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Utilising Greenhouse Technology Towards Sustainable Agriculture Using IoT

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Utilising Greenhouse Technology Towards Sustainable Agriculture Using IoT
"TechFarm"

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Abstract. Green house is a structure that consists of walls and gates, and a transparent roof which maintains a climatic condition that is favourable for the growth of plants inside the greenhouse. Greenhouse system are maintained by human beings which reduces the labour work inside the greenhouse. The automatic greenhouse formed by the utilization of Internet of Things helps in overcoming the problem faced by the farmers and provides with an automatic monitoring of the greenhouse system. This paper proposes an automation system that uses Arduino NANO and various sensors for detecting the moisture, temperature, light and humidity to get a rise in the production.

Keywords: IoT, Arduino Nano, Raspberry Pi 3, Humidity Sensor, Water Pump, Servo Motor, Temperature Sensor, Capacitive soil moisture Sensor, Light Sensor.

1 Introduction

A greenhouse is a structure that is built of walls and a transparent roof and is designed to maintain regulated climatic conditions and helps to grow plants in extreme weather conditions. The greenhouse controls the key factors which includes temperature, light intensity, irrigation and the humidity which creates a suitable for the plants to grow inside the greenhouse and leads to a good quality of production. The crop cultivation inside a greenhouse is highly affected the farming operations to protect fields and maximize crop production. Regular monitoring of these factors gives certain information obtaining individual effects of various factors for maximum crop production. The greenhouse has reduced the inconvenience and other issues that is caused by the traditional way of farming, which is benefitting the farmers.

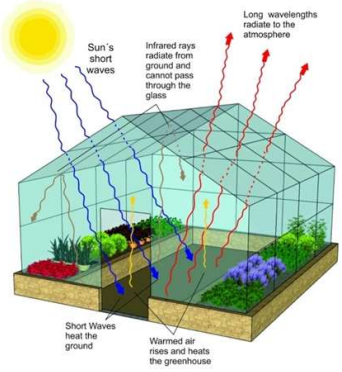

Fig 1: Structure of a Greenhouse

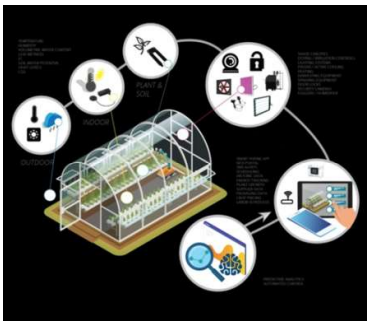

Fig 2: IoT Elements and sensors

Greenhouse has also overcome the shortcomings in the growing qualities of a piece of land. They also enables certain crops to be grown throughout the year.

Fig 3: Connection of Wi-Fi

In spite of being useful to the farmers in producing good quality crops and production rate, it causes troubles to the farmers, as they might not be familiar with the technology , they may fail to maintain the environment inside the greenhouse like suppose they may not be able to maintain the required climatic conditions or suppose how much water is required to irrigate the plants, which will lead to the damage of crops. This type of problems can be prevented with the help of smart greenhouse using IoT, where all the jobs will be done with the help of sensors.

2 Literature Review

In [1], authors mention that, this project is designed using Arduino and it Uses android phone to monitor the greenhouse (control it using android from remotelocation). It was based on SMS system (GMS-Global System for mobile communication). This system allows the farmer for taking correct decision by studying the actual status of the sensors. But there are few limitations like,

i) One person always had to be present in the greenhouse.
ii) It was time consuming and costly.

In [2], authors mention that, the design of hardware for greenhouse monitoring is used to control the environment condition of given house to get good condition. In this system the monitoring of greenhouse component consists of sensor for temperature, checking water level and soil moisture. ARDUINO UNO, GSM modem, Wi-Fi modem, water pump, DC motor, DC fan, LCD, regulator, rectifier power supply is used to detect data. They provide an instant solution for irrigation and other field activities. This system helps in improving the good production and helps in faster growth of plants. They also mentioned about reducing the wastage of water resources.

In [8], the authors mention that Internet of Things can be applied to different daily activities such as health care, smart home etc. Bluetooth, Wi-Fi and ZigBee are widely used in Internet of Things devices but along with short transmission range, middle power consumption and weakness of interference. Hence, Low Power Wide Area Network (LPWAN) for the cellular network are proposed for wide coverage, lower power consumption and massive devices with reliable communication for IoT devices. Limitations of the system is the Implementation and maintenance cost.

In [9], the authors mention that the proposed greenhouse system can control and monitor the changes like temperature, humidity and soil moisture by combining the sensor to the Raspberry-pi and then it gives alerts to the users using mobile application. Application that is developed helps in getting latest information about the agricultural background.

In[10], authors mention that, the green-house environment including Internet of Things and cloud helps to control the system and accordingly stores information. They even mentioned that implementation of the smart green house condition was always advantageous. They mentioned about Arduino based works for automatic controlling and monitoring of environmental changes.

3 Proposed Work

This paper overcome drawbacks of the existing system. This paper proposes a new system that uses various sensor to monitor various factors inside the greenhouse. The inputs pin of Arduino NANO helps to maintain the climatic conditions inside the greenhouse. Based on the threshold value set for the temperature, moisture, humidity and light. The Wi-Fi module present in the raspberry-pi enables to transfer the information collected from the sensors to the server and store it in the database. Here it uses a MQTT server. The information is then passed on to the user's device through internet to monitor the system. This system allows machine to machine interaction rather than human to machine interaction.

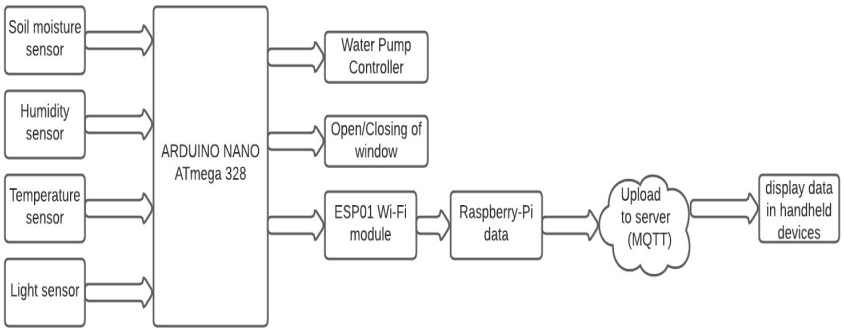

Fig 4: Block Diagram

The proposed system gives an automatic form of greenhouse condition providing a secured connection among the people and noticeable things around, and it permits real-time information gathering through various open source platform.This system provides automatic controlling and monitoring, conveys the gathered sensors information from the MQTT server to achieve an anytime access of the information that are detected from the green house, which enable high rate production and that is beneficial for the farmers.

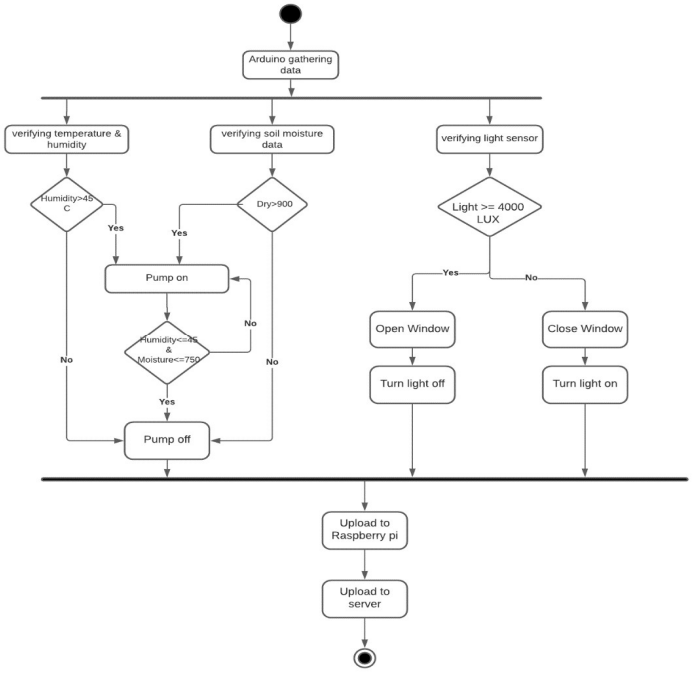

Fig 5: Activity Diagram for the system

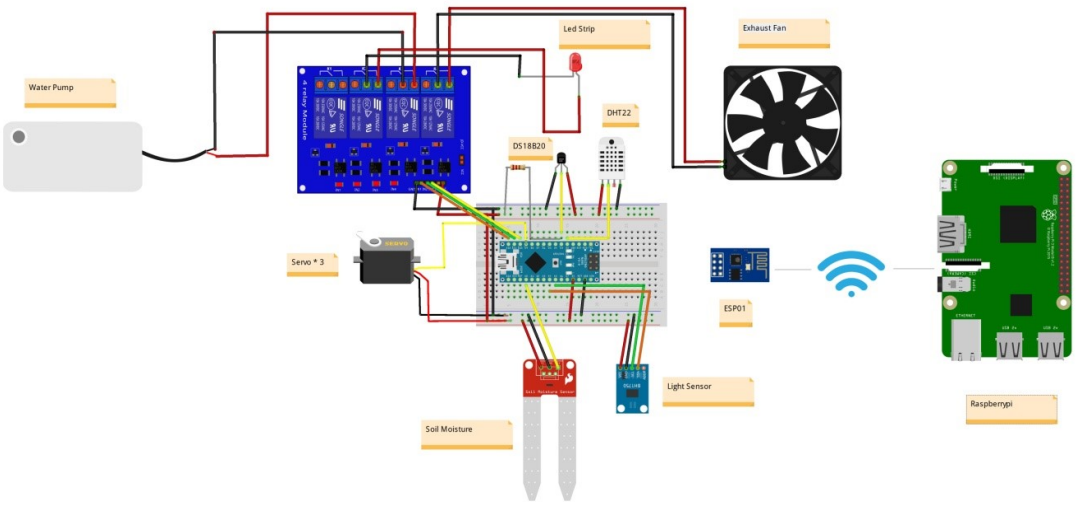

Fig 6: Circuit Diagram

We use two servo motor for opening and closing of the window and one for rotating the fan. The data connected by the sensors goes to Arduino Nano, then to ESP01 and then to Raspberry Pi. We can use this model for multiple Greenhouse. Soil moisture sensor is connected to analog pin and the humidity and the temperature sensor is connected to the digital pin of the Nano. The relay module act as a switch , depending on the light sensor it will switch on or off the LED lights. Light sensor is connected to A_4 and A_5 of the Nano board.

4 Hardware Used

Arduino Nano: -The Arduino Nano is a board based on Atmega328P which is released in 2008.It provides the same connectivity as in Arduino UNO board but is comparatively smaller in size.

Raspberry Pi 3: -Raspberry Pi is a low cost, credit card size computer that is developed in the United Kingdom. It itself is a screenless computer.

Humidity Sensor: -DHT21 sensor used here is a digital module for testing humidity and temperature to ensure high reliability and stability.

Water Pump: -The water pump is an essential tool to pump out water from the garden, pool, or under the ground.

Servo Motor: -A servomotor is a rotary device that rotates in angular or linear position with velocity and acceleration.

Temperature Sensor: -The digital temperature sensor is a single wire device that is used to measure temperature with an accuracy of +-5%.

Capacitive Soil Moisture: -This Capacitive soil moisture sensor measures the level of moisture present in the soil.

Light Sensors: -Light sensor BH1750 is used to detect the various intensities of light. It can detect wide range at high temperature.

5 Result and Analysis

The connection of various hardware devices and sensors including capacitive soil moisture sensor, light sensor, Arduino NANO, Raspberry-Pi, humidity and temperature sensor along with water pump and servo motor is shown below.

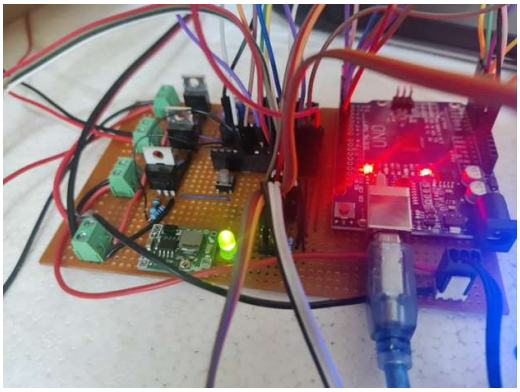

Fig 7: Hardware Setup of devices

After setting up the hardware, the parameters including temperature, pressure and humidity had been observed in two scenerios namely with green house setup and without greenhouse setup.

Accordingly, data had been plotted according to the graph shown below.

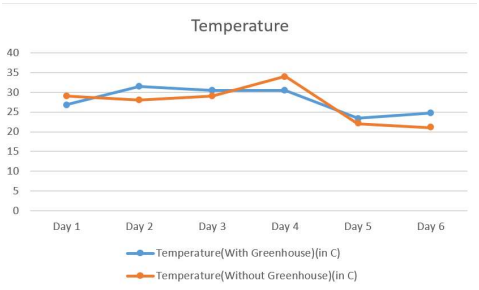

Fig 8: Temperature graph for analysing temperature inside and outside the greenhouse

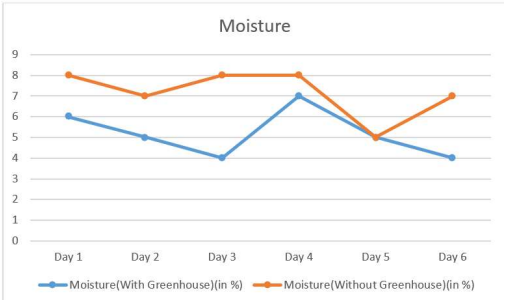

Fig 9: Graph for analysing moisture level inside and outside the greenhouse

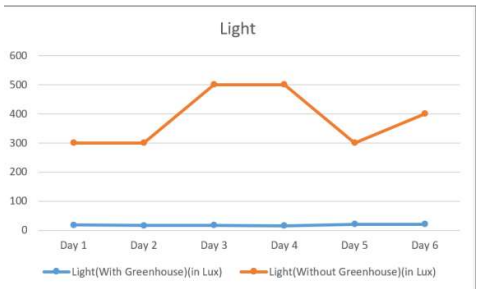

Fig 10: Light intensity graph inside and outside the greenhouse

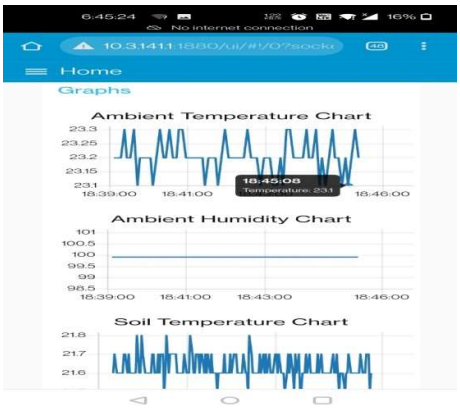

Fig 11: User control and data representation through MQTT

Collected data had been analysed and found that the proposed green house can be managed to have a controlled environment for proper growth of the crops. Moreover the collected data can be kept for further analysis as well as for prediction purpose.

6. Conclusion

This IOT based project Utilising Greenhouse Technology Towards Sustainable Agriculture will bring traditional agricultural systems and new Internet of Things together for complete visibility and automation. So here in the proposed system, it sends information about the temperature using the temperature sensor DHT11, soil moisture using the Capacitive Soil Moisture sensor, humidity using humidity sensor DHT21 and lighting using BH1750. By using this information, the farmer can decide whether to water his farm or not, by turning on the motor using and also can regulate the temperature, humidity and lighting by using his mobile phone sitting at home. The farmer also does not need to worry about the gate being open or closed. As our systemwill close the door automatically when someone forgets to close the door which will help farmers in good production of agriculture.

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