

Raspberry-Pi Based Automated Greenhouse

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Abstract - A greenhouse provides an environment to grow plants all year round, even on cold and cloudy days. However, extreme environmental factors inside the greenhouse such as high temperatures and a high humidity can negatively impact the plants. Consequently, controlling this environment is essential in order for the plants to grow strong and healthy. The aim of this project is to design and build a greenhouse controller that can maintain the environment, by acting upon live sensor readings and be able to display the status of the system to the owner. The project was split into two parts: programming a raspberry PI3 using Python language to act as the central hub that manages the various sensors such as DS18B20 Temperature, DHT11 Humidity, YL69 soil moisture, and LDR as transducers; and creating a web site to allow the user to interact with the greenhouse controller.

This work showcases a Web-Based climatic condition monitoring all the parameters that are required to grow plants.

Keywords - Sensor, Greenhouse effect, Irrigation, IOT.

1. INTRODUCTION

Monitoring is employed in various applications including temperature, humidity, soil moisture, light. The Web-Based Climatic condition monitoring system that can be access anywhere and anytime through the internet is build. With this system user can remotely monitor the greenhouse climatic conditions from anywhere which could save the human expenses. Web-Based climatic condition monitoring is one type of recorder that monitors a temperature, humidity, moisture and light in a greenhouse room and stores the data into a database and display the current temperature on the website through a web server. The system will continuously monitor the temperature, humidity, soil moisture and light condition of the environment and the data can be monitored at anytime and anywhere from the internet. Proposed design is, this system consist of various sensors, namely soil moisture, temperature, humidity and light sensors. This sensors sense various parameters and are then sent to the Raspberry pi. After studying this, the program has been written on to the raspberry pi for specific environment conditioning. The desired temperature and humidity are maintained by turning on heater/cooler. The moisture level within soil is also be controlled by turning the water valve on/off. Desired light intensity for that environment can also be controlled by emergency lights when necessary. Hence the greenhouse environment is controlled automatically. The purpose of this project was therefore to make it easier to grow food at home. This can be achieved with the use of an automated greenhouse. A

greenhouse makes it possible to replicate a different climate and consequently grow food that would not typically grow in the area. Additionally, making the greenhouse automated enables people to grow their own food or plants at home without having to constantly look after them. It can be reassuring to know that the plants are taken care of while one is on vacation or not around the house for a longer period of time. The research question of this study was to analyse if it is possible to maintain the greenhouse temperature in a desired range for optimal plant growth using a temperature control system. Another objective was to investigate if the watering system is reliable, that is whether or not is can obtain a perfect soil moisture level for the chosen plant.

2. LITERATURE SURVEY

Since 1990's for greenhouse and environment monitoring various kinds of system have been developed but due to lack of awareness, cost and implementation factors, these systems were left behind. With the introduction of this system the cultivation is increased in a controlled environment. Required environmental conditions like Respiration for plants are necessary for optimum plant growth, improved crop yields, and efficient use of water and other resources. Low soil temperatures can inhibit water absorption in plants. When RH is low, transpiration increases resulting in water deficiency in plants. Automating the data acquisition process of the soil conditions and various climatic parameters that govern plant growth allows information to be collected with less labour requirements. Automatically controlling all the factors that affect plant growth is also a difficult task as it is expensive and some physical factors are interrelated, for example, temperature and humidity are related in a way when temperature raises humidity reduces therefore controlling both together is difficult. Since the temperature and humidity of greenhouse must be always checked to guarantee ideal conditions, remote sensor organize can be utilized to accumulate the information from point to point. The data from the greenhouse will be measured by the sensor and the data that are collected will be sending to the receiver. The data that has been read will be displayed on the website. By using this system, the process of monitoring is easier and it is also cheaper for installation and maintenance process.

3. PROPOSED METHODOLOGY

The greenhouse makes use of four different types of sensors to help regulate plant cycles and give the user useful information to further aid the growing process. The four sensors are DS18B20 Temperature, DHT11 Humidity, YL69

soil moisture, and LDR as transducers. Each sensor has either a digital or analog output. Once the sensor output data is successfully read, the data will be thoughtfully presented in graphs and tables to the user.

4. COMPONENTS USED

4.1. DHT11 (HUMIDITY SENSOR):

DHT11 humidity sensor feature a humidity sensor complex with a calibrated digital signal output. By using humidity sensing technology, it ensures high reliability and excellent long-term stability. [3] This sensor incorporates a resistive measurement part that associate with execution of 8-bit microcontroller, putting forth fantastic quality, quick response, anti-interference capacity and cost effectiveness. Each DHT11 element is strictly calibrate in the laboratory that is extremely accurate on humidity calibration. The calibration coefficients are stored as programs in the OTP memory, which are used by the sensor’s internal signal decreasing process. The signal-wise serial interface makes system integration quick and easy. Its little size, low force utilization and up-to 20-meter sign transmission settling on it those best decisions for Different applications, including the most demanding ones requesting ones. The component is 4-pin signal row pin package. [4] For measuring humidity, DHT11 has two electrodes with moisture holding substrate between them. So as the humidity changes, the conductivity of the substrate transforms alternately those safeties between these electrodes transforms. This change in resistance is measured and processed by the IC which makes it ready to be read by raspberry-pi’s gpio pins.



FIGURE1-DHT11(HUMIDITY SENSOR)

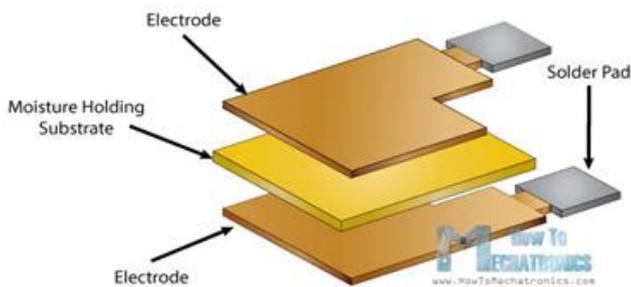


FIGURE2 - DHT11 INNER WORKING

4.2. SOIL MOISTURE SENSOR:

A soil moisture sensor can read the amount of moisture present in the soil around it. It’s a low tech sensor, perfect for monitoring a small garden, alternately your pet plant’s water level. This is a must have tool for a connected garden! [6] The Soil Moisture Sensor uses capacitance to measure dielectric constant of the surrounding medium. In soil, dielectric constant is a function of the water content. The sensor creates a voltage proportional to the dielectric constant, and therefore the water content of the soil.

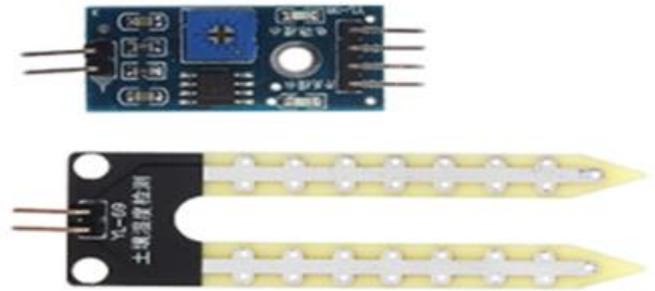


FIGURE3 - SOIL MOISTURE SENSOR (YL-69)

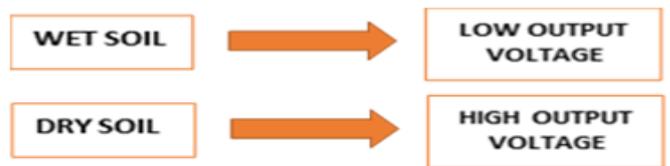


FIGURE4 - INNER WORKING OF SOIL MOISTURE

4.3. TEMPERATURE SENSOR(DS18B20):

The DS18B20 computerized thermometer gives 9-Synonyms/Hypernyms (Ordered by Estimated Frequency) of noun bite to 12-bit Celsius temperature estimations and has a warning signal a work with nonvolatile user-programmable upper and lower trigger head. [5] The DS18B20 communicate using 1-Wire method that by definition requires as it were one information line (and ground) for communication with a central chip. Each DS18B20 need a a standout amongst a sort 64-bit serial code, which permits various DS18B20s on work on those same 1-Wire transport.



FIGURE. 5 – DS18B20 TEMPERATURE SENSOR

Hence, it is straightforward to utilize one chip to control numerous DS18B20s dispersed over a huge range.

4.4. LIGHT DEPENDENT RESISTOR(LDR):

The Light Subordinate Resistor (LDR) is fair another extraordinary sort of Resistor and subsequently has no extremity. Meaning they can be associated in any course. They are breadboard inviting and can be effortlessly utilized on a perf board too. The image for LDR is fair as comparable to Resistor but includes to internal bolts as appeared underneath. The bolts demonstrate the light signals. It can be utilized to sense Light, it is a little, cheap and effectively accessible, Accessible in PG5, PG5-MP, PG12, PG12-MP, PG20 and PG20-MP arrangement.

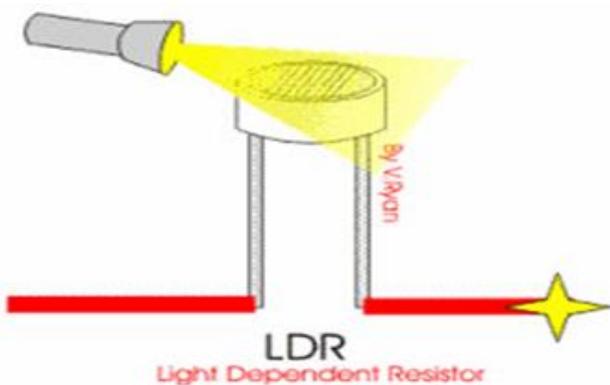


FIGURE6 - LIGHT DEPENDENT RESISTOR

[3] when light falls on the LDR then the resistance decreases, and increases in the dark. When a LDR is kept in the dark place, its resistance is high and, when the LDR is kept in the light its resistance will decrease.

4.5. FOUR-CHANNELS RELAY:

[1] This 4-Channels Relay module requires 5V, the controllers like Raspberry-Pi, Arduino, AVR, PIC, ARM and MSP430 can be connected. 4 relays are included in this module, with “NC” ports mean “Normally connected to COM” and “NO” ports mean “Normally open to COM”. It has 4 LEDs to show the status of relays.



FIGURE7 - FOUR-CHANNEL RELAY BOARD

The 4-Channel Hand-off Driver Module makes it basic and helpful to drive loads such as 12V transfers from straightforward 5V computerized yields of your Raspberry-pi board. You can utilize any of the control channels autonomously, so basically take off any unused channels disconnected.

4.6. Raspberry-PI 3:

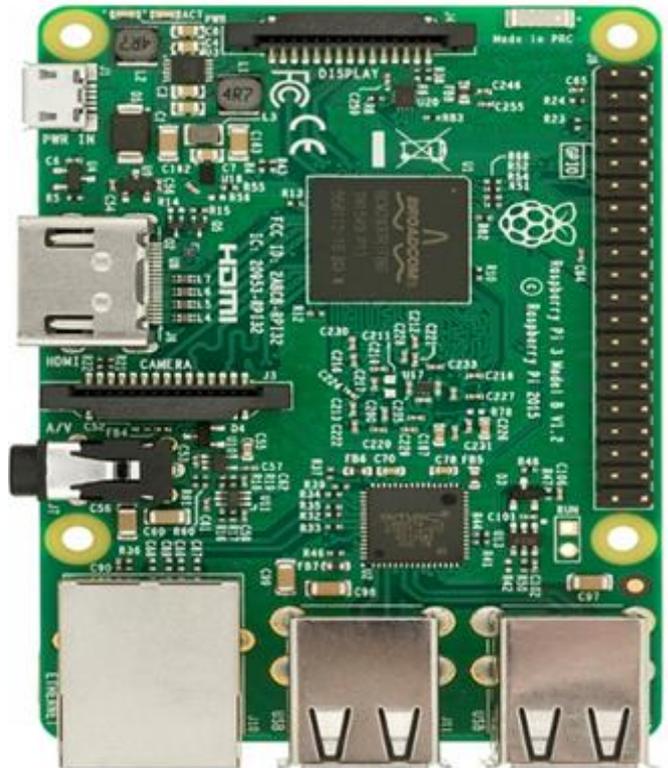


FIGURE 8 - RASPBERRY-PI MODEL B 3

The Raspberry Pi 3 Show B is the most recent form of the Raspberry Pi, a minor credit card estimate computer. Fair include a console, mouse, show, control supply, smaller scale SD card with introduced Linux Dispersion and you'll have a fully-fledged computer that can run applications from word processors and spreadsheets to diversions. As the Raspberry Pi 3 bolsters HD video, you can indeed make a media middle with it. The Raspberry Pi 3 Show B is the to begin with Raspberry Pi to be open-source from the get-go, anticipate it to be the defacto inserted Linux board in all the gatherings. [7] Technical Specification of raspberry pi:

1. Broadcom BCM2837 64bit ARMv7 Quad Center Processor powered single board machine running in 1. 2GHz.
2. 1GB RAM BCM43143.
3. Wi-Fi on board.
4. Bluetooth Low Energy (BLE) on board.
5. 40pin extended GPIO, 4 x USB 2 ports.

5. IMPLEMENTATION

The whole project has been divided in two parts first is the software and second is hardware

5.1. HARDWARE PART:

The greenhouse is constructed using transparent acrylic sheets with various cut-outs for two fans in opposite direction placed diagonally. Where one fan works as a cooler



FIGURE 9 - 12V DC FAN AND WATER PUMP and the other acts as an exhaust.

The plants are watered from the tank that enter by a hose that enters the greenhouse, pump is placed outside the greenhouse and the led lights are fixed on the roof top of the greenhouse. The soil moisture sensor is placed beside the plants, the temperature and humidity sensor is placed inside the greenhouse. The raspberry-pi and the remaining components are fixed outside the greenhouse as shown in the below

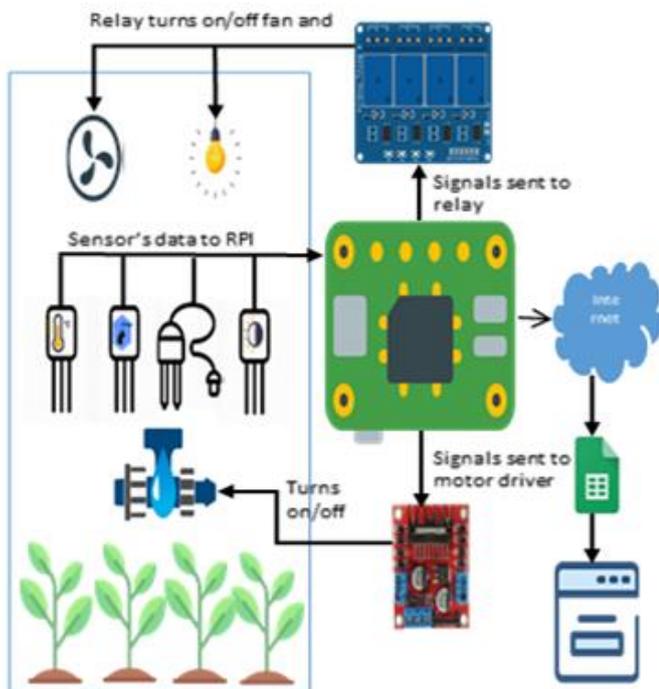


FIGURE 10 - ARCHITECTURE OF AUTOMATED GREENHOUSE

5.2. SOFTWARE PART:

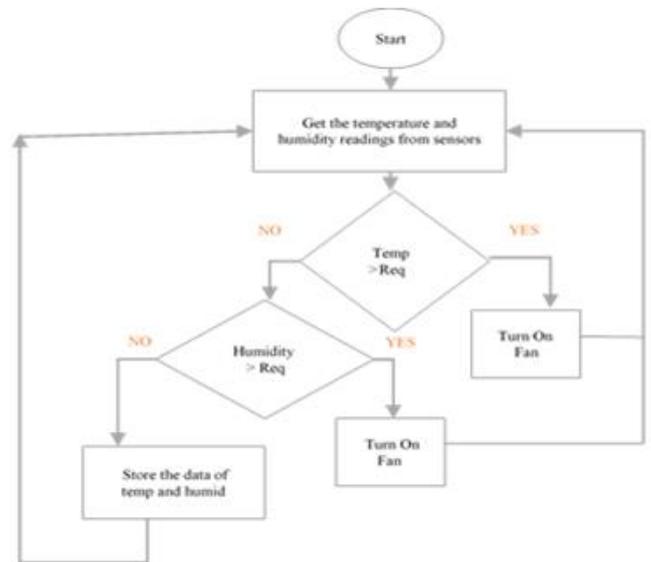


FIGURE 11- FLOW CHART ONE

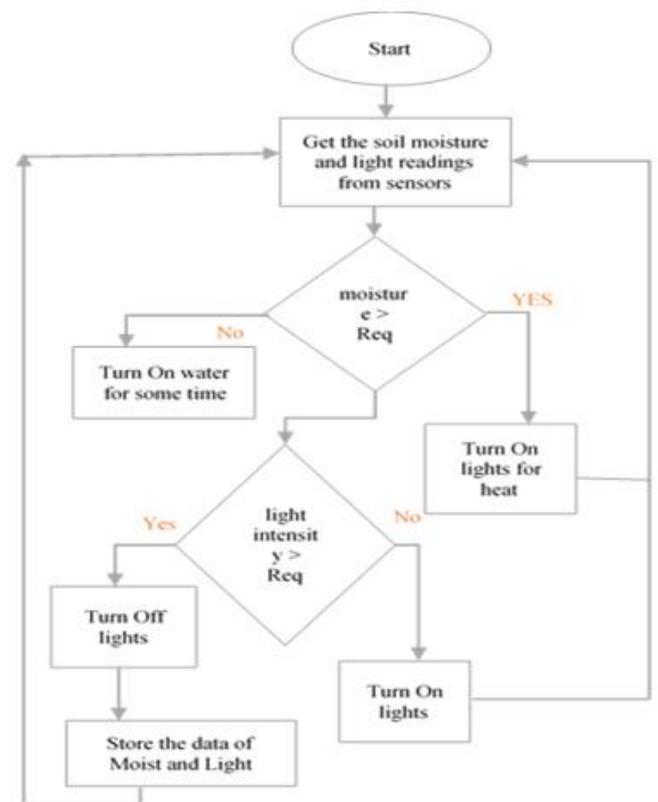
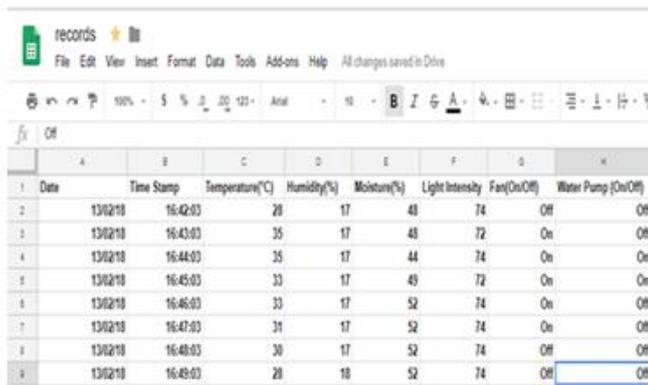


FIGURE 12- FLOW CHART TWO

The software is divided into two parts first consist of the temperature and humidity and the other is soil moisture and light intensity. Basically the raspberry-pi obtains the data from the sensors and then the input data is compared with the required data and accordingly components are turned on and off (i.e.: by sending signals to relay board). From the data received the system will calculate if there is maximum and minimum requirement not achievable at the control panel

and it will adjust the requirement needed until it pass the optimum requirement value. Simultaneously the data is stored in the google spreadsheet and then these data are displayed in the website. Here the input/output to the components and sensors are given using raspberry-pi's gpio pins and these pins are programmed using python programming language.



	A	B	C	D	E	F	G	H
1	Date	Time Stamp	Temperature(°C)	Humidity(%)	Moisture(%)	Light Intensity	Fan(On/Off)	Water Pump (On/Off)
2	13/02/18	16:42:03	28	17	48	74	Off	Off
3	13/02/18	16:43:03	35	17	48	72	On	Off
4	13/02/18	16:44:03	35	17	44	74	On	On
5	13/02/18	16:45:03	33	17	49	72	On	On
6	13/02/18	16:46:03	33	17	52	74	On	Off
7	13/02/18	16:47:03	31	17	52	74	On	Off
8	13/02/18	16:48:03	30	17	52	74	Off	Off
9	13/02/18	16:49:03	28	18	52	74	Off	Off

FIGURE 13 - GOOGLE SPREADSHEET WITH SENSORS DATA

6. RISK ANALYSIS:

Risk analysis help us in projecting ideas and system to a certain extent to which they can be implemented. Risk analysis of cost and crop yield show us the appropriate steps to be undertaken for optimum utilization of available resources and products. Risk of over-irrigation or under-irrigation is possible in case of water pump failure.

7. CONCLUSION AND FUTURE SCOPE:

The system allows monitoring the condition of greenhouse which is collected using various sensor and send the data to Raspberry-Pi and accordingly necessary action are taken. There were four objectives set at the start of the project:

1. Take Temperature, Humidity, Light and Soil Moisture readings.
2. Display past and present sensor readings to the user.
3. Be able to update the settings for multiple plants.
4. Act upon sensor readings that deviate from the defined range.

All the above objectives have been achieved/met and the automated greenhouse gives flourished plants. In coming future food becomes a valuable resource due to changes in climate. Global warming has become a great thread to many species end. Responsibility for future generations are needed to be taken by developing agriculture practices independent of climatic conditions. More intelligent machines are needed for the observation of greenhouse and for taking their own decision like humans.

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