Faculty of Engineering and Natural Sciences

CE356 - Software Engineering

Elif Pınar HACIBEYOĞLU

Automatic Irrigation System with Arduino

20181701085 - Samet ŞAHİN

20152002023 - Ömür İsmet KÜÇÜKÇINAR

20191701022 - Abdullah Emin ESEN

20181706008 - Peri Helin ÇEKİM

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Aim of The Project

The main purpose of this project is to create a system that delivers automated watering, allowing farmers, gardeners, and others to save time, money, and energy by using greenhouses, for example. In traditional agricultural land irrigation practices, manual involvement is prevalent. This project demonstrates an arduino-based Automatic Irrigation System approach. With this autonomous watering method, human involvement may be reduced. On-site humidity sensors will be installed. When the concentration of water changes, these sensors detect it and send an interrupt signal to the microcontroller. Soil is one of the most vulnerable sources of soil pH, which is used to characterize the degree of acidity or basis that impacts nutrient availability and, ultimately, plant development. As a result, the system will enable automation, remote control, and increased efficiency. The humidity sensor is linked to the internal ports of the microcontroller through a comparator; anytime there is a change in temperature and humidity in the environment, these sensors perceive the change and send an interrupt signal to the microcontroller, causing the motor to turn on. To notify that the pump is turned on, an audio or visual warning is utilized.

Importance of The Project

Irrigation systems are still operated manually in the present. A concept of automated irrigation is proposed in order to use water efficiently and productively. The sensor-based irrigation system is based on a soil moisture sensor, which measures the amount of moisture in the soil and sends the signal to the Arduino, which then irrigates the crops. The Arduino serves as a microcontroller. This will compare the moisture sensor data to the predetermined moisture levels previously recorded in the system. The Arduino will switch the irrigation system ON/OFF based on the information obtained from the sensors. In addition, a moisture sensor is fitted to determine the soil's water content. An automatic irrigation system is really useful for people who work away from the garden and do not have the opportunity during the day. Automatic irrigation systems may be incredibly cost effective and water conserving if correctly built and coded.

Among the abundant mineral resources, water is the most excessively used resource, irrigation is one of the activities that require water the most, it’s an activity that was traditionally known to be done by humans, and manual method of irrigation consumes time and resources. Considering the development in engineering and technology fields, automated systems are continually evolving nowadays, thus there is a need to automate the manual means of crop/plant irrigation to go in line with the evolving trend of technology. The world's need for synchronization to digital design was supported by generating idea Internet of Things (IoT) information that would guarantee efficiency, quality and speed. It uses IoT to control home appliances.

It is critical for quick advancement in food technology production to meet the ever-increasing demand for food and the ever-decreasing supply of food essentials. Agriculture is simply one source of this. This is an essential topic for human cultures to consider in light of the expanding and dynamic need for food production. Irrigation is the technique of artificially submitting water to dry ground or soil in order to make it conducive for plant development. Furthermore, depending on the soil type, the plant should be watered to improve production and yield.

Africa has climatic ranges that receive several centimeters of rain per year, so its soils require large amounts of water for dry season agriculture. There are also some regions in Nigeria that receive little or no rainfall per year and the economy is also dependent on agriculture and animal production as it cannot fully utilize the abundant land area due to lack of technical knowledge. Low precipitation and lack of dam or land-water reservoir systems are a few of the many causes. Therefore, some lands need to be rehabilitated with advancing technology, the traditional method needs to be updated and more reservoirs need to be rebuilt for optimum use. This proposed project is an automatic crop irrigation control system that informs users about the farm situation; this is aimed at reducing the manual traditional method of plant watering and minimizing water wastage. This will serve as a transition from manual to automatic irrigation method, it can be applied not only in farming, but also in schools or institutions, industries, homes for landscape irrigation systems. The irrigation system is controlled through soil moisture sensor, which detects the percentage of water in the soil and updates to the microcontroller for irrigation and sends notification to the owner, this project focuses on reducing excessive human intervention in the irrigation process, also reduce water wastage and keep the owner informed about the situation in the farm.

The microcontroller-based system is programmed to switch the motor on and off dependent on the moisture level of the soil. The system's goal is to use a soil moisture sensor to monitor the moisture content of the soil. The goal is to activate the pump when the soil moisture falls below a specified threshold. The next goal is to use an LCD to display the condition of the soil and the tank.

Requirements List

• It must have an electrical output variable that can be read by the Comparator Circuit.

• The relationship between soil moisture and signal output should be well known or parameterized. If this relationship changes according to the soil type, it should be known for the most common soils.

• The project should be compatible with most soil types.

• It must be durable and moisture resistant in the long term (5-10 years).

Hardware List

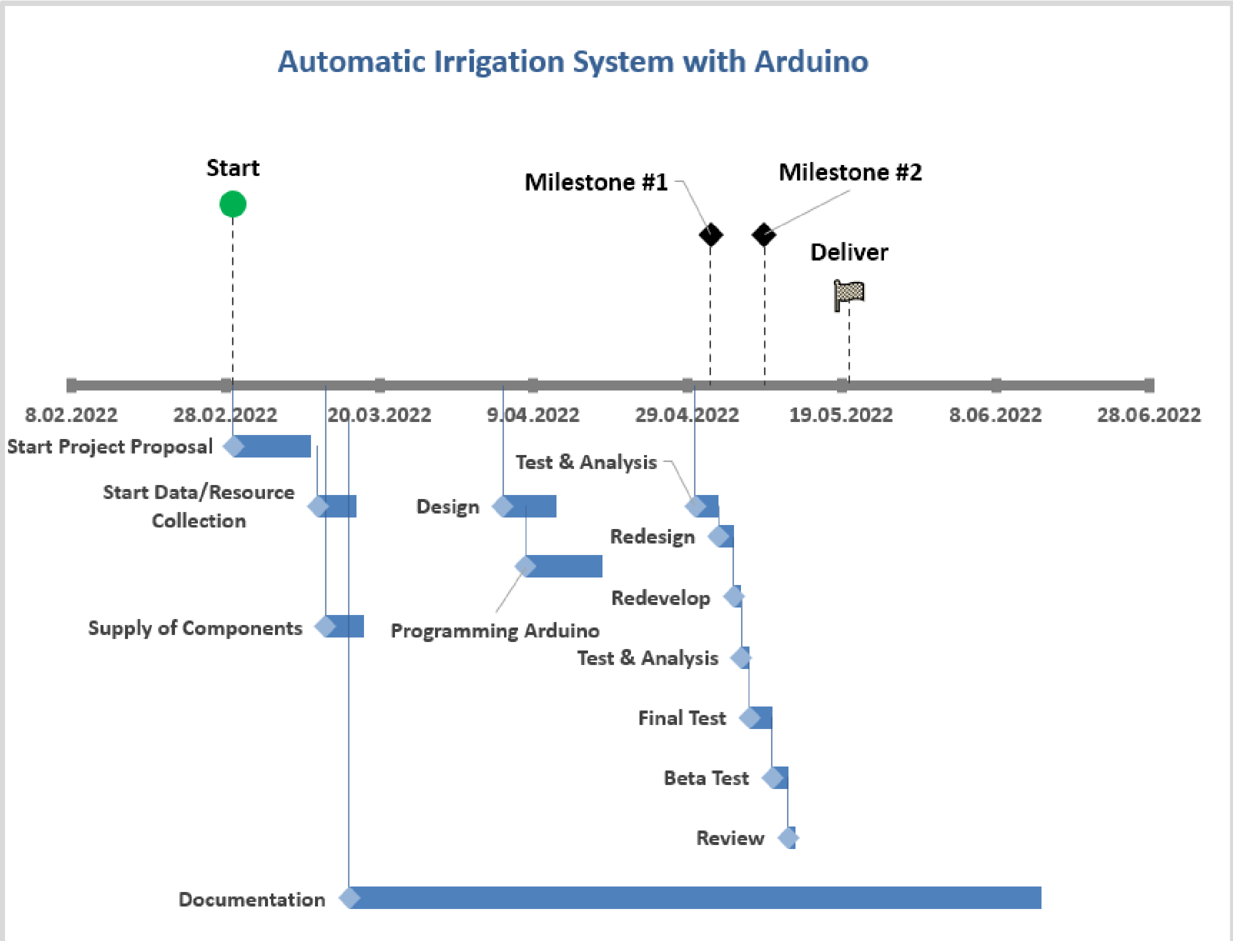
Table 1: Hardware List

Hardware Requirements List

Arduino Uno	The Arduino Uno is an open source microcontroller board which based on the ATmega328P architecture. An Arduino board contain 14 digital input/output pins, 6 analog inputs, a USB connection, and ICSP header, a power jack, a 16MHz quartz crystal and a reset button. The Arduino is the central core of this project as it controls all the hardware that are attached to it.
Soil Moisture Sensor	This sensor is used to detect the moisture level of the soil.
Liquid Crystal Display (LCD)	In this project, the LCD screen will be used to show the moisture level of the soil and the pump status set early on the Arduino board by coding.
DC Water Pump	It is used to water the plant by sucking the water from the source and push out the water from the second hole to make the water process complete. It is controlled by the relay module

	which can be switch on and off automatically based on the signal sent from the Arduino.
Relay Module	It is used to control the on and off of the DC watering pump by opening or closing the electric path that passes to the watering pump. It is controlled by the code from the Arduino.
Resistor	A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. In electronic circuits, resistors are used to reduce current flow, adjust signal levels, to divide voltages, bias active elements, and terminate transmission lines, among other uses.
LED	
GSM Module	It is a practical way to communicate using the GSM mobile phone network. Shield allows you to receive SMS, MMS, GPRS and voice over UART by sending AT commands.
Water Sensor	This sensor is used to detect the water level of the water tank.
Breadboard	A breadboard also known as protoboard is a type of solderless electronic circuit building. You can build an electronic circuit on a breadboard without any soldering.

Timeline



Milestone #1: Test & Analysis

Milestone #2: Final Test

Roles

Table 2: Roles

Group Members	*Role*
Samet ŞAHİN	Full Stack
Ömür İsmet KÜÇÜKÇINAR	Tester and Coding
Abdullah Emin ESEN	Research and Coding
Peri Helin ÇEKİM	Research and Design

Design

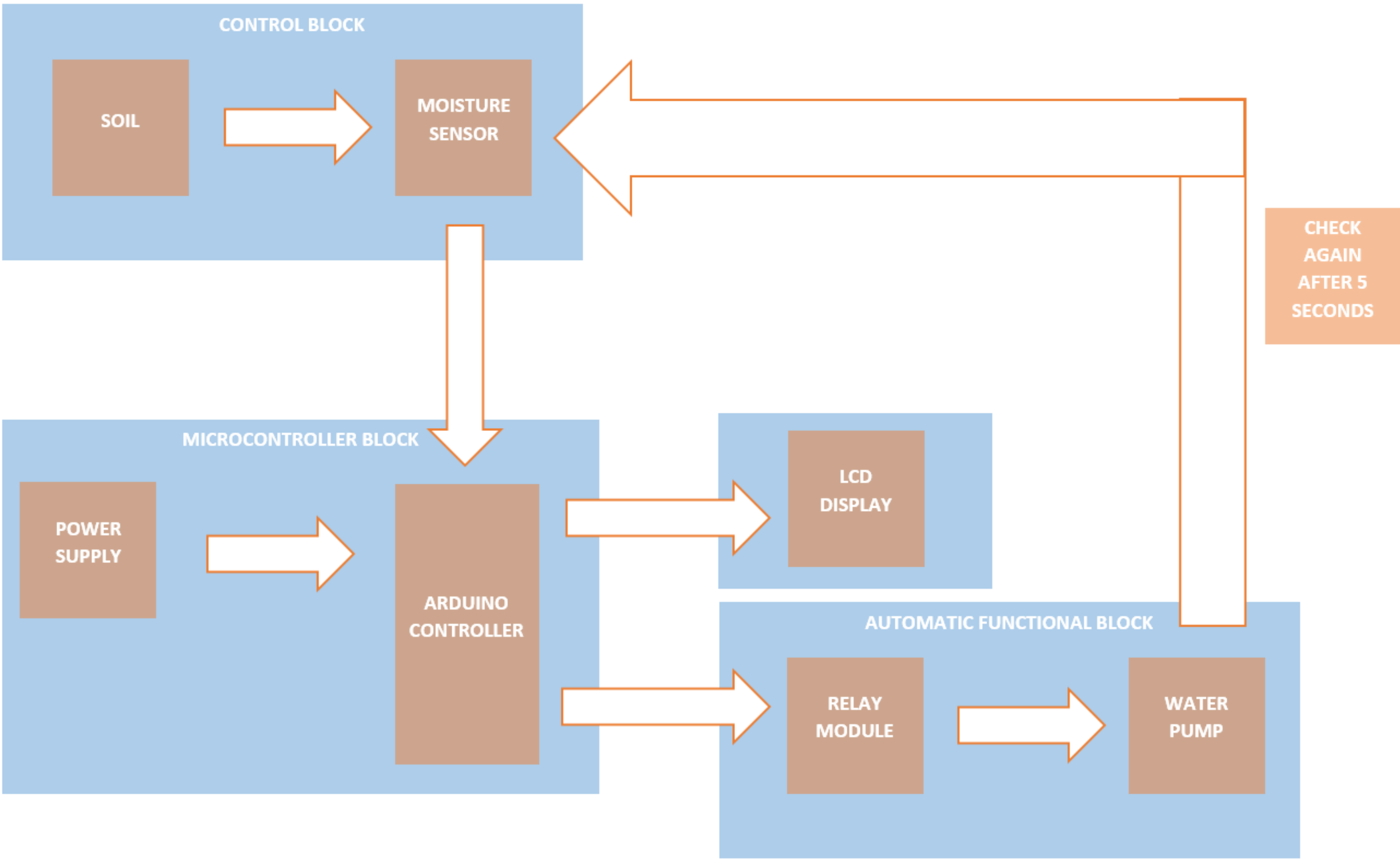


Figure 1: Functional Block Diagram

- **Control Block**

  This block is made up of one soil moisture sensor that collects data from the soil. It is determined by the moisture level of the soil whether to send a high or low voltage to the microcontroller to indicate whether the soil is wet or dry. When the soil is moist, it sends a low output voltage; when it is dry, it sends a high output voltage. This sensor is wired directly to the Arduino microcontroller.

- **Microcontroller Block**

  The Arduino Uno microcontroller serves as the project's core hardware in this block. It receives data from the soil moisture sensor and processes it according to the needs programmed into the microcontroller.

- **Automatic Functional Block**

  The automated watering element of the system is housed in this block. The automated function is controlled by two main pieces of hardware: a relay module and a DC watering pump. A relay is a sort of automated electric switch that uses an electromagnet to switch from OFF to ON or vice versa. The switch controls the electric signal that is transmitted to the water pump. When the moisture level falls below a particular threshold, Arduino sends a signal to the relay module, allowing power to flow through the water pump and water the plant. When the system detects an appropriate amount of water in the soil, the relay closes the electric line, and the water pump immediately stops pumping water.

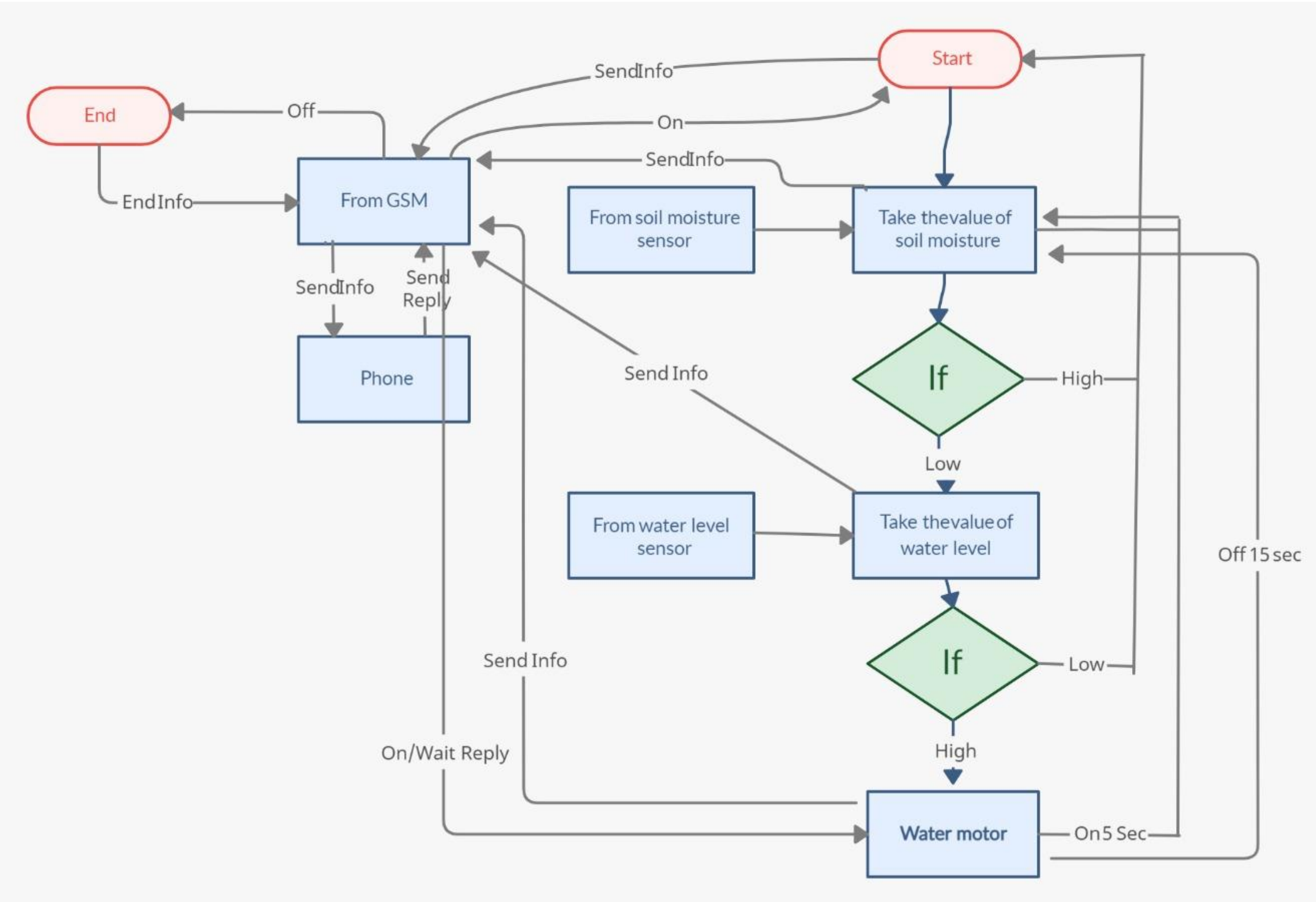


Figure 2: UML Activity Diagram

Detail Design

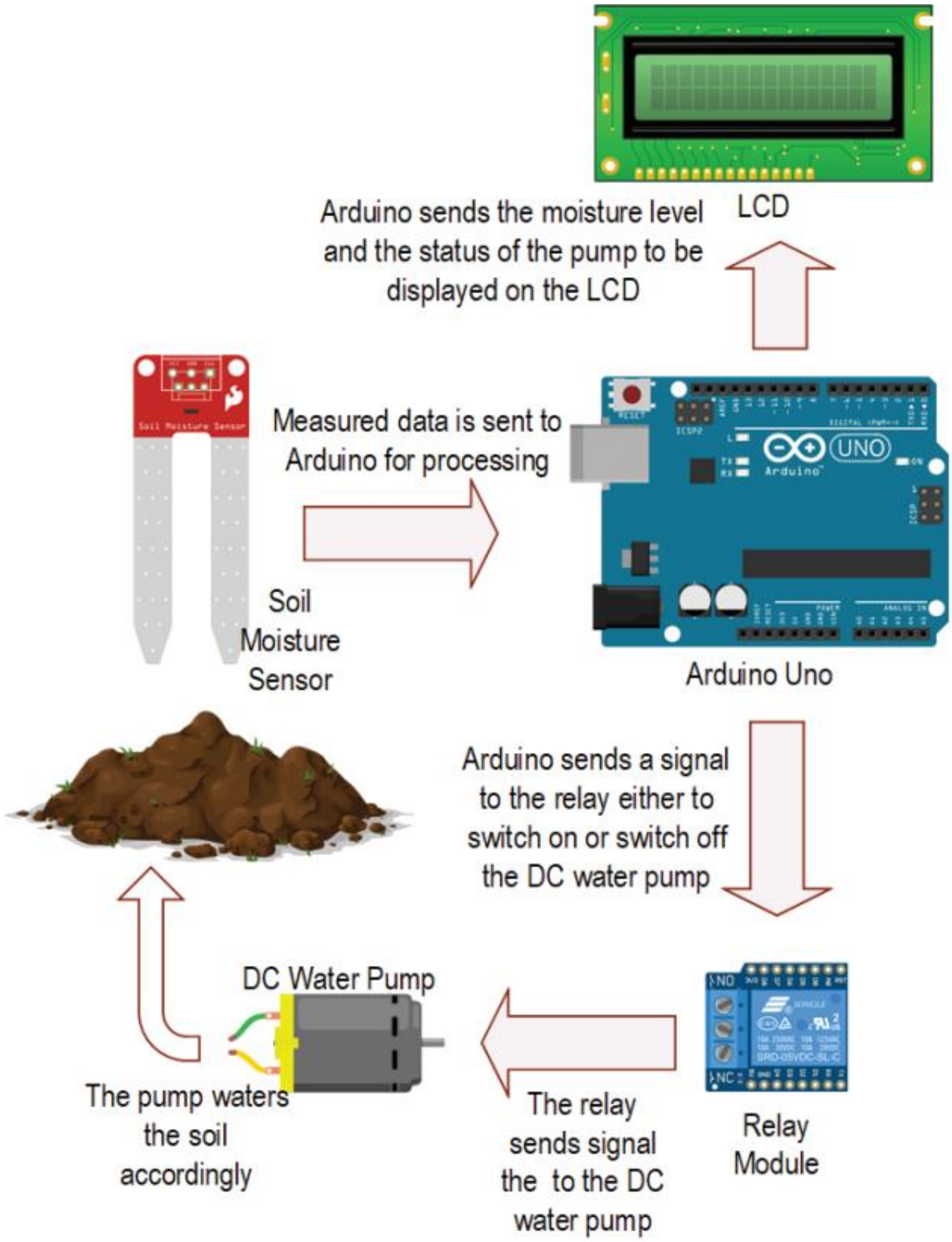


Figure 3 System Architecture

Figure 3 depicts the automated irrigation system's system design. The technique is presented in Figure. 3 to begin with the soil moisture sensor. The sensor detects the amount of moisture in the soil and sends the measured data to Arduino for processing. The moisture level and the state of the DC pump are then communicated from Arduino to the LCD screen to be shown. At the same time, the data will be relayed to a relay, which will trigger the water pump to turn on or off.

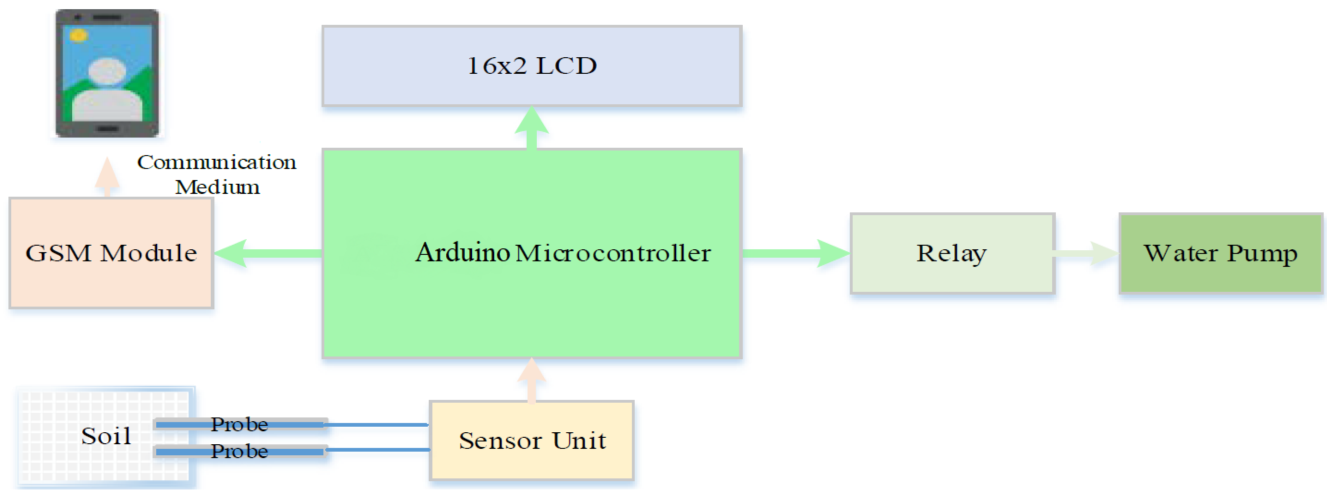


Figure 4 GSM Architecture

The moisture sensor detects the moisture level in the soil, and the irrigation system is made by the water pump, which helps to supply water to the reservoir and the farm, the GSM module provides the messaging platform that informs the farmer about the moisture content and status. In addition, thanks to the GSM module, the user can start and stop irrigation whenever he wants. It can hold off watering. GSM modem is a simple device which uses a SIM card to send and receive the messages to/from the user. The modem can be controlled by Arduino using serial communication. AT commands are used to configure the GSM modem. The use of GSM is intended in this prototype because it will allow the user to activate the water system remotely, as opposed to using a wireless system that only activates within a certain range.

GSM AT Commands;

- **#ON / #OFF**
  - Turns the system off and on.
- **#INFO**
  - It sends a message to the user about the humidity and the level of the water tank.
- **#MOTORWAIT'NUMBER'**
  - It allows the water pump to wait while watering. Replace **'NUMBER'** with seconds to wait.
- **#MOTORON**
  - It allows the user to start irrigation at any time during the day.

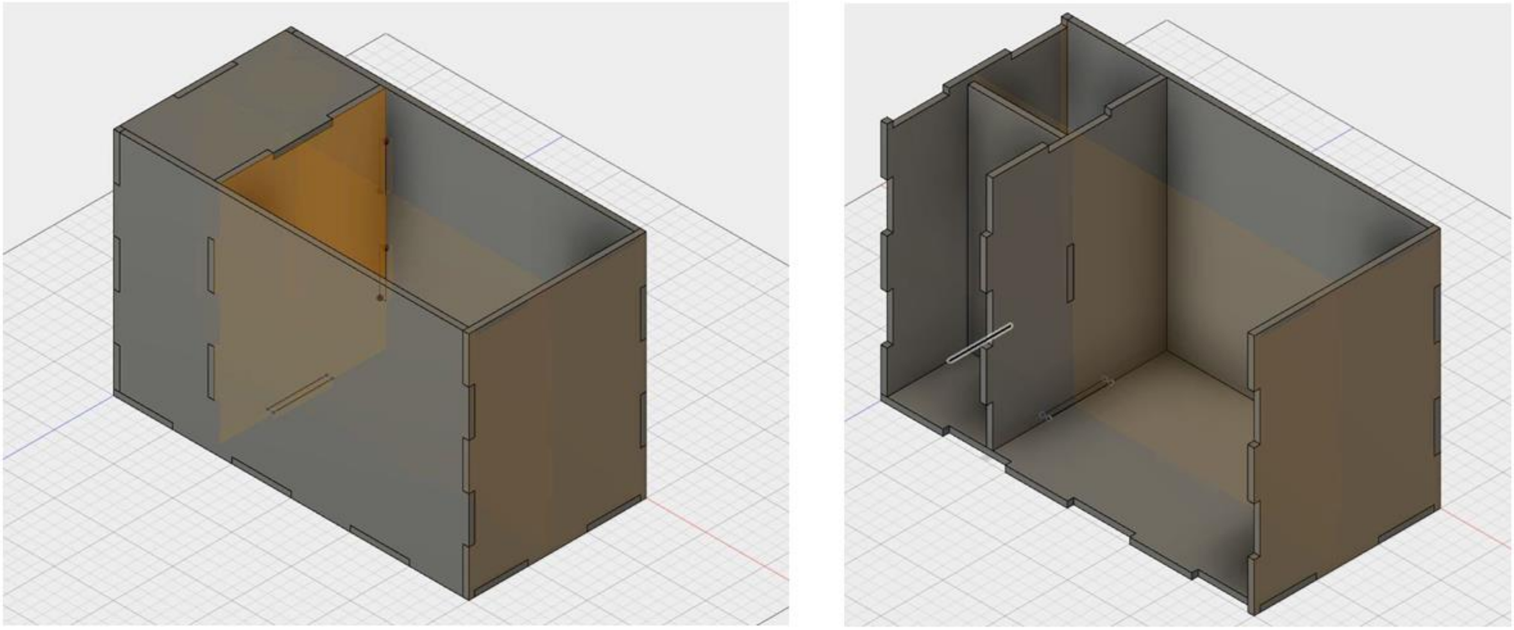


Figure 5 Box

The main body of project is a 40cm X 23cm X 21cm Box made out of PVC. The box is divided into two sections:

- The larger section contains the Soil & Plants
- The smaller section is further divided into two more sections such that one section contains the Circuit Board while the other contains the Water Reservoir.

Mounts the circuit components to the Backplate of the Box to fit its respective sections. The Pump Outlet Pipe is passed through the holes provided to reach the plant soil part. Do the same for the Humidity and water Sensor cables.

Testing

The resistances of various soil types were calculated to measure and adjust the base value of the pump to be commissioned. Soils with a high water content will have lower resistivity than soil with less water.

Table 3: Testing

Test Cases	***State***	***Relay Switch Connect***	***Water Pump Action***
Over Wet	OFF	Open State	Pump will not run
Optionally Wet	OFF	Open State	Pump will not run
Optionally Dry	ON	Closed State	Pump will run
Fully Dry	ON	Closed State	Pump will run

The soil moisture sensor must be capable of distinguishing between wet and dry soil by displaying the percentage on the LCD display panel. If the soil is dry, the percentage displayed should be low; if the soil is moist, the percent displayed should be high. Table 3 tabulates the results collected from the relay under various test settings. The results illustrate the outputs of the relay during the soil moisture test. The operation of the water pump is regulated by the relay action, and its operation is dependent on the status of the soil moisture, as indicated in table 3.

Activities and Progress

First Implementation, it shows the results of our experiment in the form of a general representation of our automatic irrigation system tested on the basis of microcontroller and Arduino sensor technology. When the program was uploaded to the Arduino, the soil moisture sensor started to show the value of soil dryness. If the drying value is higher than the given value of 950, the pump will start to irrigate in the system. Completed. If we want to flood the system or the field, the humidity sensor will stay at a higher level or the programming value should be lower than the previous fixed value. As a result of the first application, it shows that the engine starts to water when the dry value is higher and sometimes later when the engine is saturated, the engine is turned off and comes to a balanced position. Here, when we put the sensor into the soil, we see that the dryness value is 1024 and irrigation starts as the dryness value above the maximum dryness level we defined in the program. After watering, the engine was stopped automatically when it met the demand, after a few seconds the soil environment was dry and the dryness value was 970. The engine was started again and after a few seconds of irrigation, it was automatically stopped and a fixed value was given.

Figure 6 Wet and Dry

Problems and Solutions

After the system modules were combined and the coding was completed, the codes were uploaded to the arduino. Although the system started to work, no text appeared on the LCD screen. It was discovered that the problem was in the brightness adjustment key and with the help of a screwdriver the problem was solved. When switching between the two states during the testing phase, distortions occurred on the LCD screen. After the necessary research, it was understood that it should be used in the Wire.h library. However, the problem was not resolved. There was no error in the texts, but it appeared repeatedly written in succession. After examining the code, it was understood that the 'delay' command, which is of great importance in arduino, was missing. And with that, it was seen that the errors on the LCD screen were fixed.

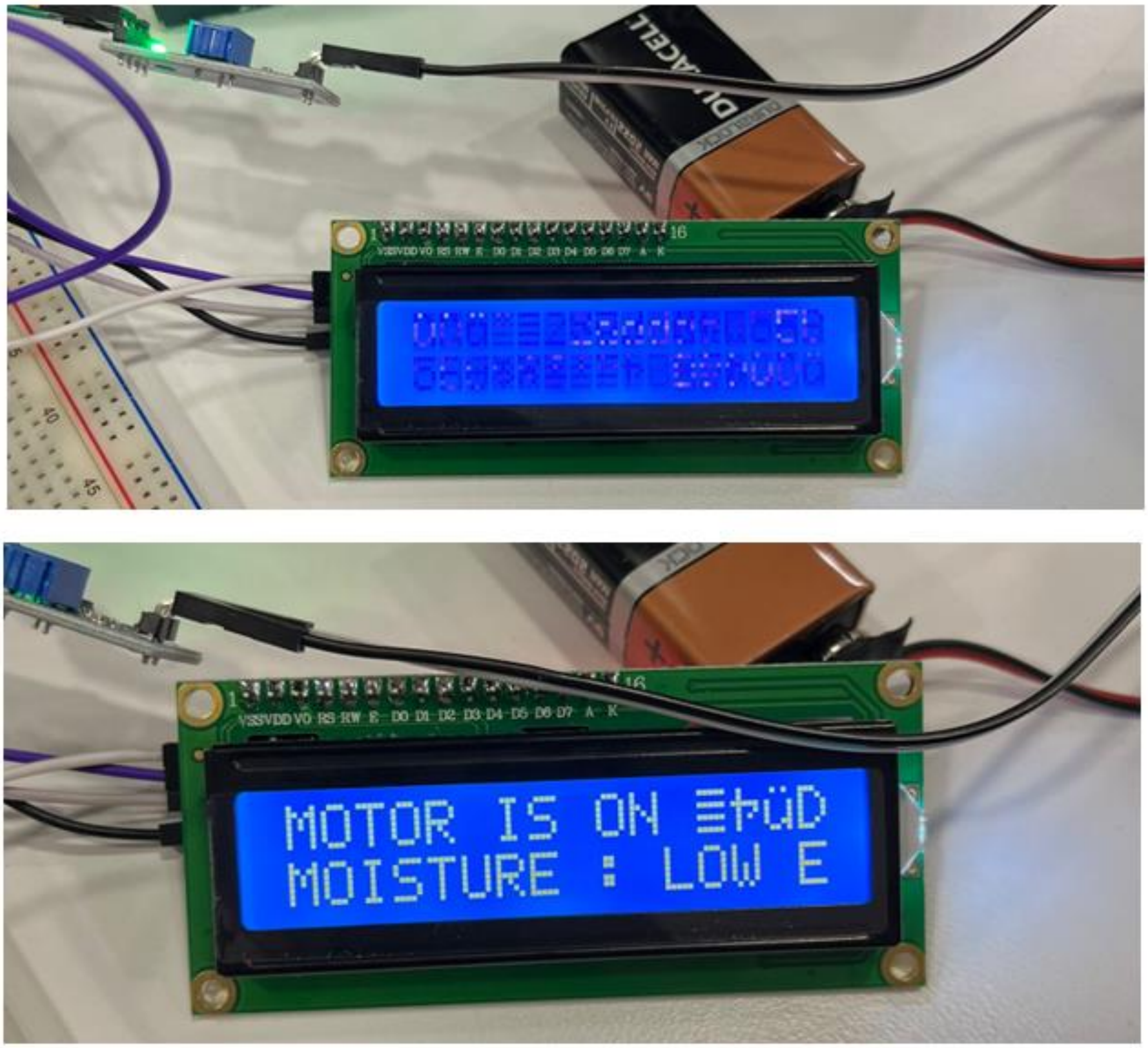


Figure 7 LCD Error

Conclusion

This study aims to automate manual water irrigation method and promote human capital development and capacity building opportunities, proposes a simple automatic plant irrigation control system technique with GSM notification. In this design, the Arduino is the main control of the system, which coordinates the control to other system components, the soil moisture sensor detects the percentage of water in the soil and updates the percentage if it falls below the threshold for this particular plant. Irrigation sends information to the user via SMS. According to the results obtained and shown, the efficiency of the system can be increased. In future work, the inclusion of a web interface for remote control could be made and the system could be made to monitor the condition of the air on the farm through the inclusion of humidity and temperature sensors.

References

BIGDOG1971. (2013). WATERING SYSTEM - INTRODUCTION. *Instructables*.

Chavan, C., & Karande, P. (2014). Wireless Monitoring of Soil Moisture Temperature & Humidity Using Zigbee in Agriculture. *International Journal of Engineering Trends and Technology*.

Ishak, N., & Awang, A. (2015). GSM Activated Watering System Prototype. *IEEE International RF and Microwave Conference*.

Leroux, M. F. (2005). Design of an Automated Irrigation System. BSc thesis, McGill University, Canada.

Parameswaran, G., & Sivaprasath, K. (2016). Arduino Based Smart Drip Irrigation System. *IJESC*.

Sahu, C. k., & Behera, P. (2015). A Low Cost Smart Irrigation Control System. *ICECS*.

Appendix: Time Frame

Time Constraints

The project began in the month of February 2022 and was completed by the month of May 2022.

Approach Breakdown

1. Initial design of the irrigation system
    - System-level design of the prototype
    - Decide either to design the controller or to program a microcontroller
2. Selection of the components
    - Moisture probe
    - Controller components
    - Pipes and pump
3. Design of the controller
    - Functional / schematic description of the controller
    - Simulate the logic circuit
    - Test the controller
4. Assembly of the irrigation system
    - Put all the pieces together
    - Test the circuit parts
    - Do some adjustments
5. Final report
    - Recommend the final product
    - Suggest additional improvements