



# Emerging Technological Methods for Effective Farming by Cloud Computing and IoT

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## Abstract

Agriculture provides a solution to the vast majority of problems that threaten human existence. When it comes to agriculture, new or contemporary technology can have a significant impact on a number of factors, including how much food is produced and how long it stays edible. The application of best management practices, for instance, is very common these days in the quest to improve agriculture. New hybrids are resistant to illnesses, use fewer pesticides, have natural defenses against pests, and may be grown in methods that minimize the number of diseases and pests that can affect them. Plants are capable of producing oxygen and medicines in addition to the food that they provide. Consequently, agriculture depends on plants that are in good health. A plant needs water, sunlight, and crucial fertilizer in order to receive the nutrients it needs to have a healthy plant. So, it is necessary to keep an eye on the health of the plant. The article discusses various technological solutions that can be implemented to automate the plant monitoring system. The Internet of Things and cloud computing are two technologies that are contributing to the development of intelligent technology by supplanting traditional agricultural practices. This clever device checks on the well-being of the plants. In order to enable intelligent agriculture, the technology relies on sensors that are dependent on IoT sensors. These sensors monitor the temperature, soil moisture, intensity of the sun's light, air quality value of the soil, vibration, and humidity in the immediate environment of the plant. The networking of these sensors ensures that the plant will continue to be healthy and will function in the appropriate manner. The findings that have been obtained up to this point are encouraging for the continuance of this strategy, which results in the highest possible profit for farmers.

## Keywords:

Internet of Things;  
Cloud; IoT;  
Sensor;  
Plant;  
Agriculture;  
Farm;  
Smart.

## Article History:

<b>Received:</b>	25	April	2022
<b>Revised:</b>	12	June	2022
<b>Accepted:</b>	06	July	2022
<b>Available online:</b>	02	August	2022

## 1- Introduction

The agricultural industry is one of the most significant contributors to the country's overall economy. Not only is agriculture the main contributor to the Gross Domestic Product (GDP) of the country [1], but it is also the principal source of income for the government. People need to be able to get food and other necessities from the agricultural sector. The populace needs to be able to get their food and supplies from the agricultural sector. Although the population is expanding at a rapid rate, the amount of land that may be used for agricultural purposes is continuing to decrease as a result of the growth of a variety of enterprises and real estate [2]. Some nations in Asia, Africa, and Latin America should implement resource-saving technologies in order to boost their food production. These technologies include total pest control; recycling of nutrients; water recycling process; water harvesting process; conservation of water and soil. As a result, farmers become specialists at managing their farms' ecosystems. Moreover, the agriculture industry needs a bigger volume of workforce and a greater number of staffs. However, people are abandoning the agricultural industry, which is resulting in an increasing labour deficit in the industry. Therefore, agriculture must use intelligent agricultural technologies in order to meet the rising demand caused by an increase in the population while reducing the amount of labour required.

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**DOI:** <http://dx.doi.org/10.28991/ESJ-2022-06-05-07>

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The utilization of information technology (IT), which enables precision in agriculture, agro automation, and farm management information systems, is at the heart of smart farming. The development of information technology (IT) has allowed the Internet of Things (IoT) to become a part of the agricultural process. The Internet of Things (IoT) is basically an infrastructure that exists on a global scale to enable the provision of improved services by means of the connecting of things via information and communication technologies that are compatible with one another. IoT forms a network of devices and sensors that are outfitted with software and connections that make it possible to gather data remotely, sense a variety of characteristics, and exercise remote control over an already existing network. IoT is transforming the globe into a wireless environment, which will allow for remote and automated control as well as activities that are more precise and require less manual labour. IoT technology should consequently be implemented in agricultural and horticultural settings as soon as possible. IoT enables the implementation of plant monitoring systems, which enables plants to develop in regulated environments for the purpose of achieving maximum yields. The research work done by Kumar et al. [1] covered only irrigation using IoT. It did not provide information about the pH value corresponding to soil alkalinity. Aharari & Yang [2] researched smart farming without vibration monitoring. The purpose of this paper is to discuss a plant health monitoring system that is based on the Internet of Things. This system monitors the irrigation process, temperature, soil moisture, humidity, pH, and other factors, which ultimately leads to a fully automated agricultural process that requires less labour. The farmer can easily keep an eye on the property with the help of the smartphone. The constant and automated monitoring of plant health and the environmental factors surrounding the plant helps to minimize the risk of error, maximize the plant's growth, and, as a result, obtain the greatest possible profit.

## 2- Literature Review

Rabhi et al. [3] briefed that connected agriculture is a relatively new concept that emerged in the age of the internet of things. The outputs of big data may be used in future agriculture in order to increase yield and intelligent decision making. IoT has many advantages, such as customer engagement in a better way, usage of optimized technology, waste reduction, and collection of data. The sensors monitor the condition of the plant, soil, and ambient environment. IoT may make it easier to conduct remote steps to guarantee a plant's survival and proper maintenance. Plant health monitoring systems utilizing soil moisture sensors to determine the quantity of moisture in the soil were investigated by Parvin et al. [4]. A pump is used to water the land based on this information. Pattnaik et al. [5] went on to say that farmers might use internet of things research to learn more about area specific details of crops, soil, and agricultural productivity. The intelligent agriculture based on technology solutions helps farmers to optimize resources and planning. The development of IoT-based intelligent Smart Farming employing smart devices is revolutionizing agricultural production by enhancing quality and yield while simultaneously lowering costs.

Gogumulla et al. [6] explored soil classes as alkaline, neutral and acidic and also researched that the possibility of predicting pH of soil by big data analysis. Mageshkumar [7] explained the project, including a soil moisture sensor, a temperature sensor, and a humidity sensor for optimal irrigation. Various sensor nodes are distributed across the farm to automate irrigation and from anywhere. This program will be more useful to farmers' well-being. Monica et al. [8] discussed an architecture three-tier system consisting of sensors and actuators with an 8-bit AVR microcontroller. ESP8266 WIFI module transfers data to the internet server after data acquisition and processing. This architecture uses a relay to control pumps as actuators to irrigate the fields. Cloud technology helps store and retrieve vast amounts of data from the sensors to help faster and more accurate decisions. Wayangkau et al. [9] suggested a framework that will support solutions by data analysis, recognition of events rapidly, continuous interoperation of sensors, and other relevant features in the agriculture context. Mat et al. [10] presented the hardware and software of IoT for smart farming and shared good outcomes. Further found that agriculture must embrace IoT to feed 9.6 billion people by 2050. Yang et al. [11] deployed an indoor intelligent agricultural with an IoT system. Monitoring agricultural environments using IoT and Machine to machine technologies is now the primary focus of intelligent agriculture.

Dagar et al. [12] employed Internet of things to improve agricultural resource management, to upgrade quality, to increase quantity, to monitor fields and crops and other applications. In order to carry out these works, various IoT sensors for monitoring temperature, moisture, pH, etc., are employed. Li et al. [13] examined uncertainty relation among parameters corresponding to agricultural environment and irrigation and also suggested an optimization model to increase efficient water irrigation under the influence of water levels due to water scarcity and water sustainability. Abioye et al. [14] found that changing soil moisture dynamics, non-linearity, and other meteorological and plant factors necessitate real-time monitoring and an accurate prediction model for optimal irrigation and crop management. This research presents enhanced monitoring and data-driven modeling of the irrigation dynamics. Rohith et al. [15] designed an IOT-based strategy that led to healthy farming. Agriculture boosts the country's economy. The work's ultimate relevance is that it reduces human labour and automates watering, allowing optimal plant growth. Saves water and energy. Seniors can farm easily. Automatically growing tomato plant on paper.

The objective of Collado et al. [16] research is to identify difficulties and opportunities for the agriculture business. IoT-designed intelligent farm systems are proposed for achieving the objective. Sadeghzadeh et al. [17] did research on a drip irrigation device that required no electricity to operate and was self-sufficient, making it ideal for the daily watering

of container plants. It was explored that the discharge of water by STI instrument gets changed experimentally due to variation in heat condition, various sizes in pump and number of working days. Research employing wireless communication by Martos et al. [18] clarified that cloud computing with a suitable algorithm can give results corresponding to yield, harvest, irrigation metrological data, etc. By employing AI and Big data, the extraction of relevant adeptness and sustainability of agriculture corresponds to remote sensing. This study looks at innovative ways to use new technology in the future. The survey study done by Alwis et al. [19] outlines key problems in smart farming through by big data analysis. Smart farming data is used for futuristic yield, analysis of growth, control of quality, and supervision of farm. Three steps of analysis are done in this survey. It finds the various categories of big data at the first step. It also finds a way of allying big data in the farming procedure in the second step. The third step is to find the way to implement Machine learning with big data. Elijah et al. [20] discuss future technology, application, business, and marketability trends and prospects. This research examines the benefits and drawbacks of the Internet of Things. This work showed how IoT and DA work together to make smart agriculture possible. WSN, RFID, cloud computing, middleware, and end-user applications are all examples of IoT. IoT and Data Analytics are being utilized to increase the efficiency and productivity of agricultural operations. Bastan et al. [21] researched that System Dynamics simulation gives profound insights into sustainable development and effective agricultural strategies. Sustainable development manages and conserves natural resources to fulfill current and future human needs. The literature survey briefed that both better irrigation technology and better plant health monitoring technology are required for efficient monitoring of farms. This research focuses on the same issue.

### 3- Methodology

Figure 1 shows the instrumentation systems employed to monitor the health of the plant. The system for monitoring the health of the plant employs NodeMCU, DHT11 sensor, pH sensor, vibration sensor, soil moisture sensor, Blynk app.

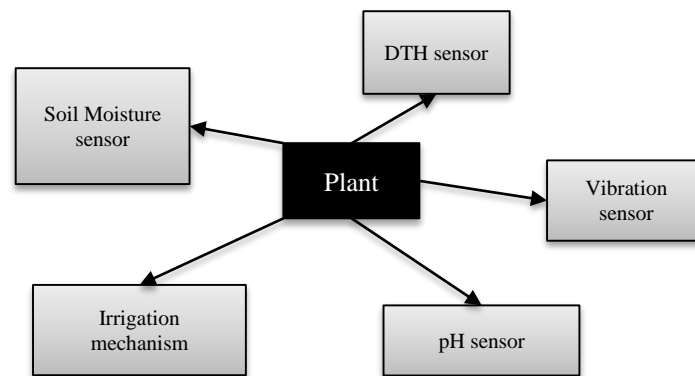


Figure 1. Plant monitoring system

#### 3-1- Soil Moisture

The soil moisture sensor, as shown in Figure 2, provides output as the moisture content in the soil and measures the volumetric content of water in the soil. The YL-69, as shown in Figure 2, the soil moisture sensor is a resistance-based sensor [22]. To measure the moisture content in the soil, the current is allowed to pass through the soil [23] from one terminal sensor to another terminal. The value of current depends upon the amount of moisture present in the soil. The current passing through soil is directly proportional to the amount of moisture. Moisture measurement helps to monitor the water amount available around the plant.

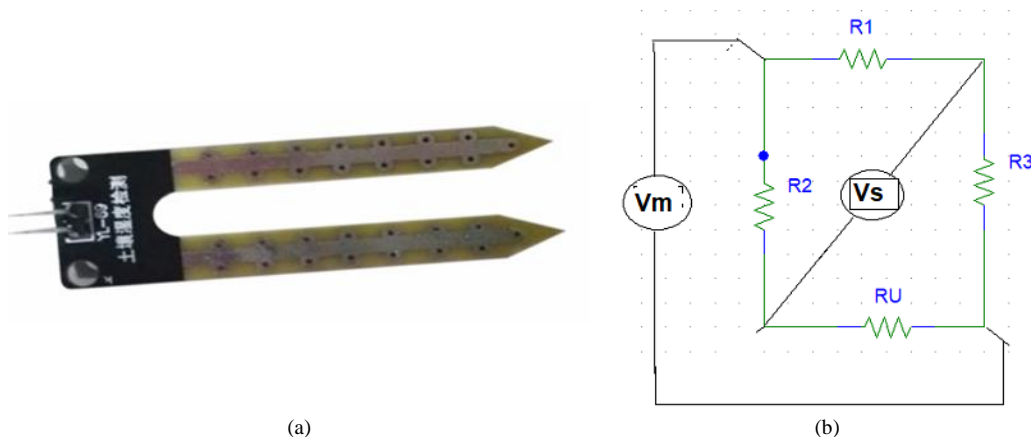


Figure 2. a) Soil Moisture Sensor, b) Soil Moisture Sensor equivalent circuit

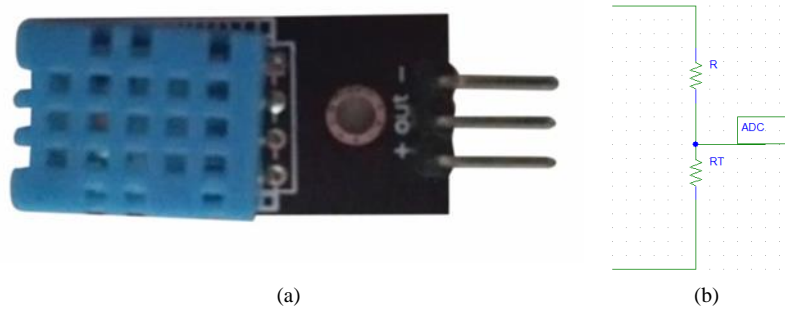
The moisture of soil is measured in terms of resistance. The unknown resistance of soil is part of Wheatstone bridge and is measured by following equation:

$$R_u = \frac{\frac{R_3}{R_1+R_3} + \frac{V_m}{V_s}}{1 - (\frac{R_3}{R_1+R_3} + \frac{V_m}{V_s})} R_2 \quad (1)$$

where  $R_1$ ,  $R_2$ ,  $R_3$ ,  $R_u$  are resistances of arms in Wheatstone Bridge,  $V_m$  is the source voltage and  $V_s$  is the voltage to be measured as per moisture in the soil as shown in Figure 2 (b).

### 3-2- Temperature and Humidity Sensor

The DHT11 sensor in Figure 3 measures the temperature and humidity. It helps to keep an eye on the temperature and humidity of the area around the plant. The resistance of the thermistor in the sensor changes depending on how hot or cold it is. By measuring the temperature, the farmer can find the best place for the plant to live. Two electrodes on DHT11 measure the amount of moisture in the air. The humidity is measured by the conductive polymer between these electrodes. The resistance between the electrodes changes when it rains [24]. These sensors are different in size and what they can do. There are two kinds of humidity sensors: relative humidity sensors (RH) and absolute humidity sensors (AH). The RH sensor senses the temperature and turns it into relative humidity. The AH sensor measures humidity by comparing the change in resistance to a known temperature. The RH sensor is a capacitive sensor with two electrodes separated by a polymer comb. The capacitance varies according to temperature. The changes in capacitance makes changes in voltage across the capacitor that in turn shows the live humidity of air at a given temperature.



**Figure 3. a) Temperature and Humidity Sensor (DHT11), b) Equivalent Circuit of DHT11**

Air has various gases and water vapour. Dry air is modelled as an ideal gas. Dry air far from the dome water pressure. The relative humidity is defined as ratio of water vapour ( $\rho_w$ ) amount with respect to saturated water vapour ( $\rho_s$ ). The water gets condense at the saturating point. The formula to calculate relative humidity is:

$$RH = \left( \frac{\rho_w}{\rho_s} \right) \times 100 \% \quad (2)$$

In order to measure temperature, a simple voltage divide network is employed with thermistor. The voltage across depends upon temperature. This analog voltage is sampled for five times and averaged. The resistance of thermistor is found by following equation:

$$R_T = \frac{R}{\frac{1023}{ADC_{value}}} - 1 \quad (3)$$

where  $R$  is resistance and  $ADC$  is voltage across  $R_T$  as shown in Figure 3(b).

The temperature across thermistor is calculated by following expression:

$$\frac{1}{T} = \frac{1}{T_o} + \frac{1}{\beta} \ln\left(\frac{R}{R_o}\right) \quad (4)$$

where,  $T$  is Temperature to be measured,  $T_o$  is room temperature,  $\beta$  is the beta value of thermistor,  $R_o$  is the resistance of thermistor at room temperature

### 3-3- pH Sensor

The pH of the environment is a key factor in all chemical reactions, biological processes, and all forms of life. Bacteria, Fungi, and mammalian cells require pH which has the activity of hydrogen ions. Using soil pH, one can determine a soil's acidity or alkalinity. pH 7.0 is considered neutral on the pH scale. In general, anything below 7.0 is acidic, and anything above 7.0 is alkaline or basic. The acidic soil has less availability of calcium, phosphorus, and magnesium. But it has more availability of hazardous aluminum and manganese. The availability of phosphorus and other micronutrients is less in alkaline soil. Most crops need an alkaline environment, so the agriculture industry needs

to test the alkalinity of the soil. By sensing pH, the farmer can control the availability of mineral nutrients, the structure of the soil microbiome, and the make-up of natural plant communities. When the pH of the soil changes quickly, the strategies for getting nutrients need to be changed all the time.

$$E = E^0 + 2.303 \left( \frac{R.T}{n.F} \right) \cdot \log a_{H^+} \quad (5)$$

Where  $E$  is the potential sensing electrode,  $E^0$  is the potential of reference electrode,  $R$  is gas Constant,  $T$  is temperature,  $n$  is the valency of ion,  $F$  is Faraday constant and  $a_{H^+}$  is the Activity of  $H^+$ . This potential measured at temperature is converted into pH by the expression given below:

$$E(T) = E^0(T) - 0.1984 T \text{ pH} \quad (6)$$

The soil's pH is measured by the liquid pH0-14 shown in Figure 4. It finds what kinds of things are in the soil. The pH sensor shows the activity of hydrogen ions in the soil [25]. For plants to grow well in the soil, the pH should be between 6.5 and 7.5 on average. To grow well, different plants need different pH levels. The type of soil used to grow a plant, the amount of fertilizer, and the amount of water can all change the pH of the soil. In this experiment, the cactus plant needs a pH of about 5 to 7. pH sensor is first calibrated with buffer solution before measuring pH of soil. The pH sensor probe has a tubular glass form of a reference electrode and sensor electrode. The reference electrode has a buffer solution having a pH value equal to 7 and sensor electrode contains potassium chloride solution (saturated). There are two tubular forms of glass electrodes constructing the electrode bulb. Silica and metal salts are coated on the electrode bulb. The buffer solution pH=7 has a silver wire coated with silver chloride. The saturated potassium chloride also has a silver wire coated with silver chloride. When the pH sensor probe is kept on soil, metal ions on the bulb get replaced by hydrogen ions. So, the exchange of these metal and hydrogen ions makes an electric current which is sensed by silver wire. Hence, there is a voltage difference between the electrode and sensor electrodes. This voltage difference is converted into a pH value. If the soil is acidic, there are more number of hydrogen ions which leads to have more voltage differences. If the soil is alkaline, it generates only less number of hydrogen ions, which establishes less voltage difference. Since the voltage at the inside electrode is constant, the pH of the soil gives different potentials that in measured as pH values. If the pH of the soil remains the same and the temperature varies, the potential also changes with respect to temperature. So, the temperature should be kept constant when measuring pH value. Soil gives different pH value when fertilizer and amount of water is added to it for the growth of the plant.

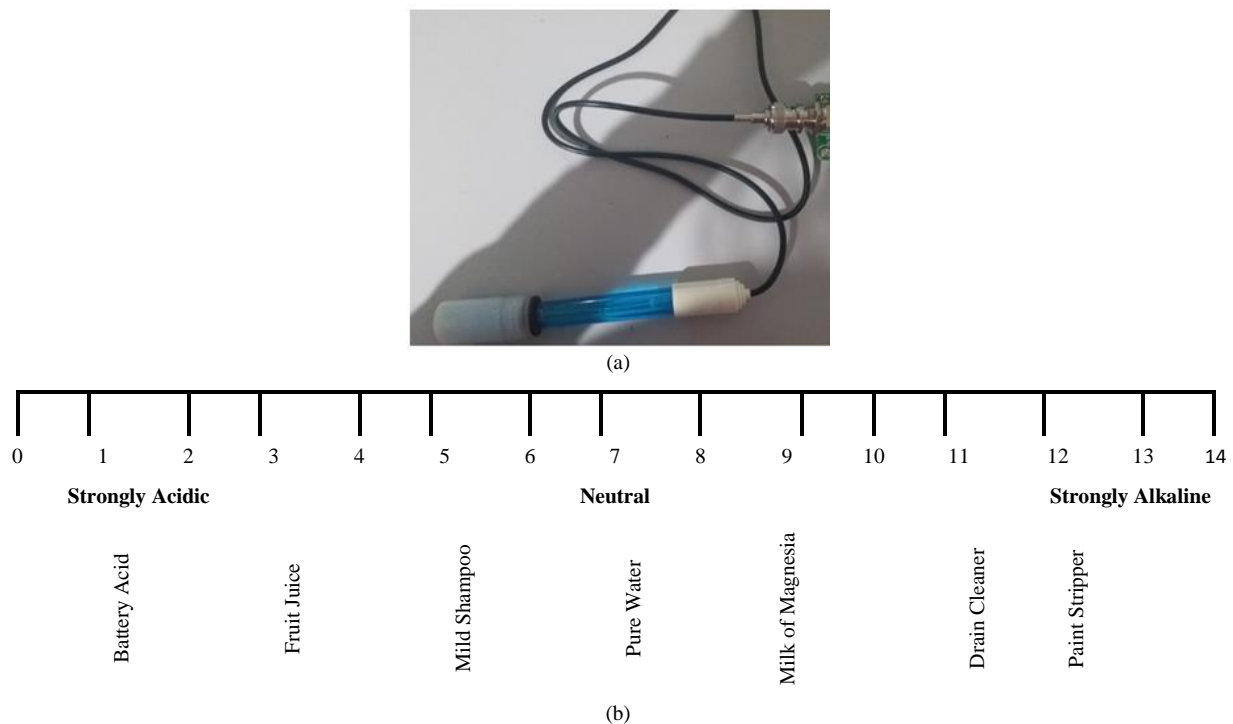


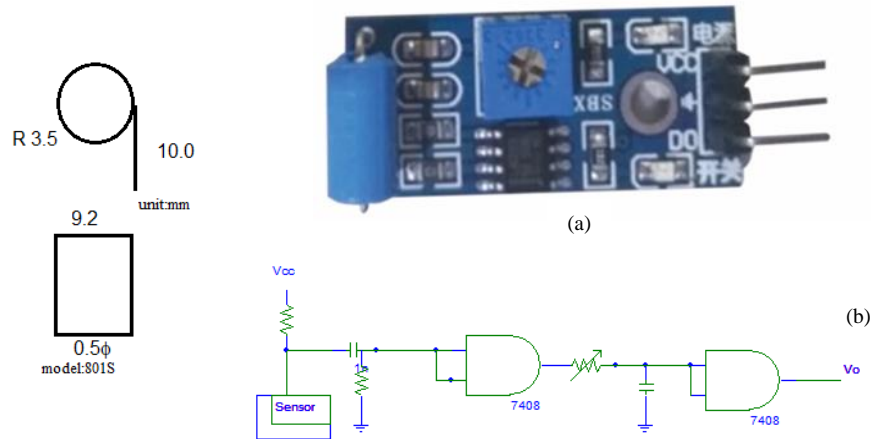
Figure 4. pH Sensor

### 3-4- Vibration Sensor

The vibration sensor (801S) notifies the farmer if there is any wind, which is destructive to the plant. This sensor converts vibrations into changes in resistance. This sensor can provide data corresponding to real time vibration even with micro shock sensing. The sensor outputs low voltage when there is no vibration. The square appears as output when the sensor detects vibration. Extreme wind can cause serious damage to the plant [26]. The vibration sensor can measure



the displacement, velocity, and acceleration of the moving plant. This action notifies the farmer whether the plant is being cut down or the plant is moving or someone is disturbing the plant (human or insect or any reptile). This process would help the farmers be more alert to protecting their plants, as the sensor would send information to the cloud if anything is done to the plant. A red LED would glow if the vibration sensor senses any harm. To measure if any harm is done to the plant, one would need to set the vibration sensor to a particular range by turning the screw on the sensor. The vibration sensor used here is given below in Figure 5.

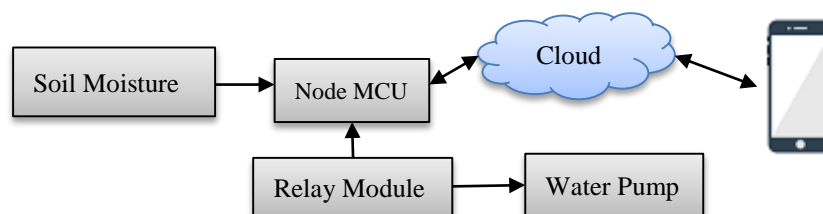


**Figure 5. a) Vibration Sensor, b) Vibration Sensor Equivalent Circuit**

### 3-5- Smart Drip Irrigation Technique

There are different types of irrigation techniques. First of all, surface irrigation is the most common form of irrigation historically. Here, the water moves across the surface of the land to wet the plants and get inside the soil. However, only the water application efficiency is lower here. The second method is sprinkler irrigation where the sprinkler rotates to irrigate the plants. Using sprinkler irrigation in arid countries like the UAE is not a good technique. When irrigation is done using a sprinkler, 60 percent of the water is evaporated because of the hot climate, and 40 percent is absorbed in the soil of the plant. Even the 40 percent of water is unevenly distributed across the whole site. This distribution can make the plant's health deteriorate. Therefore, in such cases, drip irrigation is much better at saving water and is more complex. It is also called trickle irrigation as water is distributed to each plant by droplets that fall under low pressure from a piped network. The drip irrigation system is a micro-irrigation system. It is very efficient because it minimizes the wastage of water and nutrients from the soil. Water evaporation gets minimized due to its placement closely next to the roots of plants. Moreover, Water scarcity is everywhere around the world as the standards of living are being improved and patterns of consumption of water are being changed. The developing countries require proper irrigation techniques for their water management. Therefore, Israel shifted to drip irrigation systems which require less water supply so that water could be saved. Drip irrigation can be made more efficient by the soil moisture sensor using IoT.

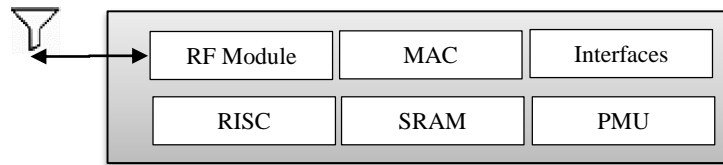
Drip irrigation systems in the Figure 6 are considered for effective water usage. This drip irrigation employs smart technology. The soil moisture sensor is a part of a smart irrigation system. This sensor monitors moisture of soil. If the moisture of the soil gets reduced, the motor employed in the irrigations system is switched ON. If the moisture in the soil is reached a sufficient level, the motor which pumps water is turned OFF.



**Figure 6. Drip Irrigation System**

### 3-6- Node MCE

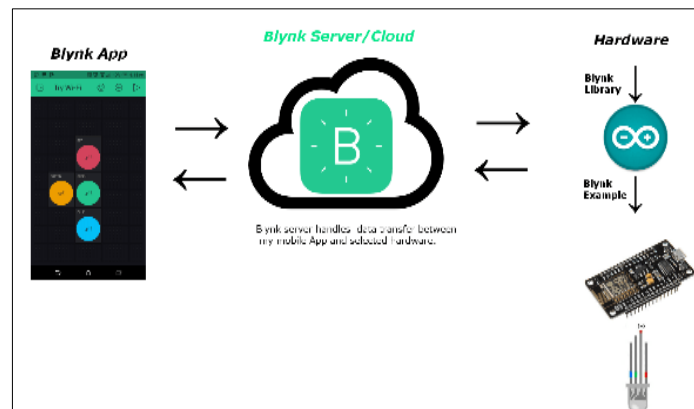
The WIFI module ESP8266 shown in Figure 7 is a system on chip (SOC) with TCP/IP protocol. This module makes IoT for sensors. This IC comes with pre-programmed with AT command. It can store and process data. The Node MCU is used here to connect all the components for IoT purposes. The Blynk app used here is to get information about the plant from all the sensors used here.



**Figure 7. Node MCU functional diagram**

### 3-7- Blynk

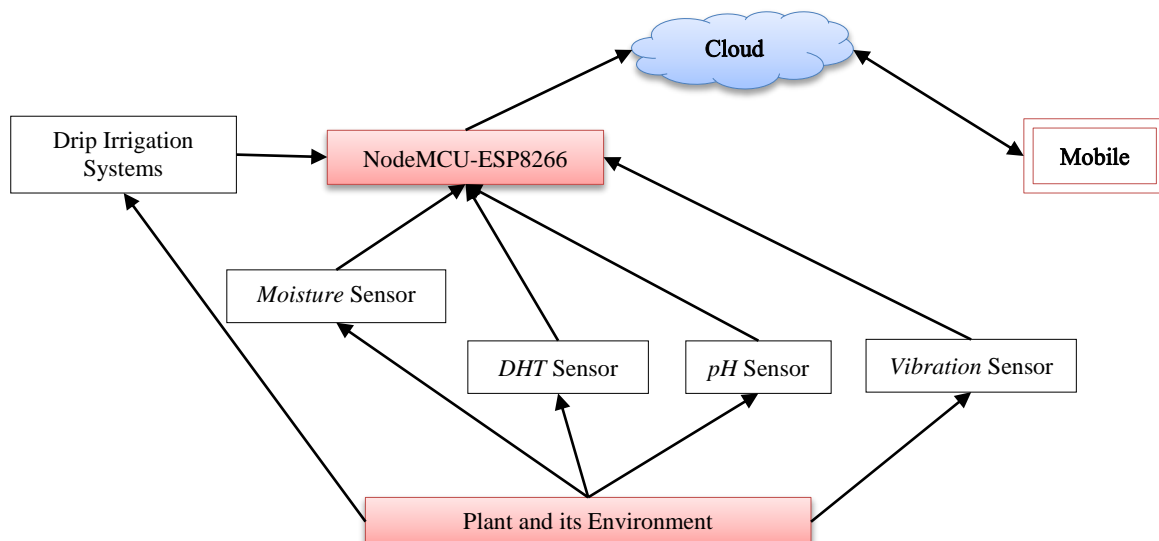
IoT employs an open source Blynk platform which controls hardware placed in a remote place. Figure 8 shows that this platform has three important components Blynk Server, Blynk Library and Blynk App. Blynk server establishes connectivity between field hardware and smartphone. Blynk libraries execute all commands and enable communication between server and hardware. Blynk App creates a proper interface using various widgets. The Blynk platform is designed to control hardware, to display sensor data, to store data and to visualize the complete process.



**Figure 8. Blynk Cloud**

## 4- Design of Proposed Plant Health Monitoring System

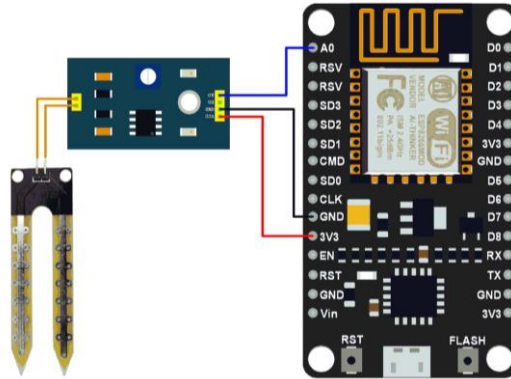
The design of smart farming is as shown Figure 9. All four sensors, DHT11, soil moisture, vibration, and pH, are connected to NodeMCU-ESP8266. These sensors get the input from the plant and its surroundings and generate the output signal according to the condition available. The NodeMCU obtains the output signal of all sensors. The entire measurement system is connected to the cloud through the NodeMCU. The cloud gets all data from all sensors. This cloud then stores them and processes them according to the requirements. Blynk app installed in the smartphone displays all actions happening in the cloud. The ESP8266 operates with 3.3 volts. Arduino IDE programs ESP8266. Soil moisture sensors send an analog signal to ESP8266. This analog signal is further processed and stored in the cloud. The Stored data can be accessed Blynk app.



**Figure 9. Proposed health monitoring system**

Steps to connect Moisture Sensor as shown Figure 10.

- Connect two pins of the YL-69 sensor to two input pins of the Amplifier.
- Connect the 3.3 v pin on ESP8266 to Vcc pin at Amplifier.
- Connect the ground pin on ESP8266 to the GND pin at Amplifier.
- Connect A0 pin of ESP8266 to Analog pin at Amplifier.
- Connect ESP8266 to PC by USB cable.

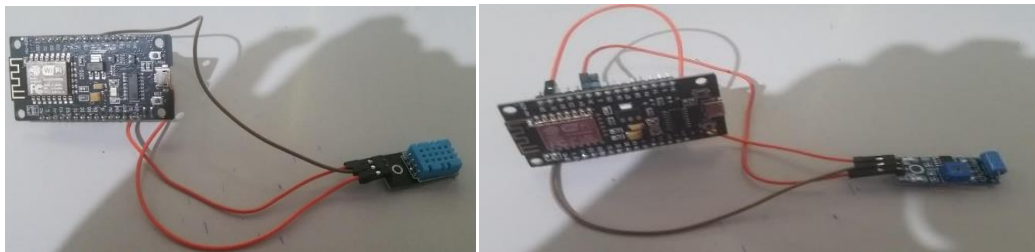


**Figure 10. YL-69 wiring diagram with ESP8266**

Steps to connect the DHT11 sensor as shown in Figure 11.

DHT11 sensor is a blue sensor consisting of three pins labelled as (+), OUT, and (-)

- Wire +3V pin of ESP8266 with (+) pin of DHT11 sensor.
- Wire Digital input D4 at ESP8266 with pin OUT of DHT11 sensor.
- Wire GND pin of ESP8266 with (-) pin of DHT11.
- Connect ESP8266 to the PC via a USB cable.



**Figure 11. DHT11 wiring diagram with ESP8266**

Steps to connect to vibration sensor as shown in Figure 12.

- Connect the VCC pin on the vibration sensor [801S] to 3V of the ESP8266.
- Next, connect the vibration sensor's ground pin to the ground pin of the ESP8266.
- Finally, connect vibration sensor's D0 pin to ESP8266's D1 pin.



**Figure 12. Vibration sensor 801S wiring diagram with ESP8266**



Steps to connect to the pH sensor (liquid pH0-14) as shown in Figure 13.

- Connect the P0 pin of the pH probe sensor to the A0 pin of ESP8266 via jumper wire.
- Connect both the grounds of the pH probe sensors to the ground of ESP8266 via a jumper wire.
- Connect the V+ pin of the pH probe sensor to the 3v pin of ESP8266 via a jumper wire.
- After this, connect the pH probe to the other side.



Figure 13. YL-69 wiring diagram with ESP8266

## 5- Wiring Diagram of Proposed Plant Health Monitoring System

The complete wiring details of the proposed plant health monitoring systems are shown in figure 14. The moisture, vibration, humidity, and pH sensors are connected with nodeMCU ESP 8266.

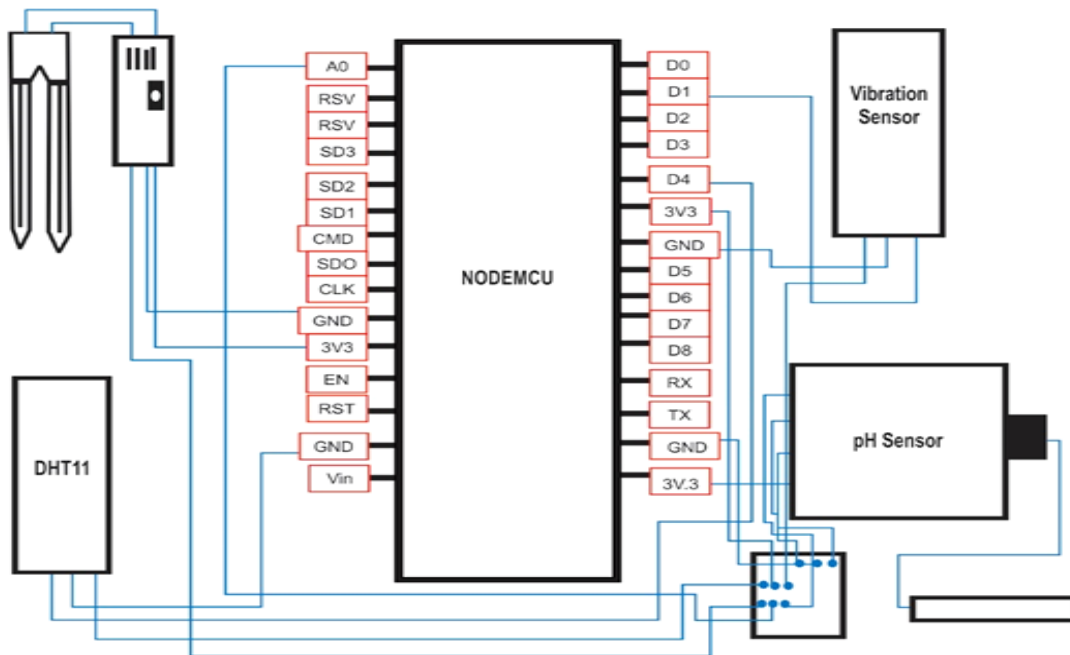
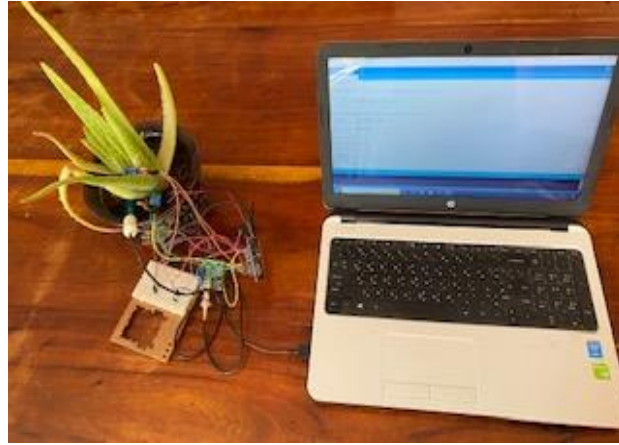


Figure 14. Complete wiring diagram for plant health monitoring systems

## 6- Results and Discussions

UN Food and Agriculture Organization report says that the world needs 70% of more food in 2050 than it had in 2006 to feed the population. The Smart farming industry will become important in the upcoming decades for agriculture. The plant health monitoring system for Aloe Vera Plant is shown in figure 15. The system with multiple sensors is used here. The performance of monitoring systems depends upon the operational status of sensors. DHT11 measures temperature and humidity change outside. Soil moisture sensor varies its output with respect to the moisture content in the soil. Vibration sensor performance depends upon vibration occurring in the plant. Finally, the pH sensor measures the alkalinity of the soil.



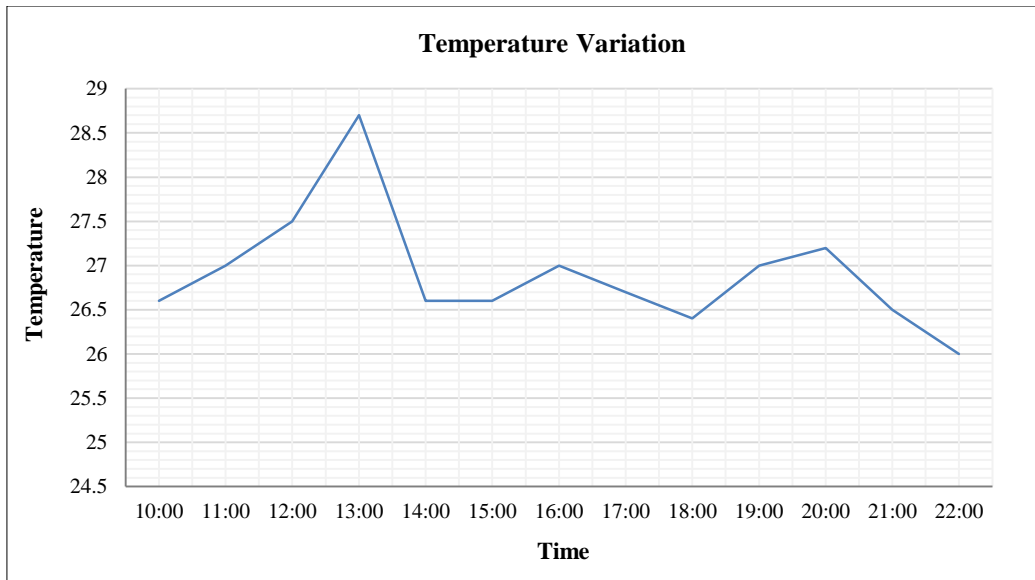
**Figure 15.** The plant monitoring system of the Aloe Vera Plant

Table 1 explains the performance of the health monitoring system. The experiments were done in the laboratory to test the functionality of all sensors. However, practically implemented on an aloe Vera. Sensors were calibrated as well. The time of study is chosen between 10:00 AM to 22:00 PM. The accuracy of the performance of each sensor was calculated by finding the deviations of each value (by subtracting the actual value from the average value). All these deviations were added and divided by the number of values. The accuracy is more when the smaller value appears in the deviation given in Table 1.

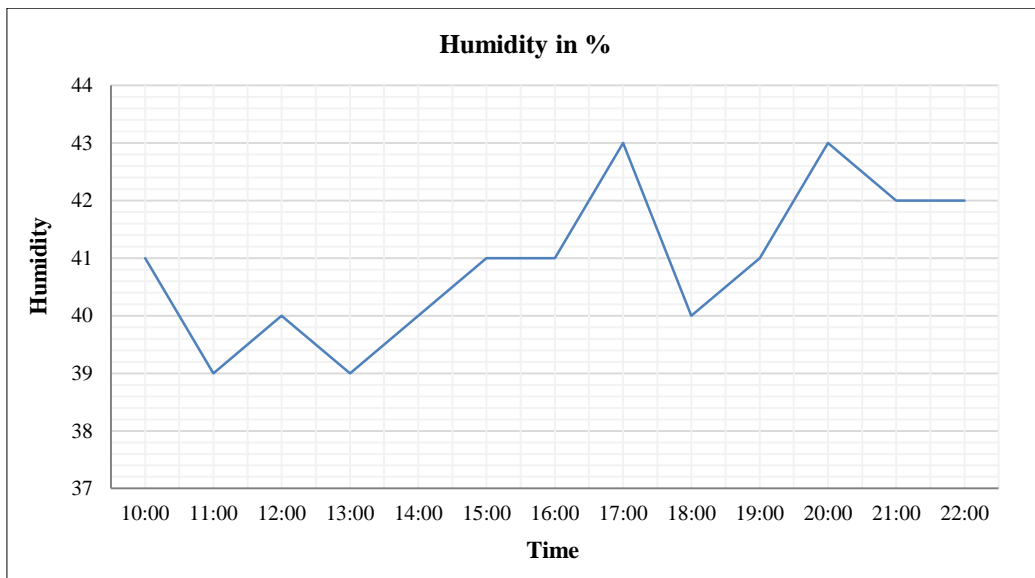
**Table 1.** Variation of parameters according to time

Time	Temperature (°C)	Humidity (%)	Soil Moisture (%)	Vibration	pH
10:00	26.6	41	50	3.1	6.67
11:00	27	39	60	3.1	6.68
12:00	27.5	40	65	0	6.68
13:00	28.7	39	70	0	6.69
14:00	26.6	40	68	0	6.65
15:00	26.6	41	63	0	6.66
16:00	27	41	60	3.1	6.65
17:00	26.7	43	57	3.1	6.66
18:00	26.4	40	54	3.1	6.68
19:00	27	41	52	3.1	6.67
20:00	27.2	43	50	0	6.67
21:00	26.5	42	50	0	6.66
22:00	26.0	42	50	0	6.66
Average	26.9	40.9	57.6	1.4	6.66

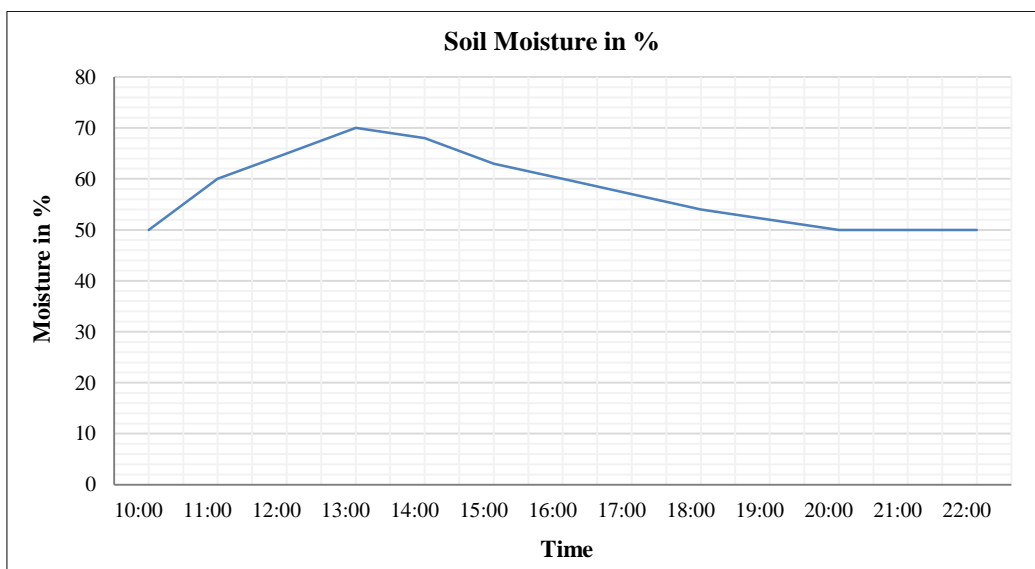
Temperatures vary from 26 degrees Celsius to 28.7 degrees Celsius. The maximum temperature of the day occurs about one in the afternoon. This variation is charted, and it can be seen in Figure 16. The humidity around the plant is at its lowest point around seven o'clock in the evening, and it reaches its greatest point at ten o'clock in the morning. The progression of the humidity levels is seen in Figure 17. Water is supplied on the hour from 10 in the morning until 1 in the afternoon. When more water is supplied to the plant's soil, the total amount of water present in the soil increases, and this change may be measured. The value being measured is fifty percent at ten o'clock in the morning, and it rises to seventy percent by one o'clock in the afternoon. The amount of moisture varies throughout time, as seen in the graph shown in Figure 18. The shaking of the plant can be caused by bringing a high-speed fan next to it and then turning it on. Altering the speed of the fan while simultaneously taking readings of the vibrations in the system. When a fan is operating at high speed, the wind generated has a great deal of force; this causes the branches of a tree to move. The waveform, which can be seen in Figure 19, is utilized to determine how far the object has moved. A voltage of 3.1 V was the most that could be produced. After fertilizer has been applied to the ground, the pH of the soil is measured with a sensor known as a pH sensor. When fertilizer is added, the pH level shifts, and the magnitude of such shifts depends on how much fertilizer was added. The pH values that were tested fell somewhere in the range of 6.6 to 6.9, which is also depicted in Figure 20.



**Figure 16. Time vs. Temperature**



**Figure 17. Time vs. Humidity**



**Figure 18. Time vs. Moisture**

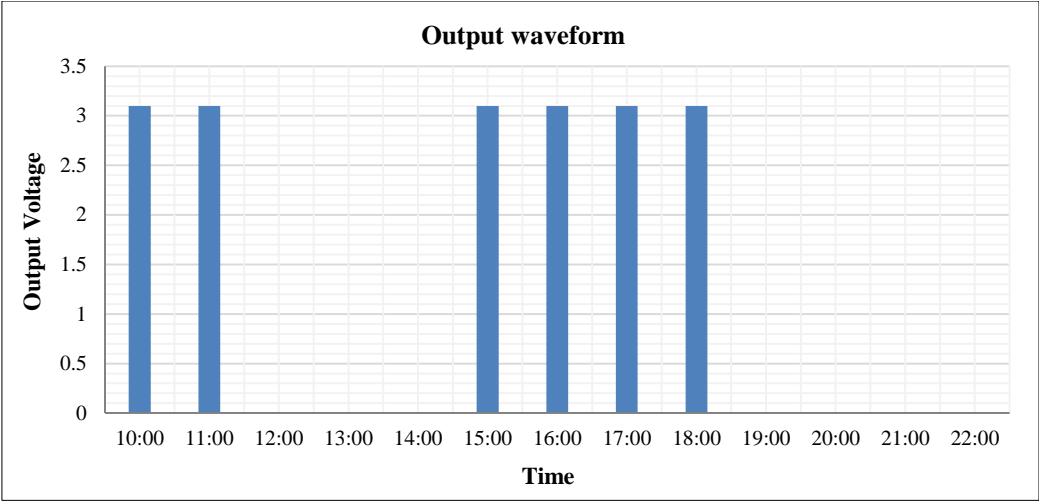


Figure 19. Time vs. Output Voltage due to vibration

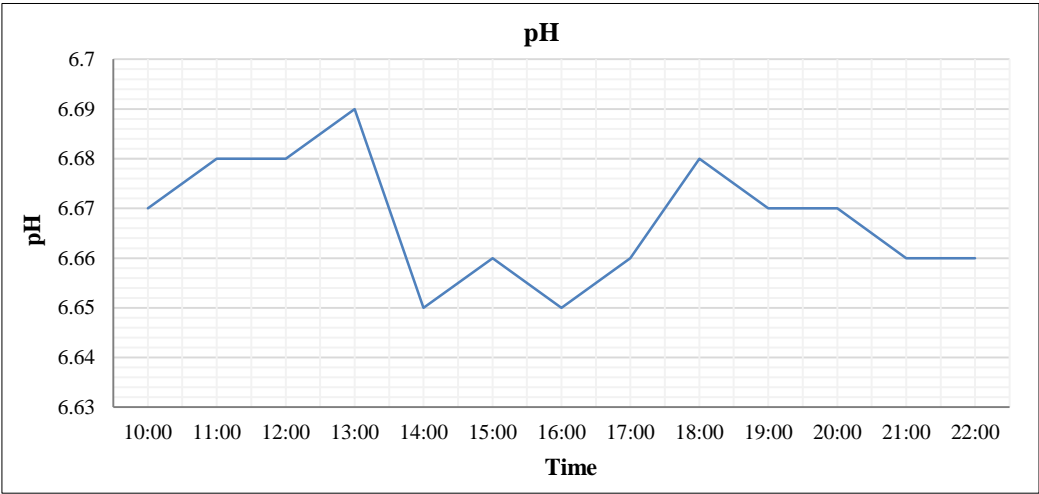


Figure 20. Time vs. pH

IoT sensor records measurements in the cloud. The cloud is established by Blynk. Smart phone executes Blynk App, it opens up measurements stored in the cloud. Figures 21 and 22 indicate that Blynk app implementation in the smart phone.

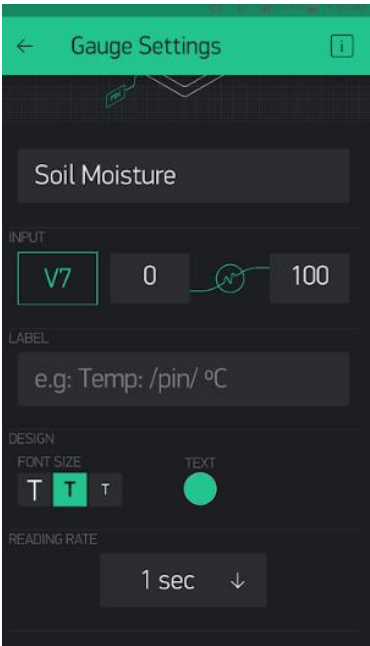


Figure 21. Blynk Gauge Setting



**Figure 22. Blynk plant health monitoring**

## 7- Conclusion

Modern agriculture has been developed to provide the highest possible yields while generating the most potential economic profit. As a result, effective use of technology is required to boost production and individual employability. Agricultural practices must include the use of inorganic fertilizers, irrigation, intensive tillage, monoculture, chemical pest control, and enatic crop plant modification. The major purpose of this study article is to understand how to employ technology in the agriculture industry efficiently. Agriculture may benefit from the development of technologies to enhance output. High-tech protected farming, biotechnology, advanced irrigation systems, and nanotechnology must be developed to assure the agricultural sector's successful growth and development. These technologies, when implemented effectively, have the potential to increase productivity and profitability. With the aid of technology, farmers will be able to preserve their livelihood possibilities.

The farmer can provide a steady distance while still keeping a watchful eye on the plant with the use of remote monitoring. Therefore, there is indeed a drop in the number of people employed. This method serves as a replacement for agricultural human resources, the availability of which is decreasing in the modern day. A plant health monitoring system may also contribute to resolving issues relating to a lack of available water by connecting it to the drip system. This trip mechanism activates anytime there is a decrease in the soil's moisture content. By using a number of different sensors to ascertain the state of the plant, the study contributes to the resolution of the bulk of the challenges facing the agricultural sector. Cloud technology is used to transmit the data collected by plant sensors to the farmer, who can then use this information to identify better patterns of issues that are encountered by farms and to make quicker choices at the right moment. The plant health monitoring system would assist in finding solutions to a wide range of problems that are associated with plants and farmers. These monitoring devices assist the farmer in conserving water and ensuring that the plant continues to thrive within a certain environment. The actual execution of this work is done in the laboratory, which becomes the limitation of this study. The work contributes by integrating smart watering with smart monitoring of the plant, along with a vibration sensor.

### 7-1- Future Scope of Work

Countries with huge agricultural lands should use this research to develop technology-based agriculture. Big data analysis about plants like herbs, shrubs, trees, climbers, and creepers can be done by machine learning and deep learning tools for better decisions, appropriate control actions, and predicting yields to be given by agricultural forms. Further, the Nano IoT sensor has less thickness, less weight, and flexibility. Using these Nano IoT sensors, research can also be done on reducing biotic and abiotic stresses and monitoring gases like CO, NO, and O<sub>2</sub>.

## 8- Declarations

### 8-1- Data Availability Statement

Data sharing is not applicable to this article.

### 8-2- Funding

The author received no financial support for the research, authorship, and/or publication of this article.

### 8-3- Acknowledgements

The authors would like to thank the Director, Birla Institute of Technology and Science Pilani, Dubai campus. This research work was supported by the communication laboratory at Birla Institute of Technology and Science Pilani, Dubai campus.

### 8-4- Institutional Review Board Statement

Not applicable.

### 8-5- Informed Consent Statement

Not applicable.

### 8-6- Conflicts of Interest

The author declares that there is no conflict of interest regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely observed by the author.

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