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AUTO-GREEN A Fully Automated Greenhouse Monitoring and Control System Using Data Logging

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Abstract
Greenhouses provide a regulated environment in which plants can be cultivated effectively. However, temperature, humidity, soil moisture, light intensity, and soil pH are all crucial elements for plant growth. We use a sensor network for continuous monitoring and control of this system. The RTC DS1307 module records the greenhouse parameters and sends them to the SD Card, where they are saved with their appropriate timestamps. We can easily access this data in an Excel Sheet. This recorded data can be analysed based on which the functioning of each sensor will begin. The major goals of this project were to create a user-friendly UI

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design and an automated system. The prototype's potential to monitor and regulate the greenhouse remotely, as well as diagnose the viability of the plants, was shown by the experimental findings. Farmers may use the smart prototype to get real-time remote measurement and sensing services.

Keywords- Greenhouse, Data Logging, Arduino UNO, Sensors, IOT etc.

I. INTRODUCTION

Agriculture has been one of man's fundamental pursuits since antiquity, and personal interventions in farming remain unavoidable even now. Greenhouses are an essential aspect of our country's agricultural and horticulture industries since they may be utilised to grow plants under supervised climatic conditions for optimal yield. The automation of a greenhouse entails monitoring and managing the environmental conditions that directly or indirectly affect plant development and therefore yield. Automation is the process of controlling industrial equipment and processes in order to replace human personnel. This is a robust mechanism that is well equipped to respond to environmental changes that occur within the greenhouse as well as to create a rapid, efficient output in comparison to human expectations. It operates on a feedback loop, which allows it to respond to external stimuli more effectively. The automated setup mechanism will provide you the opportunity to avoid and fix human errors. Currently, the greatest enabling technology for implementing such a fully automated setup mode is IOT (Internet of things). We have tried to simulate following different climatic conditions in this prototype:

a) **Soil Moisture**: Plants absorb water from their roots and lose it via their leaves as they transpire. Through the process of transpiration, a significant volume of water is evaporated. We utilise a soil moisture sensor and a water pump to retrieve the lost water level and soil moisture. The pace at which water is lost is determined by the state of the soil, wind speed, relative humidity in the air, and the ambient temperature. As a result, the soil moisture level is an important parameter.

b) **Luminosity**: Light is by far the most crucial factor in photosynthesis since it provides energy to all biological entities. We deployed an LDR sensor to detect the presence or absence of light, as well as to quantify the luminosity. In the absence of light, the rate of photosynthesis is slowed. As a result, it is necessary to regulate light in the right proportions for plant growth.

c) **Temperature**: The majority of plant growth processes, such as photosynthesis, transpiration, absorption, respiration, and blooming, are influenced by temperature. When the temperature rises, growth is accelerated, and when the temperature drops, growth is impeded. Various plant species have a certain temperature range in which they may thrive. We have used a temperature sensor to keep a track on the temperature as enzymes become dormant above this threshold, and life-sustaining processes cease.

d) **Humidity level**: Humidity Limit: This system includes a humidity sensor that measures humidity, which is crucial to plants since humidity helps to control moisture loss. Plant leaves have small holes via which CO2 enters the plant and oxygen and water escape. The percentage of humidity in the air causes transpiration rates to drop correspondingly. This is due to the fact that water diffuses from high-concentration zones to low-concentration ones.

II. RELATED WORK

"An environmental management plan within the greenhouse". This paper includes local channels and a central station. Local stations measure local boundaries and control the operation of

controlled actuators to maintain climate limits in designated areas. The system uses ZigBee wireless module servers as a link between local channels and a central channel.[1]

"WSN-based web-based monitoring and control system". This system consists of 3 nodes; sink node, wireless sensor node and wireless control node. The function of the wireless sensor node is to collect temperature data. The function of the sink node is to analyze and process information obtained from each sensor. Responsibility for a climate control node within the greenhouse based on collected greenhouse data.[2]

"An embedded system designed to monitor the temperature zone" In this paper based on these variables such as humidity, water pH, ground moisture, light intensity and temperature using sensors located in different locations, when measured, processed, and controlled. updated to owner via SMS using GPS modem.[3]

"A program using ZigBee technology and an Android application". Here, the system has a sensor that detects the location where sensory values are sent to a mobile application with the help of a computer. While using the mobile application, for example, the fan can be opened by the user. The mobile app here helps to reduce the direct monitoring of farmers.[4]

"A ZigBee-based thermal control system with embedded technology". The program consists of three main components: advanced machine processors, natural acquisition nodes, and an intelligent control block. It is mainly built with an S3C2440 microprocessor with four ARM920T cores, power, clock, reset cycle, LCD touch screen, smart end module, ZigBee connector, and terminal nodes for natural features. This program detects real-time display functions data about the location of the heat sink, data query, and alert setting.[5]

"A visual-guided operations in Nurseries". In this paper they have proposed vision plan that will work in a hot climate designed for growing tomatoes is explained. Here in this activity, use two PAL-colored cameras. By using sensors, we will make them aware of changes in humidity so that with the change of humidity they will be able to plan the right time for the water supply. Controlling all these activities will be done on any smart device remotely and operation will be done via a connecting sensor, and Wi-Fi. The signal sent by the cameras is processed in a clear working environment using a bit-slice microprocessor card for immediate image processing. [6]

"The use of Green House Monitoring Technology Based on the Android Mobile Platform". China is a major agricultural country. And agriculture is the foundation of the country's economy. They have used cell phone technology as a monitoring terminal, defined as a storage temperature. In this program they use two sensors - temperature and humidity. Sensors are a type of cable. By using sensors, we will make them aware of changes in humidity so that with the change of humidity they will be able to plan the right time for the water supply. GPRS is used to send messages. A wireless sensor network is an emerging field that can be used to monitor and control agricultural boundaries to create an intelligent automated system in the greenhouse.[7]

"Green House surveillance and control through the Android Mobile Application". This new system is designed to check indoor humidity. The complete system is designed to monitor and control the humidity inside the greenhouse. Software for android phone, connected using WIFI to a central server connected via a serial connection to a microcontroller and a sensor. The control process takes place both manually and automatically. ZigBee wireless network will send status to the control room. And there we can control tasks with a PC.[8]

III. METHODOLOGY

To develop an effective greenhouse system, the following parameters such as temperature, intensity, moisture, and soil moisture should be adjusted to such how different plants can grow completely. Therefore, continuous monitoring of temperature, light, moisture, and soil moisture are very important to greenhouse system. In this paper, four different senses such as temperature sensor, light sensor, moisture sensor, and soil moisture sensor used as shown in Figure 1 Block Diagram to collect data of four important parameters continuously. The first a greenhouse system monitoring and control device Arduino Uno R3 used to store data collected with the various sensors mentioned above and processing data. We have used a SD module in this system for the storage of sensor data detected from the greenhouse and the data saved can be easily opened in an Excel Sheet for further analyses. To maintain the date and time we will use the RTC module DS1307 which is a real-time clock (RTC) which is an integrated circuit clock module.

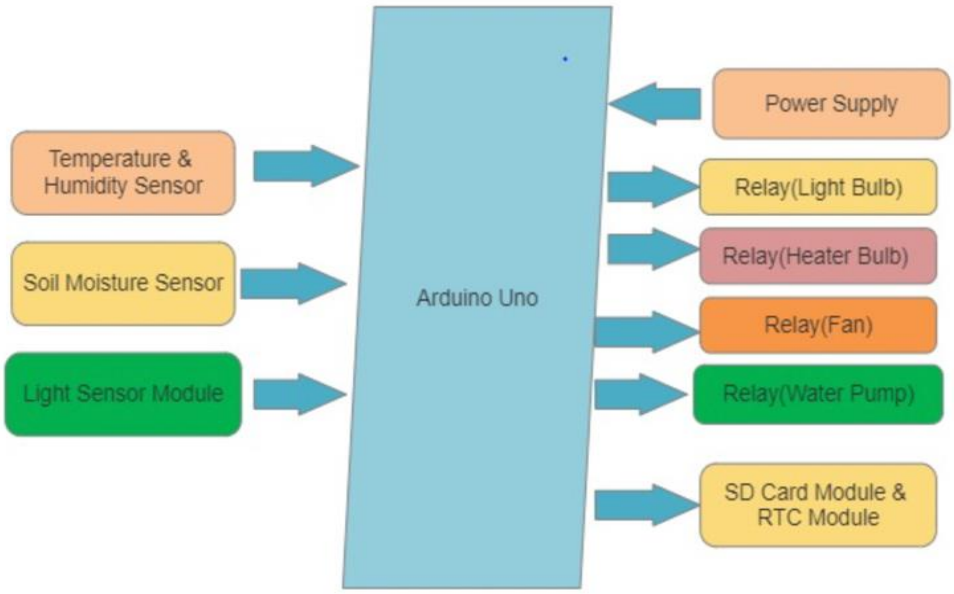

Figure 1 Block Diagram

A. Hardware Description

Arduino UNO, DHT11, RTC DS1307, LDR, relays, bulb, transformer, fan, soil moisture sensor, SD card module, water pump and ESP8266 module. Arduino Uno is used for this project without the microcontroller board based on ATmega328. Contains 14 digital input / output pins (naked 6 used as PWM output), 6 analog input, 16 MHz crystal oscillator, USB connection, power jack, ICSP header, reset button and requires 9V power supply. All of these modules are needed to support a small controller and to establish a connection to a computer via USB cable or to power it with an AC-to-DC adapter or battery to get started. Along with this hardware, the website is made with the use of Internet of Things (IoT). The DHT-11 Digital Temperature And Humidity Sensor is a basic, inexpensive digital sensor and moisture sensor. It uses a capacitive humidity sensor and thermistor to measure ambient air and drain the digital signal in a data pin (no analog input pins are required). Proper light intensity is essential for the growth of plants. There is LDR in a light sensor module that can help detect light momentum. In this paper, an LED bulb is used to solve low light intensity problem within the greenhouse system. When light is compared to a low level with a

specified level, the LED bulb turns on automatically. In the case of the normal range of intensity the intensity of the light can cause the LED bulb to turn off automatically.

The Soil moisture sensor can be used to check soil moisture, where the soil is dehydrated, and module output is high, except for output. By using this sensor one can irrigate a flowering plant automatically, or other plants that need an automatic irrigation system. By placing two soil moisture sensor probes inside the soil, the amount of moisture in the ground can be measured. It has adjustable sensitivity, and the limit level can be adjusted. The Fan operates by measuring the temperature emitted by the thermostat and / or by itself. The temperature is then transferred to the control system on board.

The Step-down transformers is used in power adapters and in regenerative devices to effectively reduce voltage. They are also used in electronic SMPS. Other applications include Power transmission cables. Electrically operated relay switch controls the region with a different low power signal anywhere several circuits must be controlled by a single signal. In this system, we have used 5V relay to switch the fan, light bulb, heater lamp and water pump if we need to turn on or off. The water pump operates at 12 V which is operated on the external 12V power adapter. The Arduino can create a file in an SD card to write and save data using the SD library. This serves as an indicator of greenhouse monitoring. The DS1307 (RTC) IC real-time clock is an 8-pin device using an I2C optical connector. The DS1307 is a low-power watch / calendar with 56 SRAM battery-backed backup. Clock / calendar provides seconds, minutes, hours, day, date, month, and year relevant data

B. PCB Architecture

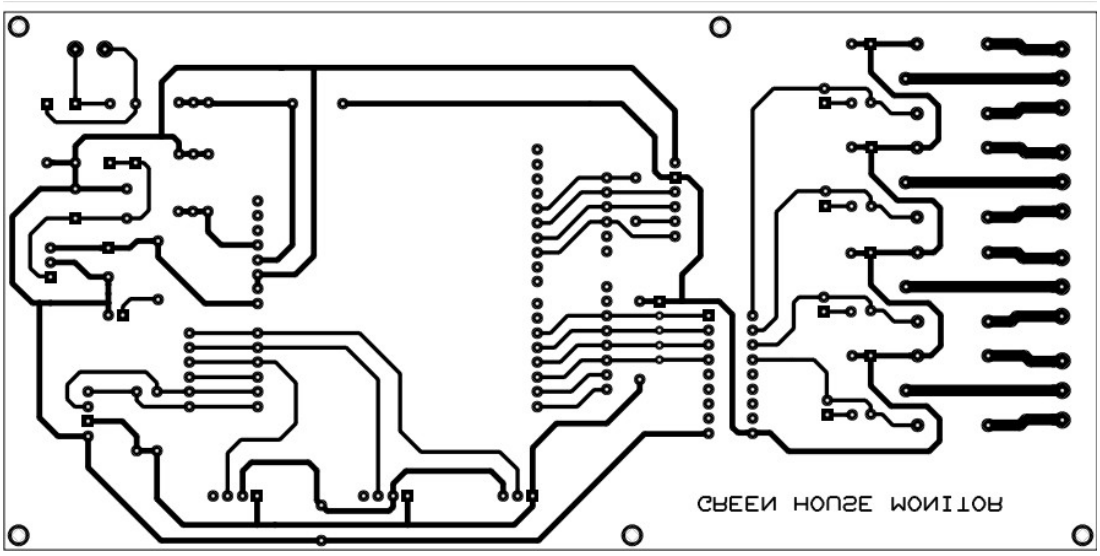

Figure 2 PCB Design

We have also Designed a PCB for Auto-Green Project. In Figure 2 PCB Design at the right most side the dark lined are the schematics of four relays that we have used. All connections to Arduino UNO board are represented inthese PCB Design.

C. Logic Intellection and Working

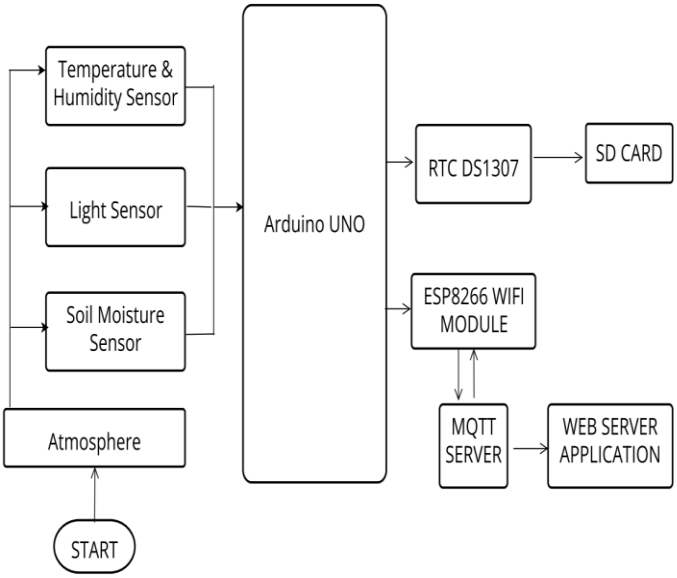

Figure 3 Hardware Design

We have taken 3 different types of power supply input to our circuit i.e. From 12 V adapter, Two 230 V power supply. The 12 V adapter's voltage is used to run 12V Water Pump and 12V Fan. Whereas one of the 230V supply is directly given two the two Bulbs present in the prototype. The other 230 V is given to Arduino UNO through Transformer. Arduino UNO works on 9 V voltage. But, we are taking 230 V for that .So, we need to pass this voltage to a Step-Down Transformer which converts 230V to 12V. This voltage is also more than the Arduino Works. So, this 12v Voltage is pass through power system and capacitance installed in the PCB which converts this 12V to 9 V and passes to the Arduino UNO. Thus, Arduino UNO get adequate Voltage supply. Another 230 V supply is for Two Bulbs. One of the Bulb is used as a Heater in the green house and the other Bulb is a yellowish-white LED bulb of 10 W as to remove the darkness or we can say alternative to sunlight.

We have used four relays. Two of them Relays are connected to 230 V and remaining two are connected to 12 V power supply. So, the Relay-1 is connected to LDR and 10 W LED Bulb. Here, we have developed a logic of that If LDR senses darkness led pin high that means led will glow and If LDR senses light led pin low that means led will stop glowing. In simple words when LDR sensor senses darkness means there is no sun light then for alternative of sunlight a LED Bulb will be glown and Vice- Versa. Relay-2 & Relay-3 is for switch between Bulb Heater and Fan Cooler. Here, if Bulb is set to High and Fan is set to Low then the Bulb will be glown and if Bulb is set to Low and Fan is set to High then Fan will start. That means if Temperature is Higher than the set on then Fan will be on and Bulb will be OFF and Vise-Versa. Relay-4 is used to switch the Water Pump according to the soil moisture. If soil moisture value is more than the defined threshold value then pump is set to high and hence pump will start pumping water and thus, soil moisture value decreases then pump will set to low. In this way we are able to maintain and Control Temperature, Soil Moisture and Light inside the Green House System as shown in Figure 3 Hardware Design.

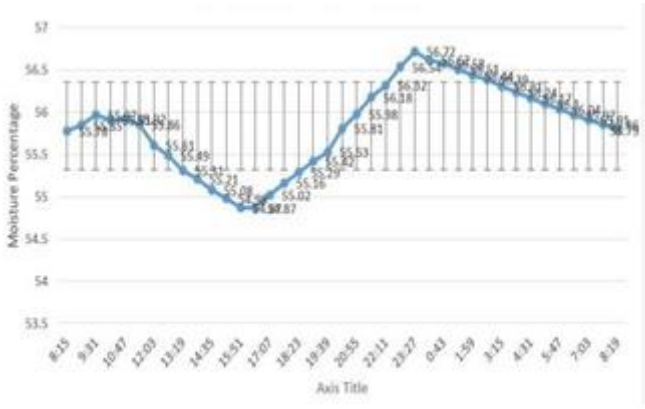

Figure 4 Soil Moisture Data

D. Data Logging

A data logger is a tool that monitors and records changes over time. They can be single units, stand-alone units or integrate multiple channels. Many stand-alone units operate on a battery, which allows it to record during transport and for long periods of time. based on system events / actions, network or IT environment. Enables tracking of all interactions when data, files or applications are stored, accessed or modified on a storage device or application.

We used the RTC DS1307 Data Logger to download real-time data. RTC stands for real-time clock. We use its four anchors, two power cables (GND and VCC) and two data cables (SDA and SCL). The RTC module is used to remember the date and time. It comes with a built-in battery which helps it to keep working when you have no external power. When inserting a CR2032 battery, it saves time in module when the maximum power is off. If we do not plug in the battery, time information will be lost when maximum power is turned off and you need to set the time again. Introducing SD card module SD card module is especially useful for projects that require data logging. Arduino can create a file on the SD card to write and save data using the SD library. Add a formatted SD Card to which Data will be added to be downloaded by RTCDS1307. Data will be added to the SD card every second. Everyday A new file is created. Of all these Data one can monitor and control the Green House System. We also have used the collected Data is transferred to Web Application Server through MQTT server by using ESP8266 Module. As, Arduino doesn't have any wireless or Wi-Fi module built in it so, we need to add external Wi-Fi module to transmit the data wirelessly.

IV. RESULTS AND DISCUSSION

Figure 5 Prototype

In Figure 5 Prototype we had showed our prototype. We have made a Wooden Cuboid covered with Eco-Friendly Plastic to make Barrier between Environment and plant. All the Components are arranged properly in the Wooden Box.

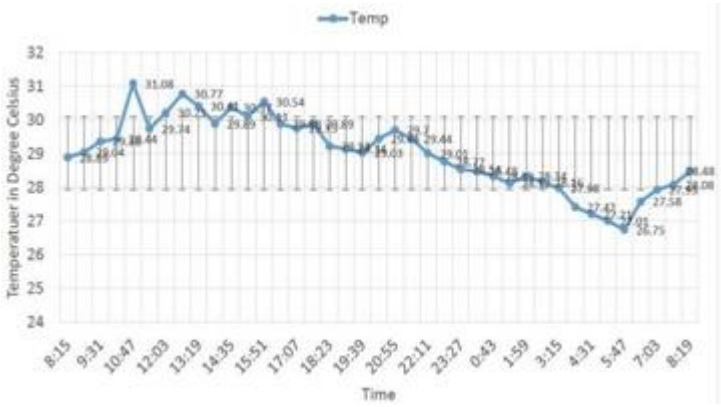

Figure 6 Temperature Data

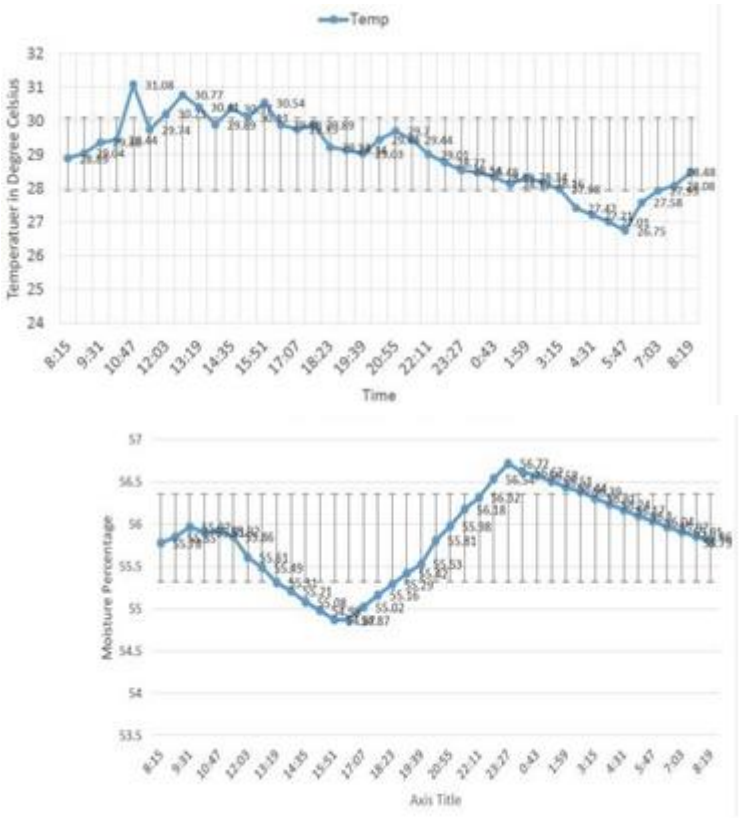

Figure 6,
Figure 4,

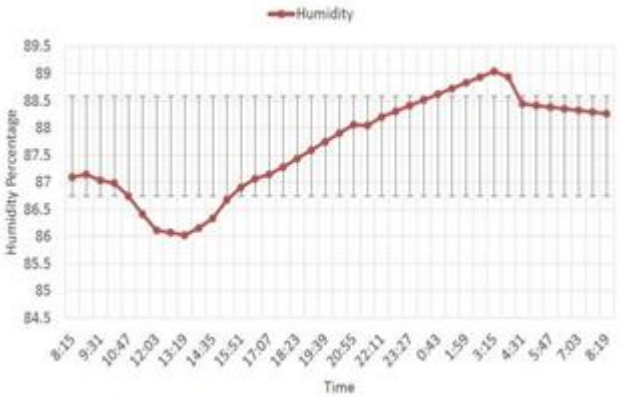

Figure 7 provide graphical representation of humidity, temperature and soil moisture respectively in different times of the day. The graph has been created using the data from the database. In Figure 8 we have used Data logging to store the all data in to the excel sheet. Here, we have used Date, Time, Temperature, Humidity, LDR, Moisture.

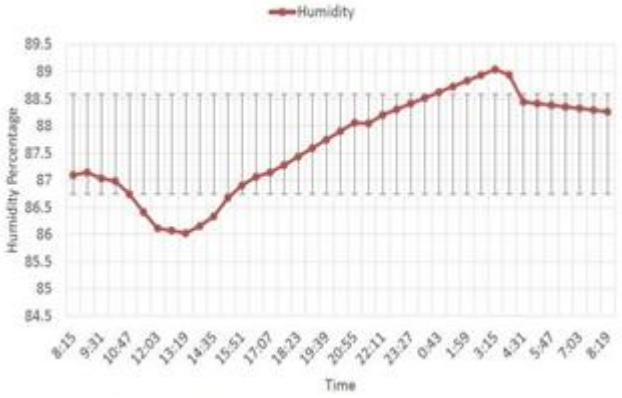

Figure 7 Humidity Data

18	17/6/2022,1:31:6,28.90,62.00,75,473
19	17/6/2022,1:31:8,28.90,62.00,76,475
20	17/6/2022,1:31:10,28.80,62.00,76,475
21	17/6/2022,1:31:11,28.80,62.00,76,474
22	17/6/2022,1:31:13,28.80,62.00,76,473
23	17/6/2022,1:31:14,28.80,62.00,76,472
24	17/6/2022,1:31:16,28.80,62.00,76,472
25	17/6/2022,1:31:18,28.80,62.00,76,471
26	17/6/2022,1:31:19,28.80,62.00,76,471
27	17/6/2022,1:31:21,28.80,62.00,76,471
28	17/6/2022,1:31:23,28.80,62.00,76,472
29	17/6/2022,1:31:24,28.80,62.00,76,470
30	17/6/2022,1:31:26,28.80,62.00,76,470
31	17/6/2022,1:31:27,28.80,62.00,76,471

Figure 8 Data Sheet of Auto-Green

V. CONCLUSION

An inexpensive advanced greenhouse model can be used to monitor and control the temperature, light intensity, humidity and soil moisture of the greenhouse and the required data is recorded on a particular plant using the data recording system in the SD and RTC card module. A timestamp module that displays data for some time this increased productivity in the cultivation and application of such a system in the field can really help to improve crop yields and overall production, and with its level of quality and cost, it will get better. affordable for most agricultural and agricultural communities.

VI. FUTURE SCOPE

The automated greenhouse monitoring system can be developed in many ways and can be used in a wide range of applications. Other sensors such as Enzyme biosensors are used to detect excess pesticides and chemical sensors that we could use as well as pH sensors to maintain a balanced soil pH for the plants to grow. Unusual energy source such as solar panels, windmills are used to provide power to automatic temperature monitoring systems. It has a bright future in the agricultural sector and will create change in it. Also we can use a 360-degree camera module to click pictures of leaves from various angles so that we can detect health of a plant and distinguish between healthy and infected plant and detect the exact disease which a plant can have by this proposed project in the future.

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