# SMART PLANT MONITORING SYSTEM


## ABSTRACT

Technology brings remarkable advancement in every field,whether it's at home, industry or agriculture. People are largely dependent on technology for their daily chores. In big cities, people are mostly busy and they face problems in their homegrown gardens regarding maintenance and availability of gardeners. This is a project to develop an automated irrigation mechanism which turns the pumping motor ON and OFF on detecting the moisture content of the earth using the soil moisture sensor without the intervention of humans. The benefit of employing these techniques is to decrease human interference and it is quite feasible and affordable. Thus ,this project "Smart Plant Monitoring System" provides an efficient and easy way to identify the current status of their gardens.This project uses an IoT based approach for smart garden monitoring using NodeMCU microcontroller as the control unit that helps users in identifying current parameters such as soil moisture, temperature, humidity of their homegrown plants and garden.The setup uses soil moisture sensors which measure the exact moisture level in soil. This value enables the system to use appropriate quantity of water which avoids over/under irrigation. The sensors gather and analyze data about changing weather and soil moisture conditions and whenever the soil moisture goes below a threshold value it sends an alert as an email or sms to water the plant as it is dry. Cloud control technology is developing at a fast pace and entering each and every sector and drastically improving the condition of sector[1].The cloud and IoT technology in recent years entered agriculture and by using these two technologies the farmer is increasing production and reducing cost. In this paper a system is discussed which uses both cloud and IoT technologies for controlling the irrigation system. The system discussed comprises many elements for performing specific task.The data collected is sent to AWS IoT Core using MQTT Protocol which subscribes and publishes to the NodeMCU . AWS IoT Analytics is used to have a graphical visualization of all the parameters. Whenever the soil moisture is below a threshold value, AWS SNS(Simple Notification Service) is used to send an alert to the email of the user. When a threshold moisture level of the soil is reached, the water will supply accordingly.This is essential because water must be provided to the plant at a particular time for a good yield. This project is highly useful for farmers, nursery

professionals by eradicating traditional or manual methods of the irrigation system.This project replaces the need for gardeners in big cities.

As water supply is becoming scarce in today's world there is an urgency of adopting smart ways of irrigation. The project describes how irrigation can be handled smartly using IOT. This project aims at saving time and avoiding problems like constant vigilance. It also helps in conserving water by automatically providing water to the plants/field depending on the water requirements. This system can also prove to be helpful in agriculture, parks and lawns.

# CHAPTER 1: INTRODUCTION

Agriculture is considered as the largest livelihood provider in India. With a rising population there is a need for agricultural growth too. Many times crops fail due to water scarcity, lack of care and thus it leads to great loss for farmers as well as the country's development. Currently,agriculture accounts for 83% of the total water consumption in India [2].Unplanned use of water results in wastage and in the agricultural sector many times it leads to water logging and destroying the crops. Thus,it is either the water scarcity or water logging destroying the crops. Thus,there is a need to come up with a solution to control these. This project therefore prevents water wastage without imposing pressure on farmers.

Over the past few years, farmers have started using android phones and have access to the internet. They are involved in internet banking and many organizations help them learn these technical advancements too[3]. In the Internet era ,where information plays a key role in peoples' lives,agriculture is becoming a very data immersive industry from which data about the health of crops can be collected and analyzed. And using these datas proper care can be given to plants. Therefore, this project enables users to view the condition of their crops and water them only when necessary.

## 1.1 OBJECTIVES

To develop a working model which can help monitor plant status and irrigate it automatically.

To read soil moisture content, temperature and humidity of the surrounding using sensors and irrigate the plant depending upon the data collected.

## 1.2 MOTIVATION

In India , agriculture is the backbone of the country, most people directly or indirectly depend upon agriculture . Country's growth is closely related to agricultural growth. Farming requires a lot of effort and care of plants. There are a lot of reasons the crop might fail. So, failure of crops not only affects the farmers and their hard work but also the economy of the country. Thus, there is a need for smart technology which will reduce human labour and also boost the production of crops. That is where Smart Irrigation and plant monitoring system comes in. Using Internet of Things in the

area of agriculture can reduce the water consumption and fertilizers. In this way the , yield of crops can be increased.Therefore,proper monitoring of soil condition ,temperature ,humidity etc. can therefore be done to achieve the objectives. Furthermore, in future it can be interlinked with drone and other technologies to measure real-time data.To save effort of farmers, the important considerations are water and time. In present condition, they need to wait until the field is fully watered. This restricts them from doing other activities. This idea is not only meant for farmers but also for watering the plants. In the present era, the farmers are irrigating their crops at regular intervals. The techniques they use will consume more water by creating water logging and result in water wastage.

Proper irrigation management is required to maintain adequate soil moisture in the crop for healthy plant growth. Impact of excess water on crop growth is influenced by soil characteristics, duration of excess water ,initial soil water, air temperature, and other factors[4]. Thus , it is necessary to read the moisture content of soil and air temperature and depending on the data read the plant can be provided with adequate amount of water at proper timings.Excessive watering of plants is also harmful for the growth of plants[5]. It can lead to water loading and clogging of pores in soil , which is not good for the plant . Thus, there is a need to develop a technology where the excessive watering of plants can be reduced.

Living in the 21st Century ,people living in urban areas are fascinated by plants and have small gardens  at their homes wherever possible. These plants sometimes are very costly, and if not taken care of ,they might die. As most of the people are working individuals, and they are out of their houses. At many times they are not at their homes for days. If they have plants at home, it might die if they are not watered properly.Even if they have gardeners at their homes, they are suspectful many times and are careless. Thus, there is a need for technology using which plants can be watered remotely using only smartphones.  This project enables the users to water their plants from distant places and keep a check on its growth. Therefore, using this project the health status of plants can be monitored and watered periodically and adequately.Another added advantage of this is that it involves only one time expense of purchasing the device which involves no cost in future.Thus,

paying monthly wage to a gardener to manage the plants is eliminated and that money can be utilised somewhere else. It’s very beneficial for working individuals with busy schedules and automatically looks after the plants for them,making them smart people not only with smartphones but also with smart plants.

# CHAPTER 2 : PROJECT DESCRIPTION

This system is a combination of hardware and software components. The hardware part consists of different sensors like YL-69 soil moisture sensor, DHT11 temperature and humidity sensor, LDR module to detect presence of light and the NodeMCU ESP8266 Wifi Development board which is the control unit of the system. Whereas, the software part consists of Arduino IDE for coding purposes. Here, AWS cloud service is also used. AWS IoT Core is used to process the data collected. Here, data is published from NodeMCU to the AWS IoT Core using MQTT protocol. The data received by the AWS IoT is analyzed and if the moisture content meets a threshold value,then an alert is sent as an email or sms is sent to a mobile number alerting water level. The improvement in the irrigation system using wireless networks is a solution to achieve water conservation as well as improvement in the irrigation process. This research tries to automate the process of irrigation on the farmland by monitoring the soil water level of the soil relative to the plant being cultivated and the adaptively sprinkling water .

## 2.1 TECHNOLOGIES AND COMPONENTS USED

### 2.1.1 Hardwares Used

- NodeMCU ESP8266 WiFi Development board
- YL-69 Soil Moisture Sensor
- DHT11 Temperature and Humidity Sensor
- LDR Module

### 2.1.2 Softwares Used

- Arduino IDE

### 2.1.3 AWS Services Used

- AWS IoT Core
- MQTT Protocol
- SNS (Simple Notification Service)
- AWS IoT Analytics
- AWS Quicksight

## 2.2 HARDWARE DESCRIPTION

### 2.2.1 NodeMCU ESP8266:

It is a WiFi development board which gathers the sensory data from sensors and sends it to AWS or other online services using WiFi. ESP8266 has built-in WiFi which enables it to be connected to the internet. Hence, it can be interacted with from far away places.The NodeMCU gathers the sensory data and sends it to the AWS IoT Core using MQTT Protocol. Thus , NodeMCU is the control unit of the project. The sketch from Arduino IDE is uploaded to the NodeMCU ESP8266 which then gathers all the sensory data from various sensors like soil moisture sensor ,DHT11 etc. and sends them to AWS IoTCore using MQTT protocol. It is a low cost device and best suited for this project.

### 2.2.2 YL-69 Soil Moisture Sensor

Soil moisture sensor measures the volumetric water content in the soil. This resistance is inversely proportional to the soil moisture. The more water in the soil means better conductivity and will result in a lower resistance. The less water in the soil means poor conductivity and will result in a higher resistance. The sensor produces an output voltage according to the resistance, which by measuring we can determine the moisture level.It is the main sensor of the project and moisture of the soil is measured using this sensor . If the moisture content goes below a threshold value, then the plant needs water and thus a notification is sent to the user stating that moisture content is less and the plant needs watering. Greater amount of output implies lesser moisture content.

### 2.2.3 DHT11

A DHT11 is used to measure and record both the humidity and air temperature. The ratio of moisture in the air to the highest amount of moisture at a particular air temperature is called relative humidity.It uses a capacitive humidity sensor and a thermistor to measure the surrounding air.

### 2.2.4 LDR Light Sensor Module

The LDR sensor module is used to detect the intensity of light or presence or absence of light. It has D0 digital pin which gives 0 when there is no light and gives 1 as output when it detects light. It has

analog pin A0 which gives analog output in the range 0 to 1023. Thus depicting the intensity of light. Here , D0 pin is used to detect the presence and absence of light.

## 2.3 SOFTWARE DESCRIPTION

**Arduino IDE :**

Arduino IDE is a text editor for writing codes. Various libraries for sensors are used to gather information from the sensors. The code is written in Arduino IDE and it is uploaded to NodeMCU. The WiFi module gathers the information from sensors and sends the data that is displayed on the monitor at regular intervals. This information is sent to AWS cloud.

## 2.4 AWS SERVICES DESCRIPTION

### 2.4.1 AWS IoT Core

AWS IoT core supports a lot of devices, it requires to register a thing and every thing can be done to that things using AWS services .The values read by sensors are sent to AWS using MQTT protocol. And this data is then processed. If the values are less than the threshold value then a notification is sent to user's smartphone alerting him/her to switch on the pump and supply water. And as the threshold value is achieved then it asks the user to switch off the pump.

### 2.4.2 MQTT Protocol

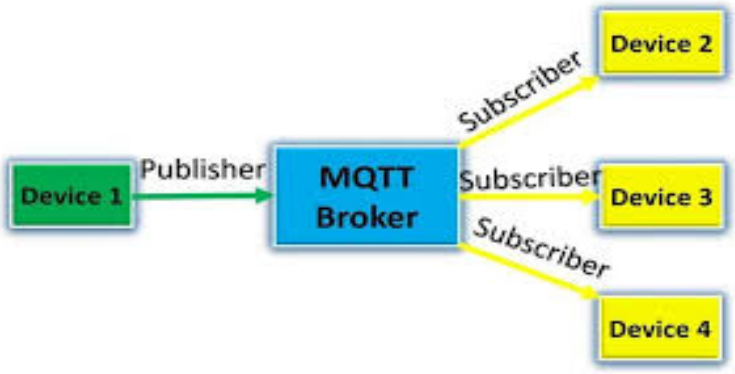



**Fig 1. Block Diagram of MQTT Protocol**

MQTT (Message Queuing Telemetry Transport) is a lightweight protocol and it is used to communicate with the device. The device (here NodeMCU) can communicate with the AWS IoT core using MQTT Broker. The NodeMCU gathers all the data received from the sensors and sends them to AWS IoT Core using MQTT protocol **[Fig 1]**. The NodeMCU publishes these data to the AWS IoT Core ,the topic which has subscribed to it. Thus, a topic in the AWS IoT subscribes to the NodeMCU and the NodeMCU published to that topic. Then the data read by sensors are visible there in the AWS along with timestamp.

It is desirable to use MQTT protocol because it is to implement in small devices ,consumes low power,uses publish and subscribe pattern.

### 2.4.3 SNS(Simple Notification Service)

Amazon Simple Notification Service (SNS) is a cloud service for coordinating the delivery of push messages from software applications to subscribing endpoints and clients.

Once a message is published to the service, it can be sent multiple times to different recipients. Service users also have the flexibility to send direct messages to several devices or to one subscriber by using a sole publish request. To get started with Amazon SNS, developers first have to create a topic, which is an access point for subscribers who are interested in receiving notifications about a specific subject. Developers publish a message to a topic when they have an update for subscribers and this action prompts Amazon SNS to distribute the message to all appropriate subscribers.

Topic owners are able to set policies specifying which types of protocols will be supported. They can also be used to limit who can subscribe to notifications or publish messages. The subscribers, who are also called clients, can choose how notifications will be delivered. Using AWS IoT a rule is created to send the notifications. This rule extracts data from the MQTT message received from the device and this rule uses SQL query to extract the data from received JSON format. And when it gets the required response ,it triggers SNS to send a notification to the registered phone number or email Id.

### 2.4.4 AWS IoT Analytics:

AWS IoT Analytics is another AWS service which enables users to view the data sent by sensors in picture and organized format.Thus,here a rule was created and the data was sent to AWS IoT analytics for proper visualization. This, rule used a SQL query to extract the data published to MQTT topic and the time-stamp were extracted. These were sent to the AWS IoT analytics. Below is the data received in the IoT Analytics **[Fig 2]**.

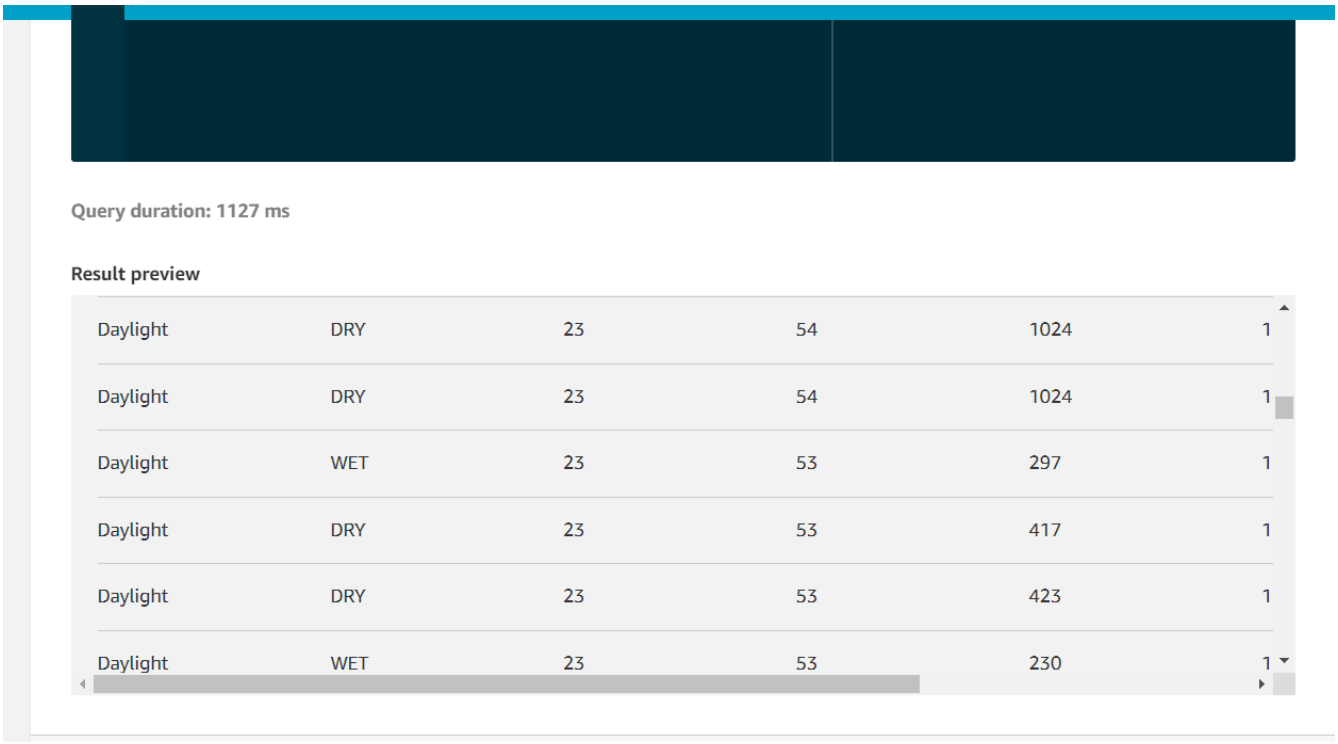



**Fig 2. AWS IoT Analytics data**

### 2.4.5 AWS Quicksight

The data from the AWS IoT Analytics was then sent to AWS Quicksight. This enables users to have a graphical view of the data. And it makes visualization easy. Thus AWS Quicksight is an AWS service for pictorial visualization of data sent by the sensors. Figure below [**Fig. 3]**shows the the data used from AWS IoT Analytics and converted to graph. This, graph refreshes hourly.

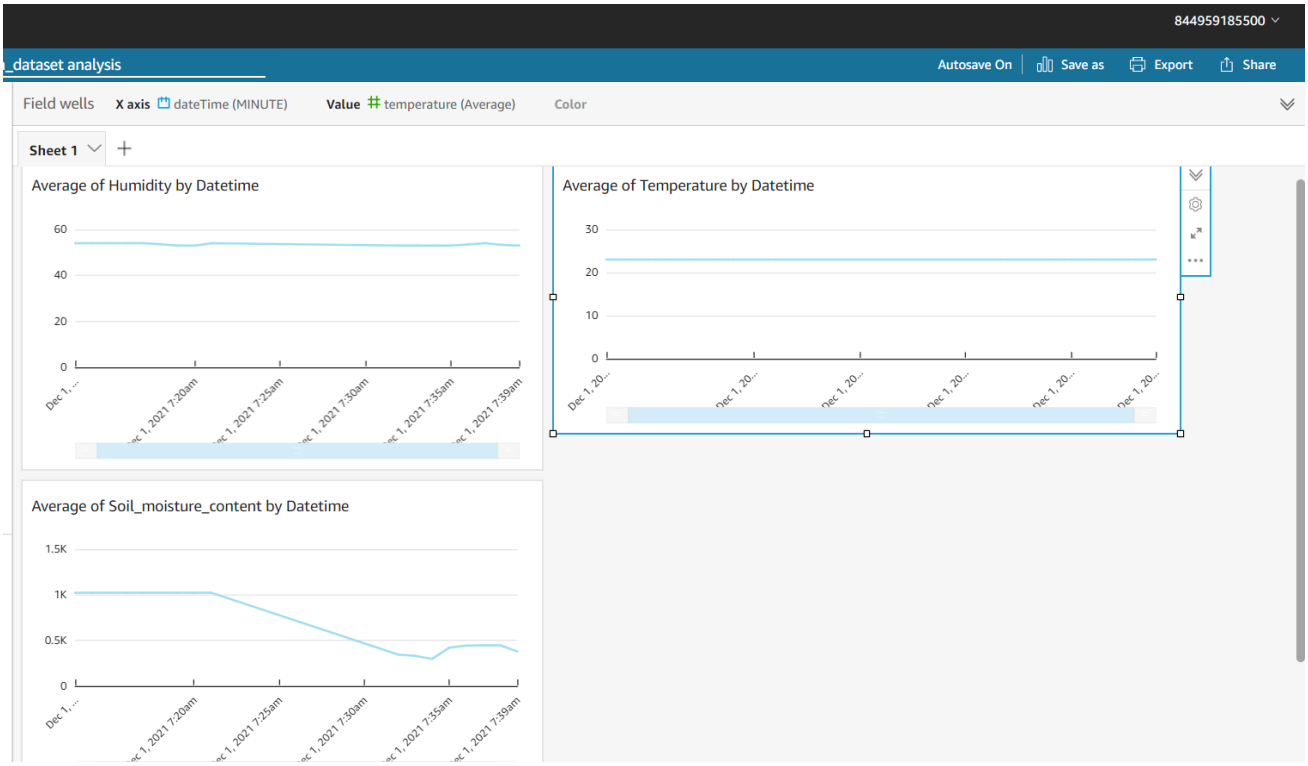



**Fig. 3 Graphical View in AWS Quicksight**

## 2.5 EXPERIMENTAL SETUP OF PLANT MONITORING SYSTEM

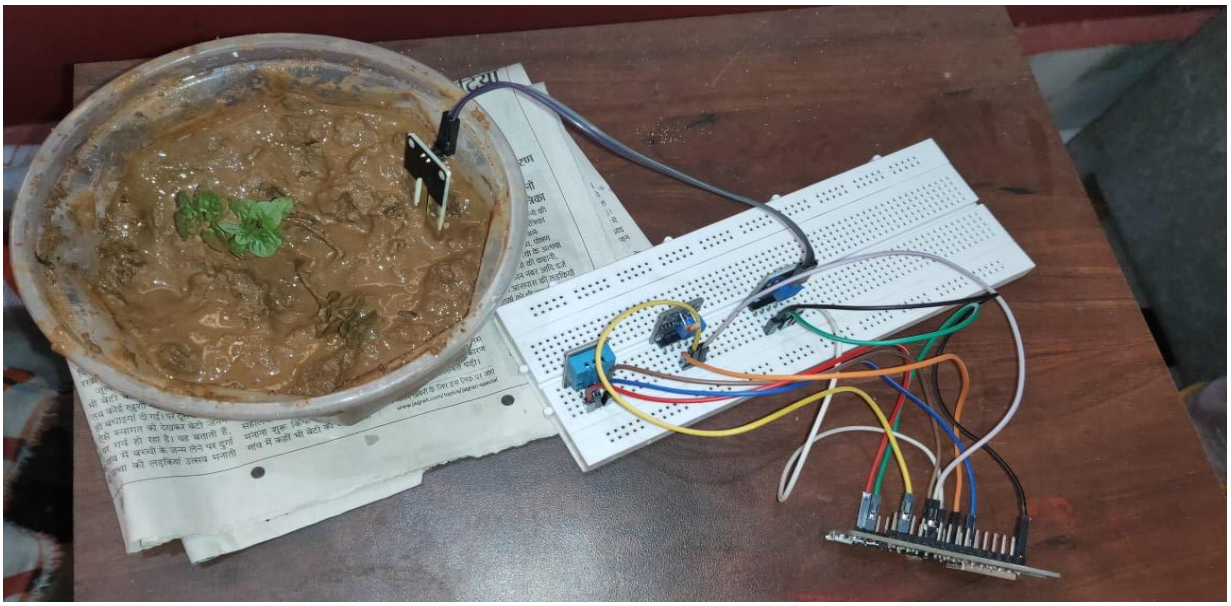


**Fig. 4 Experimental Setup**

## 2.6 BLOCK DIAGRAM OF PLANT MONITORING SYSTEM

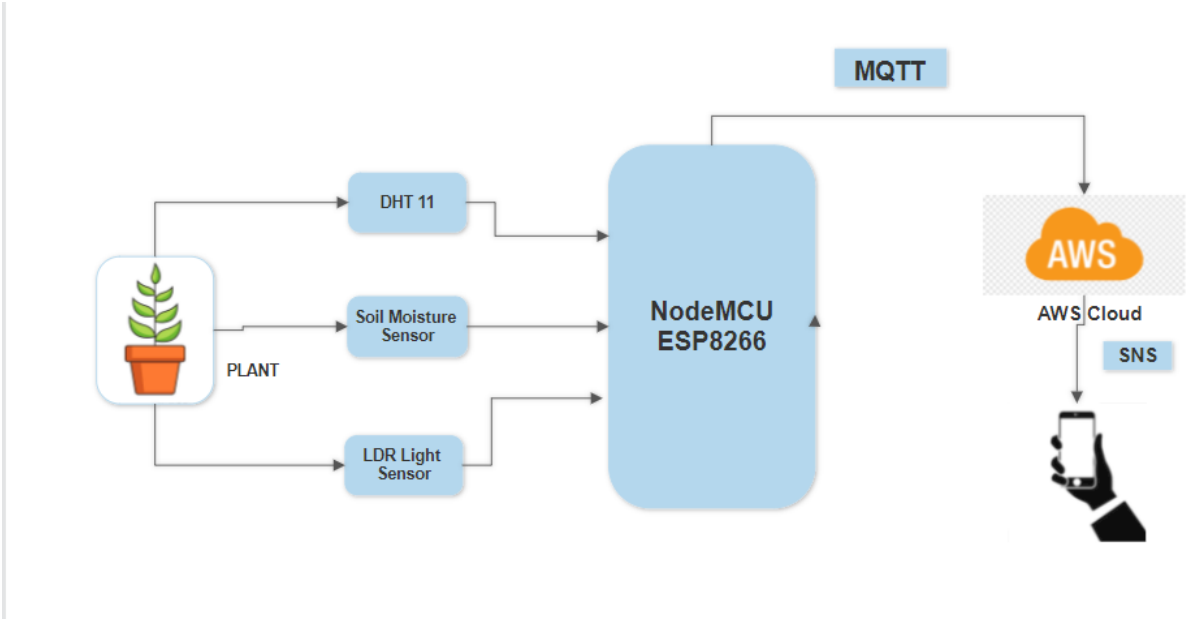



**Fig.5 Plant Monitoring System**

**Explanation :**

The DHT11, soil moisture sensor,and LDR sensor module are connected to the NodeMCU ESP8266 using connecting wires**[Fig. 4]**. The working code is written in the Arduino IDE. And it is uploaded to NodeMCU. The data read by sensors is sent to NodeMCU which sends this data to AWS service by following MQTT protocol**[Fig 5]**. The AWS Iot Core subscribes to a topic and data is published from the ESP8266 using MQTT protocol. When the subscription topic is typed in AWS and subscribed the data from the sensors can be seen on the screen in JSON format.

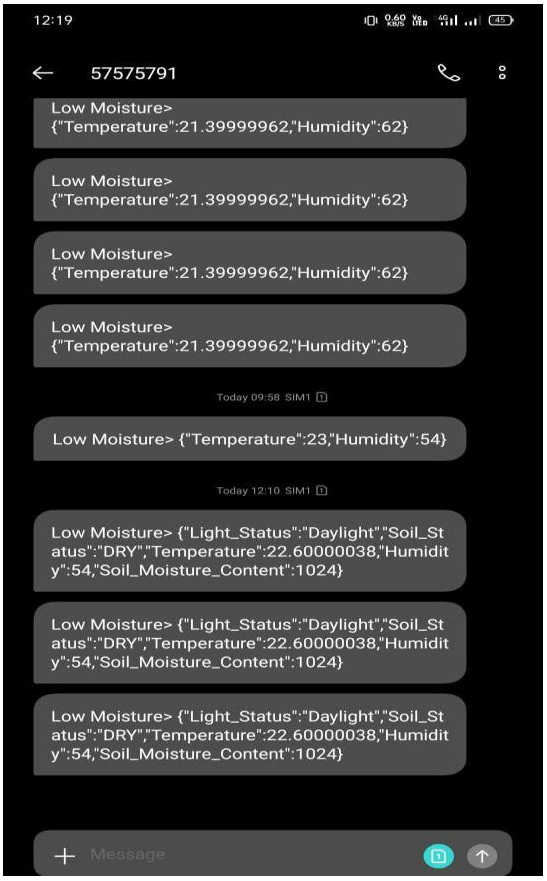
The data is then processed there. Now using the rule section in AWS IoT , a rule is created and an SQL query is given. This SQL query triggers the SNS (Simple Notification Service) and sends an alert to the registered mobile number or email address stating low soil moisture content and asking to water the plant. Thus, the user can turn ON the pump. And when the plant gets the adequate water the user won't get any notification and the pump can be turned off. Furthermore real-time status about the soil condition and plant is given . Thus, using these notifications are sent to the user about the plant condition and proper management of plant and water can be done.

# CHAPTER 3

## 3.1 RESULT

The connections were established and the data read by the sensors were sent to the cloud. This data was monitored. Real Time data was monitored about the condition of plants and the soil**[Fig 6]**.Whenever the soil moisture content was below a threshold value ,an alert was sent as Email or SMS , stating to water the plants. Furthermore, an LDR sensor was used to detect the presence of light and dht11 was used to measure the temperature. Thus , these two sensors gave information about humidity, temperature and presence of light for the plant. If the weather is cold (i.e. the temperature < 20 degree Celsius) and the moisture content is less then the alert was sent to water the plant.The plants were not watered at night and the day and night was detected by LDR sensor. Thus, every data was published to AWS IoT using MQTT protocol and SNS was used to send notifications**[Fig 7][Fig 8]**.


**Fig. 6 MQTT data published**



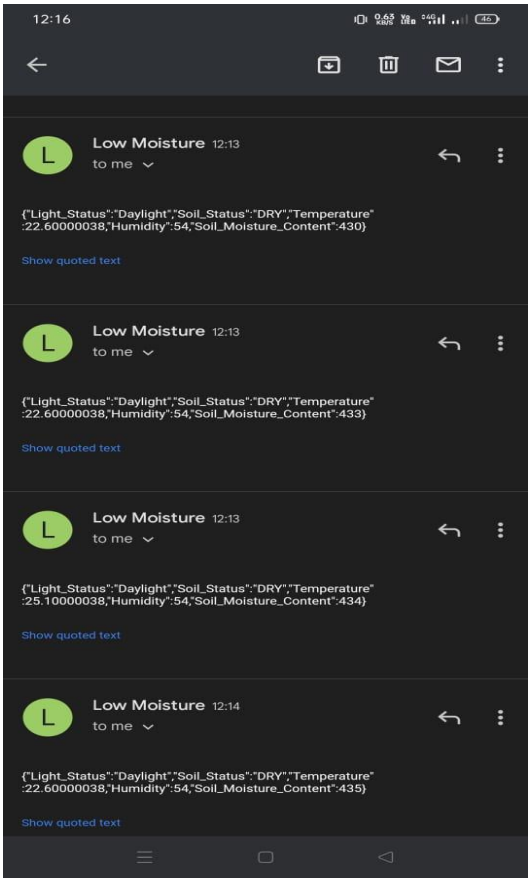




**Fig. 7 SMS Notifications** **Fig.8 Email Notifications**

## 3.2 ADVANTAGES

1. Low Cost
2. Easy to use and maintain
3. Reduces the human intervention
4. Proper care can be given to plant/crop
5. Gives status of plant remotely
6. Can boost up the agricultural growth of the country is used wisely

## 3.3 CONCLUSION

This model can reduce the efforts of daily watering of plants. It also conserves water for irrigation by locating the sensor at the right position above the soil level. The plants can still sustain at low moisture levels when the temperature is moderate. The system is used to switch on/off the water

pump according to the sensor readings there by automating the process of irrigation, which is one of the time-consuming activities. The system uses information from the sensors to irrigate soil which helps to prevent over irrigation (water wastage). Users can monitor the process online through a website. From this system it can be concluded that there can be considerable development in farming with the use of the Internet of Things.This system can be used for plants at home , even it can be extended for large farms. But for large farms, it requires more power supply. But it is effective as it can be combined with the drip irrigation. Thus ,it will help the farmers as well as the people who have plants at their home.

### 3.4 FUTURE SCOPE

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 i.e. he can switch on/off the pump in order to start/stop the process of irrigation without being present at the farm. The farmer may choose to stop the growth of crops or the crops may get damaged due to adverse weather conditions. In such cases farmer 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 minimalize human intervention in farming activities. Furthermore, the project can have pH sensors which can give information about the pH level of the soil and using that it can be determined whether soil is good or not for growth of plant and depending on that proper fertilizer can be can be provided. Also a web application or an Android application can be developed as they are easy to use and everything can be controlled from there. These applications can give all the information about the crop[6].

This project can be extended to a group of plants,farm or nurseries to monitor plants' condition. Also, for nurseries a layout of nursery can be deployed on the app which will provide a map a nursery and which plant is located at which place. Thus ,this project has a wide scope.

Also, buzzers can be fixed in this project to detect theft of plants . And these apps can also include chatbots with which the user can interact and get to know about the plants' status. Therefore, this project not only has scope in agricultural sector but also in nurseries and at home. It can proven to be very beneficial in the upcoming days if used wisely .

### 3.5 REFERENCES

[1] S. Marston, Z. Li, S. Bandyopadhyay, J. Zhang, and A. Ghalsasi, “Cloud computing - The business perspective,” Decis. Support Syst., 2011.

[2] Dr. Narayan G. Hegde, “Water Scarcity and Security in India”, BAIF Development Research Foundation, Pune.

[3]Marvin T. Batte, “Changing computer use in agriculture: evidence from Ohio”, Computers and Electronics in Agriculture, Elsevier science publishers, vol. 47, 1–13, 2005

[4] Vaishali S, Suraj S, Vignesh G, Dhivya S and Udhayakumar S, "Mobile Integrated Smart Irrigation Management and Monitoring System Using IOT", International Conference on Communication and Signal Processing Vol.5, pp.2164-2167, April 2017.

[5] Siyu Chen,Nicolas Fatras,Haoran su,"Smart water irrigation System",International Conference on Computer Sciences ,pp.85- 92,2017.

[6] Abhishek Gupta, Shailesh Kumawat , Shubham Garg, "Automated Plant Watering System", Vol-2, Issue-4, 2016 ISSN: 2454- 1362.