e-ISSN:2582 - 7219

INTERNATIONAL JOURNAL

OF MULTIDISCIPLINARY RESEARCH

IN SCIENCE, ENGINEERING AND TECHNOLOGY

Volume 6, Issue 1, January 2023

INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 7.54

6381 907 438 6381 907 438 ijmrset@gmail.com www.ijmrset.com

International Journal Of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.54|

| Volume 6, Issue 1, January 2023 |

| DOI:10.15680/IJMRSET.2023.0601008 |

A Review on Controlling Greenhouse Environment Using IoT

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ABSTRACT: This is an approach to automate the requirements in a GREEN HOUSE. If we improve the conditions and needs in a greenhouse we can have good crop yield. By creating an artificial environment where we can control the amount of light and the amount of water along with the nutrient contents supplied to the plants, we can attain stable and healthier plants, which in turn giveus good profits. Excessive sunlight may make plants brittle and it may lead to loss of nutritional content in plants. And also the counter effect is that inadequate sunlight may also cause many ill- effects**.** If we can control the amount of light supplied we can get better output. Along with this if we can control the amount of water according to type of the crop that we are going to cultivate, we can get better crops. And also controlling the amount of light during night times is not an easy task. So automating this can reduce man power. Supplying water through DRIP IRRIGATION can also improve the health of saplings and in turn we can get good harvest. A total view of our project can be defined as automating all the needs of a greenhouse along with some more added features like artificial sunlight and also monitoring the needs of different plants at the same time.By doing these things we just want to help farmers and other people who are interested in practicing new kinds of methodologies in farming.

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

I INTRODUCTION

Generally, a country's growth depends upon the large scale industries and short scale industries it is having. In a country like India, where FARMING plays a main role in determining country's GDP and economic stability we need to search for more eminent met hods which improve the profitability. On the other side of the coin, Farming needs to be done with utmost care and we need to be more vigilant. One should estimate the climatic conditions and also we need to choose the type of crop that is most suitable to grow. Apart from all these conditions, we should also look into the monetary issues. In some cases, natural calamities may wash out all the harvest we made and it leads to a huge havoc in farmer's life. Most importantly, in a country like India where most of the people lead their lives by doing farming, it is highly recommendable to use various methodologies of farming where one can be sure of farming. And one such methodology which wasintroduced in the past was GREEN HOUSES. In this methodology we grow plants in a closed environment which is made of glass through which sunlight can pass into. Plants are not exposed to rain or wind or any other external environment. We need to supply water and other nutrients manually to the plants. Doing all these chores manually can reduce the efficiency and also we need a lot of man power for that. If we consider a greenhouse where we will be cultivating different types of crops, then adjusting the climatic conditions for all of them is a huge task.

If we automate all those tasks it makes farming inside greenhouses an easier one. 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. As plants release oxygen and also when the concentration of Carbon Dioxide gets decreased, it may affect the growth of plants. So we need to turn on the ventilators and off them periodically. This can also be automated by monitoring the levels of Co2 in air.

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II. BACKGROUND WORK

Literature Review

- **Mashonjowa J. G.** proposed **The thermal performance of a naturally ventilated greenhouse using a dynamic greenhouse climate model** in 2013. The model adequately simulated the internal greenhouse microclimate using outside climate data including incident solar radiation, cover transmittances and greenhouse configuration as inputs.
- **A Zigbee based Greenhouse Monitoring and Controling system** was developed in 2013 by **Bharat Institute**. The paper presents an approachto the design and performance analysis ofa flexible greenhouse monitoring wireless sensor module, based on general purpose microcontrollers and low power ZigBee communication modules. The results show good performance in terms of functionality, accuracy, and overall cost.
- A research was done on **Intelligent management of greenhouseenvironmental information** was proposed by Li, P Wang, J J. Agric. Mach in the year 2014. Aiming at the demands of intelligent management for greenhouseenvironment information oriented tointernet of things(IOT)
- In the year 2015 **Evaluation of ventilation performance and energyefficiency of greenhouse fans** was done by **Zhang Z, Gates RS, Zou ZR, Hu XH**. The Fans Assessment Numeration System was used to measure the airflow rate. Temperature, relative humidity and power consumption were also monitored. Results show there were significant differences in the airflow rate between the fans with a cleaned and uncleanedguard screen ($P<0.05$). Power consumption also differed significantly even with the same cooling effect in greenhouse.
- **Bartok, John. W.** in 2015 proposed **Natural Ventilation Guidelines of Greenhouse Management**. These guidelines stated Natural ventilation systems operate on the principle that heat is removed by a pressure difference created by wind and temperature gradients. Wind plays the major role. For a well-designed greenhouse, wind speeds of 1 mph are adequate to keep the inside temperature within two degrees of outdoor ambient.
- **"Studies on environmental control of greenhouse for crop production**" by **Jyoti Ranjan Rath and MK Ghosal** was accepted in the year 2020. This paper elucidates the number of structural and operational design as well as the optimum level of environmental parameters for enhancing productivity in an energy efficient and economically viable solar greenhouse.
- In the year 2019 "**Greenhouse design and cooling technologies for sustainable food cultivation in hot climates**: review of current practice and future status" was proposed by Biosyst. Eng. The purpose of this work is to review the design and systems used for greenhouse cooling applications in hot climates.

REVIEW OUTCOMES

Basic idea of green house is to grow crops in a closed area by creating an artificial environment that supports the plant growth. It was partially achieved by using glass roofs. Glass roofs supported by reflecting a major part of sunlight andit only transmitted a part of sunlight that is needed. With the technological advancements, sensors were introduced into many parts of life. In the same way a review on the usage of sensors in greenhousefarming was made where people came to identify that sensors can play a major role in this. And this gave a kick start to the monitoring and controlling of greenhouse environment.

Even researchers started controlling the environment artificially. In other countries, some started research on how to accumulate Solar Energy and how can we use it in greenhouses. And also a major part in this is to reduce energy that comes from sun. As the years went by, many people started measuring thethermal performance of greenhouse and it led to conclusions like light plays a major role in determining the quality of harvest. A Zigbee based greenhouse monitoring and controlling system was developed but due to its lack of availability it was considered as a failure. Another research was done on how to manage the information of greenhouse efficiently.

III. PROPOSED WORK WITH METHODOLOGY

EXISTING SYSTEMS

Some traditional methods of farming include

- **Subsistence Farming:**

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Majority of farmers in the country practise subsistence farming. It is characterised by small and scattered land holdings and use of primitive tools.

- **Shifting Agriculture:**

  Shifting agriculture is a system of cultivation in which a plot of land is cleared and cultivated for a short period oftime, then abandoned and allowed to revert to producing its normal vegetation while the cultivator moves on to another plot.
- **Plantation Agriculture:**

  Plantation farming is bush or tree farming. It was introduced by the British in the 19thcentury. It is a single crop farming of rubber, tea, coffee, cocoa, spices, coconut and fruit crops like apples, grapes, oranges, etc. Plantation agriculture is an export-oriented agriculture. Most of the crops grown in plantation agriculture havea life cycle of more than two years.
- **Commercial Farming:**

  This form of farming generates a large amount of revenue for the country's economy. In reality, the commercially farmed crops in India are exported all overthe world.

PROPOSED WORK

Crop production is a challenging sector, with the crops being constantly exposed to unfavorable weather conditions. Weather and climate conditionsplay an important role in determining the pace of crop production. However, during times when the global food security strongly depends on crop production, there is no place for any limitations. Therefore, the search for solutions resulted in farm management practices that involve farming in a controlled environment.

While a greenhouse is an excellent way to grow plants, it needs proper supervision. Every greenhouse needs greenhouse environment and growth administration systems to get the best crop production. Greenhouse management can be achieved with the help of management automation or technology. In simple words, greenhouse management is to modify and control conditions inside a greenhouse to care for the plants growing inside. There are different kinds of systems to take care of the needs of the plants, from food intake to the amount of water it receives every day. After going through various reviews and research papers we came to know that, all the existing models or the proposed solutions mostly focused on temperature control and ventilation. Least importance is given to theamount of light that is transmitted. Instead of using glass surfaces as closing material, we thought of proposing a totally covered environment where we can use Chloro-Fluorescent lights which radiate light just in the way sun emits the light. Compared to general-service incandescent lamps giving the same amount of visible light CFLs use one-fifth to one- third the electric power, and last eight to fifteen times longer. CFLs emit light from a mixof phosphors, each emitting one band of colour with some bands still in the ultraviolet range as can be seen on the light spectrum. Modern phosphor designs balance the emitted light colour, energy efficiency, and cost. Every extra phosphor added tothe coating mix improves colour rendering but decreases efficiency and increases cost.

Good quality consumer CFLs use three or four phosphors to achieve a "white" light with a colour rendering index (CRI) of about 80, where the maximum 100 represents the appearance of colours under daylightor other sources of black-body radiation such as an incandescent light bulb (depending on the correlated colour temperature).

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The idea of light house is to prevent the crops from facing natural calamities like floods and over exposure to sunlight. So if we can control the amount of light that is being radiated and if we can control the amount of moisture present in the soil, along with humidity control, crops can be grown without any negative impact. And also Drip Irrigation, most suitable way in which we can conserve water along with attaining good harvest can also be integrated with green houses. **Drip irrigation** or **trickle irrigation** is a type of micro-irrigation system that has the potential to save water and nutrients by allowing water to drip slowly to the roots of plants, either from above the soil surface or buried below the surface. The goal is to place water directly into the root zone and minimize evaporation. Drip irrigation systems distribute water through a network of valves, pipes, tubing, and emitters. Depending on how well designed, installed, maintained, and operated it is, adrip irrigation

system can be more efficient than other types of irrigation systems, such as surface irrigation or sprinkler irrigation. As water is released drop by drop there is no chance of water wastage and there is no chance of excess water supply to plants. In addition to drip irrigation, we thought of adding oxygen sensing systems which identifies the concentration of oxygen present in the air. And if the level of oxygen is too high then the air present in the greenhouse will be articulated. This can be implemented using Oxygen level detection sensors, when the level of oxygen does not fall under the prescribed range then the exhaust fans will be turned on and then for a period of time they continue to work. And when the oxygen concentration becomes normal, fans get turned off. We can easily implement using hardware devices like Arduino, motors and sensors.

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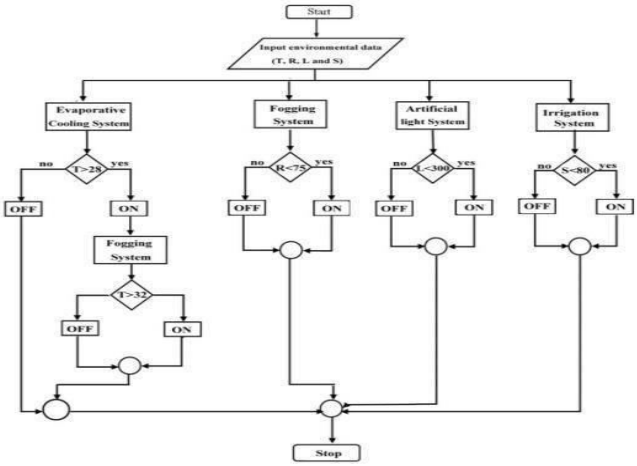
If we are able to determine the moisture content present in the air and if we can control the moisture levels present in the air, it will play a major role in the growth of plants. When we are growing more than one type of crop in greenhouse, we need to take care of all the plants. We need to adjust the lighting according to the type of plant it is. Whether it is a RABI crop or a KHARIF crop, we need to know. And we can take the information from the user itself and then we can adjust the intensity of light according to it. And we also thought of monitoring the moisture content present in the soil in stipulated time intervals. And the moisture content will vary from plant to plant. For this purpose we can make use of moisture sensors and the control of Irrigation system can be altered using Micro Processors and Micro Controllers. Nutrients supply to the plants can be done in regular intervals and also it varies from plant to plant. Our solution provides a way for it by classifying the amount of nutrients or fertilizers that are to be supplied is controlled automatically.

PROPOSED METHODOLOGY

First of all we will create a User Interface where user can log on to the web application. And then in the first web page, we will ask the user to enter the type of crop along with it.

We will also ask whether the crop is either RABI or KHARIF crop. After knowing the type of crop we can alter the light radiation and other parameters like moisture. And if the number of crops to be grown is only 1, then no segmentation is needed and we can control the total greenhouse as a single unit. This is an expected flow control diagram, we need to modify some parts of this control diagram, and also we need to add some other functions to the flow diagram.



After connecting all the devices like Micro Controllers and Sensors, Irrigation systems control will be based on the data provided by the sensing devices. As shown in the control flow, some threshold value do exist for every control mechanism, until and unless the values are in safer boundaries, everything goes as planned. But if any abnormal values

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are sensed, then an alarm will be made. And the necessary modifications are made by the controllers or processors. Even if the situation goes out of hand, then the user will be notified and then user takes care of the situation. Control flow will then be directed to the user. Drip Irrigation system needs continuous monitoring and also when the water supply stops before the prescribed time interval, it may lead to some ill effects on plants. These situations can be avoided by connecting with the user. We thought of messaging or mailing the updates of greenhouse to the user. And this whole flow of control will be different for different plants. If the crop is rabi, then the light intensity will be set accordingly. If the crop is a kharif plant, light intensity will be adjusted. Along with light intensity, water supply, humidity conditions will be changed accordingly. And this makes our idea unique from all other existing projects.

COMPARISION WITH EXISTING SYSTEMS

All the current existing models were just a result of integrating Iot with greenhouses. Only the things like controlling light sensitivity and also checking the humidity levels of soil were highlighted. More research was done in areas like effect of light on different vegetables and fruits. Some experiments gave fruitful outcomes. And those researches led usto think of new methodologies which we have usedin this proposed project. They are

Monitoring and adjusting the environment for different types of plants according to their requirements. If the crop is a rabi plant, then our system will adjust the temperature, humidity, oxygen levels according to that plant.

- Usage of CFL lights was a newmethod which acts as a replacement to LED lights which are being used inprevious approaches.
- Also the existing approaches do include Subsistence farming, Step Cultivation and many more. All those farming methods are suitable to some certain areas and they can't be used everywhere. While our approach canbe implemented anywhere, even when we are having less space we can implement our project.
- Usage of drip irrigation led to many benefits, now integrating it with greenhouses will definitely produce some magnificent changes in farming. And integrating it with greenhouses that can support different plants under one roof is definitely a good approach. It can be implemented in our idea.
- Monitoring the amount of Oxygen levels in air and so that we can turn on ventilating systems will aid the growth of plants.

IV.CONCLUSION

A smart greenhouse monitoring system has been implemented successfully using the concept ofIoTwhich 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 environmentfor the plants and thus increases the overall yield. The smart greenhouse automatically optimizes thevarious 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.

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Impact Factor
7.54

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH IN SCIENCE, ENGINEERING AND TECHNOLOGY

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