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# ADVANCEMENT IN PLANT MONITORING USING ARDUINO AND INTERNET OF THINGS

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## ABSTRACT

Advancement in farm activities can lead the agricultural domain to transform into intelligent and dynamic sector from being manual resulting in higher production with lesser human supervision. This paper describes an advanced irrigation system which monitors and maintains the desired soil moisture content via automatic watering depending upon the necessity. Microcontroller Arduino Uno platform is used to implement the control unit. The setup uses different sensors that measure the various parameters such as soil moisture, water level, temperature, presence of light. These values enable the system to use appropriate quantity of water which avoids under/over irrigation. The farmers can get the status of the field at small distance using some indicators and remote place also using IoT.Information from the sensors is regularly updated on a webpage using network of IoT through which a farmer can check whether the water sprinklers are ON/OFF at any given time. The information from the sensor is also transmitted to a Thing speak channel to generate graphs for analysis.

***Keywords:*** *IoT, Arduino, ESP266, ThingSpeak, Cloud, LM35*

## I. INTRODUCTION

People always forget to water their plants becauseof their busy life routine. They are usually come home late at night and tend to skip watering their plants. Furthermore, people need to supply water to their plants every day to prevent it from dying due to lack of nutrients in the soil. Usually, people will use water pipes or rainwater to water their plants.

Moreover it happens in nurseries and gardens that when people get some important work while watering plants so they leave the water pump ONfor a long time and forgetto makeit OFF so the water is provided in huge amount whichis not necessary and thus the water get wasted. Hence to overcome such a problem this system has been designed while will automatically sense the parameters of plants and water it accordingly.

Internet of Things is nowadays becoming a reality.Internet of Things enables the network devices to sense and collect data from the world around us, and then share that data across the Internet where it can be processed and utilized for various purposes. This implemented system consists of Sensing unit, Controller unit and the Output unit. In sensing unit different sensors are used for sensing the conditions of the field that are necessary for the monitoring. Controller section consists of Arduino Uno as a controlling element. It will sense the parameters from the sensing unit and will compare it with the threshold values set for the particular parameter. Then according to the conditions present, it will generate the output in the form of the indications. Various indicators are used for getting the status of the field in nearby location and using IoT the status can be send over the internet.

**Internet of things**

The Internet of things (IoT) is the network of physical devices, vehicles, home appliances, and other items embedded with electronics, software, sensors, actuators, and connectivity which enables these things to connect, collect and exchange data.

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*Fig.(1) Internet of Things*

IoT involves extending Internet connectivity beyond standard devices, such as desktops, laptops, smartphones and tablets, to any range of traditionally dumb or non-internet-enabled physical devices and everyday objects. Embedded with technology, these devices can communicate and interact over the Internet, and they can be remotely monitored and controlled.

## II. METHODOLOGY

The system is divided in two sections as Transmitter section and Receiver sections.
The transmitter sectionincludes sensing module, controller module and output module. Sensing module includes the soil moisture sensor and temperature sensor that will sink in the soil to measure the humidity level and temperature level. The controller module is an important part.In this system, arduino UNO board is used as the controller module to manage the system.The purpose of regulated powersupply is to supply the required power for the arduino UNO board to functions well.Besides that, output module is the module where to produce an output from the microcontroller.

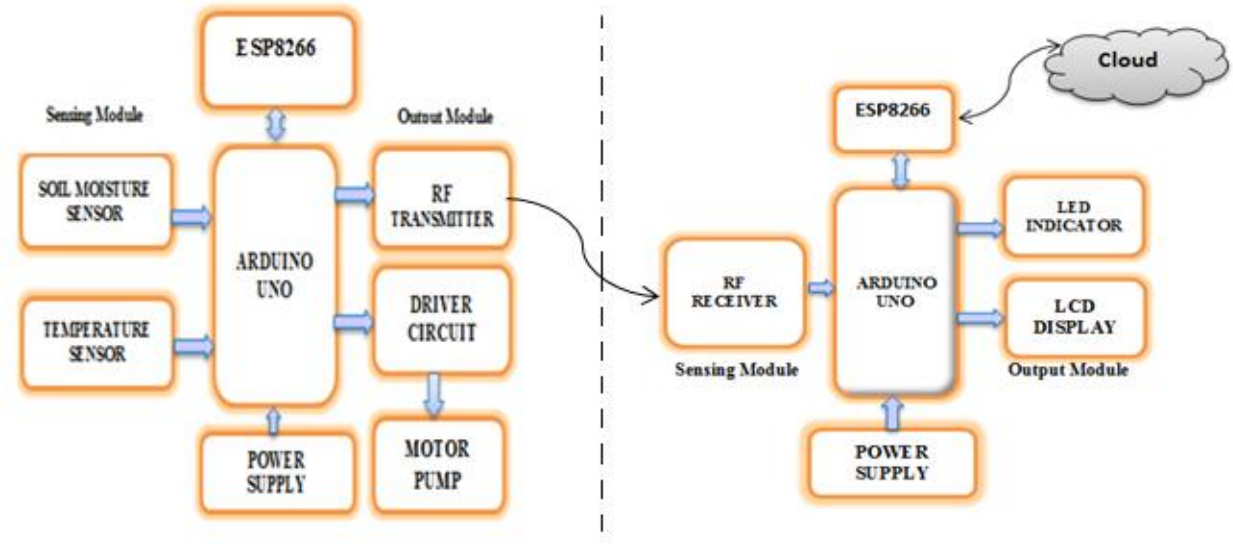


*Fig (a).Block Diagram for Transmitter SectionFig (b).Block Diagram for Receiver Section*

In this system, the output is taken through different ways. Such as

- Output is given to the motor pump through driver circuit. The motor pump is activated to provide the necessary water to the plantsbased on the plant's condition. .
- The status is indicated on the LCD display and LED indicators so as to get the status at small distance.

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- Also depending upon the status of the plants the message is send over long distance at remote place using ESP8266 prototype i.e. IoT.

**Receiver Section**

As shown in Figure (b), the block diagramfor receiver section includessensing module, controller module and output module. Sensing module includes the RF receiver module to receive themessages thatare transmitted from transmitter module toknow the status to client Depending uponthe message received the differentindicators will be activated.

The LED indicator is used to indicate the users the soil's condition either dry, moderate or wet condition. Different color of LED's are used todifferentiate the plant's condition. The buzzer also act as alert system indicating that the soil is in dry condition.

## III. COMPONENTS DESCRIPTION

### A. Arduino Uno


*Fig(c).Arduino Uno*

The Arduino UNO is a control device which incorporates a microprocessor and prototype board that can be program by using Arduino IDEsoftware. It can be interfaced to thereal world and virtual world by connecting the Arduino UNO board to the Internet, either sensing data to the internet or responding to data on the internet or both.Arduino uses ATMEGA 328 microcontroller that consist of 14 input and output for analog and digital pins.It is used for monitoring sensors including soil moisture, temperature, sound, light.

### B. Soil Moisture Sensor


*Fig(d).Soil Moisture Sensor*

The soil moisture sensor was used to measure soil humidity level by immersed the probes into the soil. When the soil was dried, the soil moisture sensor output is at high level, else the output is at low level. Water is one of good conductor. So, the conductivity is increased if it sense more water content from the soil moisture sensor. Thus, the resistance will be decrease. The conductivity of water is decreased if it is sense less water content. Then, the resistance will be increase. The soil moisture sensor has two probes and need to sink into the soil. The soil moisture sensor gives an analog input values ranging from 0V to 5V for the difference soil humidity levels.

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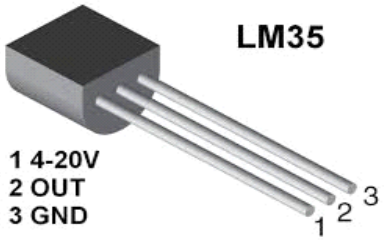
**C. Temperature Sensor**




***Fig(e).Temperature Sensor LM35***

The LM35 is an integrated circuit sensor that can be used to measure temperature with an electrical output proportional to the temperature (in $^0$C). If the temperature is high then the fan will on and vice versa.

**D. RF Module**

The RF module, as the name suggests, operates at Radio Frequency. The corresponding frequency range varies between 30 kHz & 300 GHz. In this RF system, the digital data is represented as variations in the amplitude of carrier wave. This kind of modulation is known as Amplitude Shift Keying (ASK).

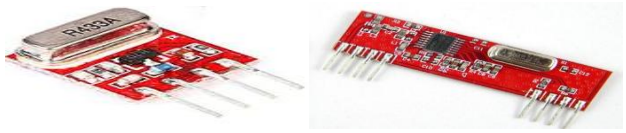


***Fig (f): RF Transmitter and Receiver module***

Transmission through RF is better than IR (infrared) because of many reasons. Firstly, signals through RF can travel through larger distances making it suitable for long range applications. Also, while IR mostly operates in line-of-sight mode, RF signals can travel even when there is an obstruction between transmitter & receiver. Next, RF transmission is more strong and reliable than IR transmission. RF communication uses a specific frequency unlike IR signals which are affected by other IR emitting sources.

This RF module comprises of an RF Transmitter and an RF Receiver. The transmitter/receiver (Tx/Rx) pair operates at a frequency of 434 MHz..An RF transmitter receives serial data and transmits it wirelessly through RF through its antenna connected at pin4. The transmission occurs at the rate of 1Kbps - 10Kbps.The transmitted data is received by an RF receiver operating at the same frequency as that of the transmitter.

**E. ThingSpeak**


ThingSpeak is an open source Internet of Things (IoT) application and API to store and retrieve data from things using the HTTP protocol over the Internet or via a Local Area Network. ThingSpeak enables the creation of sensor logging applications, location tracking applications, and a social network of things with status updates.

**F. ESP8266**

The ESP8266 is a low-cost Wi-Fi microchip with full TCP/IP stack and microcontroller capability Systems.

The ESP8285 is an ESP8266 with 1 MB of built-in flash, allowing for single-chip devices capable of connecting to Wi-Fi.The successor to these microcontroller chips is the ESP32.This small module allows microcontrollers to connect to a Wi-Fi network and make simple TCP/IP connections using Hayes-style commands. The very low price and the fact that there were very few external components on the module, which suggested that it could eventually be very inexpensive in volume makes it very reliable.

## IV. FLOWCHART

The overall module flowchartshows the overall working of the advanced plant monitoringsystem. Based on the humidity section, if the soil moisture sensor sense dry condition of the soil then the humidity level is less than the dry threshold values. Thus, Red LED indicator is ignitedfor self-watering mode to give an alert to the users for watering purpose. After red LED indicator is blinked about 1 minutes, the system is triggered to the auto watering mode and water pump will turn ON for watering process about 1 minutes.

When the soil moisture sensor sense moderate humidity condition when the humidity level is between moderate threshold value and dry threshold value. Yellow LED indicator is blink in reduction mode to indicate the users that their plant in good condition.

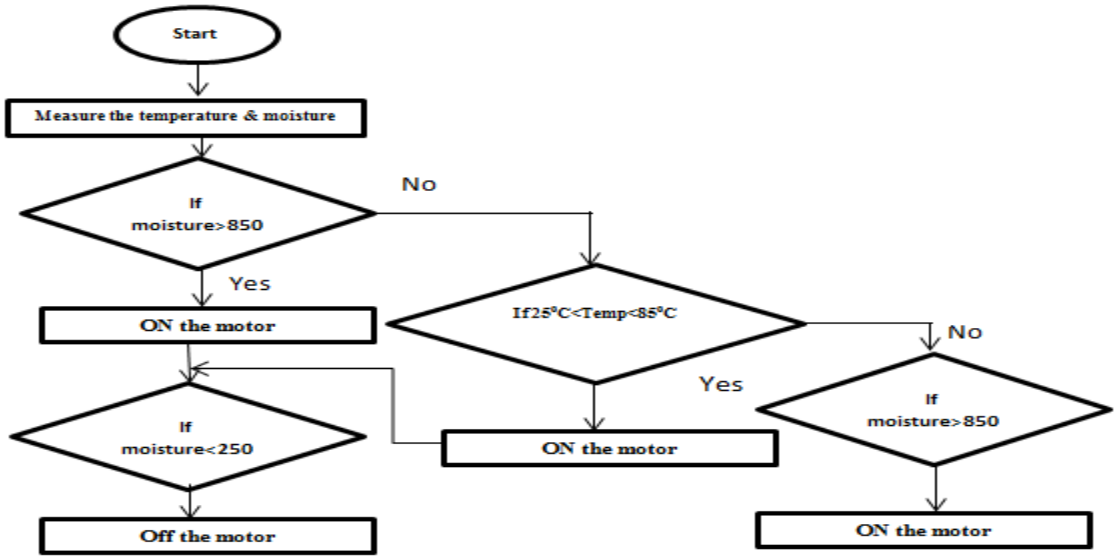



*Fig (g): Overall Module Flow for Transmitter Section*

On the other hand, when the humidity level is greater than the wet threshold value means that the plants in wet condition and green LED indicator is blink in reduction mode and the lighting system is triggered to supply some lighting to the plants.

## V. RESULTS AND DISCUSSION

The plotted graph in Figure (h) shows the average of humidity level in the plant for ten days. The reading of soil humidity level was taken every six hours per days.The plant was watered by constant volume for every six hours per days. Based on the graph, the reading of soil humidity level was not constant due to weather conditions was different for every day.

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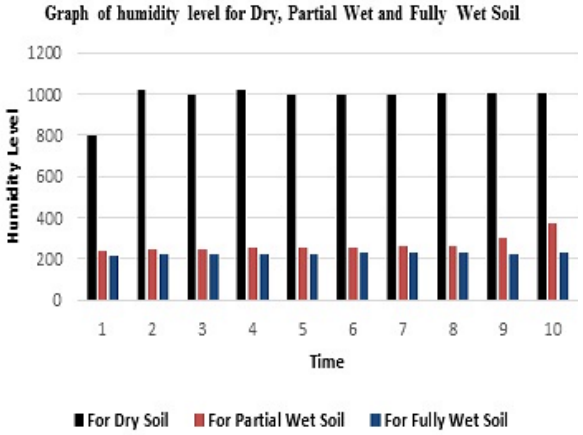


*Fig(h).Graph showing humidity in soil*

**User Indicators**

As mentioned before, this system comes with three modes that are self-watering mode, auto watering mode and lighting mode. Hence a user indicator for the self-watering mode is needed to enable the user to their plants. Table 1shows the descriptionabout the display module.

*Table 1: Description of display module*

| Parameter | Description |
|---|---|
| White LED | For indicating partial wet mode of plant |
| Red LED | For indicating dry condition |
| Green LED | For indicating wet condition |
| Reset button | Reset system |

The self-watering mode is triggered when the buzzer is activated and red LED indicator is blinked about one minute to give an alert o the user that their plant in the dry condition and needed to water it before auto watering mode was triggered. This shows that the system is very user friendly. Auto watering mode and lighting mode are activated according to the program set up in the system. Basically, auto watering mode is triggered about one minute when the system or sensor senses the plants in dry condition. This happened when it is does not have any feedback from the user in self-watering mode. Lighting mode is triggered about 1 minutes when the system or sensor sense wet condition on the plants. Figure below shows user indicator used i.e LED and buzzer.


*Fig (i): User indicator for dry soilFig (j): User indicatorpartial wet soilFig (k):User indicator for wet soil*

Figure (l)illustrates the readings to monitorthe humidity and temperature level. Digital thermometer is used for testing only but for the actual project uses temperature sensor that vary precise in term of their values. The method issame as the soil moisture sensor by s inks it into the plants and monitor it through LCD display. The test is to know the relationship between the humidity level and temperature level.

Three conditions were investigated for the humidity level and temperature level. These are dry mode, partial wet mode and fully wet mode as shown in fig(l). Dry mode is mode where the soil is fully dried and plant can't stand more if this condition continued. Partial wet mode is mode where soil was watered with some amount of water. So that, the plant becomes partial wet. Besides that, wet mode is mode where soil was watered with huge amount ofwater. So that, the plant became very wet. Wet mode was observed which is responsible for wastage of water hence we can save water before wasting it, by controlling watering automatically. The experimental phase was conducted about few days to see the relationship between the temperature level and humidity level during the dry mode, partial wet mode and wet mode.

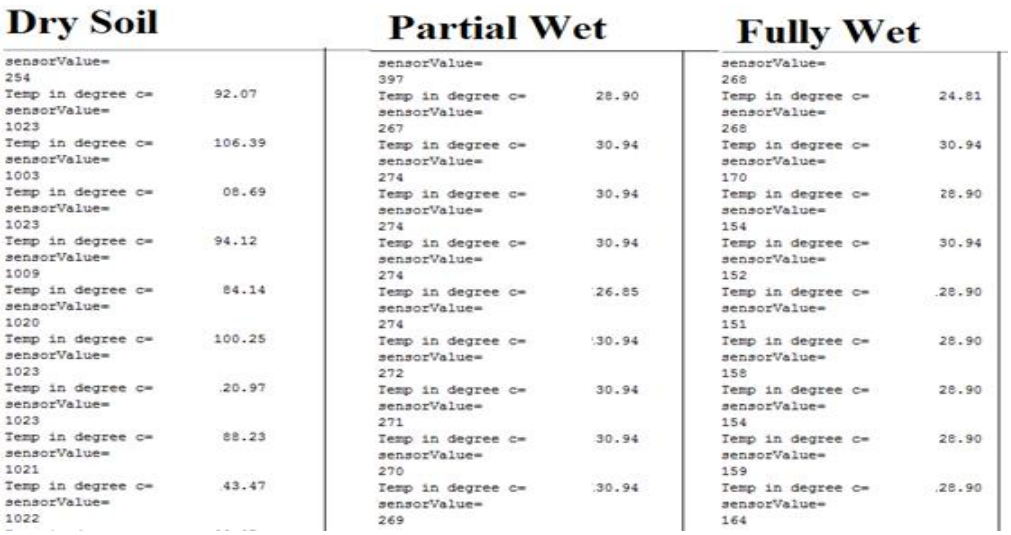


***Fig (l).Dry,partial wet and fully wet soil readings***

## VI. CONCLUSION

Nowadays people have an interest for doing planting in residential area but because many people lives at storeyed building or apartment they sometimes neglects to water their plants which causes harm to the plants. Also due to the long working hours in the office and busy schedule with their works, they tend to forget to water their own plant. Thus, this system plays a vital role for the user to monitor their plant's condition and for watering purpose. Also it is the fact that manyplants can withstand for some days under direct sunlight but it cannot sustain under lack of water. The characteristics of plant only growth at wet environment means that plant really consume a lot of water but not after fully wet condition. The system can performed automatic watering the plants based on the humidity level and temperature level detection. This technique also reduces the water wastage by giving only the needed amount of water hence water conservation is achieve.

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