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Vertical Farming Using Internet of Things

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Abstract: Vertical farming is the practice of planting the plants in vertically stacked layers which optimize the land usage as it can be implemented in an indoor environment. The main idea of vertical farming is to use a controlled-environment agriculture (CEA) technology, where all environmental factors can be controlled.
Therefore, in this project, an automatic system, which consists of the Internet of Thing [IoT] is implemented in providing the controlled environment for the vertical farming. The main purpose of this project is to build a system to monitor the soil moisture and to control water content through the web browser on the laptop, mobile phone and other handheld and compact devices. In this project, a soil moisture sensor is used to detect the moisture or water content of the soil in the vertical farm so that the plant can be consecutively monitored and controlled to have enough water. When low moisture level is detected, the signals are sent to the Arduino platform.
Then, the data is stored eventually in the Arduino IDE software and simultaneously sent to the web browser through the Ethernet that is connected to the internet router. The user can monitor their plant through the web browser that allows them to read the status of the soil moisture and can control the water valve to release the water to the plant whenever the reading is low or necessary. With this development, the monitoring of the vertical farming has been so helpful and the growth of the plant can be supervised from time to time without having the operator at the event.

I. INTRODUCTION

The modern concept of vertical farming was proposed in 1999 by Professor Dickson Despoiler. His concept was to grow the food in urban areas itself utilizing less distance and saving the time in bringing the food produced in rural areas to the cities.
Due to the increasing of population and peak country developments, alternative options are being sought for feeding the masses, yet minimizing the land used.
Vertical farming is environmental friendly because recycle material could be used to build the structure, and its pesticide free. It is monitoring system with Internet Of Things is introduced as a platform to collect data and visualize it through a web based applications. There is varieties sensors work together with the system in order to collect different kind of data namely light intensity, surrounding temperature, and soil moisture. The IOT based vertical farming monitoring system could help to reduce the burden of users and provide accurate statistics and analysis.

II. METHEDOLOGY

A. Project Description

This project aims to design and develop a smart vertical farming using LED grow lights , wooden board ,battery , sensors . The sensors are used to obtain data regarding the planting condition, and type of sensors used LDR sensor module, soil moisture sensor and temperature sensor LM35 . A protype vertical farming monitoring system will be developed including all the hardware ad software parts .the aim of the prototype is to collect required data with sensors , then analyze and display it appropriately via Thing speak web ased application .

It has the following features
1) Economical
2) Compact and portable
3) Applicable in large scale

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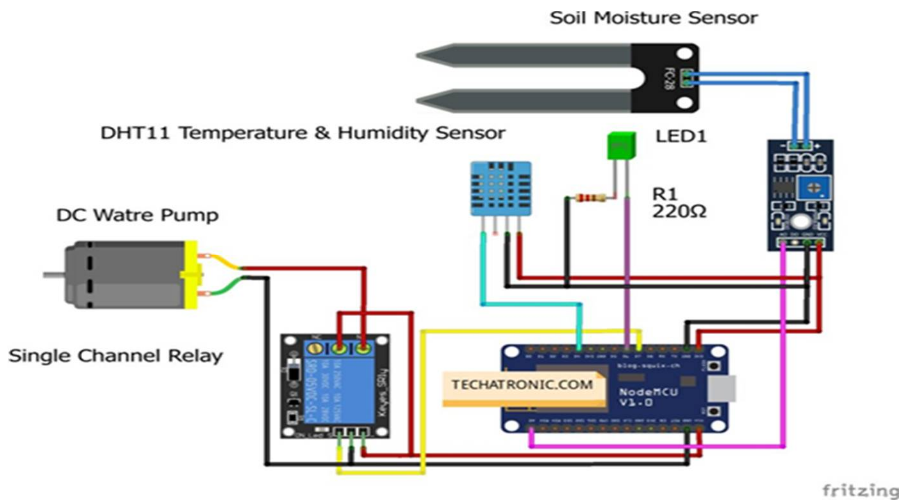

Fig 1 Circuit diagram of IOT based model

B. Working Principle of Vertical Farming

Vertical farming is an increasingly popular technique of producing crops indoors in a vertical setting. A vertical system involves the cultivation of crops in controlled environments, where every parameter affecting their growth is closely monitored and tailored to their needs. The concept of controlled environment agriculture underpins vertical farming as cutting-edge technologies are utilized to provide adequate conditions for any crop. With the use of new technologies like AI, ML, and IoT, vertical farming is poised to reach new height.

C. Controlled Environment Agriculture (CEA)

Typically, controlled environments involve hydroponic, aeroponic, or aquatic cultivation. Moreover, controlled environment agriculture can utilize advanced imaging and sensor technologies including cameras and thermal imaging to measure plant growth, temperature, and other factors. Presently, controlled environment systems have proven highly effective in growing leafy greens, herbs, microgreens, and vegetables such as tomatoes, peppers, melons, and sweet corn.

D. Sterilization Systems

Sterilization can be used ones include chemical disinfection, UV -C sterilization and ozone sanitation Recapturing water from moist. The average vertical farm that utilizes hydroponic, aeroponic and aquaponic growing methods uses 95% less water than horizontal farms. Plants are generally loss most of the water they are provided with during the process of transpiration.

E. Lighting

LED light are used to growth of the plants. in vertical farming a great deal of research goes into selecting the best performance light source since every stage of plant development has different lighting requirements.

III. CODE USED FOR MONITORING

A. Sensor used in Vertical Farming

1) *DHT 11:* The DHT11 is a commonly used Temperature and humidity sensor for prototypes monitoring the ambient temperature and humidity of a given area. The sensor can measure temperature from 0°C to 50°C with an accuracy of ±2°C and humidity from 20% to 90% with an accuracy of ±5% RH

Fig 2 Diagram for DHT11

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2) *Soil Moisture:* The soil moisture sensor consists of two probes that are used to measure the volumetric content of water. The two probes allow the current to pass through the soil, which gives the resistance value to measure the moisture value.

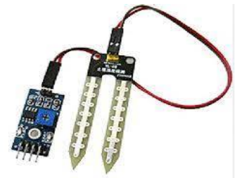


Fig 3 Diagram for soil moisture sensor

3) *Nodemcu ESP8266:* NodeMCU is an open source platform based on ESP8266 which can connect objects and let data transfer using the Wi-Fi protocol. In addition, by providing some of the most important features of microcontrollers such as GPIO, PWM, ADC, and etc, it can solve many of the project's needs alone.

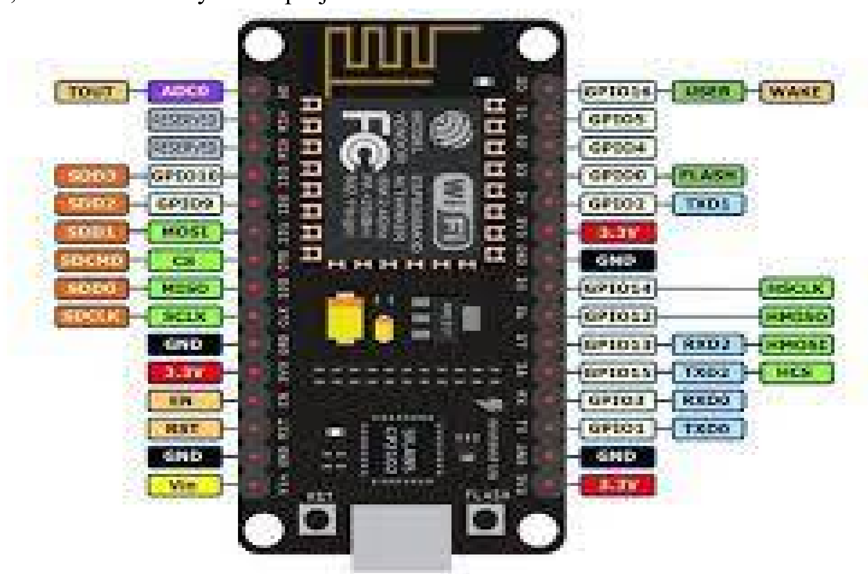


Fig 4 Diagram of Nodemcu esp8266

4) *Relay Driver:* Relays are electric switches that use electromagnetism to convert small electrical stimuli into larger currents. These conversions occur when electrical inputs activate electromagnets to either form or break existing circuits.

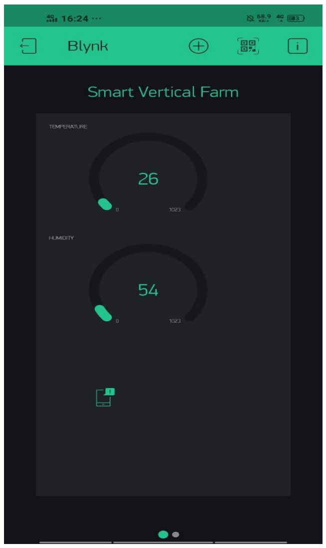
Diagram of Relay driver

IV. RESULTS

This section explained about the data collection method and also the results visualization approach. All the sensors installed at the prototype system have been tested and the results obtained are discussed in this section. Besides, the real time monitoring obtained from Thing speak channel are discussed in the next sub-sections**.**

V. TEMPERATURE AND HUMIDITY MONITERING

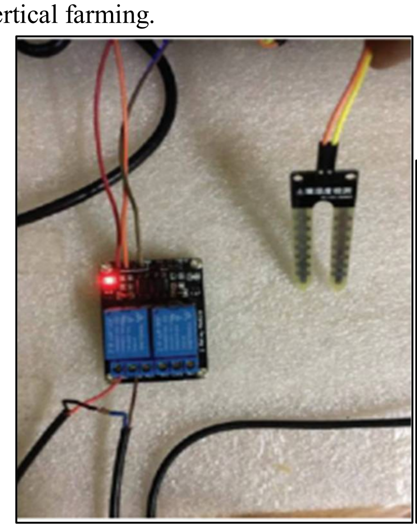
The temperature initialize at 25C, then increases to 27C, and remain for a short period. When the sensor is contacted with human body, the temperature shown in Thing speak graph has been increased gradually from 27ϵC to 33ϵC, which is very close to body temperature. The temperature stops at 33ϵC because only part of the sensor is covered with finger. There is probability that some minor part of sensor still expose to the air surrounding. Thus, the value shown was not achieving 36.5ϵC, which is a normal body temperature. However, it proof that the reading on Things peak changed accordingly to the surrounding temperature detected by DHT11

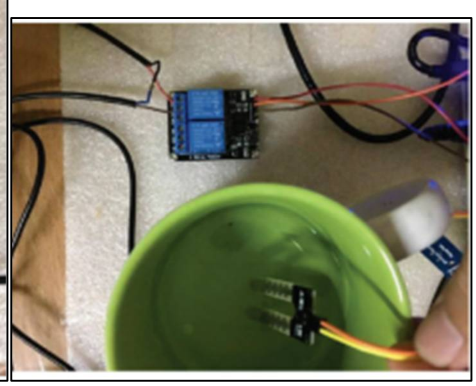


Screenshot of initial stage in DHT11 Screenshot of working stage DHT11

A. Watering System with Relay

In order to show that the water pump has been turned on only when the soil is dehydrated, 2 scenario have been created to observe the feedback of relay. Based on the figure below, the probe of soil moisture sensor module is in contact with a dry object. As a result, the relay is triggered and the water pump is turned on. The LED light on the relay module proof that it has been triggered by a low voltage signal and the circuit is closed**.** When the probe is placed into water, the LED is turned off. This situation happen because the probe detected that the moisture level is sufficient, hence no water needed. Then, a high voltage signal is sent to the relay, and causes it too pen. Finally, the water pump has been switched off. Based on the results obtained, the data collected from sensors varied with the surrounding condition, which proof that the sensors in functioning well. Besides, the graph obtained from Things peak indicates that all the data from BBB has been uploaded successfully to the Thing speak IoT, and provides real time monitoring system on vertical farming.





Probe contact with dry object Probe contact with water

VI. DISCUSSION

In vertical farm using internet of things we have discussion about cost estimate per acre and per square foot , then we discuss about Software development.

A. Cost Estimate

However, it just needs around Rs. 4 to 5 thousand if you are not starting it commercially and just utilizing for your own family then this amount is good enough which you can encourage to Rs. 8 -10 thousand as per your need. But while investing low amount you have to face the limitations in choosing the product. Small vertical farms spend an average of \$3.45 per square foot on energy while large vertical farms spend an average of \$8.02 per square foot. Small farms are facilities smaller than 10,000 square feet, while large farms are anything bigger than that.

B. Software Development

First thing to do in software development is to connect the Beagle Bone with laptop, so that the board could be programmed to carry out desired tasks. Afterwards, the flow of main program will be discussed, including function of each sensors reading, water pump control system and uploading data onto Things peak Cloud. The main coding is programed using Eclipse running in Ubuntu operating system. First of all, Black Lib libraries must be included, followed by all those declaration and initialization. Then, an infinity loop was created. Because the BBB is required to run automatically, and provide real time monitoring function. In the looping, 'ldrsens', 'Temperature' and 'Soil Mois' function are called respectively to collect desired data such as light intensity, temperature and soil moisture, then uploaded to the Things peak IoT. Before returning to the beginning of loop, it will check the value of soil moisture level. A low signal is sent to relay if the soil was dehydrated. Hence, the water pump is turned on.

VII. CONCLUSION

The IoT based Vertical Farming Monitoring System could help to reduce the burden of users, and provide accurate statistics and analysis. Besides, the system is able to offer immediate access for the users because it is an online system. The system could also locate the equipment in use and track the sensors detecting crucial change on input. In addition, the system is either controlled by the users or taking action automatically when problems occurred. For example, users could turn off the watering system via web-based application, or perform watering activity when humidity level is extremely low. The convenience of the system is expected to increase the productivity and reduce water usage in agriculture field. It also encourage the traditional farmers to practice vertical farming which is environmental friendly, and also provide a better farming experiences to all users. The objectives of project are achieved. However, there are still a lot of improvement could be done on the existing prototype system. First of all, the number of sensors could be increased to provide different type of data related to vertical farming, such as pH value, carbon dioxide level, and air quality. Beagle Bone Black in the prototype system has sufficient analog input pin to support all those sensors. Besides, a camera could be add on for the purpose of image processing. At the same time, the color of crops could be analyzed to determine the quality of crops, and the height of crops could also be calculated from time to time, to investigate the growing speed of plants. In a nutshell, the basic prototype system has been built, and it could be a better, a real system if the research and development is carried on.

REFFERENCE

[1] P. Platt, "Vertical Farming: An Interview with Dickson Despommier," Gastronomica, vol. 7,no. 2, pp. 80–87, 2007.
[2] L. Ahlström and M. Zahra, "Integrating a Greenhouse in an Urban Area," (Unpublished Master's Thesis).Chalmers University of Technology,Göteborg, Sweden., 2011.
[3] R. Albajes *et. Al*. "Building bridges: an integrated strategy for sustainable food production throughout the value chain," Mol. Breed., vol. 32, no. 4, pp. 743–770, Dec. 2013.