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“REGULATING GREENHOUSE ENVIRONMENT FOR GROWING MULTIPLE CROPS”

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ABSTRACT: In present world scenarios where the world population is being increased in leaps and bounds, we need to find proper agriculture methods which can give good harvest and also the quality of crops which are being produced must be good. Greenhouse farming is one such methodology where we will be growing plants in a closed environment. Greenhouse farming has some requirements like continuous monitoring of the environment variables like temperature, light intensity, humidity content monitoring and many more. An IOT based controlling system can be used to do all the prescribed tasks and therefore by monitoring all those environmental variables we can get good harvest. It is an Arduino based controlling system which makes use of different types of sensors like temperature sensor, humidity sensor, Carbon Dioxide sensor, light intensity sensors. We can also view the condition of planted crop using a web application. When the condition of plant is found to be unstable, respective greenhouse user will get a notification indicating that plant needs some more care. While the traditional methods support monitoring a single crop, our system can be used to monitor multiple crops. Cultivating multiple crops can be very beneficial in terms of both money and time. Hence our system can be a helping aid for all the farmers and in turn harvest rate increases which can improve food production rate.

KEYWORDS: Greenhouse, IoT, Sensors, Micro Controllers, Arduino, Oxygen Level, Monitoring, Controlling, Ventilation, Crops, Sustainable Farming.

I. INTRODUCTION

India is one of the major players in the agriculture sector worldwide and it is the primary source of livelihood for about 58% of India’s population. It is the second-largest producer of fruit, vegetables, tea, farmed fish, cotton, sugarcane, wheat, rice, cotton, and sugar. Agriculture sector in India holds the record for second-largest agricultural land in the world generating employment for about half of the country’s population. Thus, farmers become an integral part of the sector to provide us with means of sustenance. According to Inc42, the Indian agricultural sector is predicted to increase to US$ 24 billion by 2025. Indian food and grocery market is the world’s sixth largest, with retail contributing 70% of the sales. As per First Advance Estimates for FY 2022-23 (Kharif only), total food grain production in the country is estimated at 149.92 million tons. Rapid population expansion in India is the main factor driving the industry. In this ever growing population we need to make sure that all the crops which are being produced are healthy and also they follow some food safety guidelines. Normally in India there are 2 major seasons when harvesting is done. They are Kharif and Rabi seasons. Certain crops can be grown in only one season and they can’t be grown in other period of year. But in order to grow crops irrespective of season we need to make sure that suitable environment is being provided. Greenhouse is one such methodology where we will be growing crops inside a closed area which is free from external factors like sunlight, insects etc. Green house structured with transparent sheets all over maintains perfect climatic conditions under the human monitoring. It requires a constant and periodic human monitoring to control the temperature, light

intensity, soil moisture and the humidity to retain the required climatic condition that is entailed for the crop growth. It serves as protection against the climatic changes to extend the season for the growing the crops. In greenhouses we can easily control the internal environment temperature, humidity, light intensity and all other factors which will play a major role in deciding crop yield. Despite the green house being very beneficial for the farmers as it increase the yield of the crops and production rate it causes a discomfort for the farmers as they have to keep a periodic check on the green house by making regular visits and failure to maintain the perfect climatic conditions will result in the destruction of the crops and the production rate. If we want to grow multiple crops at a time and in single place we need to monitor each crop separately and we need to ensure that they are being monitored regularly and they are being grown correctly. If we can control the entire environment of greenhouse we can grow all types of crops throughout the year irrespective of the season. This controlling can be done with the help of IOT technology. The emergence of the sensors and the internet of things have changed the situation of the green-house. It has bought in the automation into the controlling and the surveillance of green-house by employing the sensors, internet of things and the embedded technology. We can use different types of micro controllers and sensors to regulate the entire environment of greenhouse. By make use of greenhouses properly we can eliminate the usage of pesticides and insecticides as greenhouses are closed environments. The yield which we can get from greenhouse is better than those of traditional farming methods. In order to provide sunlight, we thought of using fluorescent bulbs which emit light energy that is similar to sunlight. In order to control the moisture levels in soil we can make use of moisture sensors and with those results we can turn on or off the water motors. We can also make use of temperature sensors in order to monitor the temperature of the climate.

II. BACKGROUND WORK

LITERATURE REVIEW

[1] Review of Sensors for Greenhouse Climate Monitoring was developed by **V. M. Quan, G. Sen Gupta, S. Mukhopadhyay** in the year 2011. The purpose of this paper is to provide a review of a range of popular sensors on the market. The paper also discusses their operating principles as well as addresses their advantages and disadvantages. Experiments were carried to test the accuracy of the sensors and the results indicate that the sensors used in this project are relatively accurate and have good stability.

[2] Monitor and control of Greenhouse Environment the Project GreenBee by **Sumit Kumar, Mohit Kumar, Aswani Kumar, Praneet Garg** was proposed in the year 2012. An integrated Liquid crystal display (LCD) is used for real time display of data acquired from the various sensors and the status of the various devices. Also, the use of easily available components reduces the manufacturing and maintenance costs. The design is quite flexible as the software can be changed any time. It can thus be tailor-made to the specific requirements of the user.

[3] Energy reduction measures in agricultural greenhouses heating: envelope, systems and solar energy collection is an idea that was developed by **E. Fabrizio** in the year 2012. A tunnel greenhouse for basil production of 40 m of length and 10 m of width was considered as a case study and modelled within the Energy Plus simulation software. The climate locations that were considered refer to the north-west of Italy. The results show that savings of the order of 30% can be achieved by using more insulated transparent materials. On the contrary, the application of the solar collectors still remains problematic because of the large land use and lower global efficiencies.

[4] Optimum design and orientation of the greenhouses for maximum capture of solar energy in North Tropical Region was proposed in the year 2015 by W.M. El-Maghlany et al. This investigation is devoted to calculate the amount of solar energy that can be captured by the greenhouse surface. This energy reduces the cost of fossil fuel or any other heating systems used to warm the greenhouse during winter season. The novelty in this study is the handling of the greenhouses surface analytically.

[5] Android based Greenhouse Monitoring and Controlling System was developed by **Pradeep Kasale, Shekhar** Kedar and team in the year 2015. This project is designed to monitor and control the indoor humidity and weather conditions affecting the plants using embedded system and Android mobile phone. The android phone is connected to a central server which then connects to microcontroller and humidity sensor via serial communication. Thus the sensor records and manages the required weather conditions proved to be appropriate for plant growth.

[6] Ravi Kishore Kodali, Vishal Jain, Sumit Karagwal presented "**IoT based smart greenhouse**" in a conference that was held in 2016. This work is primarily about the improvement of current agricultural practices by using modern technologies for better yield. This work provides a model of a smart greenhouse, which helps the farmers to carry out the work in a farm automatically without the use of much manual inspection.

[7] The Efficacy of greenhouse natural ventilation: An environmental monitoring and CFD simulations of a study case was studied **by S. Benni et al** in the year 2016. This research considers an Italian greenhouse for horticultural production and aims at identifying optimal vent configurations and opening management procedures for indoor environment control, focusing on summer cooling. Numerical modeling of airflows and temperature distributions was carried out through finite element CFD software, with streamline upwind discretization schemes for advection terms.

[8] Wind-driven natural ventilation of greenhouses with vegetation was an approach by **C.-R. Chu et al** in the year 2018. A large eddy simulation (LES) model was used to examine the wind-driven cross ventilation of gable-roof greenhouses containing vegetation. The obstruction of air flow by vegetation was described by a porous drag model in the numerical model, and the simulation results were validated using wind tunnel experiments. The numerical model was then utilized to inspect the influences of vegetation and greenhouse length (in the wind direction) on the ventilation rate. The results revealed that the diminishing effects of the vegetation, insect screen and internal friction on the ventilation rate can all be quantified by a physical-based resistance model.

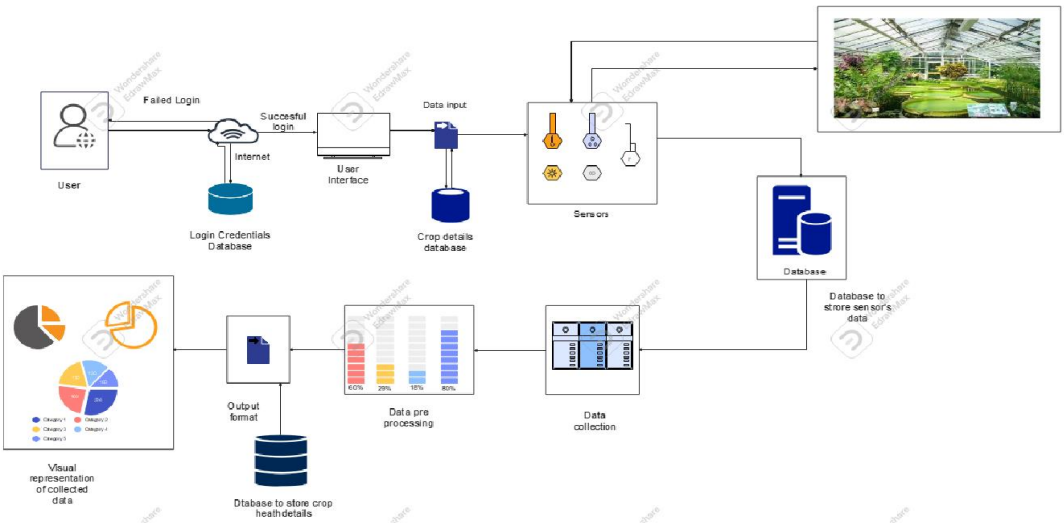
III REVIEW OUTCOMES

The basic idea of including sensors in greenhouses is mentioned in the paper **Review of Sensors for Greenhouse Climate Monitoring**. Using that paper we got the basic idea of automating the greenhouse. In the paper **Monitor and control of Greenhouse Environment the** usage of LCD display for displaying the real time values of sensors is initiated. Using those values controlling of greenhouse was facilitated. In order to control the lighting in a closed environment we need to know how it can be done and it is mentioned in **Energy reduction measures in agricultural greenhouses heating.** From this paper we came to know how light intensity can be controlled. In the year 2015 a series of experiments were conducted to know how plant growth will be affected when there are lighting intensities. As these experiments are conducted in tropical regions, plants which grow in those regions were used to monitor. In order to know how android devices can be integrated with greenhouse monitoring systems, we studied **Android based Greenhouse Monitoring and Controlling System**. This paper gave a clear view in integrating android devices and also the communication methodology used in connecting those devices. In the year 2016 a conference on modern methods in farming was held. In that particular conference a paper named **IoT based smart greenhouse was published and it emphasized** the need of new methods in farming and the paper also discussed the structure of smart greenhouse. Apart from the importance of light intensity in determining plant growth, ventilation also plays an important role in plant health. Hence the paper **The Efficacy of greenhouse natural ventilation** focused on providing ventilation in greenhouses. Basic methodology was discussed in this paper and we came to know how we can integrate those methodologies in greenhouses. In the year 2018 a paper on wind driven ventilation was published, with that paper reference, we understood how natural ventilation methods can be used in deploying a smart greenhouse.

IV. WORKING METHODOLOGY

An IOT based smart monitoring device is developed to control the environment variables of a greenhouse. This device is connected to a web application which provides insights in changing a greenhouse into a smart greenhouse. We will be guiding the greenhouse users in issues like, placement of sensors, lighting equipment and a chatbot to clear user's doubts. The working of IOT based device depends more on regulating the environment values. Our approach is to segment the entire greenhouse into multiple parts and then grow a variety of crops in those parts. For each and every part we need to adjust the climatic variables present over there. If proper environment can be arranged, then crops grow with good health and also the harvest from those crops will be profitable. In order to adjust the environmental conditions in a greenhouse, we need to know about the conditions in which the plant will grow and also the type of season in which the crop grows must be known. We will collect the information regarding the type of crop which is being grown from the owner of user and based upon that data our system works. In a greenhouse we need to concentrate more on regulating the temperature, light intensity and moisture values. We will be using different types of sensors like moisture sensor, temperature sensor, light intensity sensor and CO sensor to read the instantaneous values of crop environment. Upon reading the values from the sensors, system will compare those values with the threshold values which were already fed in the system. If those values are not in accordance with the threshold values, necessary changes will be made to adjust the surroundings. If the temperature of a particular division is high, then cooling fan of that division will be turned on. If the light intensity is low in a particular division, then the lights of that division will be turned on or turned off accordingly. If the moisture content of soil in a particular segment is not in accordance with threshold value of that segment then the water motor responsible for that particular area will be turned on and once after the value of moisture sensor reaches the threshold then the water motor will be turned off. This entire process will be repeating continuously. The levels of Carbon Monoxide present in air will definitely contribute in determining the crop health. So we also need to regulate the levels of carbon monoxide periodically. Once after collecting the values of Co levels, system regulates it by the help of exhaust fans. These fans will be turned on and off corresponding to the values which will be collected by CO sensors. All the values which will be collected by sensors are displayed in the web application from time to time. Software provides options to view the status of every crop individually, interact with chatbot to clear user's doubts, to enter the greenhouse dimensions. User can also view about our software, what it does, and the cost incurred in modifying a normal greenhouse into a smart greenhouse. User can also view the status of crop based on the present and current sensor values. In this way our entire system works. User can login whenever she/he needs to know about the status of plants. User can change the details of greenhouse as per their convenience. Once the user starts using this software, all the details regarding crops, greenhouse dimensions, crop status, cost incurred in modifying a greenhouse into a smart greenhouse will be saved. User can view those details whenever he/she wishes to see.

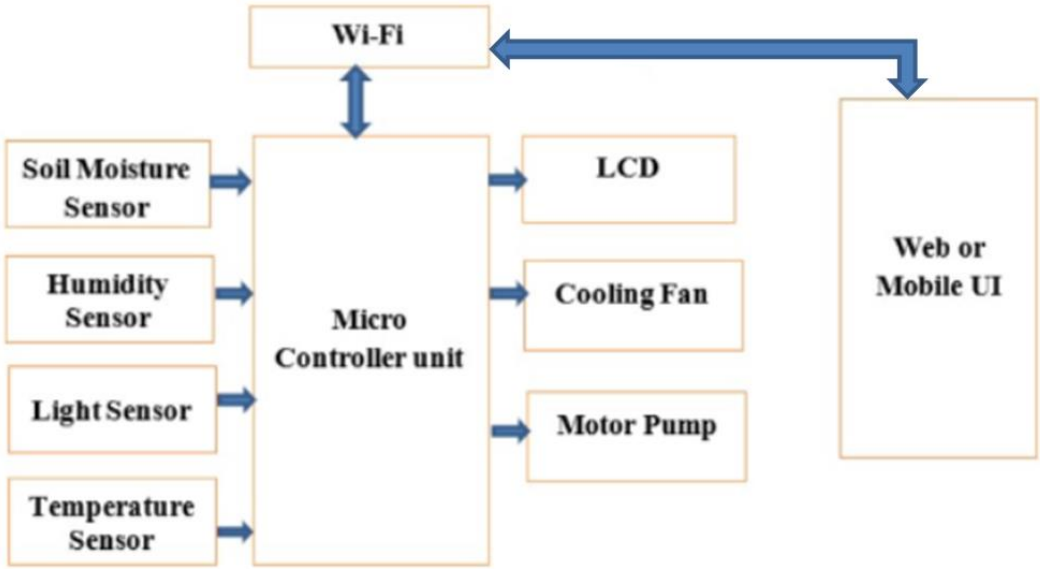
System Architecture



Components of system

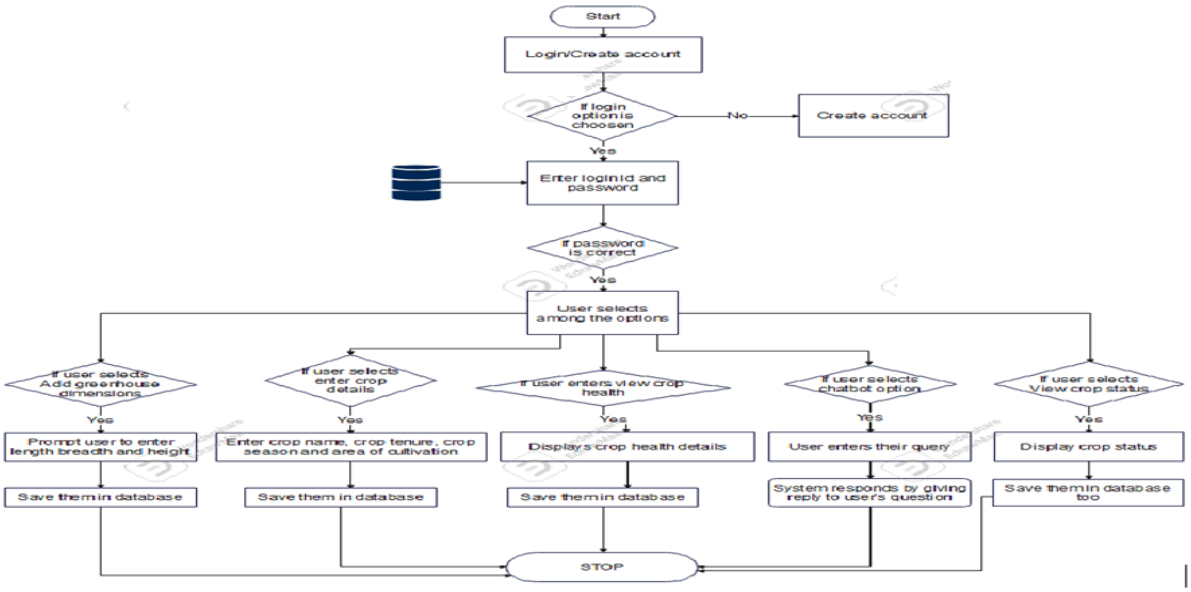
- Moisture sensor, Temperature sensor, Humidity sensor, CO sensor, Light intensity sensor
- Node MCU/ Arduino
- Connecting wires
- Cooling fan
- Water motor
- Web application

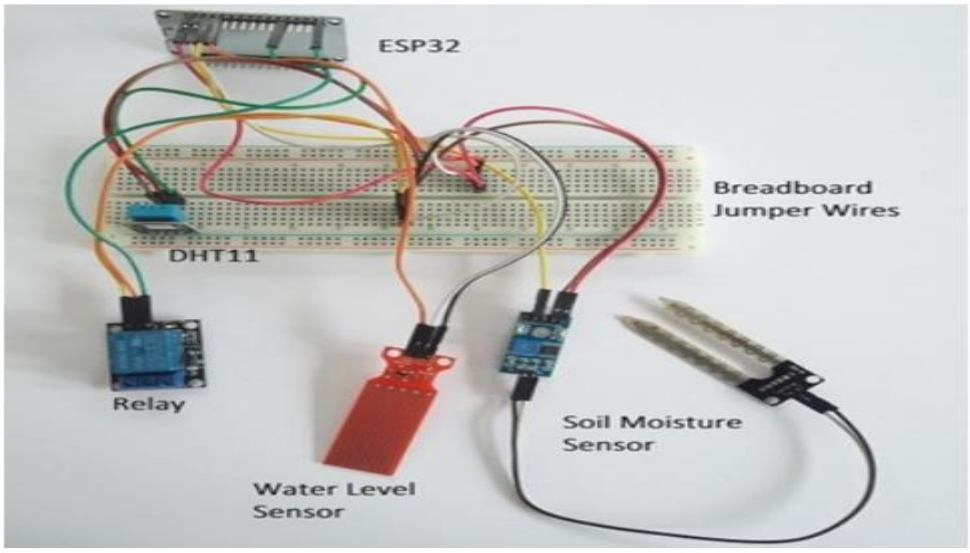
Component block diagram



We will connect all the sensors with the micro controller unit in serial manner in such a way that they transmit the measured values from instant to instant and then we will place the entire system in one segment of the greenhouse. We replaced all the normal lights which are used to transmit light to plants with CFI bulbs which are non-toxic and are also pollution free. CFL bulbs split light evenly and also the light generated by them is not harmful to plants and also it increases crop harvest.

Flowchart

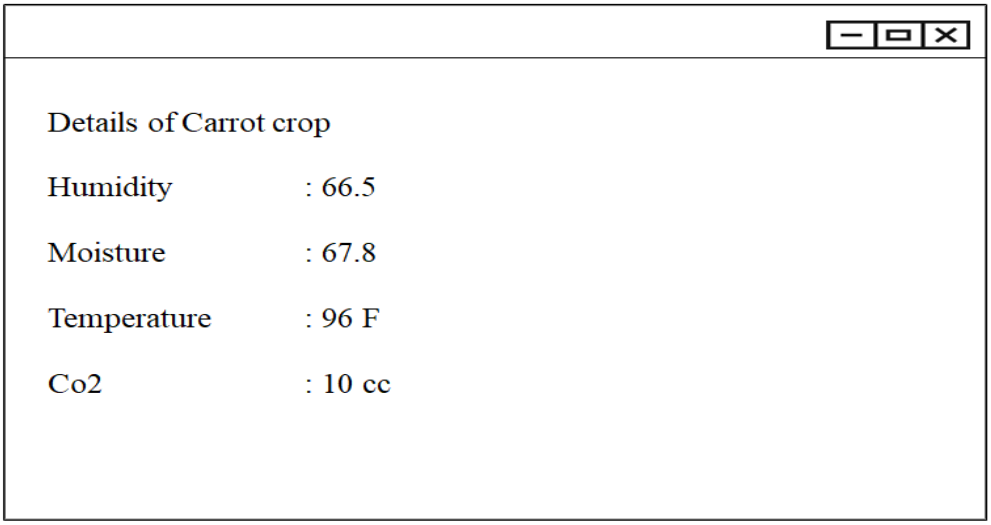




Web Application Images

1. Login page

2. Results



IV. CONCLUSION

A smart greenhouse monitoring system has been implemented successfully using the concept of IoT which can prove to be a boon for agriculture sector. The traditional system for greenhouse monitoring is labor-intensive and time consuming. The proposed system saves time, money and human effort. It provides a controlled environment for the plants and thus increases the overall yield. The smart greenhouse automatically optimizes the various parameters for the plant growth. It sends the real time data of parameters to a customized webpage for continuous and effective monitoring. The project can be used in greenhouses, botanical gardens and agriculture farms. Temperature monitoring and controlling action can be used in home or various halls like conference room, seminar hall to control the temperature of room. With little modification, this project can be used in mechanical companies to measure various parameters of operating machines like temperature and light. This paper designs a greenhouse automatic control method and system based on complex event processing and provides a general greenhouse-oriented CEP system implementation plan for agricultural experts and related workers. This structure of our system has the advantages of high efficiency, convenience, and low coupling, which can solve the problem of identification and integration of complex patterns in the greenhouses.

V. REFERENCES

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