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IoT Based Real Time Monitoring and Automation for Plant Growth Environment

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KEYWORDS

IoT, Raspberry PI3, Greenhouse,

ABSTRACT

Greenhouses are climate controlled structures with walls and roof specially designed for offseason growing of plants. Most greenhouse systems use manual systems for monitoring the temperature and humidity which can cause discomfort to the worker as they are bound to visit the greenhouse every day and manually control them. Also, a lot of problems can occur as it affects the production rate because the temperature and humidity must be constantly monitored to ensure the good yield of the plants. Internet of Things is one of the latest advances in Information and

Communication Technologies, providing global connectivity and management of sensors, devices, users with information. So the combination of IoT and embedded technology has helped in bringing solutions to many of the existing practical problems over the years. The sensors used here are

YL69 moisture sensor and DHT11 (Temperature & Humidity sensor). From the data's received, Raspberry PI3 automatically controls Moisture,

Temperature, Humidity efficiently inside the greenhouse by actuating an irrigating pipe, cooling fan, and sliding windows respectively according to the required conditions of the crops to achieve maximum growth and yield. The recorded temperature and humidity are stored in a cloud database (ThingSpeak), and the results are displayed in a webpage, from where the user can view them directly.

1. INTRODUCTION

A greenhouse can be defined as a closed structure which is used to protect the plants from external factors such as climatic conditions, pollution, etc. It offers a sustainable and efficient development of the plants throughout the year. Basic factors affecting plant growth are sunlight, water content in soil temperature, humidity etc. Numerous researchers have worked with water

sprinkling and irrigation system. They opted for different methods for determining the soil moisture condition. An article on the automated water supply system for urban residential areas showed that their system can be used to effectively manage water resource. Required physical factors are hard to control manually inside a greenhouse so there is a need for the automated system [5]. Many smart irrigation systems have been proposed and devised through

Evapotranspiration (ET), thermal imaging, capacitive methods, and neutron scattering method and gypsum blocks are some of the technologies that enable moisture sensing. Capacitive sensors, however instantaneous are costly and need to be calibrated often with varying temperature and soil type [2] [3]. G. Parameswaran et al. proposed

"Arduino based smart irrigation system using Internet of Things" [11]. Kim et.al published a work on control of irrigation with distributed wireless sensor network [7]. K S. Nemali et al. Proposed irrigation systems which are also automated through information on volumetric water [9].

Chandankumar Sahu et al. proposed a system on "A Low Cost Smart Irrigation Control System" where the sensors are integrated with ESP8266 and the data received by ATMEGA-318 microcontroller which is on the ARDUINO-UNO development board [8]. Internet of things is a growing technology of the hour which enables us to access different data's from any remote location as well.In this paper, our proposed system receives three parameters from the sensors and activates the actuators if the actual values are more than the threshold values and also stores these values in the cloud database enabling them to be accessed from anywhere, anytime. This paper also sheds light on the automatic control over the climatic conditions inside the greenhouse. There are different seasonal crops which can be grown only under certain conditions. Onions, garlic, shallots etc. are the winter crops which require cold conditions for their growth. Cucumbers, melons etc. are the summer crops which require moderate or hot climatic conditions.The prototype we used comprises of moisture sensors, temperature & humidity sensors, Raspberry PI and water pipes to supply water from tank controlled by DC motors. Moisture sensors (YL 69) are installed near the roots temperature& humidity (DHT11) sensor is installed further away to detect the temperature and humidity. These sensors send their data to the Raspberry PI to analyze the results. The Raspberry PI will turn the inlet value on, to water the spinach, until the soil moisture value becomes greater than the threshold value. Inside the greenhouse, if the temperature and humidity values are above the reference value (calculated according to the crop – spinach),to maintain them to be within the threshold levels, sliding door will be opened and fan will be switched ON.The existing system [6] consists of Manual Monitoring of the agricultural field parameters and the use of the GSM technology will take more time to get the required results. So in order to overcome that we have proposed more organized and

automated monitoring of the crops by controlling different parameters inside the greenhouse. The Internet of Things is regarded as the third wave of information technology after Internet and mobile communication network, which is characterized by more thorough sense and measure, more comprehensive interoperability and intelligence.

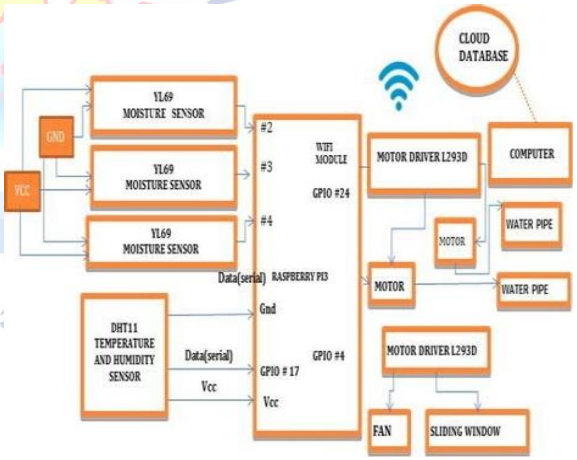

FIG 1.1 BLOCK DIAGRAM

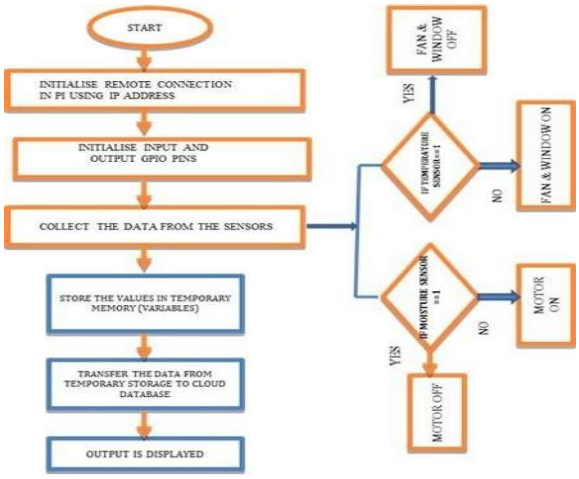

Fig 1.2 FLOWCHART

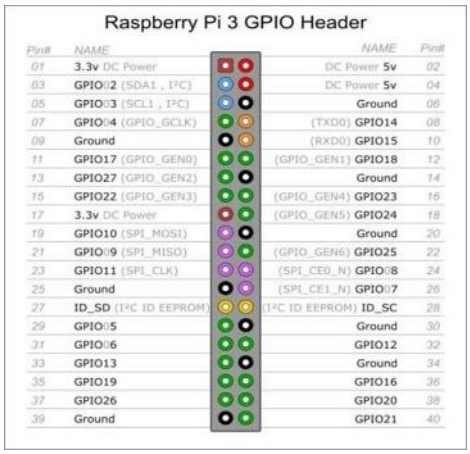

Fig 1.3 PIN DIAGRAM OF RASPBERRY PI 3

II.MODULES DESCRIPTION

From the above figure 1.1 we can see the hardware required for this project

a) Raspberry PI 3,
b) moisture sensor YL69,
c) DHT11 Temperature and humidity sensor,
d) Motor driver IC l293d and
e) Coolers and sliding windows.

A) Moisture sensor (YL69) The YL69 is an inexpensive soil moisture sensor used to detect the amount of moisture content present in the soil. The operating voltage is 3.3v to 5v and current is 35mA.This sensor consists of two electrodes which when comes in contact with the soil the voltage fluctuates i.e. the output voltage decreases when the moisture is present and the output voltage increases when the soil is dry [4].

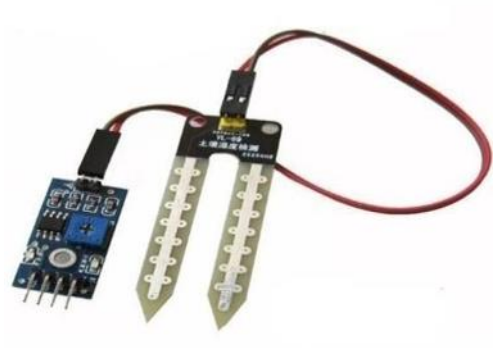

Fig 1.4 YL69 MOISTURE SENSOR

B) Temperature & Humidity sensor (DHT11)

DHT11 is one of the basic affordable digital sensors which can measure temperature and humidity. It has an operating voltage of 3 to 5 volts & max-current of 2.5mA.The temperature range lies between 0°C to 50°C, while the humidity percentage ranges between 20% to 80%. It consists of a thermistor which employs Negative Temperature Coefficient (NTC) and a humidity sensing component to detect the moisture in the air

Fig 1.5 DHT11 TEMPERATURE & HUMIDITY SENSOR

C) Cooling Fan

Coolers and sliding windows are installed on the side walls of a greenhouse to maintain the temperature and to regulate the airflow within the green house.

Fig 1.7 COOLING FAN III.METHODOLOGY

To always sustain a suitable climate inside the greenhouse and to retain appropriate moisture content in the soil we have designed an automatic temperature control and irrigation system by monitoring the parameters temperature, humidity and soil moisture content using the temperature & humidity sensors (DHT11) and moisture sensors (YL69).The Whole Area inside the greenhouse is divided into multiple sections and one moisture sensor is placed in each section. The output of these moisture sensors is given to GPIO pins 2, 3, 4 of Raspberry PI. The output from PI is given to the driver IC which in turn operates the motor ON or OFF. The experimental plant used is Spinach. Soil Humidity - 50% Air Humidity- 14% Temperature - 250c To the GPIO pin 17 of Raspberry PI, the serial output of the DHT11 sensor is connected. We have calculated a threshold value by the formula given below.

(Threshold value) I dx = Temperature+
(Humidity*0.1)
=25+ (14*0.1)
=26.4

If the temperature and humidity value exceeds the threshold value, then the cooling fan and sliding windows which are connected to l293d IC are automatically turned ON, thereby maintaining the humidity and temperature in the closed Green House system. The collected temperature and humidity data's are sent to a Thing speak cloud through Wi-Fi connectivity.

IV. REMOTE MONITORING

Nowadays, billions of IoT devices, e.g., sensors and RFIDs, arise around us providing not only computing intensive, but also delay-sensitive services, ranging

from augmented/virtual realities to distributed data analysis and artificial intelligence [6].Internet of things is a concept where each device is assigned an IP address and through that address, anyone makes that device identifiable on the internet. Nowadays internet is an evolving entity which started as the internet of computers. The major elements of IoT based greenhouse monitoring and automation systems are Raspberry PI, Relay as switch along with their driver circuits. This removes human interaction with machines and makes it technically possible and desirable in various domestic processes by replacing it with programmed electronic systems. Ultimately it is a system that aims to increase the quality of life with the automation of appliances that may be controlled over the internet.

A)Communication With Thing Speak With the help of inbuilt Wi-Fi module, the data's collected are uploaded to the Thing Speak Cloud platform. We can visualize the data's in the form of beautiful charts which features real-time updates. Using Thing Speak IoT platform, we can continuously upload and monitor real-time data which will be very useful for the farmers.

B) ThingSpeak Cloud

It is an IoT platform that is designed to enable meaningful connections between people and things. It features real-time data collection, data analysis, data processing, data visualization using a connected Social Networking Service (SNS) via an open source API to support various platforms. It helps to easily transfer data from embedded devices such as Arduino, Raspberry PI, NodeMCU, etc. Also, it supports various languages and environments. Our proposed system reads and sends sensor data using ThingSpeak. The main objective is to design and implement an automated system and to visualize sensed information as charts. The data obtained can be seen globally anywhere, anytime.

C) Presentation

To present the data in a useful form a webpage or APP can be developed. In our proposed system we have developed a webpage using HTML and CSS. To upload the data's into the cloud platform, we have the option of creating a separate account in the ThingSpeak Cloud. When logged in, we created a new channel by selecting Channels >My Channels and then Create New Channel. The channel has its own unique API key which is used to identify the channel while reading or uploading data. The API allows making visualizations to be updated in real time. Each channel has up to eight fields where data can be stored as well as four additional fields for location details. All entries are stored with a unique identifier and a date and time stamp.

V. RESULTS AND DISCUSSION

A) HARDWARE SETUP

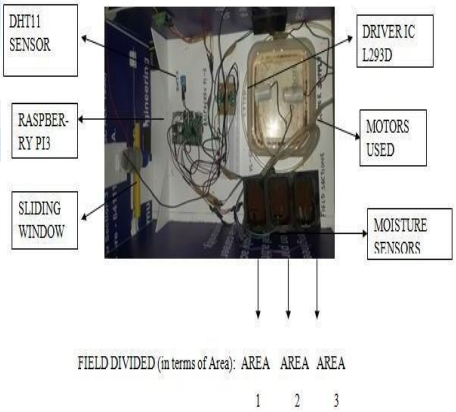

Fig 3.1 HARDWARE

SETUP VISUALISATION OF RESULTS

Fig 3.3 RESULTS DISPLAY ON THE SECOND PAGE

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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