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# Automatic Plant Monitoring and Control System

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**Abstract -** *There has been continuous growth and development of new technologies to make lives easier in all aspects. Many systems have been developed for monitoring the growth of the plant when it becomes difficult for the user to do the same by himself. For this purpose, we have designed a new system which can not only monitor various factors of the plant but also helps the user to bring them in control. In this system we have used Arduino UNO as the main brain of the entire system. Power to the entire system is given by a power bank or a battery. This system is enhanced with a Global System for Mobile Communication (GSM) for establishment of communication between the system and it's user. The system is designed for monitoring three parameters which affect the growth of the plant to a very large extent. These parameters are soil moisture, temperature and humidity. We have used HL-69 Moisture Sensor for monitoring the moisture content of the soil. A mini submersible dc water pump is also used to control the moisture content of the soil according to the requirements of the plant. We have interfaced the DHT-11 Temperature and Humidity Sensor which measures the temperature and humidity around the plant and gives its information to the Arduino UNO. A 16x2 LCD Display is also interfaced to the Arduino UNO which continuously displays the current status of the above-mentioned parameters. In addition to all of this, a GSM SIM 900a sensor is interfaced with the Arduino UNO to send the notification and updates about the controlling actions taken by the system.*

***Key Words***: **Automatic Control, Plant Monitoring, Arduino UNO.**

## 1. INTRODUCTION

Monitoring plant health is very important for their fast growth. In this busy world, people usually forget to take proper care of their plants which leads to bad growth and health of their plants. For ensuring complete development of plants it is necessary to develop proper surrounding conditions in which plants grow. The automatic plant monitoring system has recently attracted tremendous interest due to the potential application in emerging technology. More importantly, this technique is used to enhance the performance of existing techniques or to develop and design new techniques for the growth of plants. The plant monitoring system is helpful for watering the plants and to monitor few factors which are necessary for the growth of plants.

There are various factors that affect the substantial growth of the plant. These factors include moisture, temperature, sunlight, humidity, etc. Basically, according to the plant, the favourable environment is necessary for optimum results. The whole process of irrigation done by the traditional way can be performed using around 20 percent of the water with the help of smart irrigation. Thus, to reduce the large amount of water usage in irrigation, we need smart irrigation system that can save the 80% water being wasted right now. Also, each plant requires a proper amount of light and temperature so that it grows properly. Very high temperature leads to drying of the plant and very low temperature leads to improper spreading and blooming. If the amount of sunlight is not correct then it affects the process of photosynthesis.

Keeping all these factors and taking all the necessary measures for a particular type of plant we have designed a system where in we provide the required favourable environment to the plant to ensure that it grows properly and we also see to it that it is properly nurtured. All this is done in a cost and resource efficient way.

### 1.1 Literature Review of Existing System

In [1], "IoT Enabled Pant Soil Moisture Monitoring Using Wireless Sensor Networks" paper, the authors have employed Wireless Sensor Network (WSN) which is integrated with Internet of Things (IoT) to develop a remote monitoring system that continuously monitors the soil moisture of the plant.

In [2], In "Smart IoT Water sprinkle and Monitoring system for Chilli Plant" paper, the authors have used chilli plant as the instance for the system. It uses several sensors such as humidity sensor, pH sensor and EC sensor to collect data which is processed by the Arduino UNO. The advantage of the system is that it automatically sprinkles water and add specific mixtures to maintain the pH level of the soil.

In [3], In "Automatic Plant Monitoring and Controlling System Over GSM Using Sensors" by C.G.Priya, M.A.Pandu, B.Chandra AM2302 i.e temperature & humidity sensor and DHT22 i.e moisture sensor is used to obtain the following parameters such as temperature , humidity & moisture using UNO.

In [4], In "Automatic Plant Irrigation System using Arduino" by Devika CM, Karthika Bose and Vijayalekshmi S soil moisture of the plant is detected which is then

compared with the requirements of the plant and triggers the motor pump using relay accordingly.

## 2. SYSTEM COMPONENTS

### 2.1 Arduino UNO

The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable and may be interfaced to various expansion boards (shields) and other circuits. It can be powered by the USB cable or by an external 9-volt battery. Power banks are also used these days. The boards feature serial communications interfaces, including Universal Serial Bus (USB) on some models, which are also used for loading programs from personal computers.

### 2.2 Temperature and Humidity Sensor DHT-11

The DHT11 is a commonly used Temperature and humidity sensor. The sensor comes with a dedicated NTC to measure temperature and an 8-bit microcontroller to output the values of temperature and humidity as serial data. The sensor is also factory calibrated and hence easy to interface with other microcontrollers.

### 2. 3 Soil Moisture Sensor YL-69

The soil moisture sensor or the hygrometer is usually used to detect the humidity of the soil. So, it is perfect to build an automatic watering system or to monitor the soil moisture of your plants. The sensor is set up by two pieces: the electronic board, and the probe with two pads, that detects the water content. The output can be a digital signal i.e. LOW or HIGH, depending on the water content.

### 2.4 Mini Submersible DC Water Pump

This is a low cost, small size Submersible Pump Motor which can be operated from a 3 ~ 6V power supply. It can take up to 120 litres per hour with very low current consumption of 220mA. Just connect tube pipe to the motor outlet, submerge it in water and power it.

### 2.5 GSM Module

SIM900A Modem is built with Dual Band GSM/GPRS based SIM900A modem from SIMCOM. It works on frequencies 900/ 1800 MHz. SIM900A can search these two bands automatically. The frequency bands can also be set by AT Commands. The baud rate is configurable from 1200-115200 through AT command. SIM900A is an ultra-compact and reliable wireless module. This is a complete GSM/GPRS module in a SMT type and designed with a very powerful single-chip processor integrating AMR926EJ-S core, allowing you to benefit from small dimensions and cost-effective solutions.

### 2.6 16X2 LCD Display

16×2 LCD is named so because; it has 16 Columns and 2 Rows. There are a lot of combinations available like, 8×1, 8×2, 10×2, 16×1, etc. but the most used one is the 16×2 LCD. So, it will have (16×2=32) 32 characters in total and each character will be made of 5×8 Pixel Dot. The main benefits of using this module are inexpensive, simply programmable, animations, and there are no limitations for displaying custom characters, special and even animations, etc.

## 3. PROPOSED SYSTEM

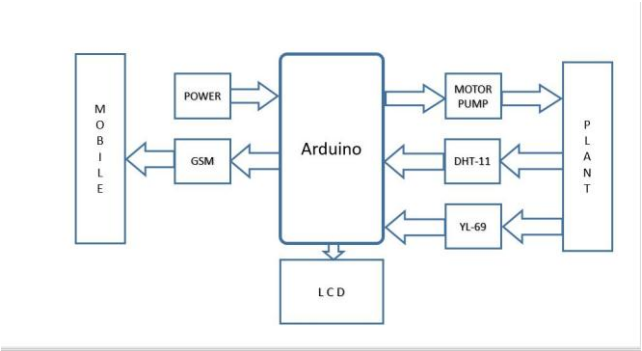


**Fig 1**: System Design

A) Soil Moisture:

Disproportionate soil moisture can lead to problems such as plant death and root disease. It also causes immense amount of water wastage in bringing a balanced soil moisture. Nutrients are distributed to the soil through irrigation or other means, the movement of water inside the soil controls how it is distributed to plant roots. Good water management is important in itself, but good water management means good nutrient management.

B) Humidity:

Humidity may be a important environmental part that has got to be controlled for healthy plants. It controls the speed of transpiration and the way the nutrients are received by the plant. Low humidity will cause a plant to own nutrient issues, ensuing from the transpiration rate being a lot of too high in low humidity level environments. Conversely, when humidity levels get too high, moisture is builds up on the plants and walls, forming whole colonies of moulds, fungi, and mildews.

C) Temperature

The biochemical capacities in plants that are required for development and endurance are temperature dependent i.e. there is an ideal temperature range inside which a specific plant types will complete photosynthesis at its most extreme rate. Outside this range, photosynthesis and

other plant forms start to back off, to where they stop and development stops.

Taking into consideration the huge significance, of the above discussed parameters, in the growth of the plant we design our system to monitor these three parameters and also apply controlling action to one of them.

The moisture sensor YL-69 reads the status of the current moisture contents in the soil and gives that information to the Arduino UNO. Based on this information, the Arduino then compares the current moisture level with the threshold level determined for the plant. If the measured moisture is less the required threshold, the Arduino UNO turns the Mini Submersible DC Water Pump On which waters the plant. The YL-69 Moisture Sensor periodically continues to read the moisture content of the soil and give that information to the UNO. Now when the moisture content of the plant exceeds the threshold + 10%, the Arduino UNO turns the Mini Submersible DC Water Pump Off. This controlling action taken by the Arduino UNO is informed to the system user through a text message using GSM SIM 900a Module. Similarly the DHT-11 Temperature and Humidity sensor gives information about the temperature and humidity of the area surrounding the plant to the Arduino UNO. Based on this information given by the DHT-11, the Arduino then compares the current measured level with the threshold level determined for the plant. If the measured temperature and humidity is less the required threshold, the Arduino UNO informs about it to the system user through a text message using a GSM SIM 900a Module. Along with the text message notifications and updates , the system also provided the on - spot updates about the soil moisture content and about the temperature and humidity around the plant by displaying them on the 16 x 2 LCD Display which is also controlled by the Arduino UNO. This LCD Display is placed along with the system near the plant. Power to the entire system is provided using a battery or a power bank which can provide 5V output.

## 4. IMPLEMENTATION

Let us understand the working of the entire system by breaking it down into small parts and understanding each part individually. We divide the system into two parts based on the parameters monitored & controlled. In the first part we will understand the monitoring and control of the moisture content of the plant and in the second part we understand the monitoring of temperature and humidity of the area surrounding the plant.

Monitoring of Temperature and Humidity

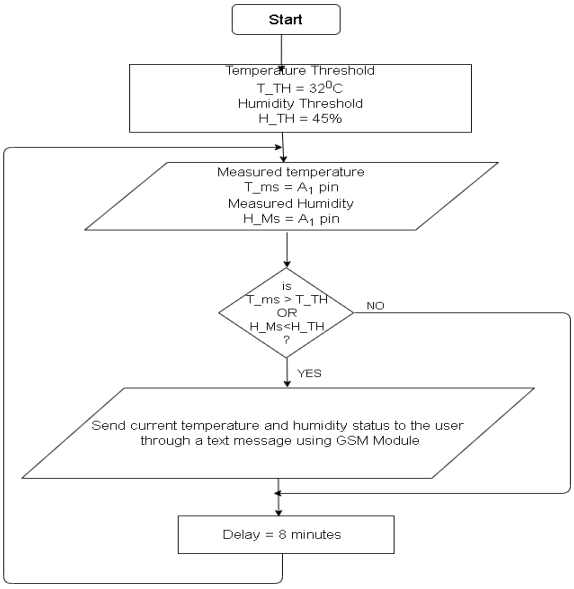


**Fig2**: Flowchart for Code of Temperature and Humidity Sensor

Algorithm for Working of Temperature and Humidity Sensor:

Step 1: Set the desired threshold values of temperature and humidity.
Step 2: Read the current temperature and humidity around the air using pin3 i.e. the Data Pin of DHT-11.
Step 3: If the current readings are then the set threshold readings then the system notifies the readings to the user through the GSM Module.
Step 4: After a delay of 8 minutes, go to step 2.

The temperature and Humidity is measured using DHT-11 sensor. The desired threshold value for both temperature and humidity is set in the variables T_ms and H_ms respectively. The dynamic measured parameters with Arduino are loaded into the variables T_th and H_th. If the measured temperature value is greater than the threshold or the measured humidity is less than the threshold value, then the user is notified with the help of a text message sent using GSM Module. If everything is as desired i.e. the measured temperature is less than the threshold temperature and the measured humidity is greater than the threshold humidity a delay of eight minutes is generated and the process continues.

Monitoring and Control of Soil Moisture

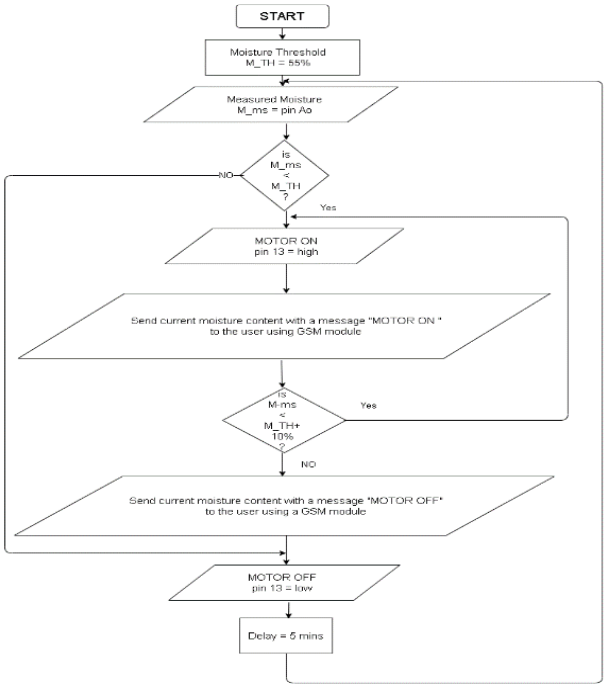


**Fig-3**: Flowchart for Code of Soil Moisture

Algorithm for Working of Moisture Sensor:
Step 1: Set the moisture threshold to the desired percentage.
Step 2: Using A0 pin of Arduino UNO, read the current moisture level of the soil.
Step 3: If moisture level is below the threshold level, turn Motor ON using digital pin 2 of the Arduino UNO, else go to step 7.
Step 4: Send the current moisture level of the plant to the user through a text message using GSM Module with "MOTOR ON" message.
Step 5: Turn the Motor OFF using digital pin 2 of Arduino UNO when moisture level is 10% more than the threshold.
Step 6: Send the message "MOTOR OFF".
Step 7: After a delay of 5 minutes, go to step 2.

The Moisture is measured using YL-69 sensor. The desired threshold value for the moisture is set in the variable M_th. The measured value of the moisture using Arduino is loaded into the variable M_ms. If the measured parameter is less than the threshold, then the motor is turned on by setting the digital pin 2 of Arduino UNO high. At this time a text message is sent using GSM Module to the user stating the current value of the moisture and the "MOTOR ON" alert. It must be noted that once the moisture level dips below the threshold the moisture level must be restored to a moisture level greater than threshold by 10. Thus, once again measured moisture is compared with the "M_th+10". If the condition is satisfied, then the motor is turned off and a text message is sent acknowledging current restored moisture level with "MOTOR OFF" message. Now, a delay of five minutes is generated and the same process continues after that..

## 5. RESULTS

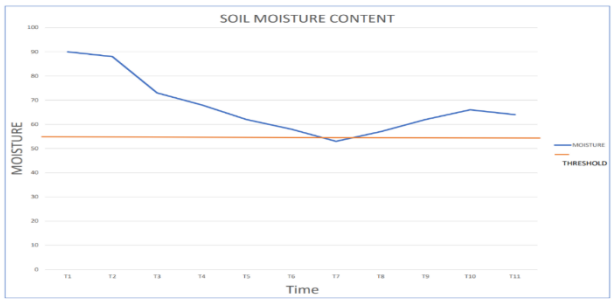


**Chart-1**: Graph of Output of Soil Moisture Senor

• The moisture sensor is successfully able to obtain the amount in the soil and gives the readings to the Arduino.

• When the measured moisture content of the soil is below the threshold moisture level the motor is turned on by giving high at digital pin 2 of the Arduino UNO.

• When the moisture content of the soil has been brought back to the favourable level i.e. above the threshold+10 moisture level the motor is turned on by giving high at digital pin 2 of the Arduino UNO.

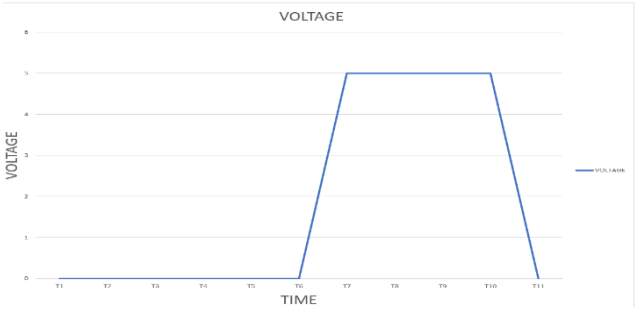


**Chart-2**: Motor Voltage Output

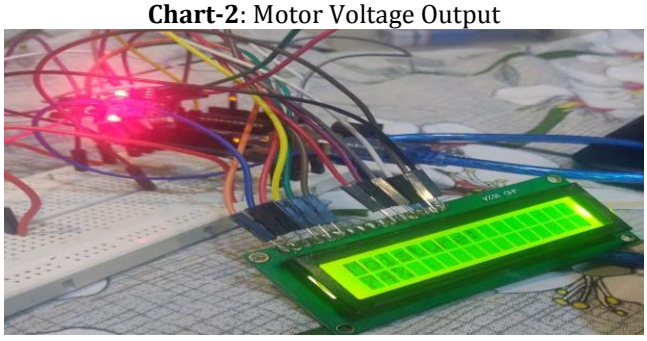

**Fig-4**: 16x2 LCD Display Output

• The LCD Screen displays the current parameter status of the plant. The moisture content status is updated every 5 minute and the temperature and humidity status is updated every 8 minutes.

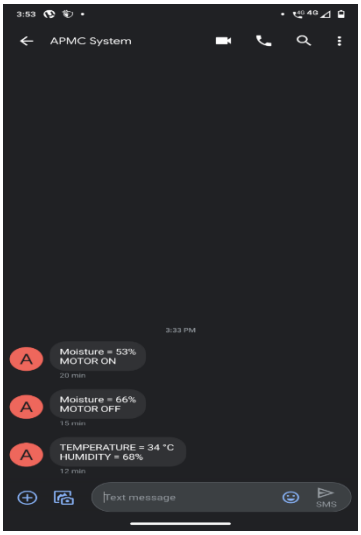


**Fig-5**: Message from GSM Module

• The system notifies the user that the measured moisture level of the soil i.e.53% is below the determined threshold level i.e. 55%, the Motor is turned ON by sending "MOTOR ON" text message along with the current measured moisture level i.e. "Moisture = 53%".

• Again, when the system has successfully applied the controlling action and the plant has sufficient moisture in the soil, the motor has been turned off, the message "MOTOR OFF" is sent to the user along with the current measured moisture level i.e. "Moisture = 66%".

• Also, inappropriate temperature and humidity conditions are also notified to the user through text messages as shown above.

• The user has been given information about the monitoring and controlling action taken by the system to maintain the appropriate level of the parameters so as to ensure the healthy, sustainable and efficient growth of the plant.

## 6. FUTURE SCOPE

A) Disease Detection

To detect or identify any disease which is caused to our plant, we can use automatic detection technique which will take less efforts and less time. A camera can be interfaced with the system and then Image Processing and Machine Learning can be applied of the captured image of the plant. Image segmentation is the process of dividing or grouping an image into different parts. Using these techniques and various comparison algorithms and methods, this system will be able to detect any diseases if present and also the affected area of the disease.

B) Soil Nutrient Monitoring

This system can also be furthered improvised to monitor soil nutrient concentration as nutrients play a vital role in growth and nourishment of the plant. Measurements of nutrients will allow us to know about the constituents of the nutrients present in the soil and also the nutrients which are lacking in soil. Using the measured information about the nutrients we can then add the lacking nutrients and ensure the better growth and nourishment of the plant.

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