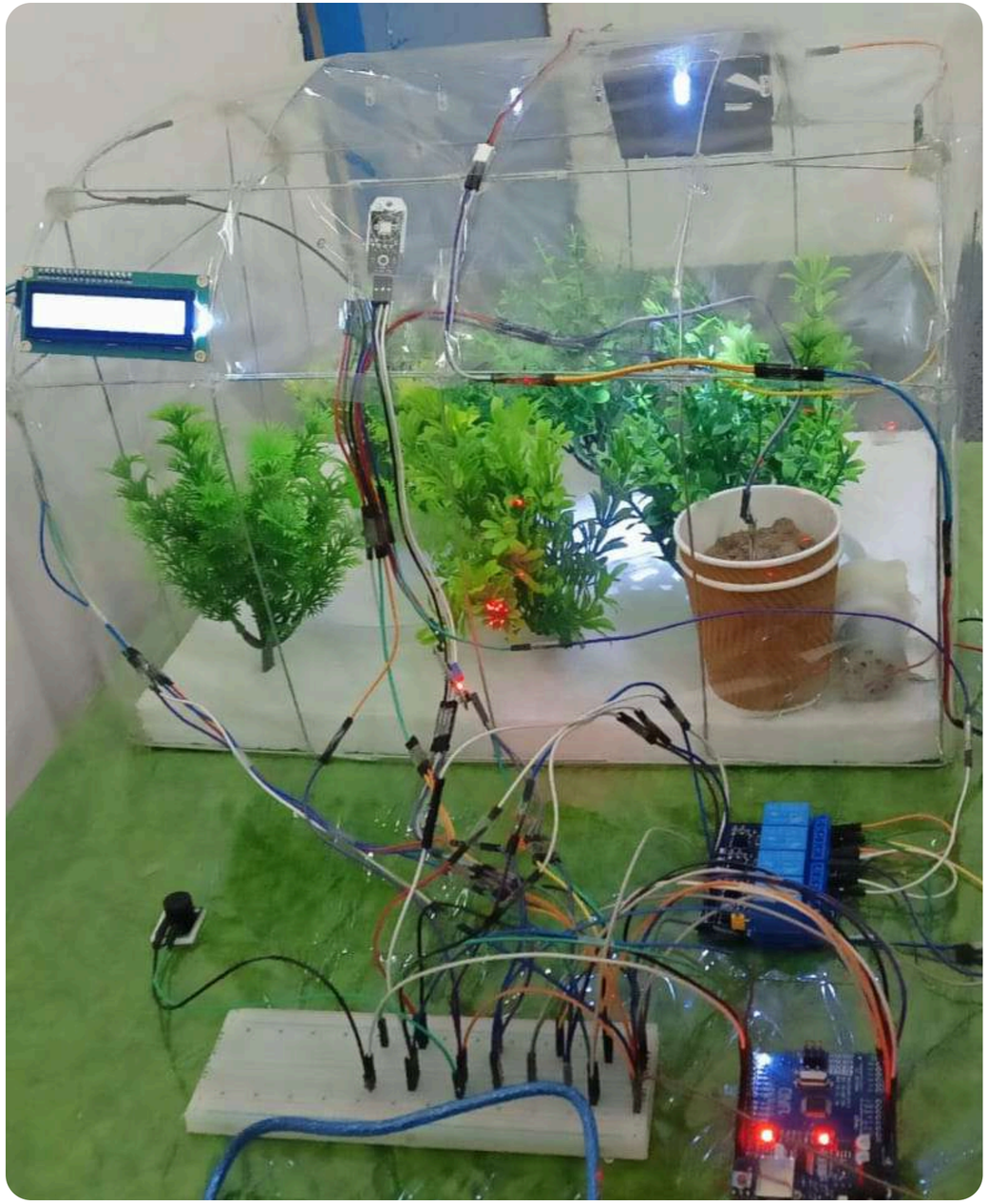
Automation in Greenhouse Climate Control – Managing Ventilation, Humidity, and Lighting Using Arduino



Presented by Satyam Kumar and Prince Patel

PROBLEM IDENTIFICATION

- Greenhouse conditions are currently monitored manually, leading to slow responses.
- Temperature, humidity, soil moisture, and light levels fluctuate rapidly and are not controlled automatically.
- Plants often experience stress due to delayed human intervention.
- Manual operation of fan, pump, and lights leads to inconsistent climate regulation.
- Human errors cause over-watering or under-watering, harming plant growth.
- Fans or lights may remain ON longer than required, causing energy wastage.
- No system exists to continuously track environmental data in real time.

PROBLEM IDENTIFICATION

- Farmers cannot stay in the greenhouse 24/7, causing periods of poor control.
- Small-scale growers lack access to affordable automation solutions.
- Data such as temperature, humidity, and soil moisture are not visualized together, making decisions difficult.
- Manual climate control results in uneven plant growth across the greenhouse.
- Lack of alerts means critical conditions (like overheating) often go unnoticed.
- Traditional systems require more labor, increasing cost and effort.
- Absence of an automated system reduces overall productivity and plant yield.

The Need for Automation

Improved Growth

Automation enhances plant growth by creating optimal conditions for photosynthesis and nutrient uptake.

Energy Efficiency

Automated systems reduce energy consumption by optimizing resource use and minimizing waste throughout operations.

Consistent Climate

Consistent climate control ensures stable growth conditions, resulting in higher yields and healthier plants.

Benefits of Greenhouse Automation

- Ensures precise and real-time monitoring of temperature, humidity, light, and soil moisture.
- Maintains a stable microclimate, improving overall crop quality and productivity.
- Enables automatic control of ventilation and exhaust systems to prevent heat buildup.
- Reduces unnecessary energy consumption through smart lighting automation.
- Optimizes water usage by operating irrigation systems only when required.
- Minimizes manual intervention, reducing labor dependency and human errors.
- Helps in early detection of abnormal conditions through system-generated alerts.
- Reduces the risk of pest infestation, fungal infections, and moisture-related plant diseases.

Benefits of Greenhouse Automation

- Improves yield consistency by maintaining ideal environmental conditions 24×7.
- Enhances greenhouse scalability for commercial and precision agriculture applications.
- Provides safe electrical equipment control using isolated relay-based actuation.
- Supports data transparency by displaying live system status on an LCD/monitor.
- Increases resource-use efficiency, lowering operational costs and improving profit margins.
- Contributes toward sustainable and climate-resilient farming practices.
- Offers future enhancement potential with IoT integration, AI-based decisions, and mobile notifications.

Methodology:

- Arduino Uno is used as the main controller
- Sensors (DHT22, LDR, Soil Moisture) collect environmental data
- Arduino reads sensor values continuously
- Sensor data is compared with predefined threshold values
- Decision is made using if–else logic
- Fan turns ON if temperature/humidity is high
- Water pump turns ON if soil is dry
- Grow light turns ON if light intensity is low
- 4-channel relay module controls high-power devices safely
- LCD displays real-time values and device status
- LED and buzzer give alert during critical conditions
- System runs continuously without human intervention

Crop Examples Section

Mushroom

Needs steady temperature + high humidity. Automation keeps both constant → faster growth, bigger size.

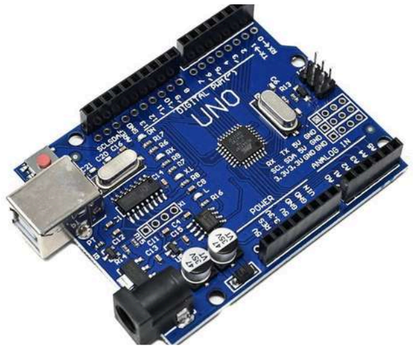
Tomato

Vent/fan auto-ON when hot → prevents flower drop → more tomatoes.

Spinach

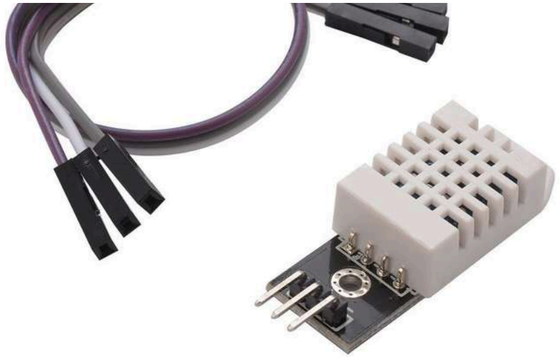
Auto water + light → leaves stay green, soft, and fresh.

Overview of Actuators in Greenhouse Control



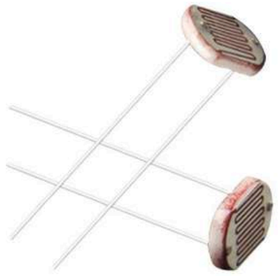
Arduino Uno

It's a small board with a microcontroller (ATmega328P)



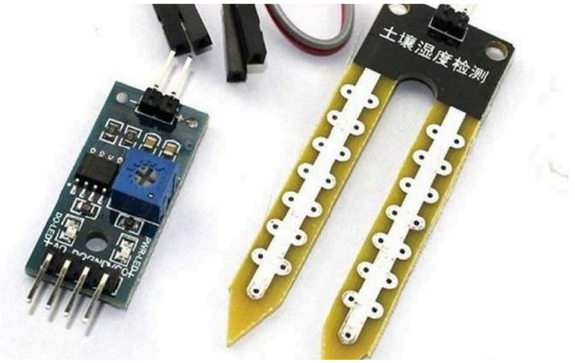
DHT22

Digital Temperature and Humidity Sensor



LDR Sensor

detect or measure light intensity



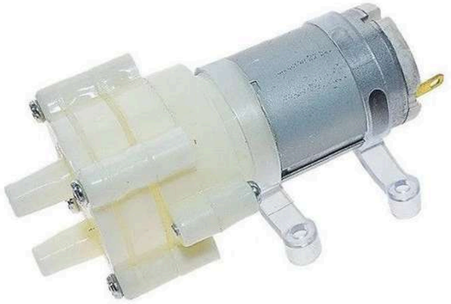
Soil Moisture Meter

Soil Humidity Sensor

Overview of Actuators in Greenhouse Control

Fans

Essential for maintaining optimal air circulation.

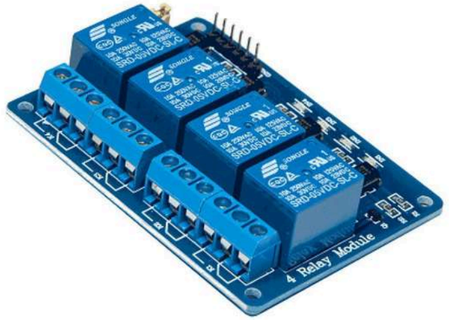


Water Motor

Pumps water for irrigation to maintain soil moisture levels.

LED Lights

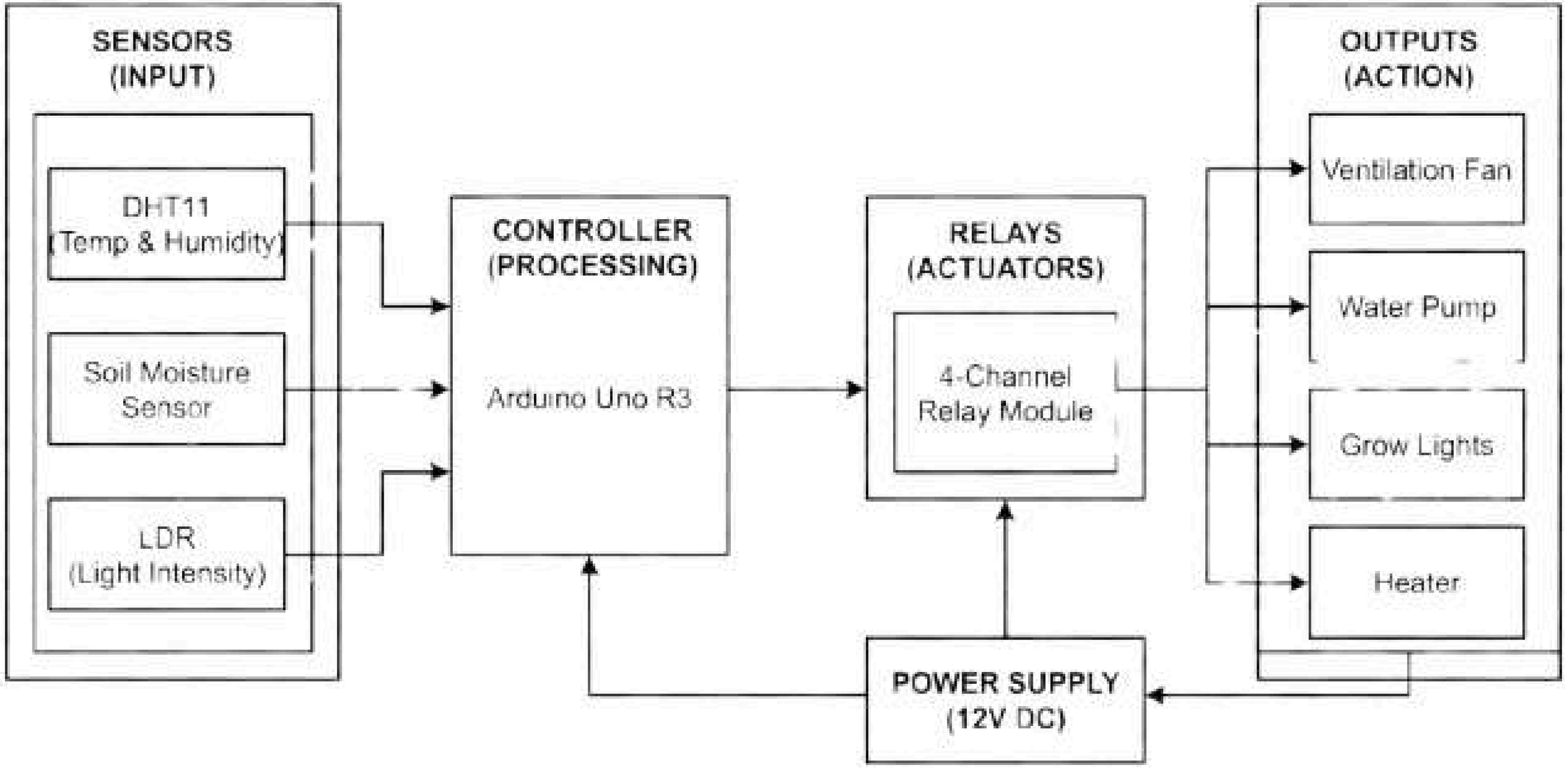
Provides essential light spectrum for growth.



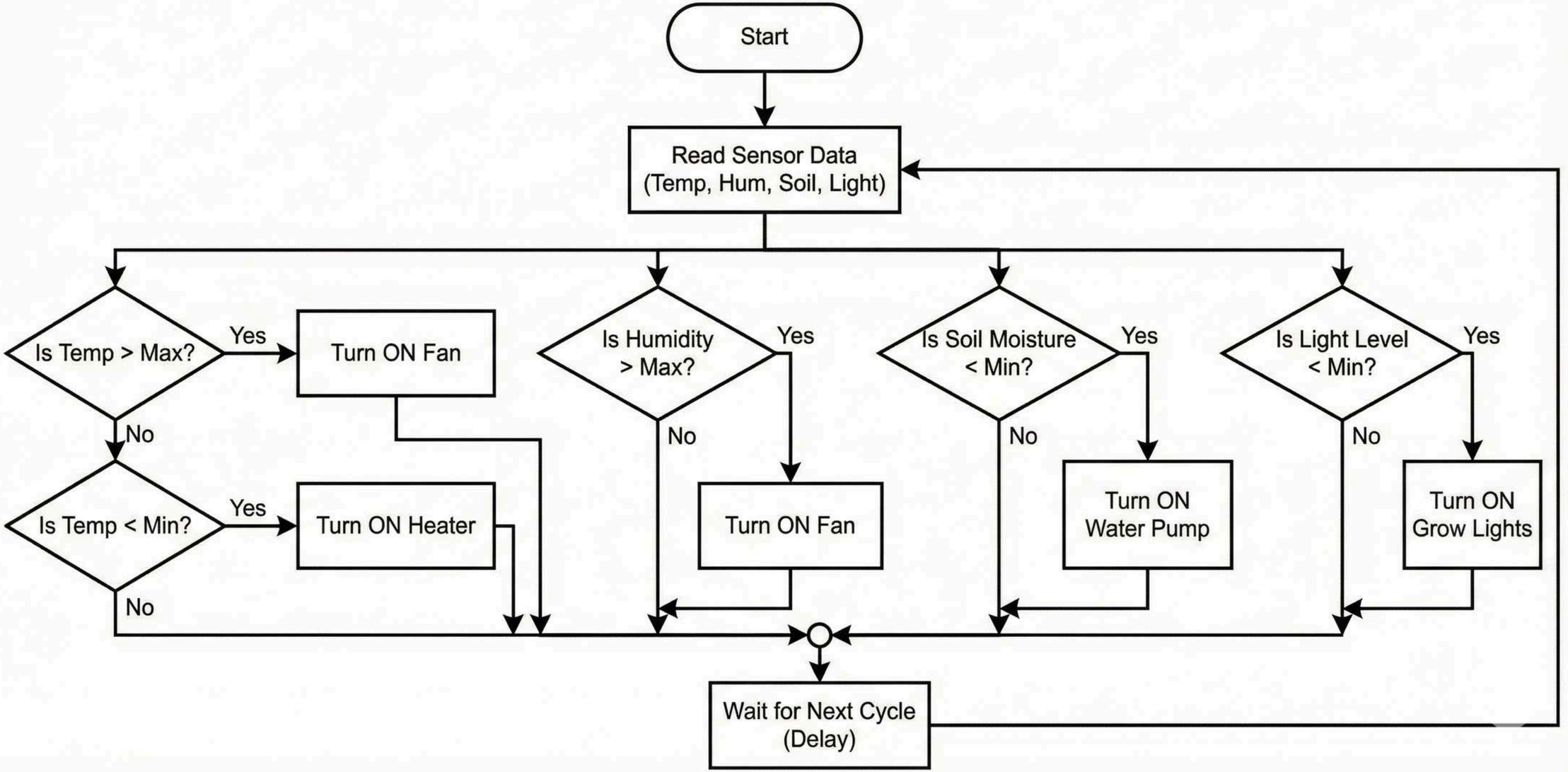
4 Channel Relay Module

electrical switch controlled by Arduino

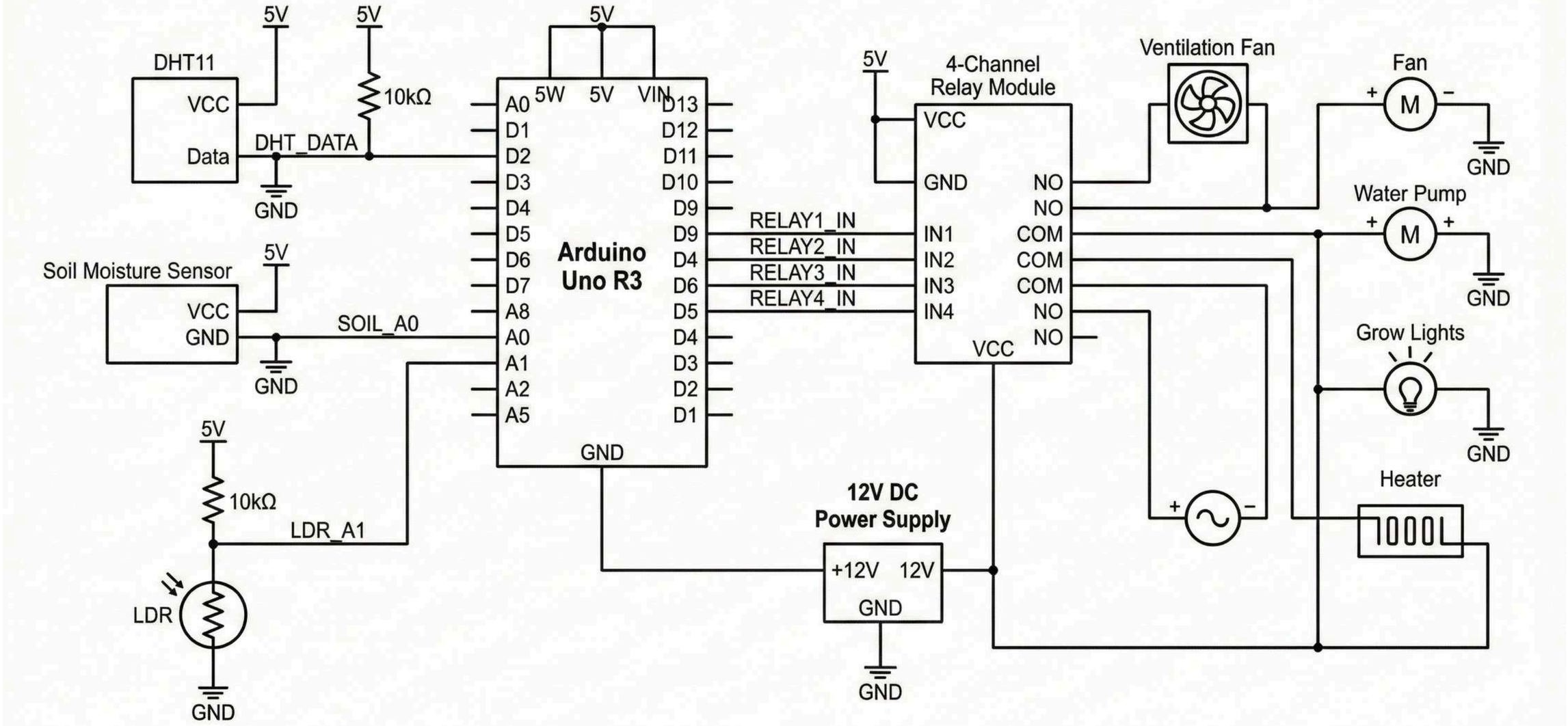
Greenhouse Automation System Architecture



Greenhouse Automation System Logic Flowchart



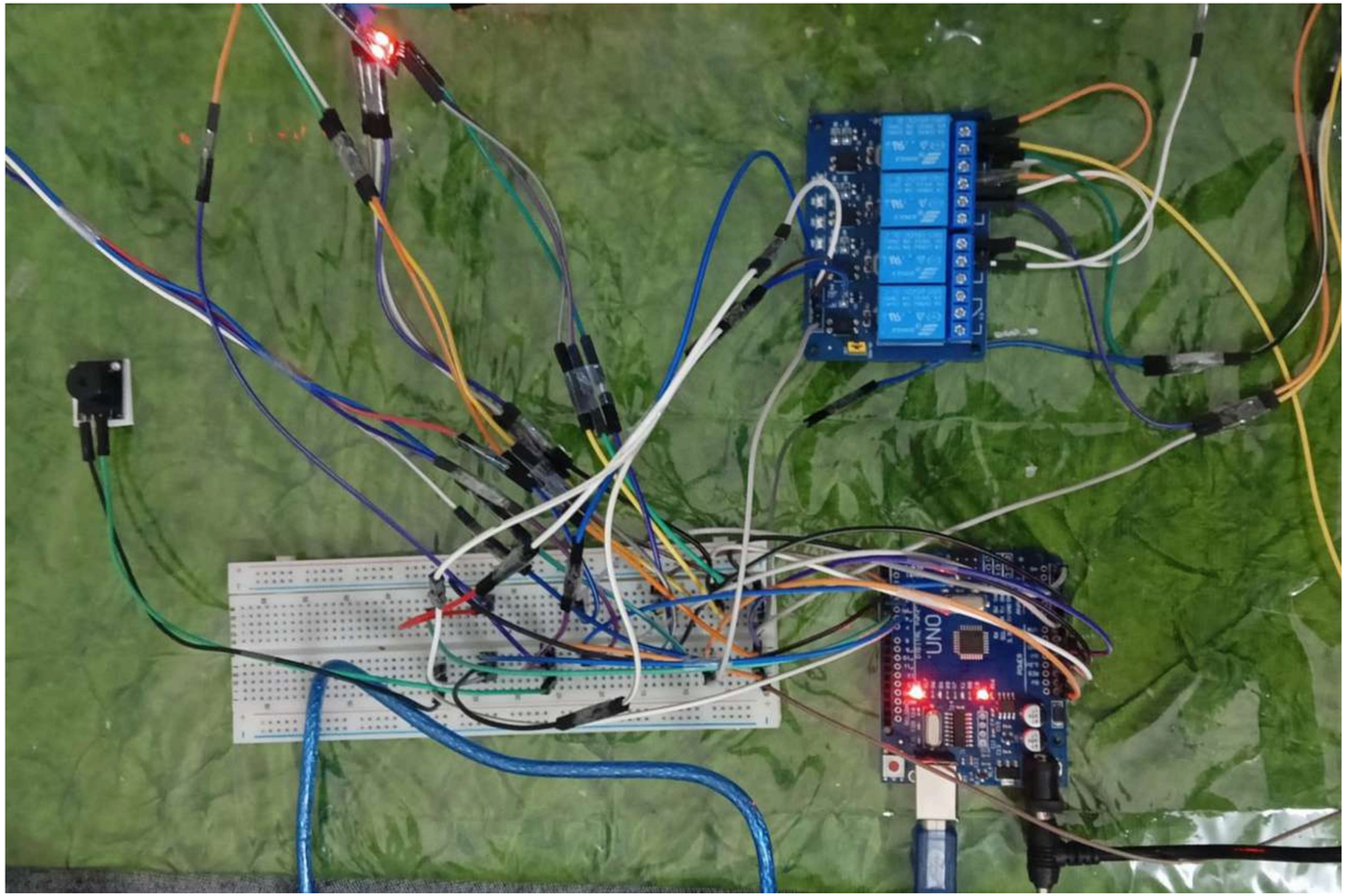
Greenhouse Automation System Hardware Schematic



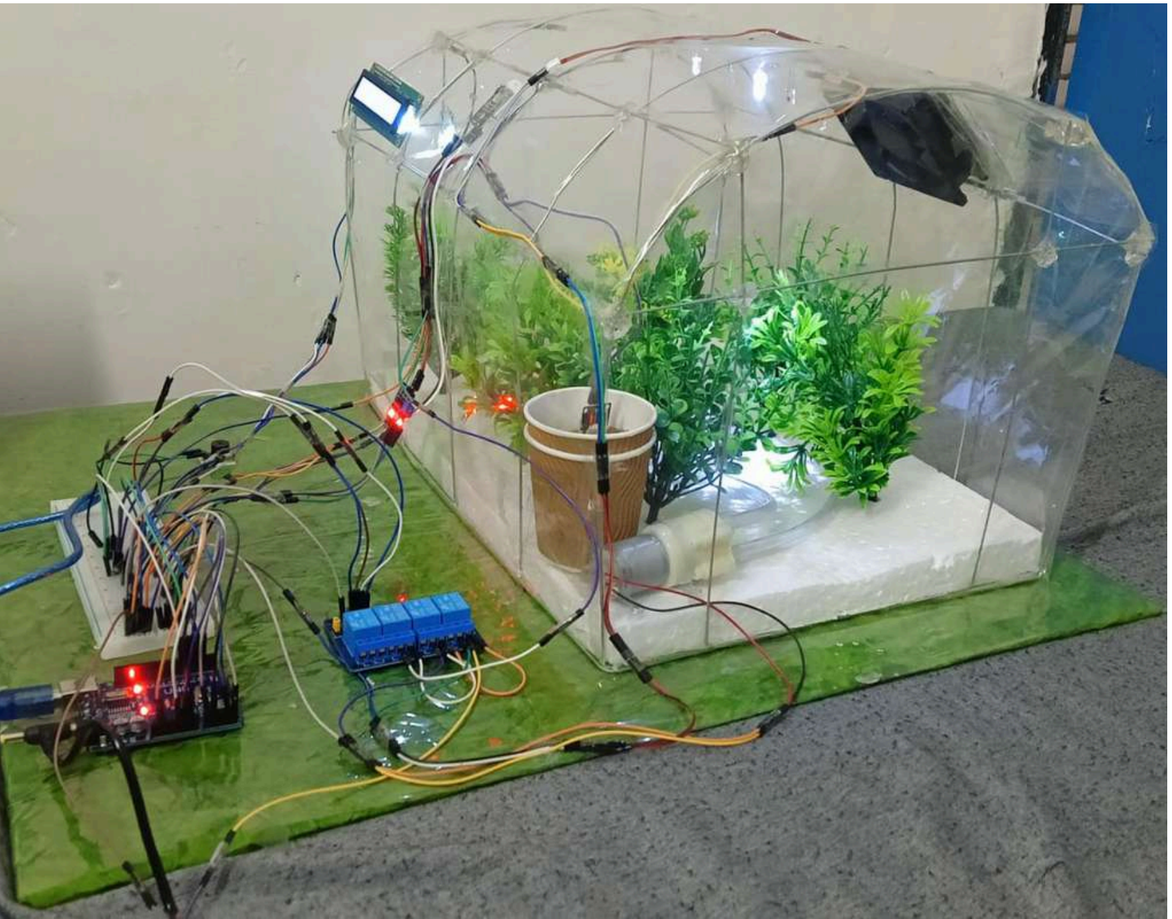
System Components Pin Connection

Module/Component	Arduino UNO Connections	External/Power Connections
DHT22 Sensor	VCC → 5V, GND → GND, DATA → D2	-
Soil Moisture Sensor	VCC → 5V, GND → GND, AO → A1	-
LDR (GL5516)	One leg → 5V, Other → A0 (+10kΩ to GND)	-
LCD1602 (I2C)	VCC → 5V, GND → GND, SDA → A4, SCL → A5	-
Buzzer (Active)	+ → D6, – → GND	-
4-Relay Module	VCC → 5V, GND → GND, IN1 → D3 (Fan), IN2 → D4 (Pump), IN3 → D5 (Light)	-
12V Fan (via Relay 1)	-	12V+ → COM1, NO1 → Fan+, Fan– → 12V PSU GND
Water Pump (via Relay 2)	-	12V+ → COM2, NO2 → Pump+, Pump– → 12V PSU GND
Grow Light (via Relay 3)	-	12V+ → COM3, NO3 → Light+, Light– → 12V PSU GND

Key Hardware Circuit



Optimal Temperature Control



01

Maintain Ideal Temperature

By using temperature sensors, Arduino ensures that the greenhouse maintains the **optimal climate** for plant growth, adjusting the fans and vents as needed to regulate heat.

02

Reduce Energy Waste

Automation minimizes unnecessary energy consumption by efficiently managing ventilation and temperature, resulting in lower operational costs and a **greener approach** to greenhouse management.

Ventilation Control

Effective **ventilation control** is crucial in maintaining a stable greenhouse environment. Temperature sensors continuously monitor conditions, while Arduino adjusts fan and vent operations to achieve optimal climate control and energy efficiency.

Automation of LED Grow Lights

Utilizing Light Sensors for Growth

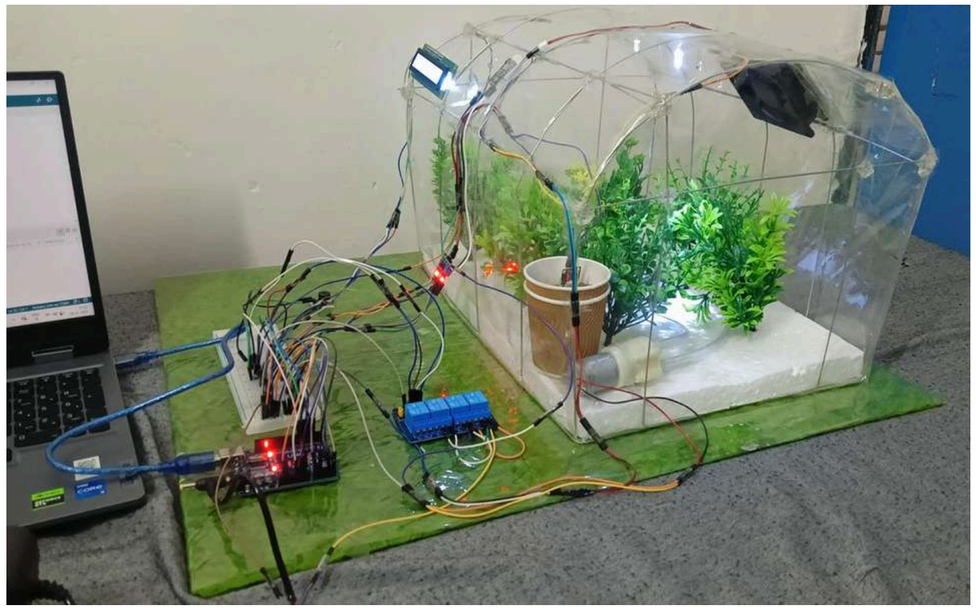
Optimizing plant health with controlled lighting

Live System Monitoring (I2C Interface)

Real-Time Dashboard: 16x2 LCD displaying live sensor data.

The system instantly displays the critical environmental metrics: Temperature (28.5 °C), Humidity (65 %), and Soil Moisture (450)

Flow of Automation Process



01

Clear Flowchart

A clear flowchart visually represents the sequence from sensors detecting environmental conditions to Arduino processing inputs and executing actions, ensuring efficient climate management in the greenhouse.

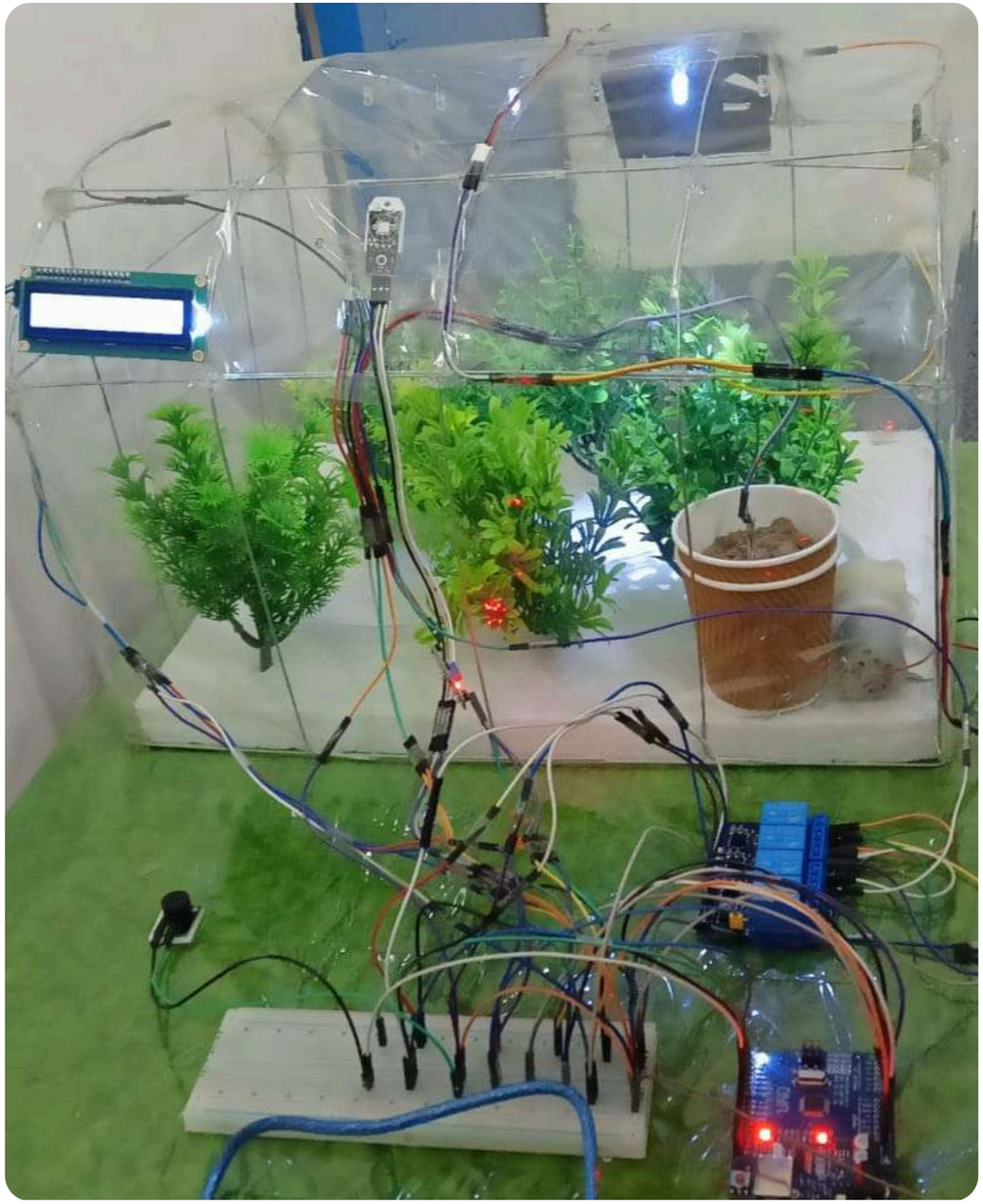
02

Simple Circuit Diagram

A simple circuit diagram illustrates the connections between the Arduino and its components, providing a straightforward view of how data flows and actions are triggered in the automated system.

Team Members & Contributions

Name	Roll No.	Reg. No.	Contributions
Satyam Kumar	34	12505700	• Lead Software & Simulation• Arduino automation algorithm & code logic• Sensor simulation and validation tests• Threshold + hysteresis control implementation• Flowchart, results, and analysis writing• Debugging, code optimization• IEEE formatting and documentation• Paper schematic + code structuring
Prince Patel	35	12501309	• Lead Hardware & IoT Design• Complete system wiring and relay control• Pump + cooling fan electrical integration• LCD/OLED display setup• Physical prototype assembly• Block diagram and architecture planning• PPT design & slide structuring• Paper references & research collection• Presentation planning



Thank You

Growing a sustainable future