UNIVERSITY OF DAR ES SALAAM

COLLEGE OF INFORMATION AND COMMUNICATION TECHNOLOGIES

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

CS 499 – FINAL YEAR PROJECT II

PROJECT TITLE: SMART IRRIGATION SYSTEM

A Project Report in Partial Fulfillment for the Award of Bachelor of Science in Computer Engineering and IT

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Submission Date: Friday 24– 06 – 2022

DECLARATION

Statement of Authorship and Originality

I declare that this report and the work described in it are my own work, with any contributions from others expressly acknowledged and/or cited.

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ABSTRACT

The smart irrigation system is the system developed to optimize water use for agricultural crops, to improve the health of the soil together with the plant health by the use of multiple sensors. The system has a distributed wireless network of soil moisture and PH sensors placed into root zone of the plant. This smart systems are very productive especially in developed counties and most system uses big networks such as internet.

In Developing countries case, this system couldn't be adopted effectively as in most of the developing countries including Tanzania there is no reliable internet access especially in rural areas where most of farms reside. Means of controlling farm's status by using internet service becomes difficult to be implemented on rural areas due to availability of internet on such areas. Systems which use normal text messages will be reliable on most rural areas due to availability of such service and most people on rural areas are using featured phones.

This project is to develop a Smart irrigation System that will be controlled using a simple text messages. Simple text message is the most used way of communication which is also the most reliable and cheap. This project will be accomplished by the use of GSM technology which is the heart of all cellular networks used by mobile devices.

The user will be able to communicate with the farm from anywhere with only simple messages. The GSM is integrated to the microcontroller to pass simple messages that are defined by the programmed instructions in the microcontroller. This module (GSM module) will be used for control and notification part of the system. Mobile phone used in two cases, firstly mobile phone is used as means of notification to notify someone who own the farmer who lived away from the farm on status of the farm by means of text message and secondly mobile phone is used as means controlling to control status of the farm whenever any parameter altered.

Apart from GSM for providing notification, also LCD display and buzzer are responsible for providing notification specifically for the one who live near the farm.

ACKNOWLEDGEMENT

I would like to thank Almighty God for giving me good health especially from when I started this final year project. Also, I would like to appreciate all those who provide their support from starting up to the end of this project for their support on this project. The special gratitude I give to Dr. Wilfred Senyoni who is my Supervisor for his contributions in advising and encouraging me by drawing some suggestion on performing day to day activities on performing project.

Furthermore, I would also like to acknowledge with much appreciation the crucial role of my team mate, Ms. Dorcas Leskanga to whom I spent most of time with to conduct this project. Her advice is much appreciated on performing this project. Also many thanks goes to Final Year Project Co-ordination Team for the work it has done from analysis of student's Titles, and solving problems facing challenges with FYP portal and other challenges related to Final Year Project.

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LIST OF ABBREVIATIONS

APP - Application

FYP – Final Year Project

GND - Ground

GSM – Global System for Mobile Communication

IDE – Integrated Development Environment

IoT – Internet of Things

LED – Light Emitting Diode

LCD – Liquid Crystal Display

PH – Potential of Hydrogen

RTC – Real Time Clock

SCL – Serial Clock Line

SDA – Serial Data Line

SMS – Short Message Service

Vcc – Common Collector Voltage

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CHAPTER 1: INTRODUCTION

1.1 BACKGROUND

Irrigation has been a way-out when there is a delay on rain season, it has been very helpful into helping people to maintain the food circle in societies and to maintain plant's life in general.

Irrigation is the artificial application of water to the soil through various systems of tubes, pumps, sprays and more. Irrigation is usually used in areas where rainfall is irregular or dry times or drought is expected. There are many types of irrigation systems, in which water is supplied to the entire field uniformly.

The earliest form of irrigation involved people carrying buckets of water from wells or rivers to pour on their crops. As better techniques developed, societies-built irrigation canals, dams, dikes, and water storage facilities, canals or pipelines carry the water from reservoirs to fields.

1.2 STATEMENT OF THE PROBLEM

There has been a rapid growth of technology and smart systems all over the world, one of the developed smart systems is the smart irrigation system where by people can control their system automatically with a use of internet. There is unavailability of reliable internet services in developing countries such as Tanzania especially in rural area where the most agricultural activities take place. This makes it impossible to access the smart systems for those who lives in these areas. Also it is difficult for the farmer who live far away from the farm to know current status of the farm. The rural area people cannot benefit from these smart systems due to this problem.

1.3 OBJECTIVES

1.3.1 MAIN OBJECTIVE

The main objective of this project is to use the normal text messages to notify and control the smart irrigation system. Normal text messages are the most accessible and reliable way of communication used in developing countries especially in rural areas. With the help of Global System for Message communication (GSM) anyone with any type of a phone will be able to control the smart farm system.

1.3.2 SPECIFIC OBJECTIVES

- To build a centralized microcontroller which is programed to receive input signals of multiple sensors of the field and generate an output that drives the relays of the circuitries.
- To integrate a soil moisture and PH sensors that will be able to sense the moisture and PH of the soil respectively then sends notifications to the microcontroller.
- To integrate the Global System for Message communication (GSM) in order to manage the normal text messages.
- To create a web based application that will store the records about the farm progress.
- To make a system that is understandable and easy to be used by farmers.

1.4 PROJECT SIGNIFICANCE

"Smart" technology is taking over everything in our nowadays life, we are surrounded with smart devices and different kinds of smart systems. Smart farm systems offer a variety of advantage over traditional irrigation systems. Smart irrigation systems can optimize water levels based on things such as soil moisture and PH of the soil. This is done by the communication between sensors and smart farm controllers. The smart system will help one to have better control of landscape and irrigation needs as well as peace of mind that the smart system can make decisions independently in case of one's absence.

It helps to save a significant amount of money on water bills because through intelligent control and automation, the smart irrigation system will optimize resources so that everything gets what it needs without needless waste.

Additionally, we all have enough knowledge to understand how our water resources are precious. With smart irrigation systems we can be better stewards of our resources which is better for environment. Also with automated system one can save a tremendously amount of time.

1.5 SCOPE AND LIMITATION

Currently, the aim on this project is to use a simple message with the help of GSM technology which will integrate a notifications chip with the controller for message management to control the smart irrigation system. Although in the future there are other scope that can be used with this work to improve the efficiency and effectiveness of the system. The idea of using IOT for irrigation can be implemented with this system. Other activities in farming such as cattle

management, fire detection and climate control can be introduced with this system. This system can be improvised by adding a Webs caper which can predict the weather and water the plants/crops accordingly. If rain is forecasted, less water is let out for the plants.

Some limitation includes:

- System cannot be used in places where there is low network signal which will result in delaying of notifications to the user and the system.
- The system should be used in areas experiencing low amount of rainfall.

CHAPTER 2: LITERATURE REVIEW

2.1 AUTOMATED IRRIGATION SYSTEM USING SOLAR POWER IN BANGLADESH

The gadget specializes in rice fields in nations depending on agriculture within the economy, such as Bangladesh. The primary concept in this gadget is to cognizance on the level of water in agricultural fields because those fields lose lots of their merchandise due to floods. The sensor sends a message from the field to the person approximately the extent of water within the area if it will increase or decreases then the operator controls the pump to regulate or flip off the telephone. The blessings of this machine are that it depends on the sun energy to get hold of electricity. The dangers of this system are that it centered on one sort of sensor, the water stage sensor, no matter whether the plant desires water or not. There may be no opportunity source of energy in case there is no solar electricity to run the device.

2.2 DESIGN AND IMPLEMENTATION OF AN AUTOMATIC IRRIGATION SYSTEM IN NIGERIA

In this machine the basic idea is to rely on the type of soil and the amount of water needed by each type of soil. This process is done by measuring the level of moisture in each type and using the pump to supply water. The result indicates that sandy soil requires less water than clay soils. The blessings of this device are to focus on soil moisture and water conservation. But making the machine much less powerful is to measure the moisture of soil from one location in the agricultural land. It's far viable that the vegetation at the other end of the rural land does no longer need watering. Also, the water source isn't constant.

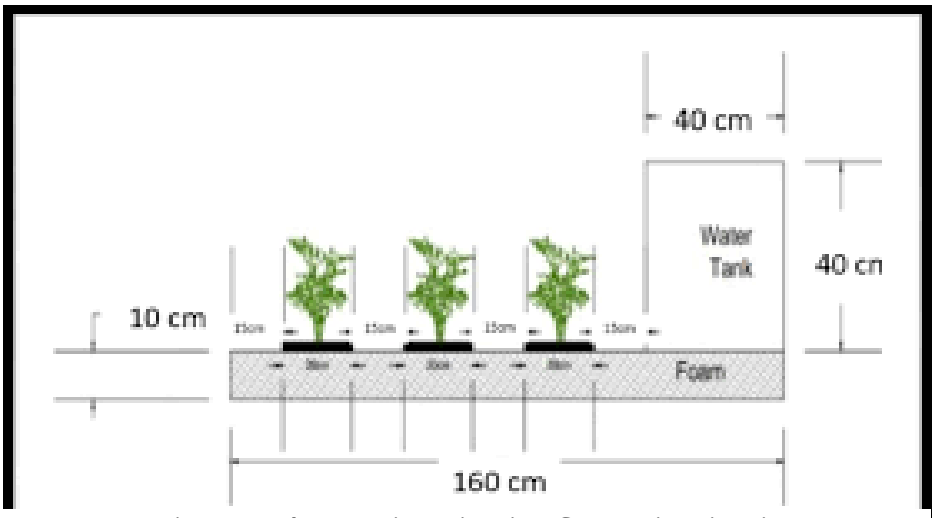

Figure 1: Automatic Irrigation System in Nigeria

2.3 SENSOR-BASED AUTOMATIC IRRIGATION SYSTEM

This system also depends on the measurement of soil humidity and temperature. The system works by sending a signal from farm controller to user phone and it phone must be in automatic reply in case that soil needs water. a signal from phone send to farm controller again to switch on or off the system.

Step 1: Start the process.

Step 2: Initialize power is supplied to GSM.

Step 3: Check the moisture level (less than or more than).

Step 4: If the level will be more than fixed criteria, no Need for irrigation.

Step 5: If the Moisture level is less than fixed criteria, start irrigation.

Step 6: Initialization of pump and rain gun.

Step 7: After the process completed, it moves to the original state.

Step 8: Stop the process

The only disadvantage of this study is that it works with Wi-Fi. Often agricultural land is far from the city so the network is not good in these areas. Also, this system needs to enter the farmer via his phone.

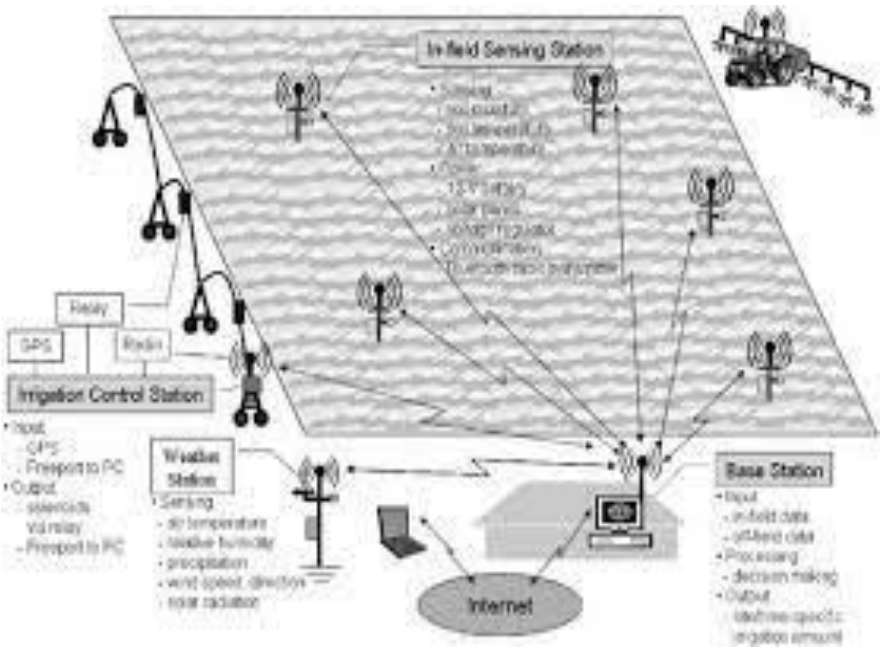

Figure 2: Sensor-Based Automatic Irrigation System

2.4 SENSOR-BASED AUTOMATIC IRRIGATION MANAGEMENT SYSTEM

The aim of this study is to build a system that helps the process of regulating water by measuring the humidity ratio. The grounded sensors all around the land area will give notice about the need for water and likewise, it will be provided. At the same time arranged a mechanized approach for the water tanker to be filled when it is empty.

2.5 SMART AGRICULTURE TO MEASURE HUMIDITY, TEMPERATURE, MOISTURE, PH AND NUTRIENTS VALUES OF SOIL USING IoT

This system helps farmers to get required information and relative data to monitor the plant's growth by use of INTERNET OF THINGS (IoT) which connects different sensors, actuators and other embedded devices to provide quality crops based on soil nutrients level and its moisture content along with Ph. factor, also been maintained. Hence in this system all these parameters are detected and controlled by with help of micro controller. Humidity sensor used to detect the moisture content where color sensor is used to determine the percentage of soil nutrients (N_2, P4 and K). It will analyses soil nutrients content present on soil at real time and Ph. sensor is used to determine the Ph. value of the soil. Monitoring of this to provide proper fertility to the soil

depending upon the soil nutrients. GSM is used to display the information to the farmers. Thus, it reduces the growing of husk in terms of wastage and there by getting good quality and health crops.

2.6 PLANT MOISTURE AND Ph. SENSING ALARM USING 8051

This system is done by using 8051 microcontroller-based systems that makes use of soil moisture sensor along with ph. value sensor to constantly check for these values. Plants need water as well as good soil (ph. rich) to ensure proper plant growth. It becomes difficult to monitor these things manually each time to ensure proper growth and any ignorance may lead to bad plant health or plant decay/death. The system microcontroller ensures the plant gets proper moisture and ph. by continuously monitoring for it. It also displays this on a display screen for user to monitor. Also, the system is equipped with an alarm which sounds a buzz in case the values fall below a certain limit which may be bad for plant health. Thus, the system ensures proper plant health using soil moisture and ph. sensing.

2.7 SOIL MOISTURE MONITORING SYSTEM USING WIRELESS SENSOR NETWORK

The response monitoring system measure the moisture of the soil, compare it with the desired values given by the user and generate alert if soil moisture goes below desired value. It helps in problems related to growing of crops in which irrigation is required at irregular interval. It is also helpful in monitoring of soil moisture in golf fields for fields. Irrigation water management practices could greatly benefit by the knowledge of moisture in the soil. To determine the soil moisture, we have designed and developed a nickel probes-based soil moisture sensor and a response monitoring system. By knowing the moisture value, we can estimate when to water and how much to water the fields so that there is no over-watering or wilting of crops. These practices will increase crop yield, improve quality of crops, conserve water resources, save energy, and decrease fertilizer supplies.

2.8 AUTOMATIC PLANT WATERING SYSTEM

This system considered to sense dryness of the soil and in the end switch on the electric pump to begin the supply of water and switch off the pump on every occasion enough water is provided. The Materials used are: Transistor 548, Resistor 1k, Variable resistor 47kΩ, Diode 1N4007, Relay 5v, LED, DC converter, Circuit board, Probes, AC water pump, Water reservoir. In this

study, there is no real implementation it is only on circuit and information about how the system should work.

CHAPTER 3: METHODOLOGY

This system is developed using a waterfall model where by one step will be accomplished after another, it is breakdown of project activities into linear sequential phases where each phase depends on the deliverables of the previous on and corresponds on specialization of tasks. This model is direct to use through its steps. The following are the procedures that will be used into developing this project.

i. Requirements gathering and analysis:

- All possible requirements needed for developing Smart Irrigation System will be captured and documented in requirement specification document, method used to obtain requirement on this system are Questionnaires and Interview.

ii. Design and simulation:

- After obtaining requirements from first phase system design is prepared, system design will involve specification of hardware and system requirements that helps in defining the overall system architecture of the System.

iii. Circuit implementation and testing:

- From the overall architecture of the system, system is then developed on small unit so as to allow unit testing to take place ie. sensors will developed separately before linking them to other devices.

iv. Integration and testing:

- After unit testing has been done on all single units (devices), those unit are combined to form full Smart Irrigation System then integration testing is performed so as to test for any fault on the whole system.

v. Operational/deployment:

- Involves deploying the system to the farmer, in this step the system is completed to be used by customers if it has any fault customer should give feedback so as to be maintained on next step.

vi. Maintenance

- It is done once farmer encounters any fault on using the system, to fix these issues, patches are released. Also to enhance the product some better versions are released. Aim of maintenance phase is to deliver these changes in customer environment.

Advantage of this methodology

- Simple and easy to understand and use
- Easy to arrange tasks
- Clearly defined stages
- Phases are proceeded and completed one at a time
- Works well on projects where requirements are well understood

Disadvantage of this methodology

- No working software will be produced until later stages.
- Not good for complex projects
- Cannot accommodate changing requirements.

3.1 BLOCK DIAGRAM OF THE SYSTEM

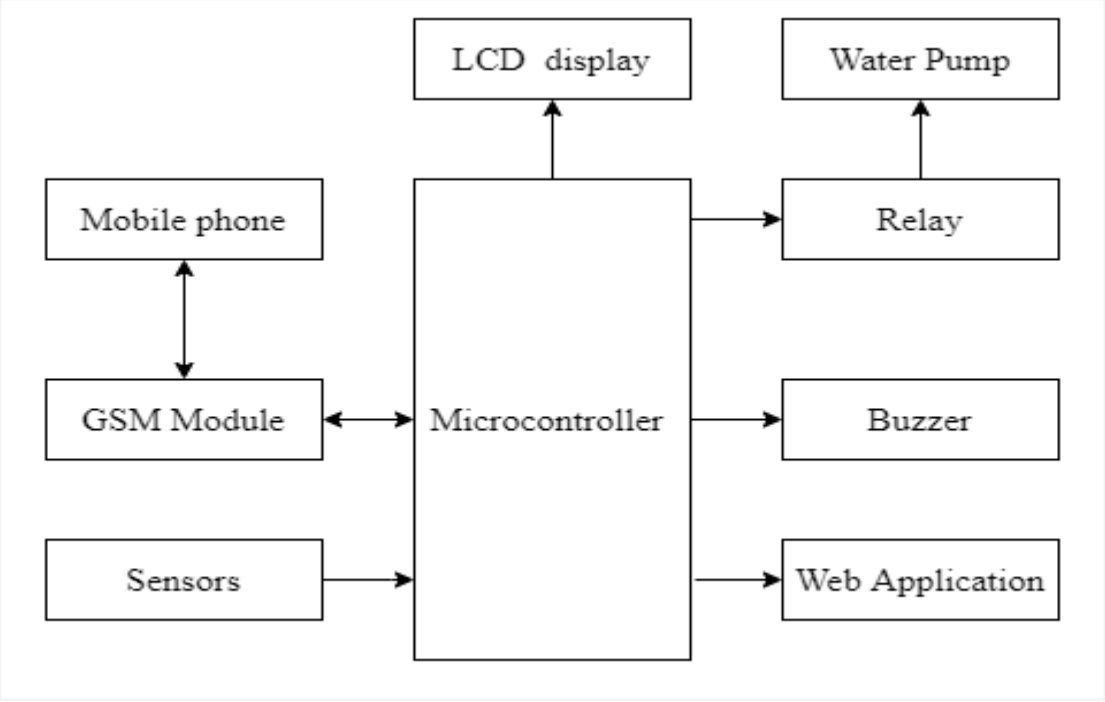

Figure 3: Block Diagram for the System

This system is categorized into three parts which are monitoring part, notifying part and control part which are integrated with software and hardware to form the complete system. Monitoring parts involves all sensors equipped on collecting data and sending them to microcontroller, such

components include sensors, GSM module and mobile phone. Notification unit involves all components used for sending signals from microcontroller to external components like Buzzer, Mobile phone and Web App. Monitoring unit including Water pump and water source to control status of the farm and Microcontroller which acts as the medium of connection which connecting all components.

CHAPTER 4: REQUIREMENTS ANALYSIS AND SYSTEM DESIGN

In this phase processes involved include planning, implementing and analysis. Planning involves data collection and drawing hardware and software requirements and Analysis involves analyse the performance and identify the conclusion. Refer to the figure below,

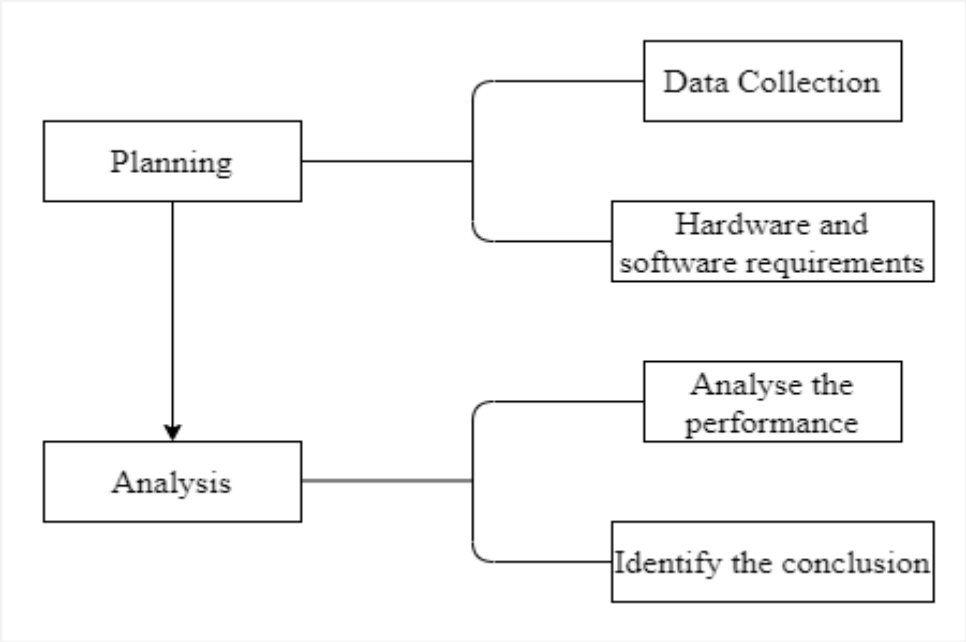

Figure 4: Planning and Analysis phase

Planning phase fall under system analysis, it involves identifying all information and requirements like hardware and software, it consists of two main elements that is data collection and hardware and software requirements. Planning should be done in proper manner since it is the starting point of whole system.

4.1 DATA COLLECTION

Project resources and requirements are planned on this stage, all data are collected from journal, texts book and articles gathered from libraries and Internet, and interview which is done on some few people regarding to the project. From the study done electronic devices used on previous done projects have been checked and other devices to be used also checked.

Studies concerns with electronic devices such as capacitor, resistor, transistor and diode were checked, how they are configured, their functions and operating voltage. Not only configurations and functions of such devices but also the small circuits built by each of those components related.

4.2 HARDWARE DESIGN AND SPECIFICATIONS

HARDWARE REQUIREMENTS

Since more than 80% of this project involves hardware than software, the project is divided into three main parts namely notification part, monitoring part and controlling part. List of hardware devices to be used on Smart Irrigation System are categorized into three category as follows:

4.2.1 Design and specification of Monitoring unit (section)

The monitoring unit involves sensors necessary for collecting data from farm and sending them to microcontroller. In this project there are three sensors that sends notification signals from the sensors to the microcontroller. These are PH sensor, Temperature and Humidity sensor and Moisture sensor that sends PH values, Temperature and Humidity value and the moisture of the soil respectively. Components under these cartegories work on maximum of 5.5V

Both sensors intends to monitor the farms status and send signal to microcontroller. Sensors include,

- **PH sensor**

Figure 5: PH Sensor

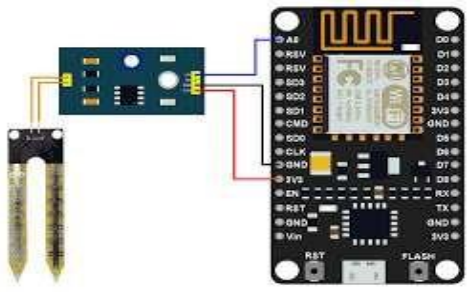

Figure 6: Moisture Sensor

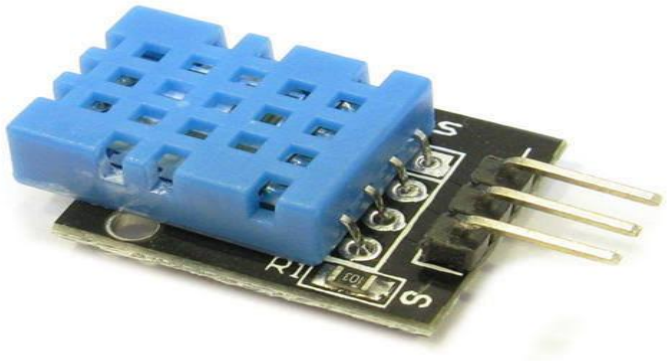

Figure 7: Humidity and Temperature sensor

4.2.2 Design and specification of Control unit

In this project the control part includes several hardware devices which are Microcontroller, GSM module and a Mobile phone.

- **Arduino (Microcontroller)**

After receiving the notification signals from the monitoring part, the microcontroller defines the signals according to the instructions programmed in it and sends the appropriate instructions to the specified devices for control mechanisms. Microcontroller controls the devices integrated with it such as buzzer and relay.

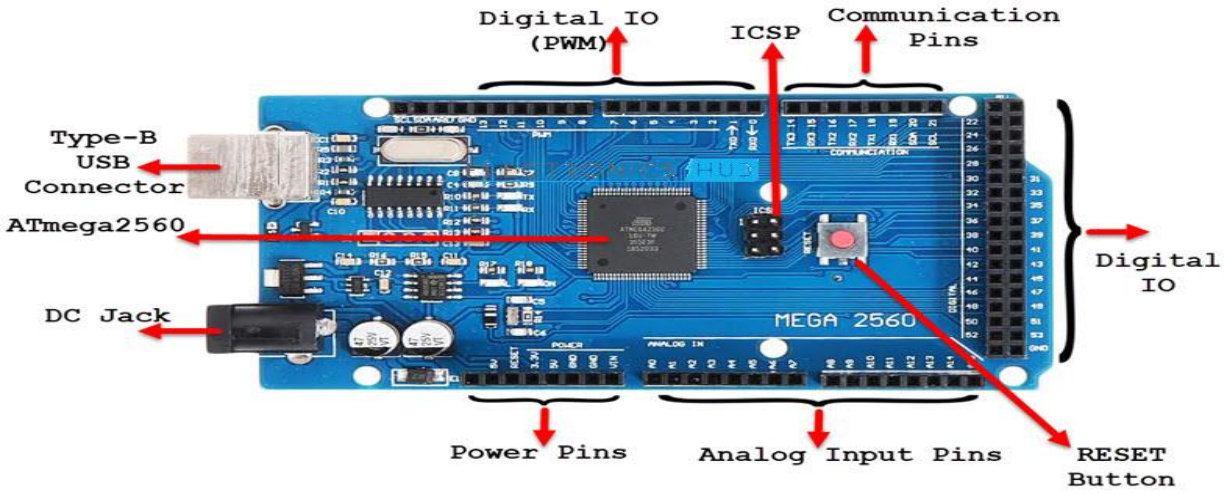

Figure 8: Microcontroller

- **GSM module**

"GSM", the Global System for Mobile communication is the technology that defines the entire cellular system for mobile communications. In this project the GSM is integrated to the microcontroller to insert the chip that will be used to pass control information from the user's mobile phone to the microcontroller. This control information are sent as a normal text messages

Figure 9: GSM Module

whereby they will be defined by the programs in the microcontroller and perform the intended control work.

GSM stands for Global System for Mobile communication. And it is a digital mobile telephony system. It is sometimes referred to as 2G. In order for the shield to work efficiently with Arduino board it has to accept or receive data from a remote location and send it to the Microcontroller, or it has to accept data from microcontroller and send it to the remote device

And this is achieved through:

i. GMS (Short Message Service)
ii. GPRS Service
iii. Audio service

It communicates with the Arduino through the GSM_TX pin on the shield to the RX pin of Arduino board and vice versa. Uses digital pins18 and 19 for software serial communication. It operates at 5V, requires a SIM card and has an on-board indicator which show the status of the device.

Other added features are:

i. Requires a SIM card to allow sending and receiving of short messages (SMS).
ii. It is powered by an external power supply 5V DC that provide 700mA to 1000mA.
iii. It has an on-board indicator (LEDs) which shows status of the device i.e GSM shield power, SIM900 power and net status.

- **Mobile phone**

A mobile phone will be used to send normal text which are defined as control instructions from the user to the chip inserted in the GSM module. The phone to be used in here can be a normal phone without the need of internet connection.

Figure 10: Mobile Phone

- **Relay**

A relay is an electrically operated switch. Relays are used where it is necessary to control a circuit by an independent low-power signal, or where several circuits must be controlled by one signal. Here relay will be used to control the water pump after receiving signals from the Microcontroller, it will either allow or deny the flow of water from the water pump.

Figure 11: Relay

4.2.3 Design and specification of Notification unit

The microcontroller sends notification signals to notify on the certain conditions in the system, notification signals are sent to the following hardware devices:

- **Buzzer**

This device is used for notifications to the users close to where the buzzer is installed, whereby on the receiving of the notification from the microcontroller the buzzer make some notification sound to attentively notify a user on a farm needy state.

Figure 12:Buzzer

- **GSM Module**

The GSM is also used for notification purpose, the chip inserted into the GSM device receives the message from the microcontroller and sends it to the user's phone to notify the user about the current situation of the farm.

Figure 13:GSM Module (Notification)

- **Web Application**

The microcontroller also sends notifications to the Web app for displaying status of the farm. These notifications sent to the Web app will be another way to notify the user on a farm state that will help the user to know the progress on the farm activities.

Figure 14:Web Application

Component		**Specification**
Arduino MEGA		
GSM Module		SIM800C
Moisture Sensor		
Temperature & Humidity Sensor		DHT11
Lcd display		16x2
Touchpad		4x3
PH Sensor		
Resistors	R1	100 Ω @5
	R2	1 kΩ @3
	R3	10 kΩ @2
Relay		12 V
RTC Module		DS 1307
Diodes		1N4007 @ 4
Capacitor		25V, 4700 µF
Transformer		18-0 V, 2 Amp
Transistor		BC 547, 1N4002
Voltage regulator		705 & 7812
LED		5mm, Red @2, Green @2
Buzzer		
Water pump		
Potentiometer		

Table 1:Summary of Hardware requirements

4.2.4 Design and Specification of Power Supply

One of the most important thing to find about the power supply is the maximum current capability of a power supply. In order to choose correctly the power supply the following 4 important features (parameters) are concerned,

i. The output voltage
ii. The ripple
iii. The current capability, and
iv. The maximum short-term current.

Output voltage necessary from the power supply required is to supply 12V DC, 1.3A. And since the digital circuit used in this project is tolerant to some glitches and dips, hence the output ripple of 1mV a project will accept without producing problem.

SOFTWARE REQUIREMENTS

For software requirement, Arduino IDE Software. This is open source software is for writing, editing and uploading codes to the board, the language supported is C and C++. Other software is Proteus, a software tool suite used primarily for electronic design automation. The software is used mainly to create electronic prints for manufacturing of printed circuit boards, by electronic design engineers and electronic technicians to manufacture electronic schematics and diagrams, and for their simulation.

After the process of gathering all the related information about this final year project, a step of designing the circuit of Smart Irrigation System was done. Using Arduino software and Proteus software, where several basics process of designing the circuit was done.

Electronic device's selection is the first and most important step in this electronic circuit design. The transistor should exhibit high gain, low noise figure, and high performance a

the lowest possible current consumption, while preserving relatively easy matching at frequency of operation.

After the electronics devices had been selected the circuit were then designed. Figure 15 shows the actual design Smart Irrigation System that had been done using Proteus software. However for the value of some devices may change on the process of obtaining the desired value is done in manually where each of the component that consist in the circuits shown below will be tuned until the desired value (output) occurs.

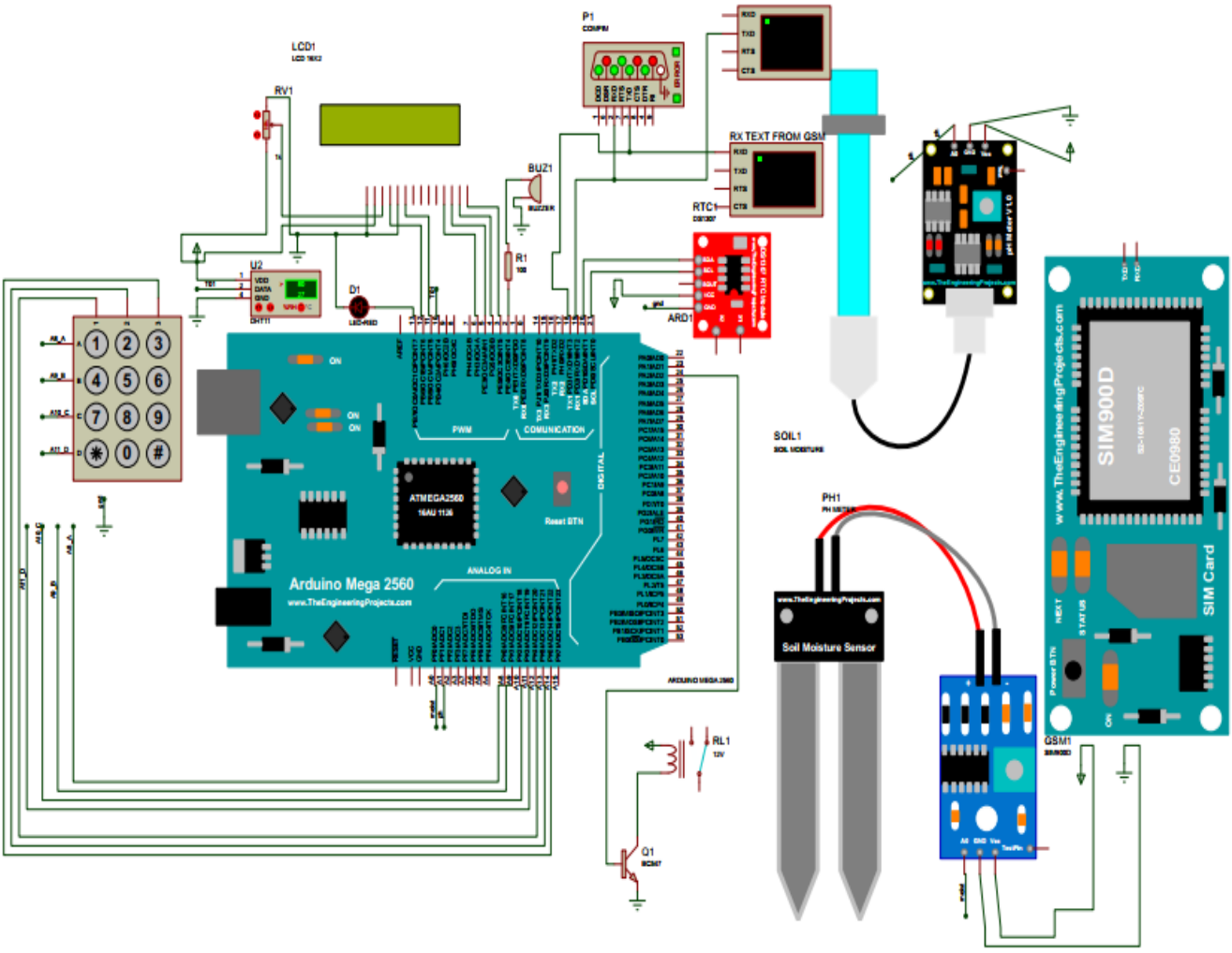

Figure 15: Circuit design by Proteus

4.3 SYSTEM DESIGN

System design involves the overall system layout that described as block diagram, flowchart and circuit diagram.

4.3.1 BLOCK DIAGRAM

The following is a block diagram indicates how the system components are interconnected with each other, and how communication is directed from one component to another. Components are grouped according to their categories that is those for monitoring unit, notification unit and controlling unit.

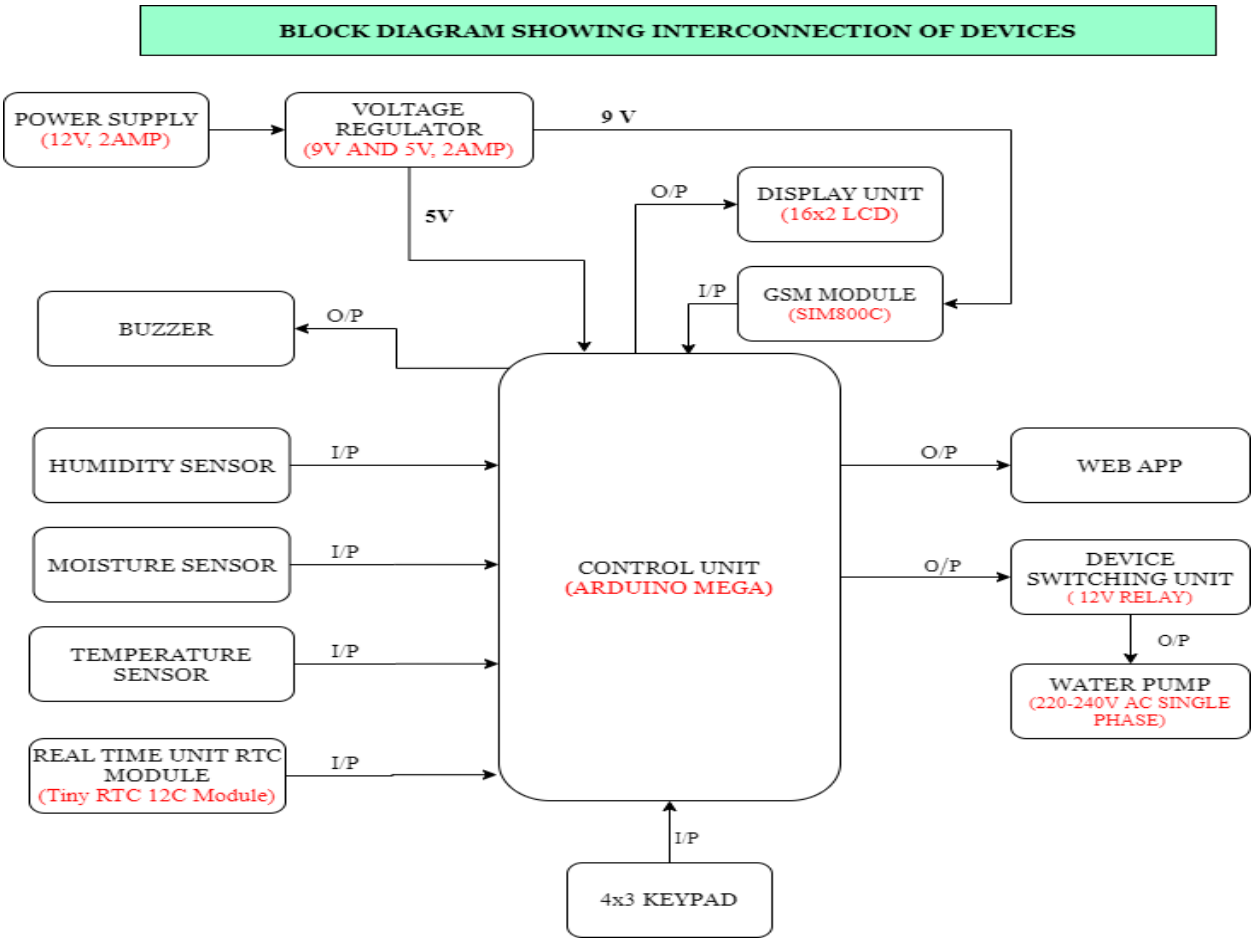

Figure 16: Block diagram (System layout)

4.3.2 FLOWCHART

Flowchart involves all the processes involved from when devices are initialized, collection of data from sensors, sending them to microcontroller, displaying and sending them to various unit and applying necessary decisions according to the command set on microcontroller. As shown on diagram below.

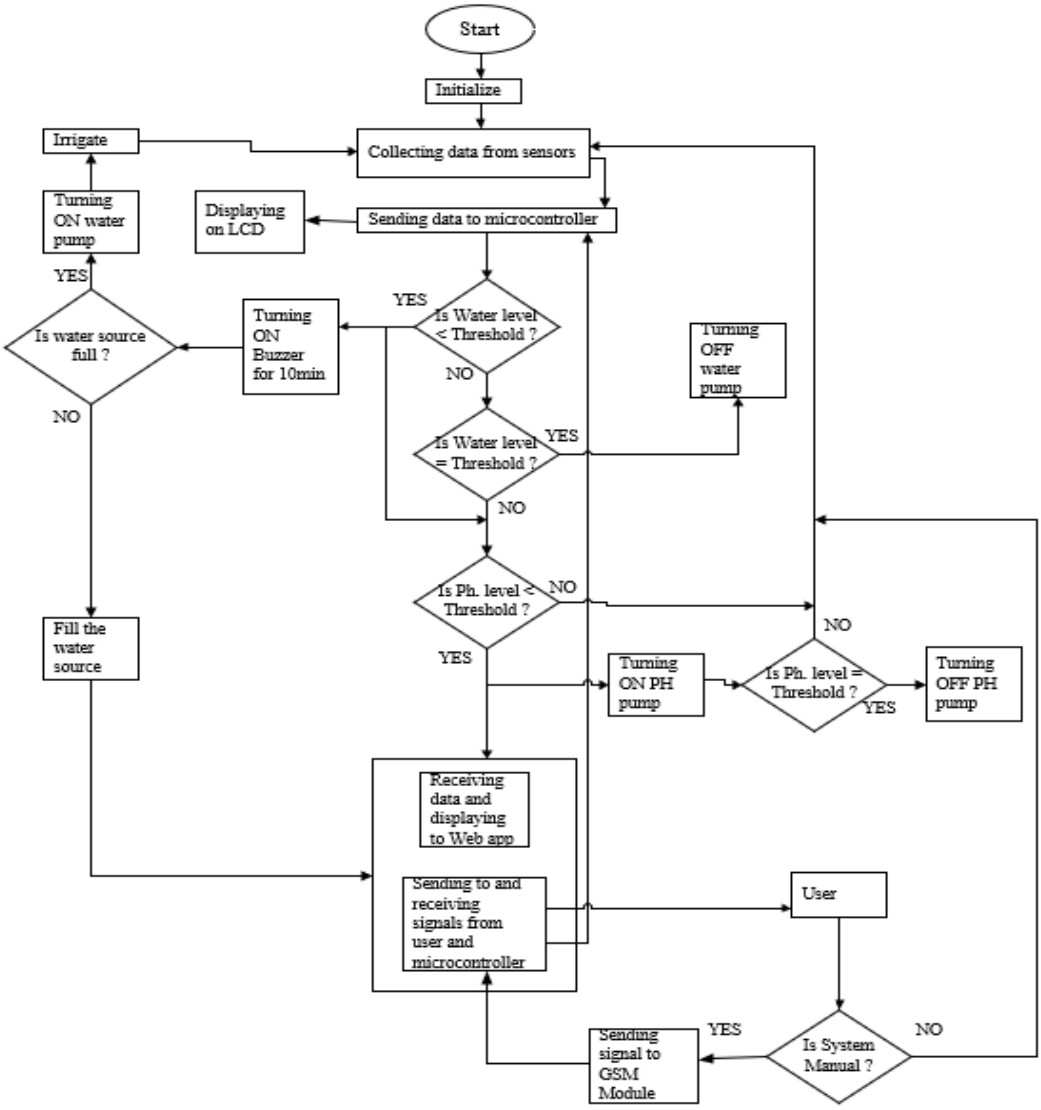

Figure 17: Flowchart of System

4.3.3 CIRCUIT DIAGRAM

This involves the physical connection of devices to microcontroller as shown in diagram below.

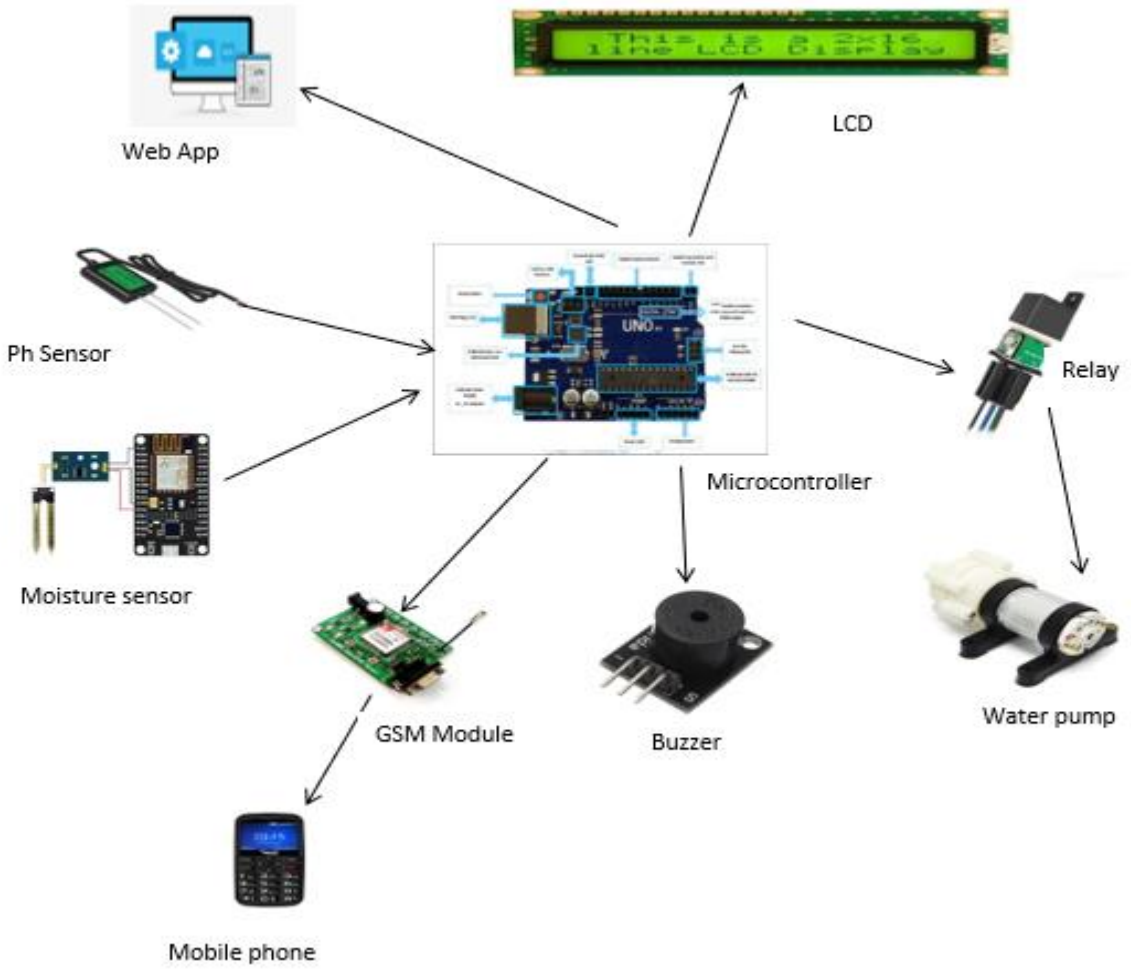

Figure 18: Circuit Diagram

CHAPTER 5: SYSTEM SIMULATION

After system design is completed and the operating values for each component is calculated and known; circuit simulation follows. This simulation shows all the components arranged, connected and implemented to show the behaviour of the system before the actual building of the system.

Proteus software is used in simulating this system, apart from its major advantages, this tool lacks some tools. Therefore simulation is done for all components to be included in the real system but with absence with some of tools. To compensate for this a Virtual Terminal was used, this tool proves to be a good substitute because it can send and receive data through serial communication in case of GSM. So Virtual Terminal will be used for following services:

i. Show message that will be sent to the farmer when water level is low.

ii. Alert the farmer once there is variation of parameters in the farm.

5.1 GENERAL CIRCUIT DESIGN

Circuit design is done on Proteus software as shown in the figure below,

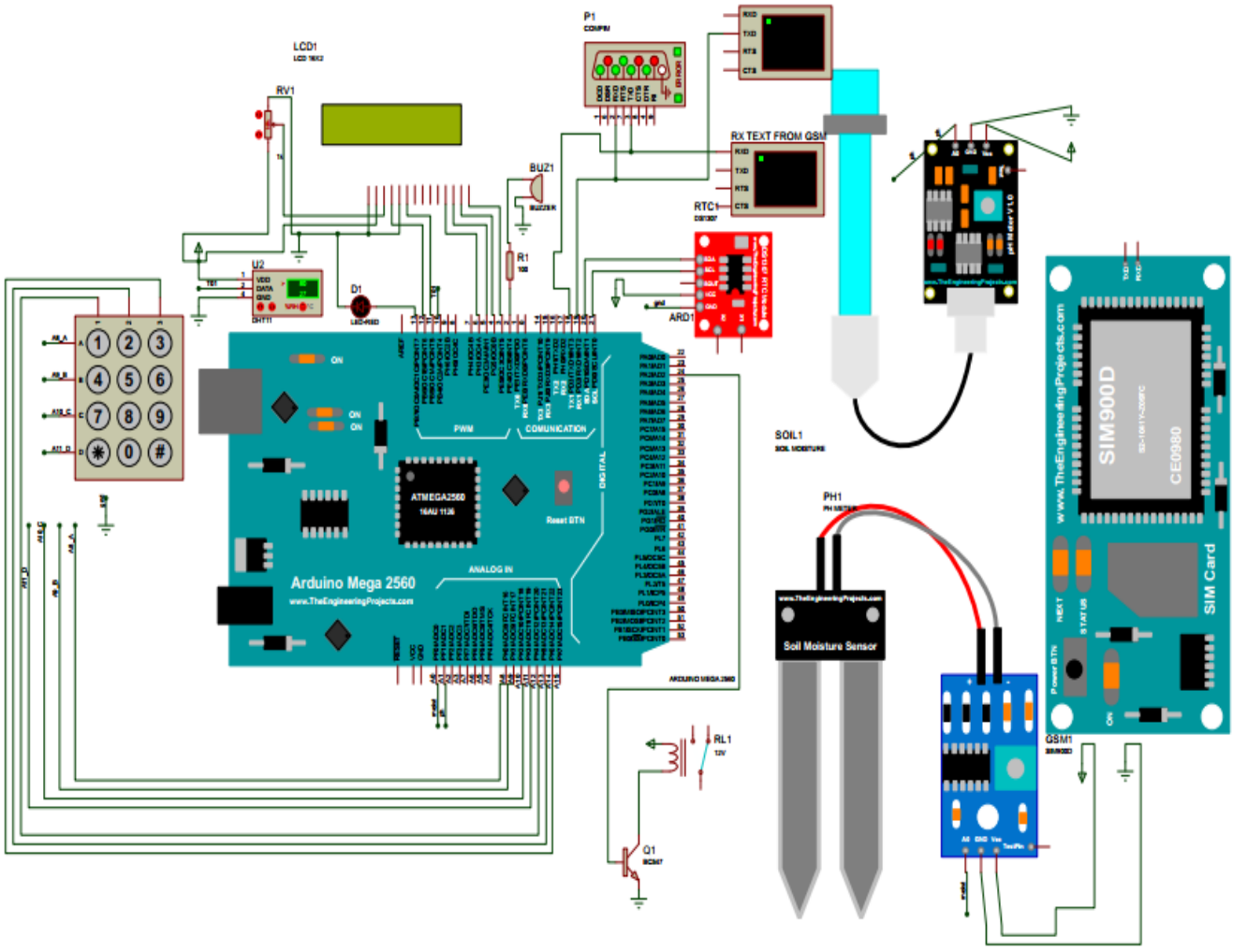

Figure 19: General circuit design

5.2 CIRCUIT SIMULATION

When codes are loaded to the microcontroller and circuit simulated the following output was obtained based on the specified conditions as follow: -

5.2.1 Output when the system is powered ON

when the system is powered ON, it display message to allow user to enter his/her phone number. He/she accept to enter phone number if and only if has not registered on the device by pressing '*' and reject it if has already registered by pressing '#'

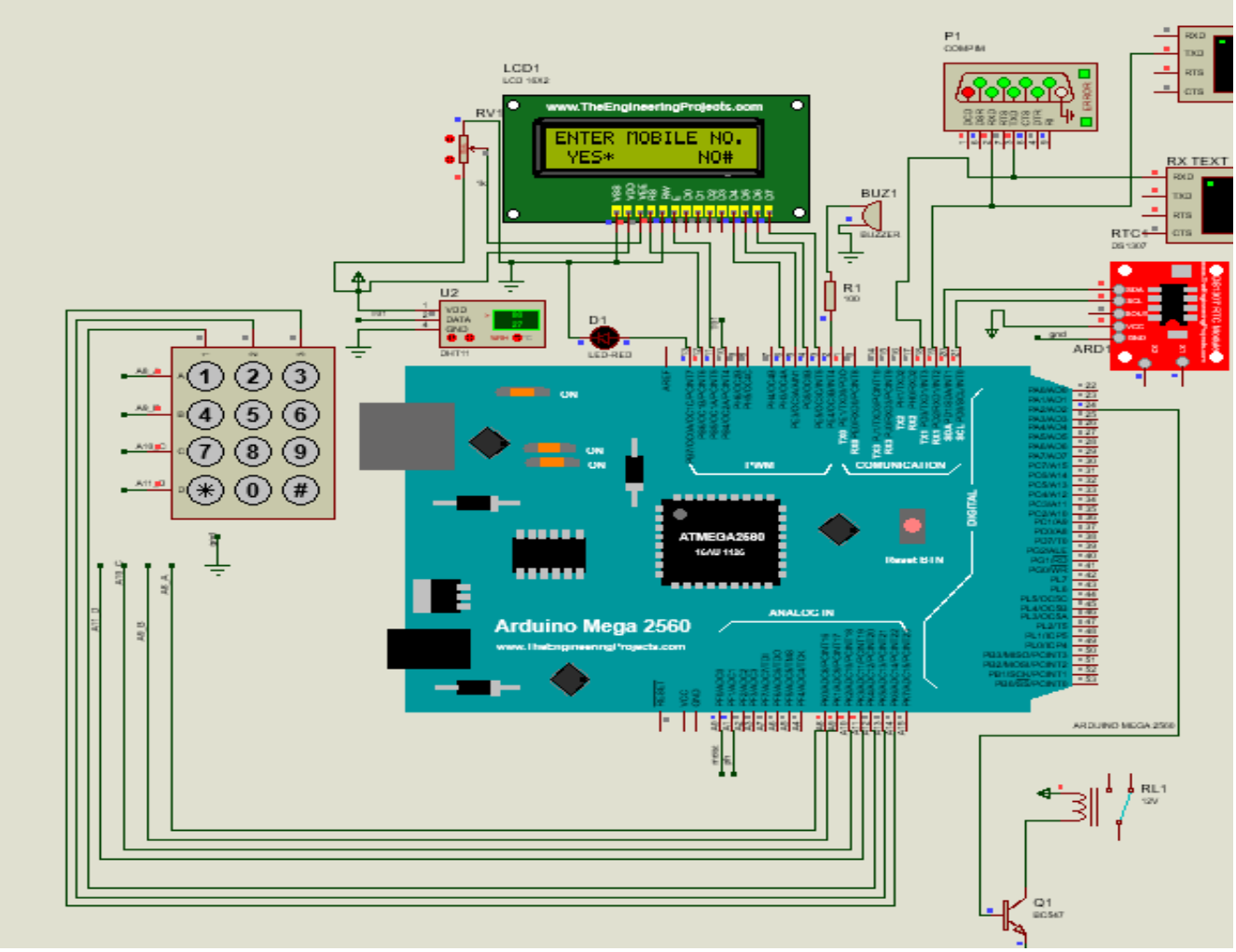

Figure 20:Output simulation when system is powered ON

5.2.2 Output when user press YES (*)

After First window which prompt user to accept or reject entering the mobile number appear, user has to decide one option out of two options, if user decided YES by pressing '*' the following window appears as shown on figure below which allows user to enter his/her phone number.

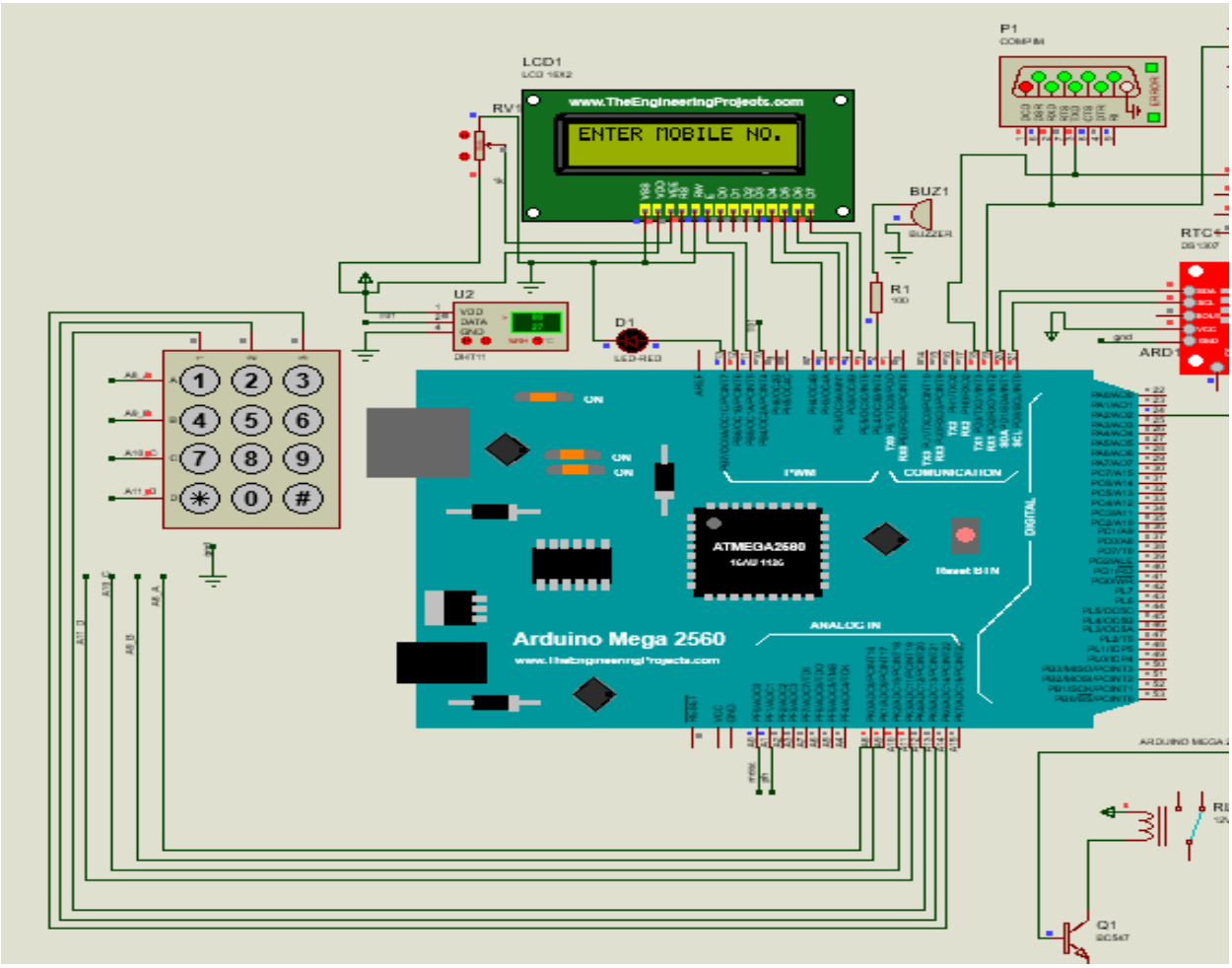

Figure 21: Output simulation when user press YES (*)

5.2.3 Output when user enters phone number

After the system allows user to enter phone number, user enters phone number and press '#' to submit and the following window appears which shows message 'WAIT' on the process of saving that number. After this step the user is already registered on the system.

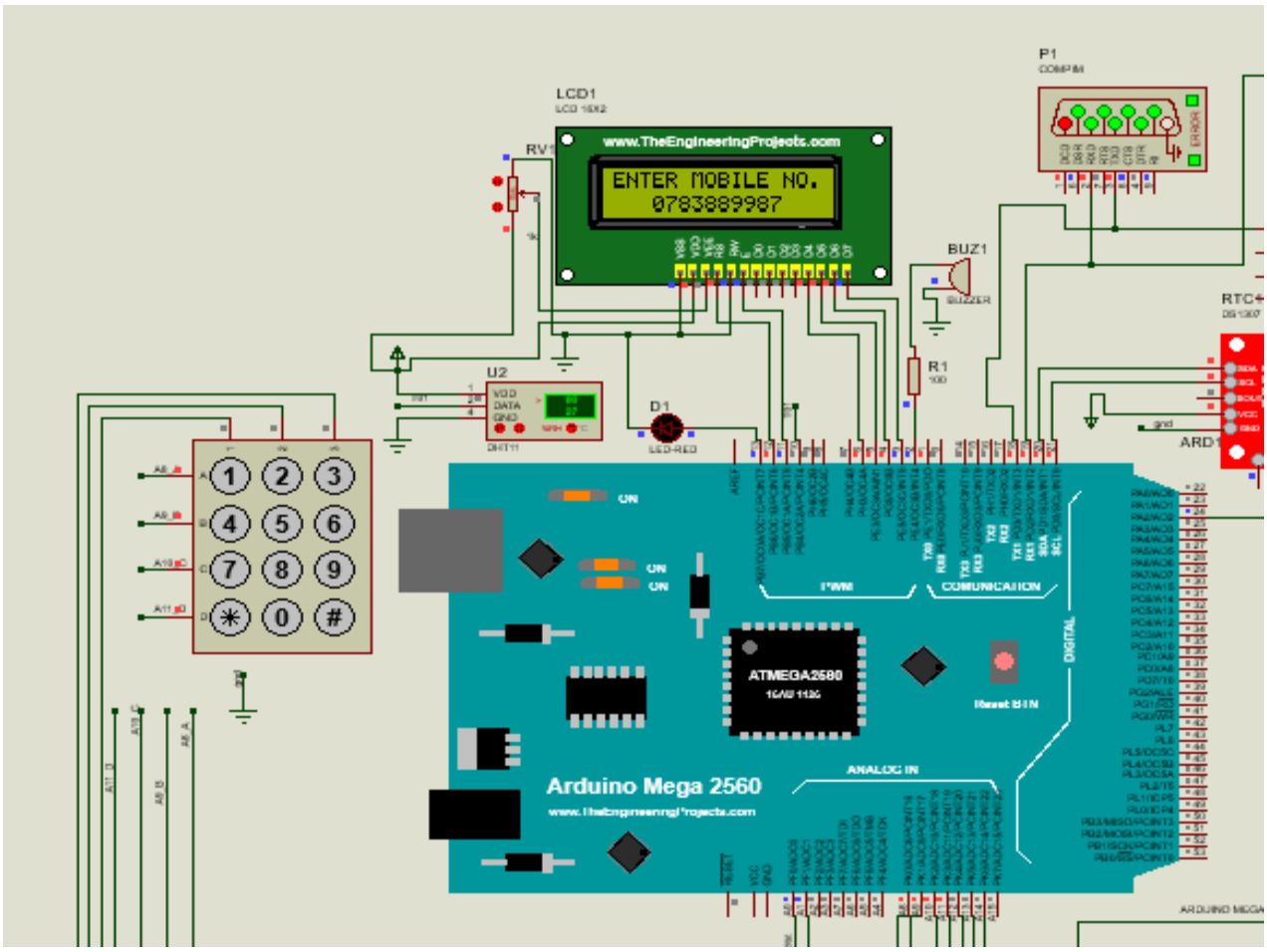

Figure 22: Output simulation for entering phone number window

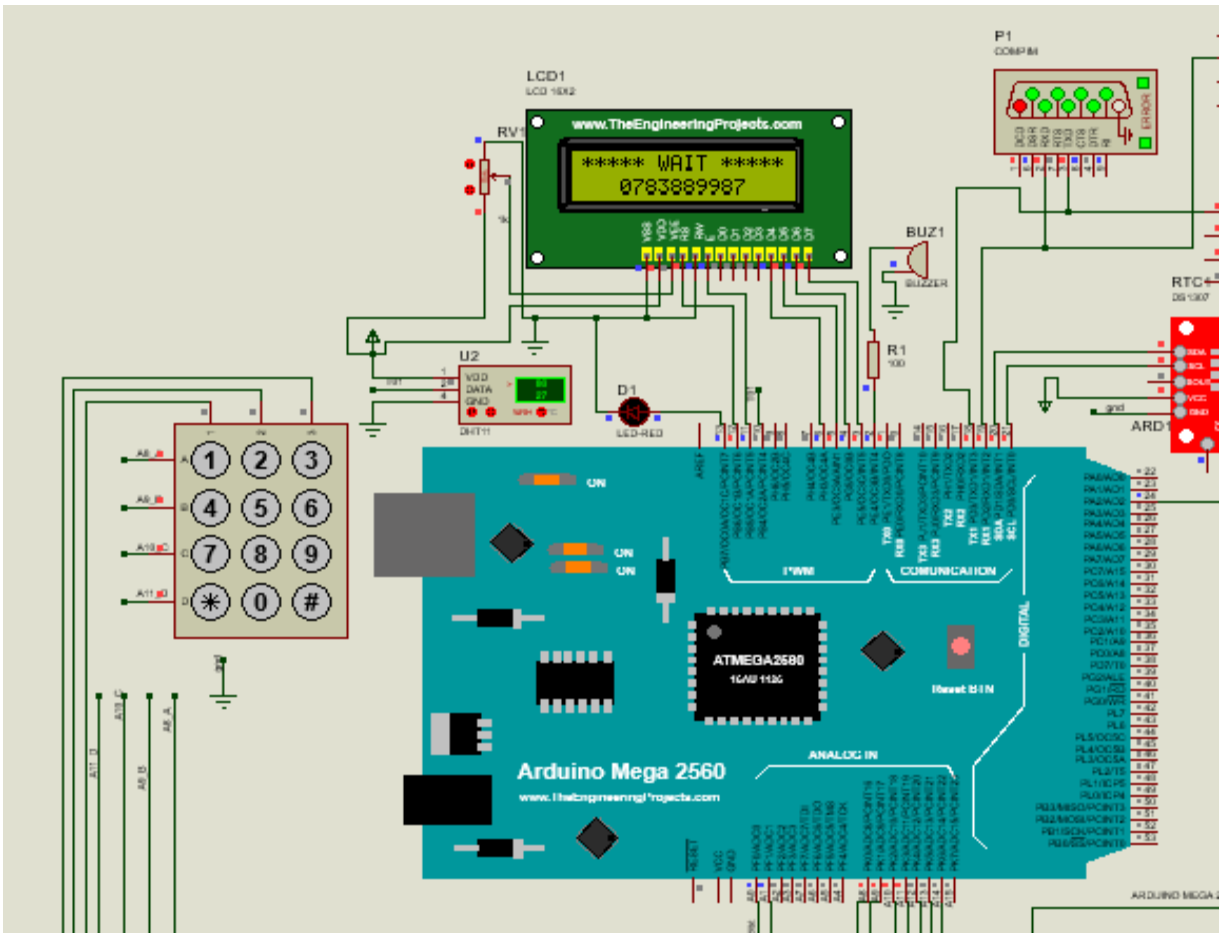

Figure 23:Output simulation for waiting window after user register phone number

5.2.4 Output for real time parameter values

After the user enters in the system, the system display real time values of parameters but the value provided are fixed for simulation purpose as shown in figure below,

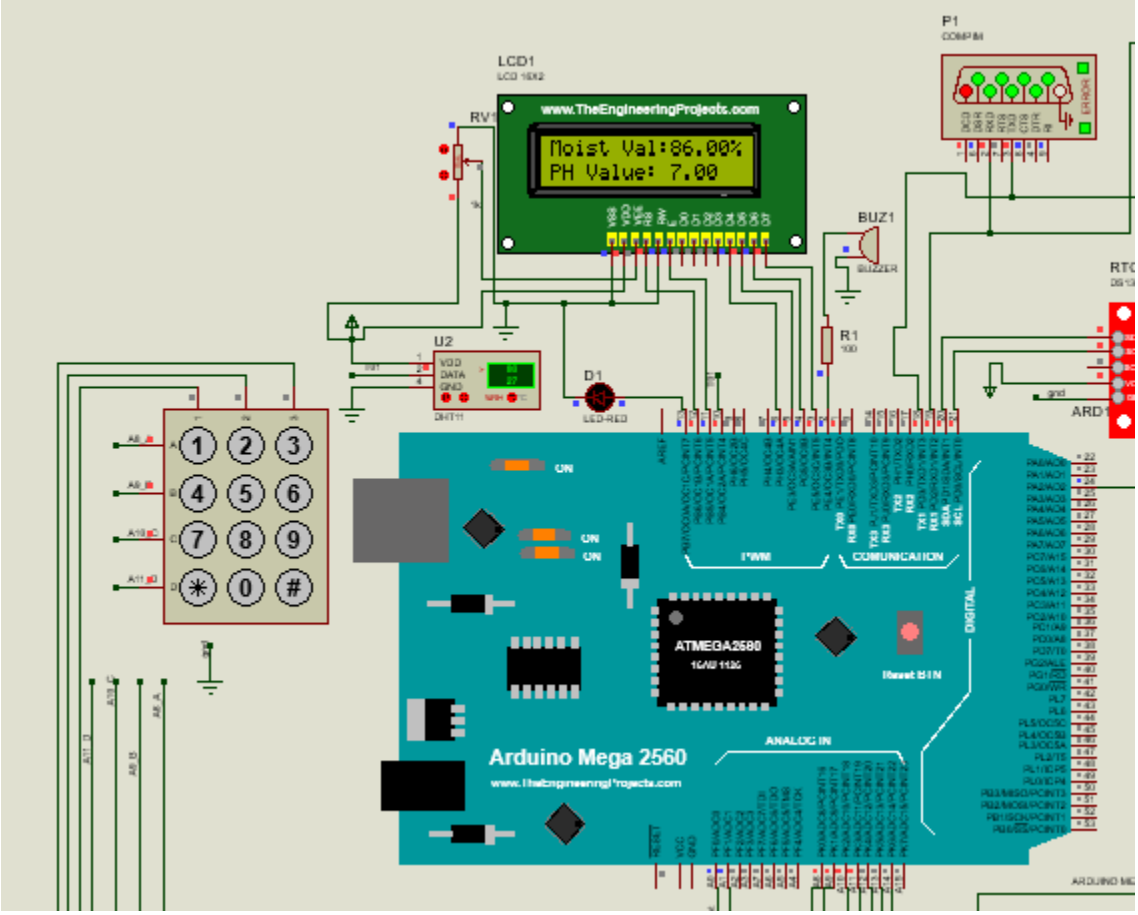

Figure 24: Output simulation of real time parameters values

5.2.5 Parameter values sent to mobile phone

The figure below shows parameter value that will be sent on mobile phone, for simulation purpose virtual terminal is used in this case. Lcd display PH and Moisture info while GSM display PH, moisture, temperature and humidity info.

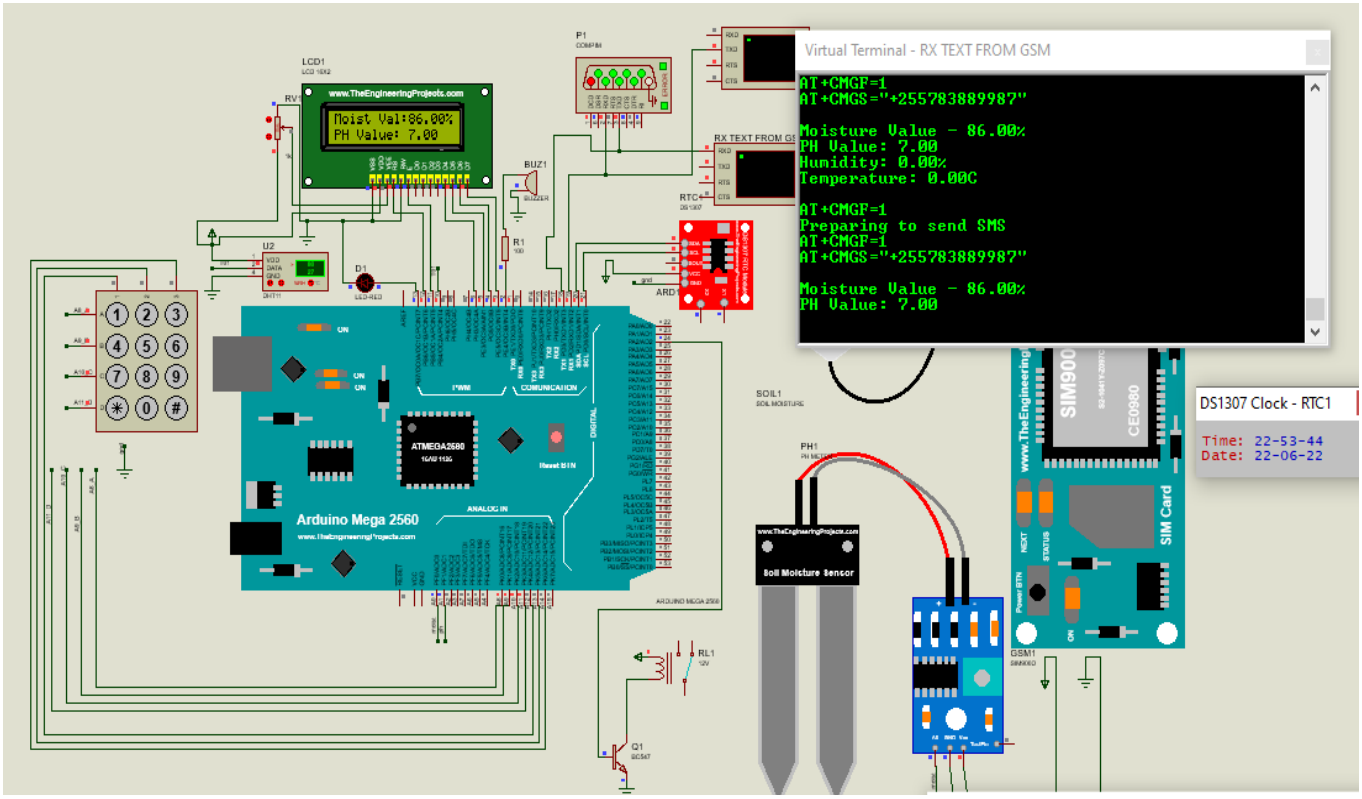

Figure 25: Output simulation when message sent to mobile phone

5.2.6 Output when user press No (#)

When user press No (#), the system skips the registration process and continue with displaying amount of soil moisture and Ph level of the soil as shown on figure below,

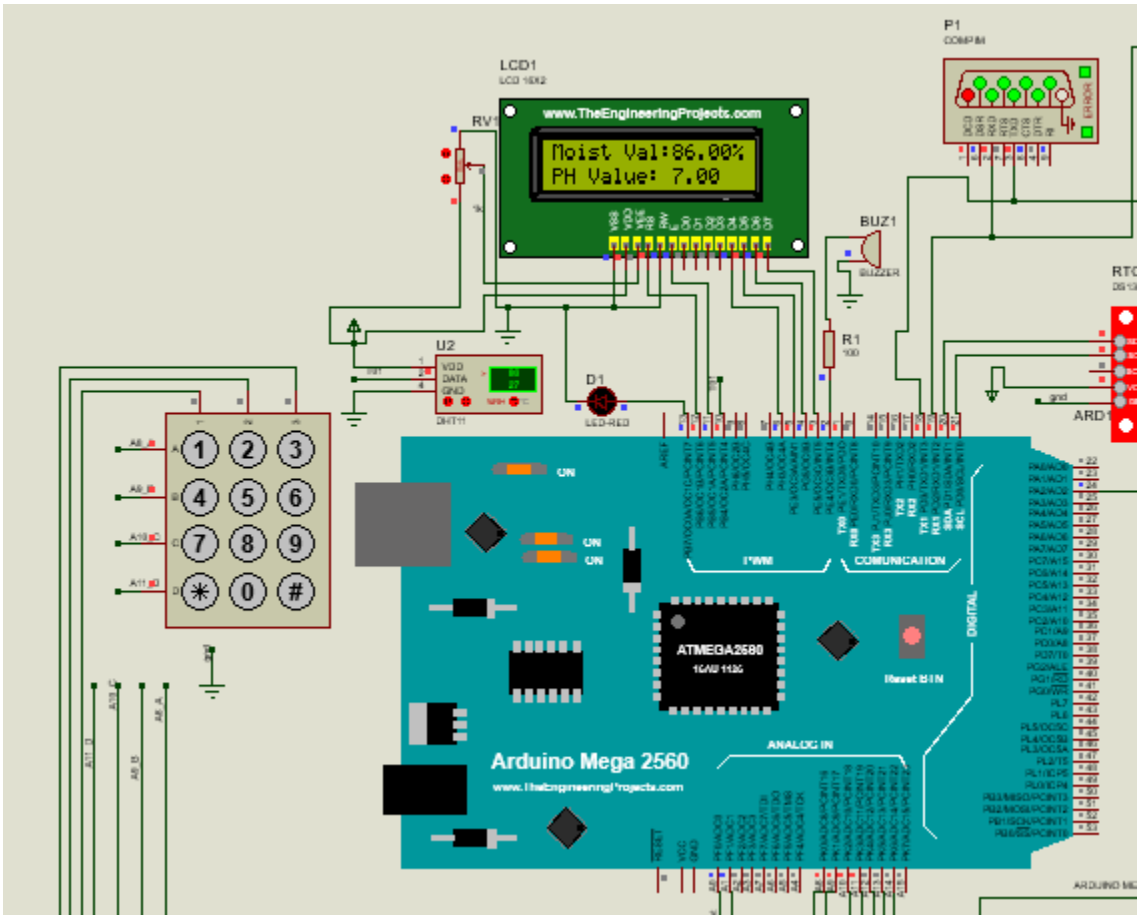

Figure 26: Output simulation when user press NO ('#')

CHAPTER 6: SYSTEM IMPLEMENTATION AND TESTING

6.1 System prototype

System prototype was created by creating and testing different system modules, final all modules were integrated, the Arduino board with the Microcontroller has been interfaced with the GSM module to enable Serial communication to send SMS to the user when the water level is beyond the threshold level after detected by soil moisture sensor, also to send SMS contain farms parameters to the farmer.

System equipped with keypad for registering user's phone number and performing some commands like updating phone number, deleting SMS logs, setting time interval for SMS alert, manual parameters check, registered mobile number check and time interval for receiving SMS check.

System equipped with LCD for displaying value (real time values of parameters).

Also, the RTC was connected to the Arduino board to so that can keep monitoring the time for sending data to the database. So far, the system is working properly and communicate well with web application as expected.

6.2 Cable connections

- **Connecting Arduino board with GSM shield**

GSM Shield is connected with Arduino according to table below

Table 2: Connecting Arduino board with GSM Shield

ARDUINO BOARD PORT NUMBER	**GSM MODULE PIN**
18	Receiver (RX)
19	Transmission (TX)
5V	Vcc
GND	GND

- **Connecting Arduino board with RTC module**

RTC module is connected to Arduino so as to keep record for the time even if power is turned off according to table below,

Table 3: Connecting Arduino board with RTC module

ARDUINO BOARD PORT NUMBER	**RTC MODULE PIN**
A4	SDA
A5	SCL
5V	Vcc
GND	GND

- **Connecting Arduino board with LCD**

LCD which used in this project is not I2C hence it has many pins and requires more wires with many ports of Arduino board, the connection is as follows.

Table 4: Connecting Arduino board with LCD

ARDUINO BOARD PORT NUMBER	**LCD PIN**
12	RS
11	E
3	D7
4	D6
5	D5
6	D4
GND	K, V_{SS}, RW
Vcc	A, V_{DD}
GND	V_{SS}

- **Connecting Arduino board with buzzer**

ARDUINO BOARD PORT NUMBER	BUZZER
2	Pin1
GND	Pin2

- **Connecting Arduino board with keypad**

Keypad pins has combination of rows and columns, due to availability of 4x3 keypad 4x4 is used instead. 4x4 keypad has eight (8) pins four first pins are rows-pin and other 3 pins are for columns and the other pin is not used. Pin connection is as follows,

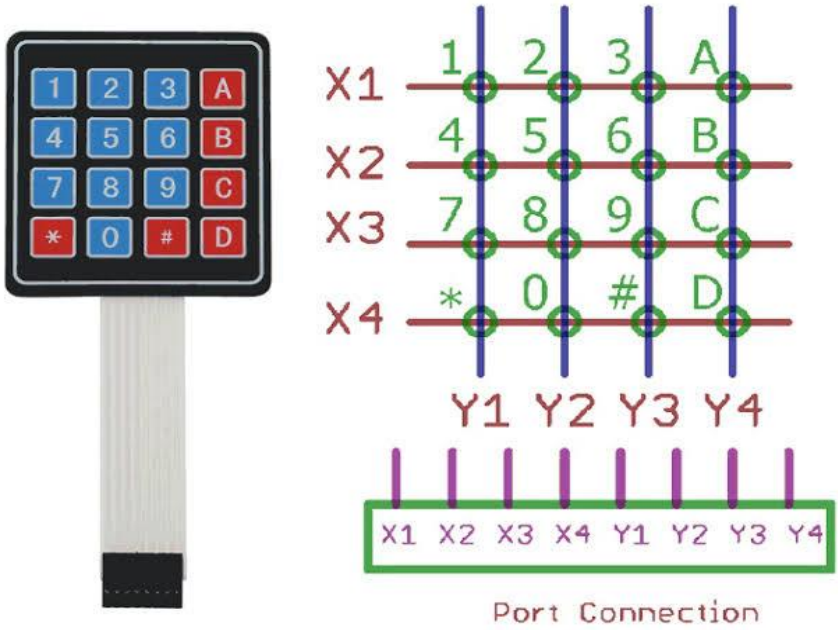

Figure 27: 4x4 keypad pin structure

Connection with Arduino board with keypad is as follows,

Table 5: Connection of Arduino board with keypad

ARDUINO BOARD PORT NUMBER	**KEYPAD PINS**
A8	R1
A9	R2
A10	R3
A11	R4
A12	C1
A13	C2
A14	C3

- **Connecting Arduino board with moisture sensor**

Moisture sensor has three terminals from which one is for data to pass to pin analog pin (A0) of Arduino and others to Vcc and GND

- **Connecting Arduino board with temperature and humidity sensor**

Temperature and Humidity sensor (DHT 11) has three terminals from which one is for data to pass to pin 10 of Arduino and others to Vcc and GND

6.3 System testing

The overall system which contain basic components like GSM shield, Arduino board with microcontroller, moisture sensor, temperature and Humidity sensor and keypad is as follows,

System testing is done in several conditions as follows,

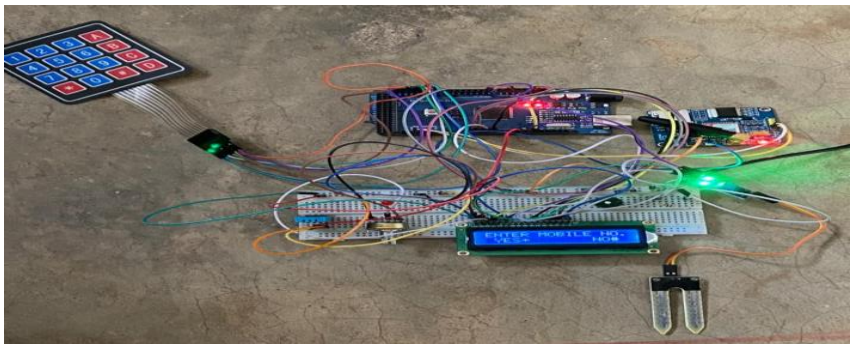

Figure 28:System testing with basic components

6.3.1 Output for registering new user

When system is powered ON the system will prompt user to enter his/her phone number if doesn't register, and skip the process if is registered as shown below,

For new user he/she suppose to press YES (*) so as to enter mobile number and the window below will be shown,

Figure 29: Output for registering new user

6.3.2 Output when user press YES (*)

When user press Yes (*) he suppose to enter the phone number for receiving notification once some parameter changes. After entering phone number user supposed to press '#' for submitting and the number will be saved as shown in figure below,

Figure 31:Entering phone number

Figure 30: Saving phone number

6.3.3 Output when user complete registration

When user complete registration LCD starts displaying values of moisture, temperature and humidity as shown below

6.3.4 Output when low moisture detected

If moisture sensor detects that there is no moisture in the soil it display alert message and sends message to the user immediately. If moisture is sufficient it displays value of parameters as shown

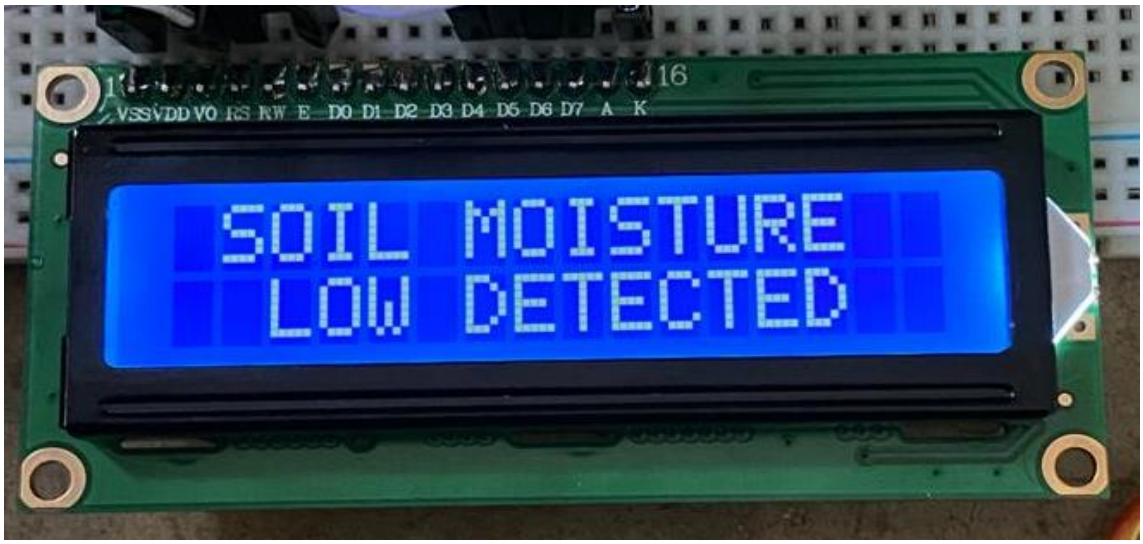

Figure 33:Output when low moisture is detected

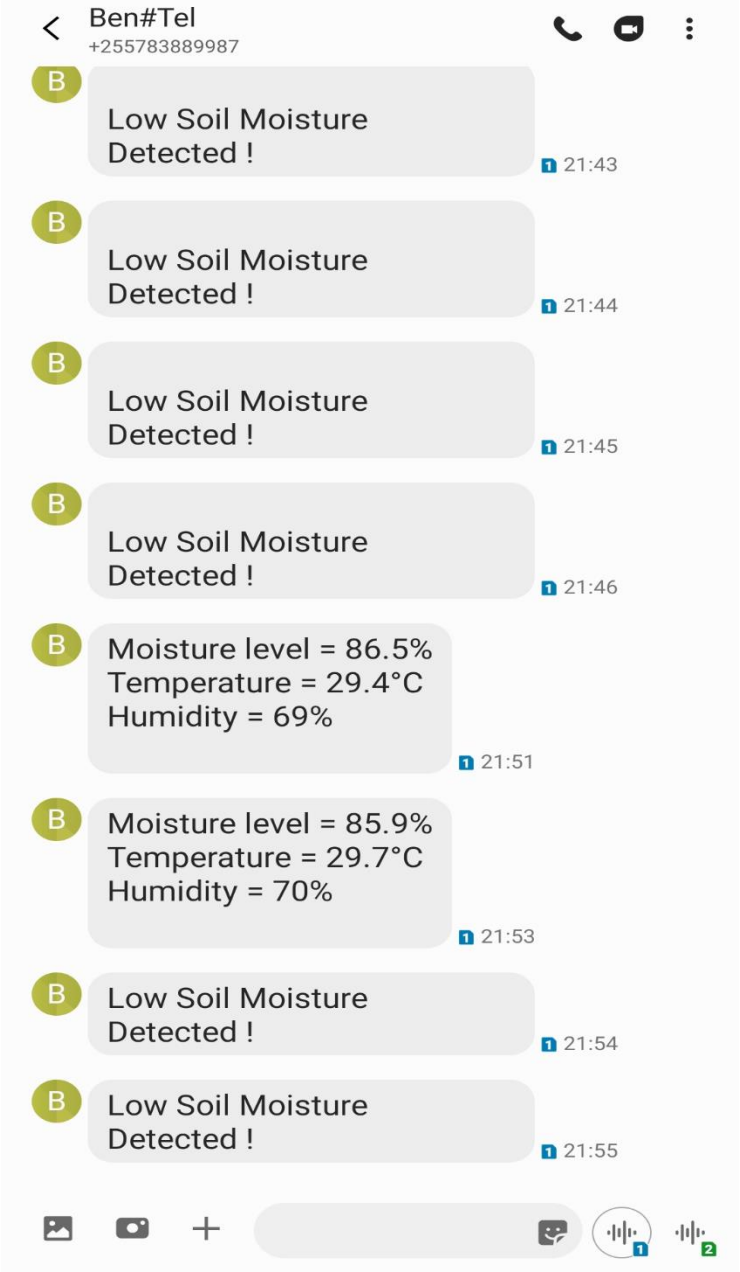

Figure 34: Output when message sent to the user

6.3.5 Output when user want to update phone number

If user wants to change phone number he/she suppose to press ‘0’ followed by new phone number the ‘#’ i.e. **0 0717378280 #** as shown on the figure below

Figure 35: Updating and saving phone number

6.3.6 Manual moisture content check

User can manual check moisture content by pressing ‘1’ as shown on figure below

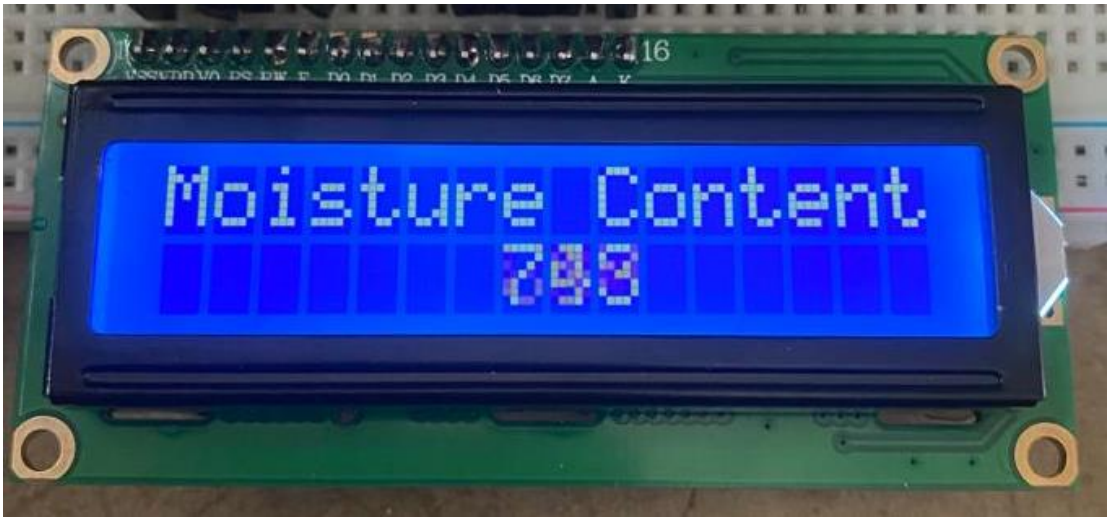

Figure 36: Manual moisture check

6.3.7 Output when checking registered phone number

If user wants to check the registered phone number he/she suppose to press ‘2’ as shown on figure below

Figure 37: Output when checking registered phone number

6.3.8 Output when setting SMS alert interval

If user wants to set SMS alert interval he/she should press ‘#’ followed by time interval in seconds then ‘#’ for example, **# 600 #** time interval set to 5 minutes

Also if user wants to check time interval set he/she should press ‘3’ as shown,

Figure 38: Output for checking time interval set

CHAPTER 7: CONCLUSION AND RECOMMENDATION

7.1 Challenges and problem encountered

Unavailability of the necessary hardware for the implementation of the project within the local markets which resulting to the increase of the project cost and time wastage for conducting project which require certain types of hardware

7.2 Recommendations

The project has been developed and implemented. However, it can be improved and modified so that it can be employed in more advanced and better application. For future improvement, the program and input circuit can be modified so that it can control many other features as possible. Therefore, I encourage the government and private sectors to use this system in agriculture both for small scale and large scale specifically Irrigation type agriculture and those sited in rural areas.

7.3 Conclusion

To achieve effective monitoring and control of farm parameters especially for the farmer who lives far away from his/her far, farmer should use this system for getting notification of what happened in the farm and control some parameters when soil moisture is decreased beyond certain level.

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APPENDIX A : PROJECT SCHEDULE

Semester 1 – Schedule

S/N	ACTIVITIES	WEEKS													
	First Semester	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Project Research															
2	Literature Review															
3	Submission of mid-semester progressive report															
4	Mid-semester presentation															
5	Reconstruction of the project per comments															
6	Gathering informatioon required for the system															
7	Study the components required for the system															
8	Design the block diagram of the system															
9	Design the flow chart for the system															
10	Design the circuit diagram of the system															
11	First-semester presentation															

Figure 40: Semester 1 Project Schedule

S/N	ACTIVITIES	WEEKS													
	Second Semester	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Literature review															
2	Simulation for individual components															
3	Simulation of whole system															
4	Mid-semester oral presentation															
5	System programming															
6	Building the prototype															
7	Circuit simulation															
8	System redesign and testing															
9	Submitting of final report															
10	Final oral presentation and demonstration															

Semester 2 – Schedule

Figure 39: Semester 2 Project Schedule

APPENDIX B : PROJECT BUDGET

Table 6: Project Budget

ITEM	COST
Microcontroller (Arduino)	35,000/=
Moisture Sensor	6500/=

Relay	15000/=
Buzzer	600/=
GSM	40,000/=
Water Pump	10,000/=
LCD Display	15,000/=
Other Components	35,000/=
Voucher	30,000/=
Transportation	25,000/=
TOTAL	**212,100/=**

APPENDIX C : QUESTIONNAIRE USED

Questionnaire used is obtained from the link below and is shown as seen in pictures below

https://docs.google.com/forms/d/e/1FAIpQLSfriq5NbTk0_EsU9YPYgZxgFPDbNXVCq1ZkwCZMTov7Phj0hQ/viewform?usp=sf_link

SMART IRRIGATION SYSTEM

Hellow there, Here is Gabriel Mturi and Dorcas Leskanga both pursuing BSc. in Computer Engineering and Information Technology, 4th year at University of Dar es salaam. We are conducting research to gather some information concerning to our final year project titled "SMART IRRIGATION SYSTEM", System itself aims to monitor status of the farm, notifying user on any variation of status of the farm and monitor the variation occured on the farm. Responses provided will be used for studying purpose

As a student, do you think is it necessary to monitor status of the farm once the farmer lives far away from the farm ? *

- ○ Yes
- ○ No

If answer is yes what parameters do you think should be monitored in the farm ?

Short-answer text

Which of the following ways will be better for notifying status of the farm if the farmer is far away from the farm ? *

- Normal SMS
- Reminder on Android/IOS devices
- Using Web App
- Using Alarm
- Other_

Which of the following ways will be better for notifying status of the farm if the farmer is not far away from the farm ? *

- Normal SMS
- Web App
- Android/IOS App
- Alarm
- Annoying sound

Do you think existance of past monitoring records on status of the farm are useful to the farmer/ anyone using the system ? *

- Yes
- No

If answer is Yes, explain why!

Long-answer text

Does it make sense developing the system on areas which receives rainfall frequently ? *

- Yes
- No

Do you know any automatic way of controlling soil PH. ? *

- Yes
- No

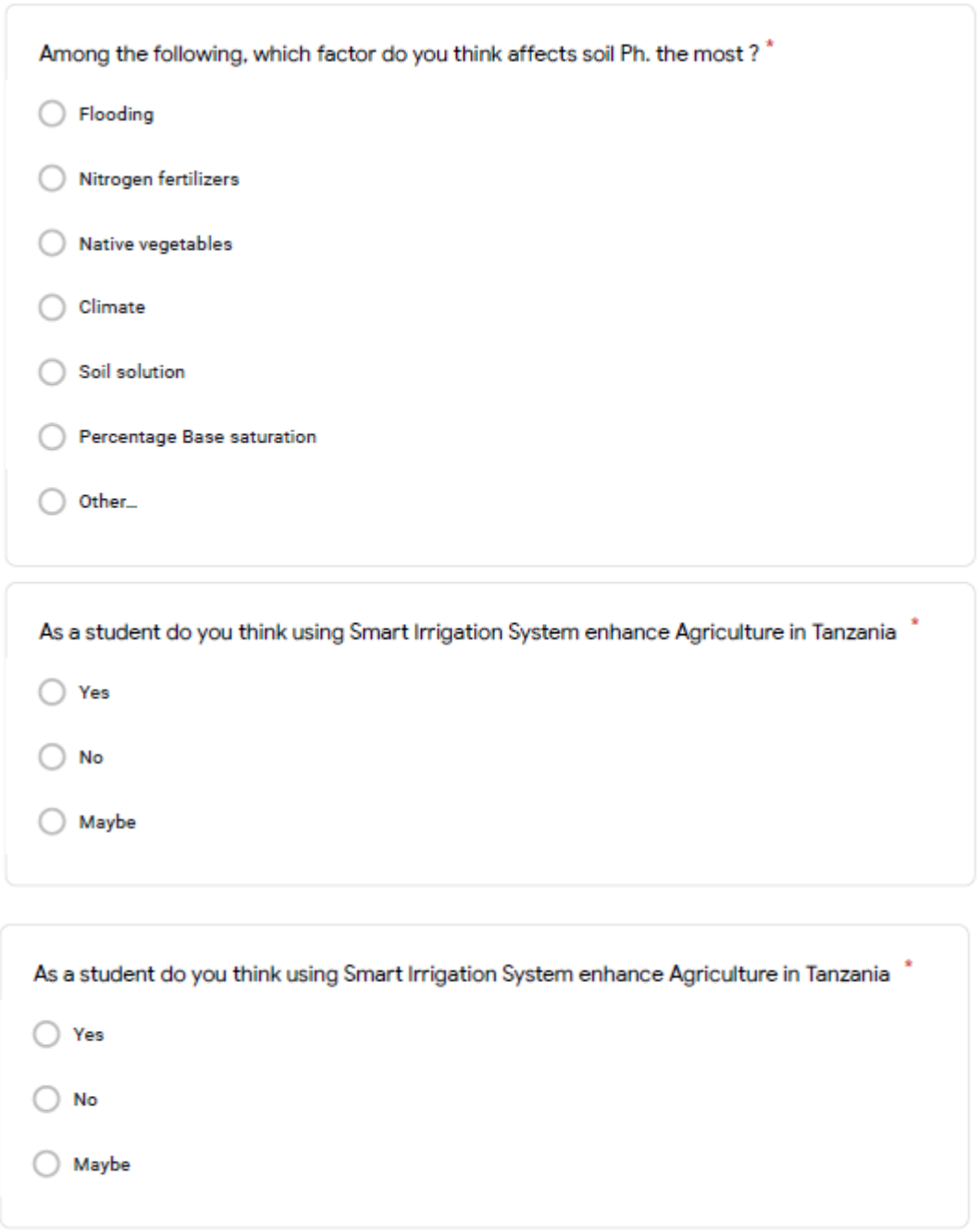

Figure 41: Questionnaire questions