1. INTRODUCTION

1.1 BACKGROUND

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 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 tend to use machine-controlled system for irrigation.

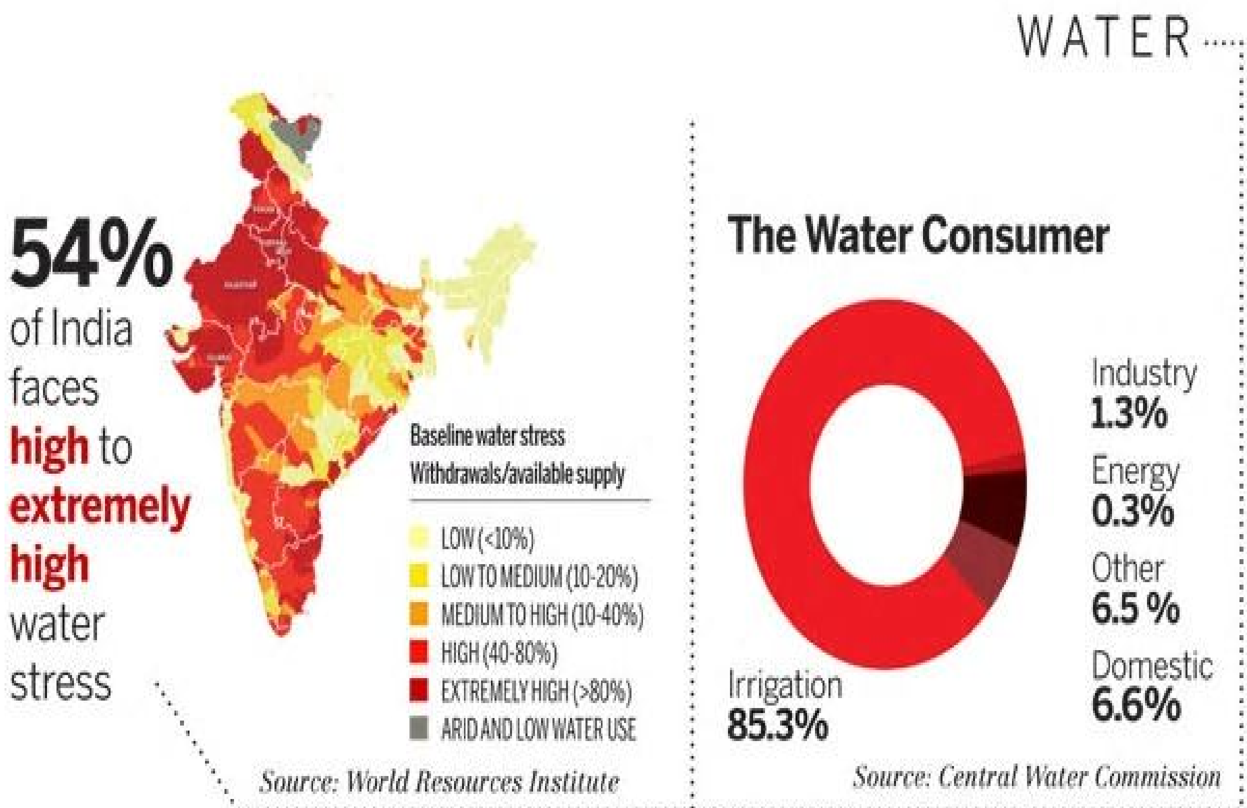

Fig 1.1: Invisible water, visible crisis

1.2 INTERNET OF THINGS

The creation of the Internet of Things will entail the connection of everyday objects and devices to all kinds of networks, e.g. company intranets, peer-to-peer networks and even the global internet. For this reason, its development is of great significance to the telecommunication industry. It will challenge existing structures within established companies, and form the basis for entirely new opportunities and business models. The Internet of Things builds upon the revolutionary success of mobile and internet networks by expanding the world's network of networks even further. It does so through the application of key technological enablers. In this report, these enablers have been identified as radio-frequency identification (RFID), wireless sensor technologies, smart technologies and nanotechnology. The 'expanded' internet will be able to detect and monitor changes in the physical status of connected things (through sensors and RFID) in real-time. Developments in miniaturization will further enable technological ubiquity. Networks and the objects they connect are also becoming increasingly intelligent, through developments in "smart technologies". Although the Internet of Things is a relatively new vision, its enabling technologies have been around for some time, developed in relative isolation from each other. RFID was invented in the middle of the last century and materials using nanotechnology have been on the market for over a decade. The impact of a combination of such technologies cannot be underestimated. In this respect, it is worth looking at the current telecommunication landscape to gauge the future potential relevance of the Internet of Things to the industry as a whole.

1.3 PROJECT

Our project, WIRELESS GARDENING's aim is to develop a wireless three 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. 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. The objective of this 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 and the sensor data can be seen on Internet. In order to replace expensive controllers in current available systems, the NodeMCU will be used in this project as it is an affordable microcontroller. The NodeMCU can be programmed to analyze some signals from sensors such as moisture, temperature. A pump is used to pump the 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. 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. Bulk of the existing systems employ micro-processorbased 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.

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 work perpetually for indefinite fundamental measure, even in sure abnormal circumstances.

2. LITERATURE SURVEY

Sotiris Nikoletseas [1] used wireless sensor networks as a crucial part of the Future Internet. Thus, they will play an important role in our everyday life in years to come. The applications of WSNs range from distributed monitoring systems to smart embedded managing systems. As water supplies become scarce and polluted, there is a dire need to irrigate more e□ciently in order to optimize water use. Recent advances in soil water monitoring combined with the growing popularity of Wireless Sensor Networks make the commercial use of such systems applicable not only to agriculture and industry but to homes as well.To date, typical irrigation automations include electromechanical programmers that can control the watering procedure. These systems are programmed to irrigate at regular time intervals for predefined periods of time; e.g. once a day for half an hour. The programming of these automated systems is heuristically based on experience and is poorly adaptable to changes in weather conditions, as well as the existence of di□erent water needs by di□erent kind of plants. As a result, water resources are poorly used, plantation is over- or under-irrigated and increased costs of garden maintenance are introduced. Furthermore, the use of Wireless Sensor Networks gives watering systems monitoring as well as remote management capabilities. With sensor motes being IPv6 capable, they can be represented as resources in a RESTful architecture, thus allowing remote access and control to the system (e.g. via Android devices).

J. Balendonck et. al. [2] described FLOW-AID system FLOW-AID (Farm Level Optimal Water management, Assistant for Irrigation under Deficit) as an on-going European project that aims to make irrigation sustainable by improving deficit irrigation practices, and by helping growers to safely, more efficiently and cost-effective manage irrigation. It aims at integrating innovative, but simple and affordable, monitoring and control technologies within an appropriate DSS (Balendonck et al., 2007; Balendonck, 2008). It focuses on the various and typical (protected as well as non-protected) growing systems found in the semi-arid regions of the Mediterranean. Testing and calibrating the system under the various local constraints of farm and basin management, helps to ensure that the technical, environmental and economic performance of irrigation systems is improved.

Nicolas Fatras [3] considered water as a crucial focus of Californian agriculture nowadays, several different water economization techniques and procedures have been put into practice already. Drip system irrigation is becoming more and more generalized and drought resistant crops are starting to replace too heavy water-consuming plants. However, following a study from the Pacific Institute, the method enabling the largest amount of water saving is through the installation of smart irrigation systems. The modest crop shifting is able to save approximately 1.25 million acre-feet per year, the advanced irrigation management is able to save about the same amount of water and the efficient irrigation technology will also save around half a million acre-feet per year. However, the smart irrigation scheduling, which is essentially the concept smart water irrigation system is adopting, can save more the total of all these alternative irrigation methods. This is also the reason our staff would like to increase the irrigation system efficiency using the smart irrigation scheduling instead of other irrigation methods or concepts.

3. PROPOSED METHODOLOGY

3.1 Problem Statement:

Water is a scarce resource, 85% of it is used in agriculture through irrigation. Inefficiencies in irrigation and fertilizer application has resulted in increased production cost and lower production in farms. Knowing when, where and how much water to provide is the important aspect of farming. Computerized control in input application has been found to be efficient and effective approach to address these challenges.

Objective:

- To design and fabricate an automatic irrigation system thereby saving time & power for the farmer.
- To learning about website handling.
- To learn how to use cloud.
- To understand interfacing various Sensors.
- To collect data about needs of different crops.

Outcomes:

- System implemented is feasible and cost effective for the optimization of water resources in agriculture.
- Hardware of the system allows it to use it large scale for greenhouses or open fields.
- Monetary savings in water usage.
- Correctly determined the soil moisture levels.
- Water supply was controlled successfully via NodeMCU.
- Displaying real time data to a web client.
- Studied to use relay module.

3.2 Problem Motivation:

Agriculture plays the important role in the economy and development, like India. Due to lack of water and scarcity of land water result the decreasing volume of water on earth, the farmer use irrigation. Irrigation may be defined as the science of artificial application of water to the land or soil that means depending on the soil type, plant is to be provided with water.

3.3 Block Diagram

The main component of our system is the NodeMCU. It is interfaced with all the sensors and it also controls all the sensors. Two sensors DHT11 & Soil Moisture Senor both give data to the NodeMCU. It gets connected to the local network available and sends the data of sensors to the local server & to the mobile application. NodeMCU also is controlling the relay, which in turn is controlling the water motor.Soil moisture sensor and DHT11 transmits analog data to NodeMCU. Water motor is connected to the microcontroller via relay module.

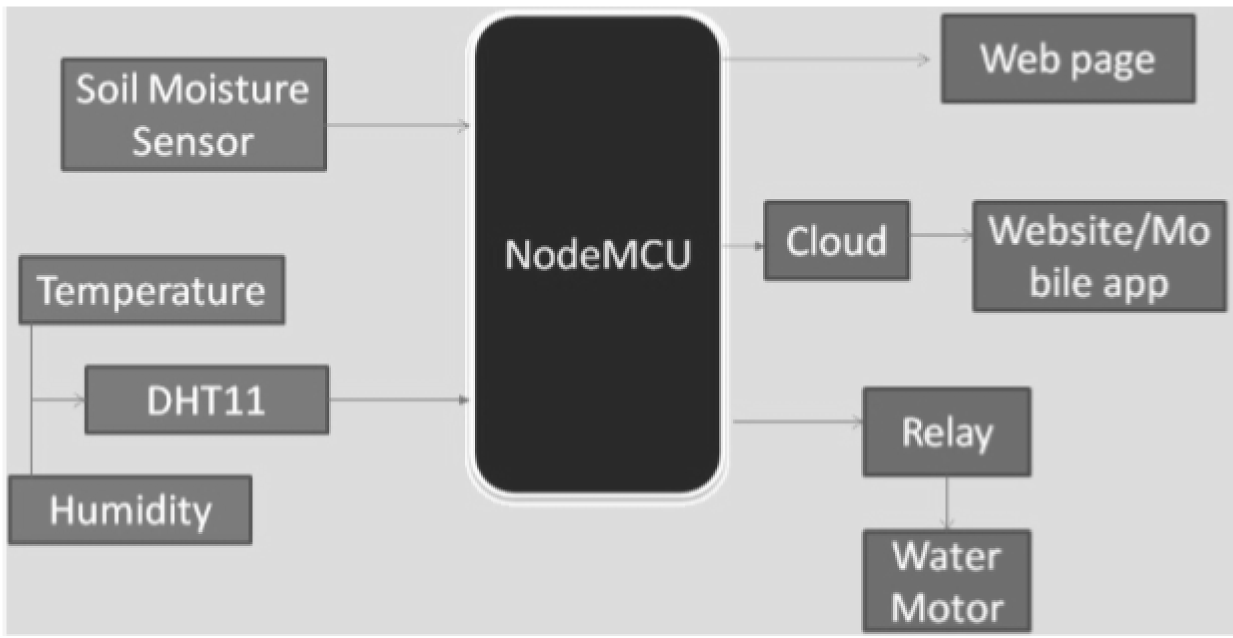

Fig 3.1 Block diagram of proposed system

The system designed has 3 different operating modes

1. Automatic Controls
2. Webpage controls
3. Through the Mobile Application.

Automatic control:

In automatic control the device is independent of any command via any source, it operates on its own depending on the moisture content of soil.

=> Motor will be turned on when the moisture drops below 50% i.e. during the Dry conditions.

=> If soil's moisture is exceeding 50% the motor will be turned off i.e. during theWet conditions.

Webpage control:

The webpage created on the local server by the NodeMCU has three button controls for the motor pump to act. It also displays all the live data collected by the device i.e moisture, pump status, temperature, humidity.

a. Pump On
b. Pump Stop
c. Automatic

Mobile Application:

Here we have used the Blynk application and server for our application-based controls it gives the user various control modes viz. pump on, pump off, automatic pump also it shows live data of the moisture, temperature, humidity & status of pump.

NodeMCU

It is an open source IoT platform.It is an open source LUA based firmware developed for ESP8266 Wi-Fi chip. By exploring functionality with ESP8266 chip, NodeMCU firmware comes with ESP8266 Development board/kit i.e. NodeMCU Development board. It can be programmed directly through USB port using LUA programming or Arduino IDE. By simple programming we can establish a Wi-Fi connection and define input/output pins according to your needs exactly like Arduino, turning into a web server and a lot more.

NodeMCU is the Wi-Fi equivalent of ethernet module. It combines the features of Wi-Fi access point and station + microcontroller.0 These features make the NodeMCU extremely powerful tool for Wi-Fi networking. It can be used as access point and/or station, host a web server or connect to internet to fetch or upload data.

Features

- Finally, programable Wi-Fi module.
- Arduino-like (software defined) hardware IO.
- Can be programmed with the simple and powerful Lua programming language or Arduino IDE.

- USB-TTL included, plug & play.
- 10 GPIOs D0-D10, PWM functionality, IIC and SPI communication, 1-Wire and ADC A0 etc. all in one board.
- Wi-Fi networking (can be used as access point and/or station, host a web server), connect to internet to fetch or upload data.
- Event-driven API for network applications.
- PCB antenna.

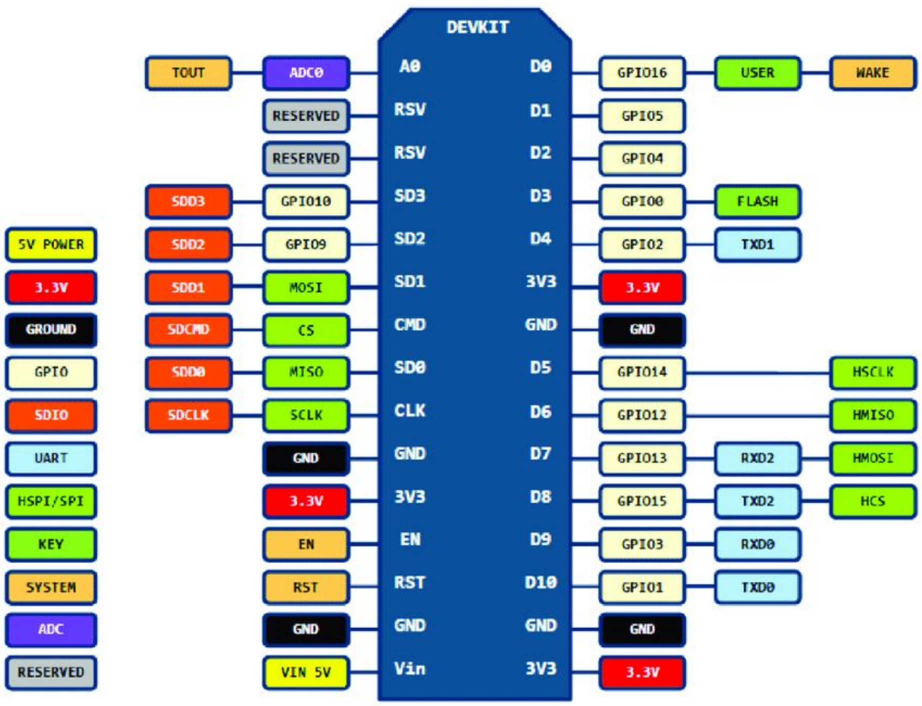

Fig 3.2: NodeMCU pin configuration

Fig 3.3: NodeMCU

Moisture Sensor

Soil moisture sensors measure the volumetric water content in soil. Since the direct gravimetric measurement of free soil moisture requires removing, drying, and weighting of a sample, soil moisture sensors measure the volumetric water content indirectly by using some other property of the soil, such as electrical resistance, dielectric constant, or interaction with neutrons, as a proxy for the moisture content. The relation between the measured property and soil moisture must be calibrated and may vary depending on environmental factors such as soil type, temperature, or electric conductivity. Reflected microwave radiation is affected by the soil moisture and is used for remote sensing in hydrology and agriculture. Portable probe instruments can be used by farmers or gardeners.

Soil moisture sensors typically refer to sensors that estimate volumetric water content. Another class of sensors measure another property of moisture in soils called water potential; these sensors are usually referred to as soil water potential sensors and include torsi meters and gypsum blocks.

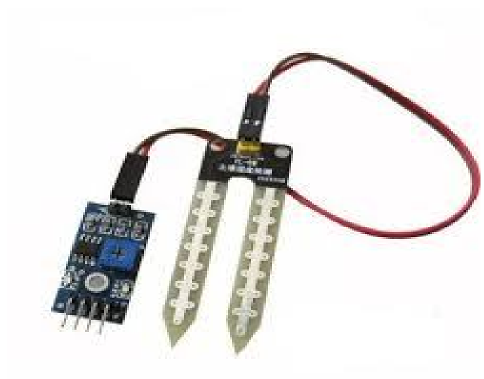

Fig 3.4: Soil Moisture Sensor

DHT11

DHT11 Temperature & Humidity Sensor features a temperature & humidity sensor complex with a calibrated digital signal output. By using the exclusive digital-signal-acquisition technique and temperature & humidity sensing technology, it ensures high reliability and excellent long-term stability. This sensor includes a resistive-type humidity measurement component and an NTC temperature measurement component, and connects to a high-performance 8-bit microcontroller, offering excellent quality, fast response, anti-interference ability and costeffectiveness. Each DHT11 element is strictly calibrated in the laboratory that is extremely accurate on humidity calibration. The calibration coefficients are stored as programmes in the OTP memory, which are used by the sensor's internal signal detecting process. The single-wire serial interface makes system integration quick and easy. Its small size, low power consumption and up-to-20-meter signal transmission making it the best choice for various applications, including those most demanding ones. The component is 4-pin single row pin package. It is convenient to connect and special packages can be provided according to users' request.

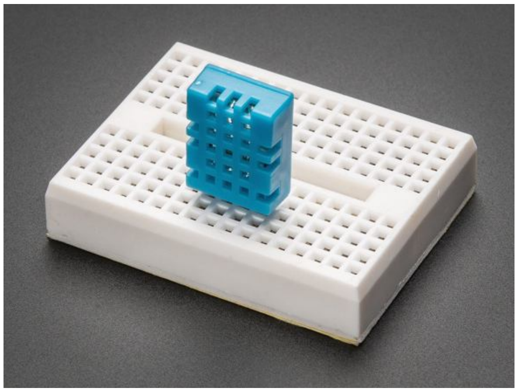

Fig 3.5: DHT11

Submersible Water Pump:

A Submersible pump is a device Which is a hermetically sealed motor closed coupled motor to the pump body. The whole assembly is submerged in the fluid to be pumped. The main advantage of this pump Is that it prevents pump captivations' problem associated with a high elevation difference between pump and the fluid surface small dc submersible water pump push fluid to the surface as opposed to jet pump having to pull fluid. submersible are more efficient than jet pump. It is usually operated between 3v to 12v.

Fig 3.6: Submersible DC Water Pump

Relay

It is an electromagnetic device which is used to isolate two circuits electrically and connect them magnetically. They are very useful devices and allow one circuit to switch another one while they are completely separate. They are often used to interface an electronic circuit (working at a low voltage) to an electrical circuit which works at very high voltage. For example, a relay can make a 5V DC battery circuit to switch a 230V AC mains circuit. Thus a small sensor circuit can drive, a fan or an electric bulb. When the Arduino supplies HIGH voltage (5V) to the relay, it turns it on (the switch is ON), otherwise, it remains off.

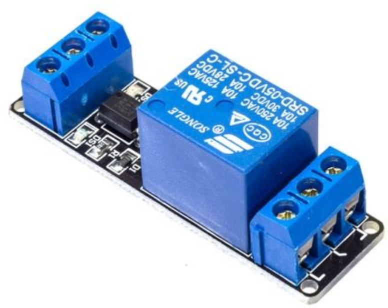

Fig 3.7: Relay

4. PROJECT IMPLEMENTATION

4.1 Circuit Design

Fig 4.1 shown below is the circuit we designed from the block diagram for our project.

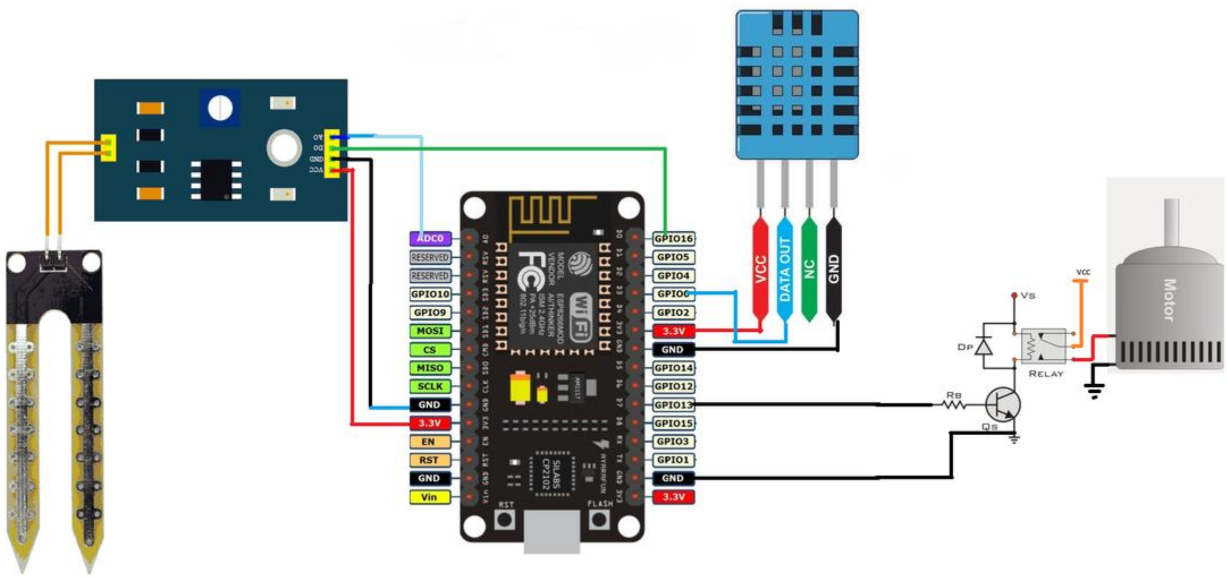

Fig 4.1: Circuit diagram of proposed system

The above circuit was designed using software with all components of the circuit taking inputs from sensors and providing outputs to the relay. The moisture sensor is connected to VCC, GND and A0 of the Nodemcu. DHT11 is connected to GPIO14 or D3 pin of Nodemcu. Relay logic pin is connected to GPIO13 or D7 pin of nodemcu. USB port of NodeMCU is connected to power source or laptop as required. All the components are given VCC and GND from the NodeMCU. Fig 4.2 shows the final circuit developed for the project. It is developed on the pcb components seen are nodemcu, moisture sensor & DHT11. Moisture sensor is not fixed as it has to be placed in the soil to collect the moisture data.

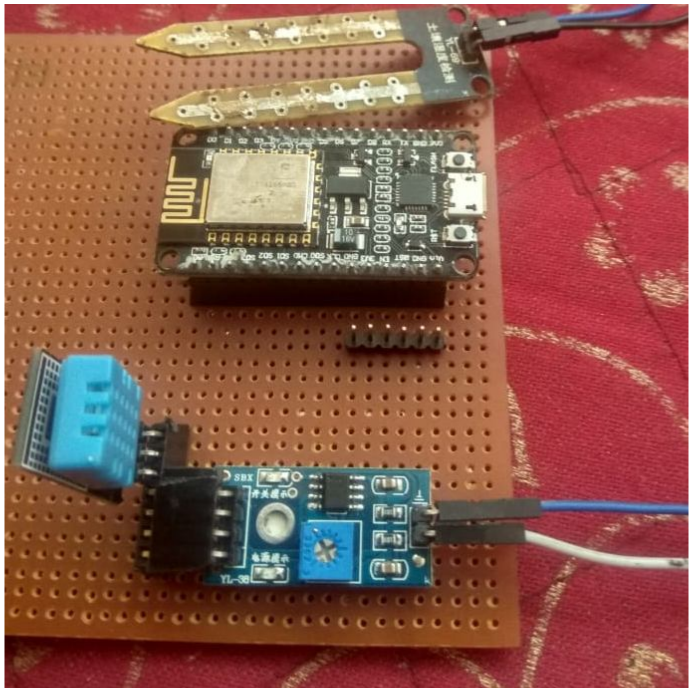

Fig 4.2: Final circuit designed for testing

4.2 Software Requirement

Arduino IDE:

The open-source Arduino Software(IDE) makes it easy to write code and upload it to the board. It runs on various OS. The environment is written in Java and based on Processing and other open-source software.We used the Arduino IDE to program our Nodemcu.

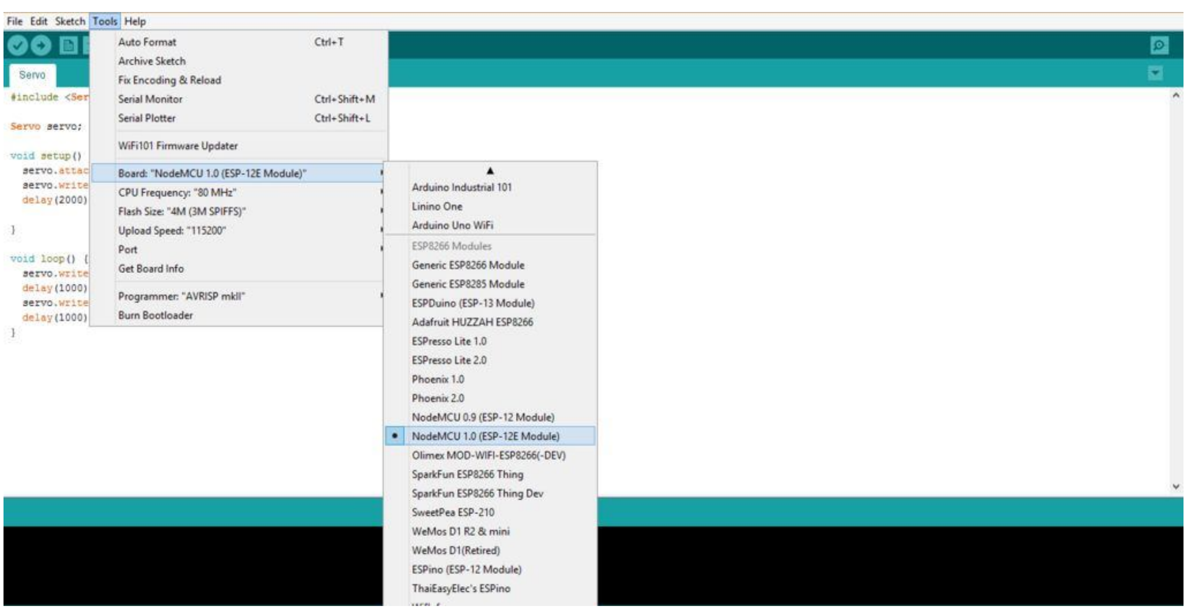

Fig 4.3: Arduino IDE settings for NodeMCU

Fritzing:

Fritzing is an open-source hardware initiative that makes electronics accessible as a creative material for anyone. For designing circuit Fritzing was used.

KiCad:

KiCad is an open source software suite for Electronic Design Automation (EDA). The programs handle Schematic Capture, and PCB Layout with Gerber output. The suite runs on Windows, Linux and macOS and is licensed under GNU GPL v3. Fig 4.2 is the B.Cu side of the pcb we designed.

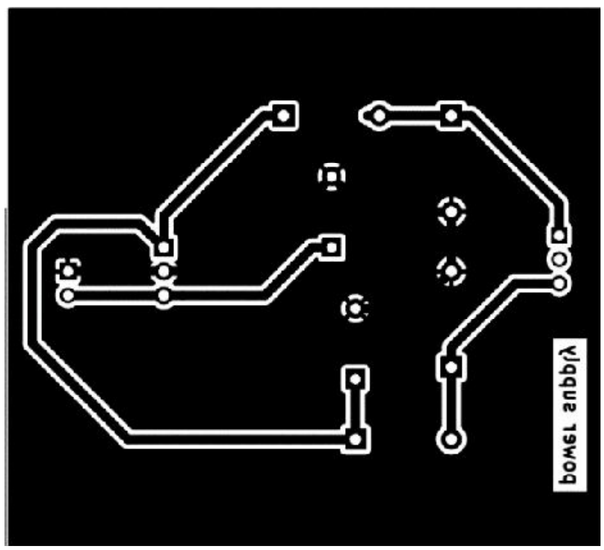

Fig 4.4: PCB layout of Power supply

Blynk:

Blynk is a new platform that allows you to quickly build interfaces for controlling and monitoring your hardware projects from your iOS and Android device. After downloading the Blynk app, you can create a project dashboard and arrange buttons, sliders, graphs, and other widgets onto the screen. Using the widgets, you can turn pins on and off or display data from sensors.

4.3 Bread Board Testing

The DC water motor we used required 12V supply so we designed a power supply for the motor, which will convert the 230V AC mains supply to the required 12V.

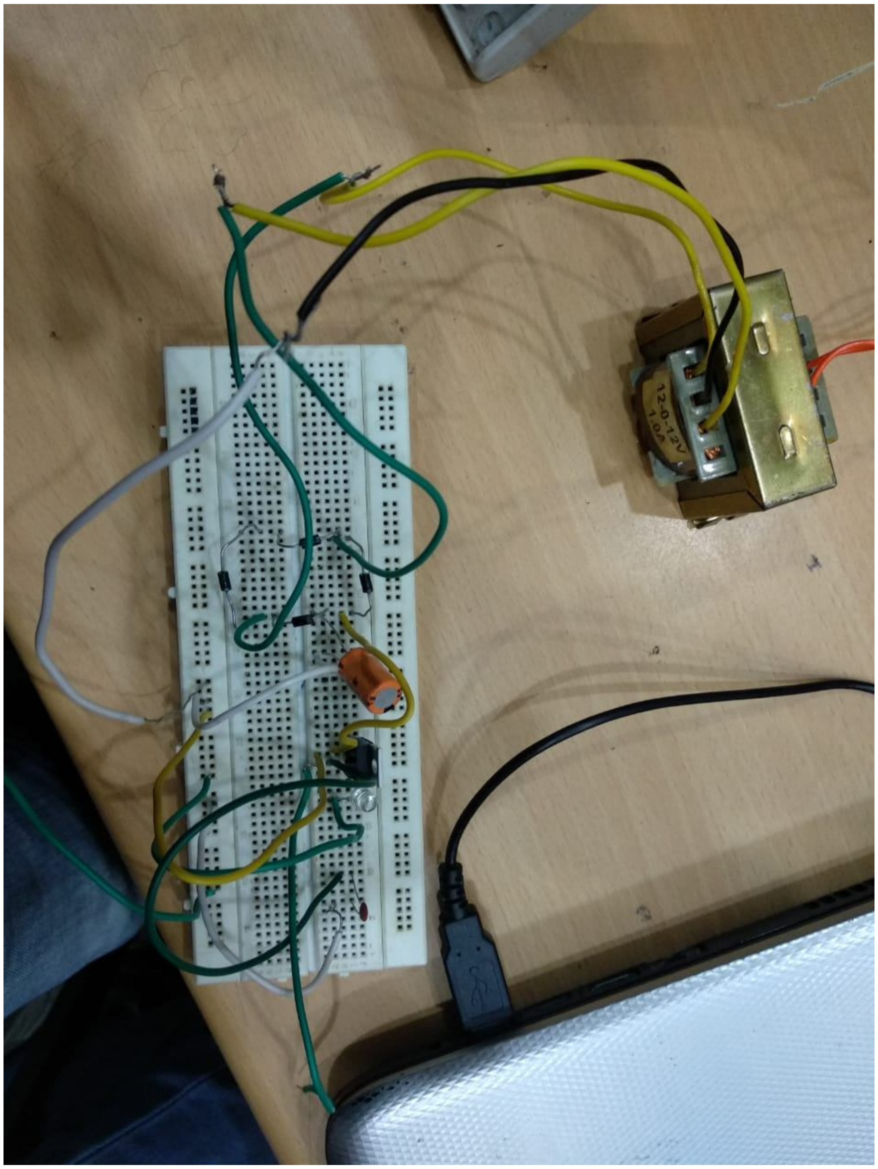

Fig 4.5: Bread board testing of power supply

4.4 Programming

Algorithm:

1) Include the ESP8266 header files.

2) Define all the input and output pins.
3) Declare the variables, constants.
4) Setting the Wi-Fi ssid and password.
5) Take inputs from the sensors. 'AnalogRead' for Moisture sensor and 'get' function for DHT11.
6) Make all the needed calculations.
7) Built "if loops" for automatic handling of motor pump.
8) Create HTML code for webpage display.
9) Triggering Blynk app and sending it the data.

Flowchart:

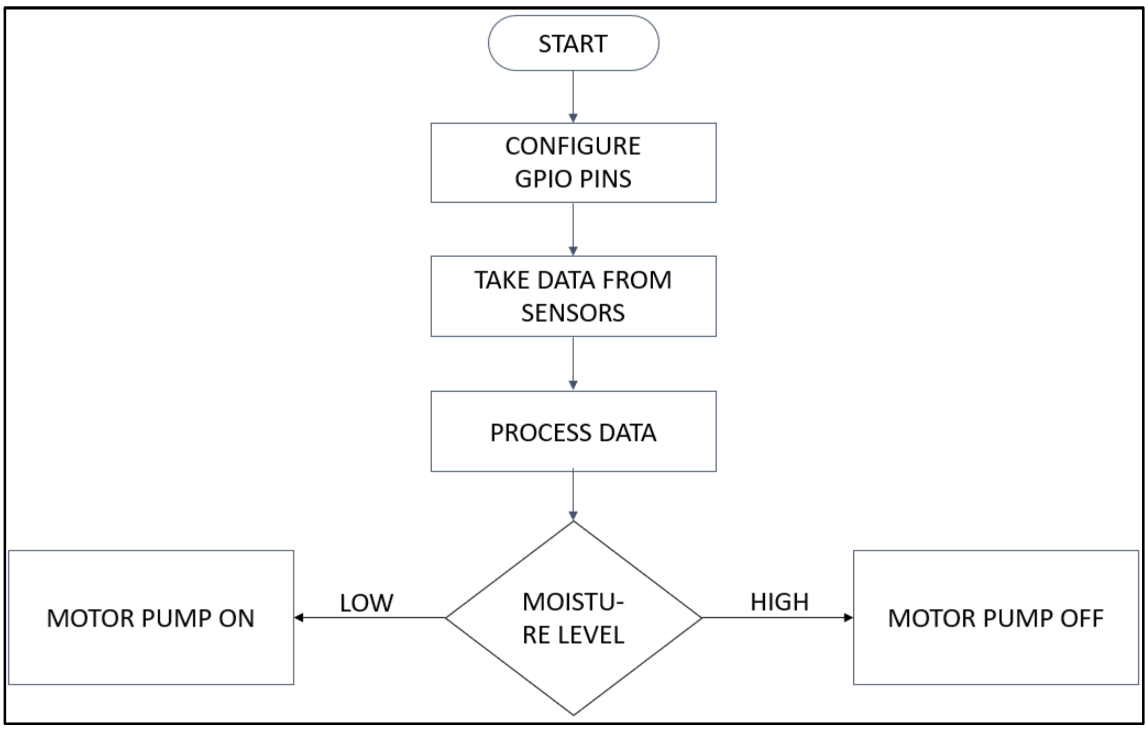

Fig 4.6: Flowchart for Automatic mode

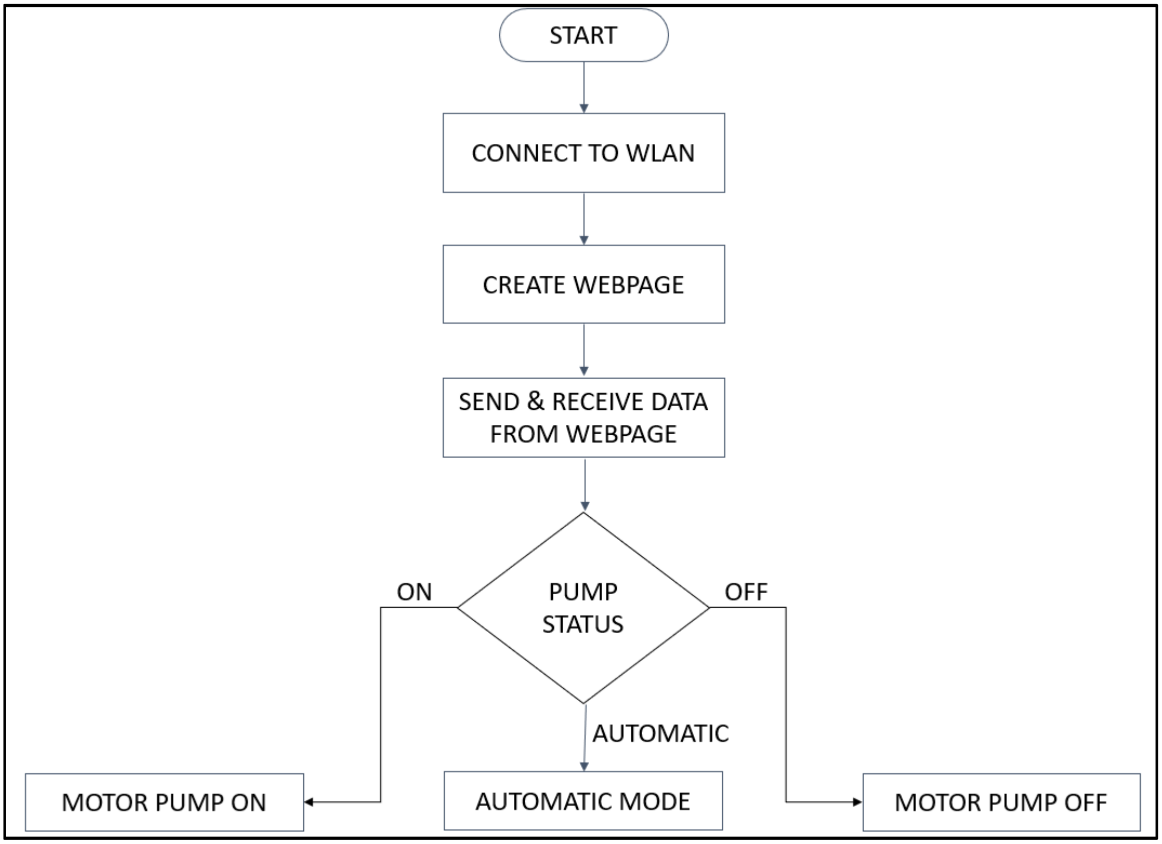

Fig 4.7: Flowchart of Webpage

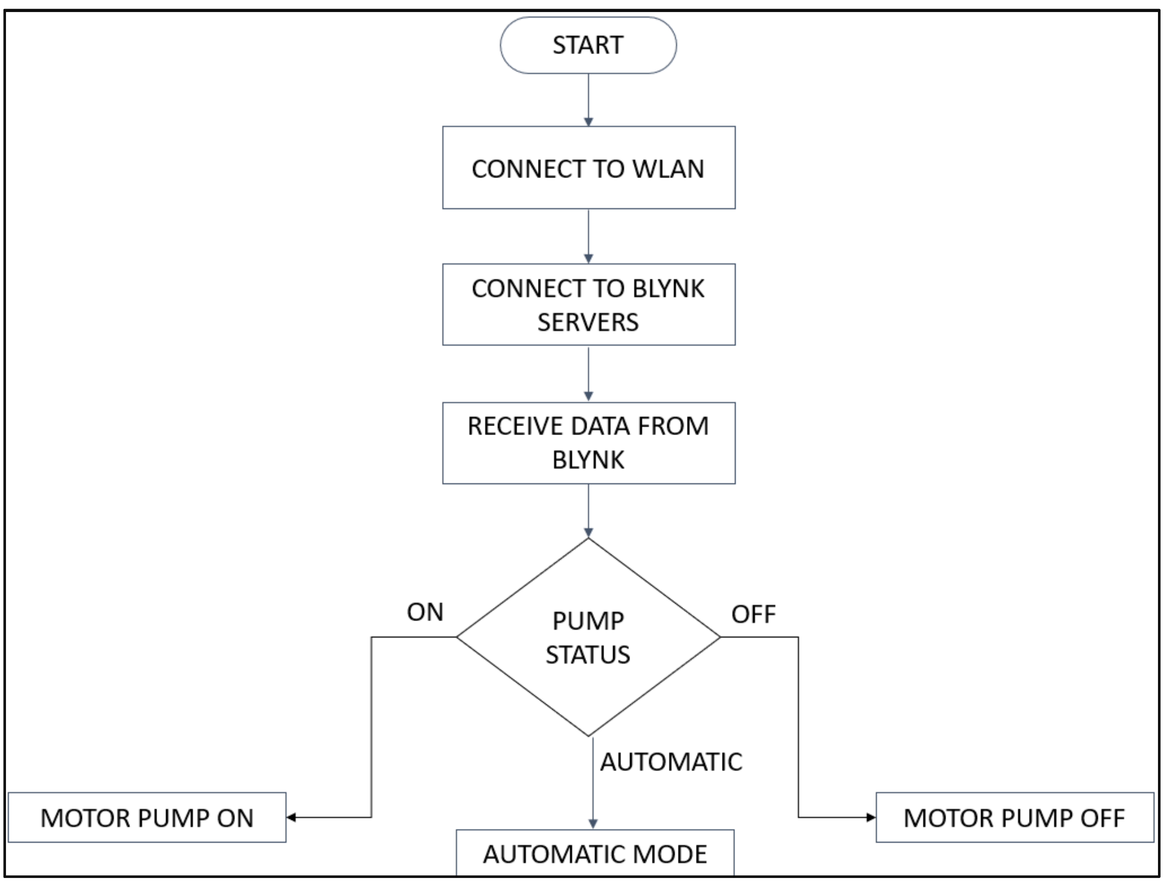

Fig 4.8: Flowchart for Blynk

Table 4.1: Source code that acts upon different situations

CONTROL	COMMAND	MOISTURE LEVEL	MOTOR STATUS
WEBPAGE	PUMP ON	Nil	ON
	PUMP OFF	Nil	OFF
	AUTOMATIC	HIGH	ON
		LOW	OFF
MOBILE APPLICATION	PUMP OFF	Nil	OFF
	PUMP ON	Nil	ON
	AUTOMATIC	HIGH	ON
		LOW	OFF

4.5 Project component and cost estimate

Table 4.2: Project cost estimate

Sr. No	Component Name	Quantity	Cost per unit	Total Cost
1	NodeMCU	1	360	360
2	Soil Moisture Sensor	1	100	100
3	DHT11	1	90	90
4	DC Water Pump	1	120	120
5	Relay	1	80	80
6	12-0-12 Transformer	1	160	160
7	Wires	30	1	30
8	Zero PCB	1	1	200
Total Budget of Project				Rs. **1140**

5. RESULTS AND ANALYSIS

Initially only moisture sensor was connected to the NodeMCU. Outputs received by it was between 0 to 1024 and after processing the values it was brought down between 0% to 100%. Sensor gave 0% when held in open air. When dropped in water the values increased as it immersed wholly in water. Full immersion of sensor in water led to the moisture level being 100%.

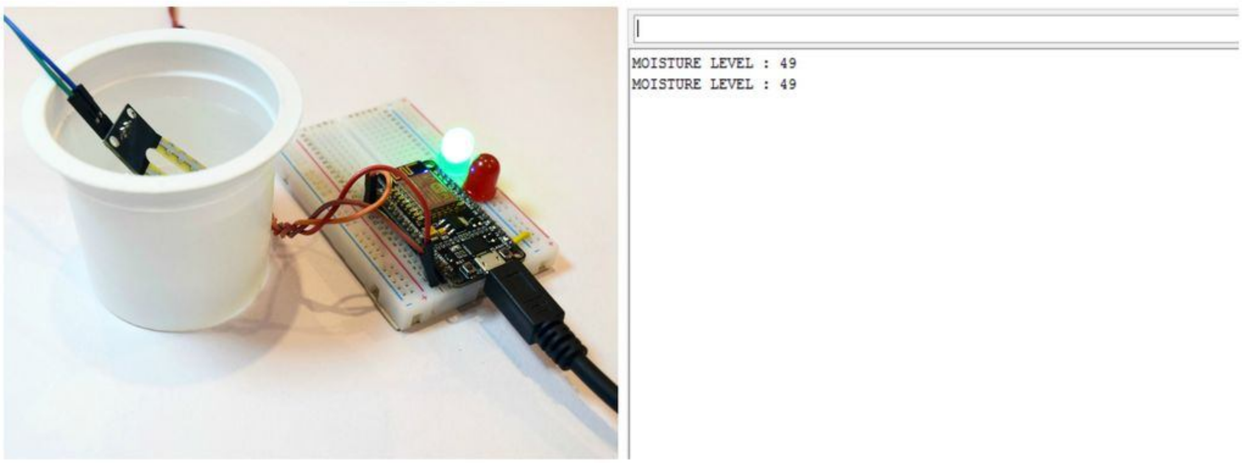

Fig 6.1: Soil moisture sensor output

Webpage mode:

The webpage is generated using HTML put in the code for the NodeMCU. It has four buttons for pump on, pump off, pump automatic, refresh. Webpage can be used on any device connected to the WLAN. The address we used was 192.168.43.18 to connect to the webpage. It has a analog chart displaying the present moisture level. Also, the status of the pump is shown. The webpage also displayed the instantaneous data about the moisture level, temperature and humidity. Based on the values of parameters various actions can be performed. When moisture is below level, the button “pump on” was pressed the motor was turned on and water started to flow. On the observation of analog chart, if moisture level is sufficient the “pump off” button stopped the motor. This will be helpful to avoid dry running of motor. The screenshot of webpage is shown in figure below for reference.

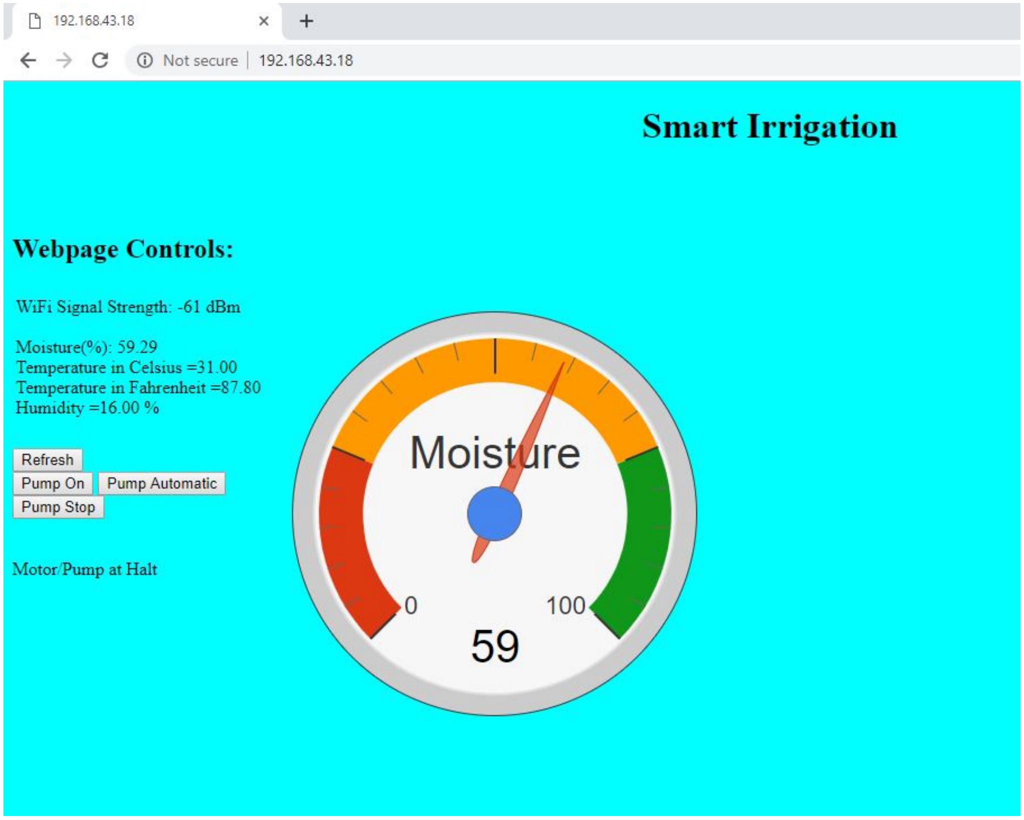

Fig 6.2: Webpage for the device

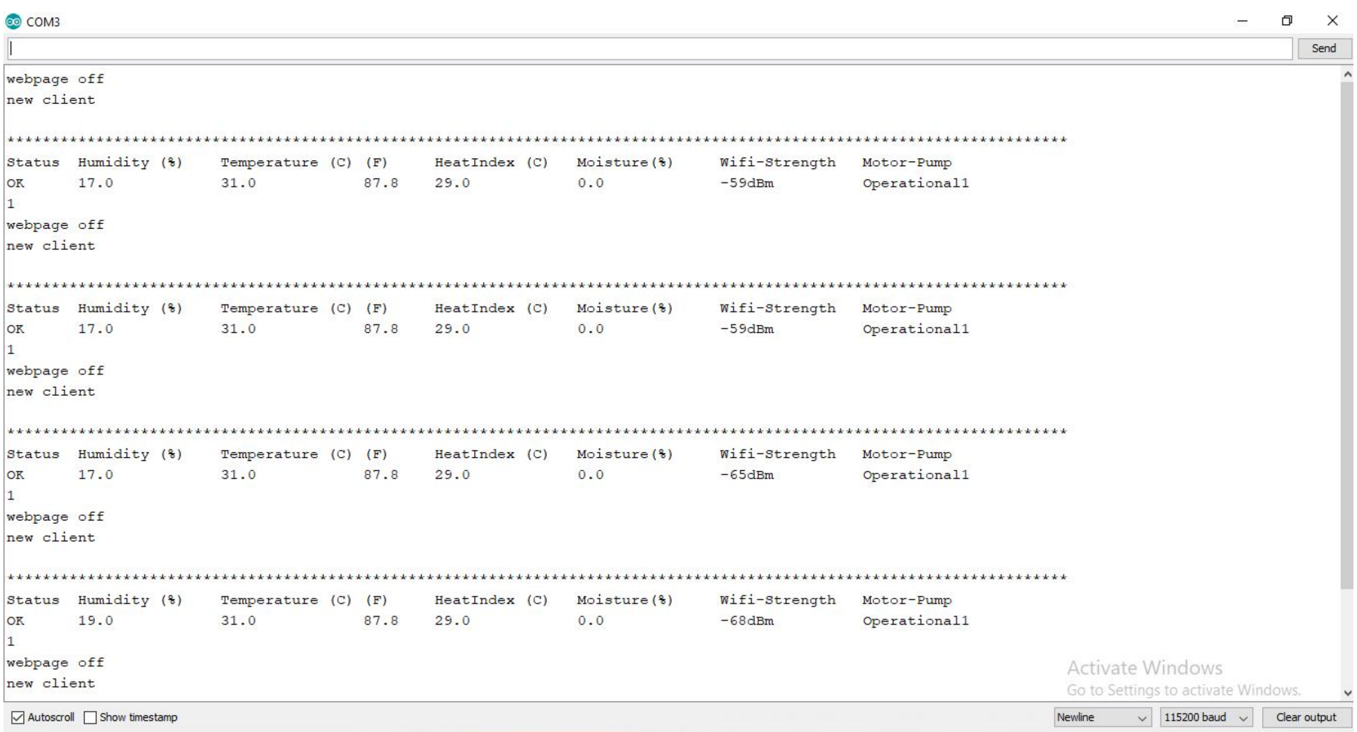

Fig 6.3: Serial monitor screenshot to showcase status of webpage

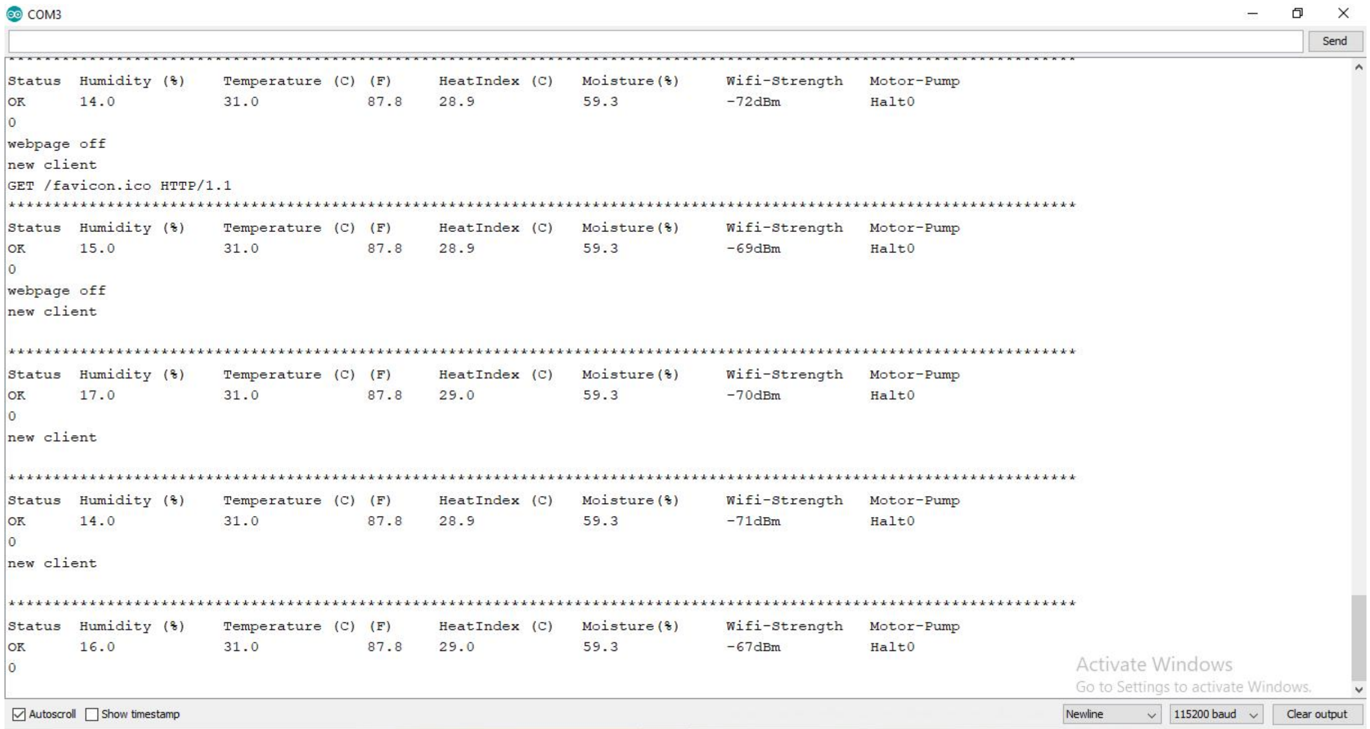

Fig 6.4: Serial monitor screenshot

App mode:

Blynk mobile application is used to control the pump. It has multiple controlling options majorly pump on & pump off but also it can put the motor on automatic also it can switch off the controlling prowess of webpage if needed. When pump on was activated the motor will get on to supply water but it took little delay because of the travel time of data from nodemcu to blynk servers and back to the mobile phone. Pump off button stopped the water supply. When motor pump put on automatic the nodemcu would take the control of the motor depending on the moisture level. Fig 6.3 shows the blynk app when the moisture level zero as the moisture sensor was in the dry soil. Webpage control is on, pump is stopped from app and the current status of pump is also off. Below screenshot (Fig 6.4) of the Serial Monitor is displaying the output of our system. It is consisting of Status: Whether the server is running/connected or not.

Humidity: Shows the present humidity level obtained from DHT11.

Temperature: The present temperature in degree Celsius and Fahrenheit is displayed.

Moisture: It is the value of moisture obtained after processing the values given by Soil moisture sensor.

Wi-Fi-Strength: The network quality available to the NodeMCU.

Motor-Pump: Displays the instantaneous status of the water motor pump.

Fig 6.4 shows the serial monitor when the webpage is not connected nor the Blynk, so it is working in automatic mode. Moisture sensor was place in totally dry soil so the moisture level is zero hence the motor is turned on and it is shown in the status part where it says operational. Motor turned on and water supply began. Water was supplied to the soil through the pipe attached to the pump which was kept inside the bottle acting as a well/lake. Supply stayed on till the moisture level increased above the 55% barrier we had set in the program was surpassed. As shown in Fig 6.5 the moisture level increased to 59% after the watering and the water pump stopped after reaching the level. Microcontroller processed that the moisture had risen sufficiently and gave the logic to the relay to turn off the motor hence stopping the water supply. The serial monitor will show the results only if NodeMCU is connected to the PC. The name of the window is COM3 because the NodeMCU was connected to Port 3 of the PC.

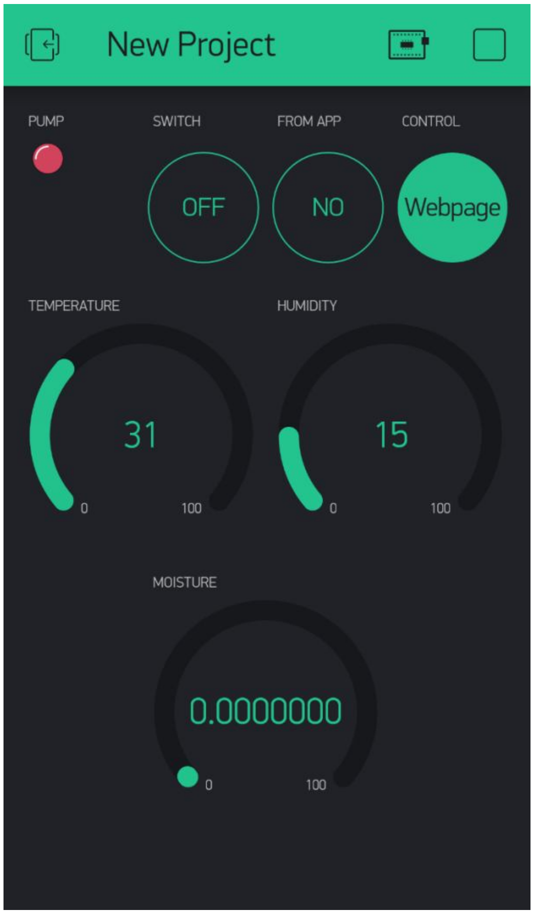

Fig 6.5: Blynk app with motor controls

6. CONCLUSIONAND FUTURE SCOPE

This irrigation system optimizes the usage of water by reducing wastage and reduces human intervention for farmers. The system is user friendly and has a lot of advantages. Helps in timely watering.

In the present era, the farmers use irrigation technique through the manual control, in which the farmers irrigate the land at regular intervals. This process seems to consume more water and results in water wastage. Moreover, in dry areas where there is inadequate rainfall, irrigation becomes difficult. Hence, we require an automatic system that will precisely monitor and control the water requirements in the field. Installing Smart irrigation system saves time and ensures judicious usage of water.

This architecture uses microcontroller which promises an increase in system life by reducing power consumption. Frequency of watering can be set by the user. In future work, we plan to use solar panels along with rechargeable batteries in order to make our system self-sustainable in terms of energy consumption.

Our project can be improvised by adding a Webscaper which can predict the weather and water the plants/crops accordingly. If rain is forecasted, less water is let out for the plants. Also, a GSM module can be included so that the user can control the system via SMS. A water meter can be installed to estimate the amount of water used for irrigation and thus giving a cost estimation. A solenoid valve can be used for varying the volume of water flow. Furthermore, Wireless sensors can also be used.

APPENDIX

REFERENCES

[1] Sotiris Nikoletseas and Georgios Constantinos Theofanopoulos “A Smart System for Garden Watering using Wireless Sensor Networks” presented in IEEE October 31–November 4, 2011, Miami, Florida, USA. Copyright 2011.

[2] Balendonck J, Hemming J, Van Tuijl BAJ, Pardossi A, Incrocci L, Marzialetti P (2008). Sensors and Wireless Sensor Networks for Irrigation Management under Deficit Conditions (FLOW-AID). International Conference on Agricultural Engineering (AgEng2008). Conf. Proc. p.19. [1] Smart Water Irrigation System, “ bySiyu Chen, Nicolas Fatras, HaoranSu ”, Civil and Environmental Engineering 186.

[3] Smart Water Irrigation System Civil and Environmental Engineering 186: Design of Cyber-physical System by Siyu Chen, Nicolas Fatras, HaoranSu

[4] Implementation of Multi Zone Smart Gardening System, by P. Tulasi Santosh Kumar, K. N. Balaji Kumar, “ IJARCCE ISSN (Online) 2278-1021 ISSN (Print) 2319 5940 International Journal of Advanced Research in Computer and Communication Engineering ”

[5] M. Dursun and S. Ozden. A wireless application of drip irrigation automation supported by soil moisture sensors. Scientific Research and Essays, Vol. 6(7):1573 – 1582, 2011