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# AUTOMATED IRRIGATION SYSTEM

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## Executive Summary

With this project, we achieved successful results by testing out the questions asked at the beginning of the paper. The purpose of the smart irrigation system for large or small scale and make it smarter and more effective.

Different sensors (Soil Moisture, Light, Temperature, level, rain, flow ) with different another device |(water pump, Battery, LCD, Solenoid valve ) have been used to make this project. Using Arduino proved profitable, it is able to serve numbers of different sensors, at the same time and the markets offer various type and sizes of sensors. Arduino boards are another device. Furthermore, two woody tables and three sheets of foam have been used in the project.

Several of design criteria had used in this system. The sensors used was perfect in detecting and sending signals to Arduino, to control the water pump and to open the solenoid valve, it has been tasted indoor as it is on the farm.

The purpose of screen monitor is to show the flow for each line, which shows if there is any passing of water in pipes. Also, if it is raining the system will not work in order to save the water.

The mobile application is to control the system remotely. Which allow a user to monitor the whole system and if there is any problem or passing of water user can switch off the system through this application.

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## 1.0 Introduction

In late decades, there is a quick advancement in Smart Agricultural Systems [1]. Show that agriculture has great importance worldwide. Indeed, in India for example, about 70 % of the people relies upon the vital sector of agriculture [1]. In the past, irrigation systems used to be dependent on the mills to irrigate the farm by conventional methods without knowing the appropriate quantities of these crops. These old systems are a major cause of the waste of large quantities of water and thus destroy some crops because of the lack of adequate quantities of water. However, with the recent technological developments, there have been innovative systems for irrigation without the farmer interfering in the irrigation process [26].

Because the Sultanate of Oman is in a region suffering from lack of rain throughout the year and lack of groundwater, modern irrigation systems will reduce this issue of lack of water. Indeed, smart systems have proven their capability to regulate the irrigation of crops. It also works to stop the waste of water in irrigation. Furthermore, it will work to minimize number of employees which lead to saving money.

Agriculture is developing from mechanized by simple methods in the twentieth century to being automated in the 21st century. There is evolving in field operation in agriculture section, which request a high accuracy in processes to optimize output and quality of the crops, in addition, limiting the production cost. To reach these prerequisites, automation systems must be introduced. It is important that producer considers on the early framework periods of mechanics and actualizes, so can achieve an elevated level of automation [2].

In this project, we try to solve the problems of irrigation such as errors caused by farmers and the consumption of large quantities of water. These errors affect trees as their fungi may also affect the overall stock of water.

It is necessary to make effective effort and contribution to achieving the desired objectives of this system. Therefore, the effort should not be limited to individual effort. In addition farmers must be very important to achieve the high efficiency of modern irrigation systems.

With the increase of world population, the need for farming yields is increasing instantaneously. Further, the farmer's potential and abilities in the agriculture filed are reducing, this is regarding different enterprises that attract workers away from the farming zone (28% of farmers in Japan are over 65 years old) [28]. The income in agriculture needs to continue

development regarding the prediction of world population increases from 6.8 billion in 2013 to over 10 billion by 2050. Efficiencies become an essential demand with the declining of farmers potential [3].

Expected objectives of this project are facilitated and simplify the irrigation system by installing and designing the whole automatic irrigation system, increase crop performance by reducing overwatering from saturated soil. It can prevent irrigation happening on the day at the wrong time, to switch engine ON or OFF by utilizing the irrigation system, the controller will work to switch the engine, so no need for employers, to reduce mistakes of operation due to employees as much as possible and to preserve water from waste.

## 1.1 Problem Statement

The economy of many countries depends on agriculture. To achieve the best quality from this research, it is important to focus on some vital characteristics such as the appropriate amount of electricity as well as water supply and a suitable schedule for irrigation of crops. Farmers are facing problems in meeting these standards, especially those living in poverty. This project looks into developing an automated irrigation system that could be controlled through mobile application. This system will work to minimize the number of workers in a crop field, control and save water and electricity, Increase agricultural production using small quantities of water, minimize manual intervention in watering operations with increasing watering speed and preserving plants from fungi. All these features make these research sustainable option to be considered to improve the agriculture and irrigation efficiency.

## 1.2 Context of Research

Because agriculture is important, this research will focus on building system that allows for automating for irrigation process and it is controlled by the software application. We are aiming to control this system by a software application and to discover the most efficient automation machine from research studies into the fields of Agriculture systems. Building an accepted hardware machine that may be used to resolve most problems associated with irrigation technique is a challenge. However, by means of finding an efficient approach to manipulate the system, then same concept of this system can then be applied to another system. This bachelor thesis will inspect

the Automation system in addition to the method used to manipulate the system and the machine that can be solved with using this system.

## 1.2 Research Questions

- Is there any automated irrigation system that allows the user to control the irrigation process more efficiently?
- What would be the requirements to create an automated irrigation system?
- In which agriculture lands an automated system could be used?
- How mobile apps could support automated irrigation systems?

## 1.3 Research Objectives

The main objective of this project is to develop an automated system that solves most problems related to irrigation and agriculture. such as controlling and saving both the water and electricity, Increasing agricultural production using small quantities of water , Minimize manual intervention in watering operations with increasing watering speed, Preserving plants from fungi, and finally. All these features make the automated system sustainable option to be considered to improve the agriculture and irrigation efficiency.

The goals of this study are to discover the excellent automation technique for irrigation system automatically controlled through software in a way that allows the user to to monitor all information and manage the device immediately from mobile.

Researchers in last decade have discussed the issue of the smart irrigation system. Many solutions are resolved from these studies (e.g. level of water in the land, control the system from mobile by SMS) [4] [7].

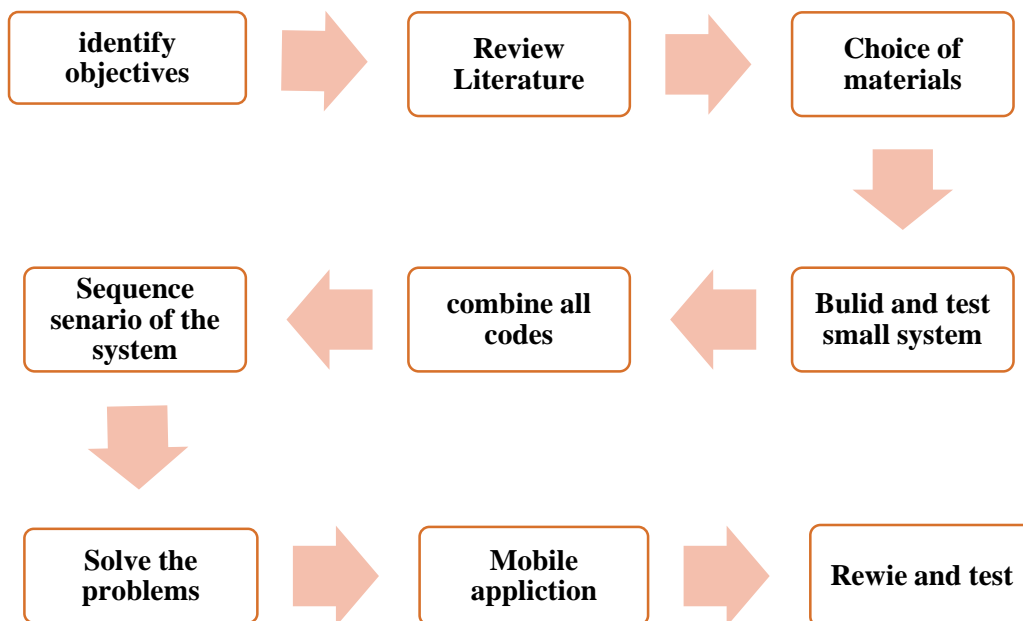
The objectives to consider are:

- Simplify the irrigation system by installing and designing the whole irrigation system.
- Save energy, which allows the application of smart irrigation system used more other application.
- Optimize water consumption.

- Automated system fully.
- Decrease the cost of operation.
- Make system easy to use by farmers.

## 1.4 Methodology

The system method includes the implementation of proto-type device work robotically and controlled thru the mobile application. For the prototype format drawing up the timeline and reading related works will be step one. After looking into benefits and downsides of previous studies in the subject of an automatic irrigation system, we can start implementing the layout and automation method for executable. The timeline of the project became set on the flowchart of the project. The steps can will be in the following process chart:



*Figure 1: Process Flowchart*



## 2.0 Related work and Background Review

In the beginning, we should have enough knowledge on how irrigation systems work and how it can be built in an efficient way. This chapter focuses on similar attempts in other papers.

### 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 [4].

### 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. [5].



*Figure 2 : Auto irrigation system[5]*

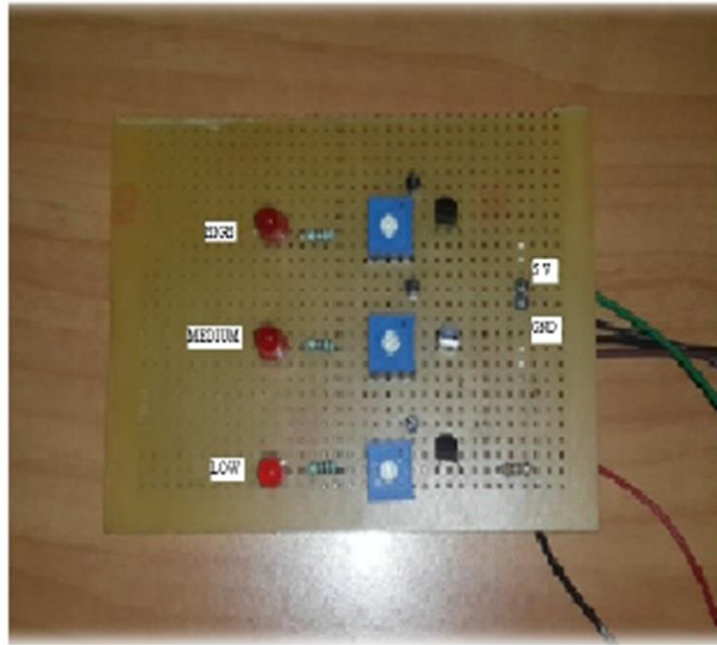
### 2.3 Automatic Plant irrigation system

This gadget works with two probes insert within the soil. When the soil is dry then the probes will now not behavior and while the soil is wet then the probes will behavior. Thy used HEX inverter and this offers the complement output for its input, i.e. whilst the enter is high it offers low output. the running of the 2 probes in the soil relies upon on the resistance for instance if the resistance is high manner the soil is dry and whilst the soil is wet then the resistance is low and the voltage given to the two probes is given from the battery linked to the circuit [6].

### 2.4 GSM based Automatic Irrigation Control System for Efficient Use of Resources and Crop Planning by Using an Android Mobile in India

This device works by using Bluetooth or GSM. This device is placed in the agricultural land. The idea of this device is to monitor the humidity and temperature in the agricultural land in

addition to monitoring the state of the climate through the temperature of the weather and humidity and dew drops after the device to send a text message to the user's machine [7].



*Figure 3: GSM based Automatic Irrigation [7]*

## 2.5 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 [8].

I think 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.

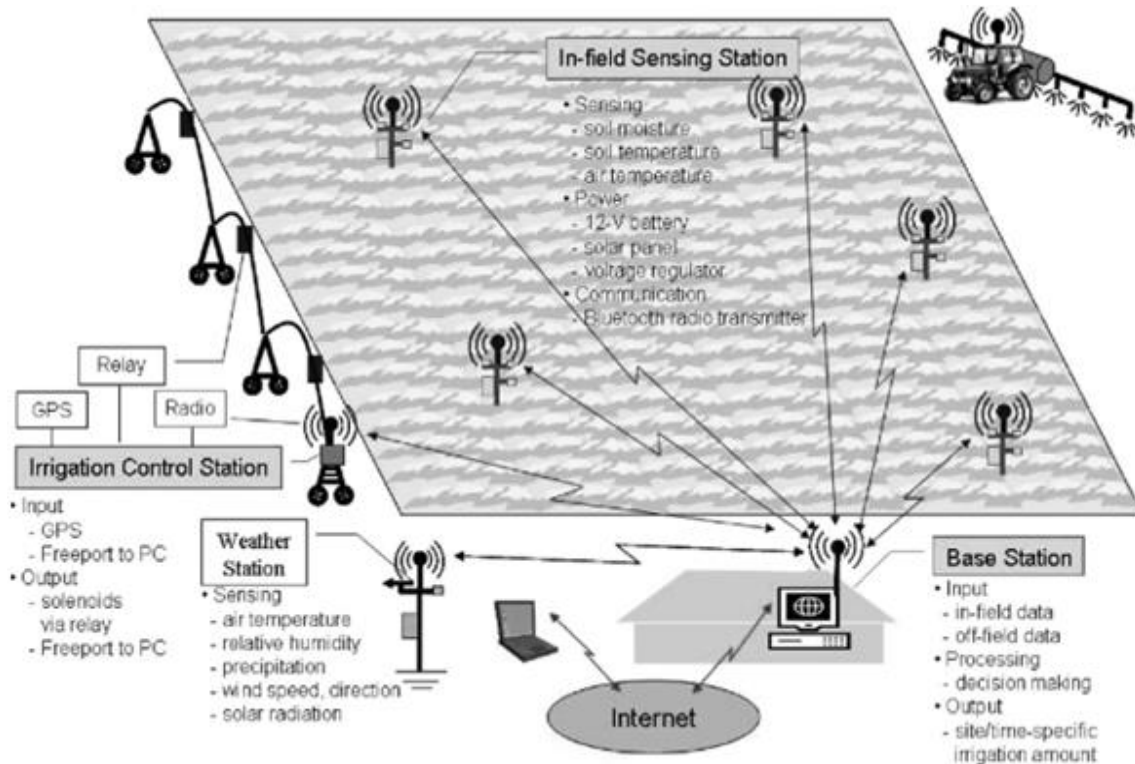


Figure 4 : Sensor-based Automatic Irrigation System [8]

## 2.6 Smart Irrigation System using Arduino

This system makes a specialty of the proper distribution of insecticides in agricultural land to fight the sickness. This machine includes flora linked to the sensor and an analytical device. The multi-sensor is an aggregate of a temperature sensor, humidity sensor, motion sensor, light sensor, vibrating sensor and UV sensor. An analytical device which functions to analyze a pattern for the presence of a particular compound is referred to as a sensor. The moisture and pH value detected

by way of the multi-sensor is taken by interfacing Arduino which is exceeded to the farmer's mobile the usage of GSM [9].

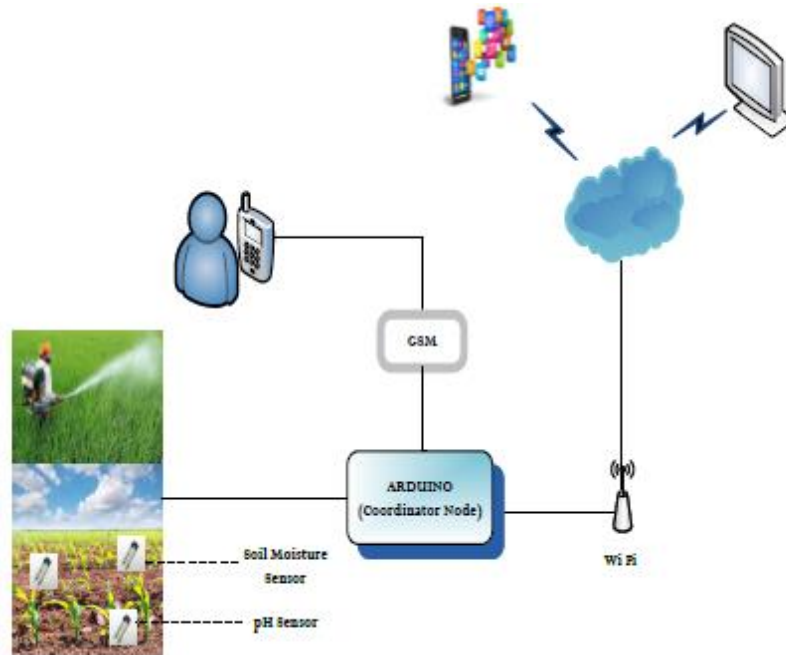


Figure 5 : Smart Irrigation System using Arduino [9]

## 2.7 Automatic Irrigation System for Sensing Soil Moisture Content

The aim of this study is also to develop a system that turns on and off the engine automatically through moisture. On this consider, I failed to find out sufficient facts around the source of water and the approach of controlling the withdrawal of water from the supply furthermore did not discover enough information nearly the supply of power applied in this study [10].

## 2.8 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 [12].

## 2.9 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 47k $\Omega$ , 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 and I think no need to use LED system can work full automated without using LED [13].

## 2.10 Identifying Soil Humidity Content by Automatic Irrigation Methods

An extraordinary plan is done on "Identifying Soil Humidity Content in Automatic Irrigation Methods" is proposed in an effort to enhance an automatic irrigation strategy that controls the pumping motorized via turn it the machine On or Off due to detecting the moisture quantity of the soil. Proved that using automated irrigation techniques enables to minimize the mistakes of operation due to employees and apply suitably automated irrigation to the agriculture field.

This project conveys by Arduino board called (ATmega328 micro-controller), which is assemble input sign of variable moisture conditions via special moisture sensing method. The project illustrates that water can be controlled and corrected in the amount of usage in crops by using a moisture sensor, to protect the valuable soil and to maintain the quantity of water needed for crops irrigation.

Vagulabranan, Karthikeyan, and Sasikala applied an automation irrigation machine based on sensing of soil moisture. This study focused on the development of an automatic device through the operation of the pump in a manner depending on the level of soil moisture. the use of programmed irrigation scheme on this prototype on detecting soil humidity content material inside the agricultural subject makes irrigation quick and more correct. whereas, difficulties confronted in measuring dry soil and water fields may be solved. This automatic irrigation application for this assignment is to store farmers time. further, it covers the needed for person inside the agricultural discipline. also, this challenge may be utilized in greenhouses to cowl farmers location [14].

## 3.0 System Requirement

### 3.1 Functional requirements

Our system works through different stages and this stages can be found in (figure 15) :

1. If the moisture sensor is dry in the line (its locations), the system will be checked by the rain sensor if there is rain the system will not work because no need to irrigate at the same time of rain, otherwise the system will check the temperature sensor with light sensor if the temperature is high and the percentage of light is high as well then the system will not work because it is not the right time for irrigation process because the water will easily evaporate.

2. If the temperature is low and the light is low and there is no rain but the moisture sensor is dry then signal will be sent to the controller to open the valve and pump.

3. If water level is low in the tank then the system will shut down automatically and send SMS to the user, by using water level sensor.

4. When the system is ON by using flow meter sensor connected to LCD we can know the amount of water goes from tank to each line so if there is a leak in the pipe we can know from LCD.

### 3.2 Non-functional requirements

- **Easy to implement**

The materials required for this project must be easy to install to implement a successful project. In addition, materials should be easy to connect with each other to build this project and become more effective. Also, the materials of this project must be easy to replace it in case of any damage.

- **Open source**

The controller used for this project is open-source, so the used hardware is reasonably priced and has a free development software.

- **Strength**

The tools needed for this project must be strong to operate for a long period of time to achieve the desired success. In addition to achieving one of the important goals required to save money.

- **Quality**

The tools required to build this project must be of excellent quality to operate for a long time. Selecting quality materials is very important to avoid wasting money and to avoid the technical problems of these devices and disturbance of the process. Excellent quality is required for this project to achieve the desired success of this project.

- **Modifiability**

The material should be chosen based on its ease of modifiability, as its common to come across designs and connections. Also, to be easy to replace or modification required in the future.

- **Communication**

Bluetooth connected to the system and real-time clock to take all data from prototype to mobile application.

- **Accuracy**

The reading of all data should be in details because it will be saved in SD card for analysis and research.

- **Performance**

The system must work at the real-time

- **Operational**

This system is work automatically and it is connected to the mobile application so the user must download the application on their mobile to control their system.

- **Cost**



The cost of this system must be not too expensive because we aim to decrease the worker which mean decrease the amount of money in irrigation process and solve the main problem (reduce the water consumption) at the same time.

### 3.2 System stakeholders, users, and client

This system is designed for the purpose of solving different problems related to irrigation process , so this system mainly target ministry of Agriculture and fisheries as well as farmers and even those people who has garden in their land. For each problem in different fields, we need to study the conditions, requirements then adapt this project to solve the problem.

We can implement this project in different sectors for example it can be like government water supplying system: in this project we used 9 blocks, these blocks can be like houses.

Also it can be implemented in big industry that is using water for cooling system, it can be implemented by using water level sensor instead of the moisture sensor.

Also we can use this system (same idea) but using different type of sensors for example in fertilizer processes for plants: if we use sensors which tell us about the minerals that are deficient in the soil such as magnesium.

And it can be implemented also in process of Spraying of pesticides.

## 4.0 Design

To achieve the exact project objectives we are shown that using Arduino as the operating system in this project is the best choice, it contain many open supply hardware and software.

### Choice of materials

The first step of this process of building the prototype of the automated irrigation system was the choice of materials for this project are known, which are suitable and importance to agriculture, research was undertaken to select materials.

### Field Control System

This step depends on the working of different sensors used in this project which are (moisture, temperature, light, rain).

### Project Preparation

For the purpose of building the structure of this project, two tables had used to make parts of the project more fixed. However, to create a perfect structure, size were measured for each part that will be used in the project later on. Places of (pumps, valve, and flow meter), type of flexible pipe to be fit. Types of different sensors based on the environment that will work on, two 12 volt battery, small plastic tank, LCD screen to monitor following of water, the different type of connecting wires, and controller (Arduino type ATmega 328V).

### Mechanical Design

In the beginning, sketch design for the project was made, then measurements, size needed for designing the project. Two wood table (1.6-meter x 1.6 meter) has been chosen as a base and stand for this project.

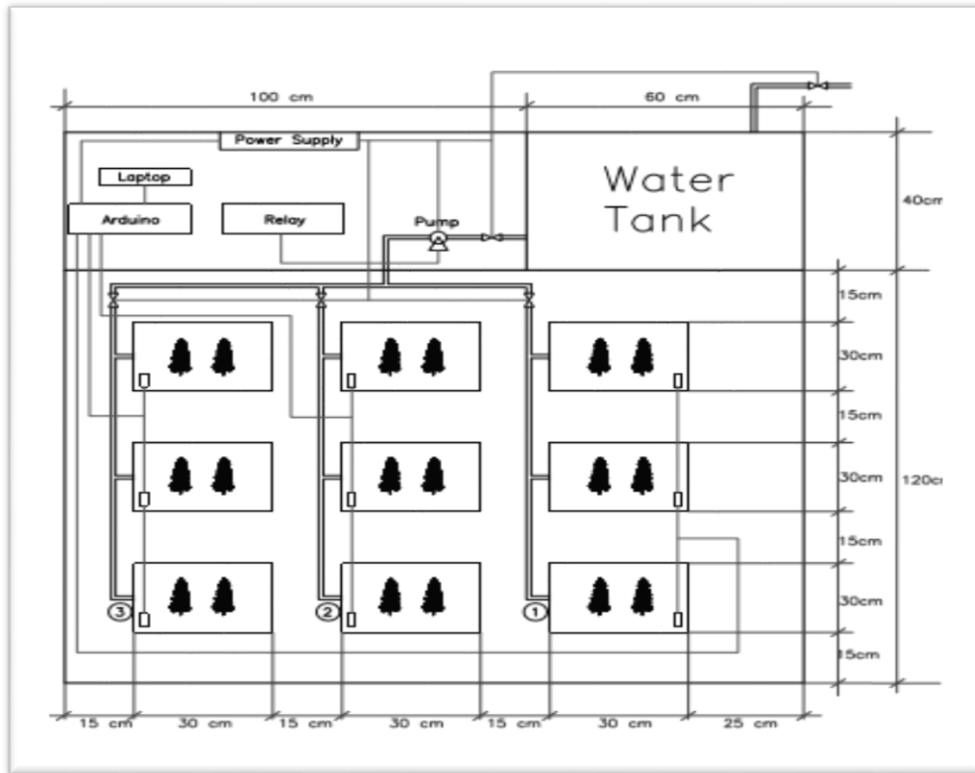


Figure 6 : sketch top view

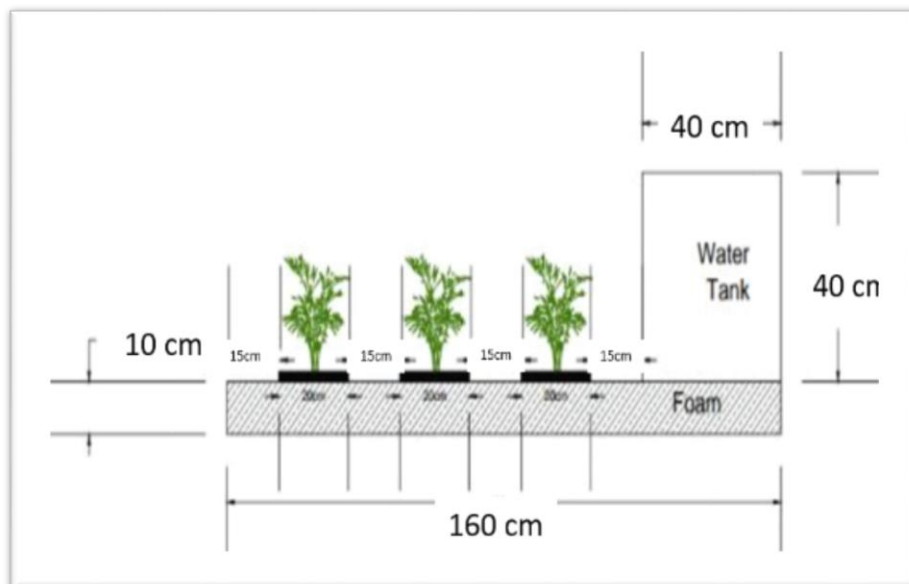


Figure 7: sketch side view

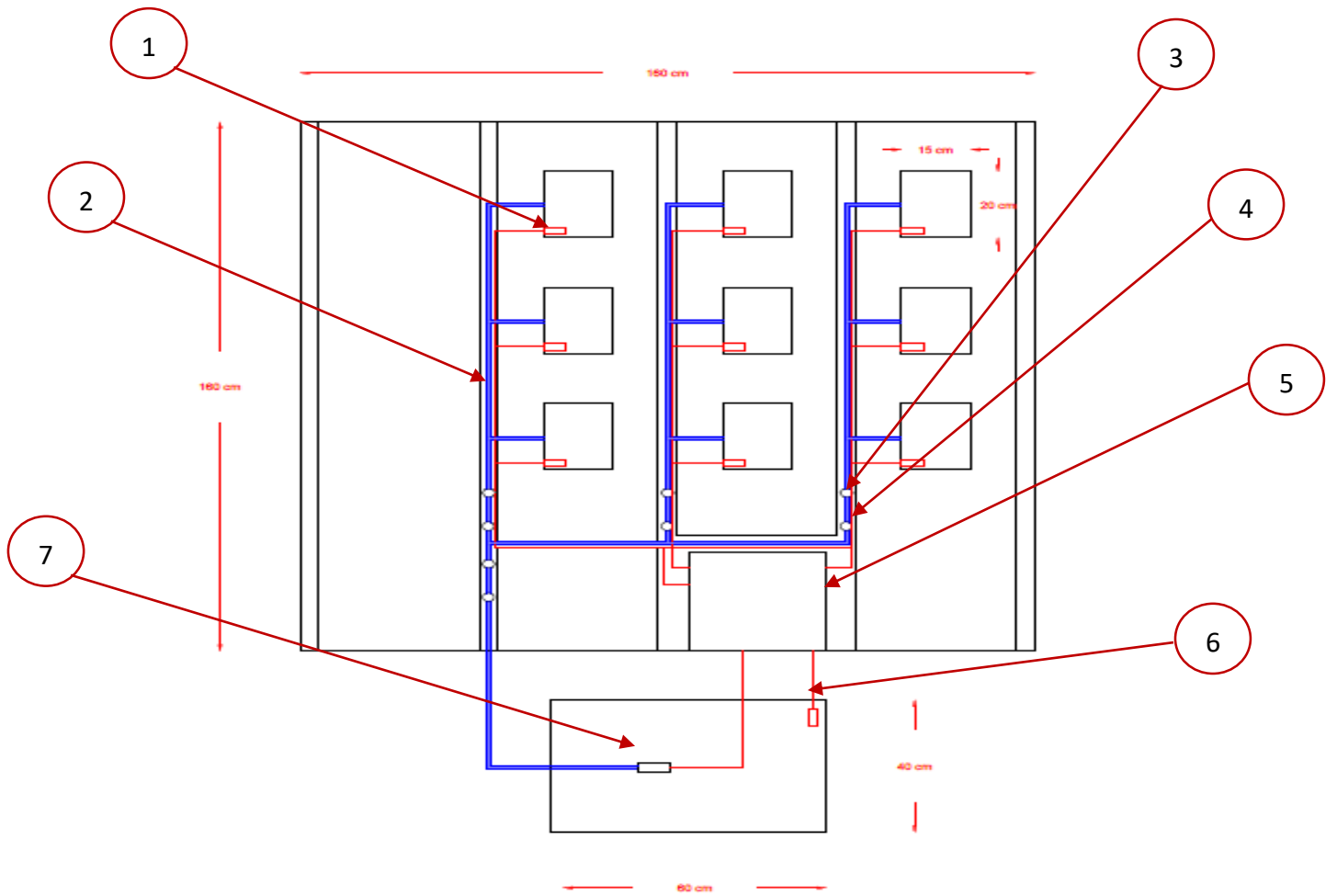


Figure 8: CAD project plan

- 1- Moisture sensor
- 2- Pipes
- 3- Valve
- 4- Flowmeter
- 5- Controller box
- 6- Water level sensor
- 7- Pump

Note: Explanation of all these parts can be found in (Hardware platforms in 5.3).

As it shows in (figure 9,10,11) , Three pieces of foam used for the area below the grass mat and the area where all wires, flowmeter, valves, are located. The size of grass mat was cut to make

nine holes to set the plastic plates. Special cutter used to cut the grass it was not easy to cut it into nine equal squares. The figures below show what was done through the implementation of this system. The plastic water tank has been chosen with large size and at the same time, it must not be heavy. Moreover, nine moisture sensor, one temperature sensor, four solenoid valve, one water pump, one breadboard, two(12 volts batteries), wires and LCD screen, are the main parts that were used to implement this project.

There were difficulties in choosing the type of pipes for this project since it should essay to connect also it should be an essay in the process of connection as well as cutting. Thus, two type of connection joint (T-joint and L – joint) has needed to simplify the installation process.

Arduino controller has been chosen as the processor since it is an open source, simple program and it combines three models at once which is Digital input, analog input, and processor. Every sensor and tools have been tested individually before connect them to a large-scale project. As it shows in figures.

We did test for every parts in the system to make sure that it works as we expected as it shows in (figure 10,11).



Figure 9 : controls tools and wiring

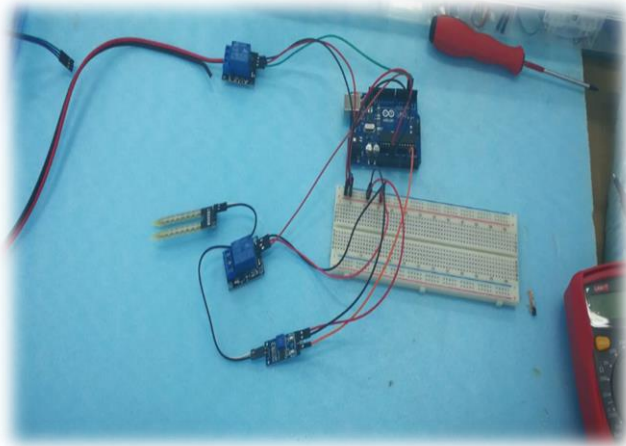


Figure 11 : sensor testing

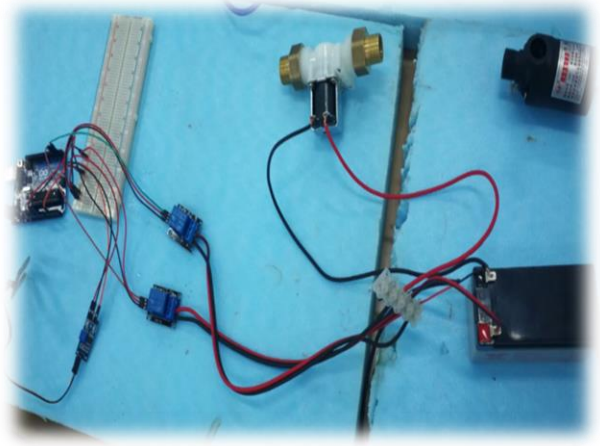


Figure 10 : valve testing and connection

The last step was to assemble all parts together to finalize the project construction as shown in the (figure12). As well as the last step in the coding process was to gather all codes in one single program and run it in a large-scale project to make sure that everything working well.(Figure 13) shows the circuit design of the whole system with wiring.



Figure 12: whole system

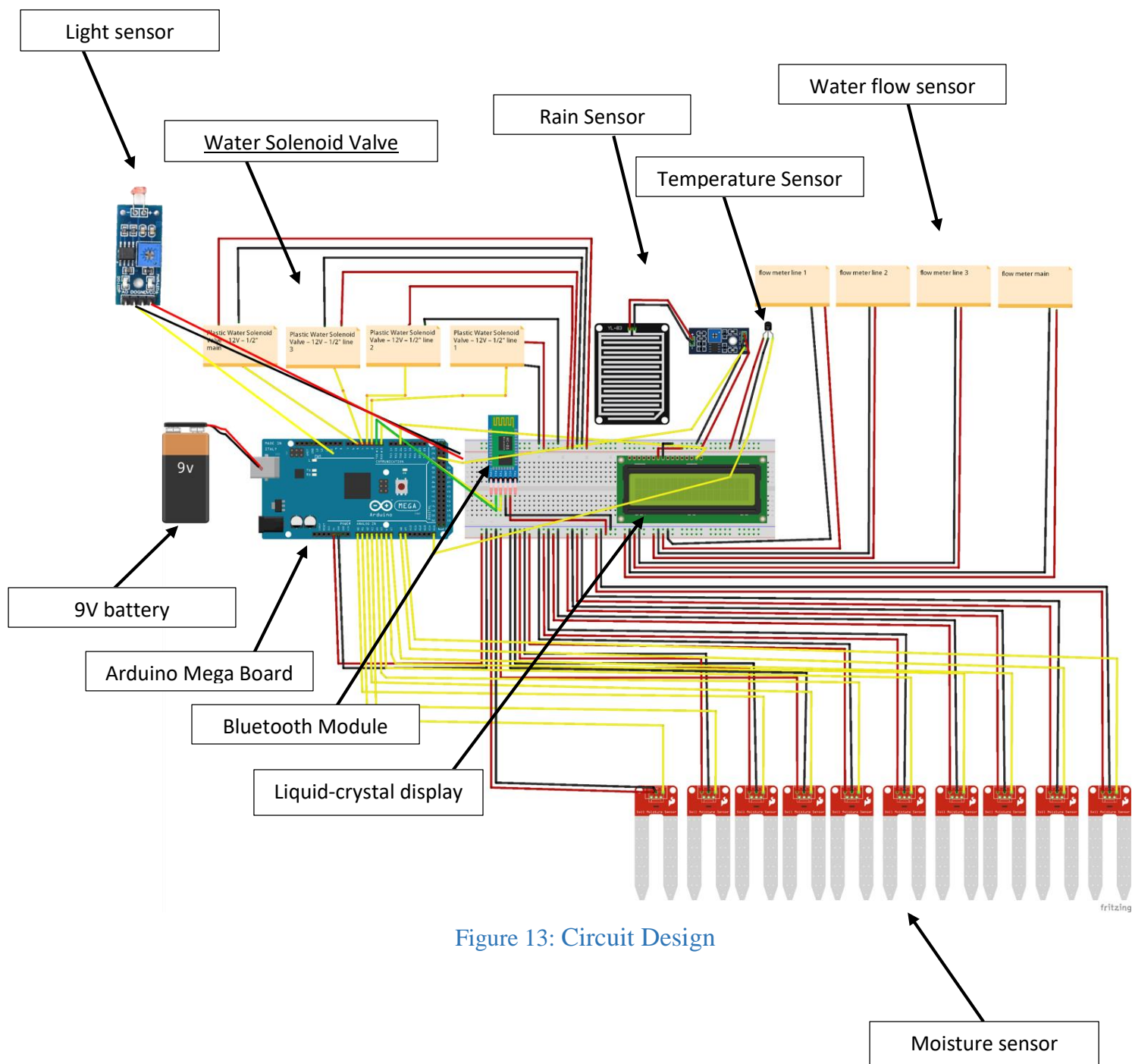
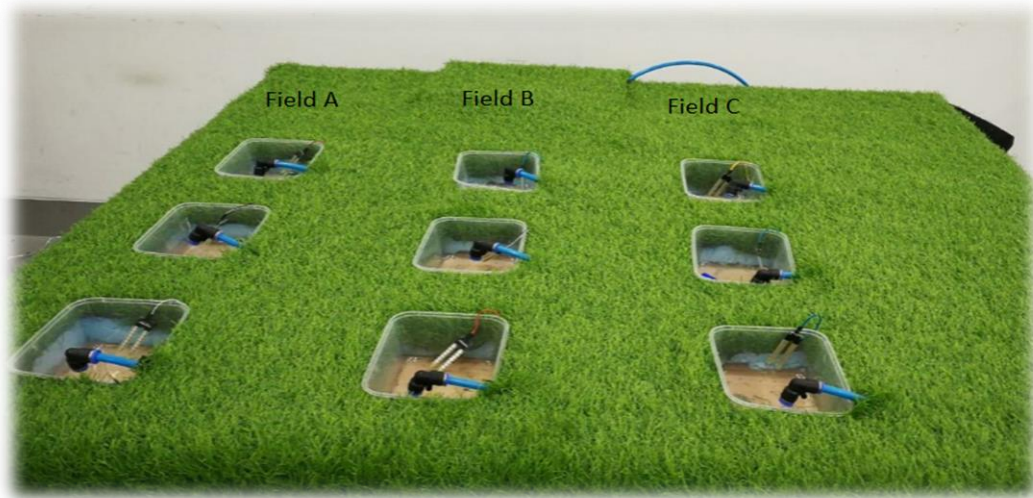


Figure 13: Circuit Design



## Sequence of Scenario of the system



*Figure 14 : Fields of the project*

As it shows in (figures 14 and 15), the project had divided into 3 fields (Field A, Field B, Field C). However, (Field A) has (valve 1 and flow meter 1), (Field B) has (valve 2 and flow meter 2) and (Field C) has (valve 3 and flow meter 3) and valve 4 with flow meter 4 is the main.

As it shows in the chart, it shows how the system works in one field if only one moisture sensor of Field B active the system will not work also temperature sensor and the light sensor works together. For example, when the temperature is more than 40 C and the light sensor is active then the system will switch OFF because the heat of the sun works to evaporate the water, this system had been configured to stop the process and schedule it. Moreover, the purpose of this system is to work in a smart way, so if there is rain the system will automatically be OFF.

Please considered that main water tank will be monitored carefully so that it doesn't go below the level where the level where the pump cannot suck the water. The system will not work if the water level is low.

To start the process, two or three moisture sensor of Field B must be activated to move to next step. Next, the rain sensor must be dry to continue the process and the weather temperature sensors should be less than 40 C to enable the process to move to next step. If the water tank level is not below, the pump will run, valve 2 and 4 will open and flow meter of 2 and 4 have the same reading.



If two or three moisture sensor of all fields(A, B, C) active at the same time and the rain sensor is dry, the temperature sensor should be less than 40 C and the light sensor is not active then the proceed to next step. If the water level sensor is not below then pump will be ON, valve (1,2,3) and 4 will open and flow meter (1,2,3,4) have the same readings.

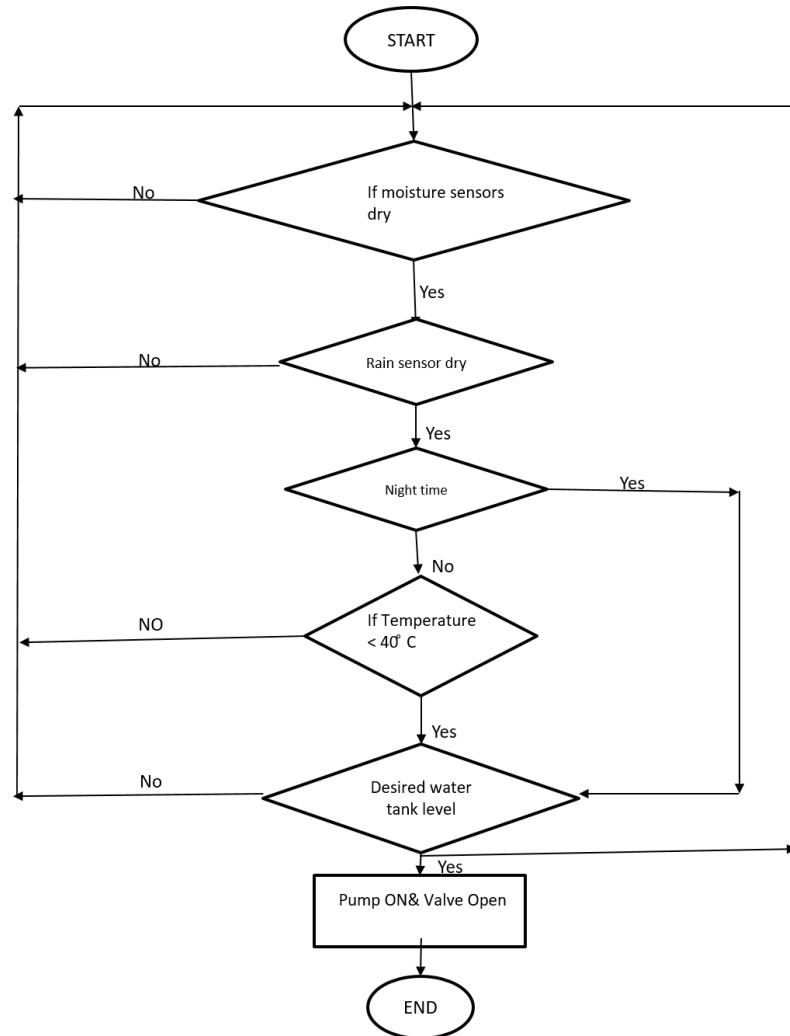


Figure 15 : Flow chart of implementation process

## 5.0 Implementation

As it shows in Figure16, The scenario of application start from installing the app on phone then open the application, First of all, the main screen of the app will be loaded when the user will choose which device is connected to Bluetooth. The system will check if the device is connected if it is connected then it notifies the user that the device is connected otherwise notify the user device is not connected. In the main screen, the user can directly switch ON /OFF the entire system. Moreover, If Details Button pressed it loads to details screen. In this Screen user will able to see all details related to whole system For example if he pressed on plant1 button he will be able to see ( amount of water, Soil moisture, Temperature) if there is problem only in this line he can switch ON /OFF line so he is able in this page to control line by line.

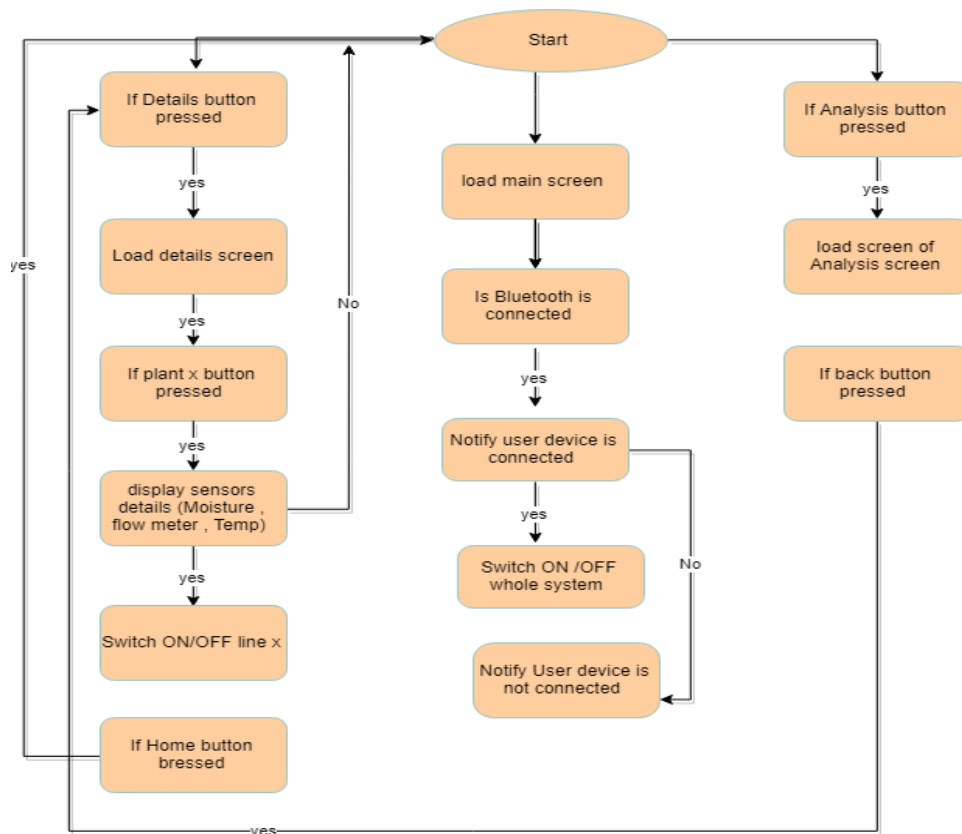


Figure 16: Flow chart of application process

## 5.1 Hardware platforms

- **Arduino**

Arduino is "an open-source electronics platform based totally on clean-to-use hardware and software". The Arduino control panel programmed by Arduino c and is based on C and C ++ [15].

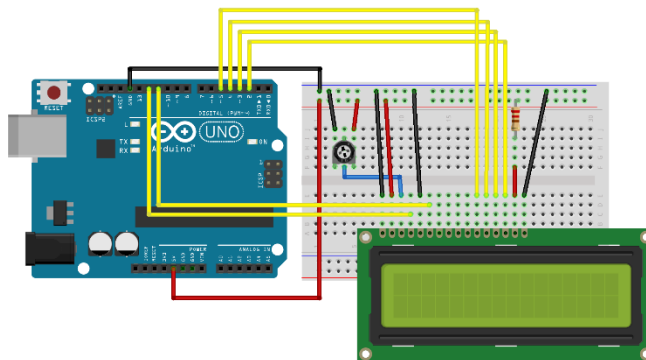


*Figure 17: Arduino [15]*

- **Arduino LCD**

### Liquid Crystal Library

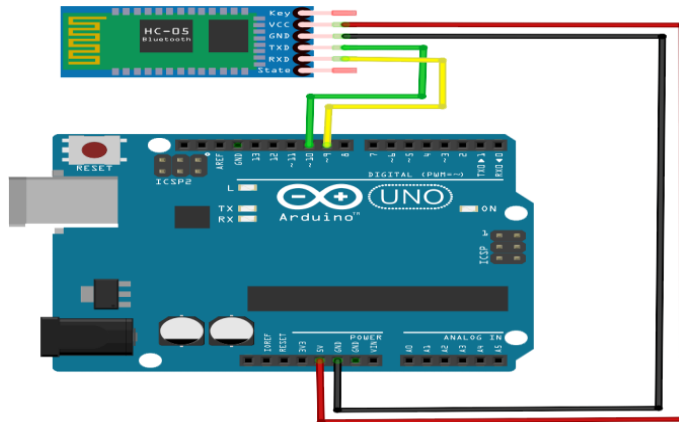
This library permits an Arduino board to control Liquid Crystal Display (LCD) that is on the Hitachi HD44780 chipset, which is on most text-based LCDs. [16].



*Figure 18 : Arduino Liquid Crystal[16]*

- **Bluetooth device**

HC 05/06 this tool works on serial connections and information is sent via Bluetooth when a particular button is pressed. Data is sent to the ARDWINO via TX, the signal is transmitted from the ARDWINO and the RX receives the signal from ARDWINO. The data is verified if gotten information is 1 the Driven turns on turns OFF when gotten information is 0 [17].



*Figure 19: Bluetooth Device[17]*

- **SD card**

The Arduino circuit makes communication with popular Micro SD cards easy and is compatible with the SD memory card library in the Arduino IDE environment, which enables easy reading and writing of files and folders, and for communication with the memory card, the circuit operates four pins of The Arduino circuit attached to it, which is 13, 12, 11, and 11 digital poles, can be selected using a conductor [18].

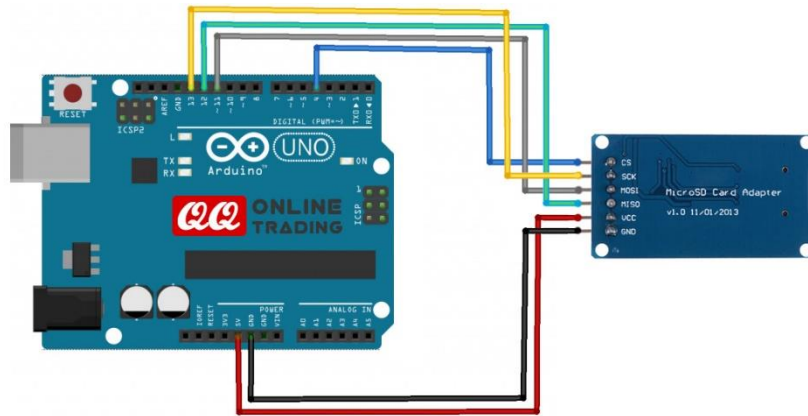


Figure 20 : Arduino SD card [18]

## 5.2 Hardware tools

- **Arduino**

Arduino is an open-source operating system that relies on easy-to-use hardware. Arduino can read the ratio of light input to the sensor and convert it to output. For example, using Arduino we can control the room by turning on or off the light or air conditioner. This is done by sending a set of instructions to the control unit on the Arduino board [20].

- **Breadboard Definition**

Breadboard is a plastic board for holding wires and electronic segments such as transistors and resistors

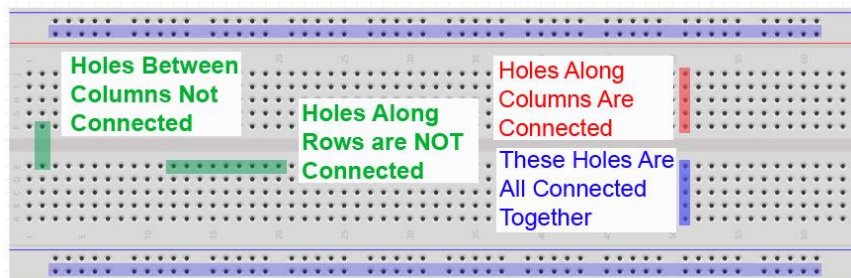


Figure 21: Breadboard [20]

- **Moisture Sensor**

The soil moisture sensor comprises of two tests that are utilized to the degree the volumetric substance of water. The two tests permit the current to pass through the soil, which gives the resistance esteem to the degree the dampness esteem. When there is water in the soil there will be less resistance and the soil will handle more power. But if the soil is dry it conduct power weakly and needs less power and more resistance. [21].

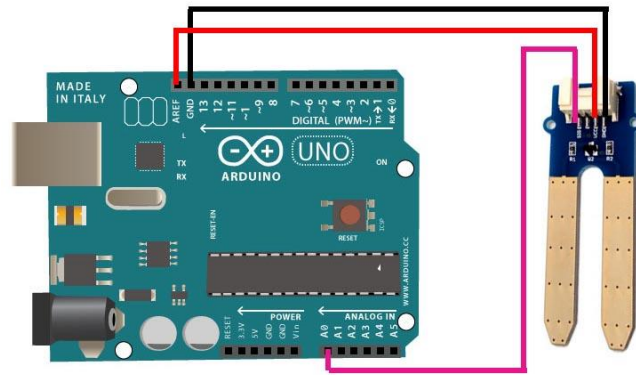


Figure 22 : Moisture sensor[21]

- **Temperature Sensor**

A temperature sensor is sensor to measure the ambient temperature. This sensor has three pins – a positive, a ground, and a flag[22].

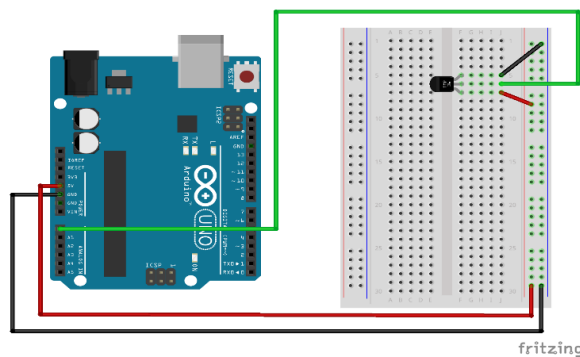


Figure 23 : Temperature sensor [22]

- **Light Sensor**

A Light Sensor is a gadget that recognizes light. It creates a yield flag that is corresponding to the escalated of light. A light sensor measures the brilliant vitality display in the wide run of frequencies in the light range. A few of the common frequencies are infrared, obvious and bright [23].

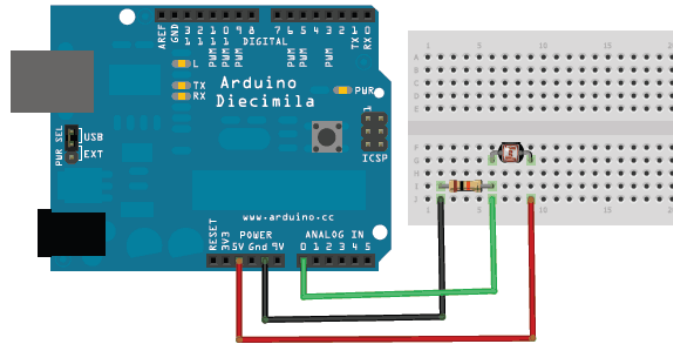


Figure 24 : Light Sensor[23]

- **Plastic Water Solenoid Valve**

Is to control the flow of fluid, a valve is ordinarily closed and has a 1/2" non-taped outlets on each conclusion. On the off chance that 12V is connected through the two terminals of the valve the solenoid will open the valve.



Figure 25 : Solenoid Valve[23]

- **Level Sensor**

The water-level pointer is utilized to demonstrate the water level in the tank, by using this sensor we can control the flood of the water as well know the level of the water in the tank , and at any time we can know the water level in the tank, it has a basic circuit [24].

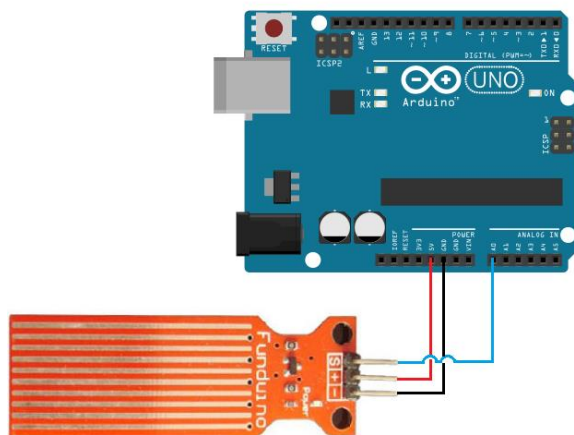


Figure 26 : Level sensor [24]



- **Water pump**

It is used in this project to pump the water needed for irrigation from the main water tank through pipes. This pump can be used for different applications, in household include cleaning, bathing, space heating and flower of water. This pump is selected for this project because it has good advantages. Such as, it has a lightweight. Also, it has a small size, so it is easy to install and replace it. Furthermore, it has an enough efficiency to pump water for irrigation. Since it operates in 12 volts, so it consumes lower power. In addition, this pump has a very Low of noise. Finally, the cost of this pump is very cheap.



Figure 27: Water pump[25]

- **Rechargeable Battery**

When selecting the appropriate battery for this project, some important points must be considered. Firstly, it should be environmentally friendly it should be sealed construction. Secondly, it should be stable quality and high reliability. Also, it must be rechargeable type, so it will not contribute to pollution of the environment. This battery is a high-quality battery that is designed in order to give top performance, strength and long life.

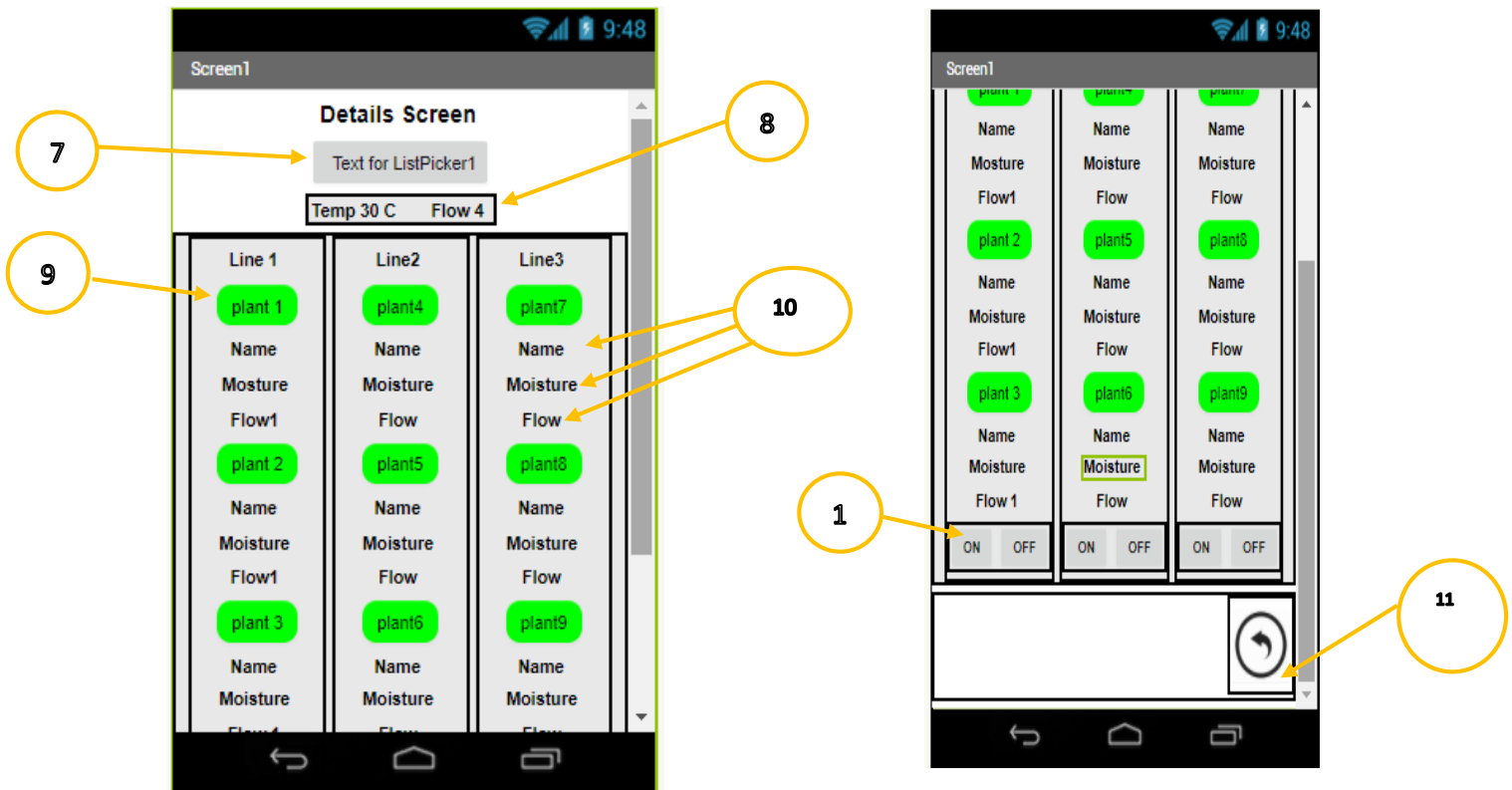


Figure 28: Rechargeable Battery

### 5.3 Software platforms

App inventor is an open source tool provided by google. This program allows beginners to create programs that can run on Android. It uses graphical interface such as Scratch[19].

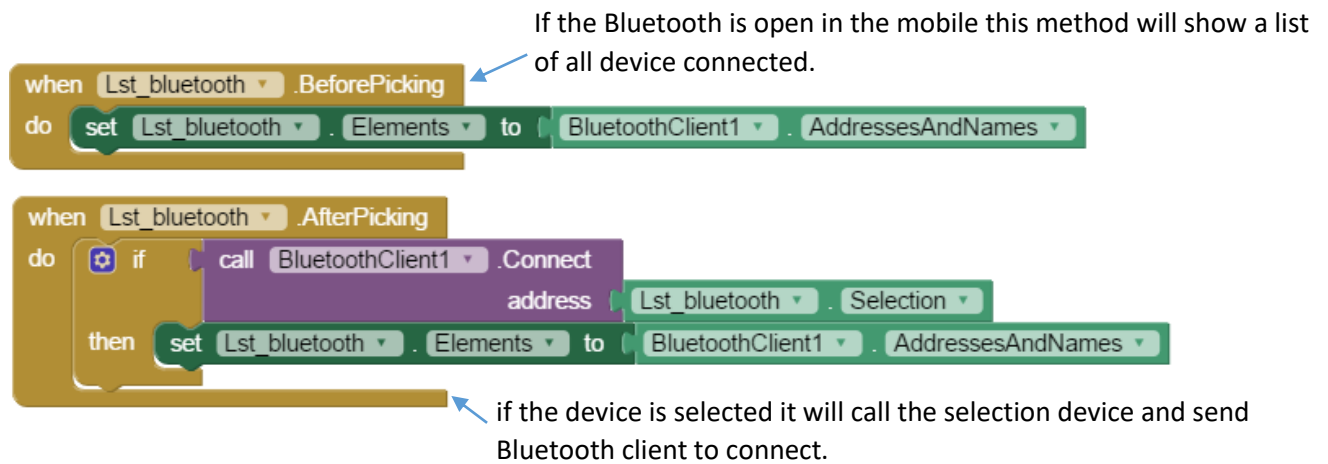




- 1- Button. If it is clicked, it goes to the user to About Page, which have information about the app.
- 2- Button. If it is clicked, it goes to Help Page, which have information about the app.
- 3- List Picker. When it is clicked, it shows a list of all connected Bluetooth devices When a Bluetooth device is clicked.
- 4- Connection. If the device is connected, the text color change to green for feedback and says 'Connected'.
- 5- ON /OFF buttons allow the user to switch on or off the system.
- 6- Details button. When clicked take the user to a details page which shows all the information and let user control system line by line.
- 7- List Picker. When it is clicked, it shows a list of all connected Bluetooth devices When a Bluetooth device is clicked.
- 8- These two labels, shows the temperature and amount of water go from tank flow4 is the main one.
- 9- Plant button. When clicked it shows user list of details about plant such as (Name of the plant, humidity and amount of water).
- 10- These three labels, it is not visible unless the user clicks on plant button, when user click on plant1 all these labels become visible.
- 11- Responsive button, when it is clicked, it takes a user to the Home page.

12- ON/OFF button in each line allow a user to switch on or off each line individually.

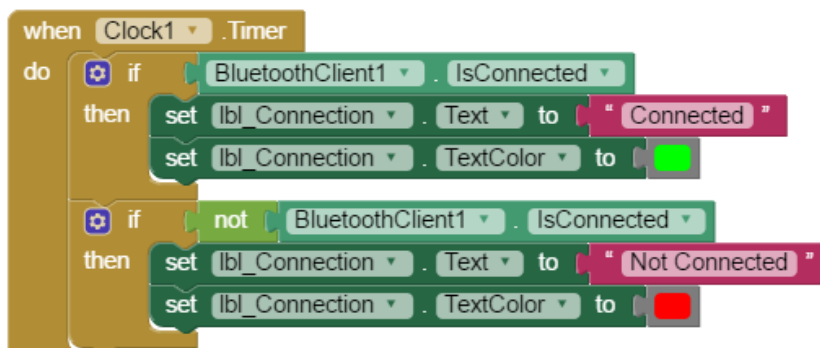
- Bluetooth client



*Figure 29: Bluetooth client*

- Clock and connection label

This method shows, when the device is connected, the text turns green for feedback and familiarity and says 'Connected'.



*Figure 30: Clock*

- System switch ON OFF buttons code blocks

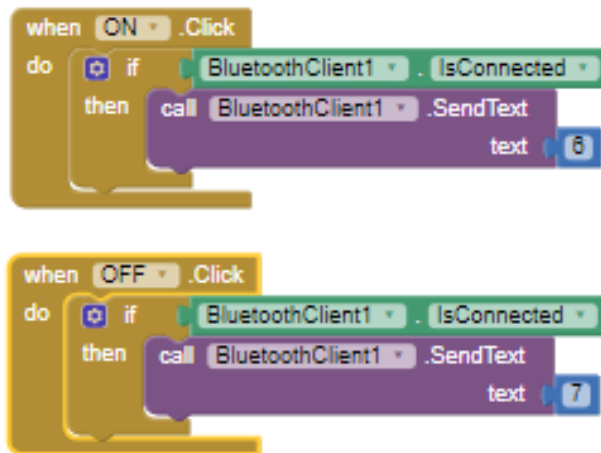


Figure 31: ON OFF code blocks

If the device is connected to the Bluetooth send byte number to Arduino to do the command. The full Arduino code and code blocks will be in Appendix.

- Receive sensors data code blocks

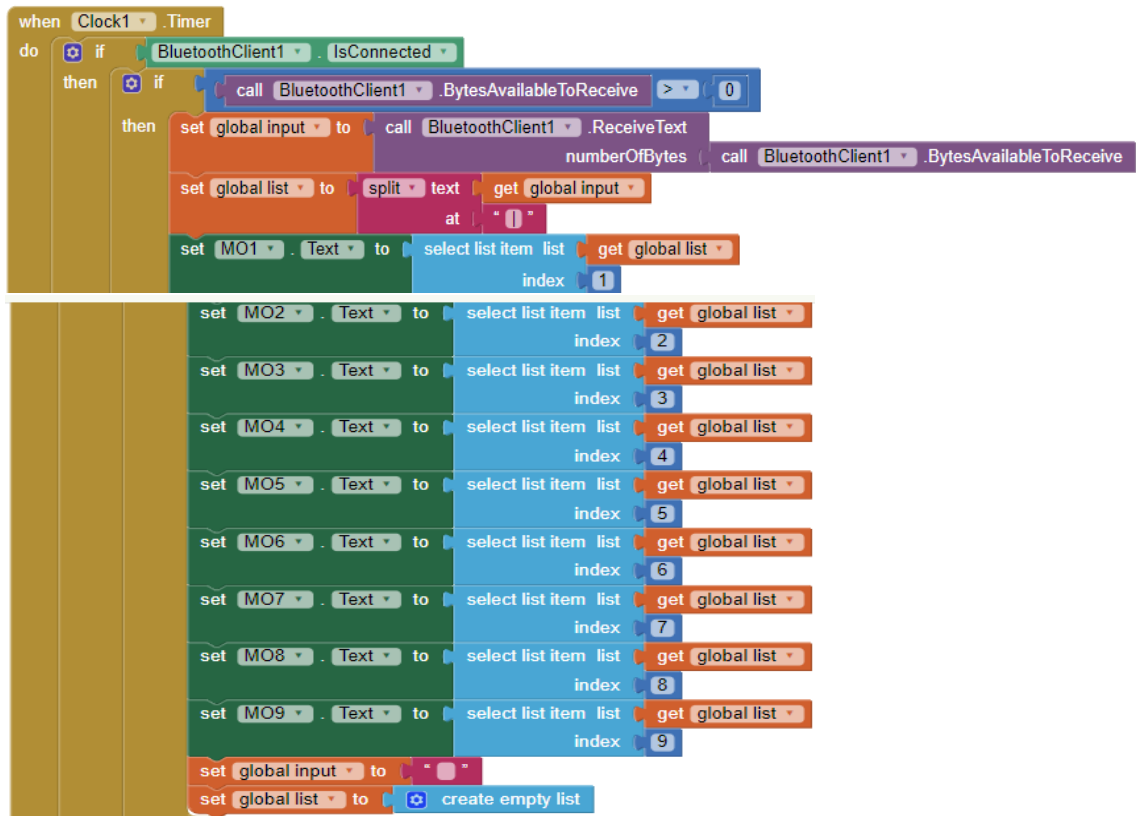


Figure 32: Receive sensors data

## 5.4 Software tools

I used App Inventor to develop the mobile application to control the system from the far distance.



Figure 33: MIT App inventor[26]

# 6.0 Results and Discussion

## 6.1 Data Analysis

I recorded the process of manual irrigations system of three types of plants (lemon, mint, and mango) for three weeks. The irrigation process takes place twice a week in the morning and the other day in the evening. To analyze data I take data of chosen plant twice a day one between 9 am - 5 pm and the second one between 6pm-11pm.

The line graph in (figure 34) shows the humidity data of the mint. Y-axis shows the number of humidity and X-axis shows the day and time. Sunday and Wednesday have the largest amount of humidity which is 900-800. When the humidity is more than 800 means the plant is dry and need to be irrigated. The number of humidity decreases on Monday in the evening and Thursday in the morning and reach 200-120 which mean the plant is not dry and does not need watering. From this data, we can say that the mint gradually dries up and it maintains water more than other plants.

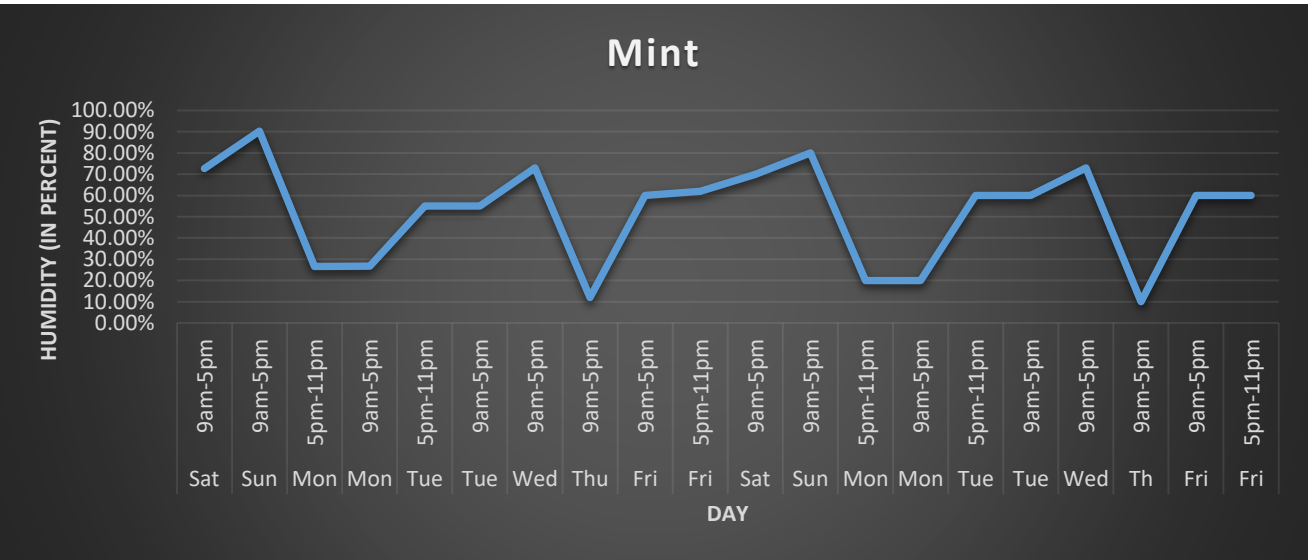


Figure 34 : Humidity data of the Mint

The line graph in (figure35) shows the humidity data of lemon y-axis shows the number of humidity and x-axis shows the day and time. Sunday and Wednesday have the largest number which is 1000 which mean the plant is very dry and it needs to be irrigated as soon as possible. On Monday and Thursday the humidity decreased but what I notice from this data than the lemon needs to irrigate more than twice a week because it loses water faster. So we can say that lemon needs water more than mint.

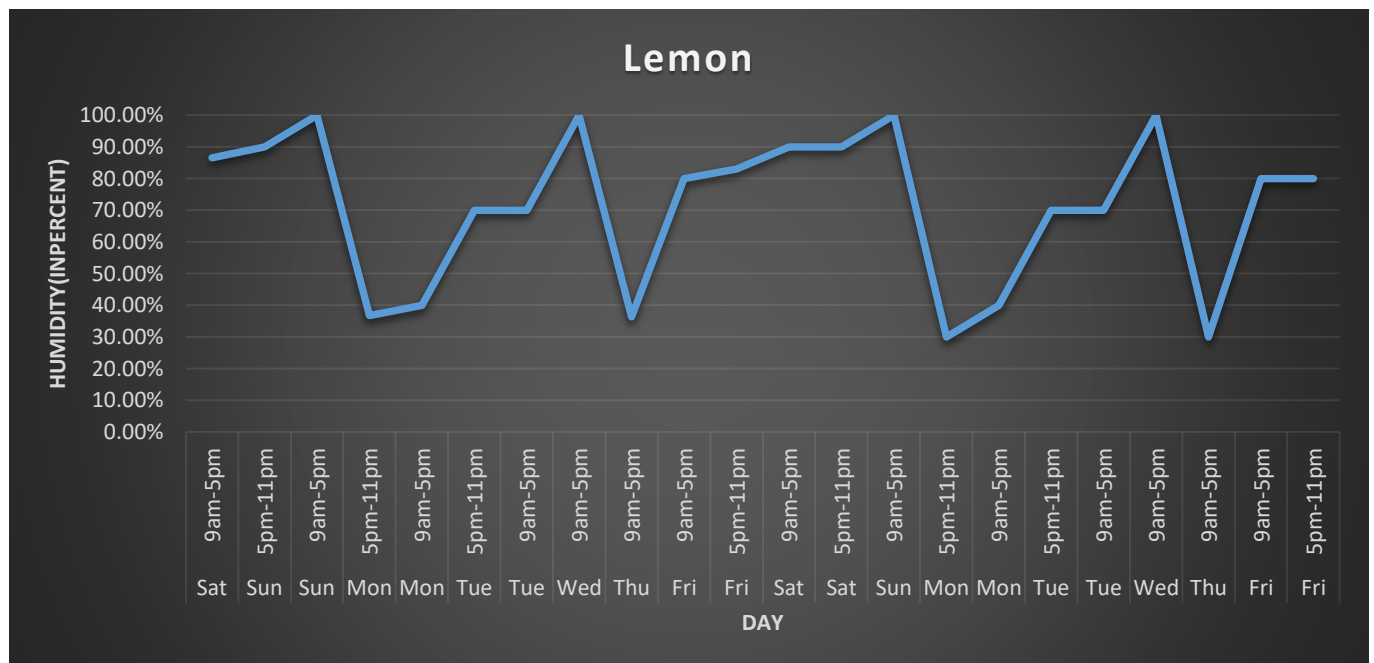


Figure 35: Humidity Data of the Lemon



The line graph in (figure36) shows the humidity data of mango. Sunday, Thursday, and Saturday have the largest number of humidity which means the plant is very dry. We can see also there is rapid decrease and rapid increase in the amount of moisture which mean mango lose water very fast and it needs to irrigate more than twice a week.

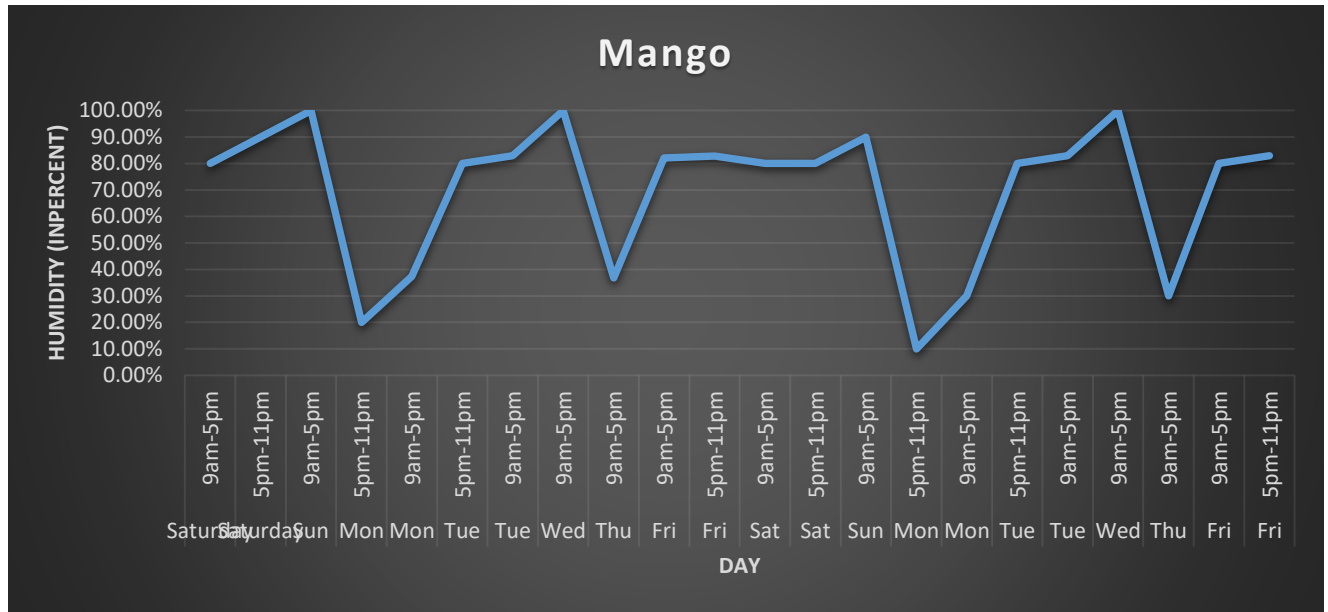


Figure 36: Humidity Data of the Mango

Through the data we can observe the following in (Figure33), All the plants were watered at one time and in equal quantities almost twice a week, but after comparing the results we found that the lemon and mango needed to water more than two times a week because the humidity ratio is significantly reduced taking into account the temperature and the time of irrigation. When they irrigate in the morning plants lose humidity quickly and very significantly because they irrigate at the wrong time so the sun evaporates water much faster. As for the mint plant through the results, we found that this plant that does not lose moisture quickly as it can withstand a longer period of mango and lemon. Through these results, we can conclude by saying that using automatic irrigation system is more efficient because it solves almost all the problems of using the manual system. Automatic irrigation system works based on the needs of plants, so it solves the problem of irrigation in wrong time by using light and temperature sensors together.

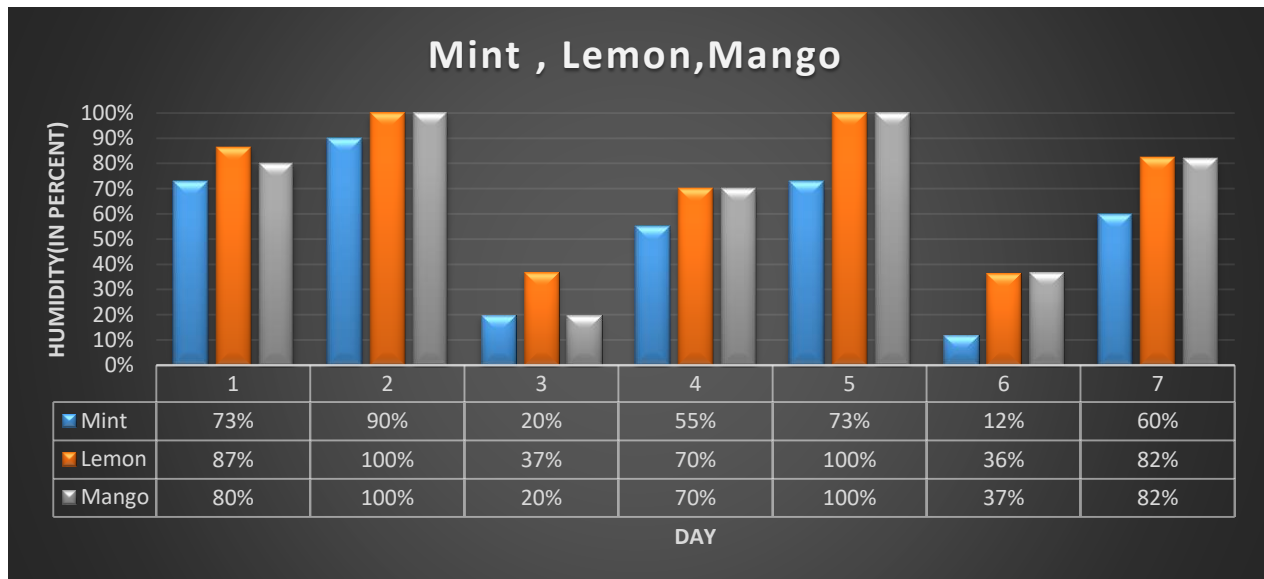


Figure 37: Humidity data of all plants

## 6.2 Result and Discussion

After completing the plan and the collection of the components of the smart Irrigation system, it's been met the goal. Also, all of the requirements were implemented in order to finish this smart Irrigation system, so that it becomes full production and finalize. After that, the system became tested, and the end result became as required. The system will now not work until two or three of moisture sensors from any line of the 3 fields send a sign to the Arduino that the soil is dry and crop needs water. After the sign reaches the Arduino, it will send a command to the relay of that specific line field valve to be energized to open the valve and a command to the relay of the pump to exchange it directly to irrigate that field. Also, all 3 fields can be irrigated at a same of time, if two or three of all 3 plants moisture sensor are activated. So, all solenoid valve relays may be energized to open all valves and the pump will run to irrigate all 3 plants. There has been a problem at the beginning to choose a suitable pump to paintings to irrigate all flowers at the same moment. The program of the system has been configured and the system will no longer operate unless (or three moisture sensors) are activated. But if one sensor is activated of any lines the system will no longer perform, because that sensor can also it be defective. If the water tank level is low the system will not operate in any respect, even all plant sensors are activated to protect the water pump.

Furthermore, this smart Irrigation system has been configured that if there is a raining, it's going to not work, because the raining sensor will activate, and it will send a sign to Arduino to stop the water pump and to close all valves too. Further, on the daytime the system will no longer work, due to the mild sensor will activate at the daytime and that will reason to close the plant's value as well as to switch OFF the pump.

For the system programming, it has been precisely chosen as stated in previous chapters to apply UNO Arduino, the wires connections from the controllers to the Arduino have been pretty difficult, due to a single mistake can damage any electric element. It was not easy to program the smart Irrigation system and upload it in Arduino to run the water pump and starting valves with eighteen sensors, but with the assist of Arduino library, this system turned into completed with best results.

Connecting the wires from 20 devices to the Arduino become very hard and complicated, but by means of using the plastic breadboard became to facilitate the connection of those wires.

For designing the plant, special flexible pipes had been used to facilitate the connection from the water tank to the plant, however, we faced problem to connect pipes together. So, two types of pipe joints (T-joint and L-joint) were used to clear up this issue.

## 7.0 Conclusion

### 7.1 Challenges

Many problems were faced, Such as the tables used to be a base of this project size was bigger than the needed size for this prototype. Also, the materials that required for this project has been difficult to find. Selection of the suitable plant plate to fix it in the foam and artificial grass has the significant problem. Also, since more than 10 devices were connected to the Arduino, wires connection have been complexes to connect. Furthermore, the batteries of this project drain quickly in use, Sequence of system scenario has been not easy to decide to function. The controllers to the Arduino were quite challenging, because of a single mistake can damage any electrical part. It was not easy to write the software for the Smart Irrigation System and upload it in Arduino to run the water pump and opening valves with eighteen sensors, but with the help of Arduino library, the program was completed with perfect results. Connecting the wires from 20 devices to the Arduino was very difficult and complex, but by using the plastic breadboard was to facilitate the connection of these wires.

### 7.2 Future work

With the result of the project first step in the future will be to transfer this project to large scale. Also to control system via Zig Bee instead of wire connection. Moreover, to create more responsive mobile application which have more controlled data. Also we can develop this system by using renewable energy which is solar power instead of batteries using solar energy will help to reduce future cost.

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## Appendices

### Appendix 1: Wiring connection between devices and Arduino's pins.

Devices	Pin number
Flow meter 1	D11
Flow meter 2	D12
Flow meter 3	D13
Flow meter 4 (MAIN)	D14
Moisture 1	A1
Moisture 2	A2
Moisture 3	A3
Moisture 4	A4
Moisture 5	A5
Moisture 6	A6
Moisture 7	A7
Moisture 8	A8
Moisture 9	A9
Valve 1	D3
Valve 2	D4
Valve 3	D6
Water Level sensor	A10
Light sensor	D28
Temperature sensor	A15
Rain sensor	D26

## Appendix 2: Material features that have been used in this project.

Material	Features
Arduino	<ul style="list-style-type: none"> <li>➤ Microcontroller AT mega328</li> <li>➤ Voltage of operating 5V</li> <li>➤ Recommended input voltage 7-9V</li> <li>➤ Range of input voltage 6-20V</li> <li>➤ Pins of digital I/O 14 (of which 6 provide PWM output)</li> <li>➤ Pins of Analog Input 6</li> <li>➤ Per I/O Pin DC Current 40 mA</li> <li>➤ Pin Current DC for 3.3V 50 mA</li> <li>➤ Memory of Flash 32 KB (ATmega328) (0.5 KB used by bootloader)</li> </ul>
Moisture sensor	<ul style="list-style-type: none"> <li>➤ Voltage of working 5v</li> <li>➤ Current of working &lt; 20 mA</li> <li>➤ Analog interface</li> <li>➤ Detection depth 37mm</li> <li>➤ Working temperature range 10°C-30°C</li> <li>➤ Weight 3 gram</li> <li>➤ Size (36×20×8) mm</li> <li>➤ Arduino compatible interface</li> <li>➤ Power consumption low</li> <li>➤ High sensitivity</li> <li>➤ Signal output of voltage 0-4.2 v</li> </ul>
Plastic Water Solenoid Valve – 12V – 1/2”:	<ul style="list-style-type: none"> <li>➤ Resistance of coil: 37.5 ohms.</li> <li>➤ It can be actuated starting with 6v</li> <li>➤ Temperature of working range: 1°C-75°C</li> <li>➤ Opening reposing time ≤ 0.15 sec</li> <li>➤ Dimensions 3”×2.25”×2”</li> <li>➤ 320 mA @ 12 VDC</li> <li>➤ ½” Nominal non-taped National Pipe</li> <li>➤ Life actuating ≥ 50 million cycles</li> <li>➤ Closing response time ≤ 0.3 sec</li> <li>➤ Its weight 4.3 oz</li> </ul>
Rain Sensor	<ul style="list-style-type: none"> <li>➤ Adopts high quality of RF-04 double sided material.</li> <li>➤ Area: 5cm x 4cm plate on side made of nickel.</li> <li>➤ Good oxidation resistance, conductivity resistance.</li> </ul>



	<ul style="list-style-type: none"> <li>➤ The output signal of Comparator has a good clean waveform, ability of driving, over 15 mA</li> <li>➤ Potentiometer is used to adjust the sensitivity.</li> <li>➤ Voltage of working 5V</li> <li>➤ Format of Output: Digital switching output (0 and 1) and analog output of voltage AO</li> <li>➤ With bolt holes, so it is easy to install</li> <li>➤ The PCB board size: 3.2cm x 1.4 cm</li> <li>➤ Uses an extensive voltage LM393 comparator.</li> </ul>
Water pump	<ul style="list-style-type: none"> <li>➤ Voltage of Input: 6-12 VDC</li> <li>➤ Rate of Flow: 1.5-2 L/min</li> <li>➤ Temperature of Operation: 80°C</li> <li>➤ Current of Operating: 0.5-0.7A</li> <li>➤ Distance of Suction: 2 meter (Max)</li> <li>➤ Pump Life: 2500 Hour</li> <li>➤ Size of Pump: 90x40x35 mm</li> </ul>
Rechargeable Battery	<ul style="list-style-type: none"> <li>➤ <a href="#">Type Lead acid Battery.</a></li> <li>➤ Model PP 2.3-12</li> <li>➤ SV code 380301 AALV4</li> <li>➤ Brand Power Plus</li> <li>➤ Color Black</li> <li>➤ Battery Voltage 12V</li> <li>➤ Battery Capacity 2.3 Ah/20 HR</li> <li>➤ Size (L × B × H) 10cm × 7cm × 4.3cm</li> </ul>

### Appendix 3: Arduino Code

```
#include <LiquidCrystal.h>

LiquidCrystal lcd(7, 8, 9, 10, 11, 12);

int Flow1 = 11;

int Flow2 = 12;

int Flow3 = 13;

int Flow4 = 14;

int Received = 0;

const int mo1 = 1; // analog

const int mo2 = 2; // analog

const int mo3 = 3; // analog

const int mo4 = 4; // analog

const int mo5 = 5; // analog

const int mo6 = 6; // analog

const int mo7 = 7; // analog

const int mo8 = 8; // analog

const int mo9 = 9; // analog

int pump = 2;

const int vlv = 3; // digital

const int vlv2 = 4; // digital

const int vlv3 = 6; // digital
```

```
const int water_level = 10; // analog

const int Temp = 15; // analog

const int light = 28; // digital

const int rain = 26; // digital

void setup() {

    // put your setup code here, to run once:

    analogWrite (water_level, LOW);

    pinMode (vlv, OUTPUT);

    digitalWrite (vlv, LOW);

    pinMode (vlv2, OUTPUT);

    digitalWrite (vlv2, LOW);

    pinMode (vlv3, OUTPUT);

    digitalWrite (vlv3, LOW);

    pinMode (pump, OUTPUT);

    digitalWrite (pump, LOW);

    pinMode (light, INPUT);

    digitalWrite (light, LOW);

    pinMode (rain, INPUT);

    digitalWrite (rain, LOW);
```

```

lcd.begin(16, 4);

Serial.begin(9600);

}

void loop() {

    // put your main code here, to run repeatedly:


    //Temperature Sensor

    // int reading = analogRead(Temp);

    // float voltage = reading * 5.0;

    // voltage /= 1024.0;

    // Serial.print(voltage); Serial.println(" volts");

    // float temperatureC = (voltage - 0.5) * 10 ;

    // Serial.print(temperatureC); Serial.println(" degrees C");

    //delay(1000);

    int moisture1 = analogRead (mo1);

    Serial.println("mo 1");

    Serial.println(moisture1);


    int moisture2 = analogRead (mo2);

```

```
// Serial.println("mo 2");

// Serial.println(moisture2);


int moisture3 = analogRead (mo3);

// Serial.println("mo 3");

// Serial.println(moisture3);


int moisture4 = analogRead (mo4);

// Serial.println("mo4");

// Serial.println(moisture4);


int moisture5 = analogRead (mo5);

// Serial.println("mo 5");

// Serial.println(moisture5);


int moisture6 = analogRead (mo6);

// Serial.println("mo 6");

// Serial.println(moisture6);


int moisture7 = analogRead (mo7);
```

```
// Serial.println("mo 7");

// Serial.println(moisture7);


int moisture8 = analogRead (mo8);

// Serial.println("mo 8");

// Serial.println(moisture8);


int moisture9 = analogRead (mo9);

// Serial.println("mo 9");

// Serial.println(moisture9);


int level = analogRead (water_level);

// Serial.print("LEVEL:");

// Serial.println(level);


int light1 = digitalRead (light);

// Serial.print("light:");

// Serial.println(light1);
```

```

int rain1 = digitalRead (rain);

// Serial.print("rain:");

// Serial.println(rain1);

// 1, 2 , 3


if (moisture1 > 800 && moisture2 > 800 || moisture1 > 800 && moisture3 > 800 || moisture2 >
800 && moisture3 > 800)

{

    digitalWrite(vlv, HIGH);

    digitalWrite (pump, HIGH);

}

if (moisture1 > 800 && moisture2 > 800 && level > 800 || moisture1 > 800 && moisture3 > 800
&& level > 800 || moisture2 > 800 && moisture3 > 800 && level > 800)

{

    digitalWrite(vlv, LOW);

    digitalWrite (pump, LOW);

}

```

```

if (moisture1 > 800 && moisture2 > 800 && rain1 == 0 || moisture1 > 800 && moisture3 > 800
&& rain1 == 0 || moisture2 > 800 && moisture3 > 800 && rain1 == 0)

{

    digitalWrite(vlv, LOW);

    digitalWrite (pump, LOW);

}

if (moisture1 < 700 && moisture2 < 700 && moisture3 < 700)

{

    digitalWrite(vlv, LOW);

    // digitalWrite (pump, LOW);

}

//4,5,6

if (moisture4 > 800 && moisture5 > 800 || moisture4 > 800 && moisture6 > 800 || moisture5 >
800 && moisture6 > 800 && Temp < 20 && light == 1)

{

    digitalWrite (pump, HIGH);

    digitalWrite(vlv2, HIGH);

}

}

```



```
if (moisture4 > 800 && moisture5 > 800 && level > 800 || moisture4 > 800 && moisture6 > 800  
&& level > 800 || moisture5 > 800 && moisture6 > 800 && level > 800 )
```

```
{
```

```
    digitalWrite (pump, LOW);
```

```
    digitalWrite(vlv2, LOW);
```

```
}
```

```
if (moisture4 > 800 && moisture5 > 800 && rain1 == 0 || moisture4 > 800 && moisture6 > 800  
&& rain1 == 0 || moisture5 > 800 && moisture6 > 800 && rain1 == 0 )
```

```
{
```

```
    digitalWrite (pump, LOW);
```

```
    digitalWrite(vlv2, LOW);
```

```
}
```

```
if (moisture4 < 700 && moisture5 < 700 && moisture6 < 700)
```

```
{
```

```
    digitalWrite(vlv2, LOW);
```

```
}
```

```
// 7,8,9
```

```
//

if (moisture7 > 800 && moisture8 > 800 || moisture7 > 800 && moisture9 > 800 || moisture8 >
800 && moisture9 > 800 && Temp < 20 && light == 1)

{

    digitalWrite (pump, HIGH);

    digitalWrite(vlv3, HIGH);

}

if (moisture7 > 800 && moisture8 > 800 && level > 800 || moisture7 > 800 && moisture9 > 800
&& level > 800 || moisture8 > 800 && moisture9 > 800 && level > 800 )

{

    digitalWrite (pump, LOW);

    digitalWrite(vlv3, LOW);

}

if (moisture7 > 800 && moisture8 > 800 && rain1 == 0 || moisture7 > 800 && moisture9 > 800
&& rain1 == 0 || moisture8 > 800 && moisture9 > 800 && rain1 == 0 )

{

    digitalWrite (pump, LOW);

    digitalWrite(vlv3, LOW);

}
```

```

if (moisture7 < 700 && moisture8 < 700 && moisture9 < 700)

{

    digitalWrite(vlv3, LOW);

}


//Tempreture & light & rain

//

// if (Temp > 20 && light ) || moisture1 > 800 && moisture3 > 800 || moisture2 > 800 &&
moisture3 > 800)

// {

//

//    digitalWrite(vlv, HIGH);

//    digitalWrite (pump, HIGH);

// }


float sensorF4 = 0;

float sensorF3 = 0;

float sensorF2 = 0;

float sensorF1 = 0;

sensorF4 = analogRead(Flow4);

sensorF3 = analogRead(Flow3);

```

```

sensorF2 = analogRead(Flow2);

sensorF1 = analogRead(Flow1);

lcd.print("Flow2: "); lcd.print(sensorF2 / 1000); lcd.print("L/S"); lcd.println ("  ");

lcd.print("Flow3: "); lcd.print(sensorF3 / 1000); lcd.print("L/S"); lcd.println ("  ");

lcd.print("Flow4: "); lcd.print(sensorF4 / 1000); lcd.print("L/S"); lcd.println ("  ");

lcd.print("Flow1: "); lcd.print(sensorF1 / 1000); lcd.print("L/S"); lcd.println ("  ");

if (Serial.available() > 0)

{

    Received = Serial.read();

}

if (Received == '1') {

    digitalWrite(vlv, HIGH);

    digitalWrite (pump, HIGH);

}

if (Received == '0') {

    digitalWrite(vlv, LOW);

    digitalWrite (pump, LOW);

}

if (Received == '2') {

```

```
digitalWrite(vlv2, HIGH);

digitalWrite (pump, HIGH);

}

if (Received == '3') {

digitalWrite(vlv2, LOW);

digitalWrite (pump, LOW);


}

if (Received == '4') {

digitalWrite(vlv3, HIGH);

digitalWrite (pump, HIGH);

}

if (Received == '5') {

digitalWrite(vlv3, LOW);

digitalWrite (pump, LOW);

}

if (Received == '6') {

digitalWrite (pump, HIGH);

digitalWrite(vlv, HIGH);
```

```
digitalWrite(vlv2, HIGH);

digitalWrite(vlv3, HIGH);

}

if (Received == '7') {

    digitalWrite (pump, LOW);

    digitalWrite(vlv, LOW);

    digitalWrite(vlv2, LOW);

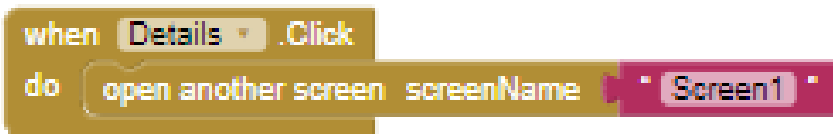
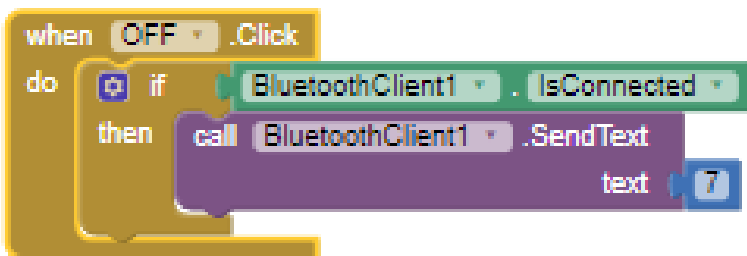
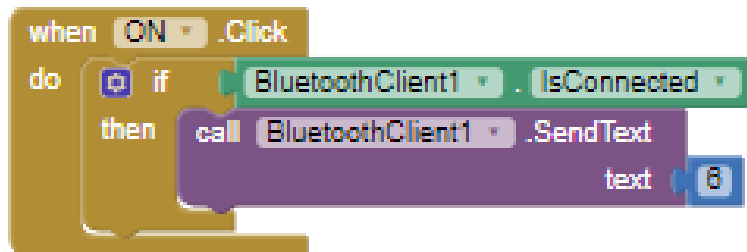
    digitalWrite(vlv3, LOW);

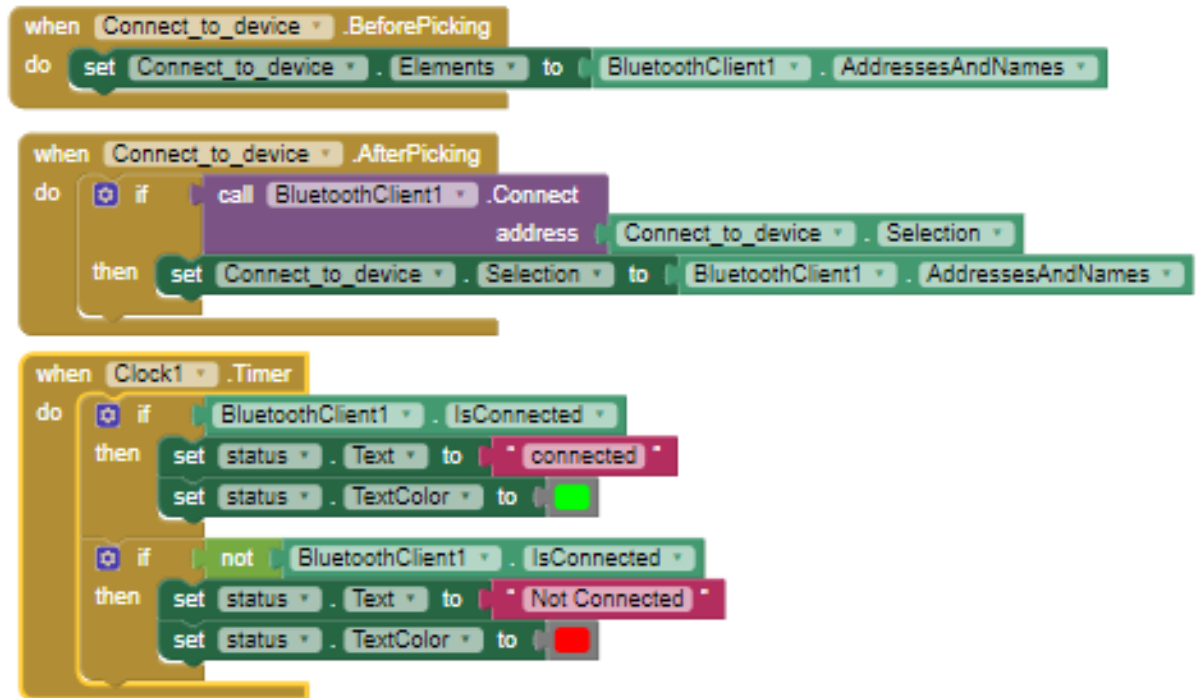
}

}
```

#### Appendix4: CodeBlocks for Mobile Application

- Main Screen :







when Home .Click  
do open another screen screenName "Screen2"

when ON1 .Click  
do call BluetoothClient1 .SendText  
text "1"

when OFF1 .Click  
do call BluetoothClient1 .SendText  
text "0"

when ON2 .Click  
do call BluetoothClient1 .SendText  
text "2"

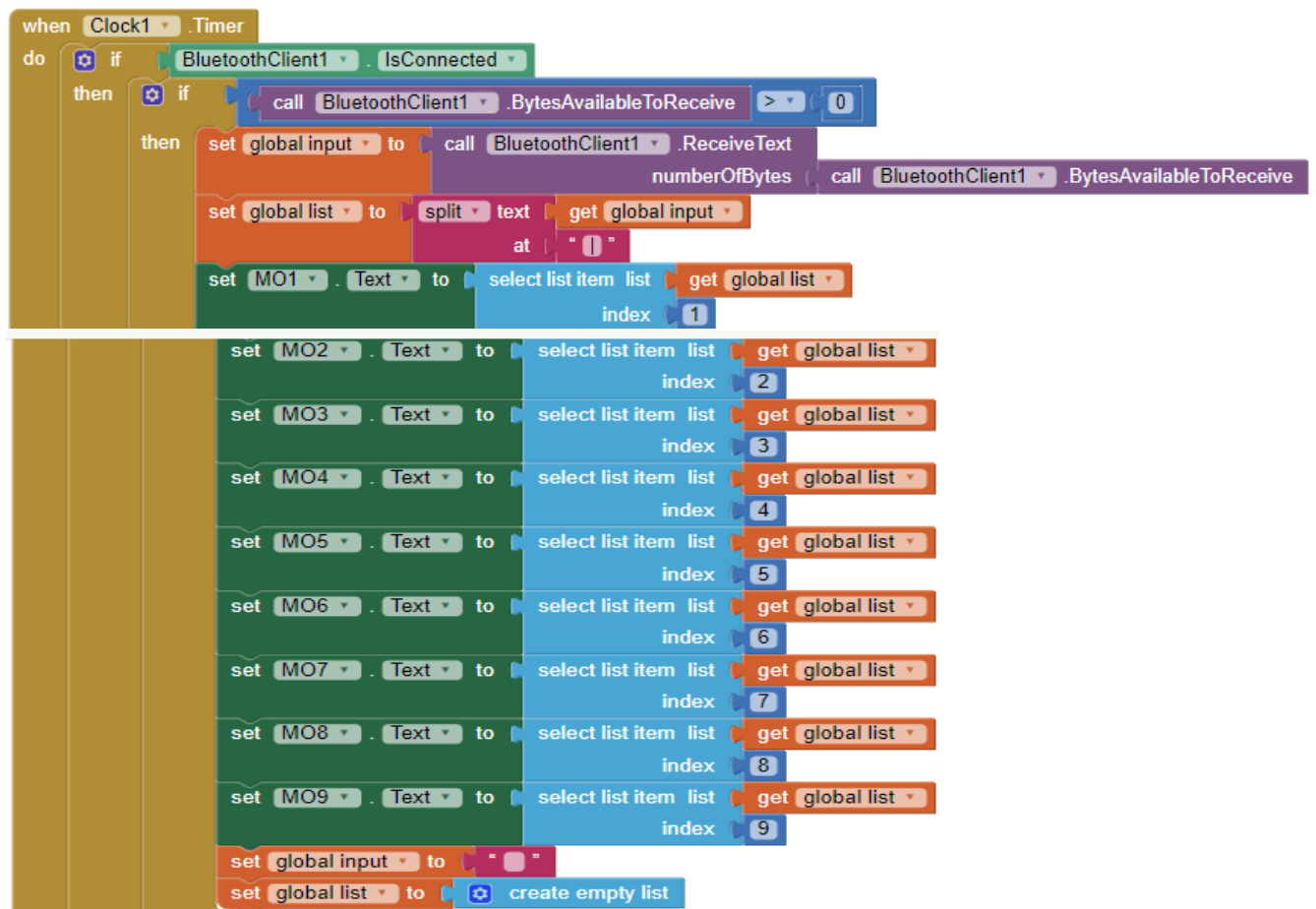
when OFF2 .Click  
do call BluetoothClient1 .SendText  
text "3"

when ON3 .Click  
do call BluetoothClient1 .SendText  
text "4"

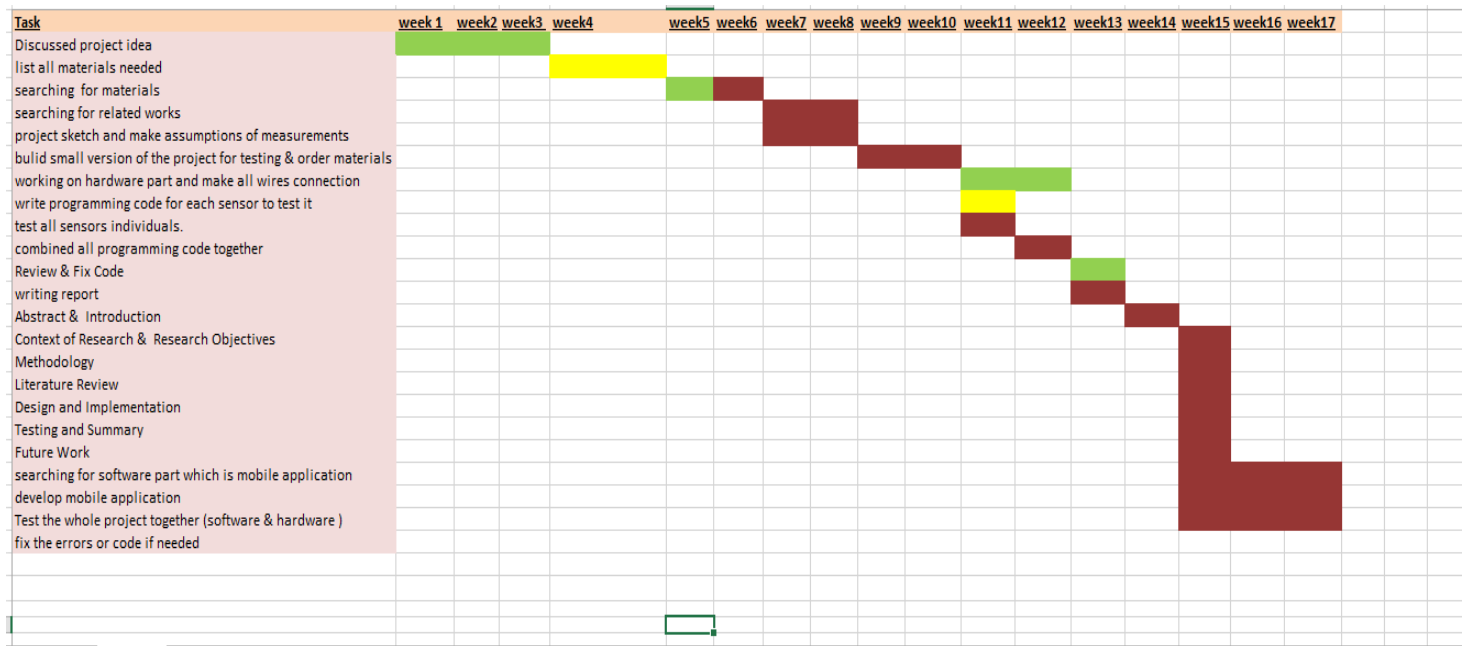
when OFF3 .Click  
do call BluetoothClient1 .SendText  
text "5"

when ListPicker1 .BeforePicking  
do set ListPicker1 . Elements to BluetoothClient1 . AddressesAndNames

when ListPicker1 .AfterPicking  
do if call BluetoothClient1 .Connect  
address ListPicker1 . Selection  
then set ListPicker1 . Selection to BluetoothClient1 . AddressesAndNames



## Appendix 3: Project Timeline



### Team member

Maryam

Budoor

All

### color

