CHAPTER 1

INTRODUCTION

This project revolves around the concept of providing an optimum method of irrigation to farmers. The irrigation system provides only certain amount of water to crop. This automated irrigation system allows it to be scaled up for larger greenhouses or open fields. An automated irrigation system was developed to reduce the water use for agricultural crops. The automated irrigation system is feasible and cost effective for optimizing water resources for agricultural production. Using the automated irrigation system we can prove that the use of water can be reduced for agricultural production.

1.1 MOTIVATION

Our motivation to take up this project came mainly from the scenario of the plight of farmers in today's society. Agriculture provides the basic platform for the economy of most of the countries. It is one of the main sources of livelihood of people. It provides not only food but also some important raw materials. The other advantage that agriculture provides is large scale employment. But in last couple of centuries, it is observed that the yield rate is not been increased, whereas in some areas it is even declined. There are number of factors which are responsible for the low yield. It may be due to fertilizer abuse, reducing arable land, fragmentation of agricultural land, agricultural indebtedness, water waste, low soil fertility, climate change or diseases etc.

Indian economy basically depends on agricultural. Agriculture uses most of available fresh water resources and this use of fresh water resources will continue to be increases because of population growth and increased food demand. Increased competition for water resources from urban areas provides strong motivation for efficient irrigation system.

1.2 PROBLEM STATEMENT

Thus we need to find a solution to provide an efficient mode of irrigation to the farmers as well as make a track of the soil conditions on daily basis. Thus we need to adopt the ideas from the concept of Internet of Things to implement a cost-effective irrigation system that can irrigate the fields effectively without wasting much water, thus being utilized only when necessary. Moreover, we have to ensure that the soil is not degraded due to excessive use of fertilizers and thus maintain a velar observation on soil conditions to make preventive actions in case of potential degradation.

1.3 OVERVIEW OF THE PROJECT

We intend to design an automated irrigation system that is capable of providing sustained water to plants in the field in the absence of farmers. For this purpose we utilize the concept of Internet of Things as well as the functions of an Arduino board to design a very efficient irrigating system. We know all too well that the motor pump that delivers water to the plants is run by an ac supply. However, for providing additional power to the circuitry we use a solar panel and a couple of rechargeable batteries to run the setup apart from the battery. A point to be noticed here is that the Arduino board needs only around 9 volts of dc supply hence a very small solar panel can suffice that need. By using soil moisture sensor we measure the moisture levels in the soil. The Arduino is programmed such that, it activates a relay system that enables the water motor to run and to solenoid valve if the moisture levels have dropped to below the threshold values. If not then the Arduino sends an off signal to the relay system.

1.4 CONCLUSION

Thus we can confidently say that the use of all these applications can result in a system which optimize the use of water and also helps detects changes in soil and helps corrects them in advance. As mentioned above, this requires the assimilation of various technologies which will be explained in subsequent chapters.

CHAPTER 2

LITERATURE SURVEY

2.1 INTRODUCTION

In this chapter we shall discuss about the previously attempted models in the field of automated irrigation system how they can be utilized to our benefit to further improve the model that was proposed in the chapter one. The drawbacks of each proposed system and how we have eliminate them in our project. The basic necessities required for implement automated irrigation system in real world.

2.2PUBLICATIONS ON AUTOMATED IRRIGATION SYSTEMS

In the recent years there is a lot of buzz created around automation of irrigation techniques to reduce the manual work in irrigating a farm. Some of the research papers we have studied identified the drawbacks in each system and tried to modify them. Archana and Priya [1] proposed an automatic irrigation system in which the humidity and soil moisture sensors are placed in the root zone of the plant. The system is completely autonomous. Based on the sensed values the microcontroller preforms the action of switching the motor on/off. The motor pump pumps the water to the plant when the moisture level reaches the desired value then the motor gets turned off automatically. But this system don’t intimate the farmer about the field status. This is problem because as every system has a lifetime, it is really difficult to estimate the lifetime of this project as it contains several components in it. So by intimating the farmer about the field status he can remotely monitor what is happening in the field even without his presence.

S.Reshmaand B.A.Sarath [2] developed a system in which soil moisture and temperature at desired location in the farm are calculated and sent to the farmer through message. The farmer has to see the message and manually operate the water pump. Though this system indicates farmer about the field status controlling of motor has to be done manually by farmer. The autonomous system is removed and manual mode of operation of the system comes into picture. If farmer neglects any message or if any information is not delivered to the farmer then he/she may not switch on the motor resulting to loss of plants.

Ashwini and Diparna Adhikary [3] done a project on automatic irrigation system. Here the soil moisture sensors are placed in the soil and sensed data is sent to the Arduino. The Arduino analyzes the data sent by the soil moisture sensor and associated with some threshold value. The motor is ON/OFF automatically depending upon the threshold value given to the Arduino. The problem with this system is that it contains only single sensor. The main aim of every project is to make it applicable in real time placing of a single sensor and a single motor for each and every plant will not work in real time.

A.Sethumathavan, K.Shree Pranav, A.Venkat Raman, Dr.B.Sathish Kumar [4] proposed an automatic system which can controlled both automatically and manually. The project uses an Arduino board as a microcontroller. The basic problem here is if the farmer forgets to switch from manual mode to automatic mode and forgets to see the message then it results in loss of plants. The circuit used here is very complex and it uses only one threshold valve. The problem with single threshold valve is that whenever the moisture is just less than the desired motor gets ON (water is supplied) whenever it becomes just greater than the threshold value then the motor gets OFF (water is not supplied). This makes the motor to continuously toggle between ON and OFF results in reduction in the lifetime of motor/water pump. This system also uses GPRS block which is unnecessary.

Aman Bafna, Anish Jain, Nisarg Shah, Rishab Parekh [5] developed a project on automatic irrigation system using IOT and online server in which weather predictions are present. The system waters the plants based on the sensed valves and the valves given by the sensors. This system also uses the concept of solenoid valve but only one. In real time single sensor won't do any work we have to divide the complete farm into sectors each provided with a solenoid valve. We require multiple solenoid valves for a farm. Most of the weather predictions might go wrong. This becomes a serious problem when these valves are considered. So relying on the moisture sensor for the sensed valves is good idea.

In present world timer controlled irrigation systems are available in the market. These things water the plants daily on the time set by the farmer. It allows the water for some specific amount of time and water stops flowing after it. The main problem associated with this system is that plants require different amount of water in different seasons. In summer, plants require more amount of water and in rainy season they require less amount of water. For performing this the timer has to be changed for different seasons. Moreover, we cannot guarantee that rainfall don't occur in summer seasons. So all the above taking into account the farmer has to manually set the timer daily which is not an efficient way. The system doesn't use any IOT or GSM to intimate to the farmer about the field status. By using either IOT or GSM we can remotely control the system.

So considering all the above examples we have decided to implement a real time project which is directly useful by the farmers. The system should consist of a platform like IOT or GSM to intimate the farmer about the field status.

2.3 CONCLUSION

Thus we have studied the above examples to get a clear picture of the problem faced by the farmers and help to deal with this. We have also learnt how there have been efforts by various members of the engineering community to try and develop irrigating models and systems which can sustain the cost of farmers too. From the above examples and use of solenoid valves we have developed our own automatic irrigation system which can serve in real time and is also capable of sending messages to the farmers.

CHAPTER 3

THEORITICAL ANALYSIS

3.1 INTRODUCTION

In this chapter we shall be discussing the basics of this project that is, the core technologies and components used in the project. Based on which we shall further showcase the implementation in later chapters.

3.2 ARDUINO UNO

Arduino is standard term for a software company, project, and user community that designs and produce computer open-source hardware, open-source software, and microcontroller based kits for produce digital devices and interactive objects that can sense and monitor the physical devices.

The project is based on microcontroller board designs, produced by many vendors, using various microcontrollers, these systems provides sets of digital and analog I/O pins that can interconnect to various expansion boards (termed shields) and other systems. The board's features are serial communication interfaces, including universal serial bus (USB) on some designs, for loading programs from personal computers. For programming the microcontrollers, the Arduino project generates an integrated development environment (IDE) based on a programming language named processing, which also assist the languages C and C++.

The first Arduino was introduced in 2005, aiming to issue a low cost, easy way for professionals to generate devices that interact with their environment using sensors and actuators. Common examples of such devices are intended for beginner hobbyists include simple robots, thermostats, and motion detectors.

Arduino Uno boards are available commercially in preassembled form, or as do-it-yourself kits. The hardware design specifications are openly obtainable, allowing the Arduino boards to be produced by anyone. Adafruit industries are estimated in mid-2011 that over 300,000 official Arduino had been commercially produced, and in2013 that 700,000 official boards were in user's hands.

3.3 SOFTWARE

Programs in Arduino Uno may be written in any programming language with a compiler that produces binary machine code. Atmel provides an expansion environment for their microcontrollers, AVR studio and the newer Atmel studio. The Arduino project creates the Arduino integrated development environment (IDE), which is a cross-plat-from application written in the programming language Java. It originated from the IDE for the languages processing and wiring.

It is designed to introduce programming to artists and other newcomers unknown with software development. It includes a code editor with characteristics such as syntax highlighting, brace matching, and automatic indentation, and gives simple one-click mechanism to compile and load programs into an Arduino board. A program written with the IDE for Arduino is called a "sketch".

The Arduino IDE supports the language C and C++ using special rules to organize code. The Arduino IDE provides a software library called wiring from the wiring project, which gives many common input and output procedures. A typical Ardunio C/C++ sketch consist of two functions that are complied and linked with a program stub main () into a viable cyclic executive program.

External (non-USB) supply can come either from a AC-to-DC adapter (wall-wart) or battery. The adapter can be attached by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the GND and vin pin headers of the POWER connectors.

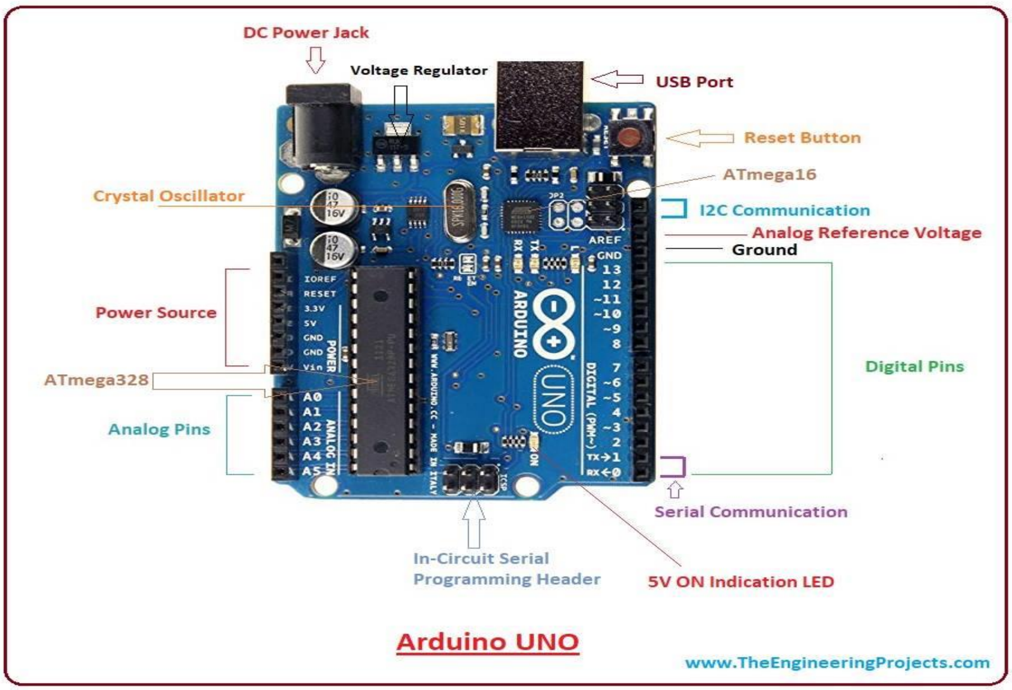

Fig 3.1: **Arduino Uno**

The board can run on an external supply from 6 to 20 volts. If supplies with less than 7V, however, the 5V pin may supply less than five volts and the board may become unstable. If using more than 12V, the voltage regulator maybe overheat and damage the board. The suggested range is 7 to 12 volts.

Severally the 14 digital pins on the Arduino Uno can be used as an input or output, apply pinMode ( ), digitalRead ( ), and digitalWrite ( )

functions. They operated at 5 volts. Each pin can provide or receive 20mA as endorse operating condition and has an internal pull-up resistor (disconnected by revert) of 20-50K ohm. A maximum of 40mA is the value that must not be exceeded on any I/0 pin to avoid permanent damage to the microcontroller.

3.4 SOIL MOISTURE SENSOR

Soil moisture sensor is an ideal sensor used for measuring the soil moisture level at the desired place by inserting the probes at the root level of the plants.

The new soil moisture sensor uses immersion gold which cares the nickel from oxidation. Electro less nickel immersion gold (ENIG) has many advantages over more conventional (and cheaper) surface plating's such as HASL (solder), including excellent surface planarity (particularly helpful for PCB'S with large BGA packages), good oxidation resistance, and usability for unprocessed contact surfaces such as membrane switches and contact points.

Sensor description: this soil moisture sensor has two probes through which current passes in soil, then take the resistance of soil for reading moisture level. We know that water make the soil more prone to electric conductivity resulting less resistance in soil where on the other side dry soil has poor electrical conductivity thus more resistance in soil. Using these properties of electricity the sensor is outlined. Inside the sensor there are system for measuring the resistance and converting it into voltage as output.

This sensor uses the two probes to allow the current through the soil, and then it takes that resistance to get the moisture level. More water makes the soil conduct electricity more comfortable (less resistance), while dry soil performs electricity poorly (more resistance). This sensor will be helpful to suggest you to water your indoor plants or to monitor the soil moisture in your garden.

3.4.1 FEATURES:

1. Supply voltage: 3.3V-5V
2. output voltage: 0-4.2V
3. current: 35mA
4. low power consumption

3.4.2 PARTS:

1. Arduino Uno (1pc)
2. Soil moisture sensor (DF robot)
3. Analog sensor cable (3 pin)

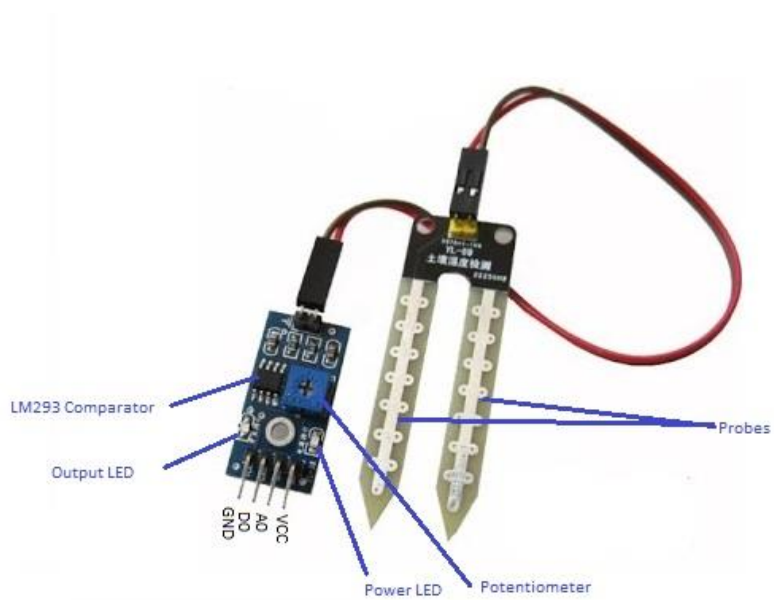

Fig 3.2: Pin configuration of soil moisture sensor

3.5 REAL TIME MOISTURE SENSORS

Some of the companies like SENTEK and METERGROUP are doing a lot of research on soil moisture sensors that are useful in real world. The companies are located in Australia and America. The companies are producing these sensors on a small scale and most of them are still in research stage. Some of the sensors are mentioned below.

3.5.1 ECH$_2$O EC-5

This is a low cost individual sensor for large sensor networks. This is produced by the metergroup company located in America. It determines the volumetric water content (VWC) by measuring the dielectric constant of the medium. It uses 70MHz frequency which makes it less effected by salinity and textural effects.

Fig 3.3: ECH$_2$O EC-5 moisture sensor

The probes of the sensors are just 5 cm long. It can measure a volume upto 0.2 liters. This sensor can accurately work in almost any type of soil since it is less affected by salinity in the soil. It’s compact design makes it easy to install in any undisturbed soil with good accurate results

3.5.2 ECH_2O 10HS

Small soil moisture sensors may not provide good accuracy as its volume of influence is small. When we go for real time we generally go for a large area so we need sensors which can detect large volume of soil. The sensor shown in the below figure have a one liter volume of influence which means it calculates the amount of volume present in 1 liter of soil. This is also developed by the metergroup America.

Fig 3.4: ECH_2O 10HS moisture sensor

The probes are 10 cm long. This sensor has three times of volume of influence than the smaller sensors. This sensor measures volumetric volume content (VMC) using capacitance technology. It has a measurement duration of 10ms and it operates at a 3 VDC voltage and at 12 mA current. The sensor operates at temperature ranges from -40 to + 60 ^{o}C. It has an accuracy of about ±1 °C and a resolution of about 0.1 °C.

3.5.3 ECH_2O 5TM

The uniqueness of this sensor is that it has onboard thermistor used for measuring temperature along with the soil moisture. This sensor is also developed by metergroup America. This sensor is easy to install and can be operated at temperature ranges from -40 to + 60 ^{o}C. it has an accuracy of about ±1 °C and a resolution of about 0.1 °C.

Fig 3.5:ECH_2O 5TM moisture sensor

As this sensor use capacitance effect for calculating the moisture valve. Since the temperature sensors is also present we can use the sensor in the places where the temperature fluctuations are more. For the purchase of the sensor and to know about the specifications of the sensor use the below link
https://www.metergroup.com/environment/products/ec-5-soil-moisture-sensor/

3.5.4 TEROS 12

TEROS 12 is a sensor which can measure both soil moisture and temperature. It has a volume of influence of about 1010 mL.it is very easy to install. It should be placed with minimal air gaps for clear readings.

Fig 3.5: TEROS 12

Unlike above sensors this sensor uses electrical conductivity for measuring the moisture valve. Thermistor embedded at the center needle. It is robust and has an epoxy body tough field conditions.Minimizes salinity and textural effects by using 70 MHz frequency capacitance technology. Steel needles cut through the soil for better soil-sensor contact. Easy-to-read voltage output for various data loggers. Ferrite core eliminates cable noise. For the purchase of the sensor and to know about the specifications of the sensor use the below link

https://www.metergroup.com/environment/products/ec-5-soil-moisture-sensor/

3.6 PUMP

A pump is a device that moves fluids (liquids or gases), or sometimes slurries, by mechanical action. Pumps can be classified into three major groups according to the method they use to move the fluid: direct lift, displacement, and gravity pumps.

Pumps operate by some mechanism (typically reciprocating or rotary), and consume energy to perform mechanical work by moving the fluid. Pumps operate via many energy sources, including manual operation, electricity, engines, or wind power, come in many sizes from microscopic for use in medical applications to large industrial pumps.

Mechanical pumps serve in a wide range of applications such as pumping water from wells, aquarium filtering, pond filtering and aeration in the car industry for water-cooling and fuel injection, in the energy industry for pumping oil and natural gas or for operating cooling towers. In the medical industry, pumps are used for biochemical processes in developing and manufacturing medicine, and as artificial replacements for body parts, in particular the artificial heart and penile prosthesis.

Fig 3.7: 0.5 hp water pump

Single stage pump- when in a casing only one impeller is revolving then it is called single stage pump.Double / multi stage pump- when in a casing two or more than two impellers are revolving then it is called \double/ multi stage pump.

3.7 RELAY

A relay is an electrically works as a switch. Many relays use an electromagnet to mechanically work as a switch, but other operating principles are also used as solid state relays. Relays are used where it necessary to control a circuit by a separate low power signal, or where many circuits must be monitored by one signal.

Fig3.8: Four-channel Relay

A simple electromagnetic relay consists of a coil of wire wrapped around s soft iron core (a solenoid), an iron yoke which allows a low reluctance path for magnetic flux a transferable iron armature, and one or more sets of contacts(there are two contacts in the relay pictured). The armature is pivot to the yoke and mechanically linked to one or more sets of moving contacts.

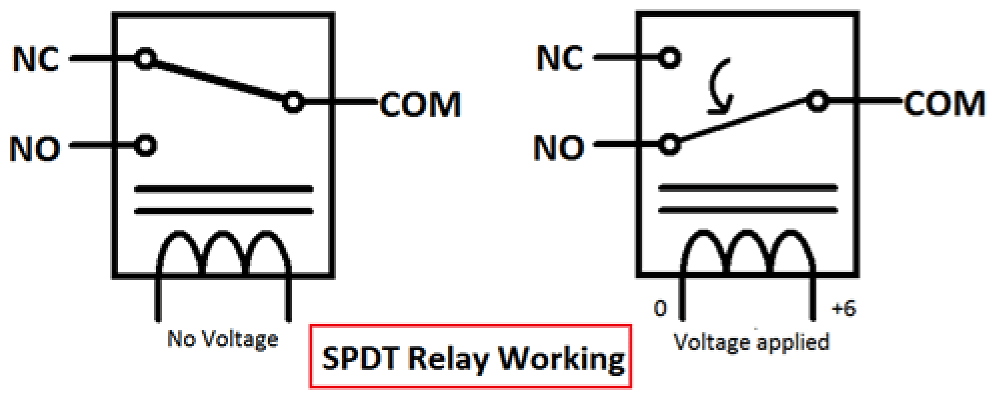

Fig 3.9: Working of relay

When an electric current is moved through the coil it generates a magnetic field that activates the armature and the resulting movement of the movable contact either off or on a connection with a fixed contact. If the set of contacts was closed when the relay was de- energized, then the movements open the contacts and break the connection, and vice versa if the contacts were open. When the current to the coil is off, the armature is returned by a force, approximately half as strong as the magnetic force, to its ease position. Most of the relays are manufactured to operate quickly. In a low-voltage application it reduces noise, in a high voltage or current application it reduces opening.

3.7 SOLENOID VALVE

A Solenoid valve is a type of electromagnet valve whose purpose is to generate a controlled magnetic field. If the purpose of the solenoid is instead to retard changes in the electric current, a solenoid valve can be more specifically classified as an inductor rather than an electromagnet.

It is a coil of wire used as an electromagnet. It is also refers to any device that converts electrical energy to mechanical energy using a solenoid. The device generates a magnetic field from electrical current and uses the magnetic field to create linear motion.

An electric current through the coil generate a magnetic field. The magnetic field strives a force on the plunger. As a result, the plunger is pulled toward the center of the coil so that the gap opens. This is the basic principle that is used to open and close the solenoid valves.

Fig 3.10:Solenoid valve

A solenoid is a very important coil of wire that is used in electromagnets, antennas, valves, inductors and many more. The application of a solenoid valve varies in many different types of industries. It can be used in simple locking device, medical clamping equipment, an automotive gear box, and an air condition unit.

3.8 GSM

GSM is abbreviated as global system for mobiles. This is a world-wide standard for digital cellular telephony, or as many people know them digital mobile telephones. The concept of cellular service is the use of low-power transmitters where frequencies can be reused with in a geographic area.

GSM is an open and digital cellular technology and also used for transmitting mobile voice and data services operate at the 850MHZ, 900MHZ and 18000MHZ frequency bands.GSM system was emerged as a digital system using time division multiple access (TDMA) technique for communication purpose. It is a digital cellular technology used for transmitting mobile and data services. It makes use of narrow band TDMA technique for transmitting signals. It was emerged by digital technology.

Fig3.11: GSM

Cellular are one of the swift growing and most demanding telecommunications applications. Today, it means a continuously increasing percentage of all new telephone subscriptions around the world. GSM modem is a peculiar type of modem which accepts a SIM card, and operates over a beneficiation to a mobile operator, just like a mobile phone. A new version of now SMS is available that supports the ability to use android phones as GSM modem devices for both sending and receiving SMS messages. It consists of a micro strip antenna used in old mobile phones. It has three main pins transmitter, receiver and ground. The GSM module with a SIM acts a mobile phone. One can make a phone call, receive call, send and receive messages. It consists of three LED's power LED, status LED and signal LED.

3.9 CONCLUSION

Thus we have reviewed each component in the project and its properties. This information helps us to efficiently interface soil moisture sensor and Wi-Fi module with Arduino Uno.

CHAPTER 4
IMPLEMENTATION

4.1 INTRODUCTION

This chapter deals with implementation of above discussed model. This involves interfacing various components with one another, the connections between them and the necessary code that should be uploaded into the Arduino to make the hardware connected to Arduino to work in the desired fashion. We will first view the overall flowchart, then discuss the interfacings for each part.

4.2 OVERALL FLOWCHART

Implementation of any project idea begins with the block diagram, flowchart and algorithm. The working of our project begins with the moisture sensors sensing the data. These moisture sensors are placed at the desired location in farm preferably at the roots of the plant. The complete farm is divided into sectors. Each sector is associated with a solenoid valve and a moisture sensor. All these solenoid valves are connected to a water pump. The sensors sense the data and send the data to the Arduino board. The moisture sensors gives valves ranging from 0-1024. Here 0 means the sensor is in wet place, 1024 means the sensor is in dry place. These range of values for better understanding are mapped to 0-100 (converted into percentages). Now 100 means the sensor is in dry place and 0 means the sensor is in wet place. A range of values is taken (two threshold values) one is higher threshold value (70) and the other is lower threshold value (40).

If the sensor detects a value greater than 70 (dry place) then Arduino sends a signal to the relay. Here in this project we use a 4 channel relay. One channel for water pump and the remaining three for solenoid valves. It is expandable to any number of sectors. So when the soil moisture (>70) then the solenoid valve of the particular sector is excited and water pump is made to ON. A message that the soil moisture in some sector say i^{th} is dry is sent a message to farmer.

FLOW CHART:

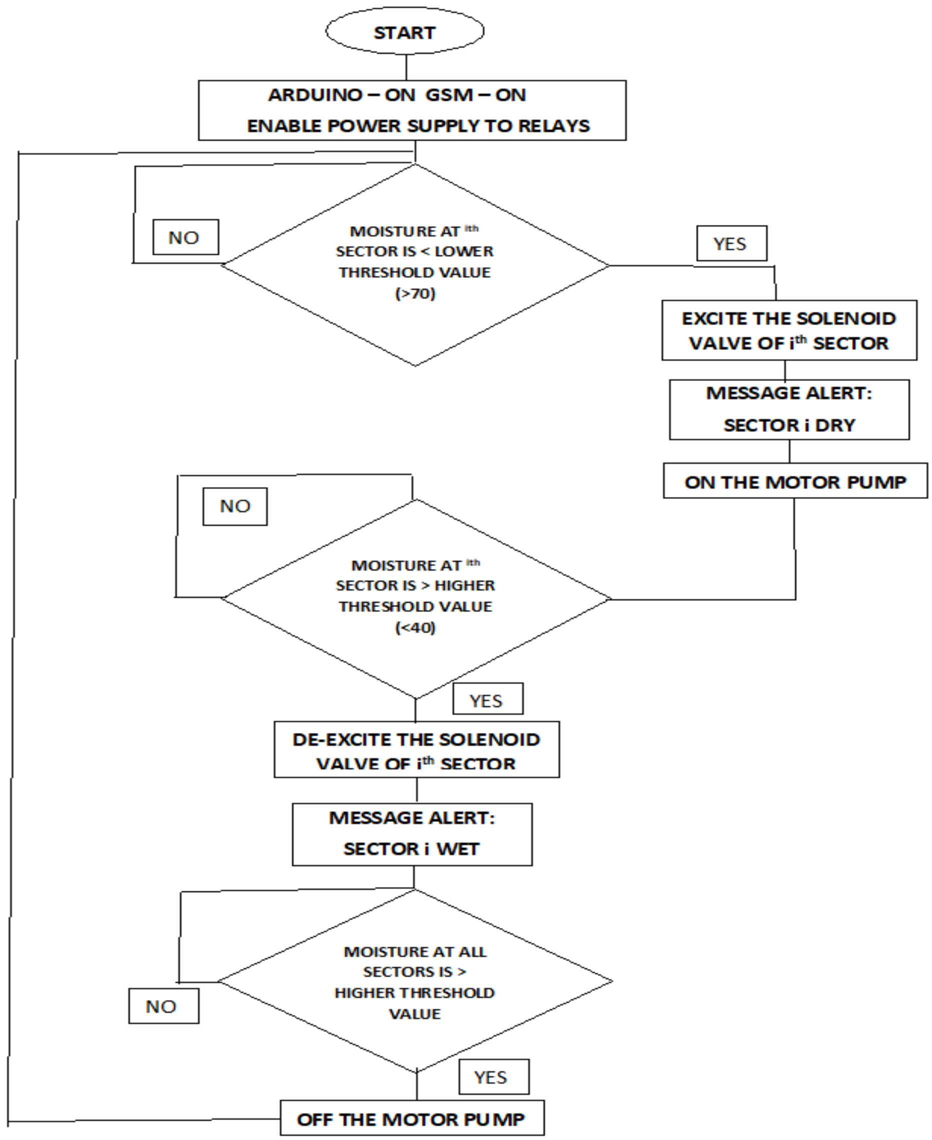

Fig4.1: Flow chart

Water pump and solenoid valves supplies the water to the required sector. After some time the moisture level at the sector reaches the desired valve (the sensor in the particular sector senses a valve <40) then the solenoid valve is de-excited.A message that the soil moisture in some sector say i^{th} is wet is sent a message to farmer. All the sectors can be watered simultaneously.

The water pump is made to OFF only when we have only one sector initially dry and reaching to wet state (if all the sectors are wet). The water pump is made to ON if any of the sensed valves is greater than the higher threshold valve (if any one of the sector is dry).

4.3 BLOCK DIAGRAM:

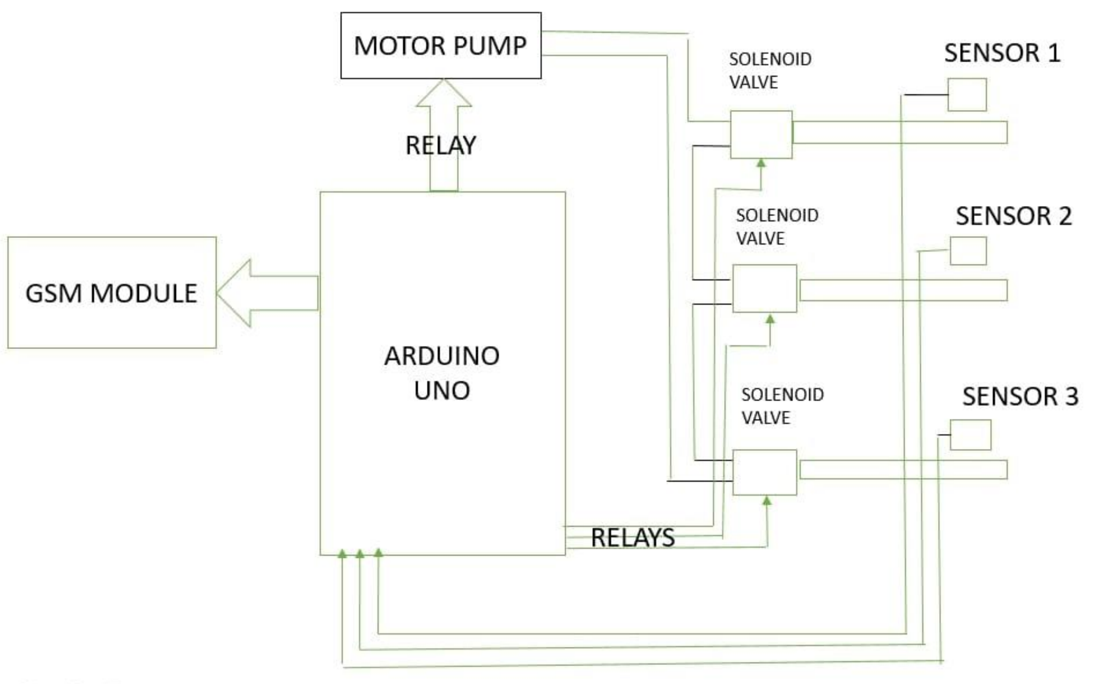

Fig 4.2: Block diagram of the model

4.4 ALGORITHM

Step 1: Switch ON the power supply to GSM module, Arduino and relays.

Step 2: Sensor measures the moisture level at i^{th} sector and sends it Arduino.

Step 3: If the moisture level is less than the threshold valve then solenoid valve of i^{th} sector is excited and motor is made to ON. Motor is made to ON if moisture at any sector is less than desired value.

Step 4: If step 3 is executed then a message will be send to the farmer regarding about whether the sector is DRY.

Step 5: When the moisture level reaches the desired value then check

- If all the sectors have desired moisture level then OFF the pump then de-excite the solenoid valve belonging to i^{th} sector.
- If not all the sector have desired moisture level then don't switch OFF the motor pump but de-excite the solenoid valve belonging to i^{th} sector.

Step 6: If step 5 is executed then a message will be send to the farmer regarding about whether the sector is WET.

Step 7: Repeat the steps from step 2 for all the sectors.

4.5 INTERFACING SOIL MOISTURE SENSOR WITH ARDUINO:

The soil moisture sensor consists of two probes one is anode and other is cathode. The soil moisture sensor is connected to an analog to digital convertor. It consists of 4 pins: analog output, digital output, Vcc and ground. The sensor sends the data continuously which is in turn transmitted to the Arduino by the A/D convertor at a speed of 300ms. Here we consider the analog data given by the sensor. The analog pin of the A/D converter is connected to the analog pin of the Arduino board. The Vcc and ground of the sensor is connected to the 5V and ground of the Arduino board respectively. We have 6 analog pins for an Arduino UNO means we can connect 6 sensors. For more than 6 sensors we use Arduino mega or Arduino i2c expander.

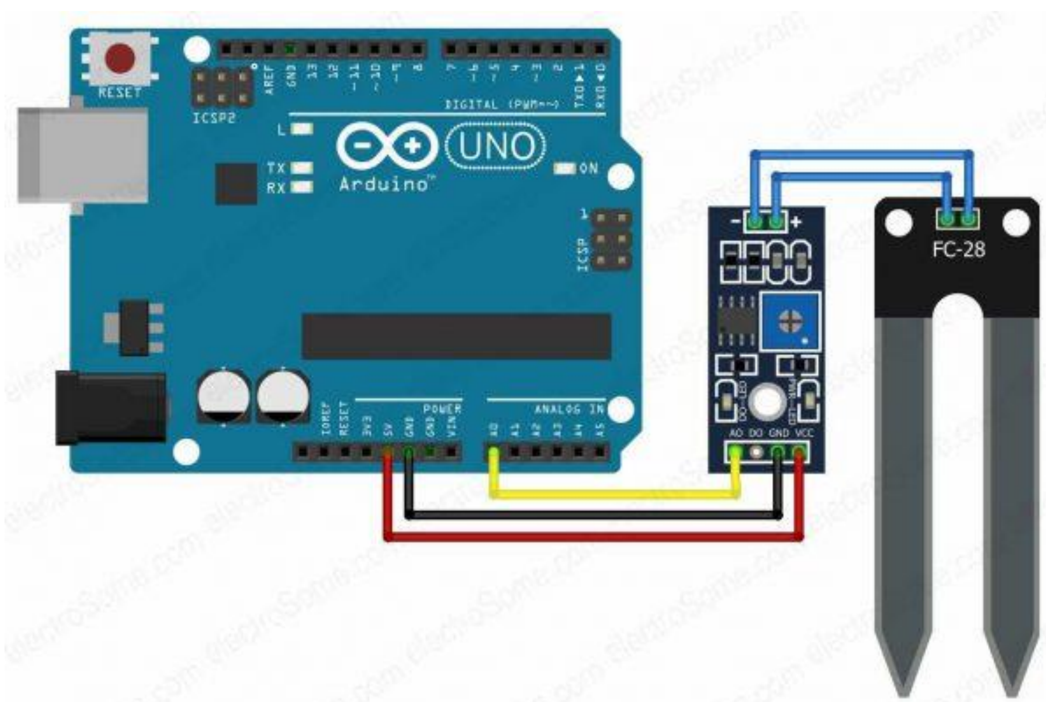

Fig4.3: Interfacing soil moisture sensor with Arduino

The sensors sense the data and send the data to the Arduino board. The moisture sensors gives valves ranging from 0-1024. Here 0 means the sensor is in wet place, 1024 means the sensor is in dry place. These range of values for better understanding are mapped to 0-100 (converted into percentages). Now 100 means the sensor is in dry place and 0 means the sensor is in wet place. A range of values is taken (two threshold valves) one is higher threshold valve (70) and the other is lower threshold valve (40). The following commands are used to read the analog data and map to 0-100 range. Consider an example where three sensors are used

```
intmoistureRaw[3] =
{analogRead(A0),analogRead(A1),analogRead(A2)};//reading of moisture
valves
```

```
int moisture[3] =
{map(moistureRaw[0],1023,0,100,0),map(moistureRaw[1],1023,0,100,0),
map(moistureRaw[2],1023,0,100,0)};// mapping of moisture valves
```

As the moisture data is taken from the sensors the pin modes of the sensors should be as INPUT mode.

4.6INTERFACING RELAY WITH ARDUINO:

In the project we considered that the total farm is divided into 3 sectors. Each sector is assigned with a solenoid valves. A 4 channel relay is used. One channel for water pump and the remaining three for solenoid valves. It is expandable to any number of sectors by simply just a required number of channel relay.

Relay consists of 4 pins namely Vcc, ground (GND), in1, in2, in3, in4. These pins are given to different pins in Arduino. Vcc is connected to 5V supply, GND to GND,in1, in2, in3, in4 are connected to the digital pins say 2,3,4,5 respectively.

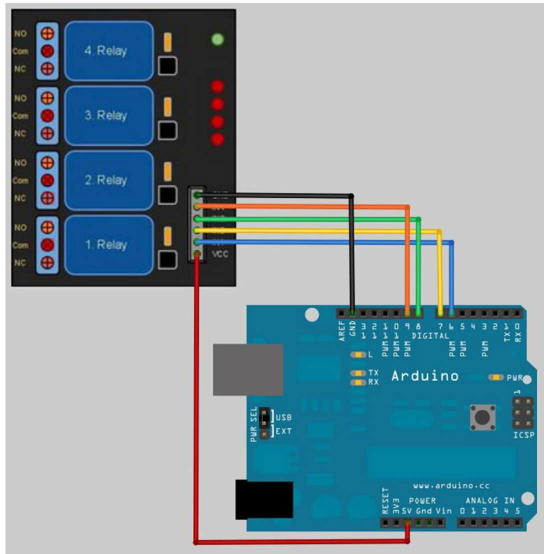

Fig 4.4: Interfacing relay with arduino

The relay has 3 internal pins NC normally close, NO normally open and common. The solenoid valves and water pump used here work on 230V ac supply. The 230V ac supply is given to the common terminal of the relay. The phase wire of the solenoid valves is given to the normally open NO pin. The NC normally close pin is left unconnected. The three solenoid valves phase wires are given to 3 relays NO pins. The NO normally open pin of another relay is given to the phase wire of the water pump.

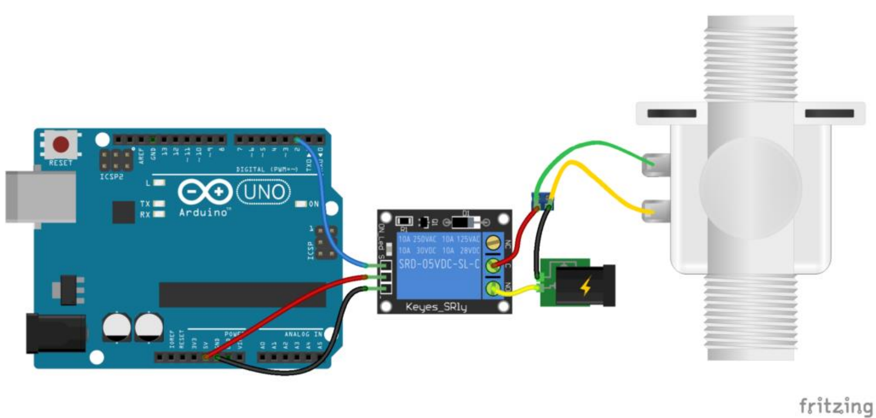

Fig4.5: Interfacing relay with solenoid valve

The following commands are given to the relay for ON and OFF

- digitalWrite(in1,LOW);

  In the above command a LOW signal is sent to the in1 pin of the relay. This makes the common of the first relay to connect to the NO pin of the first relay.

- digitalWrite(in1,HIGH);

  In the above command a HIGH signal is sent to the in1 pin of the relay. This makes the common of the first relay to connect to the NC pin of the first relay.

The NC normally close pin and common are defaultly connected. The relays used here are SPDT relays single pole double throw relay.

4.7 INTERFACING GSM MODULE WITH ARDUINO:

Global System for Mobile (GSM)consists of mainly three pins GND, TX (transmitter), RX (receiver). The communication between GSM and Arduino is through serial communication. It has several baud rates but here in this code we used 9600 as baud rate. The baud rate is configurable from 1200-115200 through AT command.This is the rate in which serial communication between Arduino and GSM takes places.

4.7.1 Steps required to interface GSM module with Arduino:

Step 1: Insert your SIM card to GSM module and lock it.
Step 2: Power up your gsm by connecting it to Arduino 5V and GND.
Step 3: Connect the Antenna.
Step 4: Now wait for some time (say 1 minute) and see the blinking rate of ‘status LED’ or ‘network LED’.

Step 5:Once the connection is established successfully, the status/network LED will blink continuously every 3 seconds. You may try making a call to the mobile number of the SIM card inside GSM module. If you hear a ring back, the gsm module has successfully established network connection.

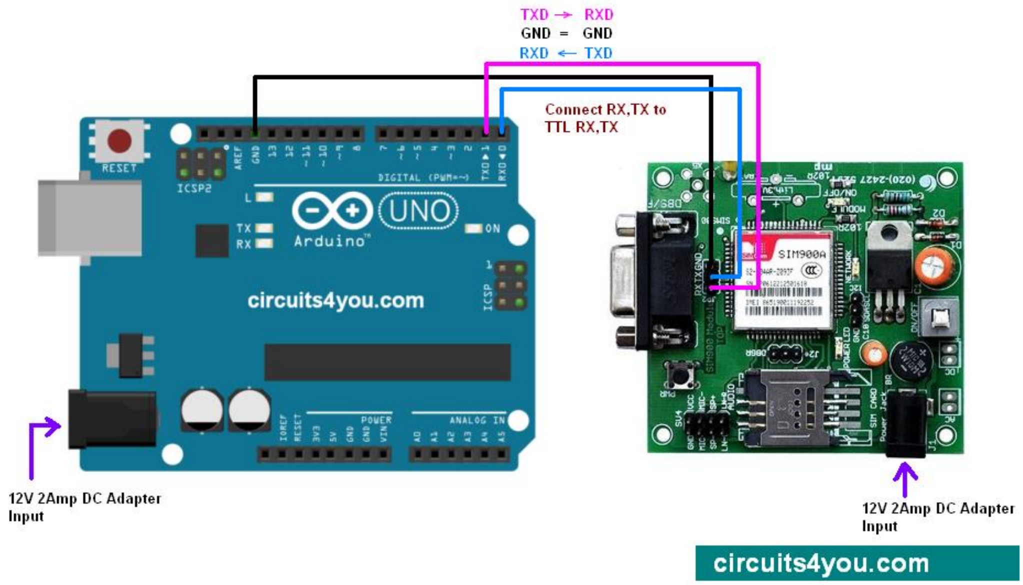

Fig 4.6: Interfacing gsm module with arduino

Step 6: Connect the GSM with arduino as shown in above figure. The TX pin of arduino should be connected with RX pin of GSM and RX pin of arduino should be connected with TX pin of GSM and GND of GSM to GSM of Arduino.

4.7.2 BASIC AT COMMANDS:

1. To change sms sending mode : AT+CMGF=1

```
mySerial.println("AT+CMGF=1");
```

2. To read SMS in text mode : AT+CNMI=2,2,0,0,0

```
mySerial.println("AT+CNMI=2,2,0,0,0");
```

3. To make a call : ATD+60XXXXXXXXX; //replace X with number you want to call, change +60 to your country code

```
mySerial.println("ATD+60XXXXXXXXX;");
```

4. To disconnect / hangupcall : ATH

```
mySerial.println("ATH");
```

5. To redial : ATDL

```
mySerial.println("ATDL");
```

6. To receive a phone call : ATA

```
mySerial.println("ATA");
```

SoftwareSerial is a library of Arduino which enables serial data communication through other digital pins of Arduino. The library replicates hardware functions and handles the task of serial communication. To be able to interface GSM module with Arduino, you will have to download this library and extract it into your Arduino's libraries.

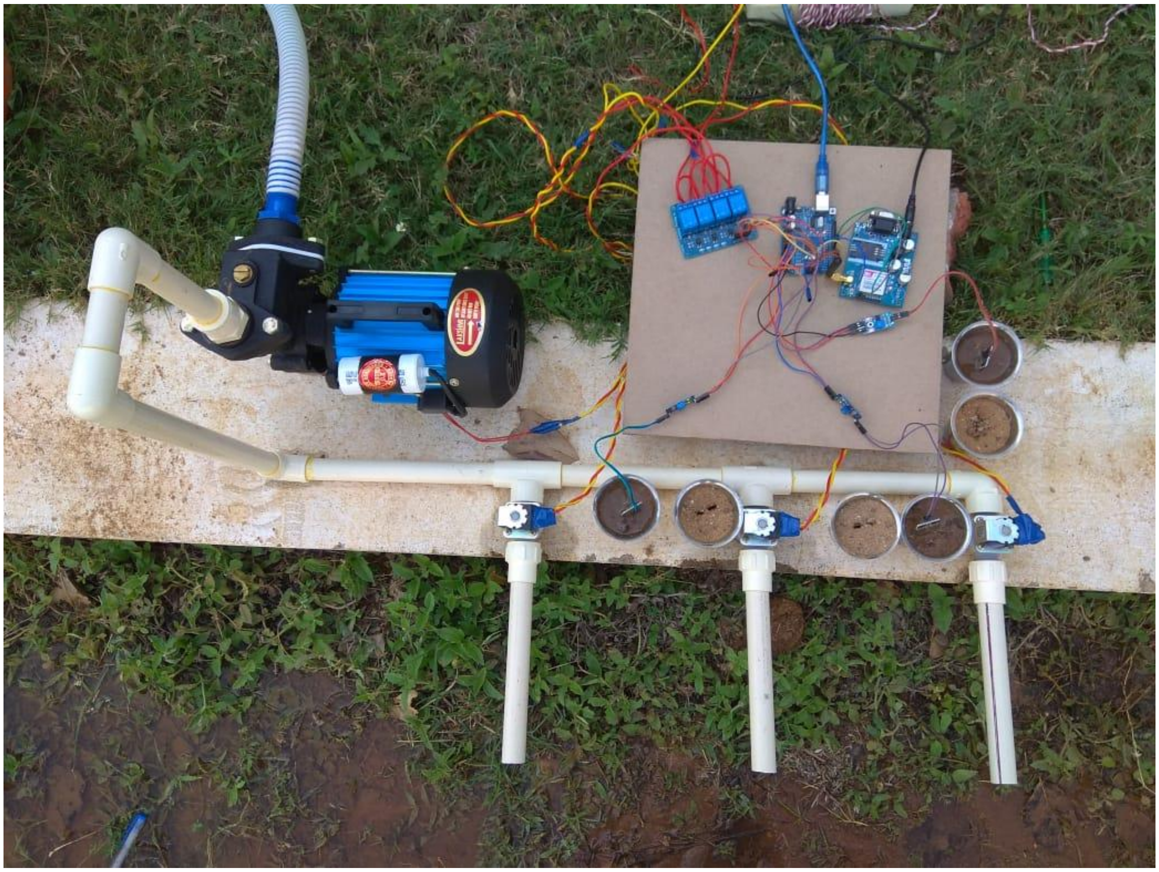

Fig4.7: Project outlook

4.8 OVERALL CODE

```
#include<SoftwareSerial.h>

SoftwareSerialmySerial(9,10);//9 Arduino RX  10 Arduino Tx

intwaterPump = 2;

intSvalve[3] = {3,4,5};

int a[6]={0,0,0,0,0,0}; //0=>true 1=>false

void setup()

{

Serial.begin(9600);
```

```
mySerial.begin(9600);

pinMode(waterPump,OUTPUT);

for(inti=0;i<3;i++)

pinMode(Svalve[i],OUTPUT);

}

void loop()

{

intmoistureRaw[3] = {analogRead(A0),analogRead(A1),analogRead(A2)};

int moisture[3] =
{map(moistureRaw[0],1023,0,100,0),map(moistureRaw[1],1023,0,100,0),
map(moistureRaw[2],1023,0,100,0)};

delay(1000);Serial.print("moisture[0] = ");

Serial.println(moisture[0]);

Serial.print("moisture[1] = ");

Serial.println(moisture[1]);

Serial.print("moisture[2] = ");

Serial.println(moisture[2]);

Serial.println(".........");

String s[6]={"SECTOR 1 WET","SECTOR 1 DRY","SECTOR 2
WET","SECTOR 2 DRY","SECTOR 3 WET","SECTOR 3 DRY"};

inti=0,j=0,b=0,c=0;

for(i=0;i<3;i++)
```

```
{
if(moisture[i]>70)
    {
digitalWrite(Svalve[i],LOW);  //LOW=>solenoid valve is OPEN
if(a[j+1]==0)
SendMessage(s[j+1]);
a[j+1]=1;
a[j]=0;
       b=1;
delay(100);
    }
if(a[j+1]==1 && a[j]==0 && moisture[i]<70 && moisture[i]>40)  //this
block is executed only after the above block & 40<moisture<70
    {
digitalWrite(Svalve[i],LOW);
       c=1;
    }
if(moisture[i]<40)
    {
      //motor OFF
if(moisture[0]<40 && moisture[1]<40 && moisture[2]<40)
```

```
    {
digitalWrite(waterPump,HIGH);
delay(5000);
    }
digitalWrite(Svalve[i],HIGH);
if(a[j]==0)
SendMessage(s[j]);
a[j]=1;
a[j+1]=0;
delay(100);
   }
 j=j+2;
}
//motor ON
if(b==1||c==1)
   {
digitalWrite(waterPump,LOW);
delay(100);
   }
}
voidSendMessage(String s)
```

```
{
mySerial.println("AT+CMGF=1");    //Sets the GSM Module in Text Mode
delay(1000);  // Delay of 1000 milli seconds or 1 second
mySerial.println("AT+CMGS=\"+916281501847\"\r"); // Replace x with mobile number
delay(1000);
mySerial.println(s);// The SMS text you want to send
delay(1000);
mySerial.println((char)26);// ASCII code of CTRL+Z
delay(1000);
}
```

CHAPTER 5

EXPERIMENTAL RESULTS

5.1 INTRODUCTION

In this chapter we shall discuss the results obtained from the project. The different samples that we had considered while testing the project. The cost estimations of the project to implement it in the real world and the possibility of reduction in the cost of the project. This also contains some sample pics of results that we had taken during the testing of our project.

5.2 RESULT

The project that has been developed by us serves the need of farmer in irrigating the farm. As it is a real world project we have used a real time 0.5hp motor and solenoid valves which operate at ac supply 230V. To indicate the farmer about the field status we have also used a GSM module which delivers the message to the farmer. For testing of our project we have considered two samples one is dry soil and other is wet sample which are shown in the below figure.

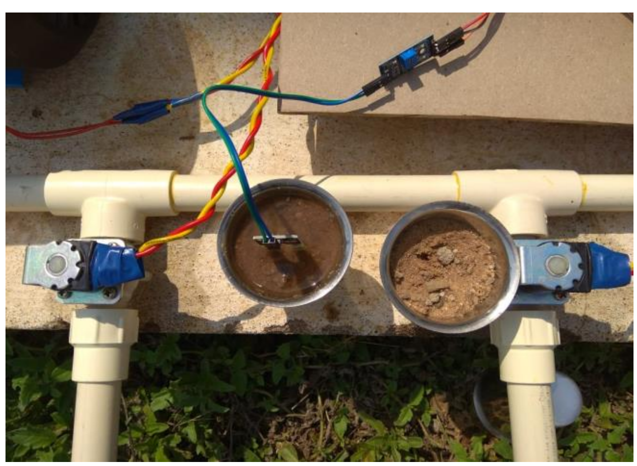

Fig 5.1: DRY and WET soil samples

If the sensor is placed in the DRY soil the moisture valve read by the sensor is greater than higher threshold value (>70) then the water should be pumped into the sector. Similarly when the soil sensor is placed in the WET sample it reads a valve lower than lower threshold value (<40) then the supply to water is stopped to the sector. For better understanding the functioning of the project we have considered the samples. Since it is fully functional it can deployed into the real time world.

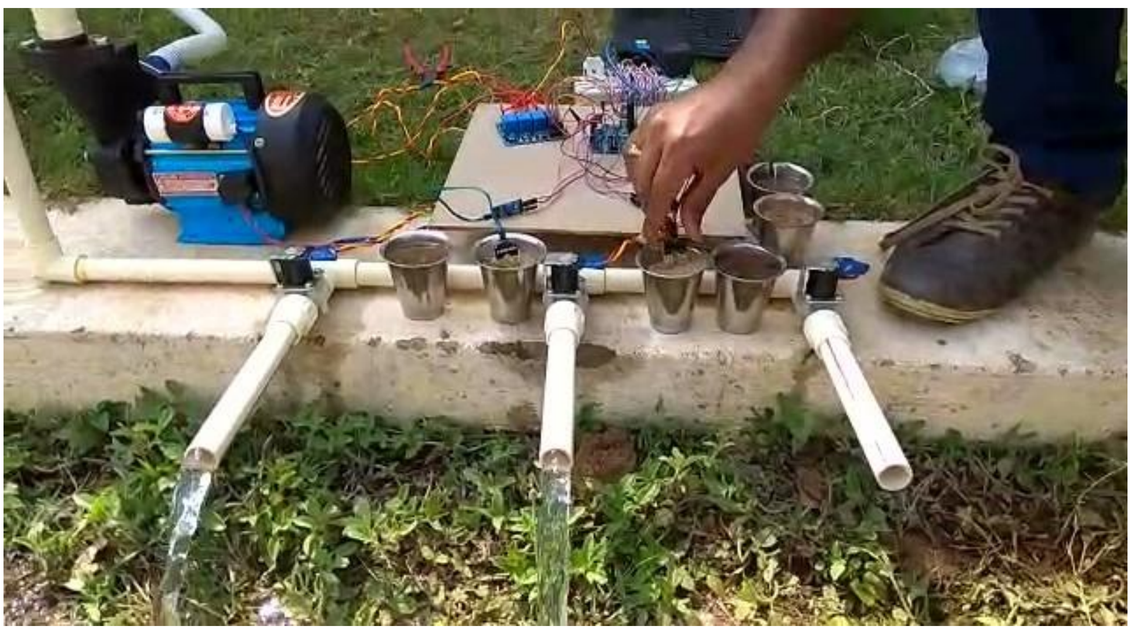

Fig 5.2: Project output

Figure 5.2 shows the result that we had obtained while testing of our project. Here we had considered three sectors. For each sector we assigned dry and wet samples. The soil moisture sensors of sector 1 and sector 2 are in DRY sample so the solenoid valves of those sectors are excited and water pump is made ON. Hence the water is coming out of the pipes associated with sectors 1 and 2. But consider the case of third sector, here the soil moisture sensor is placed in WET sample, so the solenoid valve associated with the sector 3 is not excited as the sector 3 is already in WET state.

To intimate the farmer about the field status, we have also introduced the messaging concept using GSM SIM 900A module. In this project as we are considering 3 sectors we are allocating six messages two for each sector. One DRY message and one WET message associated with the sector name (for example SECTOR 1 DRY, SECTOR 2 WET). If you consider the above case then farmer receives three messages initially as sector 1 dry, sector 2 dry and sector 3 wet. In our project the messages will be sent to the farmer only again when there is a state change like from dry to wet or from wet to dry. As the sectors 1 and 2 are supplied with water there will be a state change. The farmer receives a message again as sector 1 wet, sector 2 wet after when the desired amount of water is supplied to the those sectors. Figure 5.3 shows a sample picture of messages that farmer will get.

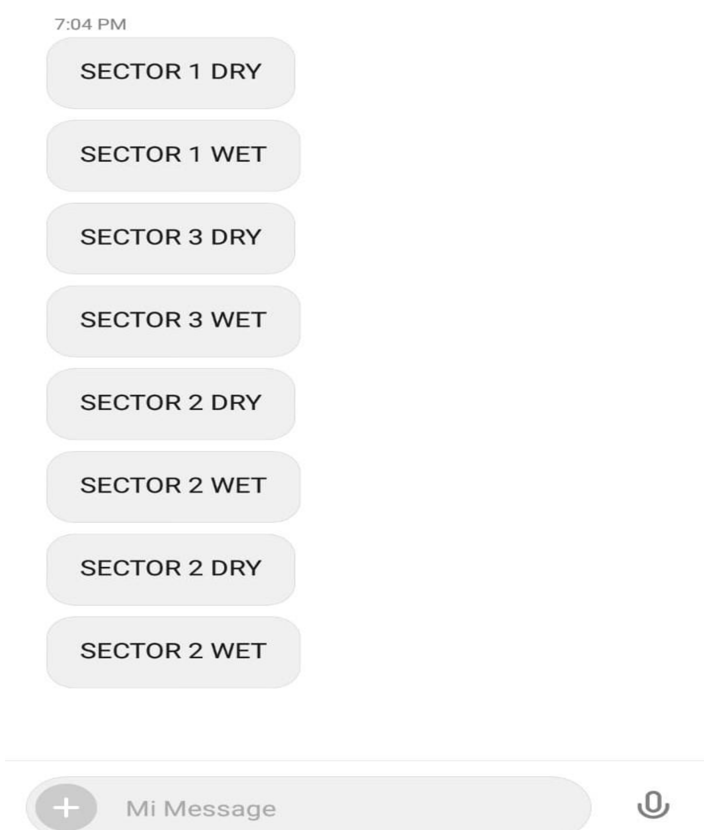

Fig 5.3: Screenshot of messages received

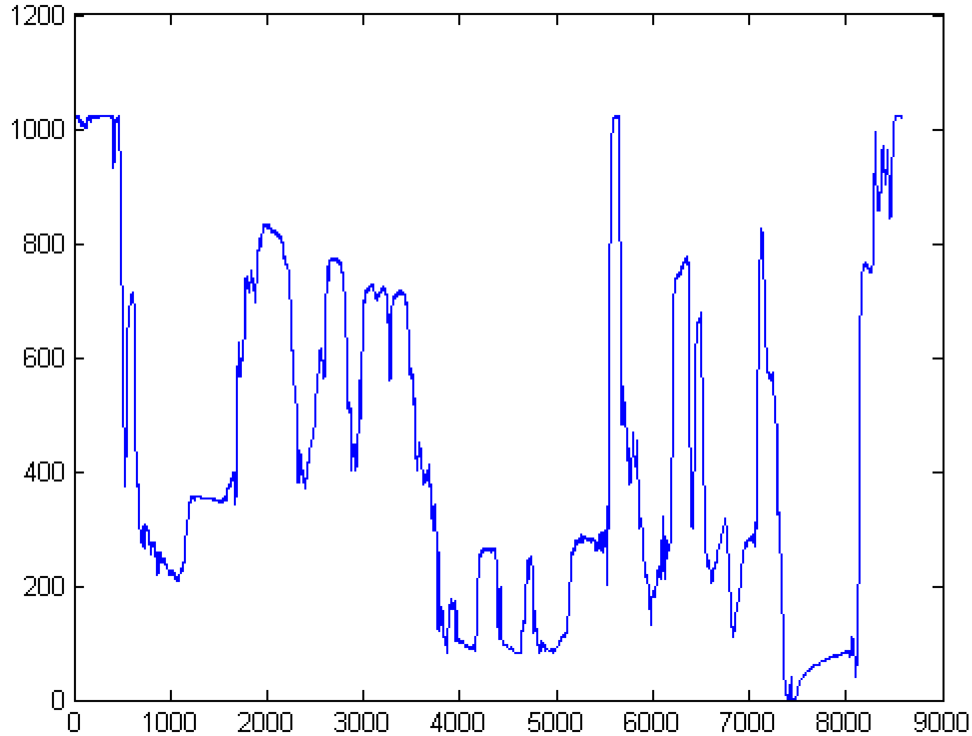

Fig 5.4: Graph between moisture values and time (ms)

Figure 5.4 is a graph drawn by taking the values of moisture sensor and time in milliseconds. The moisture sensor reads a valve of zero when placed in wet condition and 1023 value when place in the dry state. In the above graph the soil moisture sensor initially gives a value close to 1023 which means the sensor is placed in dry place. The motor is turned ON and water is supplied to the sector then the moisture valve falls below 250 (around 40 percent) then the water supply is stopped and the sector is in wet state. Now again after sometime the sensor reaches a value around 800 (around 70 percent) then the motor gets turned ON and water is supplied to the sector.

The water is supplied to the sector again the moisture valve reaches to around 100 value and again after some time the sensor reaches dry and again wet. Likewise it repeats until eight seconds and finally the sensor turn dry again. All the above mentioned are test cases here we had manually switched the sensor from the wet to dry and again dry to wet condition. We had noted down the readings given by Arduino software and the time for one sector and we had plotted the graph using online tools. By using IOT one can easily obtain the graphs in the thing speak website. It maps the soil sensor values with the time and produces a graph. We had included it in the future scope. As an interface can be developed through which the field status can be monitored without any difficulty and using of a GSM module requires a good signal strength which is always not possible.

Most of the today devices are mostly connected to internet. Internet is a widely available source of communication. Making the filed status available on it makes it very much crucial for future sustainment of the project. A web page can be created with which one can access about what is happening in the farm. The use of wireless sensors with replacement of wired sensors is also important as long wires cannot be travelled from every plant to Arduino.

5.3 LARGE SCALE APPLICATION

The project that was developed by us consists of only three sector but for large scale application we require large number of sectors. Consider a hector of land its length is 100m and width is 100m. Consider the concept of drip irrigation this can be achieved by using our project by just modifying the outlet pipe of each sector. Holes were deployed to each outlet pipe at the location of the plant in the sector. Now consider there will be two plant rows in a meter length of 1 hectare field. This means there will be two hundred rows of plants in one field each associated with a solenoid valve and an outlet. Each sector is associated with 2 sensors then we require 400 sensors for each hectare.

A single GSM module can be used to deliver all the messages of any number of sectors and any number of messages. All this can be done by just simply modifying the code (adding new messages to the array message block). Since the number of sectors are more we need an efficient microcontroller which can accommodate more number of sensors. This results going to other Arduino microcontroller boards. The table 5.1 shows a list of Arduino boards and their specifications.

Table 5.1: Comparison between different Arduino boards

Arduino Board	Processor	Memory	Digital I/O	Analogue I/O
Arduino Uno	16Mhz ATmega328	2KB SRAM, 32KB flash	14	6 input, 0 output
Arduino Due	84MHz AT91SAM3X8E	96KB SRAM, 512KB flash	54	12 input, 2 output
Arduino Mega	16MHz ATmega2560	8KB SRAM, 256KB flash	54	16 input, 0 output
Arduino Leonardo	16MHz ATmega32u4	2.5KB SRAM, 32KB flash	20	12 input, 0 output

Arduino have a maximum of 14 analog pins means we can have a maximum of 14 different sectors. To have more than 14 sectors to be controller by a single controller we need Arduino i2c expander.

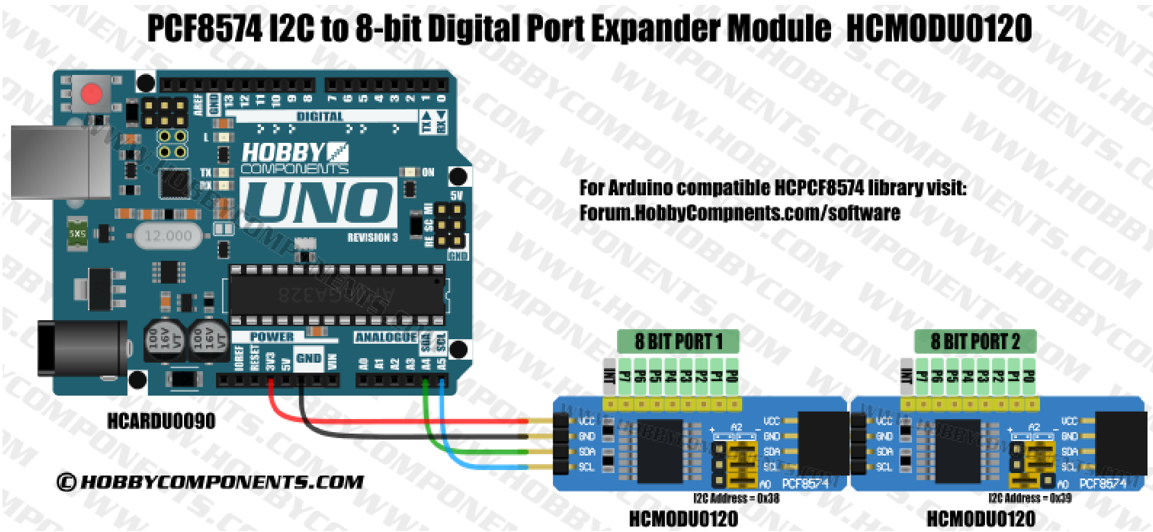

Fig 5.5: Arduino i2c expander connecting to Arduino

5.4 MATHEMATICAL ANALYSIS REQUIRED FOR FUTURE SCOPE TO INCREASE SENSORS

The problem in this project is accuracy. Here we are associating a single sensor for each sector. If we consider a farm land of one hectare (length 100m & width 100m), we assume that every sector is of length 0.5m and width 100m. Now placing a single sensor at a single plant will cover the entire sector area. Moreover, if the placed single sensor is in wet place but remaining part of the sector is in dry state. Now this leads to a mismatch of our intension to design the project. This leads to the problem of accuracy which makes the system unfit for real world application.

The use of multiple sensors is the only solution the above mentioned problem. So now let us do some mathematical analysis and derive a table so that we can come to a conclusion that how many sensors are minimum required to get desired output even if a single sensor fails for one hectare. For more than one hectare the valves in the table can be taken as a reference. If suppose a case like non-working of a sensor arises then the data will not considered by the Arduino board. For multiple sensors the concept of averaging of all the valves comes into picture.

In this analysis we are taking dry condition (>70) and wet condition (<40). The range between 40 and 70 is taken as desired range.

Consider a sensor reading (defective) as 30 and other sensor reading (accurate) as 80. Now we have to get a desired valve of 80 as it is the accurate valve. Here we assume that we can accept a five percentage of error in calculation.

Consider 2 sensors 1 defective and 1 accurate.

The average value = 80+30/2 = 55 (<70) wrong reading.

Therefore a single sensor is not sufficient to compensate a defective reading of one sensor.

Consider 5 sensors 1 defective and 4 accurate.

The average value = 4*80+30/2 = 70

The above reading gives the correct state dry but it is not in the range of 5% error.

Consider 10 sensors 1 defective and 9 accurate.

The average value = 9*80+30/2 = 75

The above reading gives the correct state dry and it is in the range of 5% error. So a minimum of 10 sensors are required to have correct output if single sensor is not working.

Suppose if we take worst case such as defective sensor reads 0 and accurate sensor reads 70 then if we consider 10 sensors then

Average valve = 9*70+0/10 = 63

The above value is not in the five percent error range. Suppose if we consider 15 sensors 14 accurate and one defective then

Average value = 14*70+0/15 = 65.3

The above valve is in the range of 5 percent error range which is acceptable. So we suggest to use 15 sensors per sector for better accuracy.

Table 5.2: Minimum number of sensors required

Defective range	**No. of sensors required**
50	10
60	13
70	15

5.5 COST ESTIMATION FOR A COMPLETE REAL WORLD MODEL

Cost estimation is an important factor which determines whether this project can be implemented in real time or not. The complete real time model cost can be estimated using the basic block of project that we have done.

Our project model costs around Rs 8000 to construct which includes Arduino board which costs Rs 500, soil moisture sensor Rs 100, GSM module Rs 1250, water pump Rs 2800, relay module Rs 250 and solenoid valve Rs 300. For the real world implementation of the project a single Arduino board, GSM module, water pump are sufficient to perform the controlling, message sending and supplying water. The soil moisture sensors, solenoid valves and relay modules are required in multiple number. The number of components depends on the accuracy in performing irrigation required by the farmer.

Table 5.3: Cost estimation for a real world model

Parameter: Land length	**No. of soil moisture sensors**	**No. of solenoid valves required**	**No. of relays required**	**Cost of Arduino, GSM &waterpump**	**Total cost of real world model**
0.5 meter	2	1	1	-	Rs 460
100 meter (1 hectare area)	400	200	200	Rs 4000	Rs 1,14,000

Hence total cost of the final real world product will be around one lakh twenty thousand rupees. However, given the governments support to upcoming industries and also various subsidies provided by them, we can expect a subsidy on the cost up to 50 percent. Hence we can expect the cost would be around Rs 50,000. For smaller farmers the cost will be subsequently lower, since the core cost of the project is only around Rs 460. Once the product is produced on mass scale, we can expect the prices to dip even lower.

5.6 CONCLUSION

Thus we have successfully shown the result of our project with necessary figures. We have also given a clear picture of implementing the project in the real world, about the cost of each individual component and the total cost that would be requiring for the project to implement it on a large scale. We have also suggested some of the subsidies provided by the government and production on a large scale would eventually reduce the cost

CHAPTER 6

CONCLUSION AND FUTURE SCOPE

6.1 APPLICATIONS:

6.1.1AGRICULTURE PURPOSES

1. In agriculture the major work for a farmer is irrigation. By using the above project one can perform irrigation without the farmer intervention. It cuts the efforts being put by the farmer for irrigation.
2. The proposed is suitable for any type of irrigation.
3. Polyculture where a farm consist of different varieties of plants. We can irrigate different type of plants differently depending on the requirement of the plants.

6.1.2 HOUSEHOLD PURPOSES

The idea of automatic stop of supply of water in this project can be used in water purifiers to control the amount of water intake by the purifier to purify and also to control the motor used to lift underground water and send it to overhead tank. Once the tank reaches full automatically the motor switches OFF.

6.1.3 INDUSTRIAL PURPOSES

In industries by using this technology we can control the amount of liquid entering a boiler. This is really useful where human cannot monitor the boiler and harmful liquids.

6.1.4 GARDENS

Gardens usually consist of a large number and different varieties of plants. Different plants need different irrigation practices. So by using this project we can perform irrigation to various varieties of plants differently autonomously without any human.

6.1.5 PETROL STATIONS

In petrol station during pumping the petrol into a vehicle tank in the present technology whether tank is full or not is accurately not known but by using this project we can stop the pumping action immediately when the sensor detects the tank is full.

6.2 ADVANTAGES

1. Reduce human effort in irrigation.
2. Effective utilization of water resources.
3. Supplying the required amount of water to plant (Not high or low).
4. Converting irrigation from manual to autonomous work.
5. Effective utilization of electricity.
6. Performing irrigation based on sudden changes in environment & natural calamities.
7. Problems of over-irrigation and under- irrigation are reduced.
8. Farmers can use the time required for irrigation in other work.

6.3 DIS-ADVANTAGES

1. Initial cost of the real time implementation of the project is high.
2. Any failure or disturbance at the sensor leads to the loss of plants of the sector.
3. For GSM to work properly we require good signal strength.
4. Continuous supply power is required.

6.4 CONCLUSION

The project developed on automatic irrigation system in real time is to help farmers to reduce their efforts in irrigation. The main motivation of this project is farmer should go to the farm one is for planting seeds and other is for harvesting.

The project helps the farmers to irrigate their without any effort. They could use this time effectively on some other work besides having knowledge about their field status. This project is fully operational and can be implemented on a large scale. This project reduces the human effort and reduces the wastage of water. Depending on the weather conditions the project can automatically adjust the water that should be supplied for each sector. This project can be suitably used for any type of irrigation. Fertilizers required for plants can also supplied by dissolving them in the tank. Since it uses a range of threshold valves instead of single threshold valve this prevents continuous toggling of motor between ON and OFF. The soil moisture values are on scale 0 to 100. The complete farm is divided into sectors which is the basic concept to implement an automatic irrigation in a real world. The cost of the project is also economical in the initial stage which makes it to have every possibility of implementing in real world. The code is an efficient one making it expandable to any number of sectors and using only one single function to send any number of messages through GSM.

On large scale implementation with hopeful subsidy from the government, we can deliver this model to farmers at a very low price, thus reducing the momentary burden on them too.

6.5 FUTURE EXTENSIONS

1. Wired moisture sensors can be replaced with wireless moisture sensors. These sensors send the data to Arduino wirelessly so that long wires from sector to Arduino can be eliminated and attenuation of sensed value can be reduced during transmission.

Fig 6.1: Wireless soil moisture sensor

2. A platform like IOT can be implemented using which entire farm can be given as a pictorial view for the farmer when he visit a website. The data whether the sector dry or wet can be indicated with colors and the sensed values can be updated to website.

3. For high end applications solenoid valves can be replaced by manifolds. The manifolds can have inlet and outlet pipes greater than 1 inch.

Fig 6.2: Manifold

4. A single sensor for each sector can be replaced with multiple sensors in each sector. An average value of all the data's sent by the sensors can be calculated which gives an accurate value.

5. The design of outlet pipe can be changed for different type of irrigational practices.