# A Greenhouse Monitoring and Crop Prediction System Implemented using IoT, Arduino Uno and Nodemcu

**M. Lavanya, R. Parameswari**

***Abstract:*** ***IoT plays a vital role in modern technologies by connecting objects to internet through which real time values can be . The system is developed using one such technology in greenhouse. The system developed for the purpose of crop prediction in greenhouse. Soil parameters such as pH and moisture, the environment parameters like temperature and humidity is acquired from the implemented system. The required nutrients such as N, P, K is fed to the crops manually is also considered as input for crop prediction. The system is developed with Arduino Uno, NodeMCU ESP8266(WIFI Module), Sensor like DHT Humidity and Temperature DHT11, pH Analogy, Soil Moisture sensor, 12V DC motor for triggering, 12V Relay and a few other components to complete the circuit. Web hosting is done using PHP. The sensors values get stored in data base using MYSQL for further analytics.***

***Keywords*** **: *Arduino Uno, Node MCU, DHT, DHT11, pH analogy, PHP & MYSQL.***

## I. INTRODUCTION

Agriculture is backbone of India. Many farmers in India were following the traditional method for crop selection. Crop rotation is practised [14] by farmers, if the crop rotation is implemented after the proper examination of soil nutrients and its pH value the farmers will get more and good yield than the usual. Nowadays,Greenhouse cultivation becoming popular for farming vegetables, greens and desired fruits. The yield in greenhouse can be maximized by providing the necessary environment such as humidity, temperature and required nutrients for that crop if so the end product from greenhouse always be in good quality, quantity and pesticide free. Greenhouse farming can be practised by anyone even in their roof top. The objective is to combine the available technology namely IoT, to sense soil nutrients, and environment parameter. Machine learning algorithm is used for analysing the values and to predict the suitable crop which suits the soil. The system is implemented with Arduino Uno, NodeMCU ESP8266(WIFI Module) which slightly differ from the proposed system with zigbee module. Zigbee in most cases used for remote monitoring and moreover it is meant for one particular location and the connection once made remains the same until the purpose get solved. The present implementation is made with Arduino Uno, NodeMCU ESP8266(WIFI Module) , deployed as a box kit which is portable in nature and can be used on any location soil sample, through which more and more soil sample data can be acquired from sensors. Unlike Zigbee which has to be fixed to one particular location. Implemented kit can be connected to internet with the help of mobile network and the data can be viewed in the URL whenever required. The rest of the paper is organized as follows: Section II deals with related works. Section III discusses the System Design. Section IV presents Implementation of the system. Section V gives the Results and Discussions. Section VI tells about the Conclusion and Future Enhancement.

## II. RELATED WORKS

Good quality and high production of crops can be made in greenhouse through proper maintenance of humidity,temperature and pH value.Developed a system with ZigBee, artificial intelligence and decision support system for real time monitoring of citrus soil moisture and nutrients. Wireless sensor node is used to predict fertilization and irrigation management. Result showed the increase of production of citrus [1]. Proposed a method only for monitoring crop with IoT, but as a future enhancement for automated irrigation and to secure the land using camera surveillance. Used ATmega WiFi Module and GSM Modem for system development [2]. Had an aim of developing a simple low cost Arduino based system for a greenhouse to monitor the environmental parameters and to be controlled to achieve optimum plant growth and yield. Sensors such as DHT11sensor, Soil Moisture sensor, LDR sensor and pH sensor were used. Values were sent to Anroid Mobile phone. A GSM modem is used to send SMS to user to know the current status of environment [3]. A model of smart greenhouse was created with soil moisture, temperature and humidity sensor, ultrasonic sensor, irrigation was managed with drip irrigation along with water management . Actuators such as fogger were constructed to control the humidity and lights are used to maintain temperature. Bee-hive boxes were used for pollination. Message sent with GSM Modem as sms to buyers when the honey was collected. Cloud was used to store the collected data. Author also concludes that this kind of system can even be installed as roof top gardening and farming can be practised by anyone with no previous knowledge. System was tested in Hibiscus plants to check its growth and increased productivity [4]. X For monitoring agriculture environment technology like WSN with Zigbee and raspberry pi were used. Authors pointed the usage of smart system as a revolution in agriculture, it is stated that remote monitoring and greenhouse cultivation is also possible through which any kind of plants can be given with necessary condition for growing. Cloud enabling and addition of more sensors was the scope of this system[5].

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***** Correspondence Author
**M. Lavanya,**Pursuing, P.hD, Computer Science, Vels Institute of Science, Technology and Advanced Studies, Chennai.
**Dr. R.Parameswari,** Associate professor, Department of Computer Science, Vels Institute of Science , Technology and Advanced Studies, Chennai.

## III. SYSTEM DESIGN

Circuit diagram for crop prediction System resembles like one in Fig. 1[13]. In addition to Arduino Uno board (Board1), and Nodemcu esp8266(Board 2) it uses DHT Humidity and Temperature DHT11 (S1), pH Analogy (S2), Soil Moisture (S3), 12V DC motor (M1) for triggering, 12V Relay (R1) and a few other components to complete the circuit

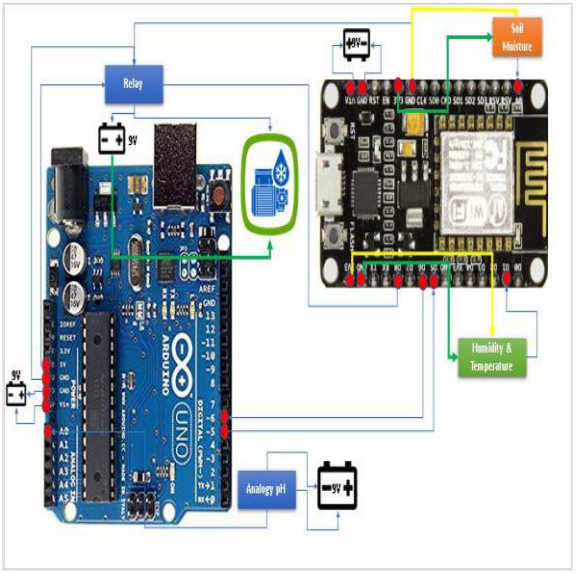


**Fig. 1 Agriculture Environment Monitoring System using Arduino Uno and NodeMCU**

### A. Components And Functions

The following are the components used in the development of this system

- **Board Used**
  - Arduino Uno board (Board1)
  - Nodemcu esp8266 (Board 2)
- **Sensor Used**
  - DHT as Humidity sensor
  - DHT11 as Temperature sensor
  - pH Analogy as pH sensor
  - Soil Moisture sensor
- **Other Components**
  - 12V DC motor- for triggering
  - 12V Relay (R1) and
  - Few other components to complete the circuit.

### B. Arduino Uno

Arduino Uno is used in this circuit to collect pH value from pH sensor and this value is sent to NodeMCU

### C. NodeMCU

This is used to collect all the reading form the sensors and send to web application. NodeMCU .ESP8266 basically is a wifi module used for remote notifications.

### D. Soil Moisture Sensor

Soil moisture sensor is used to find the humidity present in the soil. Based on the obtained value decision making is made for water supply.

### E. Temperature and Humidity Sensor

The DHT11 is chosen because it provides correct, accurate reading, good in performance, moreover stable and inexpensive.

### F. pH Sensor

pH stands for power of hydrogen, which is a nothing but the finding the hydrogen ion in soil. The pH value ranges from 1 to 14. The soil can be classified in to three based on its pH value, when the value is 7 nature of soil is neutral. pH < 7 is classified as acidic natured soil and pH > 7 are is alkaline in nature.

### G. Motor

A 12V DC motor is used of pumping water when the soil moisture value is detected below 50 percentages. A +9V Battery is used to provide power supply with help of voltage doubler circuit. It helps to increase life cycle of Arduino power supply. Based on soil moisture threshold value NodeMCU triggers the relay to ON/OFF water pump

## IV. IMPLEMENTATION

The serial monitor is used to get the moisture content value in terms of percentage. The result of the soil moisture sensor ranges from 0 to 1023 of ADC value. The formula for the representation of moisture value in terms of percentage is given below.

**moisture_percentage = ( 100.00 - ( (ADC Value /1023.00) * 100.00 ) ); //conversion formulae**

The DHT11 with NodeMCU, is need to be installed before used .First it is necessary to install the DHTLib library. It contains all the required functions which through which humidity and temperature readings from the sensor can be retrieved. The below is the general code for installation [12].

**Arduino IDE, then go to Sketch > Include Library > Manage Libraries > Search DHTLib**

Based on soil moisture threshold value NodeMCU triggers the relay to ON/OFF water pump

**if (soil >= 50) // If less moisture in soil start the motor otherwise stop**

### A. Sample Coding for Arduino Uno Module

```
float moisture_percentage;
moisture_percentage = ( 100.00 - ( (s/1023.00) * 100.00 ) );
soil = abs(moisture_percentage);
Serial.print("Soil Moisture(in Percentage) = ");
Serial.print(soil);
Serial.println("%");
if (soil >= 50){ // If less moisture in soil start the motor otherwise stop
digitalWrite(MOTOR_PIN, LOW);
ms = 0;
Serial.println("Motor OFF");
Serial.print("Soil: ");
Serial.println(soil);
delay(1000);
}
else {
digitalWrite(MOTOR_PIN, HIGH);
ms = 1;
Serial.println("Motor ON");
Serial.print("Low Soil: ");
Serial.println(soil);
delay(1000); }
```

```
temp = dht.readTemperature();
if (isnan(temp)) {
Serial.println("Failed to read from DHT sensor!"); }
else {
Serial.println("current temperature:");
Serial.println(temp); }
humid = dht.readHumidity();
if (isnan(humid)) {
Serial.println("Failed to read from DHT sensor!");
}
else {
Serial.println("current humidity:");
Serial.println(humid);}
```

## V. RESULTS AND DISCUSSIONS

The webpage for the developed system consists of the following screens as output

A. Home screen
B. Daily Report
C. Custom Report

### A. Home Screen

It is used to view the live readings consists of Soil Moisture value range from (0-100) in percentage, Environment Temperature & Humidity (0-100) in percentage , pH value (0-14) & Actuator - Motor Status based on the threshold value which is equal to 50 .Motor ON (threshold value <50) otherwise Motor will be in OFF state. Below figure shows the graphical representation of readings from various sensors and also shows the status of the connected actuators. The water flow is stopped when the expected soil moisture exists.

The following figure 2.a. shows the motor status is set to OFF when the water flow is stopped.

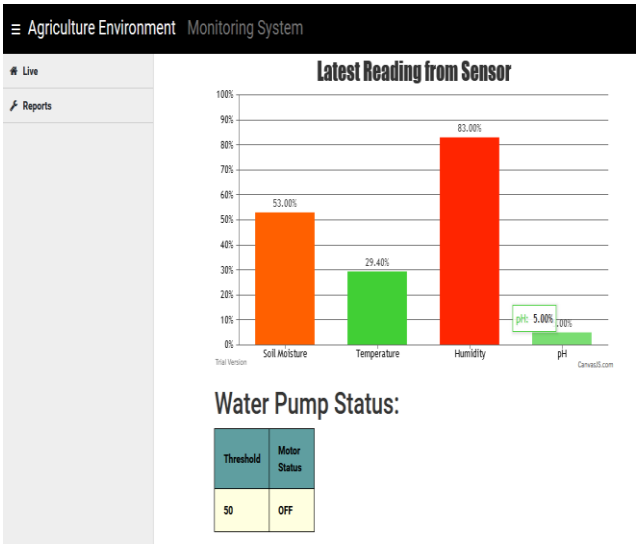


**Fig 2.a. showing motor status as OFF when the reading exceeds the predefined threshold value and sensor values**

The figure 2.b. shows when soil moisture is less than the Predefined threshold value then the motor status is set to ON which automates the irrigation of crop to maintain the required soil humidity.

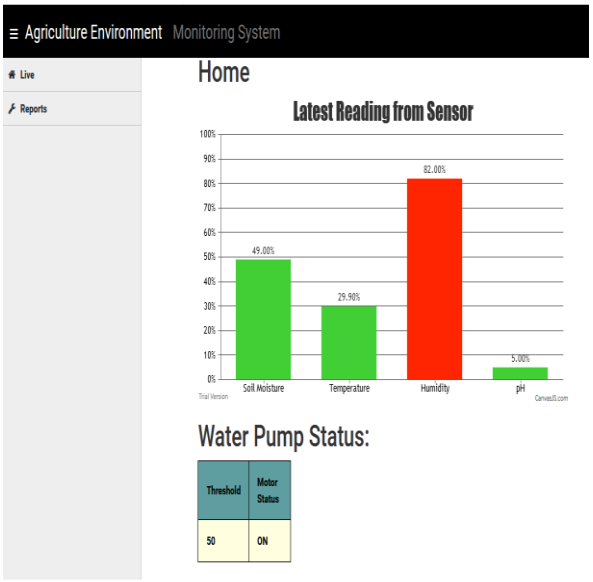


**Fig 2.b. showing motor status as ON when the reading is less than the predefined threshold value and also sensor values**

### B. Daily Report

This link gives the average of all the readings for a single day, through which the user can fetch a consolidated output and the overall status of the greenhouse, which helps them in better decision making. Fig 3 gives the consolidated output

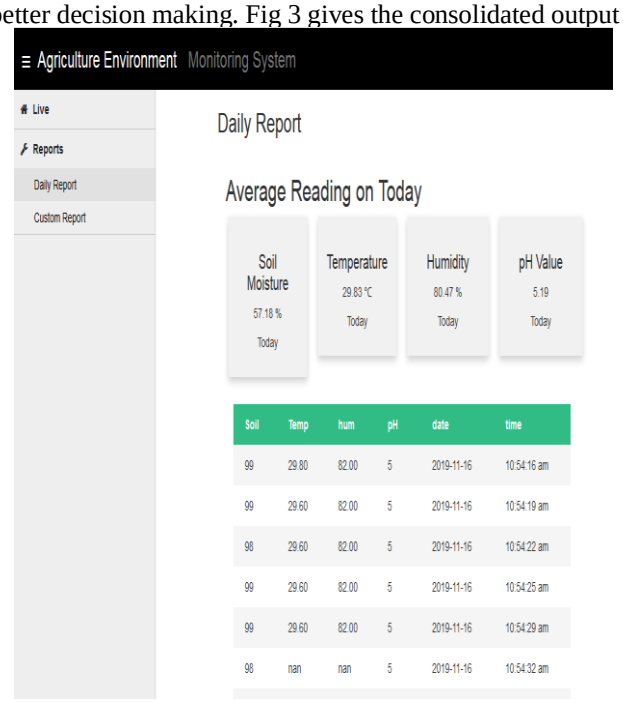


**Fig3. Shows daily report of various sensor readings**

### C. Custom Report

The reports can be viewed by choosing starting and ending date with the help of Calendar Control.

For further analysis the reports can be downloaded in one of the three formats such as Text, Excel and CSV Format. By using edit and save options N, P and K values can also be entered manually. Given below figure 4.a and 4.b explains the same.

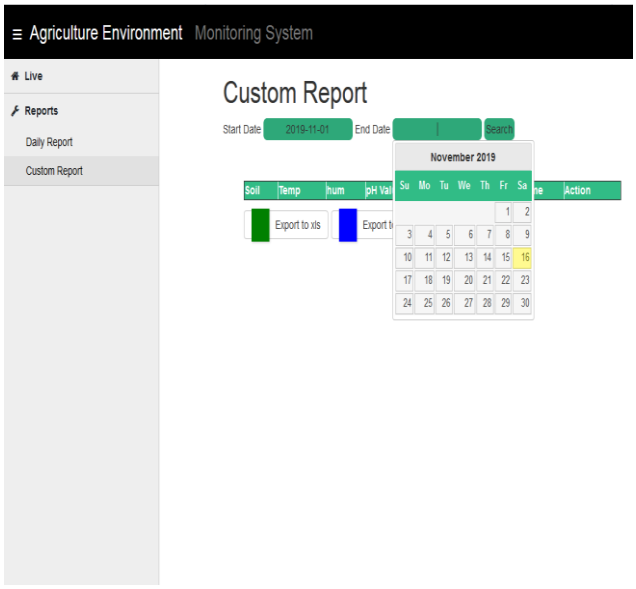


**Fig 4.a. shows the report for custom date to download**

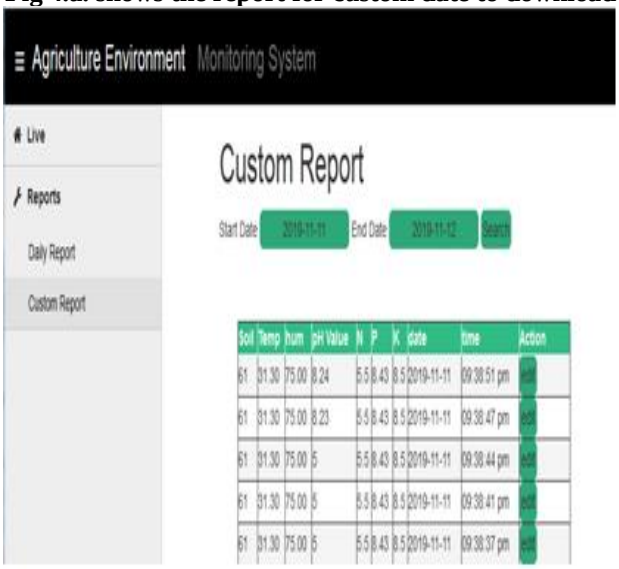


**Fig 4.b. Shows the edit option through which N, P and K values can be added.**

## VI. CONCLUSION & FUTURE ENHANCEMENT

Thus the system for Greenhouse Environment monitoring and crop prediction has been implemented, the generated data will be processed using machine learning algorithm. As a future enhancement cloud can be incorporated, Light sensor such as LDR can be added & actuators such as LED lights and fogger unit can be used to make the system more automatic.

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## AUTHORS PROFILE

**M. Lavanya** is a Research Scholar doing her P.hD in Computer Science under the guidance of Dr. R.Parameswari in Vels Institute of Science, Technology and Advanced Studies, Chennai. She has published 2 papers in journals like Scopus and IEEE Digital Library.
She has presented her papers in two international Conferences. She is active participants of workshops and seminars conducted by various educational institutions. Her research area is Internet of Things and Data Analytics.

**Dr. R.Parameswari** is working as Associate professor in
Department of Computer Science, Vels Institute of Science , Technology and Advanced Studies, Chennai. She has 13 years of teaching experience. She has completed PhD in Computer Science from St. Peter's University, Chennai. She is presently guiding 8 Ph.D scholars and 1 M.Phil Scholar. She has produced 3 M.Phil scholars. She has published 26 papers in various International journals including journals indexed in Scopus. She has presented many papers in International Conferences and attended many seminars and workshops conducted by various educational institutions. She is acting as a editor and reviewer in many International journals. Her research interest lies in the area of Cloud Computing, Big Data Analytics, and Internet of things.