VERTICAL FARMING USING IOT

[1]Venkat Sai.G[2]Vijay Kumar.CH[3]Raj Kumar.A
[4]Suraj Deep.CH [5]B.Sukumar

[1,2,3,4] *UG ScholorECE,NARAYANA ENGINEERING COLLEGE,Nellore*

[5] *Professor, ECE Department,NARAYANA ENGINEERING COLLEGE,Nellore*

Abstract: *The main aim of the project is a novel hierarchical control approach and new mathematical optimization models of greenhouses, which can be readily incorporated into energy hub management systems in the context of smart grids to optimize the operation of their energy systems. In vertical farming, we are monitoring soil moisture, temperature and humidity of the system. The objective is to minimize total energy costs and demand charges while considering important parameters of greenhouses; in particular, inside temperature and humidity levels should be kept within acceptable ranges. Vertical farming has numerous benefits. When connected to the IOT, a vertical farm can produce stacks upon stacks of high quality crops without the use of herbicides, insecticides, fertilizers, sunlight, soil or human intervention. IoT-connected vertical farms have dozens of crop cycles every year. Traditional farms only have three. This type of farm uses 95% less water than conventional farming and creates absolutely no run-off. Vertical farming is better for the environment and far more effective than any other type of farming. The main aim of this project is to provide a vertical farming monitoring system to help keeping track on the physical conditions of crops. In this system, varieties of sensors will be used to detect current physical conditions, and send the data to microcontroller (Raspberry pi pico) either in Analog or digital input. In this system, soil moisture sensor, temperature sensor and humidity sensors are used and the status of those sensors are displayed on LCD. Then, the data will be processed by controller and upload to the Thingspeak Cloud. The system also provide basic remote function where users could turn on/off the watering system. The web-based application will also be designed to analyse and display data gathered in the form of graphs, charts or figures, for better understanding. With the improvement implemented on the vertical farming culture, it is expected that the productivity and quality of crops would increase significantly.*

Keywords: *Vertical farming; Sensor monitoring; Cloud data storage*

I.INTRODUCTION

Vertical farming had become a hot topic among peak development countries. However, vertical farming is hard to practice because minor changes on the surrounding would leave big impact to the productivity and quality of farming activity. Thus, the aim of this project is to provide a vertical farming monitoring system to help keeping track on the physical conditions of crops. In this system, varieties of sensors will be used to detect current physical conditions, and send the data to Beagle Bone Black (BBB) microcontroller either in analog or digital input. Then, the data will be processed by BBB and upload to the Thingspeak Cloud. Furthermore, the system will record the position of equipment in used, which make it easier for maintenance when there is equipment broken down. The system also provide basic remote function where users could turn on/off the watering system, and the LED light via web-based application. The web-based application will also be designed to analyze and display data gathered in the form of graphs, charts or figures, for better understanding. With the improvement implemented on the

vertical farming culture, it is expected that the productivity and quality of crops would increase significantly. Due to the increasing of population and peak country developments, alternative options are being sought for feeding the masses, yet minimizing the land used. Water and land are both classified as finite resources. Thus, farmland need to be shrink in order to provide more land for housing and building. However, farmland is vital to produce oxygen and sustain food supplementallaroundtheworld.

II..LITERATURE REVIEW

As in [1], The Internet of Things (IOT) is an interconnected set of devices that interact with one another over wired or wireless networks. IOT is an invaluable tool and can be used to improve crop yield throughout the year. The Internet of Things (IOT) has sparked a slew of new applications in various fields.

As in [2], Alternative solutions to feed the people while using the least amount of land are being sought as a outcome of population growth and peak country developments. Vertical farming, which is also a productive method of cultivating plants, is one of the greatest recent innovations adopted in the agricultural sector to lessen the problem of land use. This project recommends an intelligent Smart Watering System (SWS) that helps small- and medium-sized fields and gardens use water wisely. More effective, clever, and smarter results are needed for enhanced farming in severe weather circumstances to make better use of the limited water resources available.

As in [3], demand for infrastructure has tremendously increased with the population growth and it has a direct impact on the availability of agricultural land. This paper presents the design of an IOT -based mobile application implemented on android studio for controlling and monitoring the growth of plants using Hydroponic vertical farming. The environmental conditions and nutritional parameters, such as temperature, humidity, TDS, pH, water level, etc., recorded from the sensors are sent to the ThingSpeak cloud.

As in [4], rapid change of climate, population explosion, and reduction of arable lands are calling for new approaches to ensure sustainable agriculture and food supply for the future. . Greenhouse agriculture is considered to be a viable alternative and sustainable solution, which can combat the future food crisis by controlling the local environment and growing crops all year round, even in harsh outdoor conditions.

As in [5], the combined consumption of fruits and vegetables in Indonesia is far below the threshold set by WHO (World Health Organization) and the Ministry of Health. The increase of population, unstable climate, and the attacks of pests also affected the production of vegetables due to the decreasing land availability for plantations and the growth quality of the vegetables.

III. EXISTING SYSTEM

The manual monitoring of farm is done and farm is also horizontal farm. Conventional farming have already acquired 80% of soil and mainly 65-70% of Global fresh water is used for soil based farming of which 45-67% is lost due evaporation and runoff. Due to undesired and constant changes in weather and environment leads to unsustainable usage of resources and would see an end with supply chain. Due to the increasing of population and peak country developments, alternative options are being sought for feeding the masses, yet minimizing the land used. Water and land are both classified as finite resources. Thus, farmland need to be shrink in order to provide more land for housing and building. However, farmland is vital to produce oxygen and sustain food supplement all around the world. One of a latest technologies introduced in agriculture field to diminish the land used issue is the vertical farming, which is also an effective way to grow plants. . When practicing vertical farming, most of the farmers would like to monitor

the farming conditions, and yet limited knowledge on data management have forced them to investigate plant conditions with naked eyes. Vertical farming uses significantly less land, making it ideal for urban areas where space is limited. Resource Efficiency: Reduces water usage and minimizes the need for pesticides and herbicides. Year-Round Production: Controlled environments allow for continuous production, independent of seasonal changes. Reduced Transportation Costs: Growing food closer to where it is consumed reduces transportation

IV.PROPOSED SYSTEM

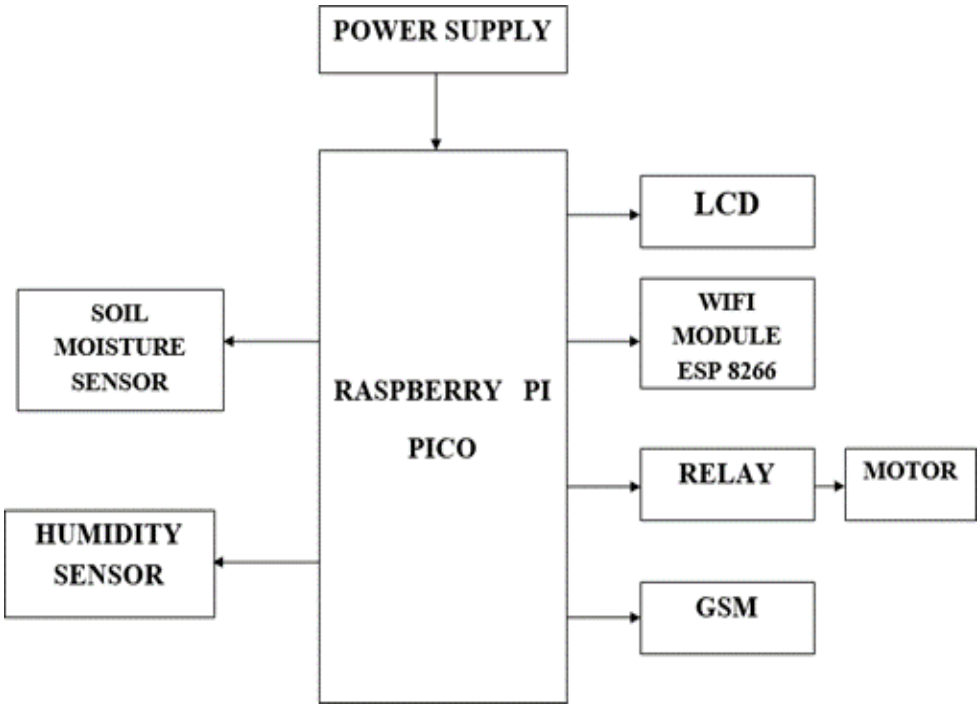

Fig.4.1. Block diagram of Vertical Farming using IOT

A. RASPBERRY PI PICO MICROCONTROLLER

The Raspberry Pi Pico is a versatile microcontroller board based on the RP2040 chip, designed by the Raspberry Pi Foundation to provide an affordable and flexible platform for embedded systems and IOT projects. The RP2040 features a dual-core Arm Cortex-M0+ processor running up to 133 MHz, along with 264 KB of SRAM and 2 MB of onboard QSPI flash memory, making it suitable for a variety of applications. ESP8266 is high integration wireless SOCs, designed for space and power constrained mobile platform designers. It provides unsurpassed ability to embed Wi-Fi capabilities within other systems, or to function as a standalone application, with the lowest cost, and minimal space requirement.

B. TEMPERATURE AND HUMIDITY MODULE DHT11

DHT11 digital temperature and humidity sensor is a calibrated digital signal output of the temperature and humidity combined sensor. It uses dedicated digital modules capture technology and the temperature and humidity sensor technology to ensure that products with high reliability and excellent long-term stability. Sensor includes a resistive element and a sense of wet NTC temperature measurement devices and with a high-performance 8-bit microcontroller connected.

C. SOIL MOISTURE SENSOR

Soil moisture sensor can be used to test the moisture of soil, when the soil is having water shortage, the module output is at high level, else the output is at low level. By using this sensor one can automatically water the flower plant, or any other plants requiring automatic watering technique. Module triple output mode, digital output is simple, Analog output more accurate, serial output with exact readings. Sensitivity adjustable. Has fixed bolt hole, convenient installation. Threshold level can be configured. Module triple output mode, digital output is simple, analog output more accurate, serial output with exact readings. Using The Sensor Connect +5v to pin 2 and ground to pin 5 and 6.Pin 4 and 5 Should be connected to particular transmitter and receiver pin of controller. Output pin may be connected to any port pins and can be used to any application, Soil moisture sensors measure the water content in soil. A soil moisture probe is made up of multiple soil moisture

D. RELAY

Neutral Relays. This is the most elementary type of relay. The neutral relays have a magnetic coil, which operates the relay at a specified current, regardless of the polarity of the voltage applied. To control a high-voltage circuit with a low-voltage signal, as in some types of modems or audio amplifiers, To control a high-current circuit with a low-current signal, as in the starter solenoid of an automobile, To detect and isolate faults on transmission and distribution lines by opening and closing circuit breakers (protection relays).

E. LCD (Liquid Crystal Display)

A liquid crystal display or LCD draws its definition from its name itself. It is combination of two states of matter, the solid and the liquid. LCD uses a liquid crystal to produce a visible image. Liquid crystal displays are super-thin technology display screen that are generally used in laptop computer screen, TVs, cell phones and portable video games. LCD's technologies allow displays to be much thinner when compared to cathode ray tube (CRT) technology

F. BUZZER

The electric buzzer was invented in 1831 by Joseph Henry. They were mainly used in early doorbells until they were phased out in the early 1930s in favor of musical chimes, which had a softer tone.

G. ESP8266 WIFI MODULE

ESP8266 WIFI module is low cost standalone wireless transceiver that can be used for end-point IOT developments.ESP8266 WIFI module enables internet connectivity to embedded applications. It uses TCP/UDP communication protocol to connect with server/client. To communicate with the ESP8266 WIFI module, microcontroller needs to use set of AT commands Microcontroller communicates with ESP8266-01 WIFI module using UART having specified Baud rate (Default 115200).

H. GSM MODULE

GSM stands for Global System for Mobile Communication. It is a digital cellular technology used for transmitting mobile voice and data services. GSM is the most widely accepted standard in telecommunications and it is implemented globally. GSM operates on the mobile communication bands 900 MHz and 1800 MHz in most parts of the world. . GSM stands for Global System for Mobiles communications. It is a digital cellular technology used for transmitting mobile voice and data services. GSM is the most widely accepted standard in telecommunications and it is implemented globally. GSM operates on the mobile communication bands 900 MHz and 1800 MHz in most parts of the world. The GSM network is divided into three major systems

I. DC WATER MOTOR

This DC 3-6 V Mini Micro Submersible Water Pump is a low cost, small size Submersible Pump Motor which can be operated from a 2.5 ~ 6V power supply. It can take up to 120 liters per hour with a very low current consumption of 220mA. Just connect tube pipe to the motor outlet, submerge it in water and power it.

V. CONNECTIONS

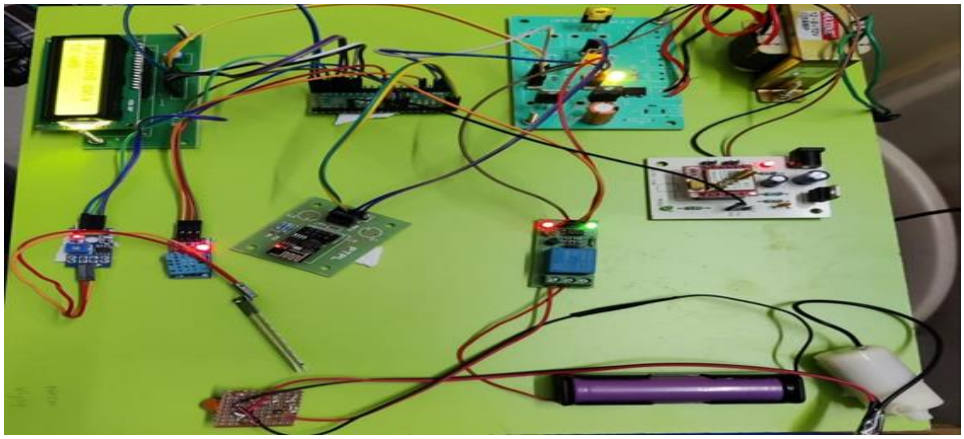

Figure 1: Here are the connections within the RASPBERRY PI PICO and difference types of sensors

VI. RESULTS AND DISCUSSION

Fig 1: Overall view of the project

Fig 2: Circuit board with vertical stacks

- From the above figure have seen that the over all setup of the project With various components and stacks in vertical manner which are connected with steel rods in that stacks, added mud and some sand which helps to grow various plants like leafy, flower plants etc with controlled manner of humidity, temperature and water.

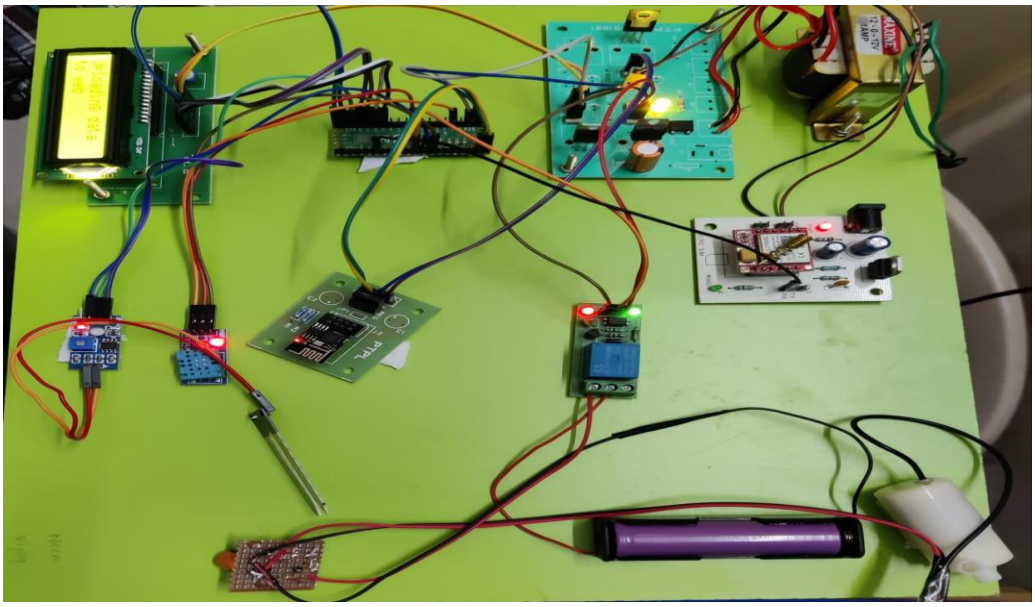

Fig 3: Circuit Board of the project

- This is the overall circuit board that used in the project which consist of various components Transformer, LCD, DHT11 sensor, Raspberry pi pico, Soil Moisture sensor, ESP8266 WIFI module, GSM, Realy, water motor.

Fig 4: WIFI module Initialization when power is on

- First by giving the power supply it gets into the first step of WIFI Module Initialization as shown in the LCD.

- In second step its start Initialization the GSM Module Which is bused the project.

Fig 6: Checks the temperature in then room and states it is in normal range

- In this step Temperature is checked in the room condition by using the DHT11 sensor and tells if it is Normal condition or if it is more than the required condition.

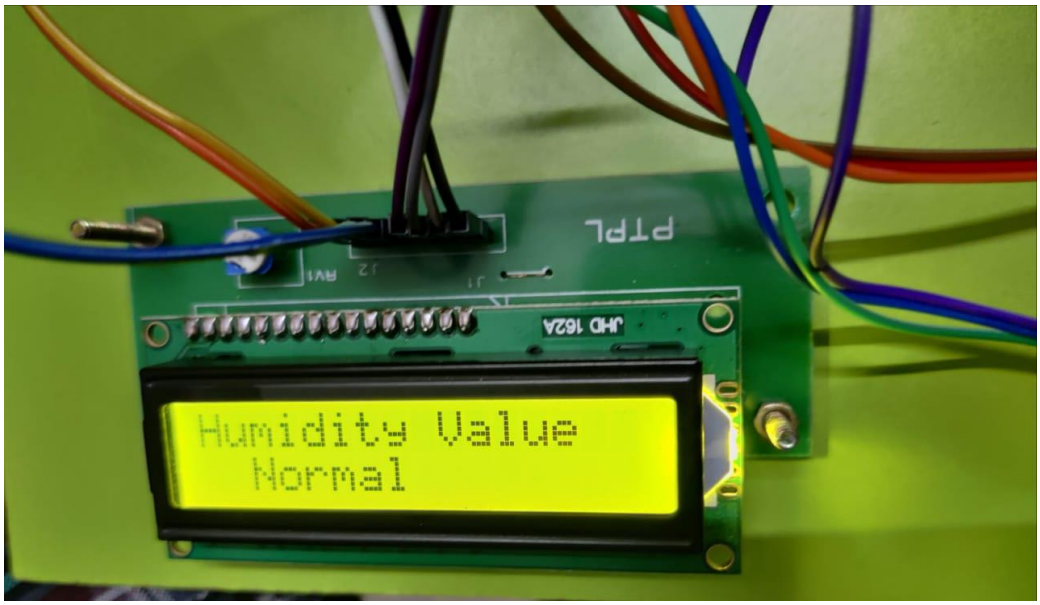

Fig 7: Checks the Humidity in then room and states it is in normal range

- In this step Humidity is checked in the room condition by using the DHT11 sensor and tells if it is Normal condition or if it is more than the required condition.

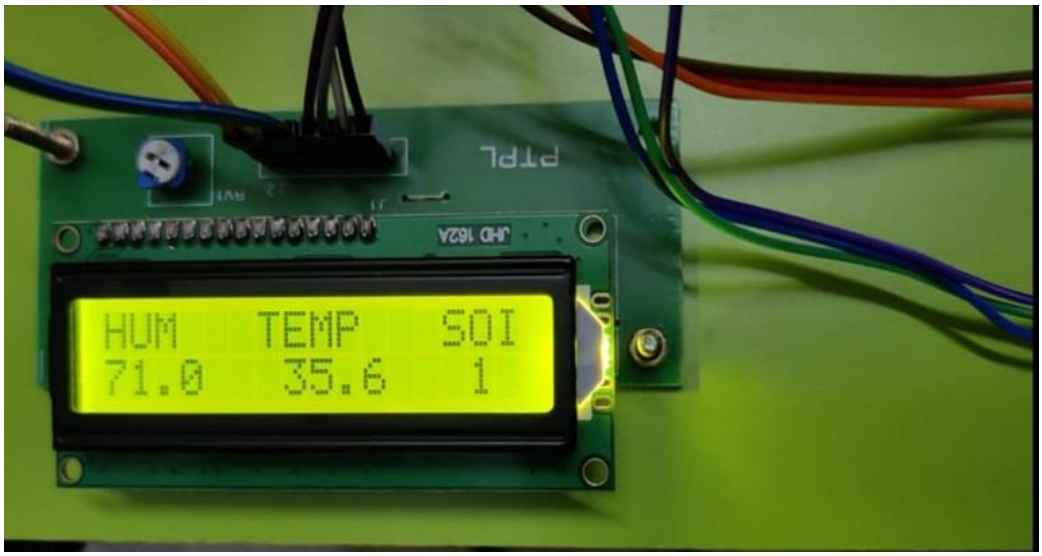

Fig 8: Checks the Temperature, Humidity in the room and the soil in the stacks and gives the values on LCD

- In above fig we can see the various parameters that are calculated in this project as shown on the LCD like Humidity, Temperature and soil Moisture.

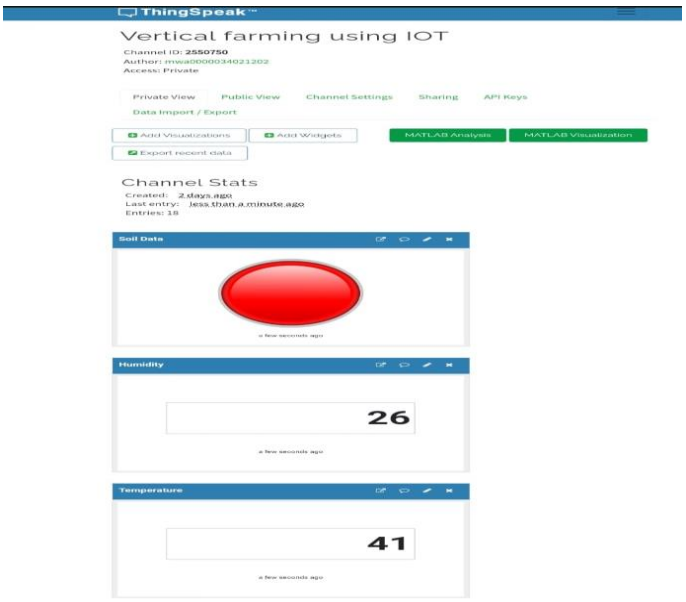

Fig 9: Thingspeek cloud website

- Which can get humidity, Temp values and motor is on or off conditions from anywhere through our mobile or PC which the WIFI module sends the data to the Thingspeak website.

Fig 10: Getting message to Phone

- If the Humidity reaches higher then given condition then GSM sends a Alert Massage to Farmer or owner of the crop states that Humidity is high at crop field similarly if the Temperature also higher than 45 degrees Celsius then the GSM sends an alert message of Temp is high at the crop field.

VII.CONCLUSION

Vertical farming, enhanced by IoT technology, offers a revolutionary approach to modern agriculture, addressing challenges like urbanization and food security. IoT allows precise control over environmental factors, optimizing plant growth and yield while minimizing resource use. This year-round production system operates independently of weather conditions, ensuring a consistent food supply. Additionally, it promotes sustainability by reducing water usage, reliance on chemicals, and transportation emissions. Urban-based production shortens supply chains, provides fresher produce, and creates job opportunities, contributing to the greening of cities. As urban populations grow, the adaptability and efficiency of vertical farming become increasingly vital. IoT-powered vertical farming exemplifies sustainability, efficiency, and resilience, with setups ranging from large commercial facilities to small residential units. Continued innovation in this field is crucial for future food security and environmental sustainability. By embracing these technologies, vertical farming will play a key role in meeting the needs of a growing global population while conserving our planet's resources.

VIII.REFERENCES

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