisture sensor in Fig.2. contains digital and correspondent outputs.

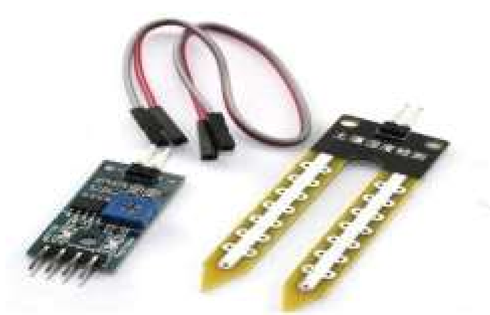

Fig. 2. Soil Moisture Sensor

c) DHT11 Sensor

DHT11 is affordable, accurate as well as a more precise sensor. DHT11 has a great enhancement to composing the digital signals with humidity and temperature sensing technology. DHT11 consumes low power and produces reliable outputs. This sensor can be interfaced with any type of microcontroller.

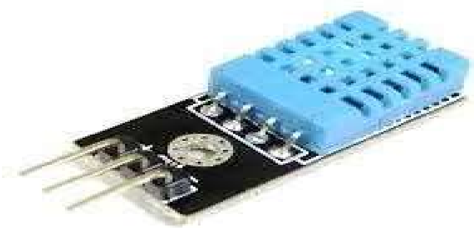

Fig. 3. DHT11 Sensor

d) Relay

The relay in Fig.4 is the electromagnetic switch that operates to turn on or off the circuit using a microcontroller.

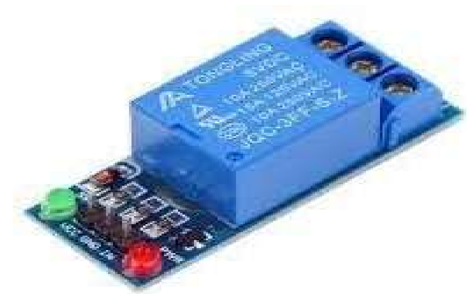

Fig. 4. Relay

e) DC Pump Motor

DC pump motor is a micro water pump with minimum cost that can be operated from 2.5-6v power. This motor takes 120 liters/hr with less consumption of current i.e,220mA.

Fig. 5. DC Moto

B. Architecture

The system's aim is to compose the data from sensors and send the information to the farmer/user. Thus moisture level can be determined along with temperature range and check the requirements for irrigation. The Esp8266 NodeMCU-12E plays a role as an interface to link the Internet and acts as broadcasting having control over the sensors. Since we use the MQTT protocol, the data is put down constantly in MQTT Server. The security of the system is managed using the Secure-Sockets layer. The lead of these protocols is that there should be no puzzling data to be stored. The DC pump motor is electromagnetically designed to on/off the microcontroller and ESP8266 NodeMCU-12E by using a protocol known as MQTT protocol. The ESP8266 is patched to the moisture sensor, DTH11 sensor, and Relay as shown in Figure.1. The relay is then linked with the DC pump Motor. Then the Esp8266 NodeMCU-12E is combined with the MQTT server that displays. The moisture sensor estimates the information and is passed to the user through the MQTT server.

Architecture Diagram

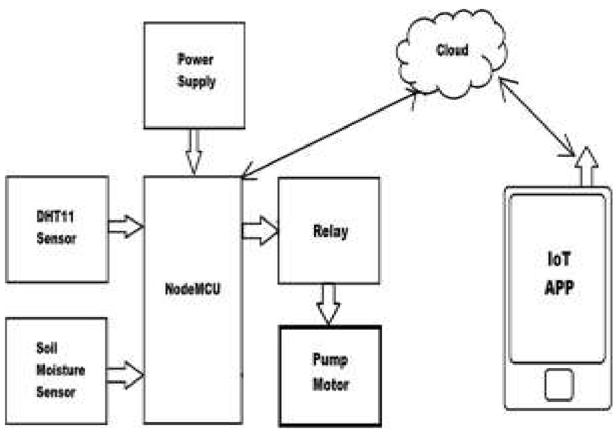

Fig.6. Proposed Architecture

C. Implementation

The implementation can be explained, by dividing it into two sections, where one section consists of hardware components like sensors and relay. The second section is composed of MQTT-blynk that exhibits accurate results. The connection between the Esp8266 NodeMCU-12E that plays as a broadcasting interface is linked to sensors and relay using the cabled connection(wired connection). Initially, The testing of the soil moisture level is done using a soil moisture sensor and the estimated data has been sent to the Esp8266 NodeMCU-12E.On the other hand, the user performs the initial work of MQTT-blynk. Blynk is a mobile app that gives information about the moisture level, humidity, and temperature range. The initial work to be done by the user is to install the Blynk library in Arduino-IDE. Then some testing can be done about its working, such as testing the accuracy of message transmissions between the MQTT protocol components. Thus we can examine the activities that are user- defined such as moisture level and temperature. To provide security to the blynk platform, SSL protocol is used. To view the activities of the blynk application the user has to log into the application. These aspects make the MQTT system to be more powerful.

The Message Queue Telemetry Transport protocol (MQTT) is a mechanism for transmitting data over a network. It generally Follows publisher architecture where messages are transmitted from one place to another using a central hub(broker). This system includes three major components: Publisher, Broker, and Subscriber. The first step is initiated by the Publisher, which is a sensor that hand-down the sensing data to the broker for processing the sensing data and if there is no need to process it then it automatically goes to sleep mode. MQTT broker connects both the publisher and the subscribers. The messages are split into “topics”.The message exchanges from the broker to the sender can be done within this topic. Then the data from the broker is sent to the subscriber, which is an application-based component that is to be connected through a broker. If any new data comes to the broker then it will notify the subscriber. Transferring of data occurs over TCP by employing MQTT and it is encrypted by SSL. This is the first step to be done for connection establishment. The port used for connection is 1883/8883. Basically, MQTT is deliberately used for huge networks and intended to reduce volumes of data.

D. Algorithm

Proposed Algorithm

Step 1: Read the sensor values.

Step 2: Calculate the Temperature(T), humidity(H) and moisture values(mv).

a) Temperature T(° C) =(32° F-32)*(5/9)
b) Humidity(H)-Relative humidity value in percentage from sensor readings.
c) Moisture Value (mv)=T-((100-H)/5)

Step 3: If the condition (T==25° C-37° C &&H==60%- 70% &&mv=60-90) is True.

The Irrigation stops and the resultant farming yields a high productivity rate under these conditions.

Step 4: Else if the condition fails

The irrigation process get starts by sending signals to the relay and the pump motor get on and water automatically gets pumped.

E. Flow chart

In the first instance of the function, we gather the statistics from sensors connected to the nodeMCU which acts as a mini-computer that stores the logic of the program. The programming used to solve the logic of this system is the C-program which acts as a communication between the user and the hardware part of the system.

This program is written, tested, debugged, and finally uploaded to the Arduino IDE platform. The values collected are calculated. By using T, H values we calculate the Moisture value by using the mathematical formula:(mv) = T-((100-H)/5). Now, check whether the condition is met. This can be confirmed by checking all three parameters are in the given range such as temperature should be in the range of 25° C-37° C, humidity range is 60%-70%, and the moisture level to be 60-90. if YES, and immediately the irrigation process stops. It provides a high productivity rate where plants grow in these conditions.

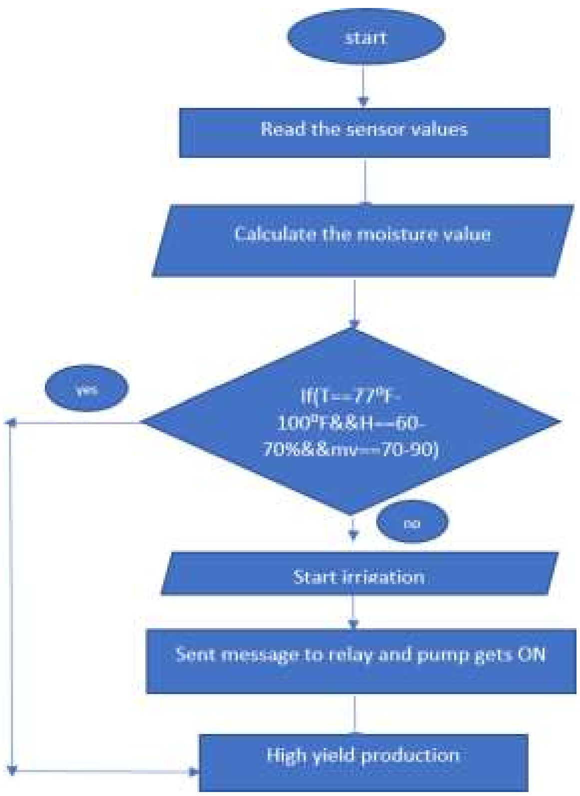

Fig. 7. Flowchart

In another case, if the condition fails then it sends the message to relay and pumps water to the farming field . Thus Irrigation gets started. Hence the adjustment of the moisture level is done accurately to make high productivity. Fig.7. describes clearly.

V. Result and Discussions

This part deals with the experimental results of the system. There are some conditions where the excess watering of the plant leads to changes in plant growth. The excess water in the roots turns the leaves edges of the plant to be yellow/brown. This symptom gives the hint to the farmer about the watering level in traditional farming. Not only the excess water there are some factors that affect the productivity of the farming like when the surrounding temperature increase drastically and when humidity level increases affect the plant growth. By keeping these aspects this system is designed to provide the solution.

Fig. 8. Installation of irrigation system

The fitting up of the machinery is done as shown in the above fig.8. The working of the automated system is done congruously. we used a mobile application blynk which is connected through the internet broadband. Another application Arduino IDE is cast-off to execute the code and this is connected to the hardware system and the blynk application using the internet network.

Fig. 9. Temperature and humidity readings

Fig.9. deals with the output of the system. This gives details about the temperature readings and moisture readings. Though the temperature range for each plant differs, the maximum and minimum temperature range for crops is 25° C-38° C. The humidity range should be 60%-70%. The above levels help in maintaining the crops in good condition and also make a good irrigation facility. This helps India from Food Scarcity and imports food at the international level.

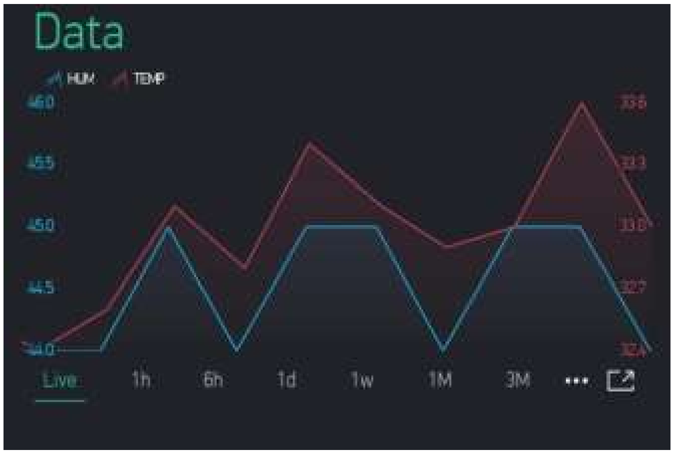

Fig. 10. Graphical representation

The Graphical representation of the moisture and temperature of the surrounding fields is given in fig.10. The red one predicts the Temperature whereas the Blue one predicts the humidity. The presentation of this graph is given in the Blynk application by the data developed for every three seconds from the sensors.

The Blynk application provides a notification every three seconds. Here we have set the time to three seconds for the updated information of the system. There is a possibility to change the time settings. This is organized in such a way that if the water content is below the level then a notification message is sent every three seconds about the water information which is shown in fig.3. But if the water content is in the required amount then it doesn't send any notification. In other forms, we can say that the blynk application gives ON or OFF information about the water.

Fig. 11. Notification of water information

The Blynk application provides a notification every three seconds. Here we have set the time to three seconds for the updated information of the system. There is a possibility to change the time settings. This is organized in such a way that if the water content is below the level then a notification message is sent every three seconds about the water information which is shown in Fig.11. But if the water content is in the required amount then it doesn't send any notification. In other forms, we can say that the blynk application gives ON or OFF information about the water.

VI. CONCLUSIONS AND FUTURE SCOPE

This article discusses the designing of a simple controller for regarding moisture sensors Using Esp8266 NodeMCU-12E.The system is provided with full security as SSL protocol is used. The components we have used in the project are very cheap in cost and the consumption of voltage is low. A mini microcontroller is used for communication for different applications of the android system. The sensors provided the digital readings and analog results. The readings of the sensors are finally displayed on the webpage of the mobile application successfully. The interaction between the components and the connection between them is successfully fitted. Finally, wired connections are no longer used. By all means, this project solves all the irrigation issues and maintains a high accuracy rate when compared to other projects.

In the future, this system could be a more intelligent system that forecasts user activities, plant nutrient levels, harvest time, and so on. We can also install a water meter to estimate the amount of water used for irrigation which gives cost estimation. More breakthroughs can be made in the future by using Machine Learning algorithms, which will benefit farmers greatly and cut water use in agriculture.

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