Iot based Plant Monitoring System

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Abstract*—In India agriculture is the main source for growth of Indian Economy be it import or export. Due to population increase in an exponential value the yield obtained should be of quality and quantity. Considering the population there is scarcity in water availability. So farmers have to make wise choices and so do people who are into gardening. Apart from wastage of water plenty of plants die every year due to excess or under watering. By doing so not only the plant but also the soil is getting harm since the minerals in the soil gets damaged. This is the main motivation for designing a system, which monitors factors necessary for a plant health and provides required amount of water. The system turns on a pump based on the moisture level present in the soil. This way the soil and the plant remain well hydrated. By automating this part of the plantation process we reduce the efforts put in by farmers every day. The developed system is cost effective as it uses low cost devices and open source software, while providing good extension to wide area, to mobile devices and cloud as well.

Keywords: Arduino, Soil moisture, Temperature, Humidity, Pressure, Greenhouse.

I. Introduction

Interconnection of a number of devices into a network for data transmission is called Internet of Things (IoT). It is considered as an upcoming trend in technology due to advancements and manufacturing costs and development. IoT can be easily implemented into a number of varied fields including agriculture. Agriculture forms major resource for our life and also is a primary income source in India. The IoT based plant monitoring system proposed in this paper forms a support for efficient agriculture management system. Intelligent monitoring and controlling system supported by IoT sensor devices & microcontroller, agriculture productivity can be increased to a great extent.

Our project is an enclosed farm or greenhouse management system. It has various functionalities and sensing systems which detect the variations in the various environmental parameters that may affect the growth of the plant. It provides various mechanisms which are efficient in controlling such parameters so as to enable the enhancement in the growth of plants. Plant growth is altered by several factors as soil moisture, humidity, temperature, light intensity and atmospheric pressure. Such variations are generally undesirable and need to be altered and managed to obtain the maximum potential for the growth of plants. Various sensors have been deployed to detect the growth determining factors and this data is transmitted to the smart phones from time to time for the remote monitoring of the enclosure. This application has been achieved by the usage of IOT.

II. Smart Plant Monitoring System

The smart plant monitoring system designed in this work is an IOT based system which monitors the anomalies in varies environmental factors which affect the growth of the plant. The most impacting factors are soil moisture, temperature, humidity, light intensity and to some extent atmospheric pressure. These factors must be optimal for the healthy growth of the plant. The system is designed not only to monitor but also to act in ways that can change the environmental parameters to favour plant growth. The following are the major functions of the project:

- Soil moisture sensing: The soil moisture sensor senses the amount of soil moisture using two probes, one of which is used to measure the volumetric content of water. As the moisture level reduces the soil conducts less electricity and therefore provides more resistance. This is connected to an LM393 module which calculates the resultant moisture level. Once the moisture level is reduced, this level is sensed by the Arduino which in turn sets the relay to high, turning on a water submersible motor pump which pumps the water on to the soil. This sensing and pumping go on repeatedly till the soil moisture level is reaches the desired level often being optimal.
- Light Sensing: The light intensity is measured using LM393 light sensor. The light intensity is then compared to a specific required limit. If the light intensity is less than this limit then a signal is sent to a servo motor which opens a part of the roof allowing increased light and also letting in ample air quantity.

- Humidity and temperature sensing: Both humidity and temperature are important factors which affect the growth and yield of plants. By monitoring these two factors various actuators can be implemented. Humidity and Temperature are measured using the same DHT sensor.
- Pressure sensor: The BMP280 module is a module which measures the atmospheric pressure. The atmospheric pressure alters the moisture absorption and transpiration rate by plants. So it is important for the plants to be exposed to the right amount of pressure for proper growth.
- 16*2 LCD Display: This module concurrently displays the above measured parameters.
- The data acquired from the sensors is sent to the user by making use of a module known as ESP8266, which is the Wi-Fi module. This module enables the system to be connected to a network using which data can be sent to the BLYNK application on a specific mobile phone connected to a particular server. This design allows user to continuously monitor the data from wherever he is and allows the devices to connect to cloud as well.
- The same data is also uploaded to a ThingSpeak server where relevant graphs are generated from time to time. This allows lots agriculture-oriented data to be recorded and the variation patterns can be analyzed enabling to make long-term decisions.

III DESIGN

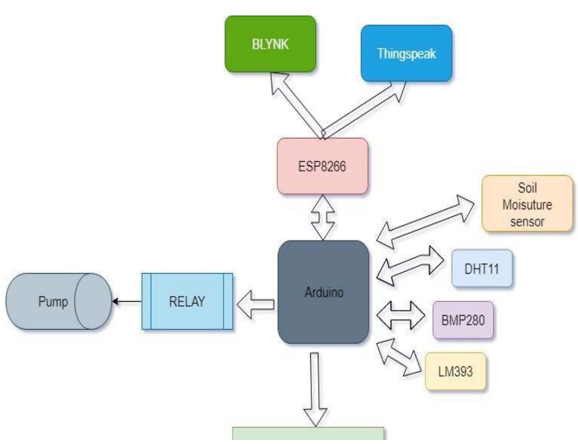

Figure 1. Overall System Design

Figure 1 shows the block diagram of the system where the Arduino is Atmega 2560 is the micro-controller used. It is connected to the sensors namely the soil moisture sensor i.e. LM293 driver to detect the moisture content in the soil. The soil moisture sends the sensed data to the Arduino which sends a high or low signal to the relay which in turn switches on the submersible pump or switches off the pump based on the reading received from the sensor.

The DHT11 sensor senses the temperature and humidity in the greenhouse. The purpose of this is to vary the humidity using a humidifier or a water mist system which turns on or off based on the humidity reading. Temperature and humidity are very important for the yield.

BMP280 is a pressure and altitude sensor which senses the pressure and sends the data to ThingSpeak which can later be analysed for further research and decisions. Pressure is important for the transpiration of plants and has a huge effect on its health.

LM393 is a sensor with LDR (Light Dependant Resistor) is used to sense the light intensity present in the enclosure. The value of the intensity gets sent to the two servers through ESP8266. Based on the value received a high or low signal is sent to the servo which lifts the roof which in our case is used for ventilation when the light intensity is less. This in real life can be done with the help of hydraulics. The concept of greenhouse is to confine heat and light inside the enclosure. Over time it can be released when the light intensity decreases so as to let in fresh air for next cycle of heat and light to be confined.

ESP8266 is the Wi-Fi module used to transmit data to the phone i.e. the Blynk app or the ThingSpeak server. The data is transmitted to the blynk app continuously but it is uploaded to the ThingSpeak server only once in 20 seconds to avoid redundant data. This is to remotely view the readings from the sensor as well as store the values based on timings for future references as well as scientific analysis if needed. The same data is also displayed concurrently in the LCD display. This can be used to have a public display of the data for better visibility.

In the Blynk app there are virtual pins set up for the sensor measures to be sent remotely onto the app. It is designed to display data on widgets such as gauges for moisture, humidity and temperature. These are designed to display data as percentage. Other three widgets are used for light intensity, pressure and altitude. These display data in Standard International form.

ThingSpeak is an open source application and API meant for the purpose of analysis of data got from Internet of Things applications and systems. It is a part of MathWorks which is the owner of Matlab so the analysis of data that gets sent to the ThingSpeak server gets stored at regular intervals to form a graphical representation. It can be used for basic analysis as well as scientific calculations, predictions and analysis.

IV Results and Output

The results indicate typical values for a system. The outputs establish the correct working of an IoT based smart system for plant monitoring. Outputs are based on the conditions that the sensors are kept in.

The system overall is cost effective because of the use of the open source software and low cost device.

Fig 2 The replica of a shade greenhouse

As shown in Fig 2, a greenhouse is used in this project. These types of greenhouses are used in places where sunlight duration is varied / abnormal and the movement of the sun from east to west is not observed much. Therefore, having a flat roof makes maximum sunlight get into the greenhouse unlike angled greenhouses which make use of the movement of the earth to deflect maximum sunlight based on the position of the sun. By deflecting the sun rays inside the closed structure, the heat is increased. So, the temperature outside is lesser than inside. Such units can be used in places where the temperature is on the cooler side.

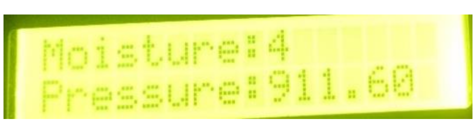

Fig 3 LCD displaying the moisture and pressure in the atmosphere.

Fig 4 LCD displaying the Temperature and Humidity

As shown in Fig. 3 and Fig. 4, the LCD was used in this project to display moisture and pressure initially and later the temperature and humidity respectively. The LCD displays the values read by the sensor which is placed inside the greenhouse for the maintenance man to just keep an eye on if necessary. If he notices a constant value and decides to change the climatic conditions inside either by switching on the humidifier or opening the ventilation he may do so manually.

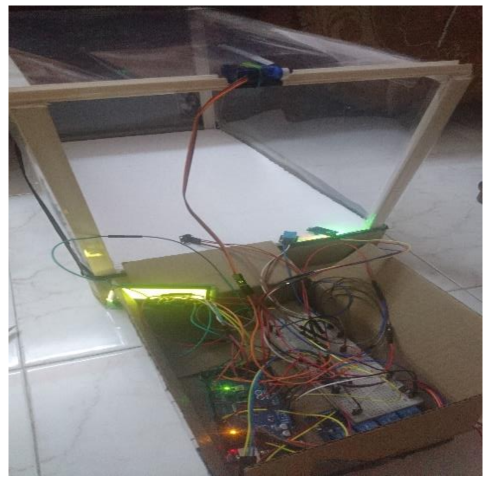

Fig 5 Whole system of Arduino and greenhouse replica.

As shown in the Fig 5, the whole system comprising of Arduino, the breadboard, the relay meant to switch on and off the motor pump based on the readings of the soil moisture is displayed.The Wi-Fi module meant to send data to Blynk server as well as the ThingSpeak server. As shown in the Fig.6, the roof is lifted by the servo motor placed to open it based on low light conditions and for ventilation, which is done with the help of the LM393 Light sensor.

Similarly, as shown in Fig 7, various measurements were shown in the Blynk app interface using gauges and meters which are either in percentage or Units of measurement based on International standards. These are useful for small garden owner to know if the system is watering and other environmental measurements. In a greenhouse it is used for the person in charge to keep track of the value in real time, whereas use of ThingSpeak to know the values based on time to know if something went wrong at a certain time since the values are stored with the time at which it was received on ThingSpeak.

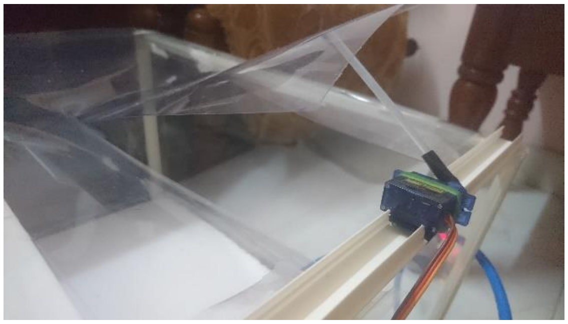

Fig 6 Servo lifting the roof for light and ventilation purposes.

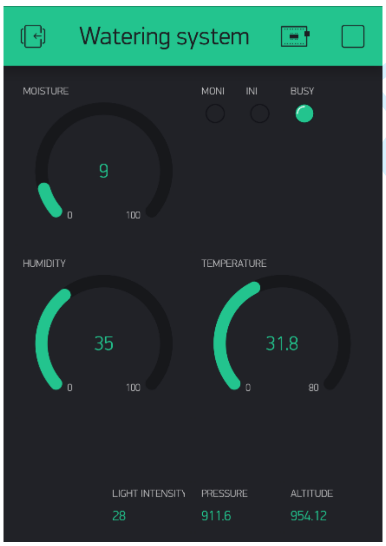

Fig 7 Blynk app displaying the different parameters.

V.BACKGROUND AND RELATED WORK

In the paper [1], the main objective is to develop an Embedded System for plant monitoring and watering system using Internet of Things, Raspberry Pi as Processor, and sensors for sensing environmental conditions. In this work, IoT concept is introduced to connect devices through Internet and facilitate information access by the users.

In the paper [2], the proposed system is based on IoT that uses real time input data. Smart farm irrigation system uses android phone for monitoring & controlling of drips remotely through wireless sensor network. Zigbee is used for communication between sensor nodes and base station.

In the paper [3], a plant watering system is designed in which the Soil Moisture Sensor checks the moisture level in the soil and if moisture level is low then Arduino kind of microcontroller switches on a water pump to provide water to the plant. Water pump gets automatically off when system finds enough moisture in the soil. Whenever system switched on or off the pump, a message is sent to the user via IOT module, updating the status of water pump and soil moisture. The work in ref.[6] involves soil moisture sensor, processing with Raspberry pi, and regulating the water supply by monitoring the water flow.

In paper [4], a system is used in a few areas like nursery farms and in agriculture. In this system a mechanism is established to find the moisture content in the soil with the help of soil moisture sensor and depending upon the condition of the sensor the water is controlled. Another important parameter is by capturing the images of the plant by using Arduino interfaced camera, and processing the image by using image processing to analyze and determine the disease effected by creating the feature vector database and retrieval of images from database similar to query image.

The paper [5], explains implementation of intelligent techniques for monitoring and enabling automatic sensing of the farming conditions. It further emphasizes how the farmer can implement the best practices in her/his farm and to reap highest productivity and yield. The paper discusses a cost-effective system that receives data about the conditions surrounding the plants from various sensors in the system. The sensors used are DHT-11, SHT-11 and a ‘Height Measuring Apparatus’ consisting of magnetic switches on a vertical pipe and a Neodymium magnet piece.

VI CONCLUSION

The plant monitoring system proposed in this paper, using Arduino is implemented to measure various parameters that affect the growth of the plant. The system we developed is cost effective because of the use of open source software and low cost devices. The Plant Monitoring System has been designed and tested so as to measure parameters such as Soil moisture, humidity, temperature, light intensity that are most important for the growth and yields of the plants. Using the automatic irrigation part of the system helps farmers and gardeners in automating the watering part of the plant growth process so as to conserve water as well as efforts in watering the plants at regular intervals. Manually watering fields not only causes wastage of water but also damages the mineral contents and integrity of the soil which worsens the yield of the plants that grow in the field over time. Using an automated sensing and watering system is thus beneficial. Considering greenhouses built in areas where the sunlight is abnormal the automatic ventilation system works based on the reading of the light intensity sensor i.e. the ventilation opens automatically when the lighting is less so as to allow fresh air inside as greenhouses work on the concept of conserving the heat and light inside the enclosure when sunlight is available to increase temperature inside the greenhouse. The temperature and humidity are sensed accordingly and even though no action is implemented in our system it can be made sure that based on the reading of the sensor the right action and necessary action takes place i.e. increasing the humidity based on the value detected by the sensor. On the whole, the system can be integrated in a greenhouse to keep track of all the parameters that affect the growth of the specific plant that they have grown.

VII References

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