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Automatic Irrigation System using Soil Moisture Sensor

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ABSTRACT

Insufficient precipitation, depleted reservoirs, and inadequate water conservation methods have a detrimental impact on the production of food commodities. This instigates us to conduct a comprehensive investigation on water conservation in agriculture. The wireless sensor network has made significant progress in detecting various parameters such as soil moisture, temperature, and humidity. By installing sensors in agricultural fields for monitoring purposes, water conservation for irrigation can be achieved. The present document provides a concise overview of the implementation of an Automated Irrigation System that utilizes a Soil Moisture Sensor. The proposed system involves updating the moisture content data to regulate the water pump. This paper aims to provide a comprehensive understanding of the appropriate technique for achieving optimal irrigation.

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1. INTRODUCTION

Increasing food demand necessitates technological advancements in food production. The production of sustenance necessitates continuous human monitoring of crops for irrigation. This continuous human monitoring is not practicable at all times. Therefore, an automatic irrigation system that irrigates crops without human intervention is a suitable one. This system will feature continuous monitoring, which will assist in enhancing production.

The automatic irrigation system is a novel model that has been developed through the utilization of advancements in communication technology. The proposed system aims to utilize wireless sensor networks to monitor the levels of soil moisture and environmental temperature. The data collected by the sensors is transmitted to a centralized computing server where it is processed to determine the irrigation requirements based on the received values. The Wireless Sensor Network (WSN) is incorporated with the microcontroller to regulate the operational aspects of the motor pumps that constitute the system. The microcontroller activates the motor pumps to irrigate the field when the soil moisture level falls below the required threshold.

The DHT11, a widely utilized soil moisture tester and temperature sensor, is utilized to gather data from the field. The microcontroller PIC16F73 is commonly utilized for the purpose of processing the sensed data and controlling the water pipeline. The PIC16F73 microcontroller is fabricated utilizing the ESP8266 chip, which has been designed to incorporate Wi-Fi and Bluetooth functionalities. The PIC16F73 microcontroller is a cost-effective option and its compatibility with the PIC IDE facilitates its usage. The functioning mechanism of the PIC integrated development environment (IDE) involves the installation of the ESP8266 board manager. In order to establish an effective irrigation system, it may be necessary to incorporate diverse technological advancements. This paper presents a comprehensive analysis of various techniques aimed at enhancing crop irrigation and maintenance.

2. AUTOMATIC IRRIGATION SYSTEM

The implementation of irrigation systems is of utmost importance in facilitating the growth and development of crops. The manual provision of water is not a definitive solution for enhancing food production. Optimal production requires precise timing and appropriate quantities of water. The implementation of an Automatic Irrigation System is intended to mitigate the excessive utilization of water in the agricultural sector, thereby reducing water consumption. The implementation of an Automatic Irrigation System enhances crop surveillance, frequently without the need for human intervention.

The design of an Automatic Irrigation System incorporates the utilization of Wireless Sensor Network and Mobile communication. Wireless Sensor Networks (WSNs) are utilized in the agricultural sector to detect and monitor soil moisture and temperature levels. These networks are composed of sensors that are specifically designed for this purpose. The data obtained from sensors are transmitted to the microcontroller to control the pump valve. In the event of a decrease in soil moisture, the sensor transmits data to the microcontroller. Subsequently, the microcontroller issues a command to activate the valve. Upon attaining the designated moisture threshold, the microcontroller issues a command to deactivate the valve. The microcontroller will transmit the revised moisture and temperature readings, along with the corresponding response, to the user.

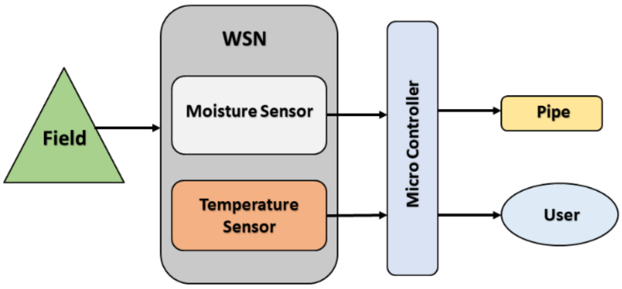

Figure 1. System of automation irrigation.

The block diagram elucidates the operational context of the automated irrigation system. Moisture and temperature sensors are utilized within the agricultural sector to detect and measure the respective levels of moisture and temperature present within the soil. The integration of sensors with a single-chip microcontroller facilitates the computation and processing of sensor data. The digital signals conveying the sensed information are transmitted to the microcontroller. The microcontroller is responsible for processing the digitized data and executing appropriate actions to regulate the water pump. In the event that the processed data pertaining to soil moisture registers at a low level, the microcontroller signals the activation of the water pump motor.

2.1. Sensor

Sensors are electronic devices utilized to detect and respond to natural phenomena, which are then utilized as input. The variables under consideration include moisture, pressure, temperature, heat, and light. The signals are produced as an output of the signal in a format that is easily comprehensible by humans. These signals are then transmitted through a network to a designated location for subsequent analysis or processing. This paper employs two sensors primarily for the purpose of sensing, as enumerated below.

2.2. Soil Moisture Sensor

The soil moisture sensor is utilized to quantify the moisture levels present in the soil. The conventional approach to characterizing soil involves a range of techniques, including drying and other methods. However, soil moisture sensors utilize alternative properties, such as electrical resistance, dielectric constant, or neutron synergy, to indirectly gauge the water content of soil. Soil moisture levels are subject to fluctuations based on a variety of factors, including temperature, soil composition, and electrical conductivity. Soil water potential sensors, also known as moisture sensors, are utilized to determine the water potential of soil.

2.3. Temperature Sensor

The temperature sensor is capable of detecting and measuring temperature across a wide range of physical bodies. It is one of the primary factors that is frequently computed. Temperature sensing can be achieved through two methods: direct or indirect. This involves the utilization of a temperature sensor. The direct method involves establishing physical contact with the source, while the indirect method relies on utilizing the radiated energy emitted by the source, without making direct contact with its body. The DHT11 temperature sensor is being utilized in the current project. The component in question comprises four distinct pins, each serving a specific purpose. The initial pin is designated for the provision of voltage, while the second pin functions as an output pin. The third pin is classified as a NULL pin, and the final pin is reserved for the supply of ground.

3. LITERATURE REVIEW

The present chapter has examined diverse forms of Automatic Irrigation systems aimed at enhancing the efficiency of irrigation. The various techniques employed in Automatic Irrigation System shall be deliberated upon comprehensively. The Irrigation Management System is a technological solution designed to optimize the management of water resources in agricultural settings. By utilizing a Soil Moisture Sensor in conjunction with a Programmable Integrated Circuit (PIC), Maniraj et al. have proposed an automated irrigation system that utilizes a soil moisture sensor and PIC technology. The present system employs a microcontroller to enable motor activation and deactivation via control mechanisms, thereby obviating the need for human intervention. The light-emitting diode (LED) is utilized to signify the operational status of the programmable integrated circuit (PIC). The soil's moisture level will be assessed and the irrigation status will be transmitted to the designated local host or server.

An automated irrigation system is a technological solution designed to optimize the process of watering crops or plants. Joaquín Gutiérrez et al. have proposed an automatic irrigation system that utilizes a Wireless Sensor Network and GPRS Module to assist farmers. A wireless network comprising of soil moisture and temperature sensors is utilized to detect pertinent data. The gateway unit serves to activate the actuators and facilitate the transmission of data pertaining to the irrigation schedule between the web application and the farmer. The utilization of photovoltaic panels is employed for the purpose of powering the system.

This study focuses on the creation of software for an automated drip irrigation system that utilizes a microcontroller and a soil moisture sensor. The authors, N.V. Gowtham Deekshithulu et al., have put forward a proposal for an irrigation system that utilizes soil moisture sensors and microcontrollers to assist farmers in irrigating their lands with optimal amounts of water. The Keil Vision 3 software is utilized in conjunction with an 8051 microcontroller and a sensor. The pump will deactivate once the moisture content of the land reaches 70%, and conversely, it will activate when the moisture content falls below this threshold until it attains a specific level of moisture. The process of regulating water pumps is accomplished through the utilization of a solenoid valve.

In 2014, Shiraz Pasha B.R. and Dr. B Yogesha conducted a study. The Microcontroller Based Automated Irrigation System was developed by the International Journal of Engineering and Science (IJES) with the aim of utilizing automation techniques to irrigate land. The soil moisture sensor is inserted into the soil. The sensor detects the relevant data and transmits it to the microcontroller. The controller issues a command to activate the relay responsible for initiating the operation of the pump in the event that the moisture level falls below the predetermined threshold value. Upon sensing the moisture level through the sensor, the pump will be automatically deactivated. The information will be exhibited on the liquid crystal display (LCD) of the controller.

Kumbhar and Ghatule (2013) presented a Microcontroller-based Controlled Irrigation System for Plantation at the International Multi-Conference of Engineers and Computer Scientists. The system was designed to facilitate automated irrigation of lands without the need for manual intervention. The device was fabricated utilizing a humidity sensor and a microcontroller. In the event that the set-point value of the humidity sensor decreases, the microcontroller will activate the motor to provide water. Once the set-point value is attained, the motor will subsequently deactivate. In 2015, Karan Kansara put forth a proposal for an automated irrigation system that utilizes sensors and the Internet of Things (IoT) technology. The purpose of this proposal is to benefit farmers in the realm of irrigation. The interfacing between the microcontroller and the Android application is established through the use of GSM technology, while the connection between the microcontroller and the GSM module is facilitated by the MAX232 interface. When the moisture level reaches a low threshold, the microcontroller triggers the mobile device to activate an audible alarm in order to prompt the opening and closing of the valve.

In their 2014 study, Pavithra D. S and M. S. Srinath proposed an Automatic Irrigation Control System that utilizes GSM technology to facilitate efficient resource utilization and crop planning. Specifically, the system is designed to detect low soil moisture content and respond accordingly. Additionally, the system is integrated with an Android mobile device. The data pertaining to moisture shall be transmitted to the microcontroller. Upon receiving the buzzer indication, the microcontroller initiates a call to the mobile device prompting the user to press a button. Subsequent to the initiation of water supply, the valve is opened, allowing for the attainment of a specific level of moisture content. Upon detection of the moisture level by the sensor, the microcontroller signals for the valve to be closed.

The Wireless Sensor Network Based Agricultural Monitoring System, as proposed by M. Jagadesh in the International Journal of Creative Research Thoughts (IJCRT) in 2018, aims to facilitate field monitoring through the utilization of sensors that measure moisture, temperature, pH, and water level. The information obtained by the sensors shall be conveyed to the PIC through the utilization of zigbee technology. The data is processed using Raspberry Pi to regulate the water pump. The current state of the field will be transmitted via the webpage, which is accessed through a pre-defined IP address within the module. Gautam and Reddy (2012) put forth an innovative embedded system for irrigation in the International Journal of Computer Applications. The system utilizes GSM-Bluetooth technology for remote control and predefines irrigation time based on sensor data and crop type for automation. The system engages in communication with the user through the use of Short Message Service (SMS). The Global System for Mobile Communications (GSM) technology is utilized for the transmission and reception of messages. The implementation of Bluetooth technology in the aforementioned meters will circumvent the imposition of SMS charges.

In 2012, Purnima and S.R.N. Reddy published an article in the International Journal of Computer Applications detailing their proposal for a remote monitoring and control system with an automatic irrigation system that utilizes GSM-Bluetooth technology. The system was designed to enable remote control and monitoring of irrigation processes with low cost and minimal power consumption. The system has been devised to incorporate sensors and a microcontroller that interfaces with Bluetooth technology to facilitate data transmission over a limited distance, thereby obviating the need for SMS charging. The utilization of GSM technology facilitates the transmission of information pertaining to environmental factors such as elevated temperature, reduced moisture levels, and increased CO2 concentration to farmers via SMS.

4. PROPOSED SYSTEM

The Automatic Irrigation System is a mechanism that enables the irrigation of land without the need for human intervention. The mechanism operates through the utilization of a sensor for soil moisture and temperature, specifically the DHT11. The utilization of Wireless Sensor Network technology is prevalent in the agricultural domain for the purpose of detecting and monitoring soil moisture and temperature levels. The Wireless Sensor Network (WSN) is interfaced with the PIC16F73 microcontroller to facilitate the processing of the acquired data from the sensor. The central server is responsible for performing data manipulation. Figure 2 depicts the operational mechanism of the Automatic Irrigation System.

The Automatic Irrigation System utilizes connecting wires to link the soil moisture tester and temperature sensor. To establish a connection between the microcontroller and the sensor, it is necessary to connect the ground of both components. The Vcc pin of the PIC16F73 should be used to supply power, while the A0 pin of the microcontroller and the sensor must be connected. The sensor sends a signal to the microcontroller to activate the valve when the soil moisture falls below the predetermined threshold. Once the sensor detects that the threshold value has been reached, it sends a signal to the controller to turn off the pump. The water pump is regulated through the utilization of a relay. The irrigation schedule is transmitted to the user on a regular basis. The GSM module facilitates communication between the microcontroller and the user.

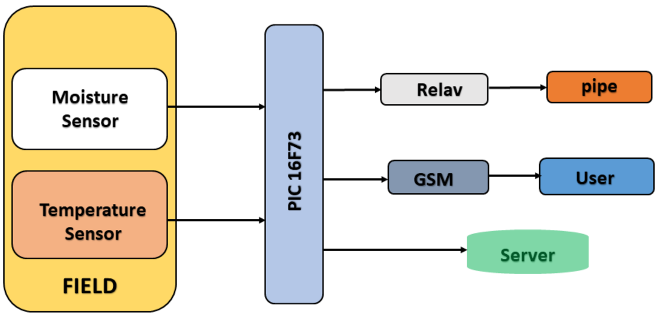

Figure 2. Block Diagram of Proposed Automatic Irrigation System

The Wireless Sensor Module comprises a Soil Moisture Tester and a Temperature Sensor. The soil moisture and temperature sensor is utilized to detect the moisture and temperature levels of the soil. Two sensors are deployed in the crop field to provide uninterrupted monitoring of soil moisture and temperature. The data obtained from the sensor will be transmitted to the microcontroller for subsequent processing.

4.1. Controlling Unit

The control unit is comprised of a microcontroller that manages the execution of operations. The sensing unit is composed of various sensors, including the DHT11 sensor and soil moisture sensor. The PIC16F73 ESP8266 microcontroller was employed in this project.The PIC16F73 microcontroller, equipped with an ESP8266 Wi-Fi module, interfaces with the DHT11 and soil moisture sensors. The sensors transmit data twice daily.

The temperature sensor outputs analog readings. The conversion of these can be achieved through the utilization of an ADC converter that is internally integrated within the microcontroller. The Wireless Sensor Unit functions as a closed-loop operation within the system. The microcontroller was used to interface with the relay in order to control the motor's ON/OFF switching. The microcontroller receives the sensed value from the Wireless Sensor Network and performs a comparison between the sensed data and a pre-defined threshold value. The microcontroller is programmed to control the motor and turn it off if the sensed data surpasses the predetermined threshold value. When the microcontroller detects that the sensed data is lower than the threshold value, it initiates a command to activate the motor and turn it ON.

4.2. Sending message using GSM

The output of the microcontroller is connected to the GSM module for interfacing. The GSM module is utilized by the microcontroller to transmit messages to the user. The sensor unit measures the temperature or soil moisture and sends the data to the microcontroller. The microcontroller then transmits an SMS alert to the end user containing the measured value. The microcontroller transmits information regarding the irrigation actions to the end user.

5. CONCLUSION

Agriculture is becoming increasingly important as a key industry in the country. Since ancient times, irrigation has been performed using conventional techniques. The automation systems are currently responsible for carrying out the irrigation process. The Automated Irrigation System has been developed with the aim of benefiting farmers. The system is designed as a real-time feedback control system that facilitates efficient irrigation of land. The system is highly dependable and designed with a user-centric approach. The system is accessible from any location and can be utilized at any time. The base station will monitor the moisture and temperature sensor. The utilization of wireless network and mobile communication technology (GSM) results in decreased need for frequent field monitoring. The utilization of Bluetooth technology enables the elimination of SMS fees within a limited proximity. The system under consideration is designed to be scalable, allowing for the deduction of additional parameters, such as nitrogen content and CO2 levels, for multiple users. This is achieved through the updating of wireless sensor networks.

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