International Journal of Innovative Research in Engineering
Volume 4, Issue 2 (March-April 2023), PP: 324-326.
www.theijire.com **ISSN No: 2582-8746**

Smart Greenhouse Control System with Plant Health Monitoring

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How to cite this paper:
B.Yuvarani[1], Hari Vignesh.S[2], Nalan.R[3], Sridhar.A[4], Surya Prakash.S[5], "Smart Greenhouse Control System With Plant Health Monitoring", IJIRE-V4I02-324-326.

Abstract: *The goal of this project is to create a smart home garden monitoring system utilising Python, Arduino, and an ESP32 microcontroller to track environmental variables for the best plant growth. The Arduino and ESP32 microcontrollers are connected to sensors for temperature, humidity, soil moisture, light, and carbon dioxide levels. Machine learning algorithms are used to assess the acquired data and calculate the ideal circumstances for plant growth. The device uses battery backup technology to assure continuous operation and is fueled by renewable energy sources like solar and wind energy. Due to the system's internet connection, it is possible to remotely watch the garden from any location in the world. A mobile application or online interface that offers real-time information on the health of the plants and environmental conditions can be used by the user to access the system. The system has a mobile communication capability that notifies the user when the plants are in good health. The system notifies the user via a mobile application when an alarm threshold is surpassed and allows the user to define the alert thresholds for various criteria. With the use of this tool, the user can prevent plant harm by acting quickly. The project's main goal is to enable people to grow their own veggies using a smart home garden monitoring system powered by Python, Arduino, and ESP32 microcontroller and Internet of Things (IoT) technologies, while also lowering the carbon impact of food production.*

Key Word: *Home Gardening, Smart Garden, Plant Health Monitoring, Iot, Python, Arduino, Insect Trap, Renewable Energy.*

I.INTRODUCTION

Home gardening gives people the opportunity to grow their own veggies, which is a great way to support wholesome and sustainable food systems. Yet growing plants can be difficult, particularly if you don't know how to take care of them or can't keep an eye on the surroundings frequently. Consequently, maintaining the proper climatic parameters, such as temperature, humidity, soil moisture, light, and carbon dioxide levels, is vital to support optimal plant growth. With the help of Python, Arduino, and an ESP32 microcontroller, we plan to create a smart home garden monitoring system that will automate the real-time observation of environmental conditions. The user will receive notifications from the system regarding the health of the plants, enabling prompt action to avoid plant harm.

II.LITERATURE REVIEW

The literature review for this project emphasises the significance of intelligent greenhouse systems for effective plant monitoring and growth. Many studies have been done on deploying sensor- and IoT-based systems for regulating the greenhouse environment and monitoring plant growth. Existing systems have some drawbacks, such as high cost, complicated hardware, and lack of portability. By utilising inexpensive and widely accessible components like Arduino, ESP32, and Python for data analysis, the suggested solution overcomes these restrictions. The system is environmentally sustainable thanks to the usage of renewable energy sources like solar and wind. Additionally, the system has an alarm system that tells the user on their mobile device of the plant's health state, enabling them to take prompt action. Insect damage to the plants is prevented by the system's integration with UV light bug traps, ensuring their healthy growth. Overall, the suggested system offers a practical and affordable option for smart greenhouse systems with plant health monitoring, which can help backyard gardeners and small-scale agricultural enterprises.

III.OBJECTIVE OF THE PROJECT

- The Design an intelligent greenhouse system with Python, Arduino, and IoT.
- Using sensors for temperature, humidity, soil moisture, and light intensity, manage the greenhouse's environment.
- To lower operating costs and make the system ecologically friendly, use solar and wind energy sources.
- Use UV light insect traps to keep insects away from the plants and promote their healthy growth.
- With the use of a mobile application, notify health of the plant.
- Provide small-scale agricultural businesses and home gardeners a portable, affordable option.
- Improve plant productivity and yield by enabling efficient monitoring and growth.

IV.PROPOSED SYSTEM

Our project uses Arduino and Python programming to build an automated greenhouse system. A variety of characteristics in the system allow it to monitor and regulate the greenhouse's environment, ensuring the best possible circumstances for plant development and health. The system makes use of sensors to keep tabs on the greenhouse's temperature, humidity, soil moisture, and light levels. Python programming is then used to analyse the data and make necessary adjustments to the environmental conditions. A soil moisture sensor is also used in the automated watering system, which ensures that plants get the right amount of water.

The device has a UV light insect trap that attracts and kills pests, eliminating the need for toxic pesticides and addressing the problem of pest infestations. The system includes plant health monitoring as well, employing sensors to find any signs of disease or stress in the plants and enabling quick intervention.

The system's integration of renewable energy resources, including solar and wind power, lessens dependency on the grid and lowers energy prices. These technologies working together can result in efficient and sustainable agricultural methods that are good for the environment and the economy.

Overall, our automated greenhouse system promotes ecologically friendly and sustainable agricultural methods while offering a dependable and effective means to cultivate plants all year round.

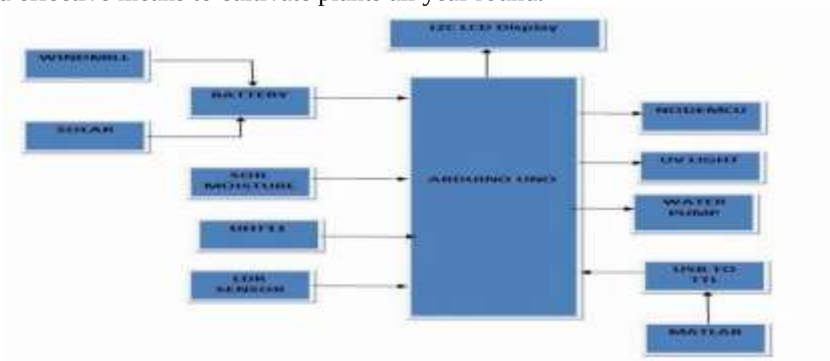

Figure 1. Block diagram of the proposed system

V.METHODOLOGY

Soil Moisture, Dht11 and LDR Sensors

The soil moisture sensor, DHT11, and LDR sensors are critical parts of this project and are extremely important for tracking the health of the plants.

The soil moisture sensor measures soil moisture, which is a crucial sign of the health of plants. Plants may not get enough water when the soil is excessively dry, which can cause wilting and slower growth. On the other hand, plants may endure root rot and other problems when the soil is overly damp. The Arduino receives data from the soil moisture sensor, which can be examined and utilised to change the watering schedule to promote the best possible plant growth.

Both temperature and humidity, which are crucial elements in plant health, are measured by the DHT11 sensor. Variations outside of this range might cause stress and stunted growth in plants since they cannot flourish in these conditions. The system can detect possible problems and change the environment as necessary by monitoring these characteristics.

The LDR sensor measures ambient light levels, which are essential for the growth and development of plants. A plant's growth and development can be impacted by too much or too little light depending on the type of light it needs to survive. The device can monitor light levels and move the UV light bug trap as necessary to reduce insect populations while still giving enough light for plant growth. This is made possible by the LDR sensor.

Together, these sensors offer a thorough system for monitoring plant health, assisting in ensuring maximum development and productivity.

Plant Health Monitor

Using image processing methods to examine plant photos and spot potential health risks, Python in MATLAB is an effective tool for plant health monitoring. The procedure involves taking digital photos of plants, which are then subjected to an analysis utilising Python and MATLAB algorithms.

The photographs are preprocessed using Python code, which also includes scaling, filtering, and brightness and contrast adjustments. Advanced image processing techniques are then used to extract properties like colour, texture, and shape on the processed images in MATLAB. These characteristics are examined to spot potential plant health problems like illnesses, nutritional shortages, and pest infestations.

The analysis's findings are provided in an easily understandable format, such as a report or a diagram that shows the health of the plant. This enhances plant growth and productivity by enabling growers and researchers to immediately identify and treat any health issues.

Overall, Python and MATLAB work together to create a potent tool for monitoring plant health that can assist increase the productivity and sustainability of agriculture.

Insect Trap

The Insects are drawn to a source of light that generates ultraviolet (UV) radiation, which is particularly alluring to many species of insects. This is how UV light bug traps function. The trap normally consists of a UV-emitting bulb and a casing that directs insects towards the light source.

The UV light alters the insects' natural behaviour, leading them to fly in the opposite direction of their regular pathways when they come into contact with it. The insects then enter the trap, where, depending on the type of trap, they are either shocked or caught on an adhesive surface.

Flying insect populations can be controlled indoors or outdoors, including in buildings such as homes, offices, and farms, using UV light insect traps. Many people and businesses find them to be an appealing alternative to chemical insecticides because they are non-toxic and safe for the environment.

Renewable Energy Source

Wind Turbine: A wind turbine transforms wind energy into electrical energy by harnessing the kinetic energy of the wind to rotate the turbine's blades, which then power a generator to generate electricity. The wind provides lift as it moves across the blades, which makes them rotate. The generator subsequently transforms the rotational energy into electrical energy.

Solar: Photovoltaic cells are used in solar panels to turn sunlight into electrical energy. Electrons migrate when sunlight strikes the cells, creating an electric current. Batteries are used to store the generated electricity, which may then be used to power a variety of appliances. Solar panels are a great option for powering the sophisticated greenhouse system because they are a sustainable and ecologically beneficial source of energy.

VI.RESULT AND DISCUSSION

It has been successfully built and tested to have a smart greenhouse control system with plant health monitoring and efficient production. The project showed how well IoT, Python, and Arduino could be used to build a complete monitoring and control system for backyard gardening.

Using sensors and actuators, the system was able to monitor and regulate a number of environmental factors, including temperature, humidity, soil moisture, and light levels. For the purpose of managing insect populations in the greenhouse, the system also contained a UV light bug trap. The system was eco-friendly since it used renewable energy sources like the sun and wind mill to power it.

The Python-based plant health monitoring module in MATLAB was able to analyse the sensor data and provide notifications to the user's mobile device on the health of the plant. The user could get real-time updates on the health of the plants and alter the environment as needed to promote healthy growth.

The method was tested on a variety of plants, including flowers, herbs, and vegetables, and the results in terms of growth and yield were encouraging. The project proved that it is possible to grow healthy, high-yielding plants at home by providing ideal environmental conditions and real-time monitoring of plant health.

VII.CONCLUSION

- The created system can be used as an affordable and long-lasting home gardening option, particularly in metropolitan settings with limited land. The project's success creates prospects for additional research and development in this area, including ways to enhance the system for tracking plant health, boost its effectiveness, and broaden the variety of crops that can be cultivated there.
- The system is an all-in-one greenhouse management solution because it has features like a UV light bug trap and plant health monitoring. The system is sustainable and energy-efficient since it uses renewable energy sources. Overall, the suggested technique is a productive method for automating greenhouses that can help the economy and the environment.

VIII.SCOPE OF THE PROJECT

- Integration of more sensors for detailed data collection.
- Use of machine learning techniques for more accurate plant health predictions.
- Improvement of the mobile app to include more interactive features.
- Optimization of resource consumption to reduce wastage.
- Expansion to larger scale applications like commercial greenhouse farming.

Overall, there are many exciting opportunities for future development and improvement of this project, and it has the potential to contribute to the development of more efficient and sustainable agriculture practices.

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