Vertical farming using Controlled Environment Agriculture (CEA) technology with IoT

Sowmya G. J.
Assistant Professor,
Department of EEE,
RR Institute of Technology Bangalore, India

Sunanda C. V.
Assistant Professor,
Department of EEE,
RR Institute of Technology Bangalore, India

Anusha D. Y.
Assistant Professor,
Department of EEE,
RR Institute of Technology Bangalore, India

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. 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.

Keywords: Index Terms—Vertical farming,soil moisturecontrol, water contentcontrol, Thingspeak,MATLAB, Internet of Thing.

INTRODUCTION:

Vertical farms are designed to grow plants in the high-tech house that normally inhabit the buildings in the middle of the city. It is a modern agricultural system that is enclosed with a controlled level of climate complete that vertical farming is no longer dependent on large-scale land use which eliminates the external environmental factors such as traditional agriculture. It is noted building that has lifted global climate without taking into account the current climate as the rainy season, winter, and so on.

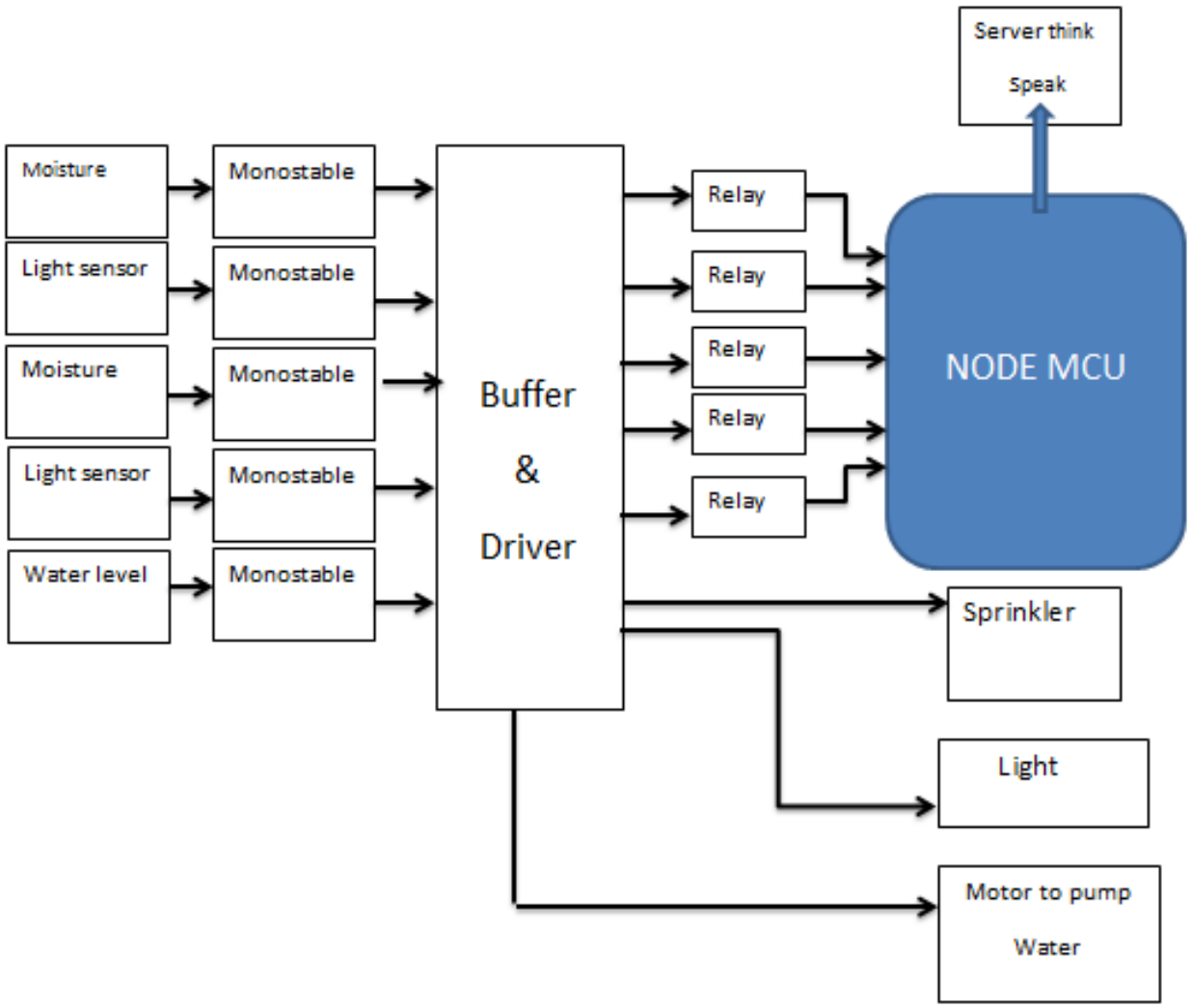
Vertical farming also contributes to the reduction of burning issues during land preparation. Vertical farms could produce crops that are grown with an incredible contained environment that can be described as genetic engineering in agriculture. Agriculture is very important to the population and agriculture advantage is quite obvious from the perspective of the population. Vertical farming allows areas with the mainland to return to the natural landscape. It can also reduce pest populations.

Vertical farming can take advantage of the available and limited spaces that are idle or unused in the developed and advanced city. The existence of vertical farming allows food to be produced throughout the year. Also, it can create an environment that encourages sustainable urban life and good health for those who have chosen to live in the city. In the future, agriculture will no longer focus only on rural areas but more on agriculture in the city. 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.

SYSTEM DESCRIPTION AND PROPOSED BLOCK DIAGRAM:

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. Just like you can have control over other parameters like Temperature & Light. Whenever there is high temperature, the fan turns on which cools the environment and whenever there is dark the LEDs turn on. And all these data are uploaded to the web browser through Internet.



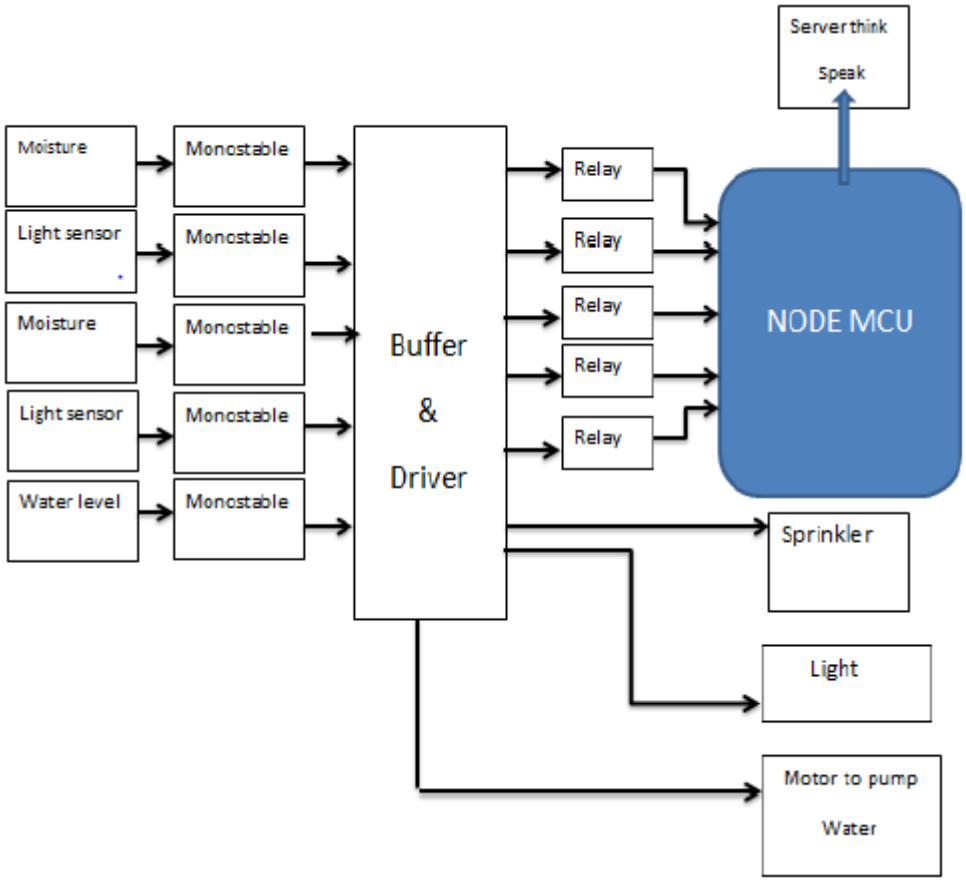
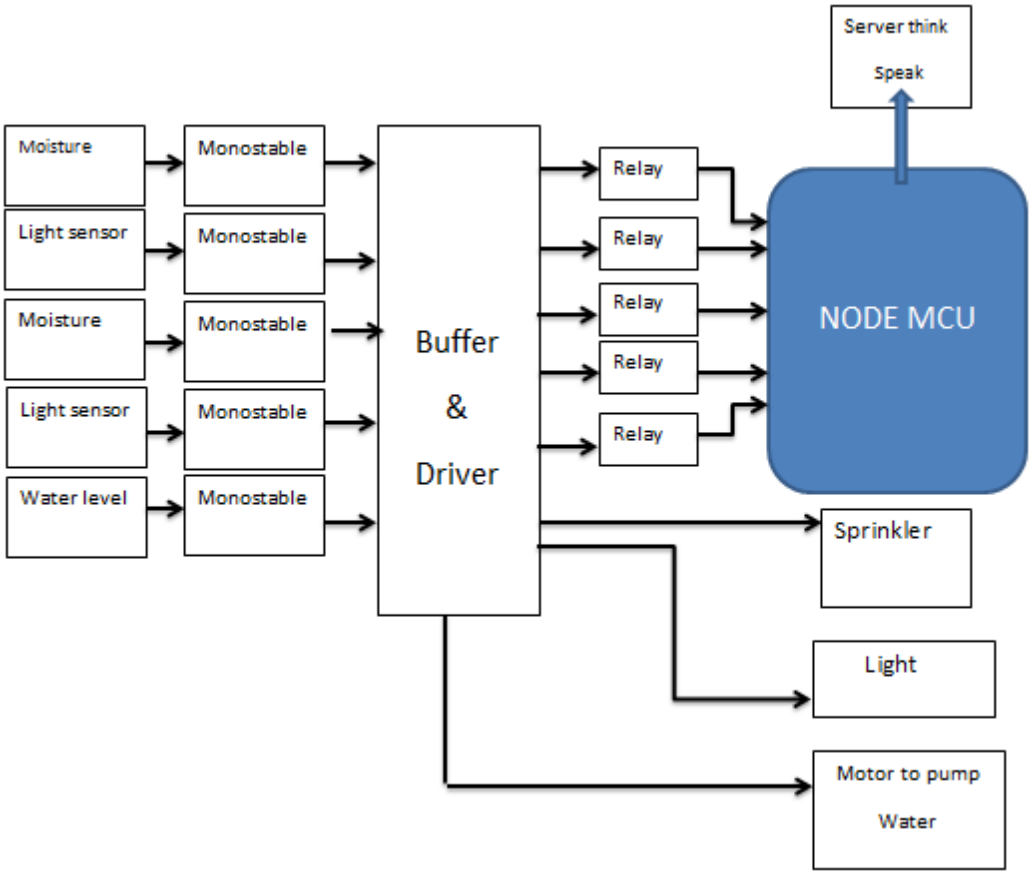


Figure: Block diagram of control circuit



MODEL DESIGN:

We can see the vertical farming model in the above picture. There are two racks we have used. Each rack is having one LDR, Soil moisture sensor, Temperature sensor, Cooling fan, LED and racks to grow plants vertically. When the soil is dry the water pump automatically turns on giving water to the plant. When the environmental temperature is very high means that it may damage the plants or decorative flowers, In that case the thermistor which is a temperature sensor detects it and turns on the cooling fan so that cooling fan is turned on since each rack is having separate cooling fan thermistor individually detects the temperature and gives the signal to the relays to turn on the cooling fan. Cooling fan is nothing but a motor in the previous section we have discussed on DC Motor. Use of artificial lights effects on the growth of the plant. If more intensity of light means the photosynthesis takes place very rapidly. During day time the sunlight light is available but during night time there will be no sunlight. So for this reason we are making use of LDR (Light Dependent Resistor) Their resistivity depends on the intensity of light we can configure it however we want. When there is light the LDR detects it and no LEDs are turned on but when there is dark the LDR detects and gives the signal to the relay circuit which turns on the LEDs giving artificial light to the plants.

Figure: Model Design

SOFTWARE IMPLEMENTATION:

Here we use c language to code NodeMCU ESP8266 and a web browser called thingspeak.com to monitor the Arduino kit.
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 ThingSpeak has integrated support from the numerical computing software MATLAB from Math Works.

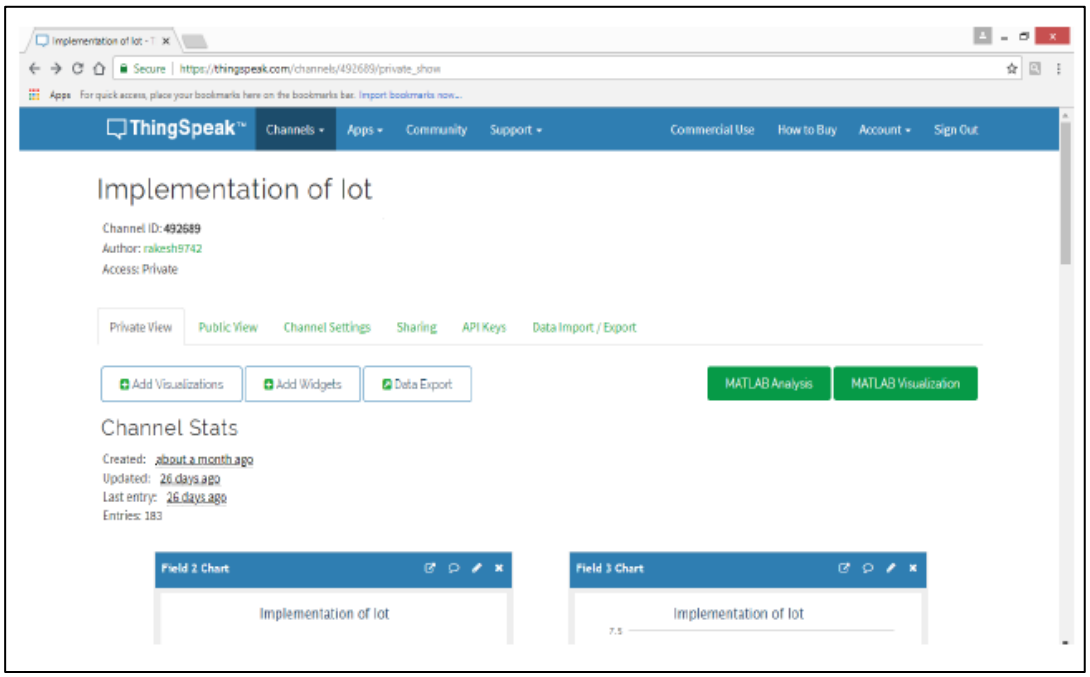


Figure: Implementation of Iot using thinspeak

RESULT:

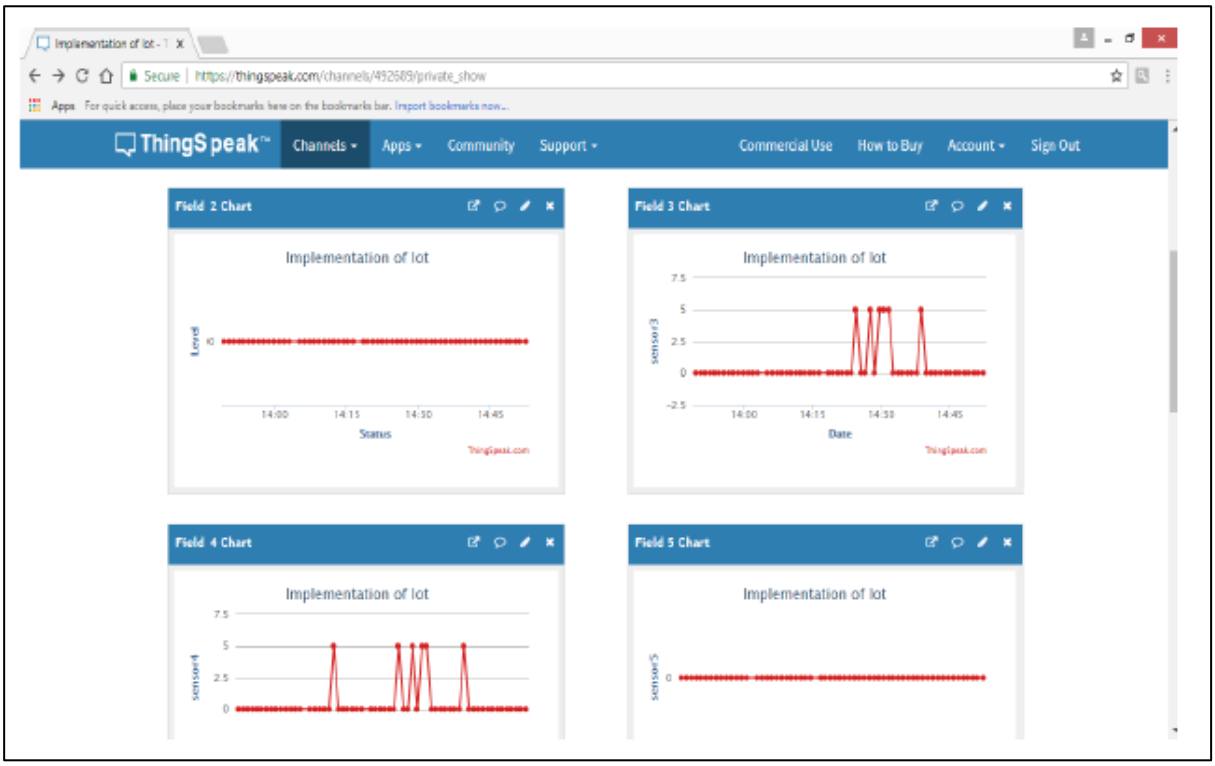


Figure: Implementation of IoT

In this project we are using thing speak as out IoT web page to display the activities of our project. Thing speak is connected to the Arduino ESP8266 Node MCU and Node MCU is programmed as requirement. Here we are using it for agriculture purpose, some parameters like Light, Temperature and Soil moisture level are monitored with this thing speak. Suppose there the temperature is very high means this data is sent to the thing speak web browser saying that the temperature of the environment is very high so the fan has to be turned on. Like this It has many more applications. We are also using artificial lights to grow plants which helps for their photosynthesis. Whenever there is no sunlight available the LDR a light dependent resistor gives information to the Arduino node MCU so that it turns on the LEDs to glow over plants.

ADVANTAGES, DISADVANTAGES AND APPLICATIONS:
ADVANTAGES:

1. Unlike traditional farming in non-tropical areas, indoor farming can produce crops year-round.
2. VF productivity is mostly independent of weather, although earthquakes and tornadoes still pose threats.

DISADVANTAGES:

1. Initial cost for the implementation of vertical farming is high
2. Requires efficient management system
3. Skilled labours are required to look over plants

APPLICATIONS:

Vertical farming has application where land available is less and where there is no regular water supply and availability of sunlight is less.

CONCLUSION:

The objectives of this project successfully achieved to develop an IoT system based on the web server to monitor and control the soil moisture, Environment temperature and Light intensity of the vertical farming. Besides that, to create a semi-automatic soil moisture control system for a vertical farming. Based on the result, a technology-based control system to control the water supply to the crops has been created. On the other hand, vertical farming can reduce the usage of the water for the watering process. It can say that because vertical farming is using the recycle water. After the farm has been watering, the excess water off the washing plant will be channeled back into the reservoir water storage. Overall, the system showed a promising result of the controlled system using a web browser with interfacing with the Ethernet shield for the indoor vertical farming application.

REFERENCES:

Dave Evans (April 2011). "The Internet of Things: How the Next Evolution of the Internet Is Changing Everything" (PDF). Cisco. Retrieved 15 February 2016.

DAVID EVANS, STRINGIFY,IoT,‖ IoT for food and water: Here‘s what the future looks like‖.[online].Available:http://venturebeat.com/2015/08/30/iot-forfood-and-water-heres-what-the-future-looks-like/

Dr. Dickson Despommier. Vertical farming takes root in urban environments‖. https://www.allianz.com/en/about_us/open.knowledge/topics/environment/articles/110 601-vertical-farming-takes-root-in-urban environments.html/, June 01, 2011

Dr. Dickson.Despommier.‖ The Vertical Farm, feeding the World in the 21st Century‖ [online]. Available:http://www.verticalfarm.com/? page_id=36

Dr.Dickson.Despommier, www.verticalfarm.com

http://www.bbc.com/future/story/20170405-how-vertical-farming-reinvents-agriculture

https://www.poplarnetwork.com/topics/vertical-farming

https://www.evergreenfarm.eu/copy-of-vertical-farming

https://www.wur.nl/en/Dossiers/file/Vertical-farming.htm

S V Devika - Arduino based automatic plant watering system International Journal of Advanced Research in Computer Science and Software Engineering, pp. 449-456 © 2014, IJARCSSE Volume 4, Issue 10, October 2014 ISSN: 2277 128X

S. V. Devika et al, Arduino Based Automatic Plant Watering System, International Journal of Advanced Research in Computer Science and Software Engineering, pp. 449- 456 © 2014, IJARCSSE Volume 4, Issue 10, October 2014 ISSN: 2277 128X

www.techtarget.com

www.verticalfarming.net
