Volume 9, Issue 4, April – 2024 International Journal of Innovative Science and Research Technology
ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24APR2167

Wirelessly Empowered Agriculture a Study on Arduino, NodeMCU and LoRaWAN Enabled Greenhouse Automation

Tushar Kadam[1]
Electronics and Computer Science Rizvi College of Engineering Mumbai, India

Tushar Vaishya[2]
Electronics and Computer Science Rizvi College of Engineering Mumbai, India

Sultan Rauf[3]
Electronics and Computer Science Rizvi College of Engineering Mumbai, India

Maseera Sayed[4]
Electronics and Computer Science Rizvi College of Engineering Mumbai, India

Dr. Varsha Shah[5]
Project Guide, Principal RCOE
Electronics and Computer Science Rizvi College of Engineering Mumbai, India

Abstract:- Greenhouse automation system is a way to benefit rural farmers through automatic monitoring and control of the greenhouse environment. It changes care directly to people. To ensure the safety of crops, temperature, light intensity, soil moisture and humidity must be monitored regularly and continuously to keep them under control. It prevents climate change and extends the growing season. Although greenhouses are beneficial for farmers as they increase crop yield and production, they are inconvenient for farmers as they have to visit and check the greenhouses regularly and if the weather conditions are not perfect, it damages crops and productivity. But the emergence of sensors and the Internet of Things has changed the situation in the greenhouse. Sensors are bringing automation to greenhouse management and monitoring through the use of the Internet of Things and embedded technologies.

Keywords:- *IOT, Greenhouse, Environment, Climatic Condition, Farmers, Agriculture, Control and Monitoring, Surveillance, LoRaWAN etc.*

I. INTRODUCTION

A growing global population requires increased food production and puts pressure on natural resources. Conventional agriculture often has difficulty meeting these needs sustainably. They can be resource intensive and have potential impacts on the environment, such as water scarcity, land degradation and increased carbon emissions. Permaculture practices are vital to ensuring long- t erm food security while reducing our environmental impact. Greenhouses offer a controlled environment for plant growth, but traditional management methods generally rely on supervision and management. This approach is time-consuming, prone to human error, and can waste resources. LoRaWAN is a low-power, long- range wireless communications system designed for applications requiring low-range data. Using LoRaWAN in the greenhouse, we can create a sensor network that will collect real-time data on various environmental factors such as temperature, humidity, light level, and humidity. This information can be used to perform various controls such as water, ventilation and lighting to ensure optimal growth for plants. We are exploring the benefits of these systems, including improved control, increased efficiency and reduced environmental impact. Additionally, the ability to monitor and control the greenhouse environment provides greater flexibility and flexibility, especially in the face of climate change. By using technologies such as LoRaWAN, we can contribute to the development of sustainable and profitable agriculture in the future.

II. METHODOLOGY

➢ *History and Scientific Research:*

Good management of the greenhouse environment requires careful measurement of temperature, humidity, and light. The traditional manual process of monitoring and managing these conditions is often tedious and requires significant effort. To streamline this process and ensure a consistent environment, this project presents a greenhouse system with remote monitoring capabilities through the Blynk application, utilizing LoRaWAN technology forlong-range, low-powr communication. Unlike previous research that focused on wired sensor networks or short-range.

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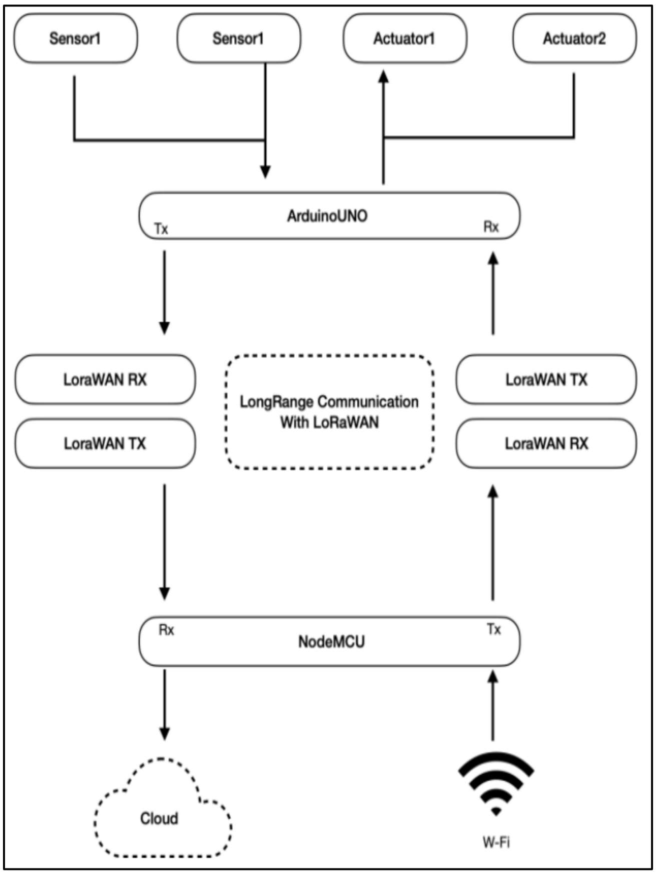

Fig 1 Block Diagram for Hardware Model

Wireless protocols, this research project aimed to develop a LoRaWAN-based automated greenhouse environment monitoring and control system with remote monitoring capabilities through the Blynk app and disease detection functionalities using a Machine Learning (ML) model.

➢ *System Design:*

The system for automated greenhouse monitoring and control consists of three main components:

- *Sensor Network:*

This network is made up of sensors that measure temperature, humidity, light intensity, and soil moisture, all connected to an Arduino Uno microcontroller for continuous data Collection.

- *NodeMCU Module:*

The sensor data from the Arduino Uno is transmitted to a NodeMCU module, which has LoRaWAN communication capabilities. The NodeMCU also connects to Wi-Fi to enable internet access.

- *Data Visualization and Control:*

The sensor data received by the NodeMCU is displayed in the Blynk app, allowing users to remotely monitor the greenhouse environment using a smartphone or tablet. Additionally, the NodeMCU can accept commands from the Blynk app to control actuators in the greenhouse, such as an irrigation system.

➢ *Sensor Selection and Calibration:*

High-quality sensors should be selected to ensure the collection of accurate data. DHT sensors are used for integrated temperature and humidity measurements. Light intensity is measured using a light-dependent resistor (LDR), and two soil moisture probes are inserted into the potting mix. To maintain reliable data collection, sensor calibration is carried out following the manufacturer's specifications.

➢ *Software Development Details:*

The Arduino Uno code is written in C++, using PulseSensor Playground for the pulse sensor and LoRaRF for LoRa communication. This code reads sensor data, processes it (e.g., temperature in degrees Celsius), and sends it to NodeMCU over LoRaWAN at predetermined intervals. NodeMCU code is written in Lua, using libraries like ESP8266wifi for Wi-Fi connection and NodeMCU lua library for LoRa SX1276/SX1278 radio communication modules for LoRa communication. The code retrieves sensor data from Arduino Uno, formats it for compatibility with the Blynk platform, and sends it periodically. It also interacts with the Blynk app to get control commands and forwards them to Arduino Uno for actuator control.

➢ *App Integration:*

Blynk App serves as a user interface for remote monitoring and control. The Blynk application is set up to receive sensor data transmitted by the NodeMCU module. The dashboard in the Blynk application is designed to display real-time sensor readings in a user-friendly format (e.g., gauges, graphs). The Blynk app also allows users to customize controls, such as water schedules and lighting controls, and send commands to the Arduino Uno through the NodeMCU and LoRaWAN networks.

III. RESULTS

Our experiments with the smart greenhouse automation system highlight its effectiveness in monitoring and controlling greenhouse conditions. Sensor data provides real-time information on temperature (°C), humidity (% RH), and soil moisture (%) within the greenhouse environment.

Visualizations such as charts and graphs are useful for illustrating trends and changes in these metrics over time with the help of ThingSpeak.io. This capability to collect and transfer data on demand supports better decision-making in greenhouse operations.The mobile application allows users to monitor real-time sensor readings in a clear, user- friendly format, making it easier to keep track of the greenhouse environment. Additionally, the app's control features enable users to adjust settings for fan, ventilation, heating, and watering systems according to their preferences.

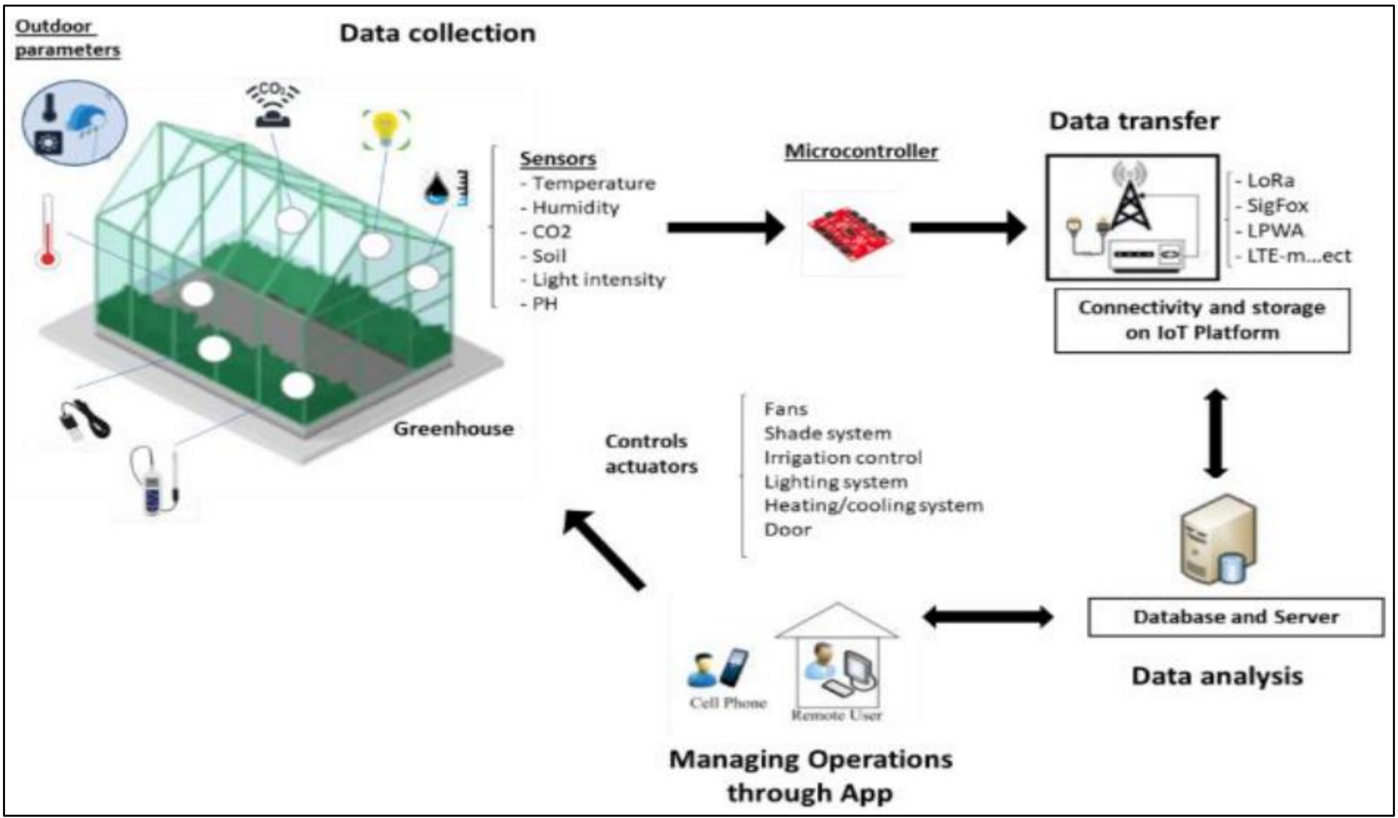

Fig 2 GrenHouse Automated System

IV. APPLICATIONS

Smart greenhouse automation systems are highly versatile, offering a wide range of potential applications in various agricultural contexts. Here's a comprehensive list of their possible uses:

- Monitor temperature, humidity, light levels, and soil moisture to ensure optimal plant growth.
- Automatically adjust ventilation, heating, and cooling to create ideal growing conditions.
- Use soil moisture sensors to optimize water usage, preventing over- or under-watering.
- Integrate nutrient sensors for real-time tracking of soil composition, allowing for precise nutrient application.
- Manage lighting and climate control systems to reduce energy consumption.
- Access greenhouse data and controls remotely through mobile apps or web-based platforms.[g] Use historical sensor data to forecast crop yields and predict environmental changes.
- Utilize smart greenhouses as educational tools to teach agricultural concepts and techniques.
- Integrate with inventory control systems to streamline resource allocation and improve operational efficiency.
- Maintain optimal conditions for crop storage to ensure quality control.
- Test new agricultural technologies in a controlled setting for safe experimentation and assessment.
- Provide automation and monitoring tools for hobbyists and small-scale growers.
- Deploy smart greenhouses in disaster-stricken areas to establish emergency food production and improve food security.

V. FUTURE SCOPE

The future of smart greenhouse automation is filled with exciting possibilities. From advanced sensor integration for enhanced environmental monitoring to machine learning applications for predictive maintenance and climate control, these systems have the potential to revolutionize agriculture. Advances in areas such as disease detection, resource management, and data integration promise significant improvements in efficiency and productivity. For instance, the integration of NPK sensors enables real-time nutrient monitoring, facilitating closed-loop nutrient management systems that optimize plant growth while minimizing waste. By embracing these future trends, smart greenhouse automation can pave the way for a new era of intelligent and efficient agriculture.

VI. CONCLUSION

In conclusion, the intelligently designed greenhouse automation system signifies a substantial advancement in the environmental management of agriculture. By effectively monitoring and controlling various environmental parameters, the system offers real-time information and automatic safety controls. This integrated approach optimizes plant growth, boosts efficiency, and simplifies greenhouse management. The potential applications extend beyond research and

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development, encompassing educational settings, commercial greenhouses, personal use, and emerging areas such as cannabis cultivation and disaster recovery. By exploring these diverse opportunities and fostering ongoing improvement, this smart greenhouse automation system could transform agriculture, enhance food security, and contribute to a more sustainable future.

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