A Mini Project Report

On

SOLAR POWERED SMART IRRIGATION SYSTEM

Submitted in partial fulfilment of the

Requirements for the award of the degree of

Bachelor of Technology

In

Computer Science and Engineering

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ANURAG GROUP OF INSTITUTIONS

(Formerly CVSR College of Engineering)

(An Autonomous Institution, Approved by AICTE and NBA Accredited)

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(2017-2021)

CERTIFICATE

This is to certify that the project entitled **"Solar Powered Smart Irrigation System"** being submitted by **Anisha Arya** bearing the Hall Ticket number **17H61A0501** and **B V Jhansi Saketa** bearing the Hall Ticket number **17H61A0504** and **A Sarika** bearing the Hall Ticket number **17H61A0543** in partial fulfilment of the requirements for the award of the degree of the **Bachelor of Technology** in **Computer Science and Engineering** to **Anurag Group of Institutions (Formerly CVSR College of Engineering)** is a record of bonafide work carried out by them under my guidance and supervision from July 2020 to March 2021.

The results presented in this project have been verified and found to be satisfactory. The results embodied in this project report have not been submitted to any other University for the award of any other degree or diploma.

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DECLARATION

We hereby declare that the project work entitled "**Solar Powered Smart Irrigation System** " submitted to the **Anurag Group of Institutions(Formerly CVSR College of Engineering)** in partial fulfilment of the requirements for the award of the degree of **Bachelor of Technology (B.Tech)** in Computer Science and Engineering is a record of an original work done by us under the guidance of **Mr. M Ravi Kishore, Assistant Professor** and this project work has not been submitted to any other university for the award of any other degree or diploma.

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ABSTRACT

In the field of agriculture, use of proper methods of irrigation is important because the main reason is the lack of rains; scarcity of land reservoir water. The continuous extraction of water from earth is reducing the water level due to which a lot of land is coming slowly in the zones of un-irrigated land. Another very important reason for this is due to unplanned use of water due to which a significant amount of water goes waste. For this purpose; we use this automatic plant irrigation system. The system derives power from solar energy through photovoltaic cells. Hence, dependency on erratic commercial power is not required. In this project we use solar energy which is used to operate the irrigation pump. Two stiff copper wires are inserted in the soil to sense whether the soil is wet or dry. The Arduino board is used to control the whole system by monitoring the sensors and when sensors sense the dry condition of soil, then the Arduino board will send a message to the mobile application. The user should send a message “ON” to Arduino to switch on the motor, then the Arduino board will send a command to relay which is used to switch on the motor and it will switch off the motor when the soil is in wet condition. The Arduino board does the above job as it receives the signal from the sensors through the output of the comparator, and these signals operate under the control of software which is stored in the ROM of the Arduino.

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In the field of agriculture, use of proper methods of irrigation is important because the main reason is the lack of rains; scarcity of land reservoir water. The continuous extraction of water from earth is reducing the water level due to which a lot of land is coming slowly in the zones of un-irrigated land. Another very important reason for this is due to unplanned use of water due to which a significant amount of water goes waste. For this purpose; we use this automatic plant irrigation system. The system derives power from solar energy through photovoltaic cells. Hence, dependency on erratic commercial power is not required.

1.1 Motivation

In India, agriculture is the most important occupation of the people. More than 60% of our total population depends for their subsistence on agriculture. After independence due to various development projects introduced in the field of agriculture, production of food grains has been continuously increasing. The entire Indian economy depends on agriculture. Any fluctuation in agriculture income will directly affect India's national income. In this regard, a thought is given to develop a Solar Powered Smart Irrigation System .

No irrigation is normally required if the total annual rainfall is 100cms or more and takes place at correct times. When it is proposed to grow valuation and better types of crops like Rice, Sugar cane, Vegetables, Cotton etc. Irrigation is very essential by implementing this kind of monitoring and control systems for the agriculture purpose, each and every field can be automated. However in this project work Arduino is used just as a controller in controlling the relay to operate the pumping motor.

In this project one relay is used and is connected at the output of the controller, which energizes or de-energizes automatically according to the received information from the copper electrodes.

Nowadays the availability of power and water is insufficient to fulfill the farmer’s needs. The demand for power is rising faster than the demand can be met (power crisis). As the need increases, power saving actions of every one will make a significant difference. Hence, solar energy can be a great alternative for traditional batteries.

1.2 Problem Definition

Agriculture is the major source of income for the largest population in India and is a major contributor to Indian economy. However, technological involvement and its Usability have to be grown still and cultivated for the agro sector in India. Although few initiatives have also been taken by the Indian Government for providing online and mobile messaging services to farmers related to agricultural queries and agro vendor's information to farmers. Based on the survey it is observed that agriculture contributes 27% to GDP, and Provides employment to 70% of Indian population.

Agriculture is the backbone of Indian Economy. In today's world, as we see rapid growth in global population, agriculture becomes more important to meet the needs of the human race. However, agriculture requires irrigation and with every year we have more water consumption than rainfall, it becomes critical for growers to find ways to conserve water while still achieving the highest yield. But in the present era, the farmers have been using irrigation techniques through manual control in which they irrigate the land at the regular interval.

According to statistics, agriculture uses 85% of available freshwater resources worldwide, and this percentage will continue to be dominant in water consumption because of population growth and increased food demand. There is an urgent need to create strategies based on science and technology for sustainable use of water, including technical, agronomic, managerial and institutional improvements. Agricultural irrigation based on Internet technology is based on crop water requirement rules. By using Internet technology and sensor network technology we can control water wastage and to maximize the scientific technologies in irrigation methods. Hence it can greatly improve the utilization of water and can increase water productivity.

1.3 Objective of the Project

The main objective of this project is to provide an automatic irrigation system thereby saving electricity, time, money & power of the farmer. The traditional farm-land irrigation techniques require manual intervention.

The objectives of this project include following:

1.3.1 Ease of Farming:

Using Solar Powered Smart Irrigation System, we can achieve ease of farming by notifying the farmer about the soil moisture in a mobile app and operating the motor by one touch using a mobile application. It helps to make watering simple. In traditional approach, the farmer should always monitor or check the plant and water whereas here we can operate by one touch. The sensors or electrodes check the moisture in soil and the Arduino will control the motor using a relay switch. Therefore, using IoT we are achieving Ease of Farm.

1.3.2 Saving Electricity:

Electricity is most important for farmers for irrigation purposes. Huge amount of electricity is required. For continuous generation of electricity, we have to use generators and large amounts of fuels to run it. But in our project, we are using completely green energy. Solar energy is the main source to supply power for our system. This can generate the power in day time, store the electricity and use it for night as well. This can save large amounts of electricity.

1.3.3 Low Cost

This system is affordable for all the farmers. Every farmer can buy the system and use it in the farms for irrigation. This system can also reduce all other costs like for electricity. Since we are using solar energy, it can help the farmers to not to spend more on electricity and man power.

2. LITERATURE SURVEY

[1] In Sensor based Automated Irrigation System with IOT mentioned about using sensor based irrigation in which the irrigation will take place whenever there is a change in temperature and humidity of the surroundings. The flow of water is managed by a solenoid valve. The opening and closing of the valve is done when a signal is sent through a microcontroller. The water to the root of the plant is done drop by drop using a rain gun and when the moisture level again becomes normal then the sensor senses it and sends a signal to the microcontroller and the value is then closed. The two mobile phones are connected using GSM. The GSM and microcontroller are connected using MAX232. When moisture of the soil becomes low moisture sensor senses it and sends a signal to microcontroller, then the microcontroller gives the signal to mobile and it activates the buzzer. This buzzer indicates that the valve needs to be opened by pressing the button in the called function signals are sent back to the microcontroller. Microcontrollers used can increase System Life and lower the power Consumption. Their system is just limited to the automation of irrigation systems and lacks extraordinary features.

[2] In Automated Irrigation System Using a Wireless Sensor Network and GPRS Module mentioned about using automatic irrigation system in which irrigation will take place by wireless sensor units (WSUs) and a wireless information unit (WIU), linked by radio transceivers that allowed the transfer of soil moisture and temperature data, implementing a WSN that uses ZigBee technology. It takes a measure of temperature and moisture using a sensor and is controlled by a microcontroller. The WIU has also a GPRS module to transmit the data to a web server via the public mobile network. The information can be remotely monitored online through a graphical application through Internet access devices. This irrigation system allows cultivation in places with water scarcity thereby improving sustainability and it is a feasible system. But due to Zigbee protocol this system becomes more costly.

[3] In Wireless Sensor Network based Remote Irrigation Control System and Automation using DTMF code mentioned about using automated irrigation systems for

proper yield and handled remotely for farmer safety. Wireless sensor network and Embedded based technique of DTMF (Dual Tone Multiple Frequency) signaling to control water flow for sectored, sprinkler or drip section irrigation. Circuit switching instead of packet switching used by SMS controlled devices available currently in the market. The farmer can use his cell phone or landline phone for the purpose of starting and controlling the irrigation and the pesticide spraying, just by dialing and sending the DTMF commands over the GSM network. This system will be very economical in terms of the hardware cost, power consumption and call charges. Farmers have to control (on/off) the valves time to time (even at night) which increases the running cost because every time we have to make a call to on or off the valves and it is also very inconvenient. Farmers are unable to know the status of power supply at the field.

[4] Wireless Sensor Network Based Automated Irrigation and Crop Field Monitoring System mentioned about using wireless sensor network based automated irrigation systems for optimizing water use for agricultural purposes. The system consists of a distributed wireless sensor network of soil moisture, and temperature sensors placed in the crop field. To handle the sensor information Zig bee protocol used and control the water quantity programming using an algorithm with threshold values of the sensors to a microcontroller for irrigation systems. The system continuously displays the abnormal condition of the land (soil moisture, temperature level). Using a GSM modem with GPRS facility feature provides the information to farmers and interfaces with PIC 18F77 A microcontroller. The Irrigation system is automatic and manual mode. This system increases the crop fields, improves the crop quality, increases the energy and reduces the non-point source pollution.Due to PIC microcontroller the length of the program will be big because of using RISC (35 instructions).

3. ANALYSIS

3.1 Existing System

In the case of traditional irrigation systems irrigation is done manually by farmers. Since, the water is irrigated directly in the land, plants undergo high stress from variation in soil moisture, and therefore plant appearance is reduced. The absence of automatic control of the system results in an improper water control system. The major reason for these limitations is the growth of population which is increasing at a faster rate. At present there is an emerging global water crisis where managing scarcity of water has become a serious job. This growth can be seen in countries which have shortage of water resources and are economically poor. So this is a serious problem in the Traditional Irrigation System.

Limitations of existing system:

- Physical work of farmer to control drip irrigation
- Wastage of water
- Wastage of time

As water sits in irrigation channels malarial mosquitoes can breed.

3.2 Proposed System

In this project we use solar energy which is used to operate the irrigation pump. Two stiff copper wires are inserted in the soil to sense whether the soil is wet or dry. The Arduino board is used to control the whole system by monitoring the sensors and when sensors sense the dry condition of soil, then the Arduino board will send a message to the mobile application. The user should send a message “ON” to Arduino to switch on the motor, then the Arduino board will send a command to relay which is used to switch on the motor and it will switch off the motor when the soil is in wet condition. The Arduino board does the above job as it receives the signal from the sensors through the output of the comparator, and these signals operate under the control of software which is stored in the ROM of the Arduino.

3.3 Software Requirements Specification

3.3.1 Purpose

Places that have sparse or seasonal rainfall could not sustain agriculture without irrigation. In areas that have irregular precipitation, Irrigation improves crop growth and quality. By allowing farmers to grow crops on a consistent schedule, Irrigation also creates more reliable food supplies. Earlier India enjoyed abundant water resources. But now population growth and overexploitation has led to a situation where there is demand for water. Water percentage is reducing year by year. If the rate continues it leads to water scarcity. So there is an emergency to conserve water. The reason behind this shortage of water is using a traditional system of irrigation. During traditional systems the requirement of water to plants is not monitored properly When the soil is moist enough water is still provided to plants. This excess amount of water is not absorbed by the plants and is wasted thus. To monitor the water requirement of the plants a system is needed. Implementing smart irrigation helps to decrease the loss of water caused by using traditional systems.

3.3.2 Scope

This system can be the more intelligent system which predicts user actions, nutrient level of the plants, time to harvest, etc. With using Machine Learning algorithms more advancement can be made in the future which will help farmers a lot and water consumption can also be reduced in agriculture. We can interface LCD screens in order to display the current status of the soil moisture content levels, percentage of water utilized to water the plant, duration of time for which the water pump is ON, etc. We can also show the graphical representation of the moisture content levels in the soil. To improve the efficiency and effectiveness of the system, the following recommendations can be put into consideration. Option of controlling the water pump can be given to the farmer. The farmer may choose to stop the growth of crops or the crops may get damaged due to adverse weather conditions. In such cases farmers may need to stop the system remotely.The idea of using IOT for irrigation can be extended further to other activities in farming such as cattle management, fire detection and climate control. This would minimize human intervention in farming activities.

3.3.3 Overall Description

Smart irrigation systems offer a variety of advantages over traditional irrigation systems. Smart irrigation systems can optimize water levels based on things such as soil moisture and weather predictions. This is done with wireless moisture sensors that communicate with the smart irrigation controls and help inform the system whether or not the landscape is in need of water.

Additionally, the smart irrigation control receives local weather data that can help it determine when a landscape should be watered. If you have ever returned home during a storm only to see your sprinklers spraying water you know how beneficial this is. Rather than wasting water resources and your valuable money on watering your landscape you can take advantage of the natural moisture from the storm and save that water for another day when it is more needed. The advantages of these smart irrigation systems are wide reaching. The smart irrigation system will help you have better control of your landscape and irrigation needs as well as peace of mind that the smart system can make decisions independently if you are away. You will save a significant amount of money on your water bills because through intelligent control and automation, your smart irrigation system will optimize resources so that everything gets what it needs without needless waste. Additionally, we have all seen many places in the country that have experienced droughts and we know that our water resources are precious.

With smart irrigation systems we can be better stewards of our resources which is better for the environment. The opportunity to save dramatically, have better control and be more eco-friendly while maintaining a lush and beautiful landscape are just a few of the advantages a smart irrigation system provides and would make a wonderful addition to any home. The primary disadvantage associated with smart irrigation is the expense. These systems can be quite costly depending on the size of the property. Furthermore, portions of the lawn will have to be dug up to install pipework and attach it to the plumbing system of the home. This can equate to days or weeks without use of the yard. Afterward, the landscaping will have to be repaired.

Even the most efficient smart systems can have their pitfalls. Wind can wreak havoc on sprinklers, directing water in the wrong direction. Underground pests may damage water-delivery systems, resulting in water pooling or broken parts. The repairs to fix an irrigation system can be much more costly than replacing a damaged garden hose.

4. DESIGN

4.1 CLASS DIAGRAM

Class diagrams are the main building blocks of every object-oriented method. The class diagram can be used to show the classes, relationships, interface, association, and collaboration. UML is standardized in class diagrams. Since classes are the building block of an application that is based on OOPs, so as the class diagram has appropriate structure to represent the classes, inheritance, relationships, and everything that OOPs have in its context. It describes various kinds of objects and the static relationship in between them.

Figure 1 shows the Class Diagram of our model; you can see Sensor, Arduino, Power, Mobile Application, Relay, MotorOnOff classes with their attributes, operations and flow of the execution of the code.

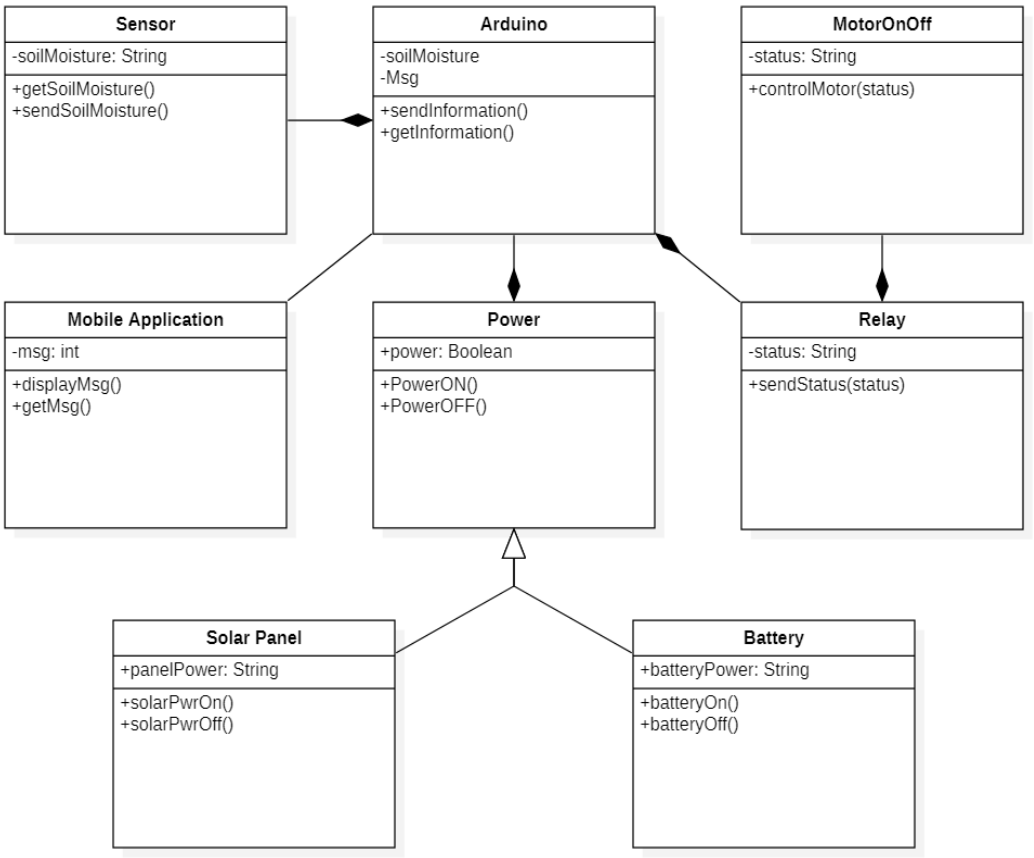

Figure 1 - Class Diagram

4.2 USE CASE DIAGRAM

Use case diagram is the primary form of system/software requirements for a new software program underdeveloped. Use cases specify the expected behaviour (what), and not the exact method of making it happen (how). Use cases once specified can be denoted both textual and visual representation (i.e. use case diagram). A key concept of use case modeling is that it helps us design a system from the end user's perspective. It is an effective technique for communicating system behaviour in the user's terms by specifying all externally visible system behaviour.

Figure 2 shows the use case Diagram of our model. In our implementation, there are 4 main actors “User”, “Arduino”, “Soil Moisture” and “Smart Plant”. This UML diagram depicts the course of actions between the system and actors.

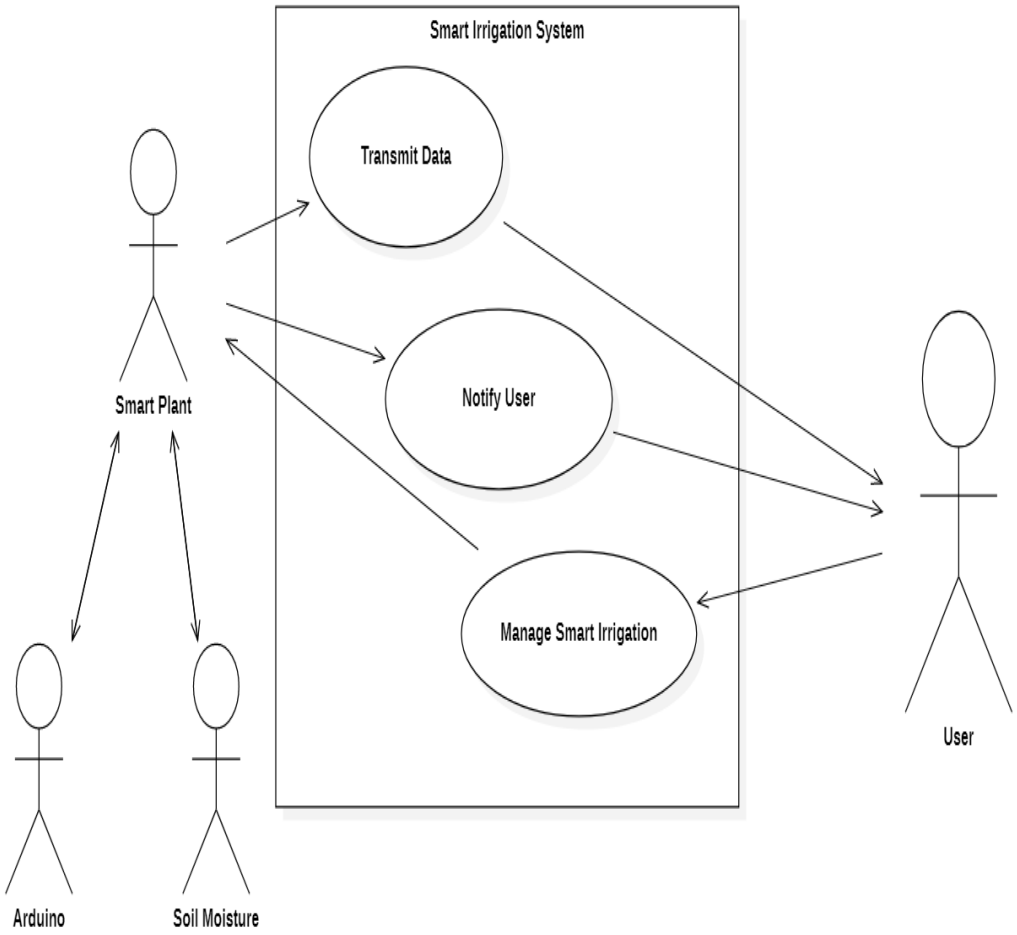

Figure 2 - User Case Diagram

4.3 SEQUENCE DIAGRAM

A sequence diagram simply depicts interaction between objects in a sequential order i.e. the order in which these interactions take place. We can also use the terms event diagrams or event scenarios to refer to a sequence diagram. Sequence diagrams describe how and in what order the objects in a system function. These diagrams are widely used by businessmen and software developers to document and understand requirements for new and existing systems.

Figure 3 shows the Sequence Diagram of our model. In our implementation, there are some sequences of actions, which we have represented in the below diagram.

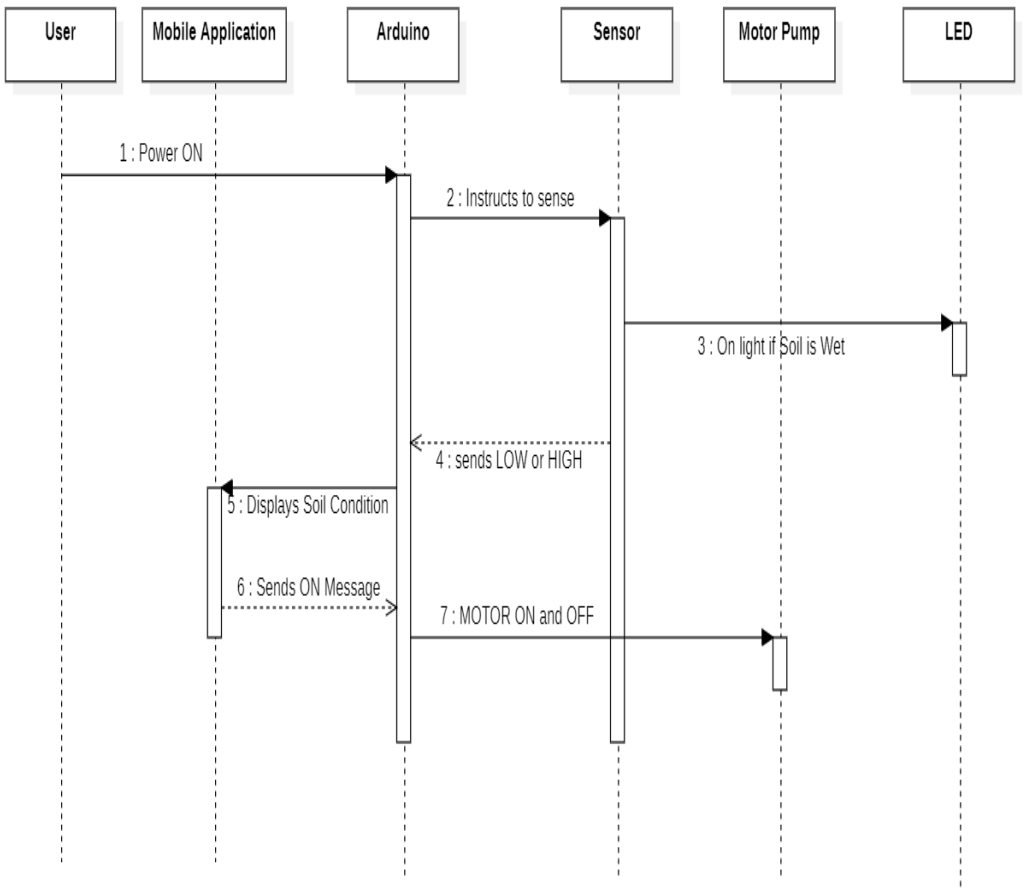

Figure 3 - Sequence Diagram

4.4 ACTIVITY DIAGRAM

Activity diagram is basically a flowchart to represent the flow from one activity to another activity. The activity can be described as an operation of the system.

The control flow is drawn from one operation to another. This flow can be sequential, branched, or concurrent.

Activity diagrams deal with all types of flow control by using different elements such as fork, join, etc. The basic purpose of activity diagrams is similar to the other four diagrams. It captures the dynamic behaviour of the system. Other four diagrams are used to show the message flow from one object to another but activity diagram is used to show message flow from one activity to another.

Activity is a particular operation of the system. Activity diagrams are not only used for visualizing the dynamic nature of a system, but they are also used to construct the executable system by using forward and reverse engineering techniques. The only missing thing in the activity diagram is the message part.

Figure 4 shows the Activity Diagram of our model. In the below activity diagram, there is an initial state and a final state. Our implementation follows the above activity steps.

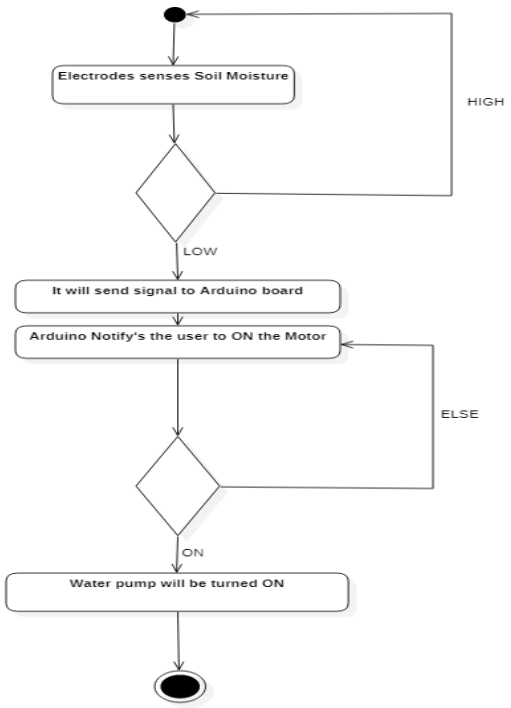

Figure 4 - Activity Diagram

5. IMPLEMENTATION

5.1 Modules

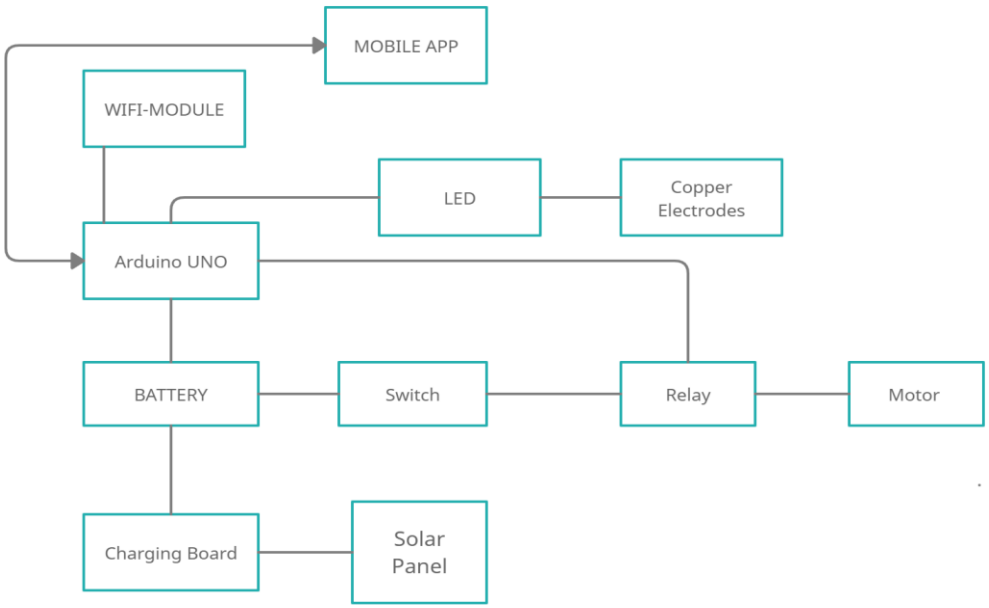

Figure 5 - Project Architecture

Figure 5 shows the Project Architecture. In this project, we used two electrodes. One electrode is fed with +5V DC and the other electrode is used for indicating the sensitivity of the soil to the Arduino board. When the soil is completely dry, the electrode will be in open circuit condition. Since water is a conductor of electricity, whenever the soil comes to wet condition, it makes continuity between the conductors (electrodes) and a logic high signal will be received by the Arduino board if the soil is in wet condition. If the soil is dry a logic low signal will be received by the Arduino board by which the Arduino board controls the pumping motor. The output of soil sensing electrode is fed to the Arduino board and according to the high/low signals from the electrode, the Arduino board energizes or de-energizes the water pumping motor relay accordingly.

The Arduino board is used to control the whole system by monitoring the sensors and when sensors sense the dry condition of soil, and then the Arduino board will send a message to the mobile application. The user should send a message “ON” to Arduino to

switch on the motor, then the Arduino board will send a command to relay which is used to switch on the motor and it will switch off the motor when the soil is in wet condition. The Arduino board does the above job as it receives the signal from the sensors through the output of the comparator, and these signals operate under the control of software which is stored in the ROM of the Arduino.

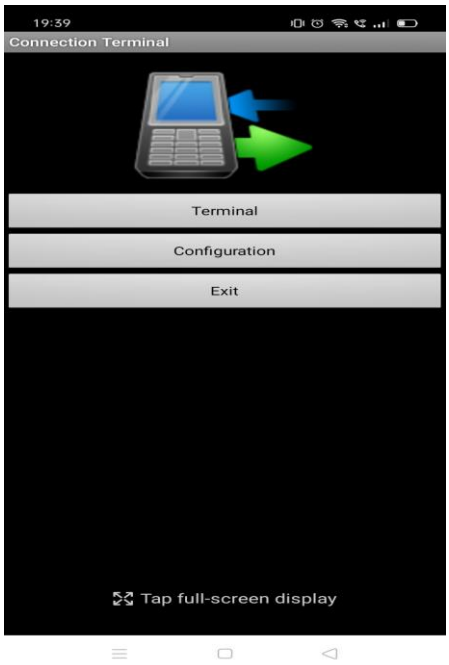

Figure 6 – Mobile App Page 1

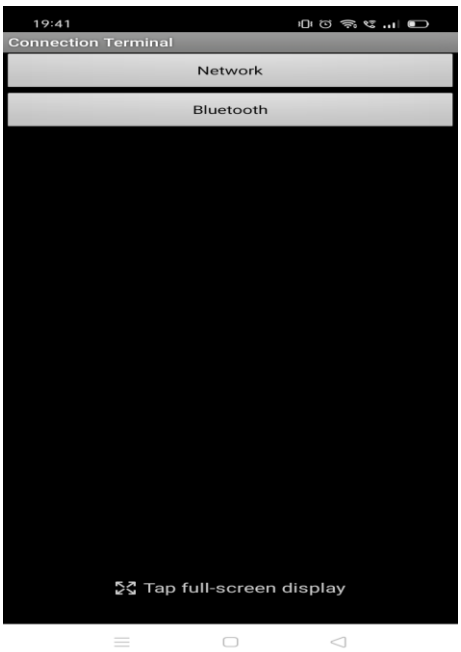

Figure 7 – Mobile App Page 2

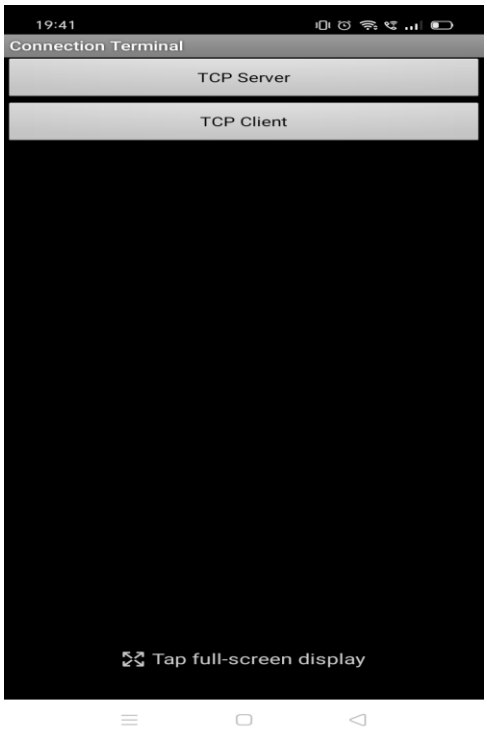

Figure 8 – Mobile App Page 3

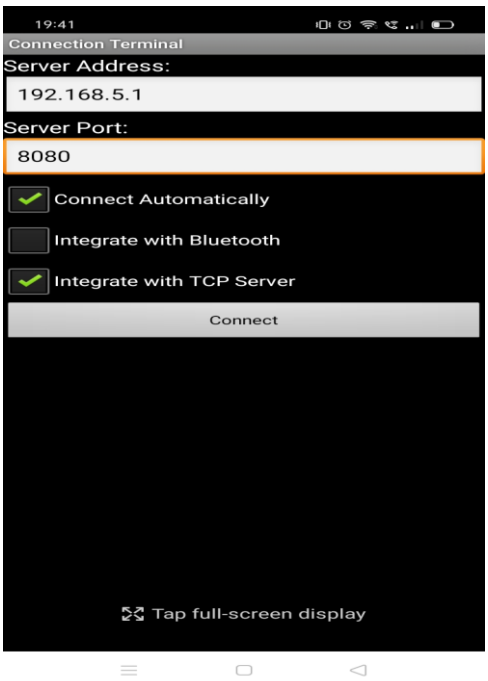

Figure 9 – Mobile App Page 4

The Figure 6 shows the starting page of our mobile application. Initially the user should configure the network by clicking the configuration tab on the screen. Next the

Application will navigate into another page (Figure 7) and the user should click on the network tab on the screen. The user should tap on the TCP Client (Figure 8) to enter the server address and port on the next page (Figure 9). By following this procedure the user can connect his or her phone to the Solar Powered Smart Irrigation System

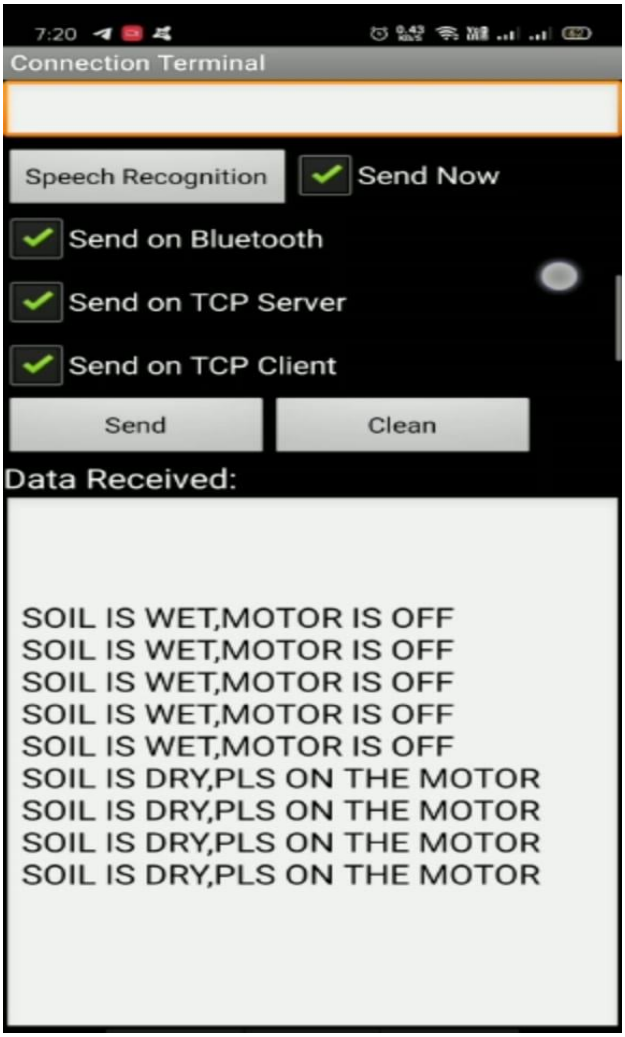

Figure 10 – Mobile App Page 5

The Mobile Application will show the above page (Figure 10) which has a command line field where the user can send command to the Arduino Board to switch on the motor. The user can also see the condition of the soil whether it is dry or wet. Whenever the electrodes sense the soil is wet, it will automatically off the motor.

5.2 Module Description

Arduino UNO

Arduino Uno is a microcontroller board based on 8-bit ATmega328P microcontroller. Along with ATmega328P, it consists of other components such as crystal oscillator, serial communication, voltage regulator, etc. to support the microcontroller. Arduino Uno has 14 digital input/output pins (out of which 6 can be used as PWM outputs), 6 analog input pins, a USB connection, A Power barrel jack, an ICSP header and a reset button.

The 14 digital input/output pins can be used as input or output pins by using pinMode(), digitalRead() and digitalWrite() functions in arduino programming. Each pin operates at 5V and can provide or receive a maximum of 40mA current, and has an internal pull-up resistor of 20-50 KOhms which are disconnected by default. Out of these 14 pins, some pins have specific functions as listed below:

- **Serial Pins 0 (Rx) and 1 (Tx):** Rx and Tx pins are used to receive and transmit TTL serial data. They are connected with the corresponding ATmega328P USB to TTL serial chip.
- **External Interrupt Pins 2 and 3:** These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value.
- **PWM Pins 3, 5, 6, 9 and 11:** These pins provide an 8-bit PWM output by using analogWrite() function.
- **SPI Pins 10 (SS), 11 (MOSI), 12 (MISO) and 13 (SCK):** These pins are used for SPI communication.
- **In-built LED Pin 13:** This pin is connected with an built-in LED, when pin 13 is HIGH – LED is on and when pin 13 is LOW, it's off.

Along with 14 Digital pins, there are 6 analog input pins, each of which provide 10 bits of resolution, i.e. 1024 different values. They measure from 0 to 5 volts but this limit can be increased by using an AREF pin with analog Reference() function.

- Analog pin 4 (SDA) and pin 5 (SCA) are also used for TWI communication using Wire library.
- Arduino Uno has a couple of other pins as explained below:

- AREF: Used to provide reference voltage for analog inputs with analogReference() function.
- Reset Pin: Making this pin LOW, resets the microcontroller.

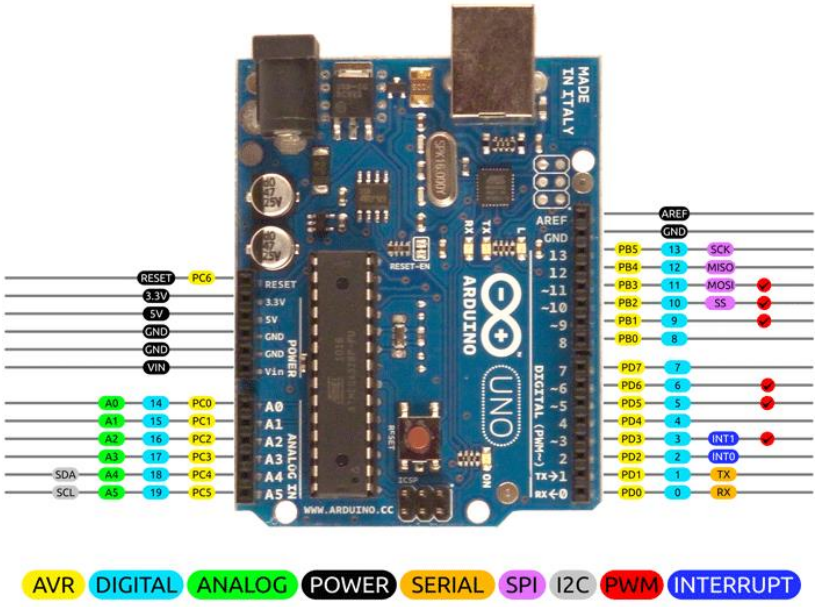

Figure 11 – Arduino UNO

Pin Description

Pin Category	Pin Name	Details
Power	Vin, 3.3V, 5V, GND	Vin: Input voltage to Arduino when using an external power source. 5V: Regulated power supply used to power microcontroller and other components on the board. 3.3V: 3.3V supply generated by on-board voltage regulator.

		Maximum current draw is 50mA. GND: ground pins.
Reset	Reset	Resets the microcontroller.
Analog Pins	A0 – A5	Used to provide analog input in the range of 0-5V
Input/Output Pins	Digital Pins 0 - 13	Can be used as input or output pins.
Serial	0(Rx), 1(Tx)	Used to receive and transmit TTL serial data.
External Interrupts	2, 3	To trigger an interrupt.
PWM	3, 5, 6, 9, 11	Provides 8-bit PWM output.
SPI	10 (SS), 11 (MOSI), 12 (MISO) and 13 (SCK)	Used for SPI communication.
Inbuilt LED	13	To turn on the inbuiltLED.
TWI	A4 (SDA), A5 (SCA)	Used for TWI communication.
AREF	AREF	To provide reference voltage for input voltage

Arduino Uno Technical Specifications

Microcontroller	ATmega328P – 8 bit AVR family microcontroller
Operating Voltage	5V
Recommended Input Voltage	7-12V
Input Voltage Limits	6-20V
Analog Input Pins	6 (A0 – A5)
Digital I/O Pins	14 (Out of which 6 provide PWM output)
DC Current on I/O Pins	40 mA
DC Current on 3.3V Pin	50 mA
Flash Memory	32 KB (0.5 KB is used for Bootloader)
SRAM	2 KB
EEPROM	1 KB
Frequency (Clock Speed)	16 MHz

Solar Panel

Figure 12 – Solar Panel

Solar panels are those devices which are used to absorb the sun's rays and convert them into electricity or heat.

A solar panel is actually a collection of solar (or photovoltaic) cells, which can be used to generate electricity through photovoltaic effect. These cells are arranged in a grid-like pattern on the surface of solar panels.

Thus, it may also be described as a set of photovoltaic modules, mounted on a structure supporting it. A photovoltaic (PV) module is a packaged and connected assembly of 6×10 solar cells.

When it comes to wear-and-tear, these panels are very hardy. Solar panels wear out extremely slow. In a year, their effectiveness decreases only about one to two per cent (at times, even lesser).

Most solar panels are made up using crystalline silicon solar cells. Installation of solar panels in homes helps in combating the harmful emissions of greenhouse gases and thus helps reduce global warming. Solar panels do not lead to any form of pollution and are clean. They also decrease our reliance on fossil fuels (which are limited) and traditional power sources. These days, solar panels are used in wide-ranging electronic equipment like calculators, which work as long as sunlight is available.

However, the only major drawback of solar panels is that they are quite costly. Also, solar panels are installed outdoors as they need sunlight to get charged.

Motor

Figure 13 - Motor

As the name suggests the Hobby DC motor is highly used by hobbyists who start exploring electronics. Hence this motor is very simple and easy to use. You can use any normal 9V battery or even a 5V supply since this motor has an operating range from 4.5V to 9V. In order to make it rotate just connect the positive (+) side of the battery to one terminal and the Negative (-) sign of the battery to the other end and you should see the motor rotating. If you want to reverse the speed of the motor simply interchange the terminals and direction will also be reversed. In order to control the speed of the motor you have to vary the voltage supplied to the Motor the easiest way to do this is using a Potentiometer. There are also many other ways to achieve this. Also remember that the motor can consume up to 250mA during loaded conditions so make sure you supply could source it.

Motor Specifications

- Standard 130 Type DC motor
- Operating Voltage: 4.5V to 9V
- Recommended/Rated Voltage: 6V
- Current at No load: 70mA (max)
- No-load Speed: 9000 rpm
- Loaded current: 250mA (approx)
- Rated Load: 10g*cm
- Motor Size: 27.5mm x 20mm x 15mm
- Weight: 17 grams

Relay

Figure 14 - Relay

A relay is an electromagnetic switch operated by a relatively small current that can control much larger current. When a small current flows through the first circuit, it activates the electromagnet, which generates a magnetic field all around it. The energized electromagnet attracts a contact in the second circuit toward it, closing the switch and allowing a much bigger current to flow through the second circuit. Typically the relay has 5 pins, three of them are high voltage terminals (NC, COM, and NO) that connect to the device you want to control. On the other side of the module, there are three pins – a Ground pin and a VCC pin to power the module and an input pin IN to control the relay. The input pin is active low, meaning the relay will be activated when you pull the pin LOW and it will become inactive when you pull the pin HIGH.

Module Pinout

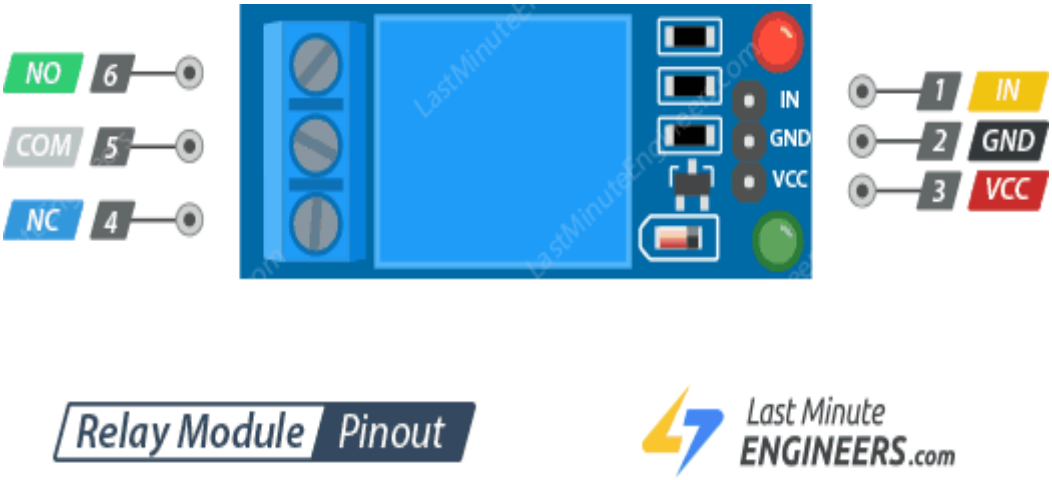

Figure 15 – Module Pinout

Control Pins:

- **IN** pin is used to control the relay. It is an active low pin, meaning the relay will be activated when you pull the pin LOW and it will become inactive when you pull the pin HIGH.
- **GND** is the ground connection.
- **VCC** pin supplies power to the module.

Output Terminal:

- **COM** pin is connected to the signal you are planning to switch.
- **NC** pin is connected to the COM pin by default, unless you send a signal from the Arduino to the relay module to break the connection.
- **NO** pin is open by default, unless you send a signal from the Arduino to the relay module to make the connection.

Copper Electrodes

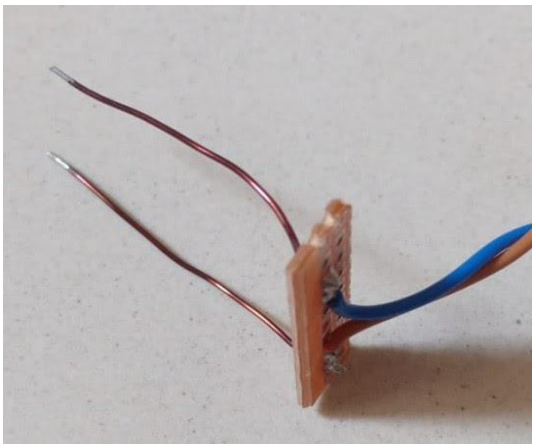

Figure 16 – Copper Electrodes

Copper electrodes are used to sense the moisture content of soil. The conductivity between the electrodes helps to measure the moisture content level.The electrodes sense the electrostatic capacity of the soil to reveal shifts in the amount of water held in the ground. It can tell how much water is absorbed by the plants' roots. Electrodes are also used to measure the resistance of the soil. Greater the resistance, lower the moisture content of the soil.

Battery

Figure 17 – Battery

The input to the circuit is applied from the regulated power supply. The ac. input i.e., 230V from the mains supply is stepped down by the transformer to 12V and is fed to a rectifier. The output obtained from the rectifier is a pulsating dc voltage. So in order to get a pure dc voltage, the output voltage from the rectifier is fed to a filter to remove any ac components present even after rectification. Now, this voltage is given to a voltage regulator to obtain a pure constant dc voltage

ESP 8266

Figure 18 – ESP 8266

The ESP8266 is a low-cost Wi-Fi microchip, with a full TCP/IP stack and microcontroller capability, produced by Espressif Systems in Shanghai, China. This small module allows microcontrollers to connect to a Wi-Fi network and make simple TCP/IP connections using Hayes-style commands.

However, at first there was almost no English-language documentation on the chip and the commands it accepted.The very low price and the fact that there were very few external components on the module, which suggested that it could eventually be very inexpensive in volume, attracted many hackers to explore the module, the chip, and the software on it, as well as to translate the Chinese documentation. The ESP8285 is an ESP8266 with 1 MiB of built-in flash, allowing the building of single-chip devices capable of connecting to Wi-Fi.

5.3 Introduction of Technologies Used

Internet of Things (IoT):

The Internet of Things (IoT) is the internetworking of physical devices, vehicles (connecting devices, and smart devices), buildings, and other items-including embedded with electronics, software's, sensors, actuators, network connectivity that enable these objects to collect and exchange data. The IoT allows objects to be sensed or controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer –based systems, and resulting in improved efficiency, accuracy and economic benefit in addition to reduced human intervention.

IoT Functional Blocks:

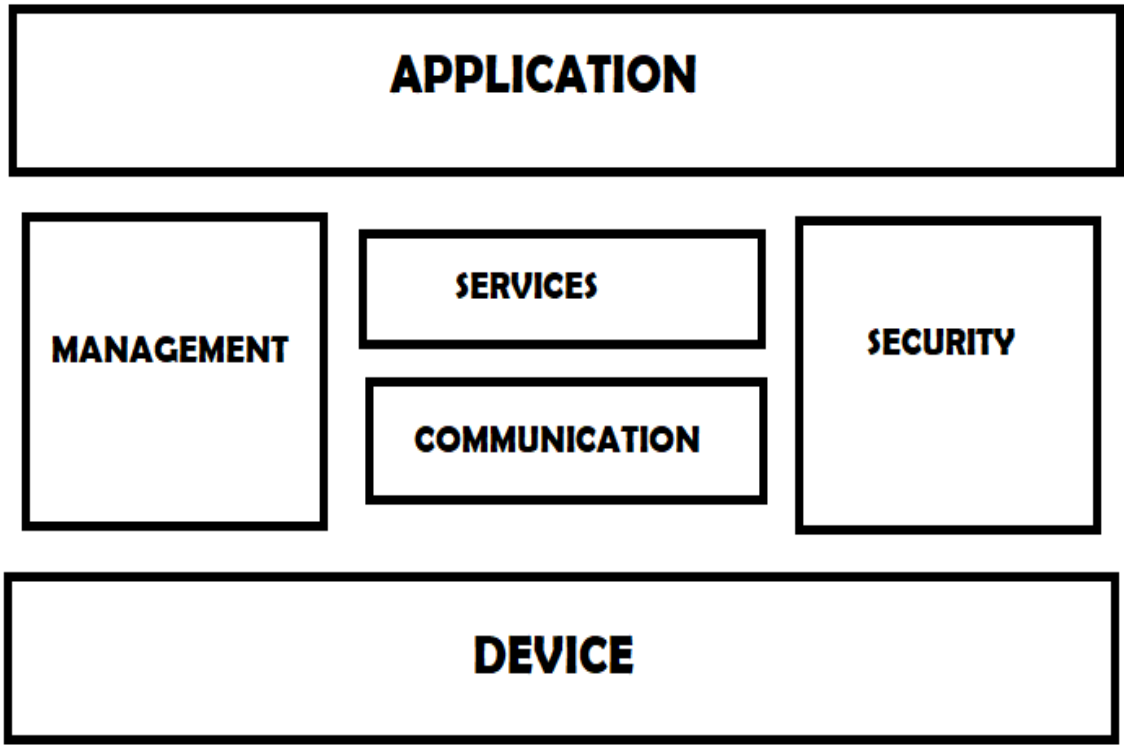

Figure 19 – IoT Functional Block

An IoT system comprises a number of functional blocks that provide the system the capabilities for identification, sensing, actuation, and management as shown in figure. These functional blocks are described as follows:

- Device: An IoT system comprises devices that provide sensing, actuation, monitoring and control functions.
- Communication: The communication block handles the communication for the Iot system. The various protocols are used for communication by IoT systems
- Services: An IoT system uses various types of IoT services such as services for device monitoring, device control services, data publishing services and services for device discovery.
- Management: Management functional block provides various functions to govern the IoT system.
- Security: Security functional block secures the IoT system and by providing functions such as authentication, authorization, message and content integrity, and data security.
- Application: IoT applications provide an interface that the users can use to control and monitor various aspects of the IoT system. Applications also allow users to view the system status and view or analyse the processed data

Applications

The applications of Internet of Things span a wide range of domains including (but not limited to) homes, cities, environment, energy, systems, retail, logistics, industry, agriculture and health as listed.

- For homes, IoT has several applications such as smart lighting that adapt the lighting to suit the ambient conditions. smart appliances that can be remotely monitored and controlled, intrusion detection systems, smart smoke detectors etc.,
- For cities, IoT has applications such as smart parking systems that provide status updates on available slots, smart lighting that helps in saving energy, smart roads that provide information on driving conditions and structural health

monitoring systems.

- For the environment, IoT has applications such as weather monitoring, air and noise pollution, forest fire detection and river flood detection systems.
- For energy systems, IoT has applications such as including smart grids, grid integration of renewable energy sources and prognostic health management systems.
- For the retail domain, IoT has applications such as inventory management, smart payments and smart vending machines.
- For the agriculture domain, IoT has applications such as smart irrigation systems that help in saving water while enhancing productivity and greenhouse control systems.
- Industrial applications such as smart irrigation systems. Industrial applications of IoT include machine diagnostics and prognosis systems.
- For health and lifestyle, IoT has applications such as health and fitness monitoring systems and wearable electronics.

IoT Protocols

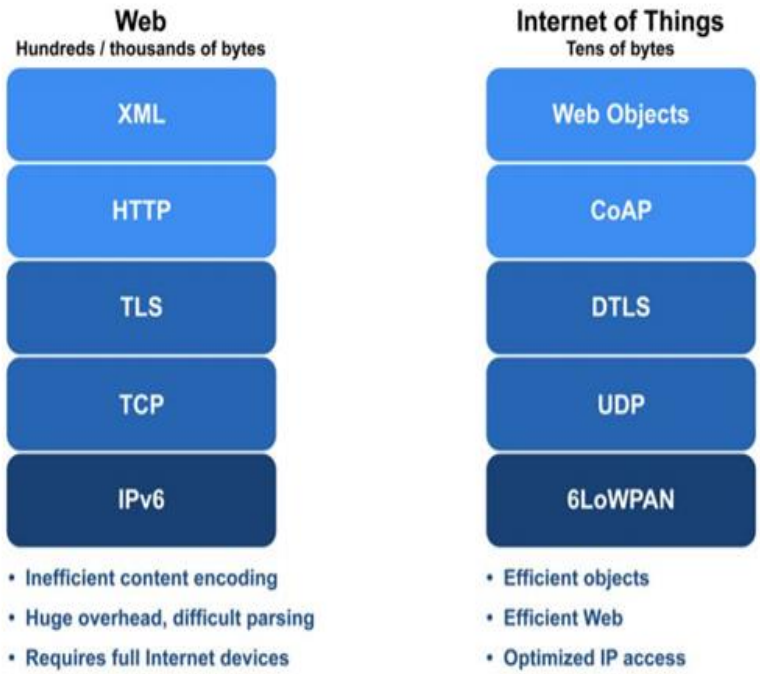

Figure 20 – IoT Protocols

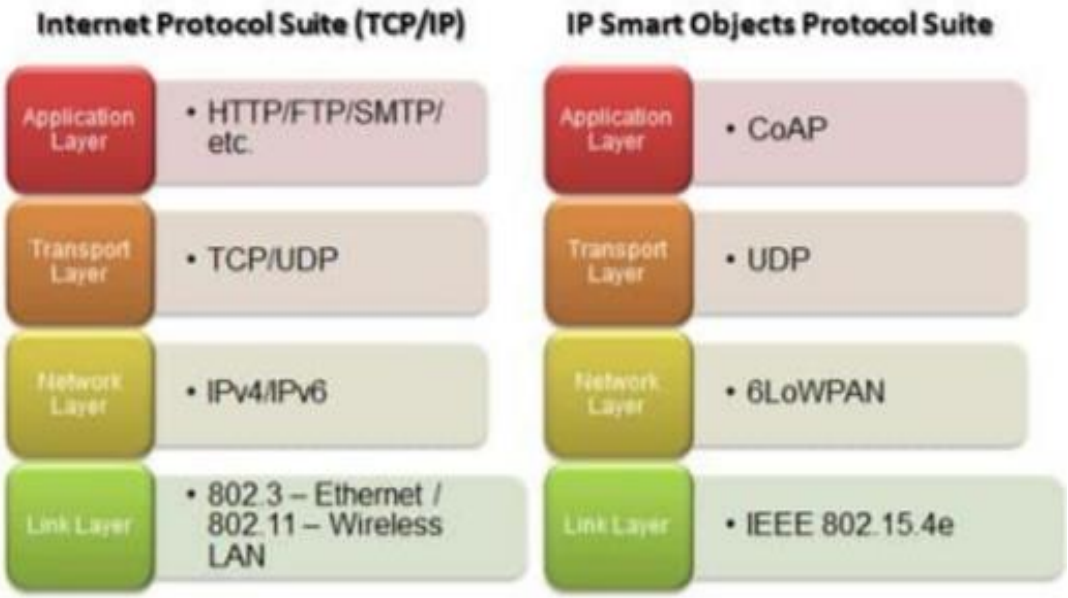

Figure 21 – Internet Protocol Suite v/s IP Smart Objects Protocol Suite

Link Layer

Link Layer protocols determine how the data is physically sent over the network's physical layer or medium (e. g., copper wire, coaxial cable, or a radio wave). The scope of the link layer is the network connection to which host is attached. Hosts on the same link exchange data packets over the link layer using link layer protocols. Link layer determines how the packets are coded and signalled by the hardware device over the medium to which the host is attached (such as a coaxial cable). Let us now look at some link layer protocols, which are relevant in the context of IoT.

- **802.3-ETHERNET:** IEEE 802.3 is a collection of wired Ethernet standards for the link layer. For example, 802.3 is the standard for 10BASIES Ethernet that uses coaxial cable as a shared medium, 802.3.i is the standard for 10BASE-T Ethernet over copper twisted-pair connections, 802.3ae is the standard for 10Gbit/Ethernet over fibre, and so on. optic connections, these standards provide data rates from 10Mbs to40Gbs and higher. The shared medium in Ethernet can be a coaxial cable, twisted-pair wire or an optical fibre. the shared medium (i.e., broadcast medium) carries the communication for all the devices propagation

conditions and transceiver capabilities. The specifications of the 802.3 standards are available on the IEEE802.3 working group website.

- **802.3-WIFI:** IEEE802.11 is a collection of wireless local area network (WLAN)communication standards, including extensive description of the link layer. For example, 802.11a operates in the 5GHZ band, 802.11b and 802.11g operate in the 2.4GHZ band 802.11n operates in the 2.4/5GHZ bands, 802.11ac operates from 1MB/S to up to upto6.75Gb/s. The specifications of the 802.11 standards are available on the IEEE802.11 working group website
- **802.11-WIFI:** IEEE802.16 is a collection of wireless broadband standards, including extensive description for the link layer (also called WiMAX). WiMAX. Standards provide data rates from 1.5 Mb/s to 1 G b/s. The recent update (802.16m) provides data rates of 100Mbit/s for mobile stations and 1 G bit/s for fixed stations. The specifications of the 802.11 standards are readily available on the IEEE802.16 working group website.
- **802.15.4--LR-WPAN:** IEEE 802.15.4 is a collection of standards for low-rate wireless personal area networks (LR-WPANs). These standards form the basis of specifications for high level communication protocols such as ZigBee. LR-WPAN standards provide data rates from 4Kb/s 250 Kb/s. These standards provide low-cost and low-speed communication for power constrained devices. The specifications of The 802.15.4 standards are available on the IEEE802.15 working group website.
- **2G/3/4G-MobileCommunication:** There are different generations of mobile communication standards including second generation (2G including GSM and CDMA), third generation (3G-including UMTS and CDMA2000) and fourth generation (4G-including LTE). IOT devices based on these standards can communicate over cellular networks. Data rates for these standards range for 9.6 Kb/s(for 2G) to up to 100Mb/s(for 4G) and are available from the 3GPP websites.

Network/Internet Layer

The network layers are responsible for sending IP datagrams from the source network to the destinations network. This layer performs the host addressing and packet routing. The data grams contain the source and destination addresses which are used to route them from the source to destination across multiple networks. Host identification is done using hierarchical IP addressing schemes such as IPV4 or IPV6.

IPV4: Internet Protocol version 4(IPV4) is the most deployed Internet Protocol the is used to identify the devices on a network using a hierarchical addressing scheme. IPV4 uses a 32-bit address scheme that allows a total of 4,294,967,296 addresses. As more and more devices got connected to the Internet, these addresses got exhausted in the year 201. IPV4 has been succeeded by IPV6. The IP protocols establish connections on the packet network, but do not guarantee delivery of packets.

IPV6: Internet Protocols version 6(IPV6) IS The newest version of Internet Protocols and successor to IPV4. IPV6 uses 128-bit address scheme that allows total of 3.4*10 38 address.

6LoWPAN: 6LoWPAN (IPV6 over Low power Wireless Personal Area Networks) brings IP protocol to the low-power devices which have limited processing capability 6LoWPAN works with the 802,15.4-based networks.

Transport Layer

The transport layer protocols provide end-end message transfer capability independent of the underlying network. The message transfer capability can be set up on connections, either using handshakes (as in TCP) or without handshakes/acknowledgements (as in UDP). The transport layer provides functions such as error control, segmentation, flow control and congestion control.

- **TCP:** Transmission Control Protocol (TCP) is the most widely used transport layer protocol. that is used by web browsers along with HTTP, HTTPS application layer protocols, email programs (SMTP application layer protocols)

and file transfer (FTP). TCP is connection oriented and stateful protocol. While IP protocol deals with sending packets. TCP ensures reliable transmission of packets in-order. TCP also provides error detection capability so that duplicate packets can be discarded and lost packets are retransmitted. The flow control capability of TCP ensures that the rate at which the sender sends the data is not too high for the receiver to process. The congestion collapse which can lead to degradation of network performance TCP is described in RFC 793.

- **UDP:** Unlike TCP, which requires carrying out an initial setup procedure. UDP of a connectionless protocol. UDP is useful for the time-sensitive applications that have very small data units to exchange and do not have stateless protocol. UDP does not provide guaranteed delivery or ensure connections created are reliable. UDP is described in RFC768.

Application Layer:

Application Layer protocols define how the applications interface with the lower layer protocols to send the data over the network. The application data, typically in files, is encoded by the application layer protocol and encapsulated in the transport layer protocol which provides connection or transaction-oriented communication over the network. Port numbers are used for application addresses (for example port 80 for HTTP port 22 for SSH etc.). Application layer protocols enable process-to-process connections using ports.

- **HTTP:** Hypertext Transfer Protocol (HTTP) is the application layer protocol that forms the foundation of the World Wide Web (WWW). HTTP includes commands such as GET, PUT, POST, DELETE, HEAD, TRACE, OPTIONS, etc. The protocol follows a request-response model where a client can send a request to a server using the HTTP commands. HTTP is a stateless protocol and each HTTP request is independent of the other requests. An HTTP client can be a browser or an application running on the client (e.g., an application running on an IOT device, a mobile application or other software).
- **CoAP:** Constrained Application Protocol (CoAP) is an application layer

protocol for machine-to-machine(M2M) applications. meant for constrained environments with constrained devices and constrained networks. Like HTTP, CoAP is a web transfer protocol and uses a request-response model, however it runs on top of UDP instead of TCP. COAP uses a client-server architecture where clients communicate with servers using connectionless data grams COAP is designed to easily interface with HTTP. Like HTTP, COAP supports methods such as GET, PUT, POST, and DELETE, COAP draft specifications are available on IEFT Constrained environments (CORE) working Group Website.

- **Web Socket:** Web Socket protocol allows full-duplex communication over a single socket connection for sending messages between client and server. Web server is based on TCP and allows streams of messages to be sent back and forth between the client and server while keeping the TCP connection open. The client can be a browser, a mobile application or an IOT device.
- **MQTT:** Message Queue Telemetry Transport (MQTT) is a light-weight messaging protocol based on the publish-subscribe model. MQTT uses a client-server (also called MQTT Broker) and publishes messages to topics. MQTT is well suited for constrained environments where the devices have limited processing and memory resources and the network bandwidth is low MQTT specifications are available on IBM developer Works.
- **XMPP:** Extensible Messaging and Presence Protocol (XMPP) is a protocol for real-time communication and streaming XML data between entities. XMPP powers a wide range of applications including messaging, presence, data syndication, gaming, multi-party chat and voice/video calls. XMPP allows sending small chunks of XML data from one network entry to another in near real-time. XMPP is a decentralized protocol and uses a client-server architecture. XMPP supports both client-to-server and server-to-server communication paths. In the context of IOT, XMPP allows real-time communication between IOT devices.
- **DDS:** Data Distribution Service (DDS) is a data-centric middleware standard for device to-device or machine-to-machine. DDS uses a publish-subscribe for models where publishers (e g. devices that generate data) create topics to which subscribers (e.g., devices that want to consume data) can subscribe. Publisher is an object responsible for data distribution and the subscriber is responsible for

receiving reliability. DDS provides quality-of-service (QOS) control and configurable reliability .DDS is described in Object Management Group (OMG) DDS specification.

- AMQP: Advanced Messaging Queuing Protocol (AMQP) is an open application layer protocol for business messaging. AMQP supports both point-to-point publishers (e.g devices or applications that generate data). Publishers publish the connections to consumers (applications that process data). Publishers publish the messages to exchange which then distribute message copies to queues. Messages are either delivered by the broker to the consumers which have subscribed to the queues or the consumers can pull the messages from the queues. AMQP specification is available on the AMQP working group website.

Green Energy:

Solar technologies convert sunlight into electrical energy either through photovoltaic (PV) panels or through mirrors that concentrate solar radiation. This energy can be used to generate electricity or be stored in batteries or thermal storage.

5.4 Sample Code

```
const int soil=2;
const int mot=3;
String a;
void setup()
{
  pinMode(mot,OUTPUT);
  pinMode(soil,INPUT);
  Serial.begin(9600);
  digitalWrite(mot, LOW);
  Serial.println("WELCOME");
 }
void loop()
{  if(digitalRead(soil)==LOW)
{
digitalWrite(mot , LOW);
Serial.println("SOIL IS WET,MOTOR IS OFF");
delay(500);
}
     Else {
Serial.println("SOIL IS DRY,PLS ON THE MOTOR");
delay(500);
}
if(Serial.available()>0)  // Send data only when you receive data:
{
  a= Serial.readString();// read the incoming data as string
  Serial.println(a);
  if (a[0]=='O')
  {  if (a[1]=='N')
    { digitalWrite(mot,HIGH);
    Serial.println("MOTOR IS HIGH");
    }}  }}
```

6. TEST CASES

CASE 1 When the electrodes are inserted into the soil it checks for the wet or dry condition of the soil ,If soil is wet it is closed circuit and then the signal is sent to the motor that stays off .

INPUT SOIL WET (High)

OUTPUT MOTOR OFF (Low)

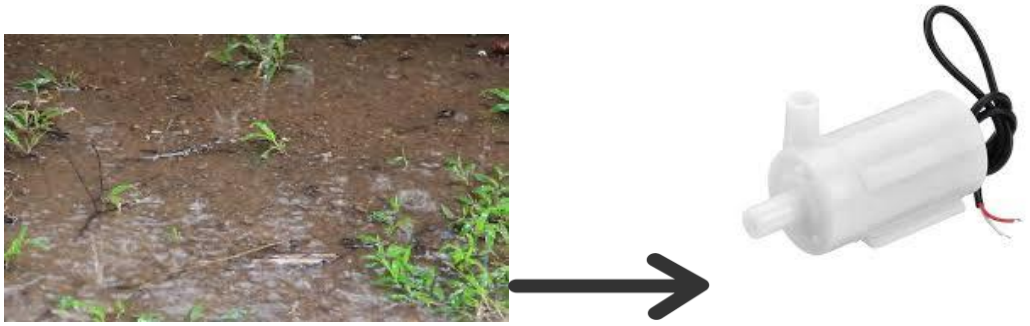

Figure 22 – Wet Soil and Motor OFF

CASE 2 When the electrodes are inserted into the soil it checks for the wet or dry condition of the soil, If soil is dry it is open circuit and then the signal is sent to the motor to start.

INPUT SOIL DRY (Low)

OUTPUT MOTOR ON (High)

Figure 23 – Dry Soil and Motor ON

7. SCREENSHOTS

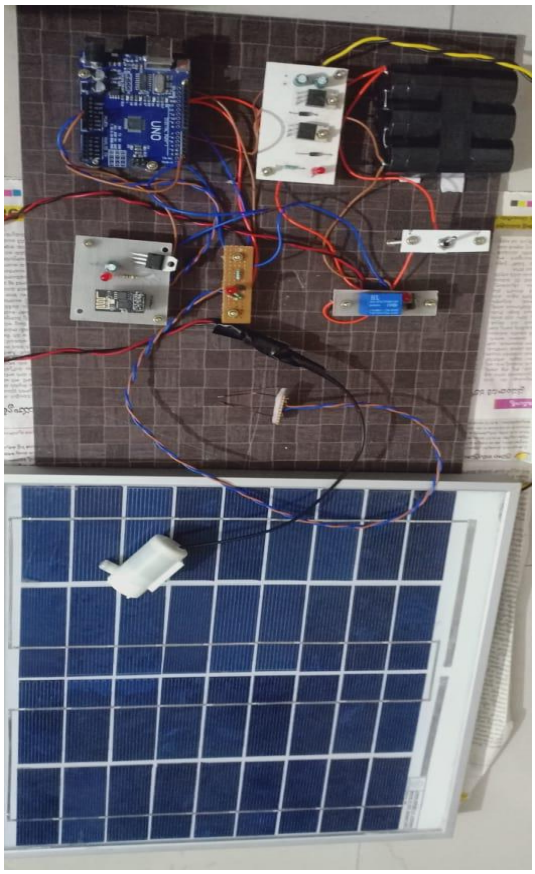

Figure 24 – Working Model

Figure 25 – Mobile Application Screenshot

Here is our complete working model in the above Figure 24. The Figure have a solar panel, Arduino board, charging board, battery, led, relay, motor, esp8266, switch and electrodes. Here in the fig. no. is a page in mobile application. The user can see the condition of the soil i.e. whether it is dry or wet. The user can also send the command to the Arduino board on the motor.

Figure 26 – Motor ON Working

In the above Figure 26, it shows the working of model, when the soil is dry. When the electrodes are taken out from wet soil i.e. under dry conditions, it will send a message to the mobile app on the motor which is shown in Figure 25. The user will send on command and the motor will be on

Figure 27 – Motor OFF Working

In the above Figure 27, it shows the working of model, when the soil is wet. When the electrodes are kept in wet soil the motor will automatically be turned off by the Arduino.

8. CONCLUSIONS

The application of agriculture networking technology is needed for modern agricultural development, but also an important symbol of the future level of agricultural development; it will be the future direction of agricultural development. After building the agricultural water irrigation system hardware and analyzing and researching the network hierarchy features, functionality and the corresponding software architecture of precision agriculture water irrigation systems, actually applying the internet of things to the highly effective and safe agricultural production has a significant impact on ensuring the efficient use of water resources as well as ensuring the efficiency and stability of agricultural production.

With more advancement in the field of IoT expected in the coming years, these systems can be more efficient, much faster and less costlier. In the Future, this system can be made as an intelligent system, where in the system predicts user actions, rainfall pattern, time to harvest, animal intruder in the field and communicating the information through advanced technology can be implemented so that agricultural system can be made independent of human operation and in turn quality and huge quantity yield can be obtained.

The proposed system developed is beneficial and works in a cost effective manner. It reduces the water consumption to a greater extent. It needs minimal maintenance.There is no issue power consumption as we are using solar energy for generating power supply..The System is very useful in areas where water scarcity is a major problem .The crop productivity increases and the wastage of crops is very much reduced using this irrigation system. The developed system is more helpful and gives more feasible results.

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