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Design and Development of Smart Irrigation System Using Internet of Things (IoT) - A Case Study

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ABSTRACT

With India's population growing at a rapid pace, traditional agriculture will have a tough time meeting future food demands. Water availability and conservation are major concerns for farmers. This paper aims to discuss the aspects related to designing and fabricating an automatic irrigation system using the Internet of Things (IoT) which will save the farmer's time and money significantly. Human intervention in fields will be reduced. Changes in soil moisture are detected by soil moisture sensors and irrigation is automated using IoT. The proposed system is most economical for underdeveloped places because it is very cost-effective. Based on the soil moisture content, the sensor detects and sends signals to the node MCU, which activates the motor. When the plants receive enough water, the motor automatically shuts off. The user will be alerted about the soil's moisture content through his mobile phone. The proposed smart irrigation system is implemented at our campus which conserves energy and water.

INTRODUCTION

India is a village-based country, and agriculture is critical to the country's prosperity. Agriculture in our country is reliant on the monsoons, which are in short supply. As a result, irrigation is employed in agriculture. Water is delivered to plants based on the soil type nature of irrigation. In agriculture, two things are critical: first, obtaining information about soil fertility, and second, measuring soil moisture content. Different irrigation techniques are now available, which are utilized to lessen the reliance on rain. Electrical power and on/off scheduling are the primary drivers of this strategy.

Any device integrated with electronics, software, sensors, and network connectivity to allow the objects for collecting and sharing data is considered an Internet of Things (IOT) item. It refers to a world in which everything is intelligently connected and communicated. Time and water can be saved by enabling smart watering. It saves water by automatically watering plants according to water demand. The sensors are placed to check the moisture of the soil. Using a moisture sensor, a smart autonomous irrigation system focuses on irrigating plants regularly with no human supervision.

It is critical to develop food technology production quickly to fulfill the ever-increasing need for food and the shrinking availability of food essentials. Agriculture is the only way to get this. This is a critical aspect in human societies' rising and dynamic food production demand. Agriculture is critical to the economy and growth of countries like India. Farmers utilize irrigation because of a lack of water and scarcity of land water, which results in water shortage on the planet.

PAST STUDIES

A project is designed to empower field owners to monitor and regulate the growth of their plants in their farms. This is accomplished by utilizing a smart IoT platform and solenoid valves to control water flow using soil moisture and provide real-time surveillance to owners who are unable to visit their farms. This initiative also enables the monitoring of employees and crops to prevent losses. Anyone with a Smartphone may use it, and once set up, it requires no upkeep (Guptha et al. 2019). A smart method was used professionally capable of employing ontology to decide on sensor data values. The ontology decision and sensor information together constitute the final decision using the outcome of a machine learning algorithm (KNN). An irrigation system is designed which activates the motor ON and OFF based on variations in moisture content. Soil moisture amount is studied in this article, however, the proposed project added to an existing project by connecting IOT (Arun & Sudha

2012). A watering system developed for tunnel farming is so intelligent that it develops and applies true machine learning decision-making capability, e-architecture, and hardware specifics in the preceding section (Archana & Priya 2016). To test the proposed system's reaction, all of the sensors (temperature and humidity, light sensor, and soil moisture sensors) were deployed (Chavan & Karnade 2014). The data is communicated to the edge server via a GSM module and an Android application, and the results may be viewed by the farmer. After that, the user can operate the valve with some actuation (Kim et al. 2019). The suggested system by Al-Ali et al. (2019) uses a chip controller with integral Wi-Fi connectivity to provide the needed energy to operate. He also suggested that if high crop production is sought, irrigation systems must be constantly monitored, particularly in distant places where water is scarce. Farming operations may also encounter issues linked to the amount of energy needed to provide a decent crop yield. Energy efficiency in agriculture is examined from a variety of perspectives. Furthermore, a renewable energy source, such as a solar cell, is given to enable stand-alone functioning in the event of a utility company power outage. A wireless monitoring system interface is also being developed, which will allow remote users to check the state of a farm from the comfort of their phone or computer. A remote irrigation method built for plantation using Arduino. Water is supplied based on the change in humidity of the soil without considering the amount of soil moisture (Shwetha 2019). Considering the points from the literature review, irrigation is the science of artificially applying water to land or soil, which means that plants must be given water based on the soil type. This paper is intended to achieve the following objectives:

1. To overcome the problem of soil moisture variation for proper irrigation
2. To develop a low-cost automatic watering system using the Internet of Things.
3. To keep track of moisture levels in various environments
4. To use a mobile phone app to improve the system

THE EXISTING SYSTEM

The farms were irrigated manually in prior irrigation technologies. It is accomplished by turning on and off the motor and examining the water level in the fields. Farmers water their crops at regular intervals despite not knowing the soil moisture content. This results in either under or over-watering, which has an impact on plant development.

A worker had to be deployed in fields to monitor plants regularly, which meant an additional fee had to be paid for plant monitoring labor. The farmer has no idea when he needs to go to the field to turn the motor On/Off during scorching sunny days or even in the middle of the night.

Due to problems in traditional irrigation technologies, crop output is reduced. Water must be supplied in sufficient quantities to allow plants to grow properly. Otherwise, crop failure will occur. As a result, the farmer loses money due to traditional irrigation methods.

THE PROPOSED SYSTEM

The crop is automatically irrigated in this suggested smart irrigation system employing IOT by sensing the moisture amount of soil. This system is led by the Node MCU, which serves as the system's brain. Using jumper wires, the Node MCU is connected to a soil moisture sensor (SMS) and relay module. The SMS is placed in the soil and detects moisture levels before sending the data to Node MCU. The Node MCU is programmed with code that turns on and off the relay switch based on a moisture content threshold.

The moisture content value is forwarded to the user's phone. Based on the content the user will turn on the motor On/Off in his phone. When the moisture content is lower than the threshold value, the motor is turned ON and it is turned off when the moisture content goes above the threshold value. The relay switch is used to turn the motor automatically dependent on soil moisture content.

The irrigation of fields is done automatically when this method is used. Human intervention is not required in fields. As a result, the farmer can save labor charges. By implementing this technology, the proper amount of water is delivered to the fields, reducing the difficulties caused by under and over-irrigation. As a result, there is no risk of crop failure. The components of the proposed smart irrigation system are depicted in Fig. 1.

METHODOLOGY USED

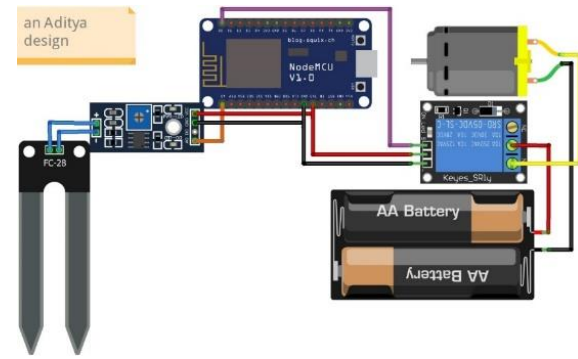

Fig. 1: Components of proposed smart irrigation system.

The design of the system produced during the project's design phase is revealed in Fig. 2, had to be properly implemented during the project's implementation. The widespread adoption of automated technology in agriculture has shown to be cost-effective. The proposed system is capable of transforming irrigation and has an impact on the commercial and industrial sectors. As a result, this project has been a system-based expert or non-expert approach to field monitoring for detecting dryness and treating the area. The food and beverage system is beneficial to the agriculture business, which is looking for smart methods to reduce costs.

RESULTS AND DISCUSSION

The irrigation of fields is done automatically when this method is used. Human intervention is not required in fields. As a result, the farmer can save labor charges. By implementing this technology, the proper amount of water is delivered to the fields, reducing the difficulties caused by under and over-irrigation. As a result, there is no risk of crop failure. The moisture sensors detect the moisture level in the plants and delivers a signal to the operational amplifier if the moisture level is lower than desired level, causing the DC Motor pump to switch on and feed water to the appropriate field area. The system comes to a complete stop when the appropriate moisture level is reached, and the DC Motor pump is shut off. As a result, the entire system's operation has been thoroughly tested and is said to work well.

To check the effectiveness of the proposed smart irrigation the following tests are performed which are given in Table 1. It is clear from the table that the motor is turned ON when the moisture level is less and the motor is turned OFF when the required moisture level is reached.

Fig. 2: Circuit diagram of the proposed system.

Table 1: Performance test on different soils.

S. No.	Type of soil	Moisture content (%)	Motor ON/OFF
1	Wet soil	75	OFF
2	Partially Wet soil	55	ON
3	Dry soil	30	ON

CONCLUSION AND FUTURE SCOPE

Agriculture networking technology is not only necessary for modern agricultural growth, but it plays a major role in future agricultural development; it will be the future path of agricultural development. After constructing the agricultural water irrigation system hardware and analyzing and researching the network hierarchy features, functionality, and corresponding software architecture of precision agriculture water irrigation systems, applying IoT to highly effective and safe agricultural production has a high influence on confirming the effective usage of water and efficiency of agricultural yield. Using the smart irrigation method, irrigation becomes simple, precise, and practical, and can be utilized in agricultural fields in the future to advance agriculture to the next level. The yield from the moisture sensor and level system has a significant impact on the output.

The proposed smart irrigation system is successfully implemented using IoT at our campus which conserves energy and water by the soil moisture content. Once the plants get sufficient water, the motor automatically stops. The user will be notified of the soil's moisture content through SMS. The effectiveness is checked and the total savings of Rs.1.5 Lakh per year are achieved by the proposed system by way of energy and water conservation. Performance test on soil moisture content using different soils (wet soil, partially wet soil and dry soil) is carried out to validate the results. The proposed system functions well and controls the water flow by turning the motor On/Off according to the moisture level.

As there is a rapid growth potential for IoT in the future, the proposed system could become more effective, faster, and cheaper. As an extension of the project, this system can be converted into a smart system that forecasts worker activities, rainfall patterns, harvest times, and animal intruders in the field, and then communicates the information using advanced technology such as IoMT, allowing agricultural systems to become self-contained and better yield.

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