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Poly House Monitoring and Controlling System with the Detection of Micro Plastics in Soil

Ritika Srivastava[1], Dhriti[2], Vartika[3], Ritu Vats[4], Jiya[5], Geeta Dahiya[6], Indu Arora[7]
[1,2,3,4,5]Student, [6,7]Guide, DAV Multi Purpose Public School, Sonepat

Abstract: The burgeoning demand for food production has catapulted playhouse[1] farming to the forefront of modern agriculture, enabling year-round crop production irrespective of environmental conditions. However, this method also poses significant ecological concerns, including micro plastic contamination, which can have far-reaching and devastating consequences on ecosystems and human health. Furthermore, culminating in substantial economic losses for farmers. To address these pressing challenges, this study presents a ground-breaking IoT-based polyhouse monitoring and controlling system designed to detect micro plastics and diagnose crop diseases. The system integrates a plethora of sensors for temperature, humidity, soil moisture, and gas detection, along with an LCD screen display and Bluetooth connectivity for real-time data transmission to farmers' mobile devices. A dedicated app enables farmers to report crop issues and receive expert advice, while a Python-based software module detects micro plastics and identifies crop diseases, providing treatment recommendations. The proposed system offers a novel solution for sustainable polyhouse farming practices, empowering farmers to take prompt action against micro plastic contamination and crop diseases, thereby reducing environmental pollution and improving crop yields. The "Poly house Monitoring and Controlling System with the detection of Micro plastics in soil " is advanced solution in agriculture mimicking real-time detection of various physical and weather conditions at any location desired. The ESP8266 and Arduino as the microcontroller, the Blynk IoT platform, and the weather forecast API are integrated within the system, which regulates primary various environmental parameters such as the: temperature, humidity, gas level and light intensity within a closed acrylic chamber. Key hardware components include a microcontroller, LDR sensor, humidity level sensor, DHT11 sensor, fan, and grow lights that provide simulations for different climatic conditions. The system is designed to assist in agricultural research, environmental studies, and even materials testing with a cost-effective, compact, and reliable solution. The project also incorporates real-time data analytics, decision-support mechanisms, detection of micro plastics in soil as organic soil is used in polyhouse but using of different mulching techniques some amount of micro plastic is present in soil, cloud-based databases in polyhouse management, improving productivity through mobiles.

Keywords: Smart Farming, IoT, Node MCU, Sensors, Poly house, Android App, Environmental Monitoring Smart Farming, IoT, Node MCU, Sensors, Poly house, Android App, Environmental Monitoring

I. INTRODUCTION

The advent of Internet of Things (IoT) and mobile applications has revolutionized the agricultural landscape, enabling farmers to monitor and control environmental parameters in real-time. This has led to optimized crop yields and reduced waste. Cloud-based databases, such as the Blynk platform, have further empowered agricultural practices by providing a centralized hub for data storage, analysis, and visualization. Controlled-environment structures, such as polyhouses, have greatly benefited from these technological advancements, enabling farmers to create optimal growing conditions for their crops.

Sensors play a vital role in monitoring and measuring various physical parameters, such as temperature, humidity, soil moisture, gas levels, and light intensity. The integration of sensor on Hardware has enabled online monitoring and adjustment of these critical parameters, allowing farmers to keep track of crop development conditions regularly. Real-time monitoring enables farmers to take prompt action against any deviations from optimal growing conditions, reducing the risk of crop failure and improving yields. Use of Internet of Things and mobile applications as well as the use of cloud-based databases such as Blynk platform, Using Python have empowered agricultural practice recently as one can monitor real data monitoring primarily in controlled-environment structures such as poly houses. Sensor are the devices which are used to monitor and measure the analog and digital values of various physical parameters so that the farmers can look at their production accordingly, adjustment of some critical parameters like temperature, humidity, soil moisture, gas level and light level keeping track of crop development conditions regularly using the real time monitoring of these parameters.

The solution will involve an automated irrigation system that automatically starts a water pump when the soil moisture value is less than the predefined threshold. Other functionalities will include real-time data visualization, crop recommendation based on sensed environmental values, and IoT-enabled weather simulations. This will ensure the synchronization of data with remote accessibility on various devices through Blynk IOT.Page Layout

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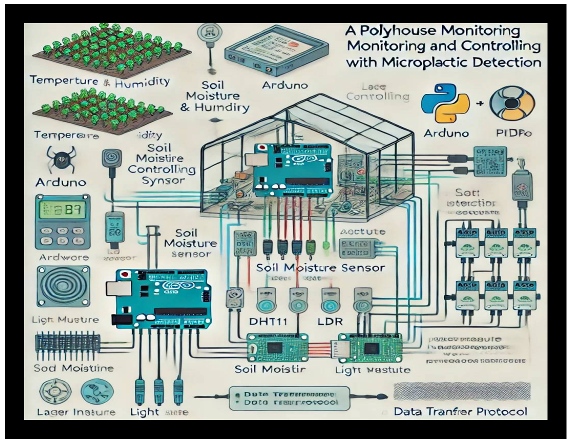

Fig. 1 A Polyhouse Monitering and Controling with Micro Plastic detection setup

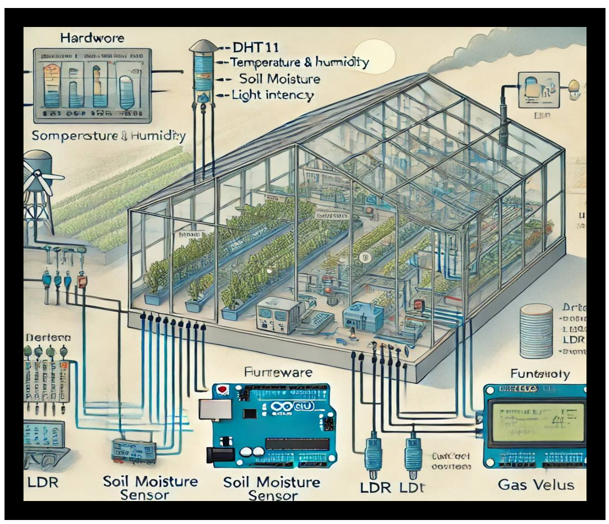

Fig. 2 Micro Plastic detection hardware setup

II. PROPOSED METHODOLOGY

We have designed a self-monitoring and controlling system [2] with combination of sensors and hardware to optimize growing conditions and ensure soil health. The sensors used Are:

1) The soil moisture sensor measures the water content in the soil.
2) The LDR monitors light intensity.
3) The DHT11 tracks the temperature and humidity in the air.
4) The gas sensor detects harmful gases like carbon dioxide, triggering ventilation systems to maintain air quality.

The data collected by sensors are transmitted to a central processing unit, Arduino where real time data is analysed and the results are displayed on the LCD screen. Moreover, we have designed an AI based micro plastic detection software using python which detects the presence of micro plastic in soil. This project leverages the integration of Internet of Things technology, wireless sensor networks, and cloud computing to create a robust and scalable system.

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III.SYSTEM COMPONENTS

A. Node MCU EPS8266

Node MCU ESP8266 is a low-cost, Wi-Fi-enabled microcontroller used for IoT and automation projects. It is built around the ESP8266 chip, which allows devices to connect to the internet and communicate wirelessly. It features built-in Wi-Fi, GPIO pins for sensor and actuator connections, and supports programming with Arduino IDE or Lua. The module operates on 3.3V and is widely used in smart home systems, wireless data logging, and remote monitoring applications.

Fig. 3 Node MCU ESP8266 IC

B. DHT11 Sensor

A temperature sensor is a device that provides the temperature measurement at a given time. It is a resistance temperature detector which detects the temperature changes. It provides high quality and quick acknowledgement. Being a mixed sensor it provides with the values both of temperature and humidity. The sensor calibres digital signal output. Using this sensor gives greater stability and higher reliability. The sensor used is DHT11 Module temperature and humidity sensor module. The DHT11 is a basic, ultra-low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and spits out a digital signal on the data pin.

Fig. 4 Temperature Sensor

C. Soil Moisture Sensor

Soil moisture sensor is the device which measures the content of water in the soil. Soil moisture measurement is important to help farmers manage their irrigation systems. It consists of two probes which are used to measure the volumetric content of water. The two probes allow the current to pass International Journal of Pure and Applied Mathematics.

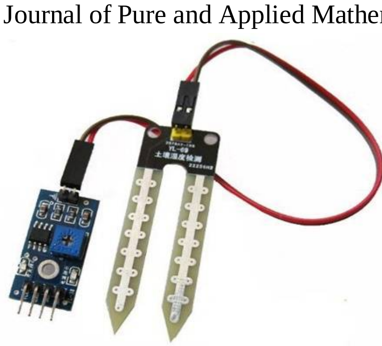

Fig. 5 Soil Moisture Sensor

D. LM35 Temperature Sensor

The LM35 temperature sensor is a precision device that provides an analog voltage output proportional to temperature in Celsius. It operates from -55°C to 150°C with high accuracy and does not require calibration. The sensor outputs 10mV per degree Celsius, making it easy to interface with microcontrollers like Arduino and Raspberry Pi. It is widely used in weather monitoring, industrial automation, medical devices, and home automation due to its reliability and low power consumption.

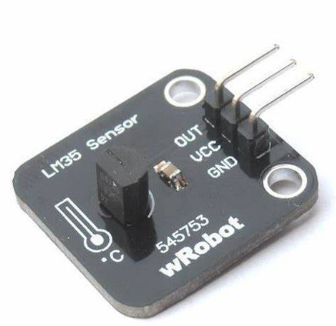

Fig. 6 LM35 Temperature Sensor

E. Relay Module

A relay module is an electronic switch that allows low-voltage microcontrollers to control high-voltage devices. It uses an electromagnetic coil to open or close circuits and can operate AC or DC loads like lights and motors. Relay modules are widely used in automation, IoT, and industrial applications.

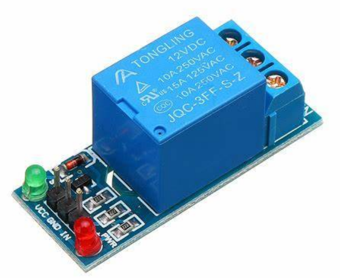

Fig. 7 Relay Module

F. L293D Motor Driver

The L293D motor driver is an integrated circuit used to control the direction and speed of DC motors. It allows microcontrollers to drive two motors independently using H-bridge circuits. The chip operates on 5V logic and can handle motor voltages up to 36V with a current of 600mA per channel. It is commonly used in robotics, automation, and motor control applications.

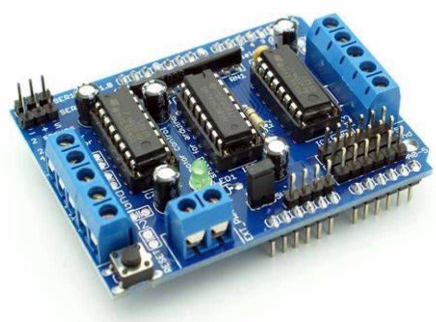

Fig. 8 Motor Driver L293D

G. DC Pump

A DC pump is a motor-driven device that moves liquids using direct current (DC) power, typically from batteries or solar panels. It operates efficiently at low voltages (such as 6V, 12V, or 24V) and is commonly used in water circulation, irrigation, and cooling systems. DC pumps are compact, energy-efficient, and suitable for portable or automated applications like aquariums, fountains, and automotive cooling

Fig. 9 Motor Driver L293D

H. DC Motor

A DC motor is an electric motor that converts direct current (DC) into mechanical motion. It works based on electromagnetic principles, where current passing through a coil generates a magnetic field that interacts with permanent magnets, causing rotation. The speed and direction of a DC motor can be controlled by varying the voltage or using an H-bridge circuit. DC motors are widely used in robotics, automation, electric vehicles, and household appliances due to their efficiency and ease of control.

Fig. 10 DC Motor

I. Micro plastic Detector App

A mobile application will be developed to provide an easy-to-use interface for farmers to monitor and control the polyhouse environmental parameters. The Micro plastic Detector App is designed for the ease of farmers, enabling them to easily share photos [3] of their crops directly through WhatsApp or other messaging apps. This feature allows even unexperienced farmers to use the app effortlessly

J. LDR

The polyhouse monitoring and controlling system uses a Light Dependent Resistor (LDR) sensor to measure and monitor light intensity levels. The LDR sensor detects changes in light intensity and helps to maintain optimal lighting conditions for plant growth

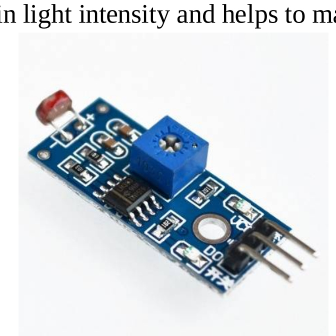

Fig. 11 LDR Chip

K. Gas Sensor

The polyhouse monitoring and controlling system utilizes a gas sensor to detect and monitor the levels of carbon dioxide (CO_2). This sensor helps to maintain optimal CO_2 levels, ensuring healthy plant growth and maximizing crop yields.

Fig. 12 Gas Sensor

IV. MICROPLASTIC DETECTION AND DISEASE DIAGNOSIS

The proposed system will utilize a software module made using python for detecting micro plastics in the soil and diagnosing crop diseases [4]. The software will use machine learning algorithms to analyse the sensor data and identify the presence of micro plastics and diseases [5].

V. RESULTS AND CONCLUSION

This automated system increases farm efficiency by producing customized growth conditions. With real-time climate control, it maximizes crop yield and quality and minimizes human labour. Automated watering ensures optimal water management, eliminating over- and under-watering. Farmers receive immediate alerts for system operations, including pump operations, to inform timely decision-making. Field trials show that IoT-based polyhouse management drastically reduces labour cost while maximizing agricultural output. Besides, data-driven insights help farmers implement precision farming techniques for better resource utilization. The "Smart Polyhouse Automation System Using Arduino Uno and IoT" is highly scalable, technology-driven, as well as cheaper in terms of cost. On the other side, the same system integrates with Blynk. IoT by processing real time data, such that continuous adaptation of control variables is ensured continuously. The employment of wireless sensor networks and irrigation al mechanisms renders farming more productive and resource-based. Future refinements may provide additional functionalities or features such as solar power harnessing, efficient pest detection algorithms, and possibly AI-based predictability.

VI. ACKNOWLEDGMENT

We would like to express our sincere gratitude to our Principal, Mr. V.K. Mittal Sir, for his invaluable guidance and support throughout this research project. His vision to establish a polyhouse in our school premises has inspired us to explore the potential of IoT-based polyhouse monitoring and controlling systems.

We are also deeply grateful to the Head of the Horticulture Department, Mr. Jwala Singh for his expert review and feedback on our project. His endorsement of our project as "very good" and "implementable" has boosted our confidence in the potential of our system to increase crop yields.We would also like to thank our colleagues and friends who have contributed to this project through their suggestions, encouragement, and support.This project would not have been possible without the guidance and support of our mentors Mrs. Ritu Vats and Mrs. Geeta Dahiya, and we are deeply grateful for their contributions.

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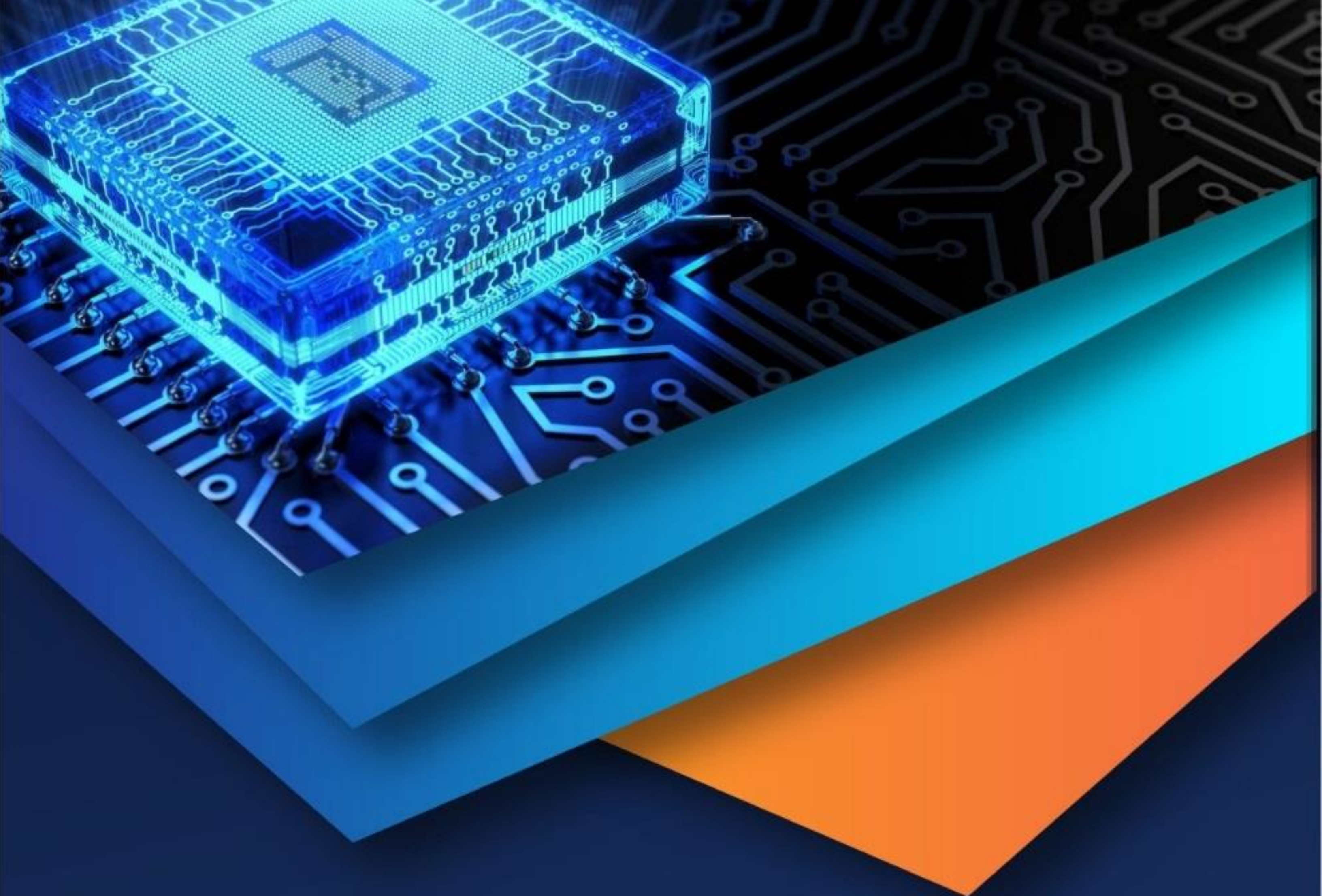

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