Empowering Agriculture: IoT Based keyad controlled Solar Powered Smart Green House

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***Abstract*:**
IoT-based smart greenhouse powered by solar energy, encompassing advanced functionalities such as a solar tracker system, battery monitoring, temperature and humidity control, automated window and exhaust triggers, soil moisture regulation using drip irrigation technology, water level indicators, light control using UV light based on LDR systems for enhanced photosynthesis, data transmission to mobile devices for remote monitoring and control, a 4x4 keypad for manual temperature control, and an OLED display for user-friendly value visualization.

***Keywords*: Green-house, GSM, Agriculture**

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I. Introduction

Welcome to the future of agriculture! Here, we delve into the innovative world of a smart greenhouse powered by the Internet of Things (IoT). The concept of a smart greenhouse is bringing a fresh and innovative approach to farming, especially in challenging places like Ladakh. Ladakh is known for its vast barren lands and extremely cold weather, where people rely on special greenhouses to grow plants. However, these greenhouses face a significant problem - they become excessively hot during the scorching summers, making it nearly impossible to cultivate local crops. Adding to the challenges, certain areas in Ladakh lack access to electricity and the internet, further complicating matters. But here's the solution: a smart greenhouse powered by solar energy. This type of greenhouse doesn't require external electricity. Instead, it uses intelligent technology to manage conditions inside. This includes controlling the temperature, providing the right amount of special light for plants (UV light), and adjusting humidity levels (moisture in the air).

The exciting part is that you can control all these aspects using a simple keyboard. The keyboard is designed to work with an OLED display, making it user-friendly and easy to understand. Additionally, you have the ability to manually control airflow by opening windows or activating exhaust fans. This smart greenhouse is designed to function even in places where electricity is scarce, making it possible to farm in extreme weather conditions. This article delves into the intriguing concept of a solar-powered smart greenhouse in Ladakh. It explores how this innovation works and how it can revolutionize farming, enabling individuals to grow food in the face of challenging weather conditions and limited resources.

At the core of this smart greenhouse is a sophisticated ventilation system designed to optimize air circulation. By utilizing IoT sensors, the greenhouse can automatically adjust ventilation levels based on factors such as temperature and humidity. This ensures an ideal growing environment for plants, promoting their health and productivity. In addition to the ventilation system, this smart greenhouse features a manual temperature controller. This allows farmers to fine-tune the internal temperature based on specific plant requirements. By monitoring and adjusting the temperature manually, growers have precise control over the greenhouse environment, maximizing crop yields and quality. Harnessing the power of renewable energy, the smart greenhouse also integrates a solar tracker to charge the battery of 12V. It also incorporates a battery monitoring system. This technology continuously monitors the battery levels, ensuring a stable power supply for the various IoT devices within the greenhouse.

Furthermore, the smart greenhouse incorporates a smart irrigation system to efficiently manage water usage. IoT sensors monitor soil moisture levels, and based on the data collected, the system automatically adjusts irrigation schedules. This targeted approach to watering minimizes water waste and ensures plants receive optimal hydration, leading to healthier and more robust crops

A. *Background: Traditional agricultural practices face numerous challenges, including climate change, resource scarcity, electricity, network connectivity and the need for increased productivity. Smart greenhouse technology leverages IoT and renewable energy sources to overcome these challenges and promote sustainable agriculture.*
B. *Solar Tracker System and Battery Monitoring: The integration of a solar tracker system allows the smart greenhouse to maximize solar energy capture by optimizing the alignment of solar panels with the sun's position.The incorporation of a solar tracker system in the smart greenhouse allows the solar panels to efficiently capture sunlight and maximize energy generation. Additionally, a battery monitoring system ensures efficient energy storage and usage.*
C. *Temperature and Humidity Control: Precise temperature and humidity regulation are critical for plant growth. The smart greenhouse employs sensors and actuators to monitor and adjust these parameters. Automated window and exhaust triggers provide effective ventilation, maintaining an optimal climate inside the greenhouse.*
D. *Manual Controller with 4x4 Keypad and OLED Display: For manual control and user interaction, a 4x4 keypad is integrated into the system, enabling users to adjust temperature and humity settings. An OLED display provides clear and intuitive visualization of greenhouse parameters as showing in Fig 2 and Fig 3*
E. *Soil Moisture Regulation with Drip Irrigation: Maintaining the appropriate moisture level in the soil is vital for plant health. The system employs drip irrigation technology, utilizing soil moisture sensors and water pumps to deliver water directly to the roots, minimizing waste and ensuring efficient irrigation shown in Fig 7.*
F. *UV Light Control for Photosynthesis: Controlling the light spectrum is crucial for optimizing photosynthesis. The smart greenhouse utilizes Lux sensor systems to detect light intensity and adjusts UV light accordingly, facilitating healthy plant growth and productivity.*
G. *Mobile Data Transmission for Remote Monitoring and Control: There is an additional system incorporates IoT capabilities to transmit greenhouse data to mobile devices, allowing users to remotely monitor and control various parameters. Real-time updates facilitate timely interventions and decision-making.but this features is additional to the main circuit board.*
H. *Eco-Friendly Approach with Arduino-Based Motherboard: The smart greenhouse emphasizes eco-friendly practices by utilizing solar energy and minimizing resource consumption. The motherboard, based on Arduino, offers relay control for precise triggering and voltage regulation to ensure stable operation.*

II. PURPOSE AND EVALUATION OF WORK

This in-depth research exploration takes us into the world of smart greenhouses, specifically in the demanding setting of Ladakh. Imagine a vast expanse of 59,146 square kilometers, home to around 2.97 lakhs of people, where each household depends on greenhouses to grow crops. However, here lies a substantial issue: as summer arrives, the interior of these poly-carbonated greenhouses heats up tremendously, creating an environment that's practically hostile to crop growth. But that's not all. Some parts of this region lack steady access to electricity and the internet, which adds another layer of complexity. Interestingly, previous attempts at using smart greenhouse technology have run into obstacles. Many of these efforts relied on traditional power sources and internet connectivity to monitor data, which doesn't really align with the situation in Ladakh. Also, the existing models have present temperature limits, which doesn't match the reality that different crops require different temperatures.

Enter our innovative solution: a self-contained, standalone model that doesn't rely on outside power sources. We're introducing a solar tracker system that harnesses the sun's energy to keep things running. This model also boasts a keypad controller linked to OLED displays, sensors, and LEDs. This keypad system empowers users to fine-tune essential factors like the cutoff temperature, humidity levels, lighting conditions, and gas concentrations. This tailored approach ensures that crops experience the perfect environment for their growth.

This research truly matters because it's about finding a smart way to navigate the unique challenges of agriculture in Ladakh. By offering a self-sustaining and personalized system that isn't tied to conventional energy and internet demands, our model holds the potential to redefine how greenhouses work in this extraordinary region. It's a carefully studied concept, one that takes into account the intricate factors of Ladakh's agricultural landscape. Through this, we're paving the way for a future where crops thrive despite the odds

This literature survey explores the implementation of smart greenhouses in cold and harsh weather areas, with a focus on Ladakh. The study addresses the challenge of maintaining optimal temperature and moisture levels within the greenhouse during the summer season, which can lead to crop damage due to overheating. To mitigate this problem, a temperature sensor is employed to monitor the internal temperature and control it through the operation of exhaust and windows. Additionally, a soil moisture sensor is used to measure the moisture level of the soil within the greenhouse, triggering automated irrigation when the sensor detects low moisture. Furthermore, an LDR-based solar tracker is integrated to charge the battery, which powers the Arduino-based monitoring system for efficient greenhouse management.

III. LITERATURE SURVEY

The paper[1] highlights the growing importance of IoT in greenhouse management. Automation through IoT enables remote control of factors like temperature, moisture, and humidity. The proposed prototype integrates three controllers for precise regulation. This system empowers farmers to manage greenhouses remotely, reducing manual effort and enhancing crop conditions. An LCD and desktop interface provide real-time parameter updates

It involves a customized app for easy greenhouse monitoring and control, focusing on crucial parameters: temperature, soil, and humidity. Real-time data is sent over the internet, allowing remote management through a user-friendly GUI. This system operates worldwide via internet-connected smartphones, with cloud storage storing necessary commands v.

The paper [3] discusses use of IoT and Raspberry Pi-based monitoring systems for greenhouse conditions using temperature, humidity, and soil moisture sensors. The challenge of controlling critical parameters like humidity and temperature for optimal plant growth is highlighted. The project introduces a greenhouse control system using Raspberry Pi, including various sensors, an LCD display, fan, bulb, and pump. The system responds to temperature and soil moisture levels by activating fans and pumps, while a cloud-based ThingSpeak module enables remote monitoring and control.

The paper [4] addresses renewable energy-based systems, particularly a smart autonomous greenhouse, that operates in dynamic environments affected by changing climate conditions. The complex dynamics include factors like radiation, wind, heating, and humidity variations. The work proposes a Smart Autonomous Greenhouse (SAG) powered by renewable energy sources and models its dynamic behavior for stability in varying climates. A VSAS model captures the greenhouse-environment interaction, enabling the creation of a Virtual Greenhouse (VSAG) for parallel simulation and predictive analysis. This Virtual SAG aids remote control, learning, and monitoring of the greenhouse behavior. The project's progress is outlined, encompassing the design, data acquisition, process modeling, and stabilization through simulations. The effectiveness of the approach is showcased through simulation results.

IV. METHODOLOGY

1) Introduction:

This section outlines the methodology used to design and develop an IoT-based smart greenhouse powered by solar energy. The smart greenhouse incorporates various features such as a solar tracker system,a keypad controller with a 4x4 keypad, a user-friendly OLED display, battery monitoring, temperature and humidity control, automated window and exhaust triggers, soil moisture regulation using drip irrigation, water level indicators, UV light control based system, Gas sensor system mobile and data transmission, The system utilizes an Arduino-based motherboard, equipped with relays and voltage regulators, to ensure seamless operation and control.

System Desicription: The smart greenhouse is a sophisticated system comprising a multitude of components such as sensors, controllers, battery management, and monitoring systems. A key player in modern agriculture, it employs sensors, actuators, and automated controls to continuously monitor and adjust vital parameters like temperature, humidity, light, and soil moisture in real-time. This level of control is accessible remotely, empowering farmers to optimize greenhouse conditions, reduce resource wastage, and enhance overall crop yield and quality. This innovative approach embodies sustainability, efficiency, and productivity.

The complex system architecture is illustrated in the block diagram (Fig. 1), showcasing the integration of diverse elements including the smart greenhouse, intelligent irrigation, and battery monitoring systems. Each functionality is meticulously designed with specific components and subsystems, encompassing solar power generation, keypad control, temperature/humidity regulation, soil moisture maintenance, light management, and seamless data transmission.

Fig. 1. Block Digram of the Smart Green House,smart Irrigation system and battery Monitering System .

2)Solar Power Generation:

- The smart greenhouse not only taps into solar energy for its operations but also embraces clean and renewable power sources. Employing an ingenious solar panel tracking mechanism featuring Light-Dependent Resistors (LDRs) and servo motors, the system adeptly optimizes sunlight exposure, resulting in a seamless flow of efficient and consistent power generation. The heart of this process lies within the Arduino board, which skillfully processes LDR data and issues commands to the servo motors, expertly aligning the solar panel to capture maximum sunlight.

- Additionally, a sophisticated MPPT (Maximum Power Point Tracking) solar charge controller, masterfully integrated with Arduino, takes center stage. This controller dynamically seeks the optimum output from the 12V solar panel, harnessing its full potential. The garnered energy efficiently charges the battery, while dual voltage regulators—namely, the 7805 and 7812—meticulously shape the output to provide steady 5V and 12V supply. This strategic power distribution fuels an array of greenhouse functionalities, all while upholding an environmentally conscious and budget-friendly ethos. Bolstering the system's resilience, polarity diodes contribute their protective role, shielding the circuit from potential harm. For an illustrative insight, refer to Fig 7 which vividly portrays the simulation of this entire process. Furthermore, a dedicated display showcases battery voltage and current data, facilitating comprehensive battery management.

3)Keypadl Control and OLED Display:

- An exciting innovation presented in the paper is the incorporation of a user-friendly interaction system, achieved through a 4x4 keypad. This ingenious interface empowers users with manual temperature control and direct management of various greenhouse functions. These functions encompass pivotal aspects such as regulating growing lights, maintaining humidity levels, and toggling the entire ventilation system. The seamless interaction is facilitated by the keypad, seamlessly integrated with an Arduino system.

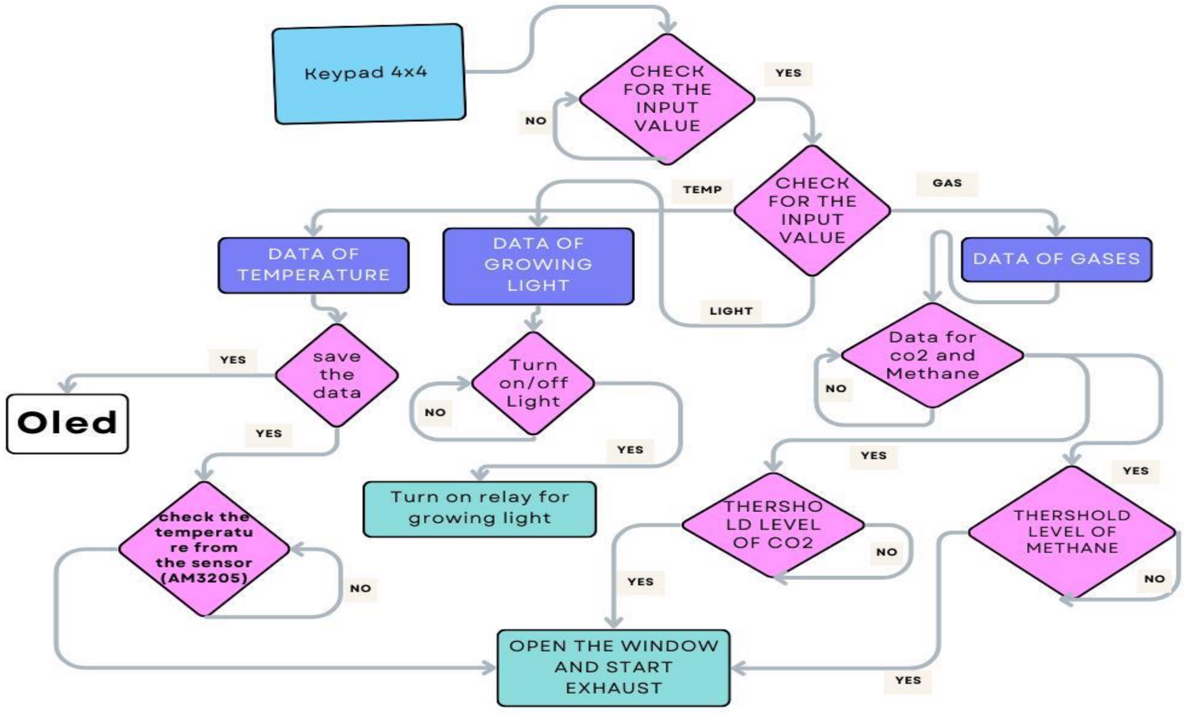

Fig. 2. Flow chart of keypad system

- A noteworthy enhancement lies in the keypad's interaction with an OLED displayi.e (ssh1106). This dynamic display furnishes real-time insights, offering a comprehensive overview of temperature, humidity, and moisture levels. This synergy between keypad and OLED display significantly amplifies monitoring capabilities, enabling users to have a real-time grasp of the greenhouse environment.

- With an array of 16 keys at their fingertips, users have comprehensive command over every facet of greenhouse operation. The intelligently interfaced OLED display serves as a user-friendly dashboard, making interaction and control of the greenhouse environment an engaging and accessible experience.

Fig. 3. Setup of keyapd with interfaced with oled

4) Temperature and Humidity Control:

- Choose suitable sensors to measure temperature and humidity levels inside the greenhouse.
- A specialized AMS2035B sensor monitors temperature and humidity within the greenhouse. By setting a temperature threshold via the keypad, the system dynamically activates cooling mechanisms, such as fans and windows, maintaining optimal internal conditions. This automated response ensures consistent and precise climate control.

5) Soil Moisture Regulation:

- For efficient plant growth, soil moisture levels are closely monitored using a moisture sensor. When moisture drops below a predetermined level, the system activates a water pump, irrigating plants and restoring optimal moisture content. Once adequate moisture is achieved, the system halts irrigation, conserving water and promoting healthy plant growth.

6) Light Control using LUX System:

- An advanced lighting setup consisting of UV and red/blue spectrum adjustable lamps supports optimal plant growth. The system includes an automatic ON/OFF feature, eliminating manual intervention and ensuring consistent light exposure. The tailored light spectrum encourages photosynthesis, ultimately leading to increased crop yields.

7) Mobile Data Transmission and Control:

- This is an additional feature as the system is stand alone. So we can further add this features if the user needs

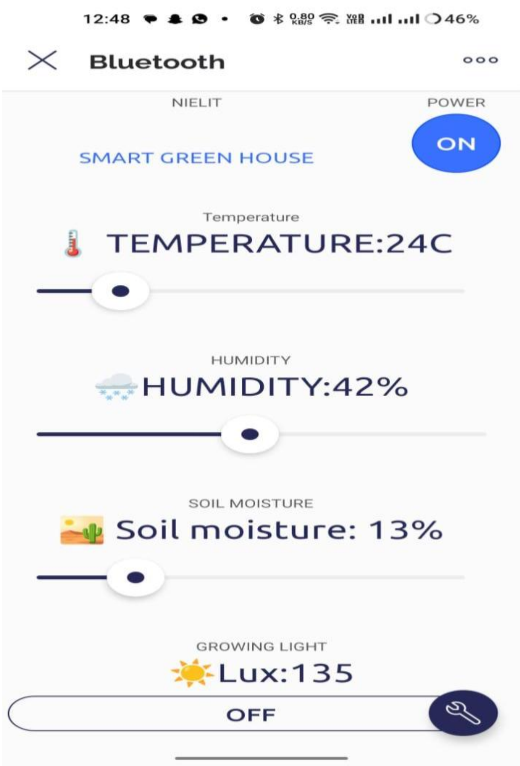

Fig. 4. Blynk app on mobile for addition feature of mobile monitering and control system

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8)Arduino-Based Motherboard:

- Select an Arduino microcontroller (Arduino Mega) board as the central control unit for the smart greenhouse system.
- Interface keypad with the Arduino to control various actuators, such as window triggers, water pump, and UV light source.
- Integrate voltage regulators, BMS, Battery monitoring system to ensure a stable power supply to the Arduino and other components within the system.
- All the system has been placed on a single PCB to make it easy to install with a dimension of 6x4 inch as mentioned in Table II.
- There is a port for extra addition of wifi module which can be interfaced with blank app. As shown in Fig 4.

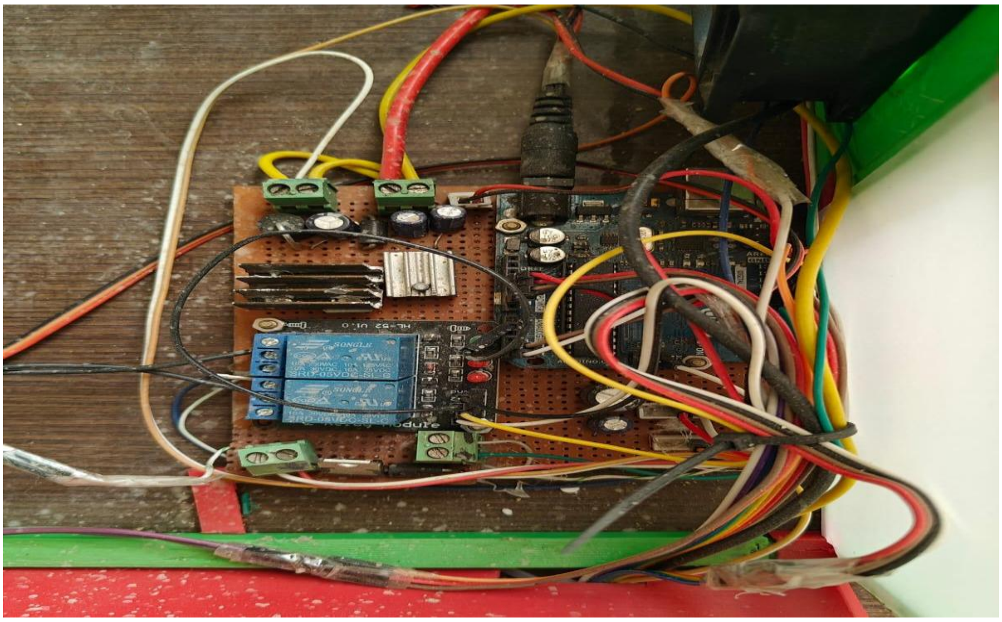

Fig. 5. Motherboard of system

9)Programming Section,:

Embedded C language within the Arduino IDE empowers the system with precise and efficient programming. Protus and SimulIDE software are utilized for simulation purposes, visually depicting the intricate interactions between solar power, IoT controls, and crop-specific conditions. This simulation bridges theory and practical implementation, validating the system's effectiveness and real-world potential.

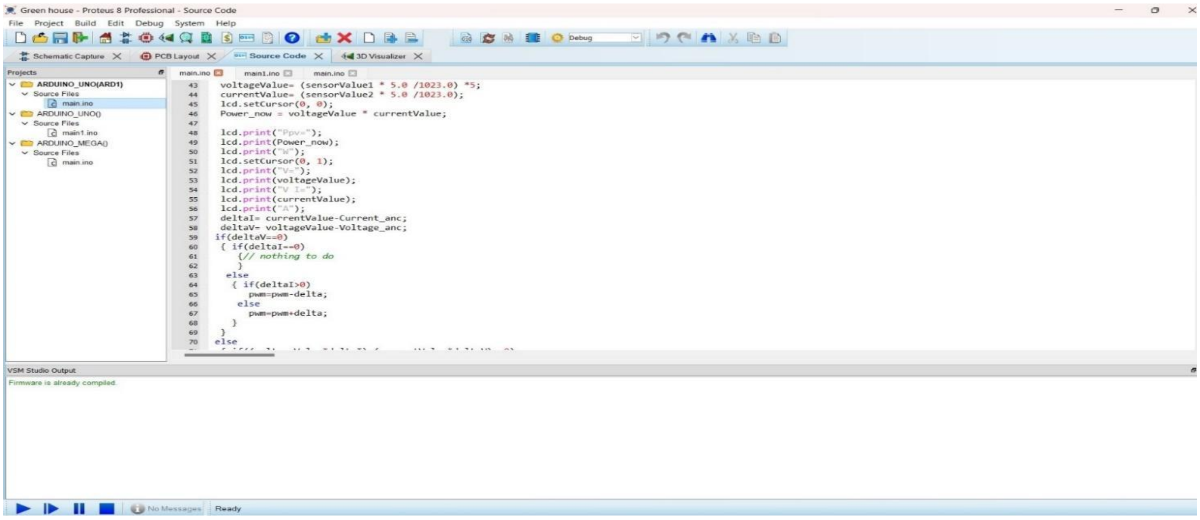

Fig. 6. Code simulated in the protus software

Moving forward, the integration of developed programs into Protus for simulation underscores the tangible applicability of the IoT-based smart greenhouse shown in the above Fig 7. This simulation reveals the intricate interplay of elements, emphasizing the synergy between programming and real-world conditions. This convergence substantiates the system's robustness and innovative prowess, transitioning theoretical concepts into impactful outcomes.

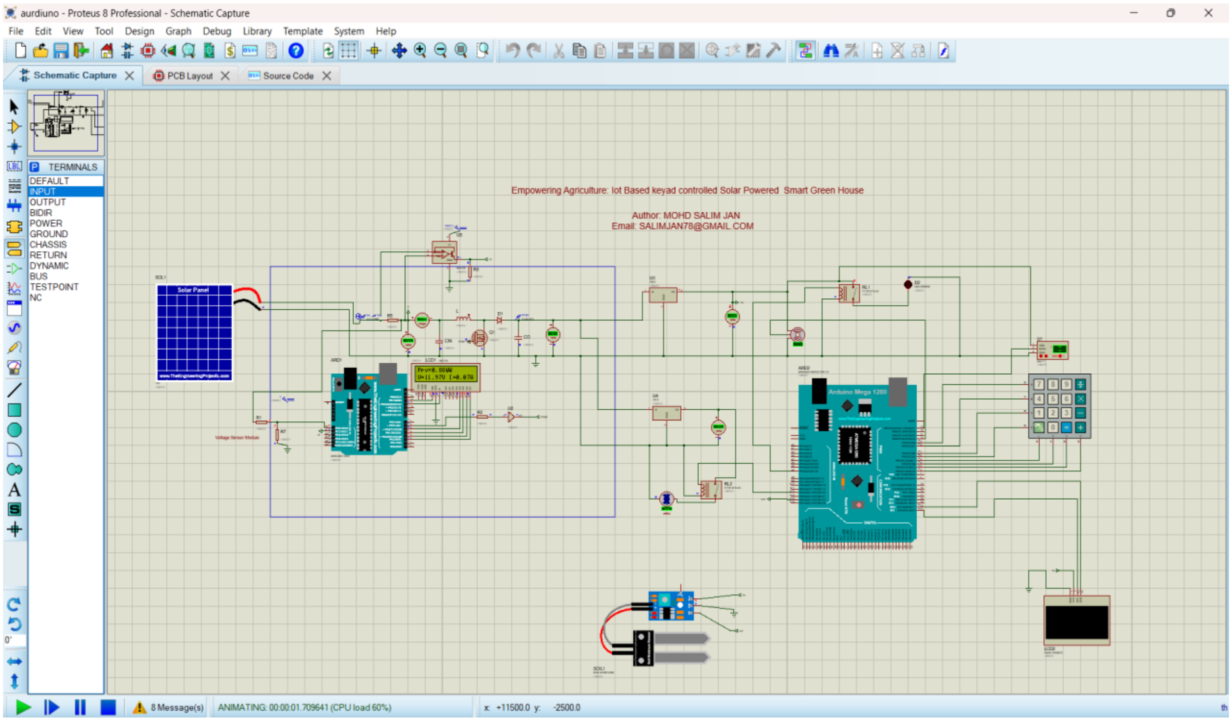

Fig. 7. Simulation of smart green house circuit

10) *Testing and Evaluation:*

- Our evaluation process involves simulating various system parameters using a range of simulation software, detailed in Table I. These software options offer distinct components, necessitating their combined use to comprehensively assess our system. The primary simulations take place in Protus.
- To glean insights, we employ tools such as the Digital Oscilloscope and Frequency Analyzer. These instruments allow us to observe intricate dynamics. The outcomes, as illustrated in Fig8, provide a tangible representation of solar power output.
- Key parameters under scrutiny encompass solar panel power output, MPPT charge controller efficiency, battery performance, and the behavior of interfaces with voltage regulators (7805 and 7812).
- In essence, our evaluation method blends simulation software, analytical tools, and precise measurements to form a holistic comprehension of our system's functionality.

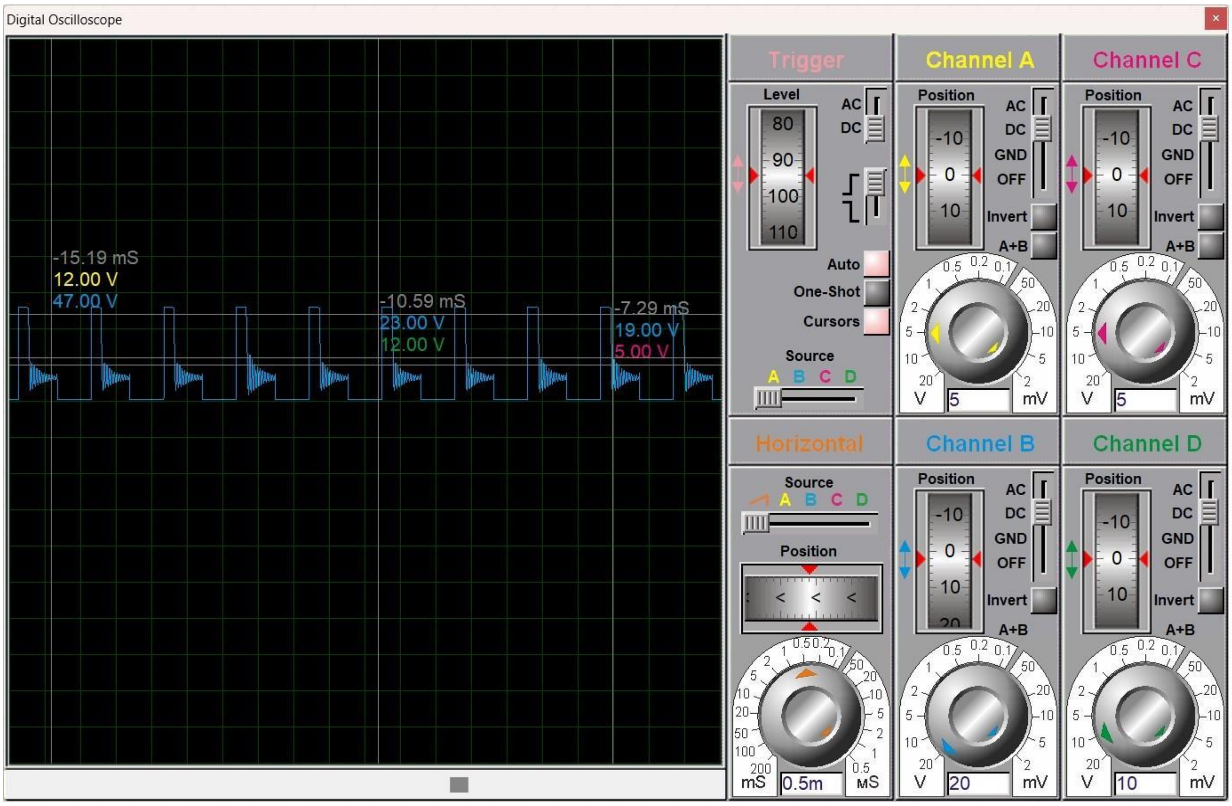

Fig. 8. Simulation of different parameter

TABLE I. RESULT OF DIFFERENT PARAMETERS SIMULATED ON PROTUS

Materials	***Channel***	***Voltage***
Solar Panel	*Channel*1	12v
Mppt charge controller	*Channel* 2	23v
Battery		12v
7805	*Channel 3*	5v
7812	*Channel 4*	12v

V. IMPLEMENTATION

The implemtation process are given below

TABLE II. HARDWARE AND SOFTWARE RESOURCES USED

Parameters	***Components***	***Purpose***	***Specification***
Processor	Arduino mega	The Arduino Mega is a powerful microcontroller board with a large number of digital and analog pins, ideal for projects requiring extensive input/output capabilities.	• Microcontroller: ATmega2560 • Operating Voltage: 5V • Digital I/O Pins: 54 (of which 15 provide PWM output) • Analog Input Pins: 16 Flash Memory: 256 KB (of which 8 KB is used by the bootloader) • SRAM: 8 KB • EEPROM: 4 KB • Clock Speed: 16 MHz • UART Ports: 4 • SPI Ports: 1 • I2C Ports: 1 • Power Pins: 5V, 3.3V, GND, VIN • Compatibility: Compatible with the Arduino IDE and various shields • Dimensions: Approximately 101.6mm x 53.4mm
Temperature and Humidity	AM2305B Sensor	The AM2305B sensor is a digital temperature and humidity sensor that offers accurate and reliable measurements for various applications. It communicates via a single-wire digital interface, making it easy to integrate into projects and systems.	• Sensor Type: Digital Temperature and Humidity Sensor • Measurement Range: Temperature (-40°C to 80°C), Humidity (0% to 100%) • Accuracy: ±0.5°C for Temperature, ±3% for Humidity • Communication Interface: Single-Wire Digital Interface • Power Supply: 3.3V to 5.5V
Keypad	Keypad 4*4 matrix	The 4x4 matrix keypad is an input device with 16 buttons arranged in a grid, allowing users to input numeric and functional commands. It's commonly used in electronics projects for user interaction and data entry.	• Type: 4x4 Matrix Keypad • Layout: Consists of 16 keys arranged in a 4x4 grid. • Connection: Typically uses a common rowcolumn scanning method for interfacing with microcontrollers. • Operating Voltage: Compatible with a range of microcontroller voltage levels, commonly 3V to 5V. • Interface: Requires digital input/output pins for row and column scanning. • Pinout: Usually has 8 pins (4 for rows and 4 for columns). • Compatibility: Easily interfaces with microcontrollers, Arduino boards, and other digital systems. • Dimensions: Compact and suitable for various electronic projects. • Material: Constructed with durable and lightweight materials. • Keypress Detection: Detects keypresses by recognizing changes in the row-column connections.
Solar Panel	Solar Panel(12v)	A solar panel is a device that converts sunlight into electricity using photovoltaic cells, providing a renewable and eco-friendly energy source for various applications.	• Voltage Output: Designed to provide approximately 12 volts DC output. • Power Output: Output power varies based on panel size and efficiency, typically ranging from around 5W to 200W for small to medium-sized panels. • Efficiency: Efficiency ranges from 15% to 20% for standard panels. • Dimensions: Comes in various sizes, usually ranging from around 10 inches by 15 inches to larger dimensions. • Operating Temperature: Generally works within a temperature range of -40°C to 85°C. • Applications: Used for various applications such as charging 12V batteries, powering small electronics, RVs, boats, and off-grid setups. • Regulation: Depending on the application, a charge controller may be needed to regulate voltage and prevent overcharging. • Compatibility: Compatible with 12V battery systems and appliances
Gas sensor	MQ-4 MQ-135	The MQ-4 sensor is a gas sensor module commonly used to detect various gases likemethane and natural gas in the environment, making it valuable for gas leakage detection applications in homes and industries. –The MQ-135 is a gas sensor module widely used to detect a	MQ-4 sensor • Target Gas: Methane (CH_4) • Detection Range: 200 to 10,000 ppm • Response Time: Approximately 10 seconds • Operating Temperature: -10°C to 50°C • Operating Humidity: 65% ± 20% RH • Supply Voltage: 5V DC MQ-135 sensor • Gas Detection: Designed to detect a range of gases including

		variety of air pollutants, including harmful gases like ammonia, carbon dioxide, and volatile organic compounds, making it valuable for air quality monitoring and safety application	ammonia (NH3), nitrogen oxides (NOx), CO2. • Sensitivity: Sensitive to various gases, providing qualitative gas detection. • Operating Range: Typically detects gases in concentrations ranging from 10 to 1000 parts per million (ppm). • Response Time: Offers a relatively quick response time for gas detection. • Operating Temperature: Suitable for operation within a range of -10°C to 50°C. • Power: Low power consumption for extended operational periods. • Compatibility: Can be interfaced with microcontrollers and systems for data processing.
soil moisture	FC-28	A soil sensor is a device used to measure soil moisture levels, helping gardeners and farmers optimize irrigation and plant care for healthier growth.	• Operating Voltage: 3.3V to 5V DC • Operating Current: 15mA • Output Digital – 0V to 5V, Adjustable trigger level from preset • Output Analog – 0V to 5V based on infrared radiation from fire flame falling on the sensor
Growing Lighting	LUX sensor (TSL2 561)	The TSL2561 sensor is a digital light sensor that measures ambient light intensity and converts it into a digital signal, suitable for various applications like automatic brightness adjustments in displays and environmental monitoring.	• Supply Voltage [V] 2.7 -3.6 • Interface I2C - VDD • Programmable Gain, integration time, interrupt • Max. Lux 40000 • Temperature Range [°C] -30 to 70
Servo Motor for window	MG 996R	The MG996R is a hightorque digital servo motor with metal gears, commonly used in robotics and RC projects for precise and powerful motion control. It offers reliable performance and durability.	• Operating Voltage is +5V typically • Current: 2.5A (6V) • Stall Torque: 9.4 kg/cm (at 4.8V) • Maximum Stall Torque: 11 kg/cm (6V) • Operating speed is 0.17 s/60° • Gear Type: Metal • Rotation : 0°-180° • Weight of motor : 55gm
Relay	relay(5v)	A 5V relay serves to control higher power devices using low-power signals, finding use in applications like home automation, industrial control, and automotive systems. Its electromechanical switching mechanism ensures reliable and isolated operation.	• VCC:Power interface,5v • IN:controlinterface.Drive Current at least 4mA • COM:Control circuit ground,Connect to GND
Current voltage display	OLED display	An OLED display offers a compact and visually appealing interface, allowing users to showcase data, graphics, and sensor readings, enhancing project interactivity and visualization.	• Type: OLED (Organic Light Emitting Diode) Display • Thinness: Ultra-thin and lightweight due to lack of backlight • Contrast: High contrast ratio and deep blacks • Response Time: Fast response, minimal motion blur • Flexibility: Can be manufactured on flexible substrates for curved displays • Power Efficiency: Energyefficient as each pixel emits its own light • Brightness: Generally not as bright as some LCD technologies • Applications: Smartphones, TVs, wearable devices, signage, VR/AR headsets • Cost: Production costs can be higher compared to LCDs
Voltage Regulator	Voltage Regulator (7805 ,7812)	Voltage regulators like the 7805 and 7812 stabilize input voltage to provide a consistent and controlled output, ensuring reliable power supply for electronic circuits and components. They are commonly used to achieve specified voltage levels for microcontrollers, sensors, and analog devices.	• Type: Linear Voltage Regulator • Models: 7805 (5V output), 7812 (12V output) • Function: Stabilizes input voltage to a constant output voltage • Package Type: Usually in TO-220 or TO-92 packages • Input Voltage: Higher than the desired output voltage • Output Voltage: 7805 - 5V, 7812 - 12V • Output Current: Typically up to 1A or 1.5A, modeldependent • Dropout Voltage: Voltage difference between input and output for regulation • Regulation: Typically offers good voltage regulation within specified conditions
Solar tracker	LDR	An LDR-based solar tracker adjusts solar panel orientation to maximize sunlight exposure, optimizing energy generation efficiency in solar power systems. It ensures panels follow the sun's movement, capturing the most sunlight throughout the day	• Type: LDR (Light Dependent Resistor) • Principle: Photoconductivity • Function: Changes resistance based on light intensity • Construction: Semiconductor material (cadmium sulfide or similar) • Operating Range: Varies based on model, generally between dark and bright conditions • Resistance: High in the dark, decreases with increasing light

			• Applications: Light sensors, automatic light control, photography exposure control • Response Time: Slow response to rapid changes in light
Software	• SimulIDE Software • Aurdiuno IDE Software • Proteus Software • Blynk	• SimulIDE: SimulIDE software enables circuit simulation, helping designers test electronic circuits virtually before physical implementation. • Arduino IDE: Arduino IDE simplifies coding for Arduino boards, allowing users to develop and upload programs, making embedded system development accessible. • Proteus: Proteus software facilitates PCB design and circuit simulation, aiding engineers in designing, testing, and optimizing electronic projects. • Blynk IDE: Blynk IDE provides a platform for creating IoT applications with visual interfaces, connecting hardware devices to the cloud for remote control and monitoring	SimulIDE • Name: SimulIDE • Type: Circuit Simulation Software • Function: Allows virtual testing and simulation of electronic circuits • Components Library: Extensive collection of electronic components for designing circuits • Simulation Modes: Offers interactive real-time simulation and analysis • Applications: Circuit prototyping, experimentation, and educational purposes • Platforms: Available for Windows, Linux, and macOS Arduino IDE • Name: Arduino IDE • Type: Software Development Environment • Function: Facilitates coding, compiling, and uploading programs to Arduino boards • Language: Uses C/C++ programming language • Interface: User-friendly code editor with syntax highlighting and autocompletion • Board Compatibility: Supports various Arduino boards and compatible microcontrollers • Code Verification: Integrated compiler checks for syntax errors and suggests corrections • Platform Independent: Available for Windows, macOS, and Linux • Open Source: Source code available for modification and customization Proteus • Name: Proteus • Type: Electronic Design Automation (EDA) Software • Function: Combines schematic capture, circuit simulation, and PCB design • Schematic Capture: Intuitive interface for designing electronic circuits • Simulation Modes: Allows interactive simulation of circuits to test functionality • PCB Design: Supports PCB layout design with auto-routing features • 3D Visualization: Offers 3D viewing of PCBs for visualization BLYNK • Name: Blynk • Type: Internet of Things (IoT) Platform • Function: Enables easy creation of IoT applications with visual interfaces • User Interface: Provides a drag-and-drop interface for building mobile app interfaces • Hardware Integration: Supports various hardware platforms (Arduino, ESP8266, Raspberry Pi, etc.) • Cloud Connectivity: Connects hardware devices to the cloud for remote control and monitoring • Widgets: Offers a variety of widgets (buttons, sliders, graphs) for user interaction • Data Visualization: Displays real-time data and sensor readings on mobile apps • Notifications: Sends notifications to the mobile app based on

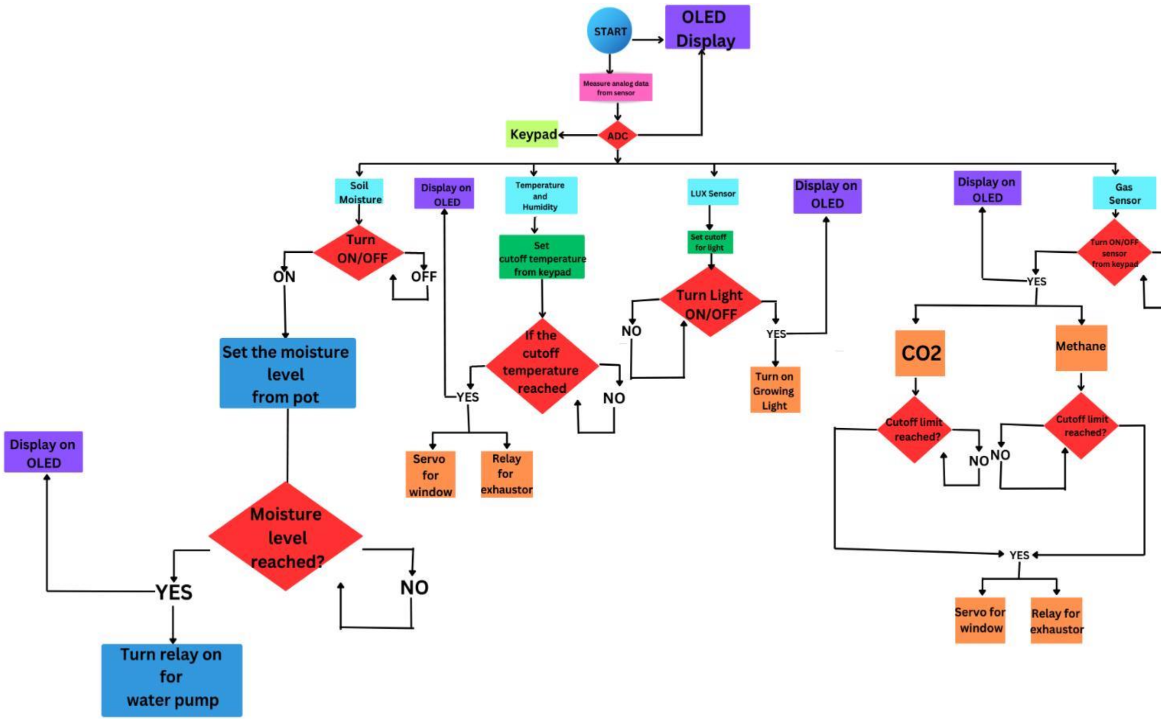

Fig. 9.   Flow Chart of the model

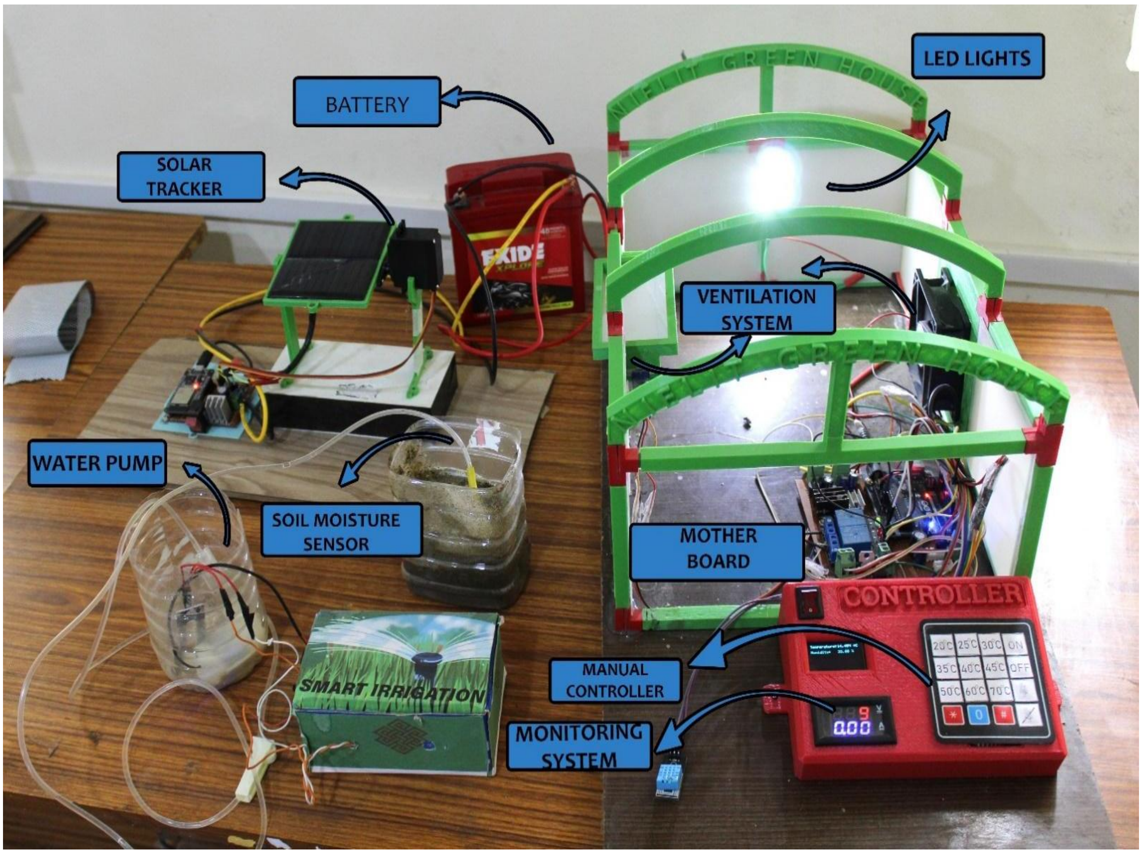

Fig. 10. Working Model Setup for Demo Purpose

TABLE III. COMPARISION TABLE

COMPONENTS		PAPER [1]	PAPER [2]	PAPER [3]	PAPER [3]	PROPOSED METHOD
MOTHERBOARD	PROCESSOR	ARDUINO UNO	ARDUINO UNO	RASPBERRY PI	RASPBERRY PI	AURDIUNO MEGA
	DIMENSION	NOT MENTIONED	NOT MENTIONED	NOT MENTIONED	NOT MENTIONED	6X4 INCH
POWER SOURCE	AC/DC	AC	NOT MENTIONED	AC	DC	DC
	TECHNOLOGY	RECTIFIER CIRCUIT	NOT MENTIONED	NOT MENTIONED	RENEWABLE ENERGY (SOLAR)	RENEWABLE ENERGY (SOLAR)
	TRACKKING SYSTEM	NO	NO	NO	NO	SOLAR TRACKER
	CHARGE CONTROLLER	NO	NO	NO	BMS	MPPT
	BATTERY MONITORING	NO	NO	NO	NO	YES
KEYPAD CONTROLLER	KEYPAD CONTROLLER	NO	NO	NO	NO	4X4 KEYPAD MATRIX
DISPLAY	DISPLAY UNIT	LCD 16X2	ON MOBILE	LCD 16X2	NO	OLED
GROWING LIGHT	SENSORS	YES	NO	NO	NO	YES
CONNECTIVITY	TECHNOLOGY	ESP8266	ESP8266	IN BUILD (PI)	IN BUILD (PI)	ESP8266 (ADDITIONAL UNIT)
TEMPERATURE AND HUMIDITY	SENSORS	DHT11	NOT MENTIOED	DHT11	NOT MENTIOED	AM3205
	Accuracy	Accuracy: ±5%RH , Temperature Accuracy: ±2°C	NOT MENTIOED	Accuracy: ±5%RH , Temperature Accuracy: ±2°C	NOT MENTIOED	Accuracy: ±2%RH ,Temperature Accuracy: ±0.3°C
GAS SENSOR	GAS SENSOR	NO	NO	SMOKE SENSOR	NO	CO2 AND METHANE

VI. FURTHER SCOPE

The Smart Greenhouse can be further upgraded in many ways and can be used in wide agricultural applications. It can be used in any environment and under any set of conditions to grow any form of plant.Other non-conventional energy sources such as wind mills are used to supply power to the automatic greenhouse equipment’s and Peltier effect for cooling purpose. Soil-less farming can be performed to further improve the nutritional value. Integration of farming with IoT can make it much more efficient and profitable activity. We can also use cloud server to store the data and control the green house from mobile application using a GPS module. The agricultural sector has a bright future for Smart Greenhouse, which will revolutionize how India practices agriculture.

VII. CONCLUSION

This research paper introduces a cutting-edge IoT-based smart greenhouse system, powered entirely by solar energy, revolutionizing traditional farming practices. By seamlessly integrating advanced functionalities like precise temperature and humidity control, efficient soil moisture regulation, intelligent water management, UV light modulation, Removal of excess gas such as methane and Co2 and remote monitoring, this system redefines sustainable agriculture. The incorporation of a manual controller, a user-friendly 4x4 keypad, and an OLED display enriches user engagement. The core of this innovation lies in the Arduino-based motherboard, ensuring not only operational excellence but also eco-friendliness.

The system is user-friendly, with keypad and a display for easy control. It's built on efficient technology, making it reliable and environmentally friendly. By using renewable energy and IoT, this greenhouse presents a modern solution to the challenges of limited resources and climate change in agriculture. Through the harmonious marriage of IoT technologies and renewable energy sources, this smart greenhouse emerges as a beacon of environmentally conscious farming, providing a potent response to the challenges posed by resource limitations and the changing climate. This novel approach empowers cultivators to create and maintain tailored climatic conditions, facilitating the growth of a diverse range of crops, including exotic species like hibiscus. Notably, the system dramatically curtails water consumption by 70%-80%, while concurrently expediting growth rates and overall yield, all while fostering the production of organic agricultural products.

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