Smart Plant Monitoring System

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Abstract

Internet of Things is being used in almost all domains around us. Internet has become a basic necessity of people in today's world. IoT is a field of technology which comprises of five components that are sensors, actuators, connectors, network and databases. It is combination of interconnected network comprising embedded sensors and software. An efficient plant monitoring system is still a challenge in various sectors. This project revolves around the idea of building a smart plant monitoring system. The proposed model is integrated with a cloud server and a web application which help the client to control and monitor the status of plants. In this project we have used NodeMCU as the controller, few sensors like Temperature sensor, Moisture sensor, Humidity for collecting data and applied a machine-based curation to regularly check the status of plants health. The primary goal of our project is to reduce interaction of humans and wastage of water by providing the water as per use.

Keywords — IOT, Monitoring, Temperature, Humidity, Moisture

1. INTRODUCTION

1.1 PROBLEM

The world that we live is totally controlled and operated automatically. Automation has taken control of everything, but there are still some important sections in our country that are deprived of this feature. One of those sections is our country’s most primary section, which is agriculture. Technology has no doubt boomed the agriculture and other sections like horticulture in India but it still lacks automation. 61.5% of total population of our country depends upon agriculture sector for their living as per Agricultural Census of India in 2011. Organizations and even households where people care to grow plants do not have the automation. Plant growth can be governed by controlling the parameter of climate and by also introducing automation in plant monitoring. Also, due to traditional methods of irrigation plants used to get over irrigated many times which also damages their health. A monitored irrigation system is needed to tell us the amount of water to be provided to plants. So, there is a potential of automation in this primary section of our country.

1.2 SOLUTION

Our plant monitoring system examines the environment conditions of plant and provides the feedback to the user through any means of network driven device like smartphone, computers, tablets etc. As our daily live is becoming more hectic, most of us are unable to monitor the health of the plant and to ensure that they are getting enough sunlight and water and required ingredients, we introduced this project comprising of various sensors such as humidity sensor, temperature sensor and soil moisture sensor. We designed a system which is triggered whenever the moisture value is above the threshold value (which is governed by the temperature and humidity values) water valve of the system is turned on automatically and appropriate amount of water is provided to the plant. Also, statistical values are shown on an IP address already known to user. Monitoring system has to be connected to the same network over which end user device is connected. So, this solution can be efficiently implemented in the offices, organizations, educational campuses and household which are end users, as long as they are connected to their network, they can monitor the plant health.

1.3 WHERE IS IoT?

- Sensing:

Various sensors such as soil moisture sensor, DHT22 are used in the project to take input to the IOT system.

- Actuators:

Water valve solenoid is used as an actuator in our project. Whenever decision is made by the NodeMCU, relay module is activated which transfer the flow of electrical signals to the water valve solenoid.

- Controller:

NodeMCU (ESP8266) is used as the Wi-Fi module in our project and acts like the controlled of the IOT system.

- Network:

Connection with the end user is built up by the NodeMCU using the network medium provided by the user end.

1.4 VISION AND CONTRIBUTION

Main aim of our project is to provide automation in monitoring of plants and at the same time conserve water as much as possible. Many plants die due to improper monitoring and litres of water is wasted during watering, so our project can save the plant health and also conserve water as there is only controlled watering of plants.

These are the benefits that we have contributed to this section:

- Automated Plant Monitoring
- Data Collection
- Plant health life cycle
- Water Conservation

1.5 PAPER ORGANISATION:

This paper consists of 11 sections that are introduction, literature work, proposed system, hardware description, approach(methodology), algorithm, flowchart, performance evaluation, results, scope of improvement, conclusion, acknowledgment, references.

2. LITERATURE SURVEY

We have gone through various research papers about the works done in this field.

[1] Around 35% of the earthly geographic region was under water. Furthermore, 66% of the piece of land is relying upon rain for the water. Water systems diminishes dependency on monsoons, makes food security better and improves efficiency. There have been numerous hardships in assessing how much water to be given and at what time, since India has wide range of seasons. Under watering and over watering have harmed the plants and degraded soil quality and leading to wastage of water. Subsequently for keep away from such harm we want to keep up with approximate water level in soil as per IOT based plant monitoring system.

[2] One of the research projects conducted by Teemu Ahonen et al at Martens Greenhouse Research Center's nursery, Narpio town tried to analysis four factors that control nursery. For these three business sensors were used alongside with Sensinode sensor. The three sensors were TSL262R light irradiance sensor, SHT75 humidity/temperature sensor and Figaro's TGS4161 CO2 sensor. Several factors were directly connected to the gateway node which estimated environment factors of the nursery such as radiance, temperature and humidity estimated environment factors. There was a broker in the middle though which the gateway hub went about and gets the required information from the sensor hubs. It was found from the experiments that the suitable range for the standalone test was 15 meters.

[3] Nivesh Patil, Shubham Patil, Animesh Uttekar, have explained about PCs or versatile application for control the framework. In their system, we found that all the sensors were connected to on central server. The communication was established by remote modules. Each of the hub performs operation co-ordinately with the components of this network.

The server which acts as a middleware sends the data from the client and the gets the data for the site that is hosted as the web. This framework utilises two modes. Manual mode and auto mode. In auto mode framework the actuator working is decided by the working code itself based on the threshold values and changing parameters, in case of manual mode the user can fully control the system and its working. Further analysing the knowledge discovered and proposing right steps of conformation by establishing correct prototypes of model solution for hardware and software of IOT.

[4] According to one of the research paper on Internet of Things and a paper on NodeMCU, it says that the proposed model the building block step of Internet of Things (IoT). An IoT model various components like physical components like actuators, sensors, microcontroller i.e., central hub, some programming including backend, development of some webpage or an interface compatible with various platforms network. For prototyping purpose, we would be using IoT microcontroller unit (MCU).The MCU board utilises very low power as compared to other processors. These processors support different programming conditions like C, C++, Arduino and are capable to extracting information from the sensor by utilizing the firmware and then upload the data to cloud and can be stored in various databases. One such example is NodeMCU which is an open source.

[5] , Harsha Mohan Hiremath, Divya D, Jyothi T U, have planned a framework. The framework measured many factors including stream rate and the quality of air. With the quality of air, we can determine the pH.. With the help of the agg. Sum we can set the value of the pH of the soil which is estimated by the pH sensor, the framework chiefly centres around naturally keeping up with the pH worth of the arrangement in repository by contrasting the detected worth and the value extracted from an application. The air quality in which the system is installed wherein the framework is introduced is consistently observed by the air quality sensor.

3. PROPOSED SYSTEM

The proposed framework comprises of 2 curation frameworks. These two frameworks are based on machine model and user-based model. These curative frameworks are set up to give a brilliant and compulsory criticism to the given climate. The previous is a greater amount of prescient framework contrived on an equipment while, in the user-based model, user has full control of the system. However, this mode of automation and user based depends upon the data gathered from the endpoints. Above this , there exist a framework which controls it . The control system contains a web application and a database , the database is stored on the cloud which acts like a broker and the web application acts as provider.

Our proposed model consists of both hardware and the software.

a. Hardware components:
   I. Soil Moisture sensor
   II. DHT22
   III. NodeMCU
   IV. Relay Module
   V. Motor
b. Language Used:
   I. Asynchronous JS
   II. C++
   III. JAVA
c. Software Components:
   I. A web-based application

3.1 WORKING METHODOLOGY

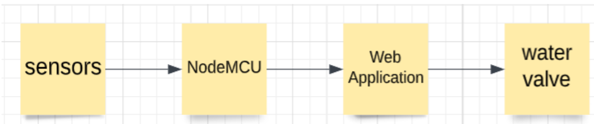

Fig 1. Block Diagram for model

In the block diagram above, we can see that two sensors are utilized. One of the sensor is DHT 22 which measures temperature and humidity. We have also used Soil Moisture sensor along with relay module which help in controlling the amount of water . Single bus information design is utilized for synchronization among DHT22 and MCU sensor. One correspondence process is takes around 4ms. Information comprises of fundamental and decimal parts. A total information transmission is of 32bit, and the sensor sends higher information bits first. Data format: 8bit basic humidity information + 8bit decimal humidity information + 8bit decimal temperature information + 8bit checksum (Error bits). Assuming the information transmission is correct, the check-aggregate ought to be the last 8bit of "bit basic humidity information + 8bit decimal humidity information + 8bit decimal temperature information + 8bit checksum". This large number of sensors are interacted to an open-source Node-MCU (ESP8266) which will go about as a microcontroller. This microcontroller is additionally communicated with 5V power supply. Valves and solenoid Pumps are being constrained by the Node-MCU for effective working of framework. This data is being send to a web application. The controlling of entire framework is automated utilizing NodeMCU and IoT framework.

3.2 CIRCUIT DIAGRAM

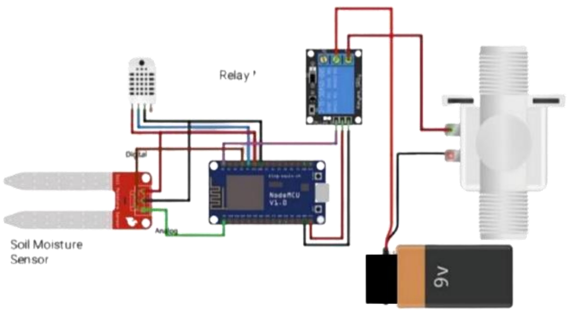

Fig 2. Circuit diagram of the System

4. HARDWARE DESCRIPTION

4.1 Node-MCU ESP8266

Node MCU is one of the IOT component that is provided as an open-source tool. The General-purpose input /output pins that are shown in Fig.3 can't be used into the input output code on Node-MCU through the pin numbers mentioned directly. For an arrangement of total independent WIFI,ESP8266EX is used ;float WIFI organizing behaviour can be inherited from another application processor through the use of it. Also, cache is integrated in it which increases the system performance of this microcontroller.

Fig 3. Node MCU

4.2 Soil Moisture Sensor

Soil moisture sensors measure the units of volume of water present in per unit volume of soil. To measure the gravimetric water content i.e. mass of water per unit mass of dry soil, it is required to dry the sample and weigh the dried soil.To avoid all this overheads, volumetric moisture is calculated by taking use of dielectric constant property of soil.Also, properties like resistance to electricity and neutrons association can also be utilised to calculate the volumetric content.

Fig 4. Soil Moisture Sensor

4.3 DHT 22 Temperature Sensor

DHT22 is used to sense moisture and temperature both. There is a surface which hold moisture and which resides between the two anodes present around it. So, whenever the amount of moisture is varied across this surface , the resistance between the anodes and the conductivity of the surface changes as long as the change is maintained. An IC handles the alteration of resistance which is further used by the MCU.

DHT22 sensor uses an NTC temp. sensor or a thermistor for finding temperature. A thermistor is a type of resistor which changes its resistance according to the temperature. Frittage of Semi-conductive materials is done and then used to build these sensors.With a little change in temperature, a huge alteration in resistance is observed. Negative temperature Coefficient(NTC) implies that resistance dimishes whenever temperature is increased.

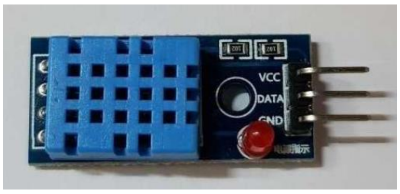

Fig 5. DHT22 sensor

4.4 Relay Module

Relay module is generally used as a switch between a microcontroller and the actuator. It is used in the project to control the operation of water pump.It is connected to the circuit ground and the normally open end of the pump.The single-channel relay module has much more functionality compared to a plain relay. It includes components that simplifies operations between the actuator and the microcontroller which can also be verified by the sequence of indications .

Fig 6. Relay Module

5. ALGORITHM

Algorithm 1 Working

start
initialize all the sensors
collect the sensors output
display the value on the web application
check the value of soil moisture
if *value > threshold* **then**
Turn on water pump
else
goto step 4
endif
check the value of DHT22
goto step 3
end

Algorithm 2 Sending Data

timedif ← *clockTime* – *previousReadingTime*
interval = 5secs
if *timedif* ≥ *interval* **then**
previousReadingTime ← *clockTime*
Read the sensor input and make XMLHttpRequest
If *status == 400* **then**
For each parameter in parameters
Display parameter. reading
If *pointCollection[parameter].size < 40* **then**
pointCollection←add[parameter]
plot the Chart
endif
else *throw error and try re-request*
endif
return

6. FLOWCHART

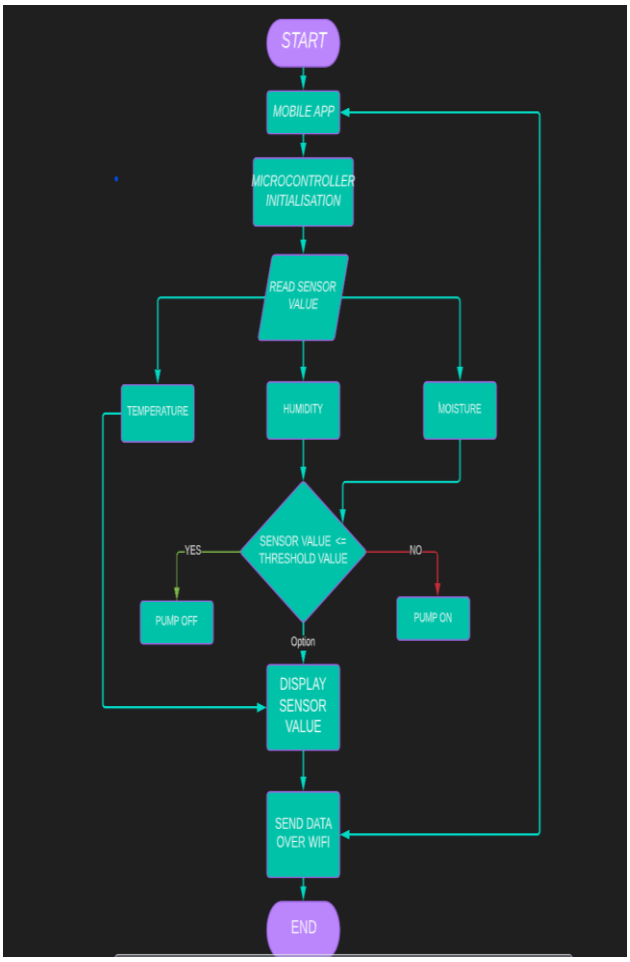

Fig 7. Flowchart of the System

The above flowcharts describe the various stages used in analysing and collecting the data.

- At the point when the power supply is ON, the information module of three sensors (DHT22, moisture) begin to actuate.
- At the point when sensors get ON it will peruse the information from soil and from environmental factors.
- As per the qualities that are distinguished by sensors motor will turn ON/OFF.
- On the off chance that moisture level is high, motor is turned off and hence the flow of water will halt.
- All the extracted values received from the sensor are send to our web application via ESP8266 and is stored in online database (firebase).
- High Charts will generate the graphical representation of information provided by the Wi-Fi Module.

7. RESULTS

Above proposed system results in output which is fast, accurate and secure. Hence, the experimental results accurately monitor the plants under various different conditions. The above system is easily accessible.

7.1 EVALUATION

- By comparing with the actual readings and the automated readings that we obtained.
- By comparing with the outcomes of the other similar research done.

7.2 HARDWARE OUTPUT

The hardware setup of the system includes NodeMCU as the central node which is powered by 9V battery source. The sensors including the temperature sensor and the soil moisture sensor are connected to NodeMCU. The relay module act as a switch to turn on and off the solenoid valve. Once the setup is completed, the Arduino code is linked with the IoT application that is designed using AJAX. The application sends the HTTPXMLResponse when it is connected alongside the IP address of the hosted server. Once the reading exceeds the threshold the valve is automatically turned on, allowing the water to flow to the soil. As the threshold is detected again, the valve turns off.

It can be seen that the entire setup is simple, compact and very user friendly.

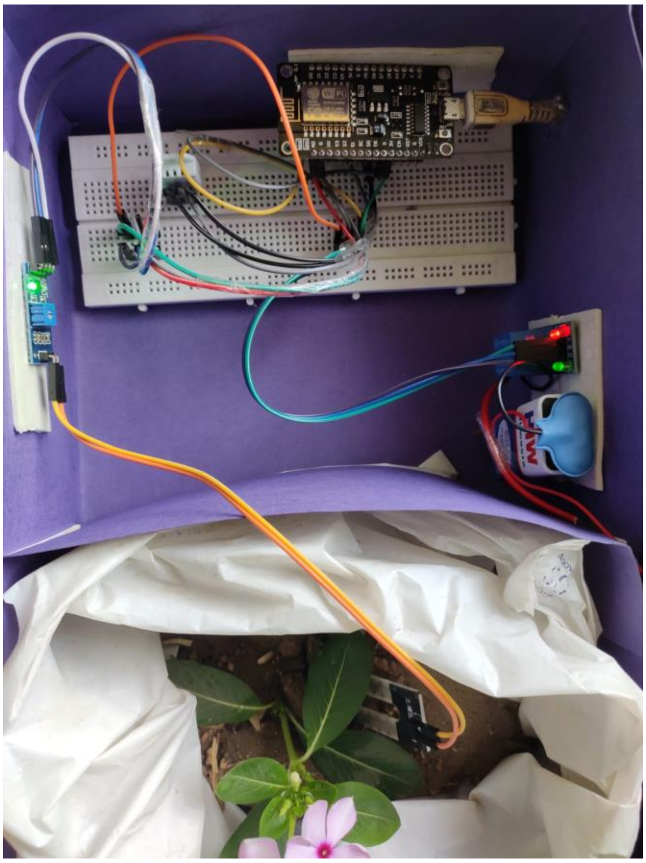

Fig 8. Hardware components of the System

7.3 SOFTWARE OUTPUT

The web application displays the parameters like soil moisture, temperature and humidity. This helps in monitoring the current condition of the plant. When the moisture level falls below 600 or 40% or when the temperature rises beyond normal room temperature, say 30 degrees the water valve is turned on automatically. Once the levels are back to normal the water value automatically turns off cutting the supply of water from the source. The web application collect the last 40 data points and store them on the cloud , these points are then displayed in form of chart so that they can easily be analysed and this time series data can be easily manipulated and studied. Each point as a time stamp associated with it. This can be seen in ESP Visualisation Station. the Application is developed on AJAX which has advantage that its asynchronous, hence the user doesn't have to refresh the application to monitor real time values which makes our webpage more user friendly and easy to use.

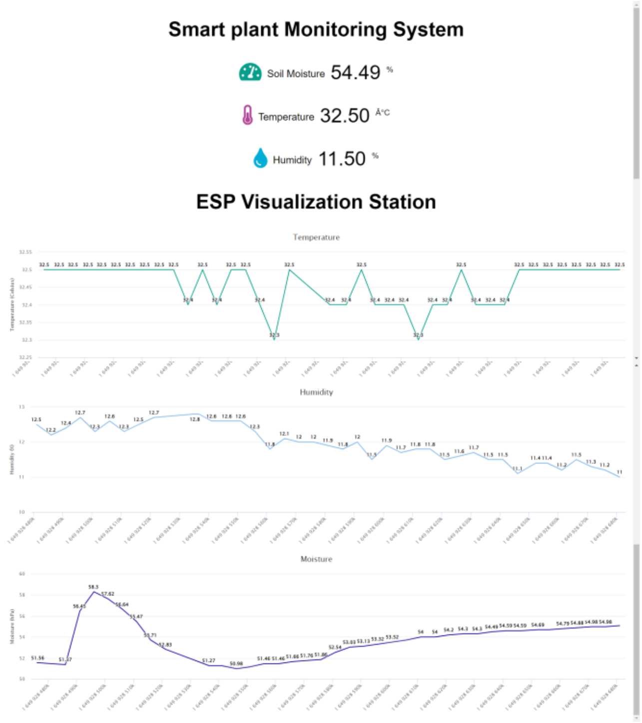

Fig 9.Software components of the System

8 SCOPE OF IMPROVEMENTS

The project is very reliable in the limited scale yet will require some improvement for the huge scope level. For more improvements and making a good market competing model, we could add specific feature for making the framework more intelligent.

- We can use better processor which would increase the performace of the system. With the increase of Instruction clock cycles, data broadcasting would be much faster .
- Number of channels can be increased. With the increased number of channels many sensors can be integrated, hence we can collect more and more information about the plant health.
- Add signin/login options so that multiple users can added. We can also added other functionality like adding

security to device and the owner's account .

- Implements AI and use OpenCV and upload the configuration of the plant at the time of setup.
- We can install camera to the model, through which we can monitor the health, later we can stream it live for which we can use various software like Wowza which uses RTMP.

9 CONCLUSIONS

This whole project mainly focuses on two results. The primary result is to assist farmers to improve their agriculture – technical information, act in consequently with minimum needs on environmental problems and principally the essential function being prevented by natural disasters to protect plants and nature from being ruptured. And the second result of project made by us is to use technology to calculate the humidity, temperature and moisture of the plant root and make the plant grow in a well suitable environment without the use of soil as per the concept of hydroponics. The farmer or user receives the message regarding the status and thus helps in avoiding delay of plant watering and protect the plant to live in a suitable environment. The economical automation on observation and management of the plants needs new and revolutionary solutions. Wireless sensing element networks will answer demand by giving associate correct and simply configurable observation system. During this work we tend to be using the moisture sensor and light sensor, we tend to expeditiously monitor the fundamental resources of the plant. In contrast to different automatic systems that depends automated data, and in order to utilize the various resources in line of accordance of the changes in climate, our model is a lot more intelligent. Our model could successfully integrate with any mobile platform, also this model is much more scalable as it is running on a cloud-based service.

10 ACKNOWLEDGMENTS

We are thankful to our professor Dr Gaurav Singhal who provided insights and expertise that greatly assisted the research and helped us providing alternate aspects to the project and helped this project grew up, although they may not agree with all the interpretation of this paper.

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