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IOT-BASED SMART PLANT MONITORING SYSTEM USING NODEMCU

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Abstract - *The Internet of Things (IoT) is transforming the agriculture industry and enabling farmers to contend with the enormous challenges they face. Livestock monitoring, conservation monitoring, and plant & soil monitoring are the challenges with which IoT can be a solution. The innovative IoT applications address the issues in agriculture and increase the quality, quantity, sustainability, and cost-effectiveness of agricultural production. Today's large and local farms can leverage IoT to remotely monitor sensors that can detect soil moisture and crop growth and detect pests and control their smart connected harvesters and irrigation equipment. This project aims at monitoring the soil parameters like soil moisture, temperature and electrical conductivity and automates the irrigation process. Decision making is done through a microcontroller. User is acknowledged about the field when there is any deviation from the expected values via text message. Along with soil parameters, plant pest detection is also included in this project. This ensures complete system health. Whereas, Greenhouses are controlled area environment to grow plants. The main aim of this project is to design a simple, low-cost, Arduino-based system to monitor the values of environmental parameters that are continuously uploaded and controlled in order to achieve optimum plant growth and yield.*

1. INTRODUCTION

Internet of Things represents a general concept for the ability of network devices to sense and collect data from the world around us, and then share that data across the Internet where it can be processed and utilized for various interesting purposes. Internet of Things is very quickly becoming a reality. We can see the proof of it around us. Our devices are getting smarter each day from smartphones to smart TV to smart car to Smart kitchen. Everything is now getting connected to Internet. Internet of Things (IoT) describes a network of physical objects that connect to each other through the internet. Objects, or 'things can transfer information wirelessly without requiring human interaction. A 'thing' can be any object that can be assigned an IP address and provided with the ability to transfer data over a network. A Thing, in the Internet of Things, can be a person with a heart monitor implant, a farm animal with a biochip transponder, an automobile that has built-in sensors to alert the driver when tire pressure is low or any other natural or man-made object that can be assigned an IP address and provided with the ability to transfer data over a network. These devices collect useful data with the help of various existing technologies and then autonomously flow the data between other devices. Current market examples include smart thermostat systems and washer/dryers that utilize WiFi for remote monitoring.

In this project, we will learn about the IoT Based Smart Agriculture & Automatic Irrigation System with Nodemcu ESP8266. Agriculture plays a vital role in the development of agricultural countries. Some issues concerning agriculture have been always hindering the development of the country. Consequently, the only solution to this problem is smart agriculture by modernizing the current traditional methods of agriculture.

Hence the method is making agriculture smart using automation and IoT technologies. The Internet of Things (IoT) enables various applications of crop growth monitoring and selection, automatic irrigation decision support, etc. We proposed the ESP8266 IoT Automatic irrigation system to modernize and improve the productivity of the crop.

2. Review of Literature

The newer scenario of decreasing water tables, drying up of the rivers and tanks, and unpredictable environment present an urgent need for proper utilization of water. In India about 35% of land was under reliably irrigated. And the 2/3rd part of land is depending on \monsoon for the water. Irrigation reduces dependency on monsoon, improves food security and improves productivity of agriculture and it offers more opportunities for jobs in rural areas. Farmers are facing problems related to watering system that how much water has to supply and at what time? Sometimes overwatering causes the damage to crops and as well as waste of water. Hence for avoid such damage we need to maintain approximate water level in soil. In this paper, humidity sensor, moisture sensor, temperature sensors placed in root zone of plant and gateway unit (ESP8266) handles the sensor information and transmit data to a android application. This application is developed for measure approximate values of temperature sensor, humidity sensor and moisture sensor that was programmed into a microcontroller to control water quantity.

2.1 Automated Plant Watering System.

Abhishek Gupta[1] et al. explain that the system consists of a soil moisture sensor, a water pump, and a microcontroller that controls the watering process. The article also discusses the advantages of using an automated system over manual watering, such as improved plant growth and reduced water waste. Overall, the article presents a useful solution for individuals who want to maintain healthy plants while minimizing their water usage.

2.2 Automated Plant Watering System.

K.Ajay Reddy[2] et al. This project provides a user friendly, reliable and automated water pumping system at fields. Now a day's technology is running with time, it completely occupied the life style of human beings. Even though there is such an importance for technology in our routine life there are even people whose life styles are very far to this well-known term technology. So it is our responsibility to design few reliable systems which can be even efficiently used by them. This basic idea gave birth to the project Node MCU based water pump controller at fields using Relay switches. The project mainly aims in designing water management system using soil moisture

2.3 Smart Garden Monitoring System Using IoT.

T.Thamaraimanalan[3] et al. They explain that the system collects data on parameters such as temperature, humidity, soil moisture, and light intensity using sensors and sends the data to a cloud-based server for storage and analysis. The article also describes how the system can be accessed remotely through a mobile application. The authors highlight the benefits of such a system, including improved plant growth and reduced water usage, as well as potential applications for large-scale farming. Overall, the article provides a useful resource for individuals interested in implementing an IoT- based garden monitoring system.

2.4 Embedded Based Green House Monitoring system using Microcontroller.

Arul Jai Singh [4] et al. presents a system designed to monitor and control the environmental parameters of a greenhouse using an embedded system based on a PIC microcontroller. The authors, Arul Jai Singh, Raviram, and Shanthosh Kumar, explain that the system measures parameters such as temperature, humidity, and light intensity using sensors and adjusts them to maintain optimal conditions for plant growth. The article also describes the implementation of a web-based interface for remote monitoring and control of the system. The authors highlight the benefits of the system, including increased yield and reduced energy consumption, as well as potential applications in commercial agriculture. Overall, the article provides a useful resource for individuals interested in implementing an embedded-based greenhouse monitoring system for optimal plant growth.

3. Methodology on present Investigation

3.1 Proposed Methodology.

We will use Capacitive Soil Moisture Sensor to measure moisture content present in the soil. Similarly to measure Air Temperature and Humidity, we prefer DHT11 Humidity Temperature Sensor. Using a 5V Power relay we will control the Water Pump.

Whenever the sensor detects a low quantity of moisture in the soil, the motor turns on automatically. Hence, will automatically irrigate the field. Once the soil becomes wet, the motor turns off. You can monitor all this happening remotely via Blynk app online from any part of the world.

3.2 Component List.

1. NodeMCU-ESP8266 12E Board
2. Soil Moisture Sensor-Capacitive Soil Moisture Sensor V1.2 3.DHT11
3. Humidity Temperature Sensor
4. Relay Module- 5V Relay Module
5. DC Motor Pump- 5V Water Pump
6. Bread Board and Jumper cables

3.3 Software Requirement.

1. Blynk Application

2. Ardino IDE

3.2.1 Node MCU (ESP8266) Wifi Module:

NodeMCU is an advanced API for hardware input/output device which can be dramatically reduces the work for configuring manipulative hardware. It uses a code like Arduino but rather is an interactive script called Lua. It is an open source IoT platform. It runs on a firmware of ESP8266 Wi-Fi Soc produced by Espressif systems. NodeMCU has 16 input/output pins and hence 16 nodes can be connected to a single node. The ESP8266 is Wi-Fi Soc which is integrated with a Tensilica Xtensa LX106 core which is widely used in IoT applications." NodeMCU" refers in default to the firmware rather than the development kits. ESP8266 is an inbuilt WiFi module which can also be used as an individual module as a Wifi module.

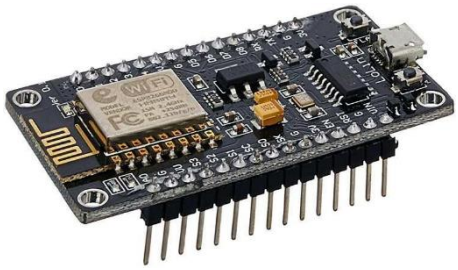

Fig -3.2.1: Node MCU (ESP8266)

3.2.2 Soil Moisture Sensor:

Soil moisture sensors measure the volumetric water content in soil. The direct gravimetric measurement of free soil moisture requires removing, drying and weighing of a sample, soil moisture sensors measures the volumetric water content indirectly by usimg 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 tensiometers and gypsum blocks.

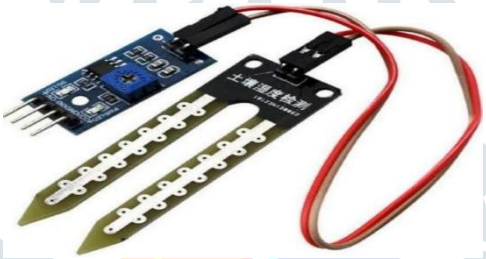

Fig -3.2.2: Capacitive Soil Moisture Sensor V1.2

3.2.3 DHT11 Humidity Temperature Sensor:

The DHT11 is a basic, ultra low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and spits out a digital signal on the data pin (no analog input pins needed). DHT11 is a low-cost digital sensor for sensing temperature and humidity. This sensor can be easily interfaced with any micro-controller such as Arduino, Raspberry Pi etc.… to measure humidity and temperature instantaneously. DHT11 sensor consists of a capacitive humidity sensing element and a thermistor for sensing temperature. The humidity sensing

Fig -3.2.3: DHT11 Humidity Temperature Sensor

Capacitor has two electrodes with a moisture holding substrate as a dielectric between them. Change in the capacitance value occurs with the change in humidity levels. The IC measure, process this changed resistance values and change them into digital form. For measuring temperature this sensor uses a Negative Temperature coefficient thermistor, which causes a decrease in its resistance value with increase in temperature. To get larger resistance value even for the smallest change in temperature, this sensor is usually made up of semiconductor ceramics or polymers. The temperature range of DHT11 is from 0 to 50 degree Celsius with a 2-degree accuracy. Humidity range of this sensor is from 20 to 80% with 5% accuracy. The sampling rate of this sensor is 1Hz .i.e. it gives one reading for every second. DHT11 is small in size with operating voltage from 3 to 5 volts. The maximum current used while measuring is 2.5mA.

3.2.4 5V Relay Module:

Relay is one kind of electro-mechanical component that functions as a switch. The relay coil is energized by DC so that contact switches can be opened or closed. A single channel 5V relay module generally includes a coil, and two contacts like normally open (NO) and normally closed (NC). This article discusses an overview of the 5V relay module & its working but before going to discuss what is relay module is, first we have to know what is relay and its pin configuration.

Fig -3.2.4: 5V Relay Module

3.2.5 5V Water Pump:

DC 5V Mini Submersible Noiseless Water Pump is a low-cost, small size Submersible Pump. It can take up to 150 liters per hour with a very low current consumption from 300mA to 1A max. The water pump works using water suction method which drain the water through its inlet and released it through the outlet.

Fig -3.3.5: 5V Water Pump

3.2.6 Blynk IoT:

Blynk IoT is main Software Tool of Our Project. It can be Installed by using Following Steps: First we have to install the Blynk IoT App from play store. After Create Account on Blynk App by using Mail Id. Then go to Developer mode and Create New Template According to our project. After creation of Template, we have to go to DataStream's and create Separate Data stream for each parameter. In our project we take two Data Streams like Temperature, Humidity and Soil Moisture. After Create Web Dash Board for Displaying parameter's purpose. In Web Dash Board we take three Gauges for measuring Temperature Humidity and Soil Moisture.

Fig -3.3.1: Blynk IoT

3.3.1 Ardino IDE:

Arduino IDE is an open-source software, designed by Arduino.cc and mainly used for writing, compiling & uploading code to almost all Arduino Modules.

Fig -3.3.2: Ardino IDE.

3.4 Connection Mechanism

When we give the power supply the NodeMCU activate. Then also sensors get ON. 2. When sensors are ON It reads the data from soil and also from Surroundings. 3. Based on the values which are detected by Sensors motor will be turn to ON/OFF State. 4. The value of Threshold is less than the Moisture then the Motor turned ON. 5. If it Detects high moisture level the motor is in OFF position. 6. The Sensor only collects all the values and sends it to ESP8266 Wi-Fi protocol. 7. The Information Display on the Blynk App. 8. Then the user can easily control the motor by using Blynk App

3.5 Block Daigram

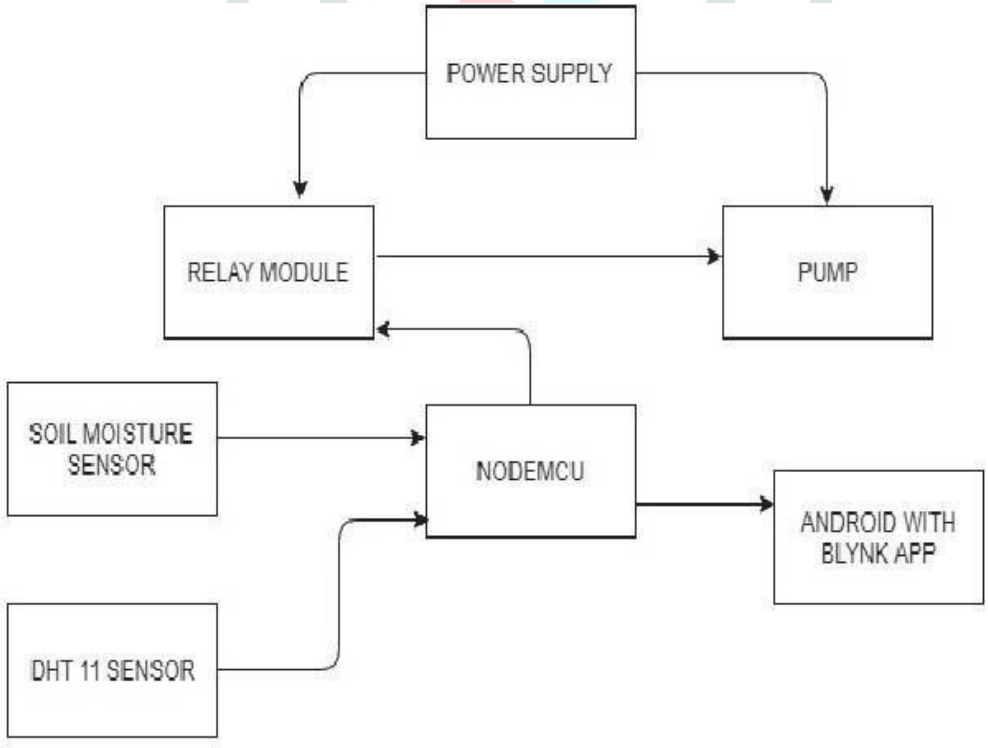

Fig -3.5: Block Daigram.

The Physical Description of project can be represented by the above Fig 5. All Sensors are connected to the NodeMCU and DC Pump and Relay module is connected to Power Supply. Here we use the power supply as Battery. The Output can be shown in Blynk App. This app is used to Monitor and Control our Hardware project and Display the parameters in Web Dashboard of Blynk App. The circuit Diagram can be shown in below Figure:6 The connections of circuit are explain below. In NodeMCU we use D3, D2,D5 and A0 along with VCC and GND Pins.DTH11 Sensor consist of Three pins the data pin is connected to D3 of MCU and Supply and Ground pin is connected to VCC and GND respectively. Soil moisture sensor signal pin is connected to A0 and remaining two pins one is connected to supply and another is ground. LED positive is connected to D2 whereas negative is grounded. Relay Module data pin is connected to the D5 and Supply and Ground is connected to VCC and GND Respectively. DC Pump

Relay Module is connected to the Battery. DC pump Operates based on the Relay and Battery. When we give Power Supply to NodeMCU 5V or 9V then the user program in flash memory is enables and display the outputs. According to the displayed information we overcome the Soil Moisture related problems then we improve the Soil Moisture by giving the proper water supply to plant through motor. Then Automatically the we improve plant growth and also reduce the wastage of water. When moisture level is high then the motor is in OFF position

3.6 Circuit Daigram

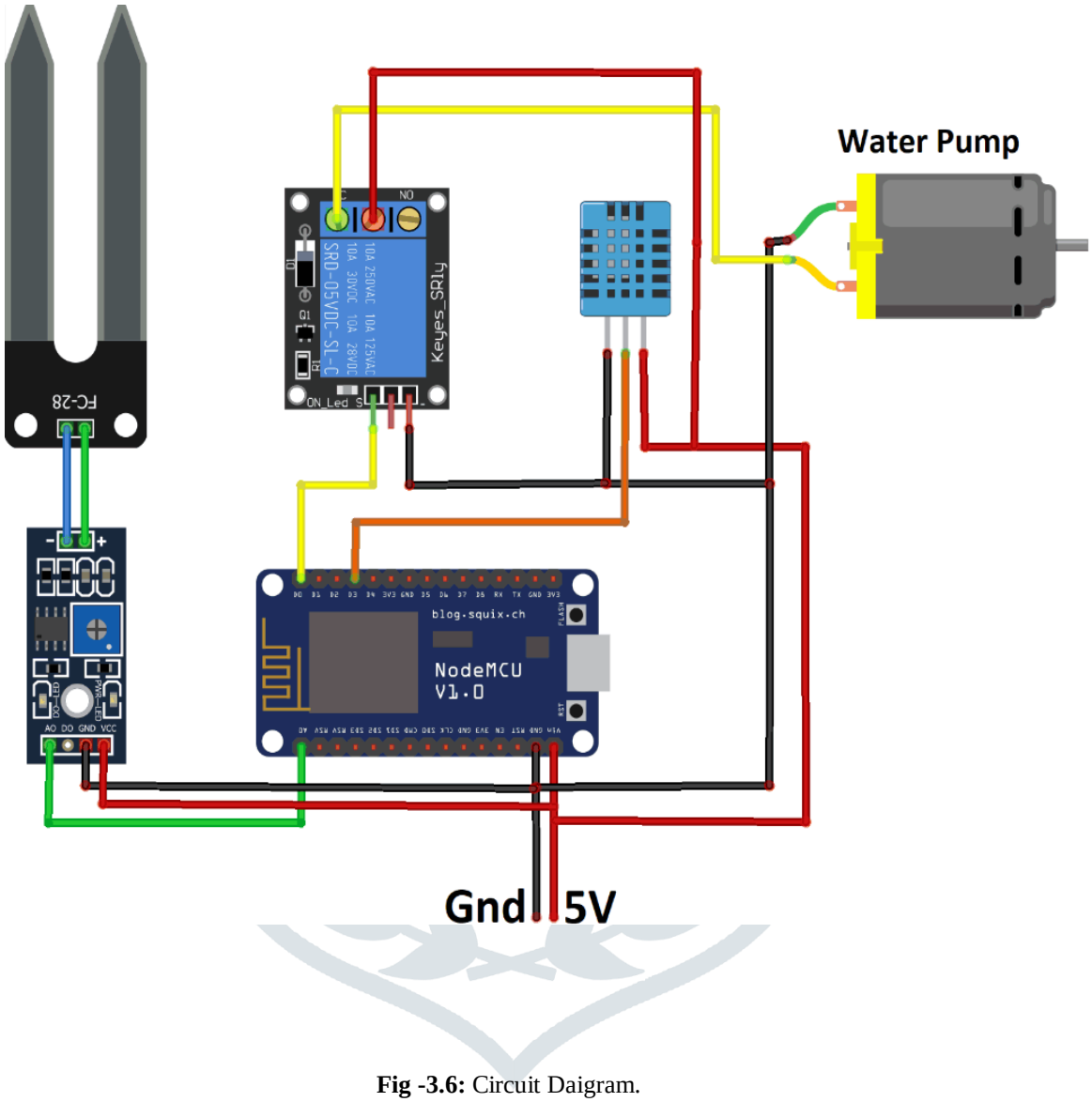

Fig -3.6: Circuit Daigram.

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3.7 NodeMCU Pin Illustration (ESP8266)

Fig -3.7: NodeMCU (8266).

3.8 Problem Statement

Farmers cannot precisely detect environmental condition around the plant. Farmers only know the wetness of soil, the humidity and temperature around the plant by feel it themselves. Nowadays, there is wireless technologies that being implement in many fields. The user need device that can send the condition of plant wirelessly. The user will get notification about the environmental condition around the plant. To always sustain and retain appropriate moisture content in the soil we have designed an automatic moisture control and irrigation system by monitoring the parameters temperature, humidity and soil moisture content using the temperature & humidity sensors (DHT11) and moisture sensors. The prototype we used comprises of moisture sensors, temperature & humidity sensors, Nodemcu and water pipes to supply water from tank controlled by DC motors. Moisture sensors are installed near the roots and temperature & humidity (DHT11) sensor is installed further away to detect the temperature and humidity. These sensors send their data to the Nodemcu to analyze the results. The Nodemcu will turn the inlet valve on, to water the plants, until the soil moisture value becomes greater than the threshold value which is 30% (calculated according to the crop - eg:spinach),

Spinach Soil Humidity - 30% Air Humidity - 14% Temperature - 25°

4. Source Code

```
#include <Ethernet.h>
/* Fill in information from your Blynk Template here */
#define BLYNK_TEMPLATE_ID "TMPL3juTyfQYe"
#define BLYNK_TEMPLATE_NAME "Plant irrigation"

#define BLYNK_FIRMWARE_VERSION        "0.1.0"
#include <DHT.h>
DHT dht(D4,DHT11);

#define BLYNK_PRINT Serial
//#define BLYNK_DEBUG
const int sensor_pin = A0;

#define APP_DEBUG

// Uncomment your board, or configure a custom board in Settings.h
//#define USE_SPARKFUN_BLYNK_BOARD
//#define USE_NODE_MCU_BOARD
//#define USE_WITTY_CLOUD_BOARD
//#define USE_WEMOS_D1_MINI

#include "BlynkEdgent.h"

void setup()
{
  Serial.begin(115200);
  delay(100);
dht.begin();
pinMode(14,OUTPUT);
  BlynkEdgent.begin();
}
```

```
void loop() {
  BlynkEdgent.run();
  int temp,humidity;
temp=dht.readTemperature();
Serial.println(temp);
humidity=dht.readHumidity();
Serial.println(humidity);
delay(1000);
  float moisture_percentage;

  moisture_percentage = ( 100.00 - ( (analogRead(sensor_pin)/1023.00) * 100.00 ) );

  Serial.print("Soil Moisture(in Percentage) = ");
  Serial.print(moisture_percentage);
  Serial.println("%");

  delay(1000);

Blynk.virtualWrite(V1,temp);
delay(50);
Blynk.virtualWrite(V2,humidity);
delay(50);
Blynk.virtualWrite(V3, moisture_percentage);
delay(50);

}
BLYNK_WRITE(V8)
{
  if(param.asInt() == 1)
  {
    digitalWrite(D6,HIGH);
  }
  else
  {
 digitalWrite(D6,LOW);
}
}
```

5. Results

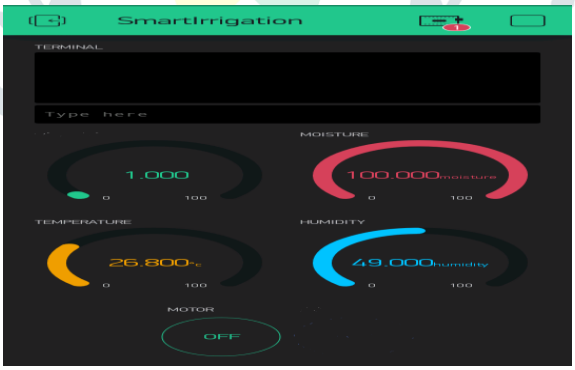

Fig -5.1: Interface of Blynk Application.

The above picture shows the real time results on Blynk App web dashboard Screen.it displays the Exact Temperature, Humidity and Soil Moisture Readings. The Blynk application is connected to Wi- Fi. Through this Wi-Fi the App can shows the Readings in any Android Device

Fig -5.2: Working Model.

6. CONCLUSIONS

In this project, we implemented an automatic irrigation facility which one can easily control from their home by using a simple online application. Labor work would be eliminated and we would get accurate results. The proposed system can reduce the efforts of farmers and provides a high yield. It also conserves water for irrigation by locating the sensor at the right position above the soil level. This work has shown that plants can still sustain at low moisture level when the temperature is moderate.Analyzing more than one parameter has made this system an efficient one for managing the field.

6.1 Future Scope

The Future Scope of this Project never be ended Because in today fast World every person will Require a helping hand to take care of plant and Plant health status. This is Further used for large Scale of Agriculture Purpose to increase the Crop Rate and help farmers to reduce man power.

Machine results and sensing provide accurate results which will help optimize production.

With IOT the Plant Monitoring system can be made portable.

Plant Monitoring system can be set up in extreme climatic conditions as the automated system will continuously make alterations such that suitable conditions for the plants are sustained.

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