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IOT Based Smart Irrigation System

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Abstract— Agriculture is the backbone of the all developed countries. It uses 85% of available fresh water resources worldwide, this percentage continues to be dominant in water consumption because of population growth and food demand. As a result, a system that uses water wisely is required. As a result, this study provides an idea for a smart watering system. The management of irrigation can be improved by using automatic irrigation systemA technology that allows a farmer to monitor the status of his fields from the comfort of his own home. This system not only provides comfort but also reduces the energy consumption, increases efficiency and time savings. This irrigation system uses two sensors namely soil moisture sensor and rain sensor. To write the program used arduino IDE 1.8.12 and uploaded into arduino mega. The data from the sensors sends the data to the mobile by using Wi-Fi module. Based on the required moisture content pump will automatically starts and after reaching the required soil moisture content pump will stops. Laboratory test, which is gravimetric test have been conducted for different soils such as red soil, laterite soil and black soil and results obtained is compared with the sensor readings which are approximately equal. Based on this system we can conclude that water can be diminished, can overcome the over irrigation and under irrigation which are major problems in surface irrigation and by using this system we can supply fertilizers in the form of liquids. Another system also developed by using arduino uno microcontroller. The irrigation system consists soil moisture sensor to monitor the soil and potentiometer to set the required moisture content. Compared two systems by plotting moisture depletion curves and concluded that they are almost same.

Index Terms— IOT, Irrigation, Microcontroller, Sensor, Soil moisture, Soil moisture sensor, Wi-Fi module

1 Introduction

Agriculture is India's main source of income and is known as the country's backbone. Farmers, on the other hand, have recently faced a host of problems in the agricultural industry. As a result, efficient water management is a major challenge in many arid and semi-arid farming systems. An automated irrigation system is necessary to optimise water consumption for agricultural crops. An automated irrigation system's purpose is to prevent overwatering and flooding. Over irrigation occurs as a result of inefficient water distribution or management. Irrigation enhances soil salinity in areas with significant evaporation, resulting in a deposit of toxic salts on the soil surface.

A smart watering system was installed to address these difficulties and save labour. By lowering production costs, improving irrigation efficiency can help the industry become more competitive and sustainable. With proper irrigation, average crop yields can be maintained (or increased) while limiting environmental concerns caused by excess applied water and subsequent agrichemical leaching. As a result of recent technological breakthroughs, soil water sensors are now available, allowing irrigation systems to work more efficiently and autonomously. Automatic irrigation based on soil water sensors attempts to maintain a specified soil water range in the root zone that is suitable for plant growth.

2 Literature survey

Understanding the existing methodologies, understanding the needs, and building an abstract for the system are all steps of the primary study. In this study, soil moisture sensors, temperature, and humidity sensors are implanted in the plant's root zone, and data is sent to an Android app. To manage water quantity, the threshold value of a soil moisture sensor was programmed into a microcontroller. Temperature, humidity, and soil moisture values are displayed via the Android app. The goal of this project, dubbed "Automatic Irrigation System on Soil Moisture Content," is to create an automated irrigation system that detects the earth's wetness content and turns the pumping motor ON and OFF. This study just looks at the soil moisture value; however, the suggested project adds temperature and humidity data to the present project. This research presents an Arduino-based remote irrigation system for agricultural plantations that is put in a remote location and distributes required water to the plantation when soil humidity falls below a set-point value. However, because we were unaware of the soil moisture level at the time, the suggested system contained an additional feature of soil moisture value, which was presented on the farmer's mobile application.

3 Literature survey

[1] G.Parameswaran and K.Sivaprasath (2016) proposed a smart drip irrigation system using IOT in which humidity, temperature and pH sensors are used. Irrigation status is updated to the server or local host using personal computer.
[2] Alberto Pardossi , Luca Incrocci (2009) published a paper on Root Zone Sensors for Irrigation Management in Intensive Agriculture which dealt with sensors in different root zones for different crops.
[3] Archana and Priya (2016) proposed a paper in which the humidity and soil moisture sensors are placed in the root zone of the plant. Based on the sensed values the microcontroller is used to control the supply of water to the field.

This system doesn't intimate the farmer about the field status.
[4] Sonali D.Gainwar and Dinesh V. Rojatkar (2015) proposed a paper in which soil parameters such as pH, humidity, moisture and temperature are measured for getting high yield from soil. This system is fully automated which turns the motor pump ON/OFF as per the level of moisture in the soil.
[5] Ray-Shyan Wu, Jih-Shun Liu, Sheng-Yu Chang and-Fiaz Hussain (2017) proposed a paper for Modeling of Mixed Crop Field Water Demand and a Smart Irrigation System which indicated that the field storage in the end block of the study area was lower than the wilting point under the 50% reduced irrigation water scenario. The original irrigation plan can be reduced to be more efficient in water usage, and a 50% reduction of irrigation can be applied as a solution of water shortage when drought occurs.

4 PROBLEM STATEMENT

The traditional irrigation method is operated by hand and is based on manually observed real-time weather and soil conditions. Water schedule is determined by heuristics based on the farmer's experience, which is heavily reliant on manual work. Farmers' biggest issue is water shortages as a result of lower rainfall. Due to supply fluctuations, farmers are sometimes forced to water the field at strange hours. Due to human mistake, there is a danger of over-watering and underwatering in a few situations.

5 PRINCIPLE

A soil sensor controls the smart irrigation system, which is controlled by the soil moisture content. The soil moisture sensor is linked to the Arduino microcontroller's input pins in this configuration. On the Smartphone, the sensors' sensed values are displayed. If the measured value exceeds the program's threshold settings, the motor driver will automatically turn the pump ON/OFF. A Smartphone application will keep the farmer up to date on the current field state, which will also be updated on the website. Using this technology, the farmer can get information about the state of the field at any time.

6 PROTOTYPE

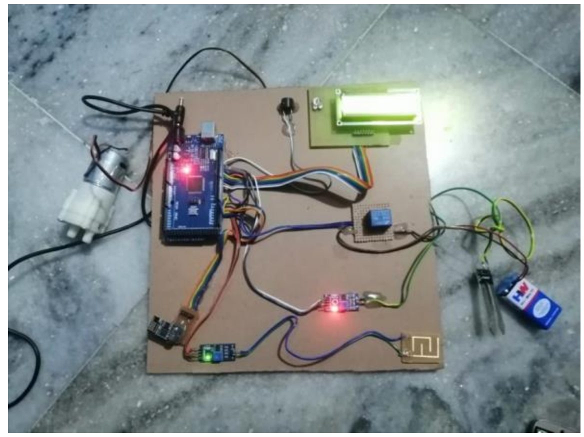

Fig. 1. Prototype of IOT based smart irrigation system with Wi-Fi module

Fig. 2. Prototype of IOT based smart irrigation system with potentiometer

Fig.1. shows the prototype of Wi-Fi based smart irrigation system and Fig.2. shows the prototype of smart irrigation system without Wi-Fi module.

7 COMPONENTS

7.1 Arduino: A physical programming circuit board (Microcontroller) as well as software are included in this open source platform (Integrated development Environment). The microcontrollers utilised in this project are the Arduino UNO and Arduino MEGA. This is a microcontroller-equipped board. The UNO and MEGA may be programmed using the Arduino software.

7.2 Soil Moisture Sensor: A soil moisture sensor is used to determine the moisture content of the soil. The Soil

Moisture Sensor (SMS) is an irrigation system sensor that measures soil moisture in the root zone prior to each planned watering event, bypassing the cycle if moisture is above a user-defined set threshold.

7.3 Wi-Fi Module: It was a Wi-Fi module that was used. The ESP8266 is a self-contained system on chip (SOC) with an inbuilt IP/TCP protocol stack that allows any microcontroller to connect to any Wi-Fi network. This preprogrammed ESP8266 module can easily be attached to an Arduino device to enable Wi-Fi capabilities. The ESP8266 module has a wide on-boarding development space and a lot of storage, so it's perfect for sensors and other application-specific devices.

7.4 Submersible Water Pump: An electric submersible pump (sometimes referred to as a submersible pump or a sub pump) is a pump that has a hermetically sealed motor that is tightly connected to the pump body. The setup is completely submerged in the fluid that will be pushed. The main advantage of this type of pump is that it prevents pump cavitation, which is a problem produced by an elevation difference between the pump and the fluid surface. A small submersible DC water pump, unlike jet pumps that pull fluids to the surface, pushes the fluid to the surface. Submersible pumps are more efficient than jet pumps. It's usually turned on when the voltage is between 3 and 12 volts.

8 DESIGN OF SMART IRRIGATION SYSTEM

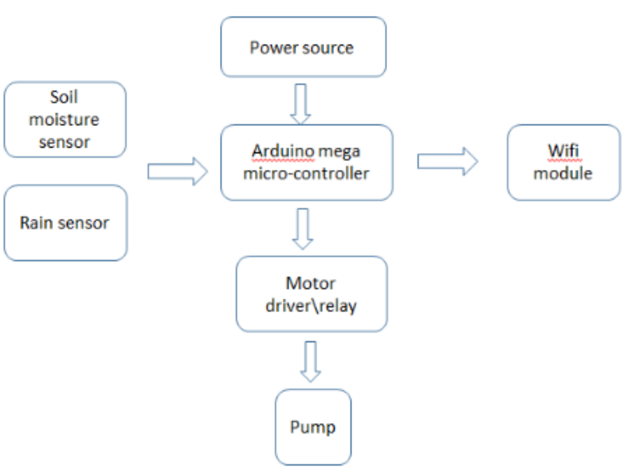

Fig. 3. Block diagram

9 SOFTWARE USED

Arduino IDE 1.8.12

This application is free open-source software for writing and debugging programmes, and it was used to create the smart irrigation system's application.

TCP server

This is an android application and app is freely available in app store

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Working

A soil sensor powers the prototype, which is real-time. The soil sensor detects the moisture in the soil. A threshold is calculated in the prototype based on the soil and crop type. The system turns on the pump and delivers water to the crops when the moisture in the soil falls below the predetermined threshold; when the moisture in the soil rises over the threshold, the water supply is cut off. There is no need for human interaction because the entire system is automated. The device will automatically supply water based on the moisture content of the soil. We may view all of the data using an app on our smartphone.

10 INTEGRATION WITH CONVENTIONAL SYSTEM

At no additional cost, the Smart Irrigation System may be readily connected into an existing traditional irrigation system. As a result, farmers will be able to employ it with ease in their crops. The system can be connected to a drip irrigation system, a sprinkler system, or a surface irrigation system for the most efficient use of water resources. In surrounding fields, we put sprinkler and drip watering system prototypes to the test.

1) Clean and dry the weighing tin+lid before weighing to a precision of 0.01 g. (W1). In the amount required by a test, select a typical quantity of damp soil. If nothing else is stated, use at least 30 g. Replace the lid on the weighing tin and place the sample inside. Weigh the tin and its contents to a precision of 0.01 g. (W2).
2) Remove the lid and place the tin in the oven, along with the contents and lid, to dry to a consistent weight between 105°C and 110°C.
3) Take the tin with the contents out of the oven, replace the lid, and cool everything in the desiccators.
4) Weigh the tin and its contents to a precision of 0.01 g. (W3).

The moisture content present in soil is given by,

$$= \frac{W2 - W3}{W3 - W1} * 100$$

Where,

W1 = Weight of tin (g)

W2 = Weight of moist soil + tin (g)

W3 = Weight of dried soil + tin (g)

Gravimetric Test Results

The test was conducted for red soil, Black soil and laterite soil in three trials and the results are given in the below table(s)

TABLE 1
BLACK SOIL

Trial-1	W1(gm)	W2(gm)	W3(gm)	Soil moisture content(%)
1	20	95	82	20.96
2	20	90	75	27.27
3	20	85	71	27.45
				Average= 25.22

TABLE 2
RED SOIL

Trial-2	W1(gm)	W2(gm)	W3(gm)	Soil moisture content(%)
1	20	100	85	23.07
2	20	95	90	21.42
3	20	90	75	27.27
				Average= 23.92

TABLE 3
LATERITE SOIL

Trial-3	W1(gm)	W2(gm)	W3(gm)	Soil moisture content(%)
1	20	95	78	29.31
2	20	100	80	33.33
3	20	105	82	37.1
				Average= 33.24

The prototype was put to the test on three different types of soil: red soil, black soil, and laterite soil. To check that the prototype worked properly, the sensor readings were compared to the results of gravimetric experiments. To acquire reliable findings, the sensor was inserted in the soil at the same time as the sample was obtained for the gravimetric test. Because the sensor is real-time, it provided immediate findings. The results shown were noted down. It was also noted that the pump supplied water at specified threshold for these three soils.

TABLE 4
SOIL MOISTIRE READINGS

Sl.no.	Soil type	Sensor reading(%)	Moisture content by gravimetric test(%)
1	Black soil	26	25.22
2	Red soil	24	23.92
3	Laterite soil	35	33.24

11 MOISTURE DEPLETION IN SOIL

A patch of land in an open region on our college campus was chosen and moisture depletion was checked.
At the same time that the soil was watered, sensor readings were taken. Sensor measurements were taken at hourly intervals to monitor soil moisture loss. The senor reading is as follows:

The Below Graph shows the moisture depletion in the selected area.

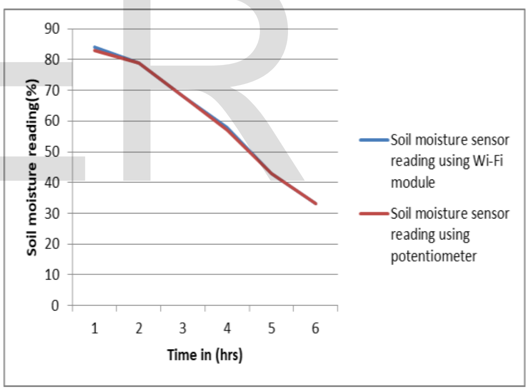

Fig. 4. The graph shows how moisture levels have decreased over time.

The moisture level dropped swiftly due to the tiny size of the targeted region. The soil type, evaporation rate, and field capacity all play a role. We set the moisture threshold at 30%, and the pump kicked in as soon as the moisture level dropped below that.

12 MERITS

No human Intervention- Because the smart irrigation system is totally automated, no human intervention is required.
Helps in conservation of water- There is an even distribution of water; there is no overwatering or underwatering.

As a result, implementing this technique may result in water conservation.

Flexible- The system is adaptable and can be used with either drip irrigation or sprinklers. It can be used on a wide range of crops and soil types. Depending on the kind of soil, a water supply threshold can be set.

Affordable- It is less expensive and requires very little maintenance because open source technology is used. It can be easily connected into an existing irrigation system at no further cost.

Low power consumption- The system can operate at 5 volts (excluding pump). Solar energy can be used to power the system. It can also be connected to a power source in the house or to batteries.

Low maintenance- Because the system is automated, routine inspections are required to ensure that it runs smoothly. It does not necessitate a lot of upkeep.

Remote Operation- The device can be controlled remotely via a smartphone app, and the data can be viewed via the internet from anywhere.

13 APPLICATIONS

The smart irrigation system can be used in agricultural areas, greenhouses, vineyards, and plantations. It's compatible with both drip and sprinkler watering systems. It's also appropriate for tiny backyard gardens and parks. It can also deliver real-time data to the user. The technique can improve sugarcane, tobacco, and other economic crops. It can also help indoor gardens and potted plants. It would help with water conservation by giving the crops the right quantity of water and eliminating overwatering. It will automate the irrigation system, decreasing the need for manual labour and enhancing overall efficiency.

14 CONCLUSIONS

Irrigation is considered the country's backbone because it is the most critical prerequisite for human civilisation. In the current environment, water conservation is a key priority. By continuously monitoring soil conditions, controlling water flow, and lowering waste, this project strives to protect natural resources. By cutting labour costs and increasing farming efficiency, this technology has the potential to greatly aid farmers. By modernising farming processes, we are able to provide outstanding harvests and increase farmer living standards. It will be useful in dry and semi-arid environments.

We believe that, with a little more research and development, this system can be implemented in our country based on the results of the testing and the prototype's use in various locations. It will be beneficial to the farmers.

15 SCOPE FOR FUTURE DEVELOPMENT

Additional sensors, such as a pH sensor, temperature sensor, humidity sensor, and moisture sensor, can be connected to the prototype to help with irrigation based on varied situations and requirements. The prototype might be connected to a weather forecasting system, allowing it to account for rainfall and weather fluctuations when irrigating.

The device can also be connected to the data cloud to collect field data. The Smart irrigation system can benefit small-scale farmers because it can be mass-produced at a lower cost. It might also be tweaked to work in a wide range of soil and crop situations.

ACKNOWLEDGMENT

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