IoT based Verticrop Monitoring and Controlling

Nikita Patil
Electronics and Telecommunication (B.E.)
Vidyavardhini's College of Engineering & Technology (VCET), Vasai (INDIA)

Mrunal Pawar
Electronics and Telecommunication (B.E.)
Vidyavardhini's College of Engineering & Technology (VCET), Vasai (INDIA)

Urja Patil
Electronics and Telecommunication (B.E.)
Vidyavardhini's College of Engineering & Technology (VCET), Vasai (INDIA)

***Abstract*— Vertical farming Automation System with the logging of the data is the technical approach in which the farmers in the rural areas will be benefited by automatic monitoring and control of the environment in the farm. It is replaced by the direct supervision of the human. It also focuses on the Generic Architecture which can be applied for many other Automation Application. Vertical farming is a building where plants are grown in stacked fashion in a controlled manner. Nowadays due to industrialization and less availability of land there is a huge need to construct the Vertical farming which will be restricted mainly for growing plants. As the technology has become advance, we can control and monitor the multiple farms using IOT via internet from the central location. The purpose of this project is to monitor and control the environmental parameters such as temperature, moisture and the intensity of light using sensors. All this data is sent via internet to the server so the user can access it at any time. By controlling the temperature managed by the intensity of LEDs and the automatic moisture detection plant will get water at the right time in the right amount which will cause the good growth of the plants.**

I. INTRODUCTION

Vertical farming is the practice of growing crops in a commutable system that can be arranged vertically to produce more production than the traditional farms. Vertical Farming is a method of growing crops using LED lights or without soil in stacked environment building arranged in a vertical manner. It grows the plant in the optimal condition throughout the development cycle of plant. It gives protection from influences coming from outdoor environment and give more ways to control uncertainties that cannot be controlled. Nowadays, vertical farming facilities can be operated on LED lighting, humidity and temperature with sensors and controlled climate. There are many aspects of vertical farming such as population growth and their growing needs, therefore there is reduction in natural resources, etc. Most of the vertical farms use similar architecture as that of greenhouses. The continuously growing world populations and the global trend to industrialization, change of climatic conditions and pressure on natural resources are the key drivers of vertical farming.

As we know that the vertical farming system also controls and monitors the environmental parameters such as temperature, moisture, light intensity, etc. And sometimes due to the lack of knowledge among the farmers, they are not able to perform their activities accurately. They usually perform such activities on the basis of their own observation from the past and because of that it may lead to unexpected results most of the times. Therefore, in order to improve the accuracy and to get the proper results this system is used. Thus, this system is based for monitoring and controlling the system which would take care of weather inside the vertical farm. It contains Arduino UNO microcontroller, various sensors such as temperature sensor, moisture sensor, RGB LED, etc. and Wi-Fi modem for controlling and monitoring its environmental parameters. When sensors reach a certain threshold or critical value it will send the signal to microcontroller and the required action will be taken automatically.

II. OBJECTIVE

Nowadays due to metropolitanization and less land availability there is a great need to construct the Vertical Farming which will be reserved mainly for growing crops. Vertical farming Automation System with data logging is the technical approach in which the farmers in the rural areas will be benefited by automatic monitoring and control of farm environment. It replaces the direct supervision of the human. System is based on the limitation in the present monitoring system. It also focuses on the Generic Architecture which can be applied for many other Automation Application. Vertical farming is a building where plants are grown in slanted fashion in a controlled manner. With the advancement of technology, we can control and monitor the multiple farms using IOT from the central location wirelessly. We are using 8-bit micro-controller and a Wi-Fi enabled chip esp8266 for wireless iot communication to the cloud. Wi-Fi chip is based on IEEE 802.11 WLAN protocol used to send data to the Server/ IOT cloud. Cloud stores the data and displays it in graphical format for the user. Microcontroller is so selected which is having features such as UART for serial communication. ADC for analog parameter's measurement, one wire protocol working and many others. There are various sensors like moisture sensor, temperature and humidity sensor which will monitored in the environment. We are using warm LEDs to enhance the photosynthesis process of the plants. The lights are pwm, controlled for proper frequency and wavelength matching as that of sunlight. The main prototype of this project is to benefit the farmers with better crop yield.

III. INTERNET OF THINGS

Internet of things is the most commonly used and advanced technology. It can be used in almost every applications, depending from our day to day life. It is an environment in which small objects or any type of appliance could be able to get accessed or operated by internet. It basically uses IP address to make the objects accessible to the internet and then could be used according to the function.

Internet of things could be also defined as a collection of various types of sensors, controllers, resistors, capacitors and many such electronic gadgets. They can also be operated without manual assistance. It can be operated by detection and controlling of the sensors or the parameters accordingly. The results are displayed on our screen even when one is not around that particular system.

In this proposed system, the sensors detects the parameters and the data is sent to the microcontroller accordingly. Microcontroller collects all the data and sends to the thingspeak server where all the information is collected and stored. So by using the internet, the user or farmer can access those information at any time. Also, the updated data is displayed time to time, according to the changes of the environment or parameters. This system is an advancement of farming observations and controlling.

IV. RELATED WORKS

a) Smart Vertical Farming using IoT :

The implementation using IOT based monitoring which overcomes existing issues of vertical farming. The system consists of temperature, humidity, soil moisture, intensity of light and intruder detector modules. AT89C52 microcontroller takes the sensor data and take the action required. The temperature sensor LM35 is used to measure temperature in degree Celsius(◦C). The soil sensor senses the water level, if it is low then it sends the message to the farmer. If the light intensity on the LDR sensor is high it does not take in any action and if the light Intensity is less the series of led lights will be on. PIR sensor checks whether there is any intruder or not. GSM system is used to send the SMS to the farmer to inform about the water provision. Red and blue LED strips are provided to maintain the intensity of light for the crop yield.

b) Smart Vertical Farming Using Hydroponics :

The hydroponic technology is used for a vertical farm in which the plants will be grown in a vertical pipe stack. The temperature and humidity inside the module is continuously monitored using sensors and is passed to the ATmega8 microcontroller. The magnetic float switches monitor the liquid level inside the pipes and the solenoid valves controlled the liquid level inside the pipes. The temperature is controlled by using bulb and fan arrangement using PLC. The LED strips of blue and red light were pasted on the walls of the side of the frame and the pink light is produced. The pink light is absorbed by the plants during the photosynthesis process.

c) IoT implementation for indoor vertical farming watering system:

The practice of planting plants vertically arranged in layers which enhances the usage of the land as it can be implemented in the indoor environment. The environment control is provided by implementing an automatic system which consist of internet of things. The main idea of this project is to control content of water and monitor soil moisture using moisture sensor through web browser on mobile, laptop or other compact devices. When the moisture is low, the signal is sent to the Arduino software and the user can be able to view the signal. The data is stored in the Arduino software and sent through the ethernet to the web browser. It can be monitored and controlled by the user through web browser.

V. IOT BASED VERTICROP MONITORING AND CONTROLLING

Proposed system block diagram shown in fig. 1 uses an 8-bit microcontroller and a Wi-Fi enables chip. Microcontroller is so selected which is having features such as UART for serial communication, ADC for analog parameter's measurement, one wire protocol working and many others.

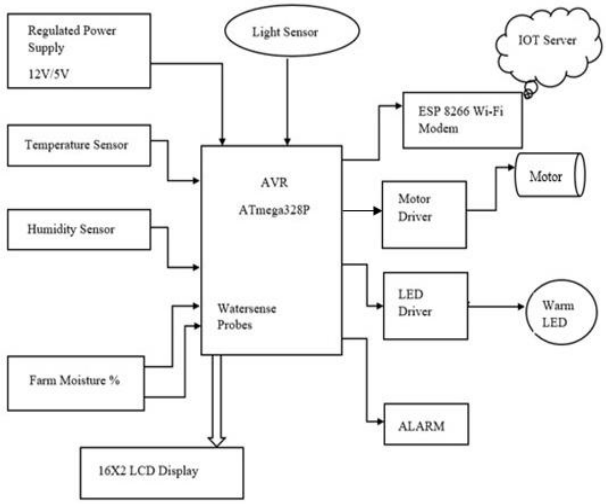

Fig. 1. BLOCK DIAGRAM OF IOT BASED VERTICROP MONITORING AND CONTROLLING

Wi-Fi chip is based on IEEE 802.11 WLAN protocol used to send data to the Server/ IOT cloud. Cloud stores the data and displays it is graphical format for user. Moisture sensor is based on conductivity of soil, which measures the moisture and microcontroller converts the voltage to digital format. DHT11 digital temperature and humidity sensor is also used to measure present humidity and temperature in environment. Warm LED lights are used to enhance the photosynthesis process of plants. Lights are pwm, controlled for proper frequency and wavelength matching as that of sunlight. Basically, we interface our esp8266 Wi-Fi modem with microcontroller through serial communication which involves three wires RX, TX and Ground respectively. AT (attention command) such as eg. AT+RST, AT+CIP etc. are used to make communication between Wi-Fi modem, microcontroller and IOT cloud server.

Detailed working of each section:

a) Power supply section:

Power supply is essential part of any project. Steady and constant DC power is required for flawless running of any system/project. We have designed the DC constant regulated power supply using following components.

1. 1N4007/Rectifier Diodes
2. Slide Switch

3. LED 5mm
4. 330ohm resistor
5. DC Terminal block/jack
6. 220uF Filter capacitor
7. 7805 5V constant voltage regulator
8. 10uF filter capacitor
9. 100pf ceramic capacitor

Initially AC 12V or DC 12V input is given at the input of terminal/DC jack; Bridge rectifier converts this AC voltage into fluctuating DC voltage. To remove ripple from this DC signal we use filter capacitor. 220uF capacitor filters the DC signal. All project components like microcontroller, buzzer, LCD and sensors works on 5V, hence this 12V needs to be converted to 5V using constant voltage regulator using 7805 regulators. 5V output of 7805 regulators is again filtered using 10uF and 100pF capacitor to get smooth, constant and steady 5V DC supply. One LED and resistor are connected at the output side of 7805 as a power on indication LED.

b) 16X2 LCD:

LCD is used in project to display the various parameters in the running project. Usually LCD is provided as a human interface device. Whatever process is going on that should be displayed on the LCD. All the command and values of different sensors are displayed on the 16X2 lines of LCD for user to see them physically changing and appearing time to time. The 16X2 LCD has 2 rows and 16 columns of character lines. It has in total 16 pins as shown below; in this LCD each character is displayed in a 5×7-pixel matrix.

c) RS (Register select):

A 16X2 LCD has two registers, namely, command and data. The register select is used to switch from one register to other. RS=0 for command register, whereas RS=1 is for data register.

d) Command Register:

The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. Processing for commands happens in the command register.

e) Data Register:

The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD. When we send data to LCD it goes to the data register and is processed there. When RS=1, data register is selected.

f) Atmega328P-PU Microcontroller:

ATmega-328 is basically an Advanced Virtual RISC (AVR) micro-controller. It supports the data up to eight bits. ATmega-328 has 32KB built-in memory. ATmega 328 consists of 1KB of Electrically Erasable Programmable Read Only Memory (EEPROM). This property shows that if the electric supply supplied to the micro-controller is removed, it can store the data and can provide results after giving the electric supply. ATmega-328 is mostly used in Arduino. ATmega328 is an 8-bit and 28 Pins AVR Microcontroller which is manufactured by Microchip. It follows RISC Architecture and has a flash type program memory of 32KB. It has 8 Pin for ADC operations, which all combines to form Port (PA0 – PA7). It also consists of 3 built-in Timers; two of them are 8 Bit timers while the third one is 16-Bit Timer. Arduino UNO is based on atmega328 Microcontroller. It's UNO's heart. It operates in the range from 3.3V to 5.5V but normally we use 5V as a standard. It consists of excellent features which include the cost efficiency, low power dissipation, programming lock for security purposes, and real timer counter with separate oscillator. It's normally used in Embedded Systems applications.

g) Crystal oscillator:

For microcontroller to work properly it requires 3 things Power supply, Reset and Clock this three things are necessary for it to work. Clock is taken from external crystal oscillator which is usually 16 MHz or 11.0592 MHz Quarts crystal oscillator. Along with crystal 2 ceramic capacitors are connected to filter out the noise in oscillations. Once clock is given to the controller its software starts executing as per the prescalar or machine cycle rate.

h) Reset circuit:

As we said above microcontroller to work properly it requires 3 things Power supply, Reset and Clock, after clock RESET circuit is also very important. There are two types of reset circuits, one is power on reset which uses one capacitor and resistor RC network to provide a small duration pulse to the reset pin of controller and another is reset switch which is need to be pressed manually to reset the microcontroller, once microcontroller is reset it starts executing the program from 0X00000000 memory location.

i) Buzzer Circuit:

Buzzer is used as alarm to make user of project/system alert about some parameter for eg. In case voltage exceed or fire is detected then buzzer must produce a beep sound to tell user that something is wrong

j) Transistor as driver:

Usually microcontroller pins cannot provide the high current required to drive the devices like motors, relays or even high watt LED's. In such situation the driver is used. A simple NPN transistor like BC547 or 2N222 can be used as a current amplifier which can drive loads up to 800mA. Also voltage such as 9V, 12V can be applied as per the convenience of driving the external device. Simple common emitter configuration with transistor as a switch application is used in a project to drive the different loads such as relay's, buzzers or LED's etc.

k) Relay (5V/12V):

Relay is basically used to isolate the low power circuit from high power circuit. Usually relay is used in between low power DC system and a high power AC load system. Not only DC-AC isolation but it can also be used to provide isolation between low voltage DC like 3.3v and 12V devices such as 12V motor pump, 230V ac lamp can be driven using a SPDT (simple pole double throw) relay.

l) Moisture sensor:

Moisture is a parameter which can be measures in term of conductivity of a Probe/metal. In our case we are using a tined PCB with zigzag pattern printed on it. This pattern basically provides a certain resistance to the probe. So when this PCB/probe is inserted into a moisture soil, its resistance decreases and conductivity increases. This sensor is configured in a voltage divider arrangement to make the voltage difference measurable. The output of this sensor is nothing but the voltage corresponding to the moisture of soil. Higher the voltage higher the moisture in soil. This voltage is an analog signal which is then converted into a digital signal in order to

measure it using microcontroller. Our microcontroller has inbuilt ADC (analog to digital converter) of 10bit which converts the value of moisture level in the range of 0 to 1023. 0 is lowest moisture or dry soil and 1023 means highest moisture or completely wet soil.

m) DS18B20 Temperature sensor:

The DS18B20 digital thermometer provides 9-bit to 12-bit Celsius temperature measurements and has an alarm function with nonvolatile user-programmable upper and lower trigger points. The DS18B20 communicates over a one-Wire bus protocol that by definition requires only one data line (and ground) for communication with a microprocessor. Each DS18B20 has a unique 64-bit serial code, which allows multiple DS18B20s to function on the same one-Wire bus protocol. Thus, it is simple to use one microprocessor to control many DS18B20s which are distributed over a wide area.

Features:

Measures Temperatures from -55°C to +125°C (-67°F to +257°F)

±0.5°C Accuracy from -10°C to +85°C

Programmable Resolution from 9 Bits to 12 Bits

n) PC817 (opto-isolator):

Optical isolator is used to isolate the low power and critical circuits such as microcontroller from high power or rather switching devices like relays, motors or MOSFET's. Devices like relays and motors may produce a back emf or short spike or high voltage which can make damage to our main system (microcontroller. Which microcontroller give a high signal LED gets on which makes transistor to be ON and then that transistor is used to drive the load or relays which may ultimately drive the another big load. Here in our project as we are interfacing high power energy meter with the microcontroller to avoid any mishap with the circuit we are optically isolating it.

o) ESP8266 Wi-Fi Modem:

The ESP8266 ESP-01 is a Wi-Fi module that allows the microcontrollers to access a system to a Wi-Fi network. It is a small chip by which a system can get access to the internet which may or may not include microcontroller to manipulate inputs or outputs. Depending upon the version of the ESP8266, it is possible to have up to 9 General Purpose Input Output (GPIOs). So by using this small chip, various types of functions can be done, and it can almost be used in any and every type of circuitry. The Wi-Fi is a very important parameter in today's generation. And it can be easily installed and readily used in any system.

p) 2N222 Transistors:

Three 2N222 NPN transistors are used in a circuit to switch the high watt LED lamp between colors like RED, GREEN and BLUE. Even using a PWM technique and gate voltage control the intensity of LED's can be changed to make different colors out of it.

VI. ADVANTAGES OF THE PROPOSED SYSTEM

The proposed system is going to play an important role in future of agriculture system and hopefully it would going to help in boosting the efficiency of growth and production of agriculture industry. Apart from that some of the important advantages of the proposed system are listed below.

a) The plants are not affected by weather changes.
b) It increases crop yield.
c) It gives better quality of the produced crops.
d) In future, the population will increase incredibly, resulting in the reduction of lands. This particular system can be increased to a large extent even in a small amount of land by just by increasing number of floors.
e) It can give more productivity, even with very less usage of land.
f) The water in the system can be reused. The excessive water from the soil can be drained back to the motor, which will result in saving plenty amount of water.

VII. CONCLUSION AND FUTURE SCOPE

A very effective and useful way of farming can be constructed if this proposed system is used widely. Farming does not necessarily require outdoor parameters like sunlight or rainfall for yielding of crops. It can be monitored and controlled even indoors by varying a few parameters. For example, the instead of the sunlight, the LEDs can be controlled by using a pwm signal to give the intensity as that of sunlight and it doesn't have to wait for rainfall. The motor pump can be used to maintain a proper moisture level of the soil. In this way the plants can also be saved from irregular climate changes and can be continuously grown in a specific manner. This system is very useful from future point of view as the land is going to be reduced. Also, the IoT makes it more easy to control and monitor the yeilds, which will give better output as compared to that of present even if one is not around the building of vertical farming.

VIII. RESULT

The Internet of Things is used to detect the parameters like temperature and soil moisture and the values are displayed on the thingspeak. When the moisture level of the soil is low, the sensor detects it and it is displayed on the thingspeak as well as on the LCD screen and it automatically switches on the pump which will also be indicated on the thingspeak.

The plants when exposed to sunlight gives better results than the RGB LED combination. But the water is to be given manually.

Due to automatic moisture detection, the plants get right amount of water at the right time, which causes good growth of the plants. Also, the temperature is managed by the intensity of RGB LED.

REFERENCES

The template will number citations consecutively within brackets [1]. The sentence punctuation follows the bracket [2]. Refer simply to the reference number, as in [3]—do not use "Ref. [3]" or "reference [3]" except at the beginning of a sentence: "Reference [3] was the first ..."

Number footnotes separately in superscripts. Place the actual footnote at the bottom of the column in which it was cited. Do not put footnotes in the abstract or reference list. Use letters for table footnotes.

Unless there are six authors or more give all authors' names; do not use "et al.". Papers that have not been published, even if they have been submitted for publication, should be cited as "unpublished" [4]. Papers that have been accepted for publication should be cited as "in press" [5]. Capitalize only the first word in a paper title, except for proper nouns and element symbols.

For papers published in translation journals, please give the English citation first, followed by the original foreign-language citation [6].

[1] G. Eason, B. Noble, and I. N. Sneddon, "On certain integrals of Lipschitz-Hankel type involving products of Bessel functions," Phil. Trans. Roy. Soc. London, vol. A247, pp. 529–551, April 1955. *(references)*

[2] J. Clerk Maxwell, A Treatise on Electricity and Magnetism, 3rd ed., vol. 2. Oxford: Clarendon, 1892, pp.68–73.

[3] I. S. Jacobs and C. P. Bean, "Fine particles, thin films and exchange anisotropy," in Magnetism, vol. III, G. T. Rado and H. Suhl, Eds. New York: Academic, 1963, pp. 271–350.

[4] K. Elissa, "Title of paper if known," unpublished.

[5] R. Nicole, "Title of paper with only first word capitalized," J. Name Stand. Abbrev., in press.

[6] Y. Yorozu, M. Hirano, K. Oka, and Y. Tagawa, "Electron spectroscopy studies on magneto-optical media and plastic substrate interface," IEEE Transl. J. Magn. Japan, vol. 2, pp. 740–741, August 1987 [Digests 9th Annual Conf. Magnetics Japan, p. 301, 1982].

[7] M. Young, The Technical Writer's Handbook. Mill Valley, CA: University Science, 1989.