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INTERNET OF THINGS ENABLED SMART SPRINKLER SYSTEM FOR EFFICIENT IRRIGATION THROUGH SMART AGRICULTURE TECHNOLOGIES

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Abstract: Modern day agriculture suffers from various ailments in all spheres involved in it such as water scarcity, water wastage, lesser yield without surplus, and lack of proper fertilizers and manure. To solve the issue of water wastage and ensure judicious usage of water resources, the Smart Sprinkler System is an innovation brought to agricultural sciences and engineering by electronics and electrical engineering streams. Irrigation was a huge breakthrough in agriculture that paved the way for establishing crop and paddy fields at various regions where water from rivers ceased to cross and flow. But this also led to a huge exploitative usage of water and unnecessary flooding. This has caused great scarcity of freshwater sources on earth, which worryingly constitute just 3% of the total water level present on earth. In order to combat this ever-growing problem of unrestricted consumption of our freshwater supply, various private and government backed research projects are being funded and implemented in most countries. The question is how electronics engineering, electrical engineering and telecommunications can prove beneficial to solving an issue pertaining tothe fields of biotechnology, hydrology and agricultural engineering and pure sciences. Also, the final product design needs to be cost efficient and equipped with good affordability for the customers, in this case being farmers and environment conservationists.

Keywords: Smart Sprinkler System, Biotechnology, Freshwater Supply, Hydrology, telecommunications, Agricultural Engineering, Flooding, Cross And Flow.

1. INTRODUCTION

Arduino, Raspberry Pi, Intel Edision, Intel Galileo, and Netduino are among the best IoT boards for running multiple applications. Every board has its own set of characteristics, benefits, and drawbacks. Sensors and analog-to-digital converters are the two most common subunits (ADCs). The ADC converts analogue signals from sensors into digital signals, which are then fed into the processing unit. Agriculture-IoT helps to increase crop productivity by regulating and controlling activities like watering and fertilising. Agriculture water management - A sufficient water supply is required for agriculture, and crops can be harmed by either an excess or a scarcity of water.. In drought-stricken areas, IoT can be extremely beneficial because it intelligently controls the limited water supply with the least amount of waste. Through a simple smartphone control mechanism, farmers and agriculturists will be able to easily ensure efficient irrigation and judicious use of water supply. To reduce the exploitative use of massive amounts of electricity while using such sprinklers, and to avoid the problems of negligence and absentmindedness in turning off the devices on occasion. To provide a powerful network of systems through which multiple sprinklers can be activated and operated at the same time in order to conserve time and resources used in agricultural fields.

2. EXPERIMENTAL METHODS OR METHODOLOGY

The methodology used is divided into the following steps to explain how each component works. Using A Tcommands, Raspberry Pi activates the GSM Module connected to it to perform SMS and Phone Calls. Following that, the Arduino UNO receives the humidity value from the moisture sensor and categorises the outputs into three groups:

- When the value of humidity is >= 500, the moisture sensor declares the soil as “Wet" and sends the found value to the Arduino UNO, the microcontroller decides not to alert the user to switch ON the sprinkler.

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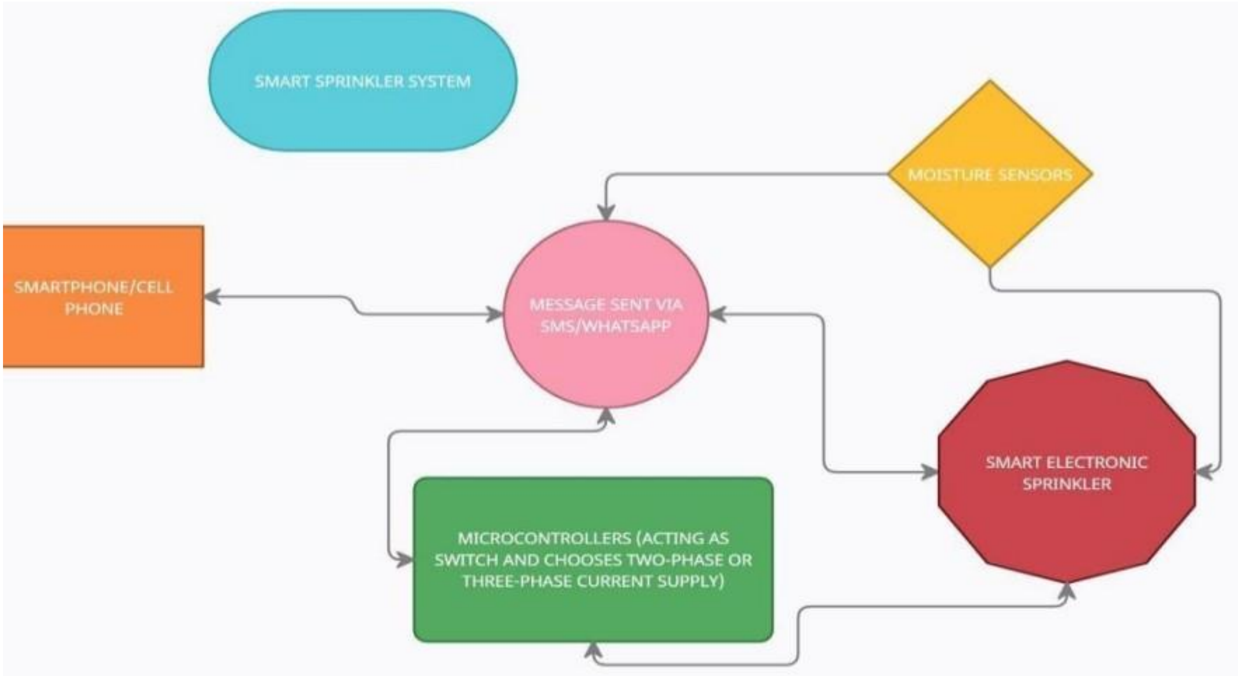
- When the value of humidity is < 500, the moisture sensor declares the soil as "Dry" and sends the found value to the Arduino UNO, the microcontroller decides to alert the user to switch ON the sprinkler.

The user's smartphone receives an SMS message or a phone call alerting notification when the switch is turned on. The Arduino then sends the message "Please turn on the sprinkler" to the user via the GSM module. The user then sends an SMS to the GSM Module that says "Yes," which is temporarily stored in the GSM Module. The GSM Module sends the "Yes" message to the Arduino microcontroller, which understands the message and activates the water sprinkler via programming logic. The water sprinkler has a timer that determines the duration of water pouring, after which it sends a message to the microcontroller, which in turn informs the user via GSM of the status "Completed."

3. THE DESIGN BLOCK DIAGRAM AND MICROCONTROLLER CONNECTIONS OVERVIEW (FIG.(A), FIG.(B))



Figure(1): Display Of Flow Of Water(In Litres) Using Water Flow.

A microcontroller, a GSM module, a solenoid valve, a relay, a soil moisture sensor (LM393) figure B, an LCD display (16x2), and a water resource comprise the system. The water supply is linked to a pipe, which is then linked to the solenoid valve. Figure B depicts a solenoid valve that only opens when a signal from the microcontroller is received; otherwise, it remains closed. The moisture is absorbed beneath the ground near the plants. The sensor is always on and monitors the moisture content before sending the data to the controller, who then displays it on the LCD. Because the moisture/humidity sensor uses only 0.4 mA of power, there is little chance of a loading effect.The solenoid valve requires 24 volts of power, but the controller can only supply 5 volts.

As a result, the valve receives power from outside sources. The LCD is connected to the controller via standard connections, which include +5V and ground connections for backlighting, which is useful for viewing in low light. The display, as designed, shows the moisture content as a percentage. The wireless module is linked to an Arduino, which accepts input voltages ranging from 3.3V to 5V. The code is designed to collect information from and send it to a specific server address.

4. NOVELTY OF THE PROJECT

An IoT-based irrigation system promises to make agriculture easier by leveraging the benefits of embedded systems. The system uses sensors attached to the controller to read the soil moisture, temperature, and electrical conductivity, and then processes the data in the controller. The microcontroller is the system's decision-maker. It examines both the moisture content and the temperature. First, a moisture and temperature threshold must be determined. When the observed moisture value exceeds the threshold value, the controller checks for temperature. Only if the measured temperature value exceeds the threshold value is irrigation performed and the user acknowledged. This is due to the fact that if the temperature is moderate, all crops can withstand the dry soil moisture condition. This would aid in lowering the amount of water used for irrigation. The ability to remotely monitor the farm area is enabled by sending SMS notifications about the field to the user. The SMS contains a warning as well as a suggestion for the affected system. It alsohas a good flood monitoring and control system.

5. PROPOSED METHODOLOGIES

For use in agricultural crops, an automated irrigation sensor was developed and implemented. The sensor takes and processes digital photos of the soil around the crop's root zone with a smartphone before visually estimating the water content. This acts as an irrigation sensor for smartphones. To maximise the use of water for agricultural crops, an automated irrigation system was developed. Throughout the plant's root zone, a wireless network of soil moisture and temperature sensors is deployed. The system operates in tandem with wireless sensor networks, reaping the benefits of a synergistic, symbiotic relationship between GPRS and GSM Modules. A wireless sensor network is used to optimize water usage for agricultural purposes in an automated irrigation system.

6. FEASIBILITY OF THE PROJECT

The Total Cost of the project (10,000+/-), is in market standards of affordability coupled with the unique selling proposition that it offers to the end users. By including loan waiver benefits and government backed subsidy after approving the project. The average cost of the product will be reduced more to a cheaper rate. An Average Agricultural Field requires around 27,000 gallons of water for the proper growth and replenishment of crops of all kinds.
Agricultural fields which implement this device must always practice multi- cropping and cross-cropping of different breeds and varieties of crops and seeds, to ensure proper judicious usage and requirements of water supplied on a day-to-day basis. It also fulfills the demands of organic farming, farming innovations in response to climate change and global warming, by loT and Agri-research and Agri-Innovative technologies being used to produce surplus crops, end wastage of water and show the importance of electronics in the agriculture sector through a synergistic and symbiotic relationship.

7. PROJECT'S SENSOR'S PARAMETERS WITH DETAILED EXPLANATION

This module discusses the project's sensing unit, which includes sensors like a soil moisture sensor, a temperature sensor, and an electrical conductivity sensor that are placed in contact with the soil to be farmed. These sensors communicate with the controlling unit via wired or wireless connections.
For measuring soil dryness, the soil moisture sensor can measure up to 1023 units. This measurement characterises the total dry soil. The maximum temperature detection range of the temperature sensor is 150 degrees Celsius. The EC is a number between 1 and 14.

8. COMPLETE METHODOLOGICAL PROCESS FLOW ANALYSIS AND DECISION MAKING TECHNIQUES

Based on the sensed information, the microcontroller makes a decision. As a first step, the software on the controller must be configured. Before reading the analogue inputs from the sensors, the threshold values for each parameter must be determined. The moisture threshold has been set to800 units in this project. The threshold temperature is 24 degrees Celsius. The EC value is in the range of 5.5 to 6.5 units. These figures are based on an extensive soil examination. The sensors are connected to the correct pins on the Arduino microcontroller. In software implementations, simple coding in the C language is used. The controller examines the moisture value first. The temperatureis measured whenever the moisture level exceeds 800.

9. IMPORTANCE OF MEASURING TEMPERATURE

The temperature is also measured in this project. This value aids in irrigation water conservation. Even if the temperature is not excessively high, irrigation to the crop can be limited if soil moisture is low. This is because many plants can withstand low moisture conditions when the temperature is mild. Arduino is an open-source electronics platform that is based on simple hardware and software. Arduino boards can convert inputs, such as light from a sensor, a finger on a button, or a Twitter message, to outputs, such as turning on an LED, triggering a motor, or publishing anything online. By sending a series of instructions to the board's microprocessor, the board can be powered on. The Arduino programming language (based on Wiring) and the Arduino Software (IDE) (based on Processing) are required for implementation.
The Sensors' moisture and temperature readings are processed by the Arduino uno microcontroller. The controller

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performs the specified task when the values exceed the threshold. Soil moisture sensors are used to calculate the volumetric water content of soil. Because direct gravimetric measurement of free-soil moisture requires the removal, drying, and weighting of a sample, soil moisture sensors measure volumetric water content indirectly by using another property of the soil as a proxy for moisture content, such as electrical resistance, dielectric constant, or neutron interaction. The relationship between the measured property and soil moisture must be calibrated, and it can change depending on environmental factors such as soil type, temperature, and electrical conductivity. Reflected microwave radiation, which is used for remote sensing in hydrology and agriculture, is affected by soil moisture.

9. PROVIDING SERVICE OF RECEIVING ACKNOWLEDGEMENT FROM THE USER

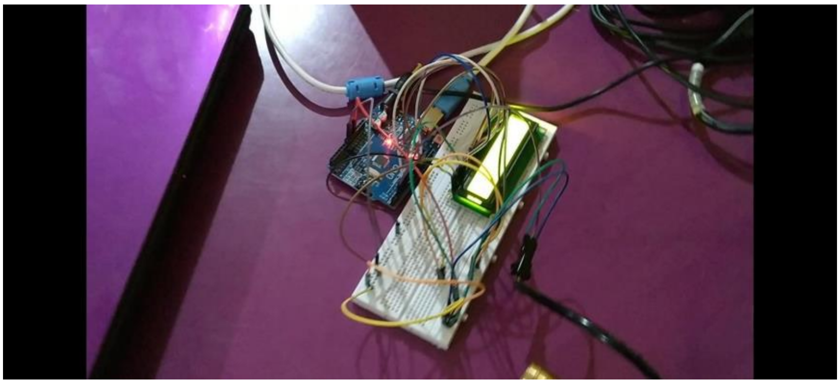
A module for user acknowledgement is included in this project. The user/farmer has complete control over the field and cultivation as a result of this. Farmers who rely on labour to cultivatetheir land stand to gain the most from this venture. They are not required to visit their home country on a regular basis. Instead, they can use this clever idea to learn vital information and avoid dangers in the field. Using GSM connectivity, the text message is delivered to the farmer's phone.
To acknowledge the user in this project, the GSM SIM900 module is used. Any type of GSM module can be used depending on our requirements. AT instructions are used to deliver the message. It also supports two-way communication, allowing the user to respond to the system. When there is a lack of moisture and a high temperature, the GSM alerts the user and requests that the plant be irrigated.
When the (EC) value exceeds the range, fertilisers and manures will be included. Soil moisture refers to the water that remains in the spaces between soil particles. The water available to the plants in the first 200 cm of soil is referred to as root zone soil moisture. Moisture plays an important role in many hydrological, biological, and biogeochemical processes. Soil moisture measurement is the main module of the proposed system. The soil's water content is used to determine irrigation and user recognition. Electrical conductivity (EC) is a measurement of the ability of a dissolved material to conduct electric current in an aqueous solution.
The units used to calculate EC are Siemens per unit area. The EC increases with the amount of dissolved materials in the soil. The pH of the soil, like the EC, measures the acidity based on the concentration of hydrogen ions in it. Soil pH ranges from 1 to 14, with 1-6 being acidic, 7 neutral, and 8-14 being basic on a logarithmic scale. The pH range of 5.5-7 is ideal for most plants. The pH value can be used to calculate the nutrient level of the soil.

10. VALUABLE INSIGHT FROM SELECTED RESEARCH PAPERS AND MODULES

Suresh et al"GSM .'s Based Automated Irrigation Control Using Rain-gun Watering System" discussed the use of an automatic irrigation system based on a microcontroller, with irrigation occurring only when there is a high demand for water. The disadvantage of this technique was that it only covered a small portion of agricultural land and thus was unaffordable. The system can only automate the irrigation system to a very basic level. Furthermore, using GSM to send messages is inefficient.
Microcontroller, Shiraz P and colleagues described an automatic irrigation system based on a microcontroller. They were also able to avoid overwatering already wet soils and watering at the incorrect time of day, which could have harmed or destroyed the crop. This microcontroller-based system can be easily improved by incorporating other current controllers, such as Arduino, which are significantly less expensive but far more functional and do not require an ADC. And there are no user-controlled applications in this system, which is simple but functional.
In their paper "A wireless application of drip irrigation automation supported by soil moisture sensors," Mahir et al work described a wirelessly controlled irrigation system that continuously checks soil water content and is powered by solar energy. The irrigation technology eliminates the need for human labour. However, solar energy is currently unreliable because the system will not receive enough electricity from the Sun if the weather is overcast. Although the range is limited,this technology uses an RF module to control the sensor via a remote. The basic components of the unit are inexpensive, but the overall cost of the system is substantial.

11. RESULTS AND DISCUSSION

Using the above Figures, Figure(2) and Figure(3) As Conclusive Result, The goal of an IoT-based irrigation system is to simplify agriculture by utilising the features of embedded systems. The system reads the soil moisture, temperature, and electrical conductivity of the soil using sensors connected to the controller, and the sensed data is then processed in the controller. This system's decision-making is handled by the microcontroller.



Figure(2): Display Of Flow Of Water(In Litres) Using Water Flow.

Figure(3): Demonstration Of User's Acknowledgment, Switching Action (ON/OFF)Controlled By GPRS, GPS Modules.

It examines the moisture content and the temperature. To begin, the moisture and temperature thresholds must be established. When the moisture value exceeds the threshold, the controller checks the temperature. Irrigation is performed and the user is acknowledged only if the sensed temperature value is greater than the threshold value. This is due to the fact that if the temperatureis moderate, all crops can withstand the dry soil moisture condition. This would save water that would otherwise be used for irrigation. Sending an SMS to the user about the field allows the userto monitor the agriculture area remotely. The SMS contains a warning as well as a suggestion to theaffected system.

12. CONCLUSION

The project's results demonstrate the functionality of water flow control and sprinkler activation using appropriate microcontrollers linked to them. Antennas used for GSM Modules must be upgraded for greater coverage and to incorporate 5G and 6G technologies (in the near future), as well as to operate in WAN or MAN networks. Cloud computing platforms such as Amazon AWS, Microsoft Azure, and others are being researched and considered for the project to further reduce costs and other components.
Standard Internet of Things technologies like Zigbee and IBM Watson Platforms are being compared and analysed for further advancements and improvements. PCB Fabrication and placement of the final circuit board (still in progress) are being checked in relation to the position inthe agricultural field, and which specific location works to ensure maximum efficiency and perfect equi-distribution, equal segregated distribution of water supply and minerals to each corner of the land.

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