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IoT based Automated Greenhouse Monitoring & Controlling System

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Abstract - *The aim of this paper is to design a greenhouse monitoring and controlling system based on the internet of things (IOT). A greenhouse is a covered area where plants grow and cultivate. It is also known as land of controlled crops and plants. There are some important parameters to be monitored inside the greenhouse are temperature, light, and harmful gases etc. It will start monitoring when its sensor is connected to the wireless embedded system.*

***Key Words*: *Keywords*-**IoT, ARDUINOIDE SOFTWARE Greenhouse, ThingSpeak, ARDUINO UNO microcontroller

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]. Wi-fi along with IOT 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, arduino uno , and water pipes to supply water from tank controlled by DC motors. Moisture sensors (YL 69) are installed near the roots and temperature & humidity (LM35) sensor is installed further away to detect the temperature and humidity to analyze the results. if the temperature and humidity values are above the reference value,to maintain them to be within the threshold levels, collingfan 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.

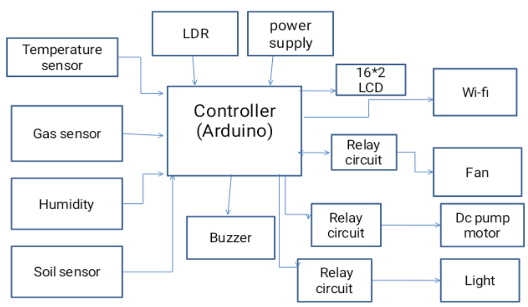

Fig-1: Block diagram

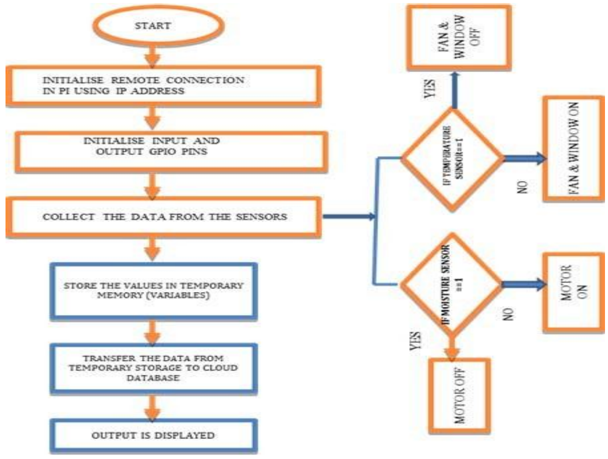

Fig-2: Flow chart

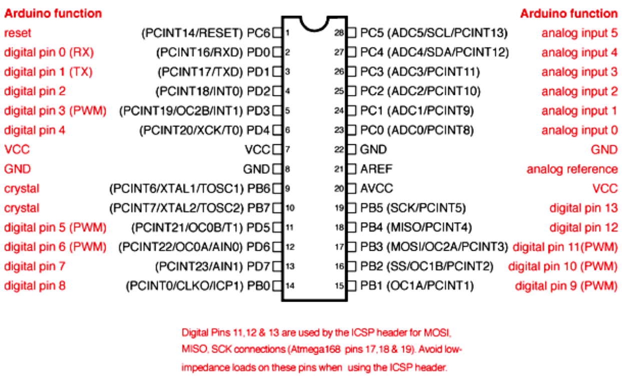

Fig-3: Pin Diagram of Arduino uno

1.1 Modules description

From the above figure 1.1 we can see the hardware required for this project a) ARDUINO UNO , b) moisture sensor YL69,

c) LM35 Temperature and digital humidity sensor, d) Motor driver IC l293d and e) Coolers ,gas sensors & LDR.

ARDUINO UNO

The heart of our project is the ARDUINO UNO. The Arduino Uno is an open-source microcontroller board basedonthe Microchip ATmega328P microcontroller and developed by Arduino.cc The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable. It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between The hardware reference design is distributed under a Creative Commons Attribution Share-Alike 2.5 license and is available on the Arduino website. Layout and production files for some versions of the hardware are also available.

1.2 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]

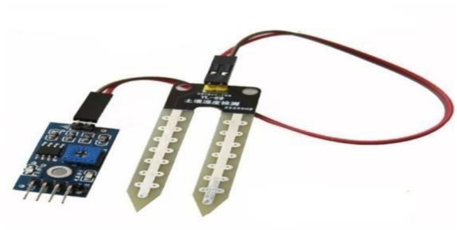

Fig-4: YL69 MOISTURE SENSOR

1.3 Temperature & Humidity sensor

LM35 is a precession Integrated circuit Temperature sensor, whose output voltage varies, based on the temperature around it. It is a small and cheap IC which can be used to measure temperature anywhere between -55°C to 150°C

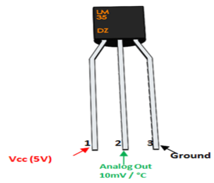

Fig-5: Digital Humidity Sensor

A digital humidity sensor works via two micro sensors that are calibrated to the relative humidity of the given area. These are then converted into the digital format via an analog to digital conversion process which is done by a chip located in the same circuit. A machine made electrode based system made out of polymer is what makes up the capacitance for the sensor. This protects the sensor from user front panel (interface).

Fig-6: LM35 TEMPERATURE & HUMIDITY SENSOR

1.4 Motor driver IC L293D

L293D is a 16pin motor driver IC which has the ability to run two DC motors on both directions concurrently. DC motors cannot run directly without the use of a driver IC. Hence L293D crucially assists the motor to run.

Fig-8: MOTOR DRIVER IC L293D

1.5 Coolers and Gas sensor

Coolers

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

Gas Sensor:

Used in gas leakage detecting equipments for detecting of LPG, iso-butane, propane, LNG combustible gases. The sensor does not get trigger with the noise of alcohol, cooking fumes and cigarette smoke.

Fig-7: COOLING FAN & GAS SENSORS

LDRs or Light Dependent Resistors are very useful especially in light/dark sensor circuits. Normally the resistance of an LDR is very high, sometimes as high as 1000 000 ohms, but when they are illuminated with light resistance drops dramatically.

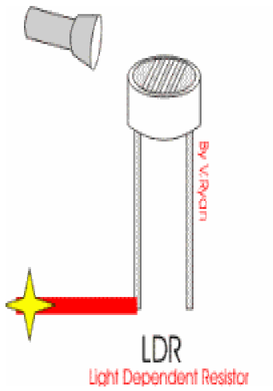

Fig-9: LDR

2. 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, finding of harmful gases if any are there, providing sufficient light to grow fastly and irrigation system by monitoring the parameters temperature, humidity and soil moisture content using the temperature & humidity sensors (LM35) and moisture sensors (YL69),gas sensor,LDR

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 ARDUINO UNO 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%

AirHumidity-14%

Temperature -25^0c

To the GPIO pin 17 of Arduino uno, the serial output of the LM35 sensor is connected. We have calculated a threshold value by the formula given below.

(Threshold value) idx = 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 ThingSpeak cloud through Wi-Fi connectivity.

2.1. 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.

2.2. Communication with ThingSpeak

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

2.3.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

2.4. 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.

In the webpage developed, the sensed data's are continuously uploaded and the page gets refreshed every 16 seconds. the first page of the webpage is entitled to the system name and images. One link is made available to the end-user for which after pressing the link, opens up another new page where the sensor values are displayed in the graphical format. In that, First graph represents the temperature values and the second graph represents the humidity values.

GUI shows the present status of the system in terms of soil moisture content, air humidity, temperature. From these parameters, the environmental conditions within the greenhouse are continuously monitored and maintained, enabling the necessary climatic conditions are always maintained in the Green house for the Spinach

3. RESULTS AND DISCUSSION

HARDWARE SETUP

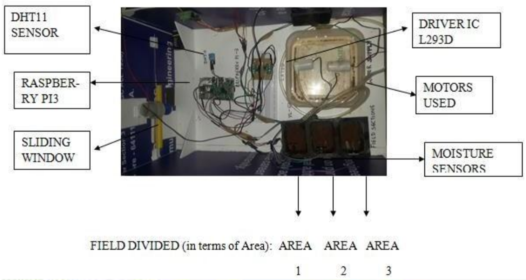

Fig-10: HARDWARE SETUP

VISUALISATION OF RESULTS

Fig-11: FIRST PAGE OF THE WEB PAGE

Fig-12: Results display on the second page

The Ideal threshold value for the spinach crop is found to be IdX = 26.5 (Humidity and Temperature) and for moisture it is 40%.

1. If the value exceeds 26.5, ARDUNO UNO automatically turns ON the Exhaust Fan.
2. If the value is less than 26.5, the ARDUNO UNO turns OFF the Exhaust fan.
3. If the moisture content is greater than 40%, then the ARDUNO UNO turns on the Sump motor, which in turn turns ON the water pump.

If the moisture content is less than 40%, then the turns ARDUNO UNO OFF the sump motor, which in turn turns ON the water pump.

4. CONCLUSIONS

The greenhouse monitoring system based on internet of things can give accuracy in an efficient way and continuous monitoring of greenhouse environment has been done. The proposed study about building greenhouse monitoring system based on internet of things in which the software for the development board with sensor has been developed with the embedded system and communication technology. The graph contains temperature, relative humidity and carbon-di-oxide from the sensor. The result of this project shows that a new proposed system for green house monitoring has a great advantage in remote monitoring also. The implementation of the internet of things also occurs in a more secure fashion. Thus it has a broad application prospect and industrial value.

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