IoT Based Plant Health Monitoring System using Arduino Microcontroller

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Abstract: ***Plant health management is the science and practice of understanding and overcoming the succession of biotic and abiotic factors that limit plants from achieving their full genetic potential as crops, ornamentals, timber trees, or other uses. Plant monitoring is one of the most important tasks in any agriculture based environment. In this paper, we discuss about the implementation of a plant health monitoring system. This will check some environment parameters like temperature, humidity and light intensity that has effects on plants. In addition, retrieve the soil moisture. All this information is sent by Arduino Uno dev boards to the Ubidots IoT (Internet of Things) cloud platform.***

Index Terms – Arduino Uno, Ubidots IoT cloud platform, Environmental factors, sensor, IoT, Wi-Fi.

1. INTRODUCTION

International Telecommunication Union defines IoT as "A global infrastructure for the Information Society, enabling advanced services by interconnecting (physical and virtual) things based on, existing and evolving, interoperable information and communication technologies." IoT is also defined as "The network of physical objects – devices, vehicles, buildings and other items – embedded with electronics, software, sensors, and network connectivity that enables these objects to collect and exchange data. The IoT allows objects to be sensed and controlled remotely across existing network infrastructure." At its very basic level, IoT refers to the connection of everyday objects to the Internet and to one another, with the goal being to provide users with smarter, more efficient experiences. Some recent examples of IoT products include the Nest Protect smoke detector, August door locks and Nest thermostat. One of the known examples is the Nest thermostat. This Wi-Fi connected thermostat allows you to remotely adjust the temperature via mobile device. The potential value is that we can save money on utility bill by being able to remotely turn off air condition, which we forget to do before leaving the house.

Certain important factors such as temperature, humidity, light and the level of carbon dioxide has an impact on the productivity of plant growth. Therefore, continuous monitoring of these environmental factors gives information to the user, how each factor affects growth and how to maximize the growth of plants. In recent years, precision agriculture has become the trend in agriculture. Here the focus is mainly on understanding the environment through the interpretation of wide variety of data. The main idea of the system is to monitor the plants whether they get required amount of water and light. If there is enough moisture in the soil, the same will be reported to the user. This will help the user to give the resources to the plants every day without much manual effort and constantly monitor the health of a plant from a remote location. Improvement of agricultural field has become biggest challenge for countries like India, so new technologies are to be adopted. We have implemented a novel methodology of physical parameter monitoring, data integration to the cloud, alert generation and predicting the future values. We have used Temperature humidity sensor, Soil moisture sensor and Light intensity sensor. These sensors have been installed in the agriculture field to collect the data, and thus data is stored into the cloud using Ubidots IoT cloud platform.

2. INTERNET OF THINGS TECHNOLOGY

Internet of Things Technology The Internet of Things (IoT) is the network of physical objects that enables these objects to collect and exchange data through internet. The Internet of Things allows objects to be sensed and controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer based systems, and resulting in improved efficiency, accuracy and economic benefit; when IoT is augmented with sensors and actuators, the technology becomes an instance of the more general class of cyber-physical systems, which also encompasses technologies such as smart grids, smart homes, intelligent transportation and smart cities. Each thing is uniquely identifiable through its embedded computing system but is able to interoperate within the existing Internet infrastructure.

3. LITARATURE SURVEY

We have studied many previous works done in this field by different researchers. Use of technology in the field of agriculture plays important role in increasing the production as well as in reducing the man power efforts. Research for improving agricultural production by utilizing different controllers like PIC microcontroller,8051 controller, ARM 7 etc or also monitoring done by different communication technology like Zigbee, Wireless sensor network(WSN),even using GSM.

Mancuso and Franco [1], have done a similar research work in a tomato greenhouse in the South of Italy. The Sensicast device is used for air temperature, humidity and soil temperature with wireless sensor network and a web based plant monitoring system is developed. User can read the measurements over the Internet, and an alert message is sent to his mobile phone through SMS if there are any deviations from normal measurements. Sensor node will transmit the data of temperature and relative humidity in one minute interval to the Bridge node.

Teemu Ahonen, Reino Virrankoski and Mohammed Elmusrati [2], have done a research in Martens Greenhouse Research Center in the Narpio town in Western Finland, they had integrated three commercial sensors with Sensinode's sensor platform to measure four environmental key variables in greenhouse control. The system feasibility was verified in a simple star topology setup in a tomato greenhouse. The sensors used were SHT75 humidity/temperature sensor and TSL262R light irradiance sensor, and Figaro's TGS4161 CO2 sensor used. Application of the concept in the greenhouse: temperature, luminosity and humidity sensors measured climate variables and communicated directly with the gateway node. The gateway node acted as a coordinator and received the measured data from the sensor nodes. The maximal communication range, 15 meters was figured out in individual test where the distance between the coordinator and the sensor node inside the greenhouse dense flora was increased, the reliable communication range fell to one third in the greenhouse's dense flora.

4. PROPOSED SYSTEM

In our proposed scheme we are using Arduino as a main controller. Arduino gets the data from industrial environment and process the data to run the industrial appliances smoothly. Normally temperature in industrial environments is high when compared to normal situation because industrial machines produce more heat, which affects the machineries. Temperature sensor monitors the temperature and gives the values to Arduino.

Based on the value either the fan is switched ON or OFF through relay. Further we can monitor and control the industrial appliances through internet. To send the information to internet Ethernet shield is used. To monitor and control, we are creating a web page that will display the information about an industrial situation.

4. IMPLEMENTATION

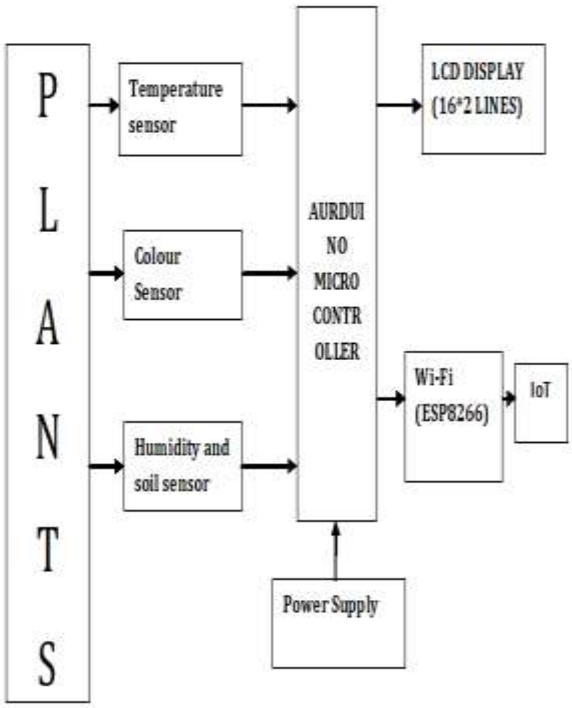

Fig.1 Proposed Block diagram

The proposed IoT based plant health monitoring system consists of hardware and software modules as shown in Fig.1.

I. *Hardware used:*

A. DHT11

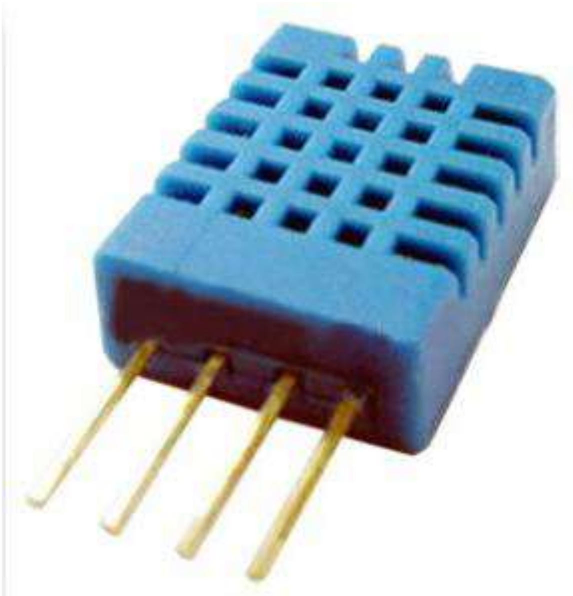

Fig. 2. DHT11 humidity and temperature sensor

DHT11 is a Temperature and Humidity monitoring sensor using digital signal acquisition technique and temperature & humidity sensing technology. This sensor consists of a resistive type humidity measurement component and an NTC temperature measurement component, connects to a high performance 8-bit microcontroller, offering excellent quality, fast response, anti-interference ability, low power consumption, cost-effective cheap sensor and suitable for Arduino. It has following specifications humidity measuring range 20% to 90% RH with an accuracy of 5.0% RH and temperature measuring range of 0 to 50 C with an accuracy of 2.0 C.

B. Soil Moisture Sensor

YL-38 + YL-69 is a soil moisture sensor also known as hygrometer used to detect the humidity of the soil. Which helps to monitor the soil moisture of plants or build an automatic plant watering system. The sensor is made up of two parts namely the electronic board and a probe with two pads, that detects the water content in soil. When the soil is wet the output voltage decreases and when the soil is dry the output voltage increases. The output can be a digital signal low or high, depending on the water content. If the soil humidity exceeds a certain predefined threshold value, the modules outputs low, otherwise it outputs high.

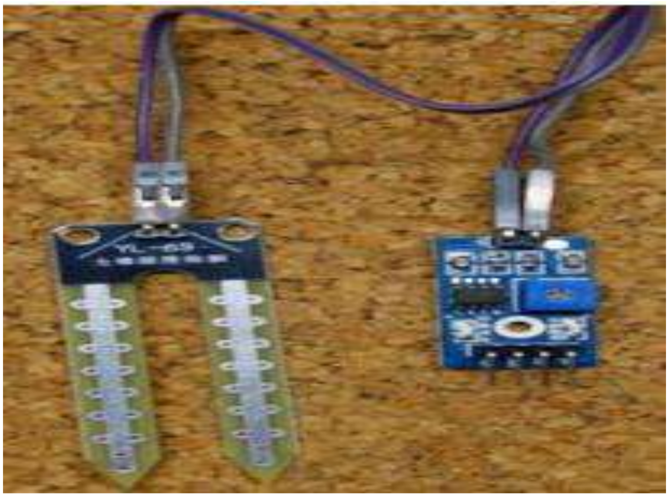

Fig. 3. Soil Moisture sensor

C. Light Sensor

is a sensor to measure the light intensity so that we can know how much light the plant is receiving. Sensor acts like a transistor greater the incoming light, higher will be the voltage on signal pin. It detects the light density and reflect the analog voltage signal back to Arduino controller. It mimics the human eye, it does not react well to IR or UV light. TEMT6000 has following specifications like supply voltage range from 3.3V to 5.5V, operating temperature range 40 to 85 C and illumination range 1 to 1000 Lux.

D. Arduino Microcontroller

Arduino was born at the Ivera Interaction Design Institute as an easy tool for fast prototyping, started as a simple 8 – bit board to products for IoT applications. All Arduino boards are completely open source electronics platform based on easy to use hardware and software. It has been the brain of thousands of projects, from everyday objects to complex scientific instruments

Arduino board can read inputs like light on a sensor, a finger on a button, or a Twitter message and turn it into an output activating a motor, turning on an LED, publishing something online.

Arduino board can be instructed by sending a set of instructions to the microcontroller on the board. Instructions are written in Arduino programming language and the Arduino software is used as Integrated development environment (IDE) for processing these instructions. Arduino offers many advantages over other microcontrollers such as cross platform – Arduino IDE runs on Windows, Macintosh OSX and Linux operating systems, inexpensive, simple programming environment and open source. In this system Arduino Uno dev board is used as a microcontroller that can be programmed in C or C++. It has an IDE to simplify the development process. Arduino Uno can use an Ethernet shield or Wi-Fi shield so that it can send and receive data. It can be controlled remotely. Arduino Uno is perfect for IoT project based on sensors when the project requirements are sending sensor data to the cloud. Fig. 6. Arduino Uno Dev Board.

II. Software's Used

A. Ubidots IoT Cloud platform

Ubidots is the most important component of the plant health monitoring system. When building an IoT system based on sensors, dev board sends data to the cloud platform. These platforms store data and use it to build charts. An Ubidots IoT cloud platform is like a PaaS (Platform as a service) that provides some services useful in IoT ecosystem. These services enable dev boards connecting to remote services or other service providers. It would be expensive to connect Arduino to a remote service. These platforms make the heavy work. They execute a set of custom rules based on the incoming events from Arduino sensors. These events trigger external action like sending a short message. Most of these platforms have a free account that is useful to build an IoT Project.

5. EXPERIMENTAL RESULTS

Fig.4 Experimental setup

Fig.5 Showing the temperature and Humidity values

Fig.6 Showing the Soil Value

Fig.7 Showing the Light Value

Fig 8. Showing the status of data sending to IoT

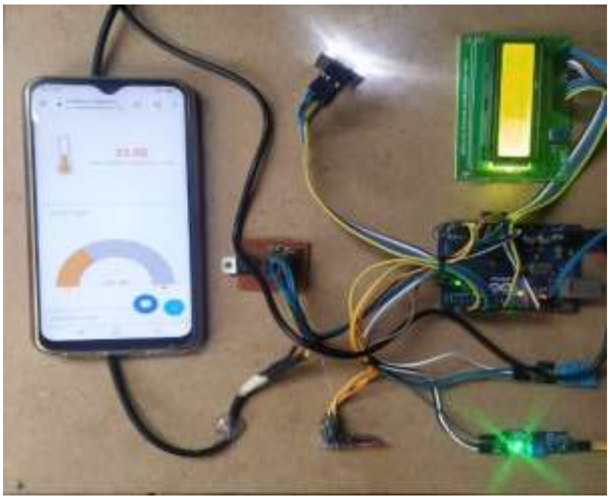

Fig 9. Showing the status of data sending to IoT

Fig.10 Showing the Plant health Condition

6. CONCLUSION

The sensors and microcontroller are successfully interfaced with the cloud. The data is stored successfully and can be accessed remotely. All observations and experimental set up proves that this is a complete solution to monitor the health of a plant. User can have access to the data and can know if there are any deviations with respect to temperature, humidity, soil moisture and light intensity. Implementing this system will allow users like farmers to monitor and improve the yield of crops and overall production.

Future Scope

The performance of the system can be further improved in terms of the operating speed, memory capacity, and instruction cycle period of the microcontroller by using other high end controllers. The number of channels can be increased to interface more number of sensors which is possible by using advanced versions of controllers.

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