Automated Monitoring and Controlling of Greenhouse

Rushabh Shah[1], Manish Inamdar[2], Shreshthi Nalawade[3], Sahil Mujawar[4], Rahul Sonkamble[5]

[1,2,3,4,5] *Sanjay Ghodawat Group of Institutions, Kolhapur, Maharashtra, India*

Abstract— *Internet* of Things (IoT) is a new growing technology. In this technology, multiple peripheral devices and sensors are connected and these devices and sensors can collect and share the data which is collected by various of the sensor from different environmental parameters. Greenhouses are the closed structure area so the environmental parameters such as heavy rain, high temperature, clod can't affect the plants inside the greenhouse so we can manage the environmental parameters inside the greenhouse. We are creating an environment that helps for the growth of plants inside the greenhouse so definitely, it will be going to helps our plants for their growth. To get the maximum plant growth, it required that all the parameters such as temperature, soil moisture, air humidity should be monitor from time to time and it should be controlled automatically so the environment inside a greenhouse will be good for the growth. It has to measure the environmental parameters this parameter is the very important for a greenhouse. Our intention is to create system which user-friendly so everyone can easily use it also it should cost-efficient so it will affordable. Arduino based system that will monitor the values of environmental parameters, which will be frequently changed and manged to get the optimum result. DHT11 sensor which is used for measuring the air humidity and temperate and the Soil Moisture Sensor which measures the water content inside a soil we are also using LDR sensor which helps to get the light intensity and Flame sensor which will detect the fire these all sensors are going to be used in this system. So that it will give the values like temperature and humidity inside an atmosphere as well as it will give the water content and light intensity inside a greenhouse. All environmental parameters are sent to the user through Global System for Mobile communication (GSM) modem. Through GSM we can send the present data of all sensors to the user through the internet.

Keywords: Greenhouse, Monitoring, Controlling, Sensor data, GSM

I. INTRODUCTION

India is a developing country whose more than 40% of peoples do farming. The main source of income for India is agriculture. So, India is an agriculture-based country. And for agriculture water is very important aspect. On earth, there is only 0.5% of water is useful for farming. As per the reports, there is lots of water wastage in the earth and it is a very dangerous problem so we have to find solution for smart and efficient way of irrigation. In the fast-moving world, the human requires that everything is done very quick and fast without manual inaction. Our Lifestyle wants everything around us to be operated without any manual interaction. And without any manual interaction for that simply we can say automation. For the automation, Internet of Things (IoT) is the best technology. The IoT is nothing but creating connection of different intelligent and the self-configuring nodes. That all nodes are connected to each other in a network. IoT is a network of devices that are connected to each other, and then they communicate to perform given tasks. And all those tasks are done without any manual inaction i.e. without any human to human or human to computer disturbance. IoT is new technology which is demanding in different sectors like agriculture, healthcare, retail, transport, environment, supply chain management, infrastructure monitoring, etc. The use of IoT in agriculture will be going to help the farmer. The objective of this project is to measure accurate temperature and humidity inside the greenhouse. And automate the foggor or cooling fan based on present humidity and temperature level so the atmosphere inside a greenhouse maintains. Also, automate irrigation by detecting the exact moisture level in the soil and give only the required amount of water to the plants. And it will be provided only irrigate nutrient diluted water to all crops. It will add nutrients in the water every time. And it will show the data of all sensors on the website and mobile application with good looking UI. A greenhouse can be defined as a closed structure that is used to protect the plants from external factors such as climatic conditions, pollution, etc. Basic factors affecting plant growth are sunlight, the water content in the soil, temperature, humidity, etc. Manual irrigation using buckets, and watering cans, flood irrigation, drip irrigation, sprinkler irrigation is still being used today. The previous system has several limitations; leaching off soil nutrients, erosion due to flooding, loss of water from plant surfaces through evaporation, water wastage which can result in water scarcity in drought areas and production of unhealthy crops. There are some devices are in the market which waters the soil from time to time. They do not sense the moisture inside. This problem can be rectified if we use Monitoring, and Controlling System using the Arduino Platform in which the irrigation, monitoring and controlling will be automated.

II. LITERATURE REVIEW

This system is made up of Arduino microcontrollers. Arduino can receive input from various sensors and it can control motors, lights and other actuators devices. Some sensors, DHT11 sensor, LDR sensor, Soil moisture sensor, and pH sensor is used in this project. Working with a DHT11 sensor is to measure the temperature and humidity

of the environment. The soil moisture sensor is used to measures the water content inside the soil. pH sensor measures the pH of the soil. LDR sensor is used to measure light intensity. Devices like a cooling fan, exhaust fan, water pump, artificial light, and motor pump are also connected to the Arduino which help to maintain the to the mobile user, and the mobile user turns on the fan by sending another SMS. When the temperature comes to the normal range, the mobile user turns off the fan by sending another SMS. When humidity exceeds a defined level, the system sends SMS to the mobile user, and the mobile user turns on the exhaust fan by sending another SMS. When the humidity comes to the normal range, the mobile user turns off the exhaust fan by sending another SMS. When pH of the soil exceeds a defined level, the system sends SMS to the mobile user, and the mobile user turns on the motor pump which sprays acidic or alkaline solution by sending another SMS. Similarly, when light intensity is lower than a defined level, the system sends SMS to the mobile user, and the mobile user turns on the artificial lights by sending another SMS. Finally, when the soil moisture sensor does not sense moisture in the soil than the system sends SMS to the mobile user, and the mobile user turns on the water pump by sending another SMS. To eliminate SMS charges, all environmental parameters are sending to the server through Ethernet and stored in the database. It has disadvantage that the water pump is going to be operated using Wi-Fi module through mobile, so controlling water pump user should carry his mobile phone, or any other device with internet connectivity [4][17].

This proposed system is an irrigation system that uses a photovoltaic solar panel to power system because the electric power supply would be expensive. For the water-saving purpose, an algorithm developed with a threshold value of temperature and soil moisture programmed into a microcontroller gateway. The system has full-duplex communication links based on the internet cellular interface using GPRS based on mobile data for graphically display and stored in a database server. The automation irrigation system consists of two components were WSU and WIU. Wireless Sensor Units (WSU) components were used for minimizing power consumption because the microcontroller is well suited by its lower power current in the sleep mode. Wireless Information Unit (WIU) transmits soil moisture and temperature data to a web server using the GPRS module. The WIU identify recorded and analyzed received temperature and soil moisture data collected by WSU. WIU functionality bases on a microcontroller that programmed to perform the different tasks as to download the data, and time information from a web server and compare the temperature and soil moisture value with maximum soil moisture and minimum temperature value so that irrigated pumps activated [1][11].

This system calculates the three parameters. It takes all this parameter from the various of sensors and activates the other devices 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. The prototype consists 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 and 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 is above the reference value (calculated according to the crop – spinach), to maintain them to be within the threshold levels, the sliding door will be opened and the fan will be switched ON [5].

This Design specifies the system for the Automation of Drip irrigation. In this technology, the humidity and temperature of plants are continually monitored and controlled. Water is very important to the humans and plants. In this system the design of a Microcontroller is based drip irrigation technology, this system control the monitoring and it will be controlling all the activities of drip irrigation system. Water supply system controls by using automated controller to turn ON & OFF. This will help the farmer to give the right amount of water. This saves the water by giving only required amount of water. It improves crop performances and help in time saving in all the aspects [6][12].

“plant irrigation using 8051 microcontrollers” system the deficiency of water in the field is sensed by the op-amp based sensor. Whenever there is a need for water in a particular field, the high signal appears on the output pin of the sensor of that particular field. The output pins of all the sensors are connected to PORT 2 of the microcontroller. The high signals (logic 1) from the sensor are entertained by the microcontroller at a particular pin. By knowing the position of the pin on which signal appears, the microcontroller rotates the water funnel type cup at the desired angle by using stepper motor connected at PORT 0 in a clockwise direction. & switch ON the RELAY (i.e. Water pump) connected at port 0. Now water starts flowing into the required field. After completion of watering the sensor sends a low signal (logic 0) to the microcontroller. When the microcontroller receives this signal, it switches OFF the water pump & rotates the stepper motor in an

anticlockwise direction to the previous angle to bring the funnel cup in its initial position. The project has a disadvantage that it uses 8051 whose signal processing ability and operating speed is not good. Also, it has a limitation on memory this controller has only one serial port therefore interfacing more sensors become difficult [8][10].

Monitoring of soil parameters using this system effective irrigation can be done by using the Wireless Sensor in a Networks, System to develop WSN based soil moisture controllers that determine the water requirement by comparing soil moisture with the predefined threshold value. An intelligent remote system consists of wireless sensor nodes and computer systems in which data is transmitted to a server system from where the data accessed by individuals for decision making for automated control of irrigation for the yield productivity. Field validation tests routinely performed on different soils to measure the soil moisture, water amount in the soil for the efficient irrigation system. If the stored data does not match with the soil measured data, an interrupt sent to the pressure unit and stop irrigation automatically [2][14].

In this system it identifies the field parameters using wireless communication Wireless technology for an intelligent irrigation system has become a popular. Monitoring parameters of temperature and humidity is an important for obtaining high-quality environment inside greenhouse. Remote monitoring is a useful method to avoid interference environment and improve efficiency. In this system through the website farmer can view the status of the farm such as the temperature, moisture, fertility of the soil and live video of the farm and also makes a social network in between the farmers [7][13].

"Precision irrigation based on wireless sensor network," describe the different type of sensor nodes for real monitoring and control of irrigation system. Each node consists of Telos mote and actuator. Telos mote is an ultra-low-power wireless module for monitoring applications. Soil nodes used to measure the soil moisture weather nodes used to measure environmental parameters and actuators used for controlling the opening of valves for irrigation. The system has cost-efficient and reduces the power consumption the experimental result shows that the plants are well irrigated and if there is any change in threshold value the system alert to a farmer about the problem to take the appropriate decision [3][9].

There are some limitations of the existing system. which are It required more manual work Previously there are some microcontroller the operating speed of that microcontroller is very poor So, interfacing more sensors become difficult We Cannot Control the Environment inside the greenhouse Also, it required 24/7 internet connectivity And it Cannot Monitor the system from a remote location through web-site or mobile application.

Watering the plants is usually a very time-consuming activity and when it comes to the farm it requires a large number of human resources and time. Traditionally, all the process was executed by humans. Nowadays, there are some systems that use new technology so it reduces the number of workers or the time required to water the plants. With the help of these systems, the control over the system is very limited, and many resources are going to be wasted. Water is one of these resources used excessively. One of the methods is Mass irrigation this method we can use to water the plant. This method has massive losses since the lots of water given is in excess of the plant's needs.

If in case the excess amount of water is given to the plants then it came out by the holes of the pots in greenhouses. As in mass irrigation the massive amount of water is came out of the holes. That's why wastage of lots water is done. So, as a result, if no effort is invested in optimizing these resources, there will be more money involved in the same process. Technology is the solution to reducing costs and utilizing this resource. These resources have to use very carefully to save this resource. So, use of the proper irrigation system with technology is very important in today's era.

III. PROPOSED SYSTEM

The proposed system supports water management by sensing soil moisture and controlling the environment inside a greenhouse by measuring the parameters like temperature and humidity. The system continuously monitors the soil moisture and provides an accurate amount of water required to the crop by adding nutrients inside water automatically. The system can also control the environment inside a greenhouse by sensing the humidity and temperature inside a greenhouse. The system works 24/7 without any interrupt. It is a Low-cost system and effective with less power consumption and without any manual interaction. Users can monitor the system from a remote location through the website or mobile application. Cameras used to capture live videos of the greenhouse. By using these videos, the user able to see the real condition of the greenhouse and control the greenhouse remotely from any part of the world.

IV. PROPOSED SYSTEM ADVANTAGES

• Conserves Water and Time

Watering the plants manually can take substantial time. The user doesn't need to monitor the watering because the

water will be going to provide only when the plants required it. It does not require any manual interaction so it saves time. Also, your water bill should be lower if the irrigation system is effective.

• Remote Monitoring

Through this system user can monitor environmental parameters inside a greenhouse from any geographical location. User can monitor this parameter in graphical forms through the website. User can also view the live picture inside a greenhouse.

• Complete elimination of manpower

By using this system, it does not require a large amount of manpower. In the traditional farming amount of manpower. By using this system, we complete eliminating the manpower.

• Controlling the Environment

This system can maintain the greenhouse environment inside greenhouse. This system can maintain the temperature and humidity inside a greenhouse. By using some peripheral devices.

• Preserves Soil Structure and Nutrients

When we provide a much amount of water to the farm as a result, nutrients leach out with the water runoff. So, in that condition this system is very useful it gives only the required amount of water to the plants so it preserves the soil structure and nutrients inside the soil. Using either drip or sprinkler irrigation produces smaller droplets, helping to preserve nutrients and reducing soil compaction. It gives the water to the roots of the plants. So, it will be helpful for the growth of the plants.

V. SYSTEM ARCHITECTURE

Our system has different sections, One section is for supervising which keeps an eye on every sensor and another section that controls all the electronic devices which are connected to the microcontroller kit. The supervising section consists of a variety of sensors like DHT sensor, LDR sensor, Soil moisture sensor and fire sensor these all sensors follow the environmental parameters. We are also using a GSM modem which is connected to our microcontroller kit. Which receives and transmit the data which comes from all the sensor. IT sends that data to web-site through that out client can see the current data inside a greenhouse. The next section consists of a cooling fan or fogger, exhaust fan, water pump, artificial light, and motor pump or valves these are all electronic devices that are used to create an environment which supports the growth of plants. Arduino microcontroller is placed in the middle of the system which controls every activity of the greenhouse. The system can also capture live videos of the greenhouse. The block diagram of greenhouse monitoring and controlling is given bellow

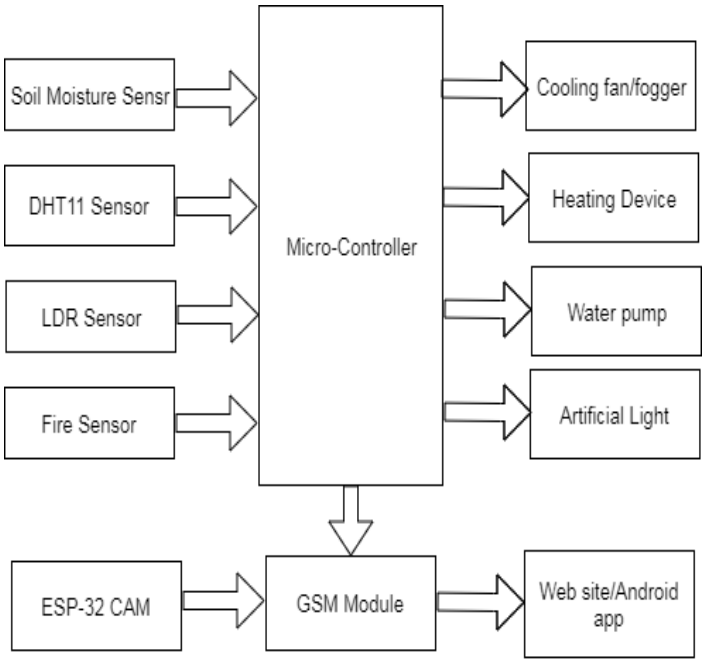

Figure.1. System architecture

VI. METHODOLOGY

We have to implement this system through which we will create a climate inside a greenhouse that is useful for the plant's growth. For that, we have to get appropriate values of all sensor data. Our sensor data will be soil moisture and temperature and air humidity inside a greenhouse. Also, we are going to take light intensity value so that only when required the lights will going to start. So, through that, we can also save electricity. So, to implement this all we have developed this system named “Automatic monitoring and controlling greenhouse”. All greenhouse is divided into a different area and in all areas, the soil moisture sensor is placed inside a soil so it can take the soil moisture values of that particular area. The result of the sensor is given to the Aurdion kit. And that result came from a sensor is given to electronic devices so from that result it will do next action like turn ON or OFF. Like soil moisture sensor we are also going to take values from the DHT sensor and that values will be Air humidity and temperature inside a greenhouse. And by using these values we are setting some Threshold value values. And to calculate that the formula is given.

*Threshold value = Temperature + (Humidity*0.1)*

If the *Threshold value* exceeds, then the electronic devices automatically turned ON, So we can maintain the required atmosphere inside a greenhouse by staring at these electronic devices. And through that, we are maintaining humidity and temperature in the closed Greenhouse. The

information collected from this sensor is given to the client through the website using the GSM module.

VII. ALGORITHAM

Step 1- Start
Step 2- Initialize the Arduino
Step 3- Initialize the ESP32
Step 4- Initialize the Sensor's
Step 5- Assign pin to get the sensor sensed data
Step 6- Assign the variable's for data send by sensor Step 7- Print the sense value
Step 8- if current data < threshold value || current data > threshold value write function and write the data as to high
Write (device, HIGH)
else
write function and write the data as to low.
Write (device, LOW)
Step 9- This value sends to the relay
Step 10- Depending on value relay start/stop the devices automatically
Step 11- After the process completion, it moves to original state
Step 12- Stop.

VIII. RESULT

- **ARDUINO**

Arduino is a microcontroller. The microcontroller is an electronic board on which we can upload only a single program at the time. It is an open-source electronics board so it is very popular. In Arduino, ATmega328P microcontroller is used. It provides 5V and 3.3V output voltage options. In Arduino, there are 14 digital input/output pins which give result in only o's and 1's and is also have 6 analog inputs pins through which we can take result in analog form. There are different types of Arduino boards are in market Arduino Uno, Arduino Mega, Arduino Yun, etc. [15]

- **GSM MODULE**

GSM is nothing but a global system for mobile communication (GSM). GSM was introduced in Bell Laboratories in the year 1970 The main purpose of GSM is a mobile communication system. GSM is digital cellular technology. By using GSM, we can transmit mobile voice and data services. Every mobile device has inbuild GSM facilities. A GSM collects the data. And then sends it through a channel with two different clients, each in its given time slot. It has 64 kbps to 120 Mbps of data rates.

- **SOIL MOISTURE SENSOR**

In soil moisture sensor there are two probes. Through these props we can get the moisture value inside a soil. The current transmits through these two probes. It allows the current to pass through the soil so it will get the resistance value. Through the resistance value, we can get the moisture value inside a soil. When there is more water inside a soil, the flow of current from the soil will be more because there will be no resistance to current. So, we can say that there will be less resistance and more current flows from the soil it means soil is wet. In the dry soil the electricity flow is poor. so, when there will be less water in the soil, then the flow of electricity from dry soil is less because it will increase a resistance. The soil will conduct less electricity which means that there will be more resistance. Therefore, we can say that soil is too dry. This sensor can work in analog mode as well as digital mode. [16].

- **DHT11 SENSOR**

DHT11 sensor is made to measure the temperature and humidity in one sensor. Its manufacturing cost is very low. It is highly reliable and it works with a high efficiency. So, it has long-time stability. It uses thermistor and humidity measuring component. Using the thermistor, it calculates the temperature. And by using humidity measuring components it measures the humidity.

- **LDR SENSOR**

LDR is nothing but Light Dependent Resistor. It is sensor module which uses to measure light intensity.

It works on both mode analog as well as digital. It gives output in both mode analog and digital. If intensity of light increases, then the resistance of LDR decreases. And if the intensity of light decreases, the resistance of LDR increases. From this method it calculates the intensity of light. This sensor has a potentiometer knob. By using that it can adjust the sensitivity of LDR sensor towards the light.

- **FLAME SENSOR**

A flame-sensor is used to detect fire. This senor is more accurate then another sensor. This sensor also works on both mode digital and analog. When it detects the fire it gives result as 1 and when there is no fire it gives result as 0.

Figure.2 describes the environmental Parameter inside a greenhouse and this value is shown on the serial monitor

Figure.3 shows live picture inside the greenhouse by using ESP-32 WEBCAM module. It captures the live images of a greenhouse.

Figure.4 describes the initial parameters inside a greenhouse. It shows the environmental parameter such as Moisture inside a soil, Temperature, Humidity, and Intensity of light. Initially. the soil moisture value is 0% there is no water present inside the soil. And the temperature is constant at 26℃. **Figure (c)** shows the

humidity which is 95% and the intensity of light is more than 100 and it is changing after some time from more than 100 to less than 100.

Figure.5 shows the same environmental parameters which are shown in **Figure.2** It is showing this parameter after the specified time interval of 10 minutes. In **figure.3** it is showing water contain inside a soil which is the same as in the previous figure but the temperature is increasing from 26℃ to 27℃. Humidity is constant 95%. And the intensity of light is changing from 10 to 17 to 15 to18 to 15 to 18 to 23 to 22 constantly.

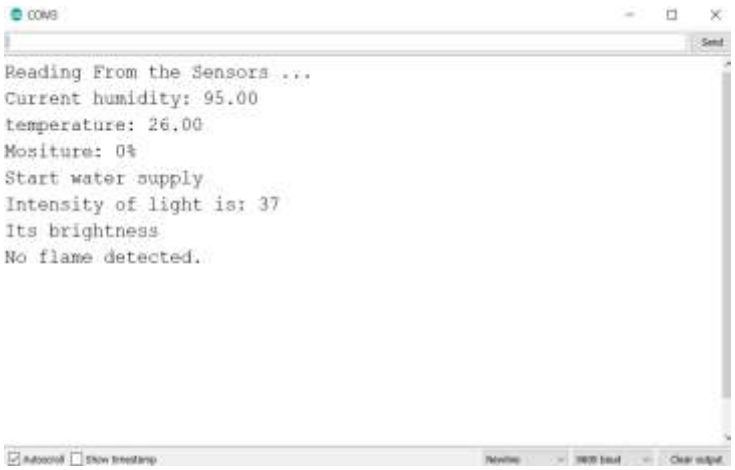

Figure.2. Parameter values on serial monitor

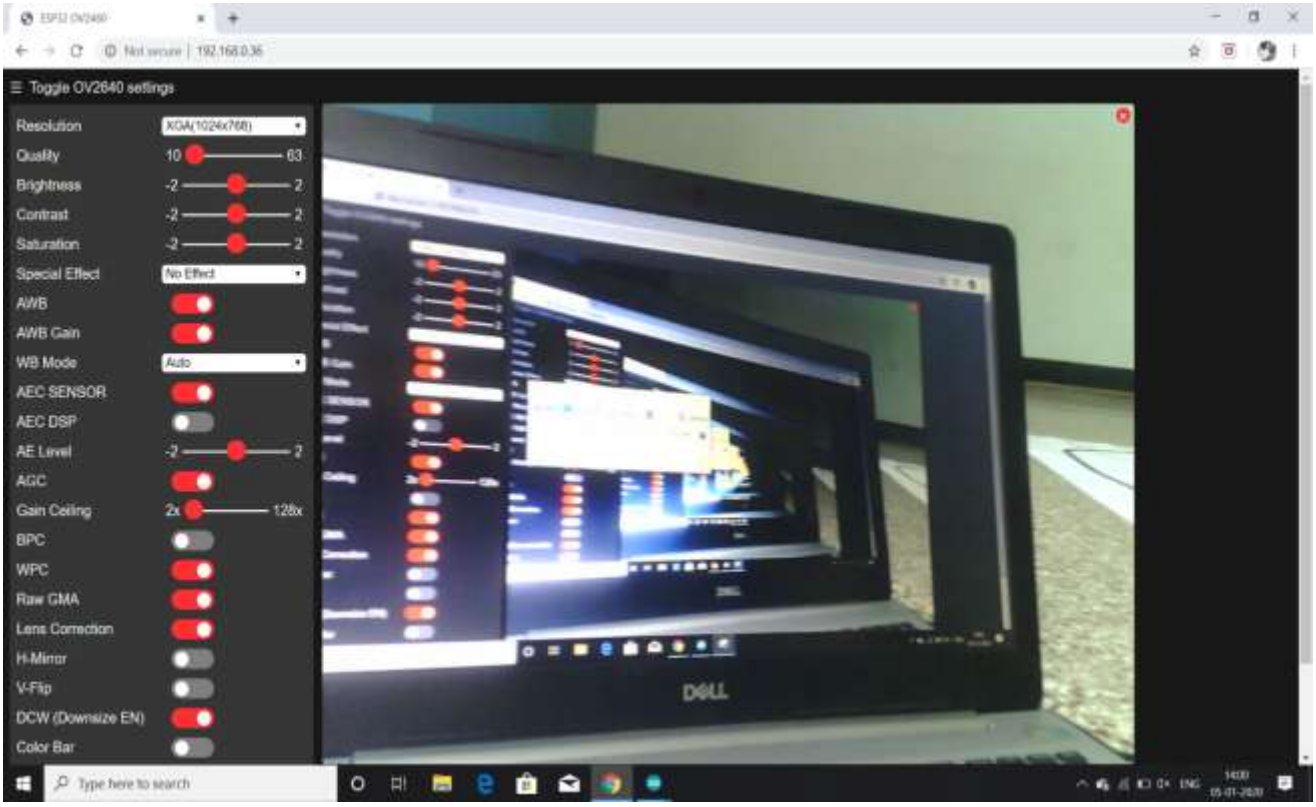

Figure.3. Live Streaming Using ESP-32 WEBCAM

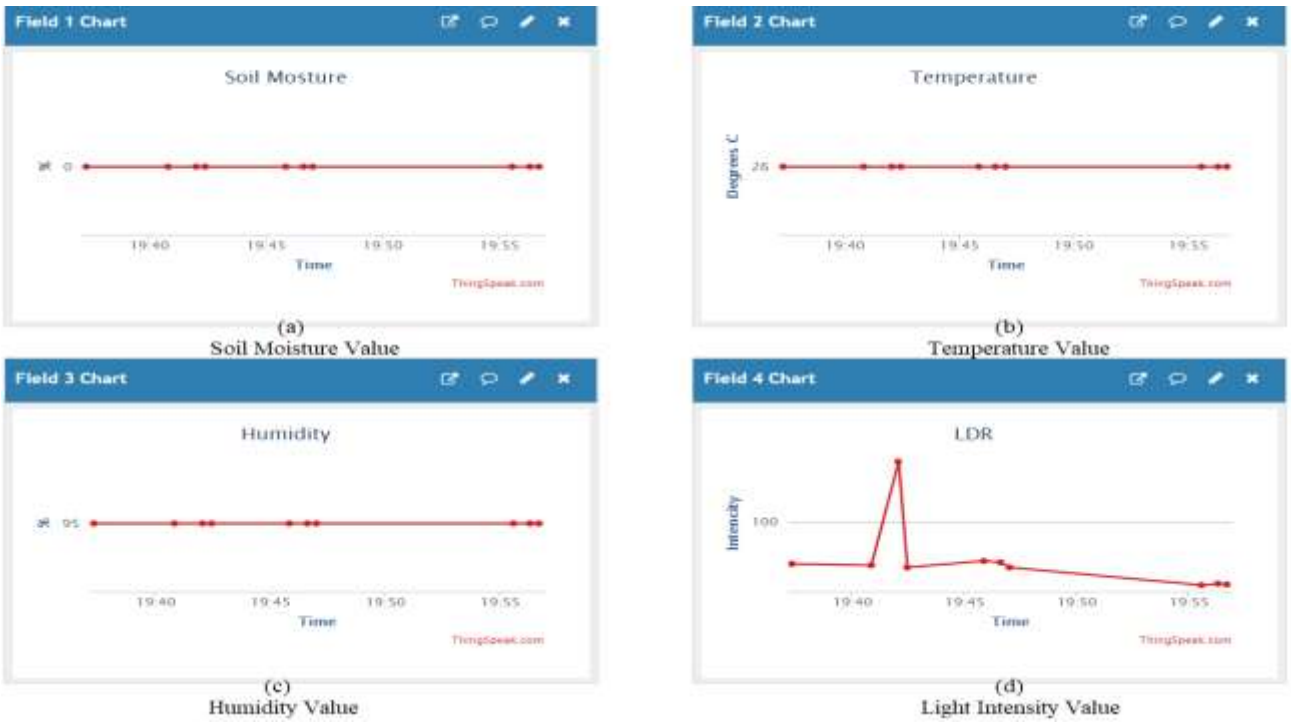

Figure.4. Initial Values of Environmental Parameters Inside Greenhouse

Figure.5. Values of Environmental Parameter After Specific Time Interval of 10 minutes Inside Greenhouse

IX. CONCLUSION AND FUTURE WORK

An Arduino based **"Automated Monitoring and Controlling of Greenhouse"** is designed using the DHT11 sensor, Soil Moisture Sensor, LDR sensor and flame sensor are the main sensors used in this project which give the exact value of temperature, humidity, moisture content, light intensity respectively. This system found to be feasible and cost-effective for optimizing water resources for agricultural production. Implementation of this system proves that the use of water can be diminished for a given amount of fresh biomass production. This system can change by the variety of the crop and there needs so it requires minimum maintenance of crop. The modular configuration of this system allows it to be scaled up for larger greenhouses or open fields. Also, other applications such as temperature and humidity monitoring take place. And according to that, it manages the environmental parameter and the electrical devices inside a greenhouse. This system gives the accurate value of temperature, humidity and moisture content inside a soil it also gives light intensity. This system is designed for controlling and monitoring environmental parameters in the greenhouse. Internet is used to send the data parameters to the website and the android application. This system reduces power consumption, maintenance, and complexity.

Future work can be done on plants disease detection. As well as we can do the face recognition and face detection using this system.

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AUTHORS PROFILE

Rushabh Shah BE in Computer Science & Engineering from Sanjay Ghodawat Group of Institutions, Kolhapur.

Manish Inamdar BE in Computer Science & Engineering from Sanjay Ghodawat Group of Institutions, Kolhapur.

Shreshthi Nalawade BE in Computer Science & Engineering from Sanjay Ghodawat Group of Institutions, Kolhapur. She has worked in women monitoring system.

Sahil Mujawar BE in Computer Science & Engineering from Sanjay Ghodawat Group of Institutions, Kolhapur.

Rahul Sonkamble Assistant Professor in Sanjay Ghodawat Group of Institutions, Kolhapur. He is pursuing Ph.D. in "Blockchain" domain from Symbiosis International University.