Project Report

on

Smart Irrigation System

Submitted in partial fulfillment for
the requirements of the Diploma in

Electronics Engineering

(Semester V)

By

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have successfully completed and submitted the project entitled

Smart Irrigation System

for the partial fulfillment of

Diploma

In

Electronics Engineering (Semester VI)

during the academic year 2019-2020 as prescribed by VJTI Mumbai.

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Head of Diploma (Electronics)

Prof. Rahul Ingle
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Date: -

Place: - Mumbai

Seal

ACKNOWLEDGEMENT

The success and final outcome of this project required a lot of guidance and assistance from many people and we are extremely privileged to have got this all along the completion of the project. All that we have done is only due to such supervision and assistance and we would not forget to thank them.

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We heartily thank the Head of Department (Electronics engineering), Mr. Vikram Kehri, for his guidance and suggestions during this project work.

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CHAPTER 1: INTRODUCTION

1.1 Objective and Aim

The key objective of the project is to monitor the soil's moisture content with the aid of a moisture sensor circuit, and irrigate it based on its nature using a Arduino UNO, NodeMCU, YL-69 and an automatic water inlet setup which can also monitor and record soil moisture which is constantly modified using mobile application and can be controlled in future to optimize these resources so that the plant growth and yield is maximized. A record of soil moisture in ThingSpeak database for backup. This backup directs the farmers regarding the type of crop to be cultivated in future. IOT gives the whole information to the operator about the irrigation. In this project, we experiment for different soils suitable for different crops in various climatic parameters that govern plant growth and allow information to be collected with less labor requirements.

Our aim is to develop a wireless level controlled smart irrigation system to provide irrigation system which is automatic for the plants which help in saving water and money. The main objective is to apply the system for improvement of health of the soil and hence the plant via multiple sensors. In order to replace expensive controllers in current available systems, the Arduino Uno will be used in this project as it is an affordable microcontroller. The Arduino Uno can be programmed to analyze some signals from sensors such as moisture, temperature, and rain. A pump is used to pump the fertilizer and water into the irrigation system. The use of easily available components reduces the manufacturing and maintenance costs. This makes the proposed system to be an economical, appropriate and a low maintenance solution for applications, especially in rural areas and for small scale agriculturists. Bulk of the existing systems employ microprocessor-based systems. These systems offer several technological advantages but are unaffordable, bulky, difficult to maintain and less accepted by the technologically unskilled workers in the rural scenario. The Internet of Things (IoT) is transforming the agriculture industry and enabling farmers to contend with the enormous challenges they face.

1.2 Motivation

Appropriate soil water level is a necessary pre-requisite for optimum plant growth. Also, water being an essential element for life sustenance, there is the necessity to avoid its undue usage. Irrigation is a dominant consumer of water. This calls for the need to regulate water supply for irrigation purposes. Fields should neither be over-irrigated nor under-irrigated. The objective of this project is to design a simple, easy to install methodology to monitor and indicate the level of soil moisture that is continuously controlled in order to achieve maximum plant growth and simultaneously optimize the available irrigation resources on monitoring software ThingSpeak and the sensor data can be seen on Internet.

This research work enhanced to help the small-scale cultivators and will be increase the yield of the crops then will increase government economy. Over time, systems have been implemented towards realizing this objective of which automated processes are the most popular as they allow information to be collected at high frequency with less labor requirements.

The industry must overcome increasing water shortages, limited availability of lands, difficult to manage costs, while meeting the increasing consumption needs of a global population that is expected to grow up to 70% by 2050. India’s major supply of financial gain is from agriculture sector and seventieth of farmers and general folks rely upon the agriculture. In Republic of India most of the irrigation systems square measure are operated manually. These antique techniques square measure replaced with semi-automated and automatic techniques. The on the market ancient techniques square measure like ditch irrigation, terraced irrigation, drip irrigation, system. The global irrigation situation is classified by redoubled demand for higher agricultural productivity, poor performance and decreased accessibility of water for agriculture. These issues are befittingly corrected if we have a tendency to use machine-controlled system for irrigation. Automating farm or nursery irrigation permits farmers to use the correct quantity of water at the correct time, regardless of the provision of labor to show valves on and off. Additionally, farmer’s mistreatment automation instrumentation is able to scale back runoff from over watering saturated soils, avoid irrigating at the incorrect time of day, which will improve crop performance by making certain adequate water and nutrients once required. Those valves are also simply automated by mistreatment controllers. Automating farm or nursery irrigation permits farmers to use the correct quantity of water at the correct time, no matter the provision of labor to show valves on and off.

They lack in an exceedingly featured mobile application developed for users with acceptable user interface. It solely permits the user to observe and maintain the wetness level remotely in no matter of time. From the purpose of reading and performing at remote places the developed microcontroller primarily based irrigation system will.

CHAPTER 2: LITERATURE SURVEY

The exact primitive methods used to measure moisture of the agricultural field has been analyzed in this section to make the suitable modifications and necessary improvisations to automate the process.

2.1 Problems that are faced today:

Today the technology in this particular issue is still hindered.

- In our Agriculture sector, the availability of water is decreasing day by day due to the increase in population, industrialization and short rainfall.
- Wastage of water is caused due to seepage in the drain.
- Increase labour and electricity cost.
- Promote soil erosion**.**

Water is very important for the growth of plants but excessive irrigation of field leads to water logging of soil. Too much water is harmful for crop production as discussed under:

1. Too much water is the soil inhibits the process of germination of seeds. It due to the reason that under these conditions the seeds do not get sufficient air to respire. Is due to the reason that under these conditions the seeds do not get sufficient air to respire. our might have observed that the seeds fail to germinate, if it rains soon after sowing. This is due to excessive water in the field, which affects the soil aeration.

2. Roots do not grow properly in a waterlogged field. You must have seen that potted plants do not grow well if they are given excess water. This is due to the reason that excess water affects soil aeration and hence plants roots do not grow properly.

3. Excessive water in the field increases the amount of salt on the surface of soil due to evaporation. The accumulation of salts damages the soil fertility, except rice; almost all crops receive as ever set back in their growth when excess water stagnates. Damage caused by excess

water and consequent development of salt problem can be minimized by removing standing water from the fields through proper drainage system.

2.2 Primitive methods:

Disadvantages of Traditional Irrigation Methods [1]:

(i) Check Basin Method

- Due to seepage in drains, wastage of water is caused.
- Machines cannot be used m this method because during spray of insecticides or fertilizers, the earthen walls of basins are damaged.
- There IS imbalance in distribution of labour. After growth of crops, water reaches the basins in disproportionate quantity thereby causing wastage of water.
- Creation of problem of water logging.

(ii) Furrow Irrigation Method

- Due to imbalance in flow of water, wastage of water is caused in it.
- It is not suitable in all types of crops.
- Making 'Dol' for drains requires more labour information.
- Due to filling of excess water, there is risk of underground salts coming up to the surface layer.

iii) Strip Irrigation Method

- It is not suitable for all types of crops.
- It is not possible to get balanced supply of water.
- It is not suitable for all soil compositions.

(iv) Basin Irrigation Method.

- It is not useful for all crops.
- Wastage of water is caused in it.
- Diseases spread in trees.

Modern Irrigation Methods [2]:

(v) Sprinkler Irrigation Method

- Sprinkler irrigation method is expensive.
- It requires technical knowledge.
- Sprinkler irrigation method cannot be used in all crops.
- Crop is damaged by changing sprinkler system again and again.
- Water to be used in sprinkler method should be clean.
- In spite of the above defects, sprinkler irrigation method is being adopted with great speed due to increasing water crisis.

(vi) Drip Irrigation Method

- Drip irrigation method is expensive.
- It requires special technical knowledge for successful operation of this method.
- In heavy soils, it creates problems of flow and water blockages.
- Plants are able to get nutritive elements in a very limited area.
- It is not suitable for every crop.
- Utmost care has to be taken for holes of drippers, because soil may come along with water at any time, which will prevent water dripping smoothing from holes.
- Animals may cause damage to branch pipelines and dripper pipelines.
- Most of the drippers work on pressure. Wherever land is sloppy, pressure on valves increases by 50 to 10 per cent, which results in stoppage of working of valves on the upper side.

(vii) Pot Irrigation Method.

- Irrigation in this method is possible in a limited area.
- This method requires clean water because unclean water would cause blockage of minor holes, which would not be able to provide moisture any longer.
- It is costly to draw out pitchers again and again and re-fix them.
- It is not suitable for every crop.

The table below gives some idea about the different seasonal water needs of the most important field crops [3].

Crop	Crop water requirement (mm/total growing period)
Alfalfa	800-1600
Banana	1200-2200
Barley/Oats/Wheat	450-650
Bean	300-500
Cabbage	350-500
Citrus	900-1200
Cotton	700-1300
Maize	500-800
Melon	400-600
Onion	350-550
Peanut	500-700
Pea	350-500
Pepper	600-900
Potato	500-700
Rice (paddy)	450-700
Sorghum/Millet	450-650
Soybean	450-700
Sugar beet	550-750
Sugarcane	1500-2500
Sunflower	600-1000
Tomato	400-800

Table 1: Crop water requirement

Deficient	When an essential element is at a low concentration that severely limits yield and produces more or less distinct deficiency symptoms. Extreme deficiencies will lead to death of the plant.
Insufficient	When the level of an essential plant nutrient is below that required for optimum yields or when there is an imbalance with another nutrient. Symptoms of this condition are seldom evident.
Sufficient	When the concentration of an essential nutrient is present in adequate amounts for optimum crop growth.
Excessive	When the concentration of an essential plant nutrient is sufficiently high to result in a corresponding shortage of another nutrient.
Toxic	When the concentration of either essential or other elements is sufficiently high to reduce plant growth severely. Severe toxicity will result in death of plants.

Table 2: Water Level specifications

Nutrient Requirements

All required elements must be present in the soil for plant use, in varying degrees of availability, to ensure both the immediate and long-term needs of the crop.

CHAPTER 3: FLOW OF PROJECT

3.1 Block Diagram

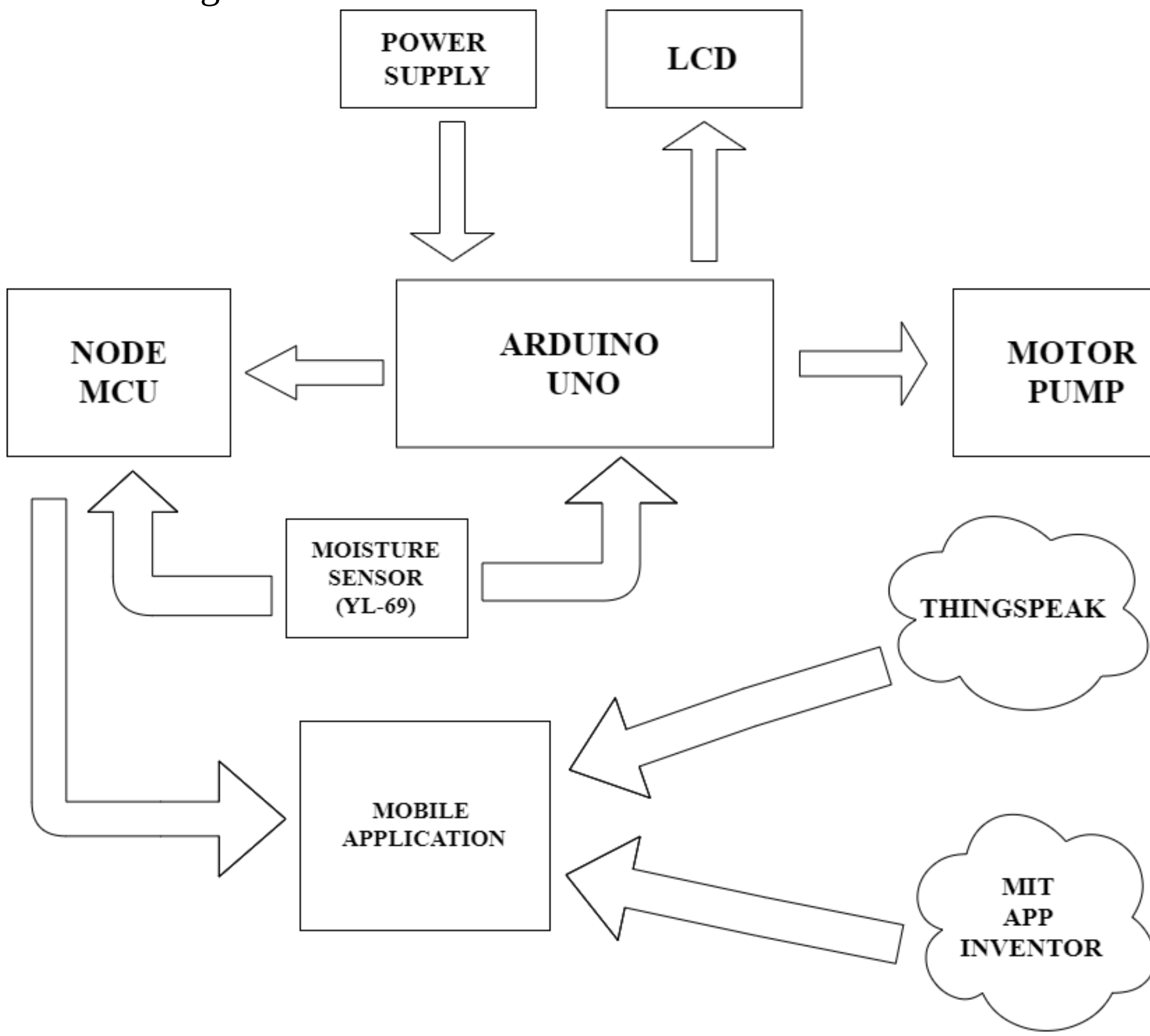

Figure 1: Circuit Block Diagram [4]

3.2 Approach/ Proposed flow of techniques

We decided to divide the whole project into two segments.

The first segment is about interfacing the Liquid Crystal Display (LCD) with Arduino Uno board and also the connections to the water pump (which is the output of the whole project).

The second segment is about interfacing the NodeMCU with Arduino UNO and developing an application according to our requirement.

On the application we can observe real time moisture sensor readings. Along with this we have provided MOTOR ON and MOTOR OFF control directly from the application for easy use.

CHAPTER 4: COMPONENTS SPECIFICATION AND DESCRIPTION

Main components and software specifications

Main components of our project are as follows:

- YL-69 Moisture Sensor.
- NodeMCU.
- Arduino Uno.
- Liquid Crystal Display (LCD).
- ThingSpeak IOT.
- MIT App Inventor.

4.1 Hardware

4.1.1Arduino Uno Board

The Arduino Uno is an open-source board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 Digital pins, 6 Analog pins, and programmable with the Arduino IDE (Integrated Development Environment) via a type B USB cable. It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts. It is also similar to the Arduino Nano and Leonardo. The hardware reference design is distributed under a Creative Commons Attribution Share-Alike 2.5 license and is available on the Arduino website. Layout and production files for some versions of the hardware are also available. [5]

Technical specifications:

- Microcontroller: Microchip ATmega328P
- Operating Voltage: 5 Volts
- Input Voltage: 7 to 20 Volts
- Digital I/O Pins: 14 (of which 6 provide PWM output)
- Analog Input Pins: 6
- DC Current per I/O Pin: 20 mA

- DC Current for 3.3V Pin: 50 mA
- Flash Memory: 32 KB of which 0.5 KB used by bootloader
- SRAM: 2 KB
- EEPROM: 1 KB
- Clock Speed: 16 MHz
- Length: 68.6 mm
- Width: 53.4 mm
- Weight: 25 g

Pins

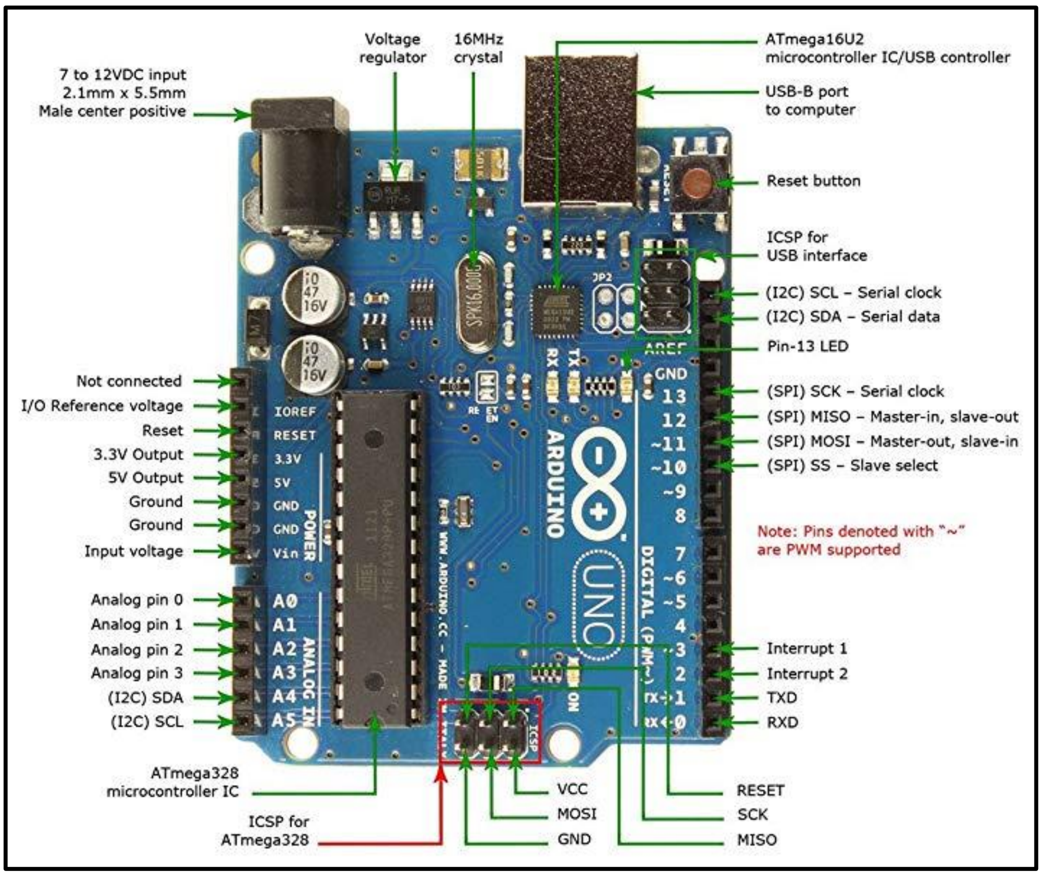

Figure 2: Arduino UNO

General pin functions

- LED: There is a built-in LED driven by digital pin 13. When the pin is high value, the LED is on, when the pin is low, it's off.

- VIN: The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
- 5V: This pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 20V), the USB connector (5V), or the VIN pin of the board (7-20V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage the board.
- 3V3: A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.
- GND: Ground pins.
- IOREF: This pin on the Arduino board provides the voltage reference with which the microcontroller operates. A properly configured shield can read the IOREF pin voltage and select the appropriate power source or enable voltage translators on the outputs to work with the 5V or 3.3V.
- Reset: Typically used to add a reset button to shields which block the one on the board.

Special pin functions

- Each of the 14 digital pins and 6 analog pins on the Uno can be used as an input or output, using pinMode(), digitalWrite(), and digitalRead() functions. They operate at 5 volts. Each pin can provide or receive 20 mA as recommended operating condition and has an internal pull-up resistor (disconnected by default) of 20-50k ohm. A maximum of 40mA is the value that must not be exceeded on any I/O pin to avoid permanent damage to the microcontroller. The Uno has 6 analog inputs, labelled A0 through A5, each of which provide 10 bits of resolution (i.e. 1024 different values). By default, they measure from ground to 5 volts, though is it possible to change the upper end of their range using the AREF pin and the analogReference () function.

In addition, some pins have specialized functions:

- Serial / UART: pins 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL serial chip.
- External interrupts: 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 (pulse-width modulation): 3, 5, 6, 9, 10, and 11. Can provide 8-bit PWM output with the analogWrite () function.
- SPI (Serial Peripheral Interface): 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These pins support SPI communication using the SPI library.
- TWI (two-wire interface) / I²C: A4 or SDA pin and A5 or SCL pin. Support TWI communication using the Wire library.
- AREF (analog reference): Reference voltage for the analog inputs.

4.1.2 Liquid Crystal Display (LCD)

LCD (Liquid Crystal Display) screen is an electronic display module which has wide range of applications. A 16×2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on. A 16×2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5×7-pixel matrix. This LCD has two registers, namely, Command and Data. The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD. Click to learn more about internal structure of a LCD. [6]

4.1.3 YL-69 Moisture Sensor

Product Description

This is a simple sensor that can be used to detect soil moisture/ relative humidity within the soil the module is able to detect when the soil is too dry or wet. Great for use with automatic plant watering systems

Info / Specs:

- Sensitivity is adjustable via the blue digital potentiometer

- Operating voltage 3.3V-5V
- Module dual output mode: digital output or analog output giving more accuracy
- Has pre-drilled hole for easy installation
- Small board PCB size: 3cm * 1.6cm
- Power indicator (red) and digital switching output indicator (green)
- Uses the LM393 comparator chip

Figure 3 :YL-69 sensor

Connections:

- VCC connect to 3.3V-5V
- GND connect to GND
- DO digital value output connector（0 or 1）
- AO analog value output connector

When the soil is:

- Wet: the output voltage decreases
- Dry: the output voltage increases

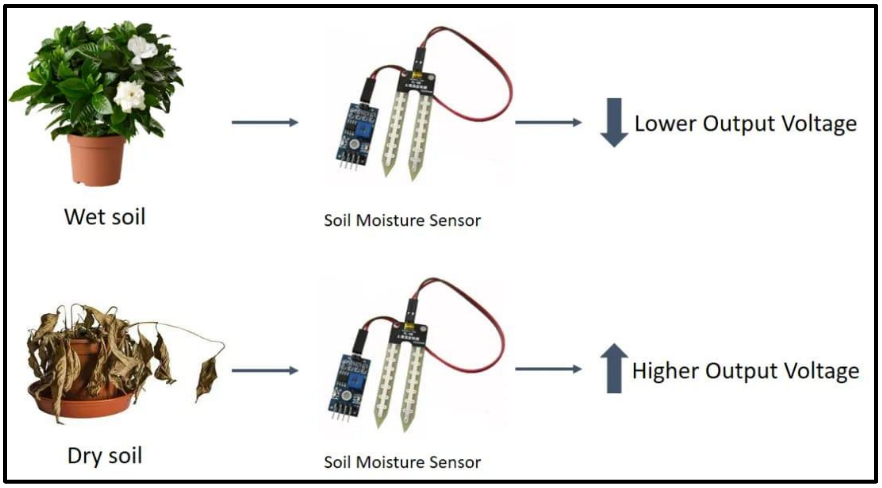

Figure 4: sensor output for dry and wet soil

The output can be a digital signal (D0), LOW or HIGH, depending on the water content. If the soil humidity exceeds a certain predefined threshold value, the modules outputs LOW, otherwise it outputs HIGH. The threshold value for the digital signal can be adjusted using the potentiometer. The output can be an analog signal and so you'll get a value between 0 and 1023. [7]

4.1.4 NodeMCU

NodeMCU is an open source IoT platform. It includes firmware which runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which is based on the ESP-12 module. The term "NodeMCU" by default refers to the firmware rather than the development kits. The firmware uses the Lua scripting language. It is based on the eLua project, and built on the Espressif Non-OS SDK for ESP8266. It uses many open source projects, such as lua-cjson and SPIFFS. [8]

Pins:

NodeMCU provides access to the GPIO (General Purpose Input/Output) and a pin mapping table is part of the API documentation.

I/O index	ESP8266 pin
0 [*]	GPIO16
1	GPIO5
2	GPIO4
3	GPIO0

4	GPIO2
5	GPIO14
6	GPIO12
7	GPIO13
8	GPIO15
9	GPIO3
10	GPIO1
11	GPIO9
12	GPIO10

Table 3: NodeMCU pin configuration

[*] D0 (GPIO16) can only be used for GPIO read/write. It does not support open-drain/interrupt/PWM/I²C or 1-Wire.

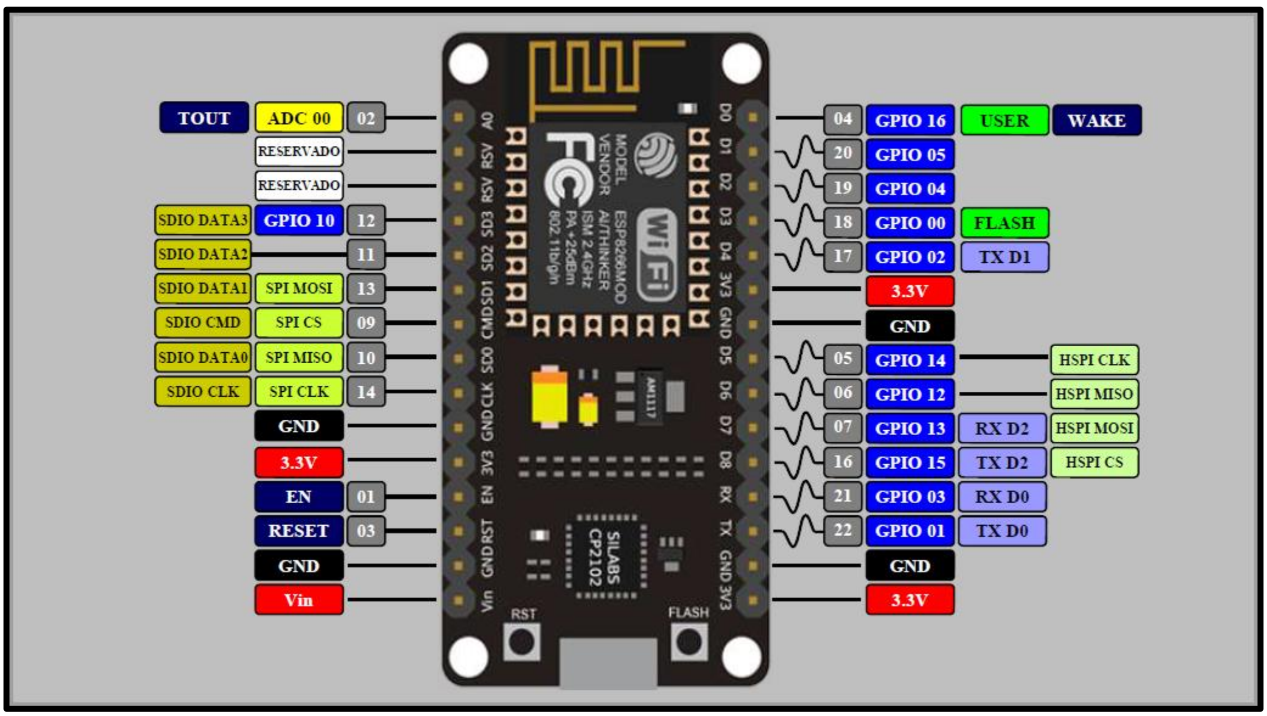

Figure 5: Node MCU

4.2 Software

4.2.1 ThingSpeak

According to its developers, "ThingSpeak is an open-source Internet of Things (IoT) application and API to store and retrieve data from things using the HTTP and MQTT protocol over the Internet or via a Local Area Network. ThingSpeak enables the creation of sensor logging applications, location tracking applications, and a social network of things with status updates".

ThingSpeak was originally launched by ioBridge in 2010 as a service in support of IoT applications. [9]

ThingSpeak has integrated support from the numerical computing software MATLAB from MathWorks, allowing ThingSpeak users to analyse and visualize uploaded data using MATLAB without requiring the purchase of a MATLAB license from MathWorks.

ThingSpeak has a close relationship with MathWorks, Inc. In fact, all of the ThingSpeak documentation is incorporated into the MathWorks' MATLAB documentation site and even enabling registered MathWorks user accounts as valid login credentials on the ThingSpeak website. The terms of service and privacy policy of ThingSpeak.com are between the agreeing user and MathWorks, Inc. [10]

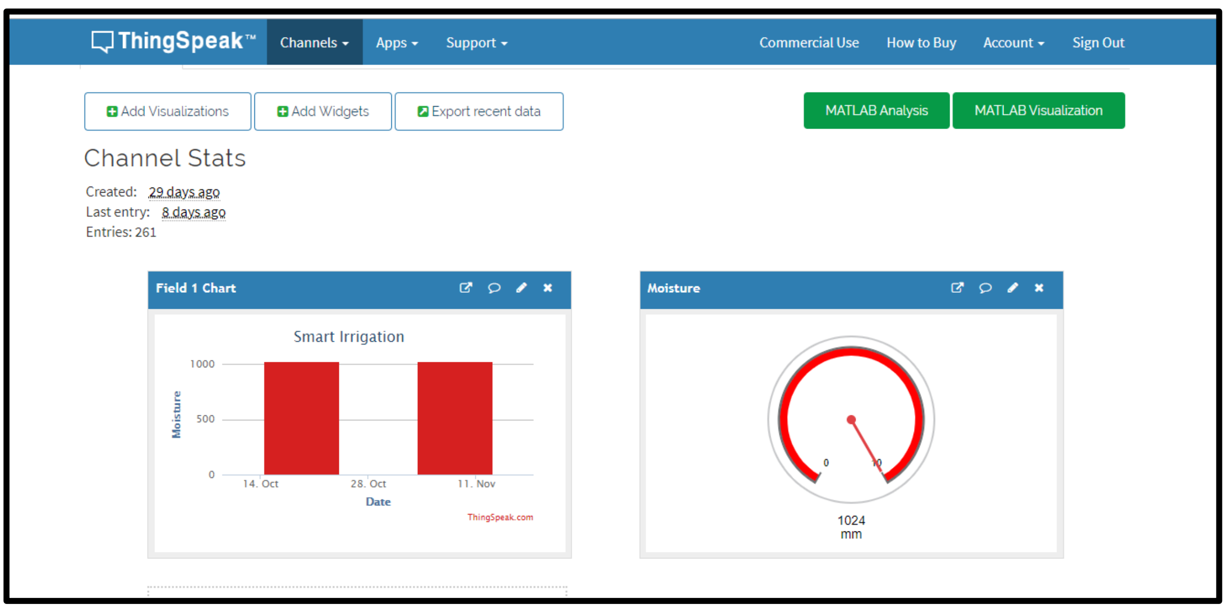

Figure 6: ThingSpeak Page

4.2.2 MIT App Inventor

MIT App Inventor is a web application integrated development environment originally provided by Google, and now maintained by the Massachusetts Institute of Technology (MIT). It allows newcomers to computer programming to create application software (apps) for two operating systems (OS): Android, and iOS, which, as of 8 July 2019, is in final beta testing[citation needed]. It is free and open-source software released under dual licensing: a Creative Commons Attribution ShareAlike 3.0 Unported license, and an Apache License 2.0 for the source code.

It uses a graphical user interface (GUI) very similar to the programming languages Scratch and the StarLogo TNG user interface, which allows users to drag and drop visual objects to create an application that can run on mobile devices. In creating App Inventor, Google drew upon significant prior research in educational computing, and work done within Google on online development environments. [11]

App Inventor and the projects on which it is based are informed by constructionist learning theories, which emphasize that programming can be a vehicle for engaging powerful ideas through active learning. As such, it is part of an ongoing movement in computers and education that began with the work of Seymour Papert and the MIT Logo Group in the 1960s, and has also manifested itself with Mitchel Resnick's work on Lego Mindstorms and StarLogo. [12]

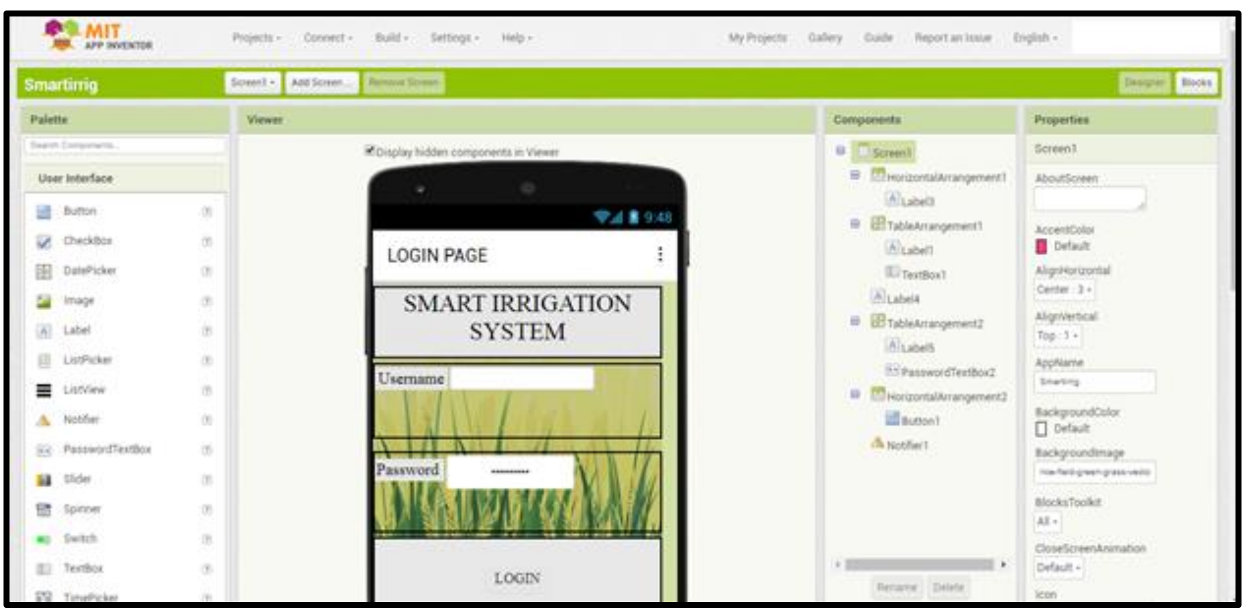

Figure 7: MIT app Inventor page

CHAPTER 5: WORK DONE IN SEMESTER V

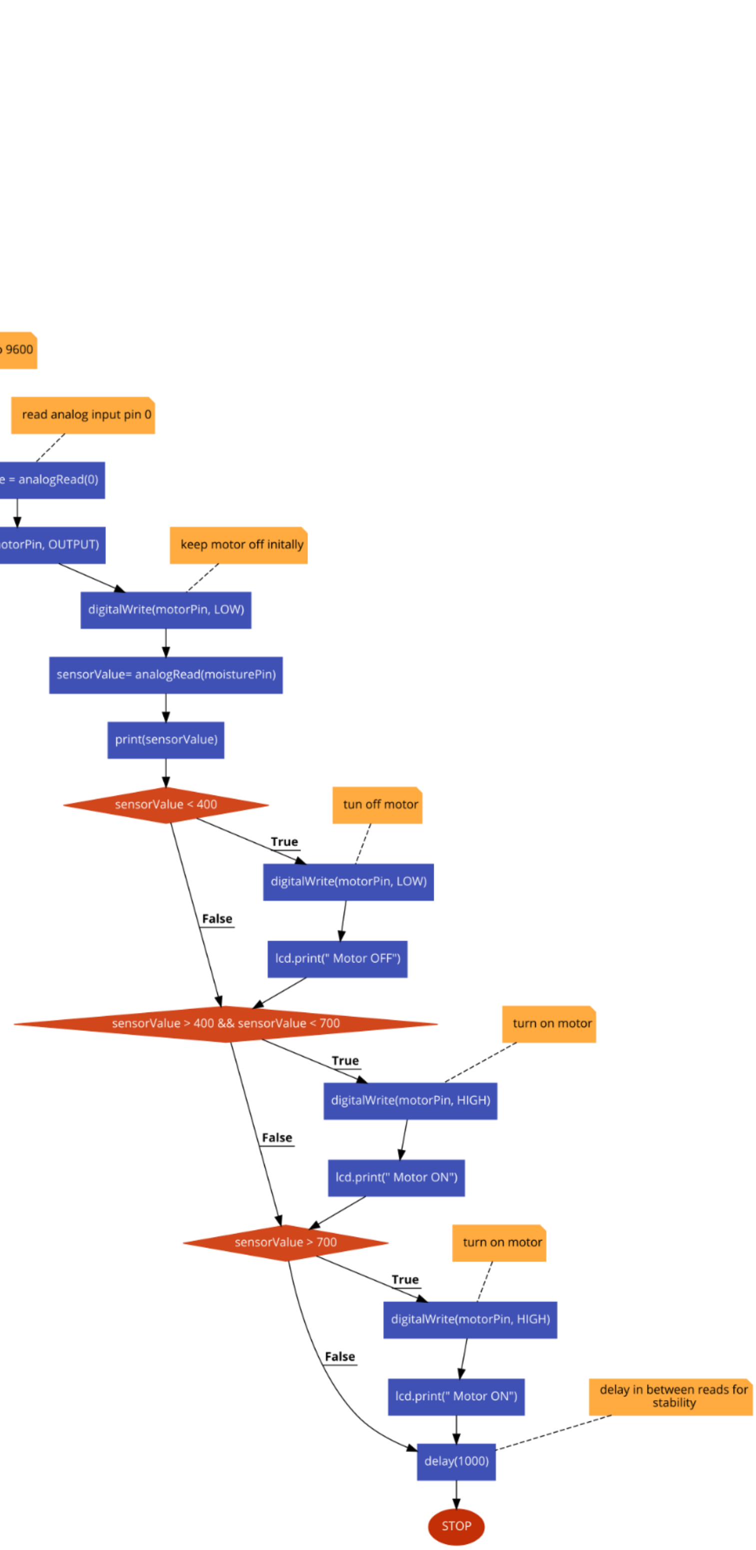

Figure 8: Algorithm for Arduino UNO

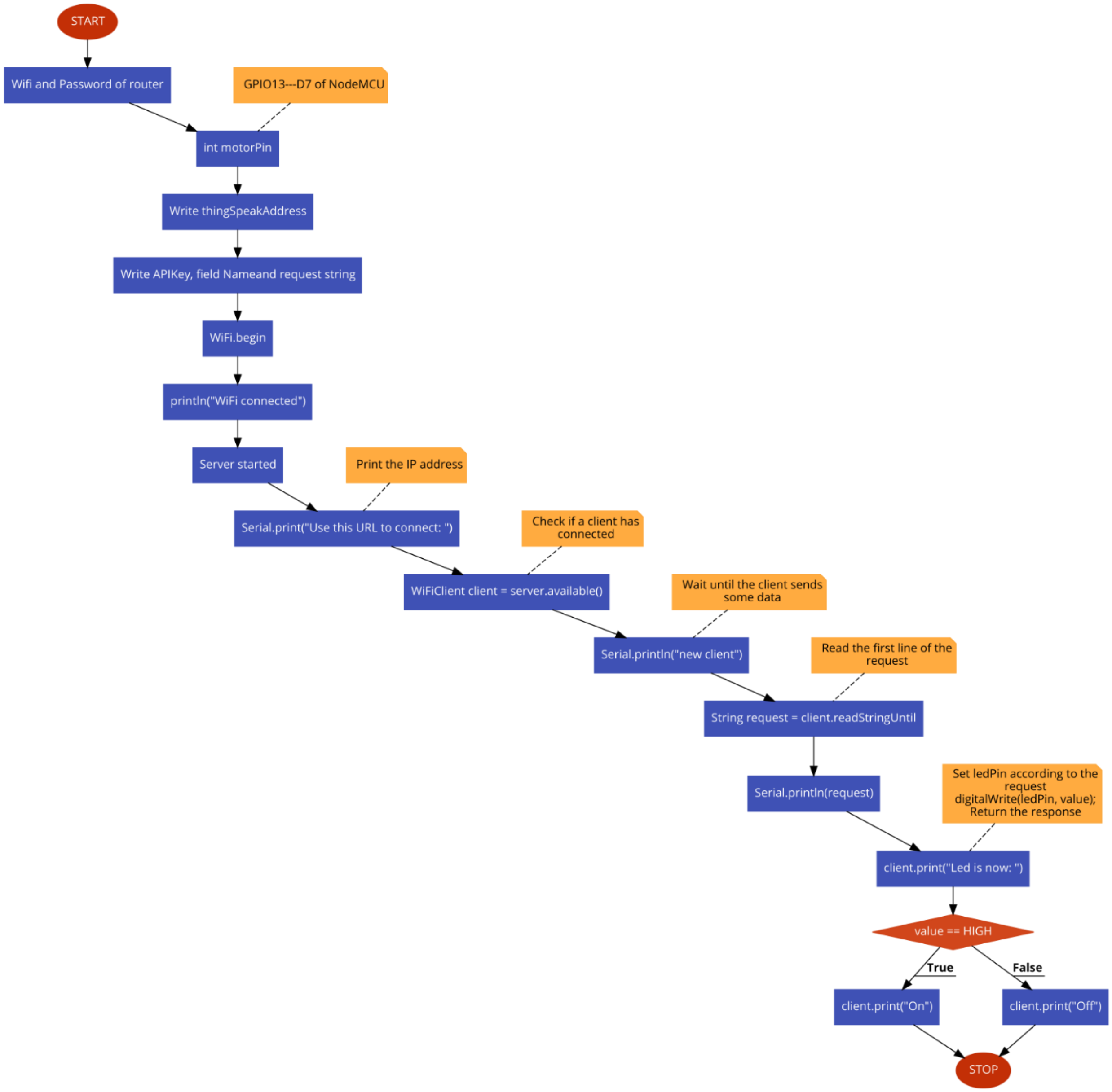

Figure 9:Algorithm for NodeMCU [13]

5.2 Hardware-software Interfacings

The Arduino is connected to Laptop and hardware-software interface is done via Arduino ide.

DRY CONDITION:

If the sensed signal is greater than the threshold voltage for every particular soil, it means it executes the true condition and thus the soil is dry.

The above statement is based on the property of the moisture sensor, i.e., if the sensed value is greater than or equal to the threshold voltage, then the soil is dry and also if there is no rain.

Because the condition is true, the Boolean LED will glow ON and the water pump should turn ON in order to irrigate the plant

WET CONDITION:

If the sensed signal is less than the threshold voltage for every particular soil, it means it executes the false condition and thus the soil is wet.

above statement is based on the property of the moisture sensor, i.e., if the sensed value is less than the threshold voltage, then the soil is wet.

Because the condition is false, the Boolean LED will glow OFF and the water pump should turn OFF because the plant has excess of water content in the soil, irrespective of rain.

Threshold	Soil Moisture	Motor condition
>700	DRY	ON
<400	WET	OFF

Table 4: Motor condition for different thresholds

5.2.1 Experimental Results

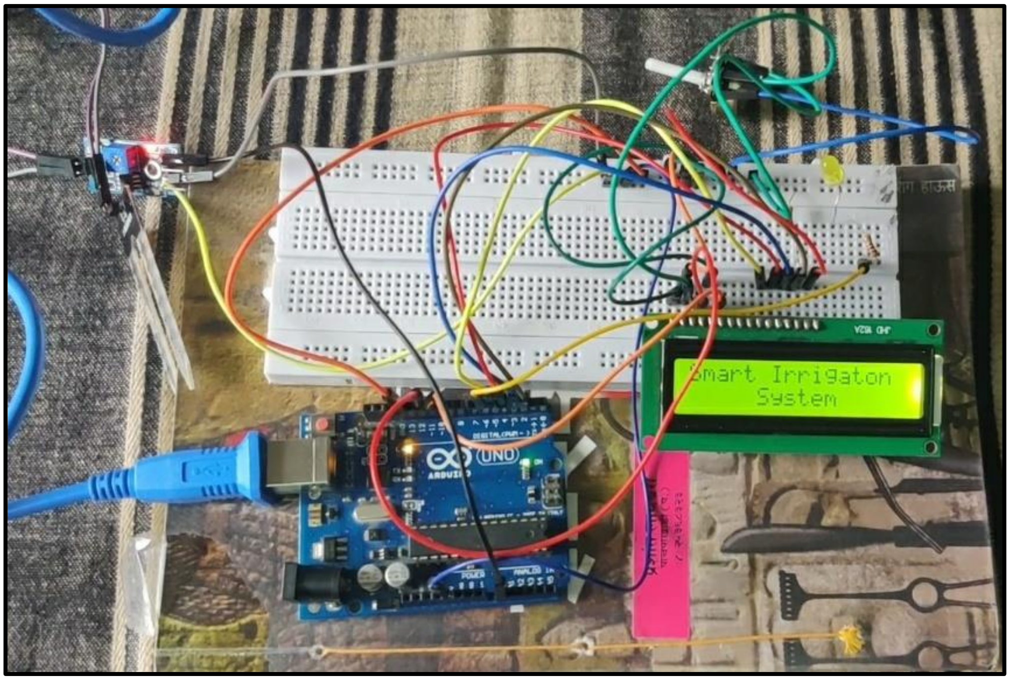

Figure 10: Circuit Connections

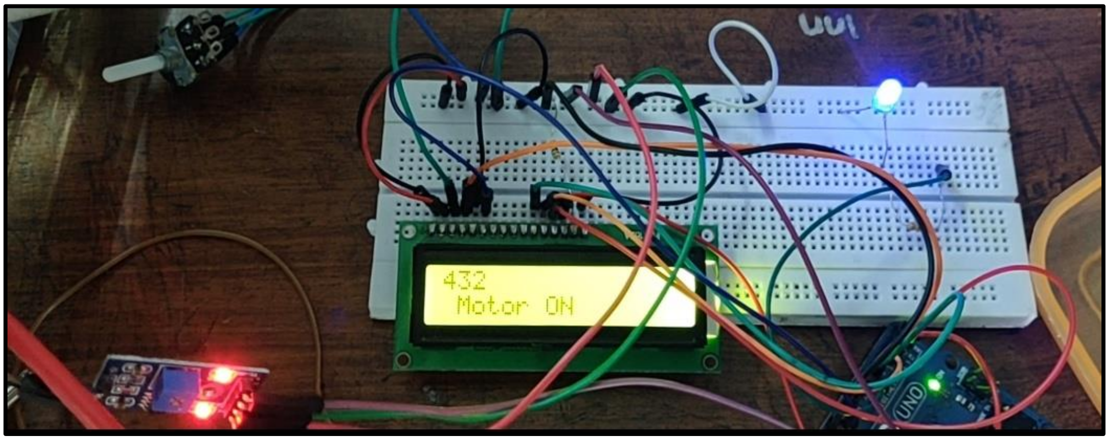

Figure 11: Output window

5.2.2 Mobile Application:

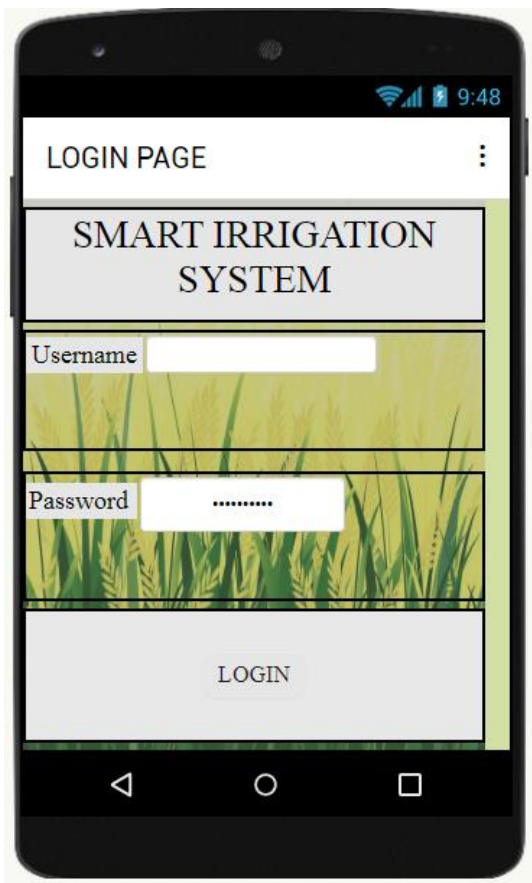

Figure 12: Screen 1

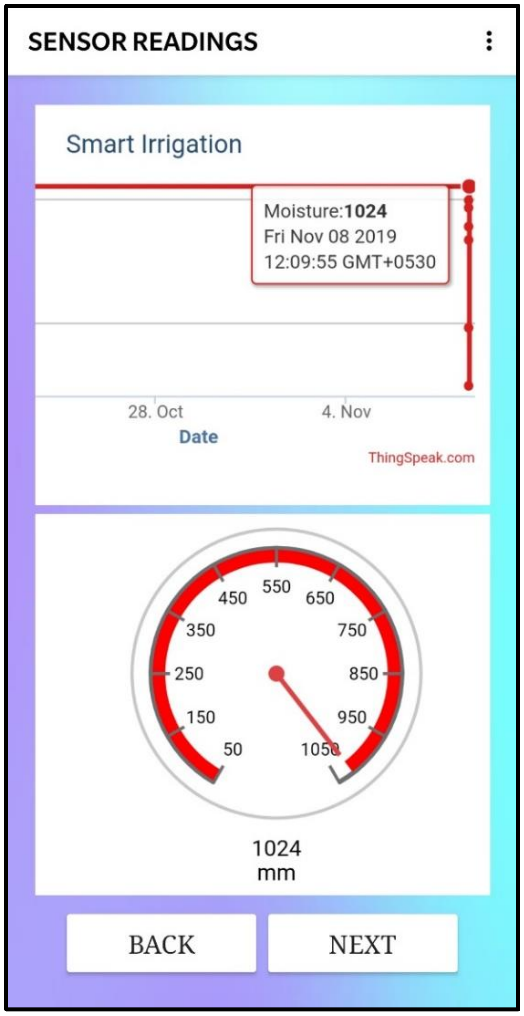

Figure 13: Screen 2

CHAPTER 6: ROADMAP FOR FUTURE WORK

The problem statement has been analyzed properly and the work load is distributed evenly among the group members. Numerous methodologies and various technical papers have been looked into and studied for implementing different parts of the project. The different parts of the project involve building the algorithm for training with the input images, research on hardware building and interfacing etc. Based on the current understanding of the project the time input has been stated below.

Training is one of the very important tasks of the entire project. Only if the training algorithm and mechanism is working properly can the rest of the project be implemented. So, the very first task that we have taken in hands is to build the hardware properly. The input data need to be fed into the system accurately so as to equip the system to understand and learn better.

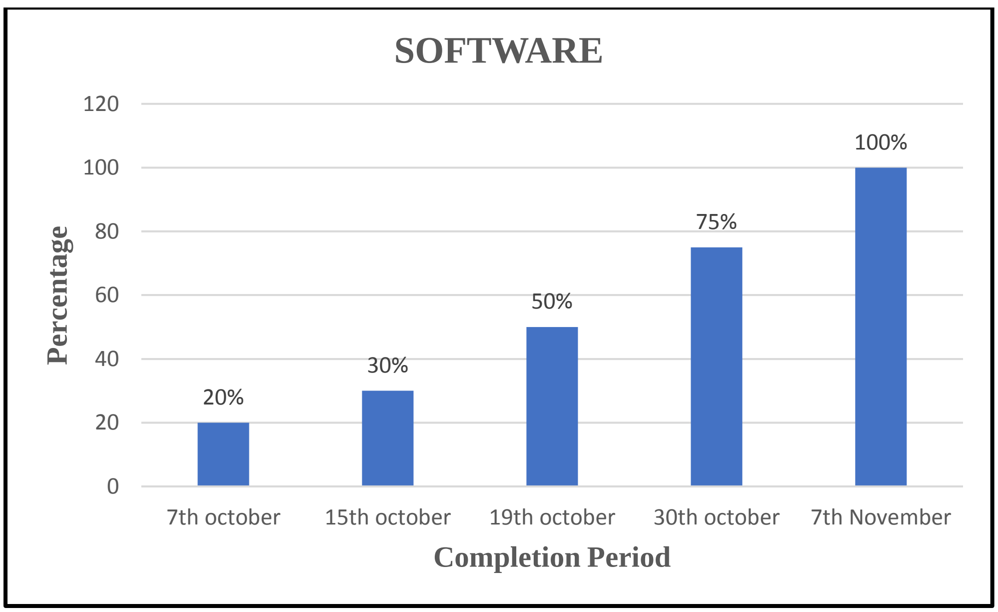

Figure 14: Work completed

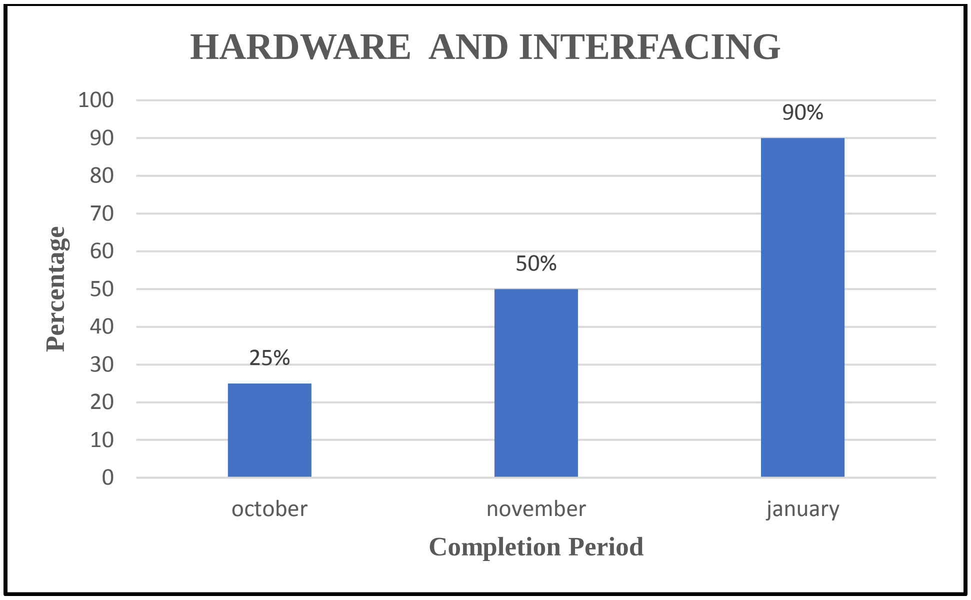

Figure 15: Estimated completion date

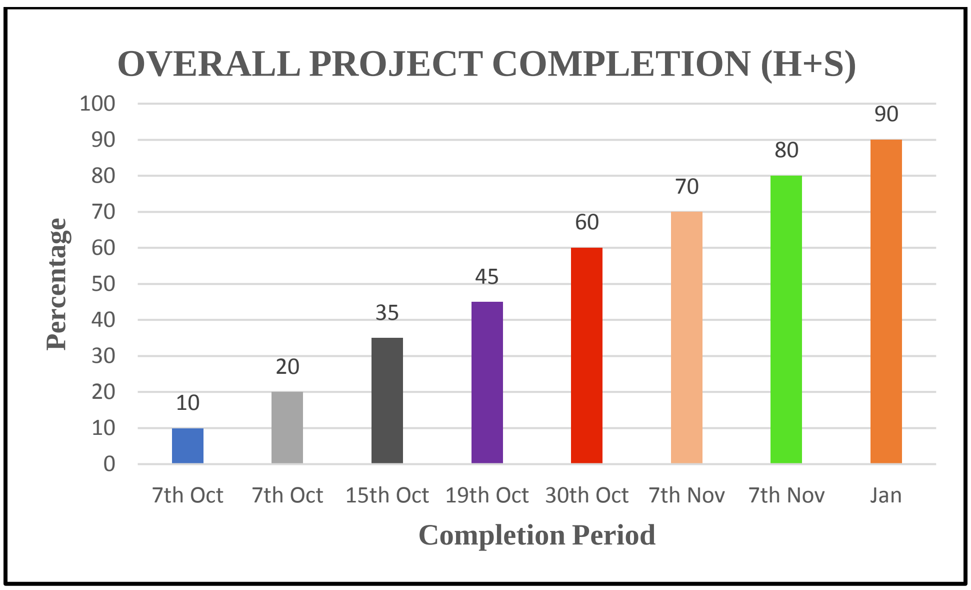

Table 5: Overall project completion

The above bar graph (Figure 1) gives the amount of work done in each time span and the expected project completion time. The deadline of the completion of the project can be considered to be at the end of January 2020. The work in the sixth semester post the winter break would be to create the prototype of the project system which will help us to visualize the project better in the real time environment. The prototype will include a real life looking agricultural field demo model which will have the smart irrigation system installed and help the users get a better understanding of the project and application.

CONCLUSION

In this project we have interfaced Moisture sensor with Arduino in order to measure the moisture of the agricultural field.

Moisture sensor senses the moisture level (0-1023) and turns the motor ON or OFF according to the given threshold. This is then transferred to the application via a NodeMCU module.

The application consists of the information of the current sensor moisture levels and a graph of moisture vs time, present in the field.

The application also provides an option to turn OFF and turn ON the motor manually.

No longer only are farmers able to generally use much less water to grow a crop, but they're able to increase growth yields and obtain satisfactory results of the crop by using better management of soil moisture. Hence, precise irrigation control through thus project permits producers to maximize their productivity whilst saving water.

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