SMART IRRIGATION

AND

WATER RESOURCE MANAGEMENT SYSTEM

FACULTY OF COMPUTER SCIENCE AND ENGINEERING

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Certificate of Approval

It is certified that the work presented in this report was performed by **Mohammed Saad Khan 2019250, Malik Muneeb 2019225, and Husnain Ali 2019178** under the supervision of **Dr. Farhan Khan.** The work is adequate and lies within the scope of the BS degree in Computer Science/Computer Engineering at Ghulam Ishaq Khan Institute of Engineering Sciences and Technology.

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ABSTRACT

The goal of this project is to design and implement a smart irrigation system that reduces water consumption, fertilizer usage and increases crop yield substantially by more efficient water utilization. The project employs the use of Arduino microcontroller, GSM900a, soil moisture sensor, DHT22, rain drop sensor, buck converter and mechanical assembly that supports a 1/2 inch ball valve mounted with a 25 kg RC servo motor to automate irrigation.

The system has to be able to measure accurate real time data of moisture content in the soil, and temperature and humidity in the surroundings to determine the amount of moisture required at any given time for the irrigation process. This is accomplished by soil moisture sensor, DHT22 and a rain drop sensor to detect rainfall.

The goal of this project is to create and deploy a smart irrigation system that automates the irrigation process using an Arduino microcontroller, a GSM900a, a soil moisture sensor, a DHT22, a rain drop sensor, and a buck converter. With the help of the suggested technology, farmers may remotely monitor and manage the irrigation process, cutting down on water waste and boosting crop productivity.

To monitor the moisture content, temperature, and humidity of the air, respectively, the system uses a soil moisture sensor and a DHT22 sensor. The system decides whether to start the watering procedure based on the readings. A raindrop sensor is also included to detect rain so that irrigation can be adjusted appropriately.

Additionally, the system has a GSM900a module for remotely transmitting real-time data gathered by sensors to Thingspeak, an IOT analytics platform that enables users to view data in the cloud. The system's voltage supply is controlled by the buck converter, ensuring stable operation.

ACKNOWLEDGEMENTS

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We consider ourselves fortunate to have had the opportunity to work under his guidance, and we are confident that the knowledge and skills we have gained will be helpful to us in many of our future ambitions.

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The mechanical workshop engineers in FME have been very supportive in helping to set up the hardware for the project and providing their invaluable guidance which helped to achieve the practical implementation of our project.

We would also like to extend our heartfelt gratitude to Dr. Dur-e-Zehra Baig Assistant Professor Faculty of Electrical Engineering at Ghulam Ishaq Khan Institute for her mentorship in solving the problems encountered in electric circuit design e.g., power distribution for the components, sensor interfacing and testing of hardware. Her guidance has proved to be crucial in this project.

Chapter No. 1

Introduction

Millions of people throughout the world depend on the agriculture industry for their livelihood. Technology advancements have had a significant impact on the agricultural industry since they have boosted crop yields, reduced prices, and enhanced efficiency. Irrigation systems are one area where technology has advanced significantly. Traditional irrigation methods can reduce soil fertility and are ineffective and costly. Our team created a smart irrigation system that automates watering while retaining soil fertility and minimizing the use of excessive fertilizer to address these problems.

The smart irrigation system keeps track of the soil moisture levels and adjusts the watering procedure as necessary using a combination of sensors, microcontrollers, and communication technologies. Data is gathered by the system from a soil moisture sensor, a rain sensor, and a DHT22 temperature and humidity sensor using an Arduino microcontroller. The GSM900a connection module on the microcontroller then communicates this data to Thingspeak, a cloud-based platform. The watering procedure is efficiently automated since the device steps down the power from 12 volts to 5 volts using a buck converter.

One of the smart irrigation system's key benefits is its ability to change valve opening based on the required amount of soil moisture. By doing this, you may ensure that the crops get the proper quantity of water, reduce waste, increase agricultural output, and pay less for water. The method also reduces the need for fertilizers, which might be harmful to soil and crops.

Due to its ease of setup and operation, the system is perfect for farmers of all sizes. The communication module and microcontroller are linked to the irrigation system, and the sensors are buried in the soil. The system's power supply is a 12V DC unit that is converted to 5V DC via a buck converter. Once the system is set up, the farmer can monitor the temperature, humidity, andmoisture content of the soil using a computer or smartphone.

In general, smart irrigation technology may cause a significant revolution in the agriculture industry. Technology may improve agricultural yields, reduce water and fertilizer costs, and maintain soil fertility by automating irrigation and managing soil moisture. To accommodate the requirements of farms of various sizes, the system may easily be modified and scaled. A unique innovation, the smart irrigation system has the potential to greatly increase agricultural productivity and sustainability, which might fundamentally transform how we grow our food.

Chapter No. 2

Literature Survey

Smart irrigation systems are becoming more and more common as a way to reduce fertilizer consumption, boost crop yields, and preserve water. These systems use a variety of sensors to keep track of soil moisture levels, weather patterns, and other characteristics so that the irrigation schedule may be changed automatically to meet the needs of the crops.

One example of a smart irrigation system is the venture described by Rana et al. (2019). This project employs the use of soil moisture sensors, temperature and humidity sensors, and a microcontroller to automate the irrigation process for agriculture. The system is designed in such a way that it is affordable and quite simple to set up initially and can be maintained via a smartphone app. The system contains a function that alerts the user regarding any problems related to the irrigation system.

Wang et al. (2020) has used a similar sensor-based approach to automate. irrigation process. The project uses a soil moisture sensor, temperature and humidity sensors and water flow sensor to monitor soil’s conditions and adjust the irrigation schedule. The system also includes a smartphone app to enable remote control and monitoring of the data as well as a data analysis feature to help users streamline their watering processes.

Das et al.'s (2018) project is the third example of a smart irrigation system that they provide. This project uses soil moisture sensors, temperature and humidity sensors, and a Raspberry Pi to automate the watering process. The system is intended to be cheap and easily affordable and easy to set up, and it also offers a web-based interface to enable the user to remotely monitor and control the irrigation process. The system contains a function that alerts the user if there are any problems with the irrigation system.

Although these projects share a lot of similarities, there are also some notable differences in the features and methodologies employed. The project presented by Rana et al. (2019) integrates a rain sensor to detect rainfall and modify the irrigation schedule properly, in contrast to Wang et al. (2020) and Das et al. (2018). A water flow sensor is also included in the Wang et al. (2020) project to measure water usage, although it is not included in the other two projects.

Another unique aspect of these projects is the microcontroller they use. Rana et al. (2019)'s project uses an Arduino, but Das et al. (2018) and Wang et al. (2020) utilize a Raspberry Pi microcontroller. Since both types of microcontrollers have advantages and disadvantages, the selection will depend on the specific needs of the user.

Chapter No. 3

Design (System Requirements/Specifications)

In order to successfully design and implement the smart irrigation system that aims to optimize water flow for better natural resource utilization and reduced water and fertilizer consumption, the following components are essential system requirements:

1. Hardware:

The system must include a microcontroller to which the soil moisture sensor, DHT22, rain drop sensor must be interfaced. There also has to be a mechanism for wireless transmission of real time sensor data. For this purpose, we have used GSM sim900A to send weather data on Thingspeak. Other system requirements include servo motor and ball valve clamped on metal plate, power supply and jumper wires.

In addition to these initiatives, there are several other examples of automated irrigation systems that use sensors. By integrating soil moisture sensors, a microcontroller, and a smartphone app for remote monitoring and control, the idea proposed by Patil et al. (2021) automates irrigation. Similar techniques are used in the work by Abid et al. (2020), but the pH sensor is also used to monitor the acidity of the soil.

Smart irrigation systems that automate watering through the use of sensors are generally gaining popularity. These technologies may significantly reduce the need for fertilizers, agricultural output, and water consumption. While many projects share strategies and methodologies with one another, there are also many differences in the specific features and technologies used. The choice of irrigation system will depend on the size of the farm, the crops being grown, and the technology and resources available.

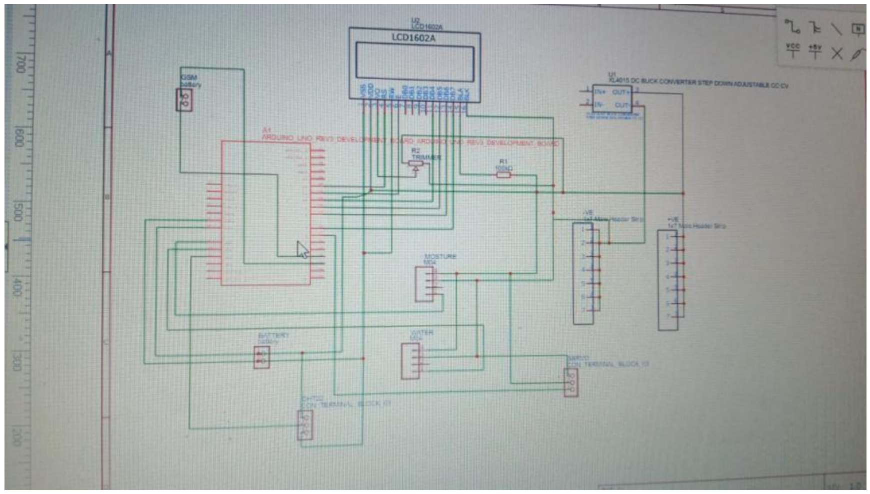
In contrast to Khan (2020)'s idea, which utilizes a pH sensor in addition to the soil moisture sensor, our method includes a rain drop sensor and a DHT22 sensor to monitor humidity and temperature in the air, which can help determine the best time for irrigation.

Second, although Das et al.'s (2018) approach employs a Raspberry Pi to complete the same task, our solution uses an Arduino microcontroller to receive input from the sensors and regulate the valve opening.

Thirdly, unlike the Internet of Things (IoT)-based projects discussed by Wang et al. (2020) and Patil et al. (2021), which connect to the internet using Wi-Fi and Bluetooth, respectively, our project sends data to the cloud using GSM900a.

Finally, we have included a buck converter that steps down 12V to 5V which is helpful for reducing energy consumption.

Overall, despite similarities to other projects in the literature survey, our smart irrigation system project stands out from the competition due to a unique combination of sensors, microcontroller, connectivity, and power management.

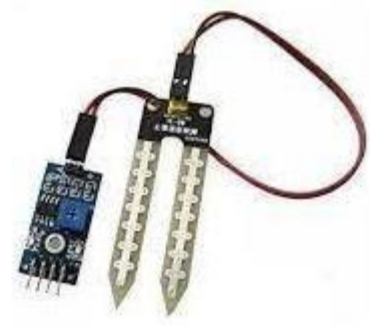


Circuit Diagram Fig 3.1

2. <u>Sensors:</u>

The soil moisture sensor, rain drop sensor and DHT22 must be interfaced with Arduino and be able to send accurate real time data with as little delay as possible.

DHT 22 Fig 3.2



Soil Moisture Sensor Fig 3.3

3. <u>Connectivity:</u>

The GSM sim900A has to be able to provide a reliable connection to the internet to allow transmission of sensor data so that the valve can be automated to open in stages to control water flow accordingly.

GSM 900A Fig 3.4

4. Power Management:

Having the right power distribution for all the components in the system is crucial to this project's successful practical implementation. It ensures that all the components get the required power input to work. The power supply used is 12v 5A, which is stepped down using buck converter to 5v 5A to power all the components. Power loss has to be minimized.

Buck Converter Fig 3.5

5. User interface:

An IOT analytics interface must be used that can display the sensor data so that it can then be remotely accessed. The interface must be simple and easy to use.

6. Robustness and reliability:

The system must be designed in such a way that it can sustain non-ideal conditions such as humidity, temperature, rainfall for a long period of time for it to be of practical use. The components must not get damaged easily due to environmental conditions.

Chapter No. 4

Proposed Solution (Methodology, Implementation)

The initial step of the smart irrigation system's development is its planning and construction. The project's requirements are analyzed, critical components are determined, and a comprehensive schematic architecture of the system is created during this phase. The design should incorporate an Arduino microcontroller, a soil moisture sensor, a rain sensor, a DHT22 sensor, an RC servo, and a GSM900a.

Once the design has been completed, the appropriate system components must be chosen. This calls for selecting goods of exceptional quality that satisfy the project's requirements. Track humidity, rain, and other weather-related events using reliable soil moisture sensors, rain drop sensors, and DHT22 sensors, for instance.

The circuit design process may begin once all of the system's components have been selected. A buck converter, which reduces voltage from 12V to 5V, should be used to power the microcontroller and other components.

The system's functioning prototype has been built and put through a lot of testing. This is accomplished by mounting the components to a breadboard and programming an Arduino microcontroller to use sensor data to operate an RC servo that opens and shuts the irrigation valve in response to the soil moisture level. The system also has to be tested to make sure it can transfer data to the Thingspeak cloud platform and connect with the GSM900a module.

The system must be designed and integrated once it has undergone functional testing. The components of a printed circuit board (PCB) are linked and encapsulated using this method. The system must be easy to set up and maintain.

The system must then be installed and kept up with. The system has to be installed and tested. To ensure that the system continues to work, it must be made simple to maintain. It should frequently be serviced.

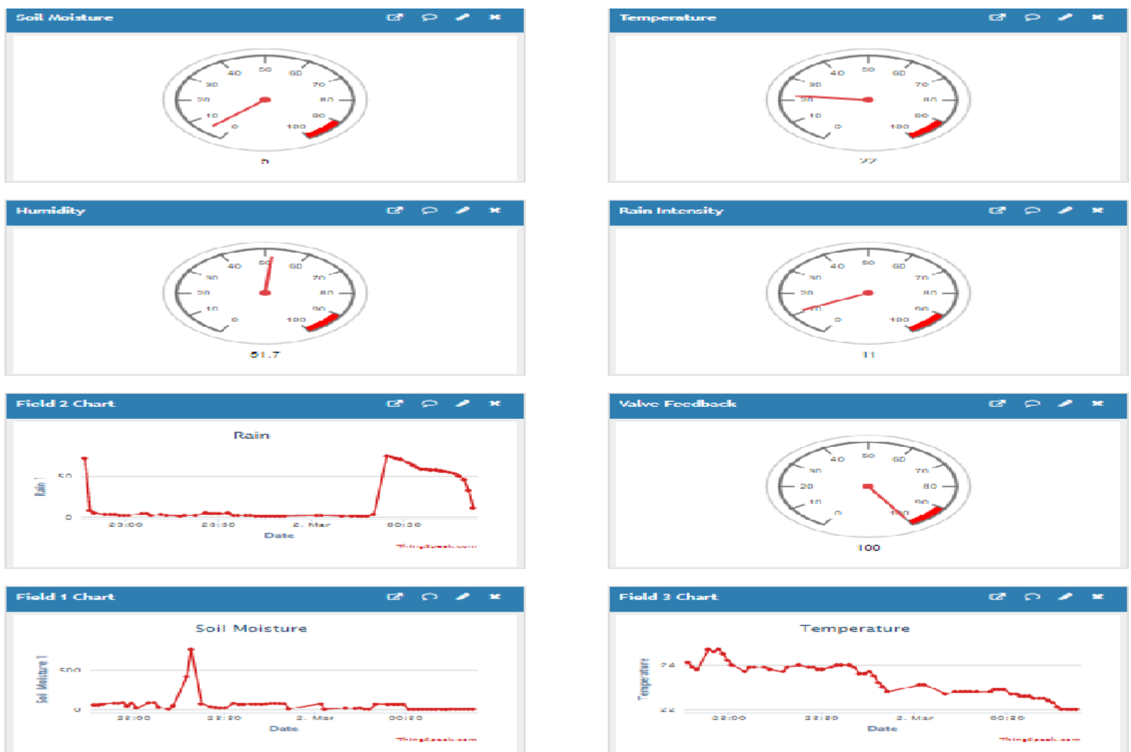
Conclusion:

A farmer may create a smart irrigation system that automates irrigation, maintains soil fertility, and consumes less fertilizer using an Arduino microcontroller, a soil moisture sensor, a rain drop sensor, a DHT22, and a GSM900a. The project process includes planning and design, component selection, circuit design, prototyping and testing, assembly and integration, deployment, and maintenance. This strategy makes it possible to plan, develop, and deploy the system in the most effective and efficient way possible.

Chapter No. 5

Results and Discussion

Results:



Screenshot from Thingspeak Fig 5.1

The displaying of real time data collected from the sensors and the corresponding valve feedback plays a crucial part in this project. It enables the user to remotely monitor the irrigation process and ensure that it is functioning properly. The data displayed visually through graphs and gauges makes it easier for the user to assess the data obtained by the system and draw informed irrigation-related conclusions.

The purpose of valve feedback gauge is to demonstrate how change in environmental factors such as temperature, humidity and soil moisture content corresponds to the proportional opening and closing of the valve. It can also identify any unusual activity related to the valve or any defects.

The gauges for the soil moisture, rain, and humidity sensors display changes in real-time data as the various environmental conditions vary from time to time. The gauges can also be used to change the threshold values for the sensors so that the irrigation system is optimal for the current situation. The gauges help to provide a clear and concise visual representation of data collected by the sensors placed on the field making it easier to comprehend and make sense of the data for the user.

Overall, the display of sensor and valve feedback data is an essential component of the smart irrigation system. It enables the user to monitor the system and make informed decisions about the watering schedule. The visualizations also provide insightful information on the behavior of the system that may be used to increase crop yields and boost performance.

Discussion:

The smart irrigation system is a crucial and innovative application of technology in the agricultural sector. Automation of irrigation is the major objective of the technique, which will reduce water use and boost agricultural output. In order to maintain soil fertility, it also tries to avoid the use of excessive fertilizers that might harm the crop.

The major component of the system is the Arduino microcontroller, which collects data from a number of sensors including the soil moisture sensor, rain drop sensor, and DHT22. After that, a GSM900a module transfers the data from the microcontroller to the cloud based Thingspeak platform. The platform's data storage and analysis allow farmers to remotely monitor the health of their crops and make informed decisions about fertilization and irrigation.

One of the most important sensors in this system is the soil moisture sensor. The ability of the gadget to monitor the moisture content of the soil enables the microcontroller to open and close irrigation valves in accordance with the needed soil moisture levels. This practice ensures that the crops get the optimum amount of water required for growth, increases crop yield and enables more efficient utilization of water resources and prevents water wastage.

The temperature and humidity levels which are measured by DHT22 sensor have a significant impact on amount of water required for irrigation. Farmers may use the sensor data to make informed decisions about when and how often to apply fertilizer to the soil as well as whether or not to irrigate their crops depending on the given sensor data as displayed by gauges and graphs. By optimizing these factors, farmers may optimize crop growth and output, which will boost income and enhance food security and also help to preserve soil fertility and water resources by preventing water wastage.

Another important component of the system is the raindrop sensor. When rain is detected, the gadget may suspend irrigation to avoid overwatering the crops during wet conditions. This feature helps to conserve water and prevent waterlogging, which can damage crops and reduce output. The system's capacity to respond to shifting weather patterns also helps farmers conserve water resources and keep the optimal moisture level in the soil.

A key component of the system is the buck converter, which converts 12 volts to 5 volts. This feature ensures energy efficiency and protects the system's electronic components from damage. By maximizing its use of energy, the system may function sustainably and lessen the environmental impact of agriculture.

Chapter No. 6

Conclusion and Future Work

Conclusion:

This project was created to help the farming community with automatic irrigation solutions. It focuses on preserving the soil fertility and reducing the use of artificial fertilizers that may harm the crops. DHT22, rain drop sensor and a soil moisture sensor are used by the Smart Irrigation System to collect data in the Arduino microcontroller which is further used to control water flow using a proportional valve made using RC servo and a ball valve.

The GSM900A module is used to make it simple for the farmers to monitor their crops by looking at the visualized data on Things Speak IoT cloud platform. Farmers can get access to real time data and monitor the moisture content and other crucial data through this platform.

A buck converter is used to reduce the voltage from 12V to 5V to boost the system's energy efficiency. This reduces energy usage while improving system performance.

This project will help reduce fertilizer usage, produce more crops and practice environmentally friendly farming methods.

Future work:

In this section we will explore how this project can be further expanded by other engineers by adding new modules that will make it more useful and add a whole new range of functionality to it. This is discussed briefly below as follows:

1. Expansion of sensor network for disease and pest control:

The hardware of this project can be expanded to incorporate ultrasonic sensor, passive infrared sensor (PIR) interfaced with Arduino microcontroller that can emit and receive IR radiation from nearby objects including pests, insects that can harm the crops. Once a pest is detected by the PIR sensor, a buzzer can be activated that will produce ultrasound waves in the frequency range of 1-5 kHz to 100 kHz to repel the pests. Other techniques such as RGB imaging, thermography, chlorophyll fluorescence can be used for disease detection.

2. Development of a mobile application:

A mobile app can be developed for this project to enhance the ease of accessibility and flexibility that will show real time data of the crops and soil moisture content allowing farmers to remotely access the data at any time from any place using just a mobile device.

3. Integration with precision farming techniques:

Precision irrigation means providing a crop with water and nutrients at the right time in small, measured doses to facilitate optimal growth and better utilization of natural resources. This improves crop yield and efficiency. This module can be incorporated to expand this project further.

4. <u>Testing and optimization in different environments:</u>

This system can be tested on various different environments to check how the system performs in different weather conditions. Farmers can determine how well the system works for different crop types and environmental conditions and identify any areas for improvement.

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