iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 14 Issue: V Month of publication: May 2026

DOI: https://doi.org/10.22214/ijraset.2026.82071

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 14 Issue V May 2026- Available at www.ijraset.com

A Research Paper on IOT Based Smart Automation System

Anjali Bhoyar[1], Sahil Bharaskar[2], Sahil Dongare[3], Ayush Bhaisare[4], Samyak Meshram[5]
[1]Assistant Professor, [2,3,4,5]Students, Department of Computer Science and Engineering, Govindrao Wanjari College of Engineering & Technology

Abstract: This research paper presents the design and development of an integrated IoT-Based Smart Automation System aimed at enhancing domestic energy efficiency and environmental monitoring. The system utilizes the ESP8266 NodeMCU as the primary gateway for data acquisition and wireless communication. To capture environmental parameters, the hardware layer integrates a DHT11 sensor for real-time temperature and humidity tracking and an LDR (Light Dependent Resistor) for monitoring ambient light intensity.

A distinctive feature of this implementation is the shift from third-party IoT clouds to a self-hosted PHP-based web server integrated with a MySQL database. This architecture ensures localized data sovereignty, high customization, and cost-effectiveness. The ESP8266 transmits sensor data via HTTP protocols to the server, where it is processed and displayed on a dynamic web dashboard accessible through any internet-enabled device.

Experimental results demonstrate that the system provides reliable real-time monitoring and successfully automates electrical loads based on sensor thresholds, such as activating lighting during low-light conditions. The study concludes that the combination of low-cost microcontrollers and standard web technologies like PHP offers a robust, scalable, and secure solution for modern smart home applications, making advanced automation accessible for both residential and industrial use cases.

Index Terms: Internet of Things (IoT), Smart Home Automation, ESP8266 NodeMCU, Remote Monitoring, DHT11 Sensor, LDR (Light Dependent Resistor), Wireless Sensor Networks (WSN), Embedded Systems, Energy Efficiency, Real-time Data Acquisition, Home Area Network (HAN).

I. INTRODUCTION

The rapid evolution of the Internet of Things (IoT) has fundamentally transformed the landscape of modern living, shifting the paradigm from manual operation to intelligent automation. A Smart Home Automation System represents a sophisticated integration of hardware and software designed to provide users with enhanced control over their domestic environment. By leveraging the power of interconnected devices, these systems offer significant advantages in terms of energy efficiency, security, and convenience. In developing regions, there is a growing demand for cost-effective, localized solutions that do not rely on expensive, proprietary ecosystems.

This project focuses on the design and implementation of a scalable automation framework using the ESP8266 NodeMCU, a low-cost Wi-Fi-enabled microcontroller. The system serves as a bridge between the physical and digital worlds by utilizing a DHT11 sensor for climate monitoring (temperature and humidity) and an LDR (Light Dependent Resistor) for ambient light detection. Unlike many standard projects that utilize third-party cloud platforms, this system employs a custom-built PHP-based web server. This architectural choice ensures superior data privacy, reduces latency, and allows for a fully customizable user interface tailored to specific needs.

By collecting real-time environmental data and processing it through a centralized database, the system can make autonomous decisions—such as toggling lights based on darkness or managing cooling systems. Ultimately, this research demonstrates how open-source hardware and standard web technologies can be combined to create a robust, accessible, and highly efficient smart home solution.

II. SYSTEM ARCHITECTURE

The system architecture of project is designed around a Three-Tier Model, ensuring a seamless flow of data from the physical sensors to the end-user interface. This structure facilitates modularity, allowing hardware components or software scripts to be updated independently.

A. Hardware Layer (Perception Layer)

This layer consists of the physical components responsible for interacting with the environment.

Data Collection: The DHT11 sensor captures thermal and moisture data, while the LDR measures the intensity of light.

Execution: A Relay Module is connected to the digital pins of the ESP8266 to act as a switch for AC appliances (e.g., a lamp or a fan).

B. Network Layer (Communication Layer)

The ESP8266 NodeMCU acts as the core gateway.

Connectivity: It connects to a local Wi-Fi access point.

Data Transmission: Using the HTTP protocol, the ESP8266 sends "GET" or "POST" requests containing the sensor values to a specific URL on the web server.

C. Application Layer (Management Layer)

The software stack residing on the web server processes and visualizes the information.

Backend (PHP): A PHP script receives the incoming data packets, validates them, and executes SQL queries to store the information.

Database (MySQL): Stores historical data for analysis and logging.

Frontend (HTML/CSS): A user-friendly dashboard retrieves the latest data from the database and displays it in a readable format (gauges or tables) for the user.

III. HARDWARE COMPONENTS

The reliability and efficiency of the Smart Automation System depend on the selection of high-performance, low-power hardware. The following components form the physical backbone of the system:

A. ESP8266 (NodeMCU)

The ESP8266 is the heart of the project. It is a low-cost, open-source IoT platform that includes a 32-bit microcontroller and a built-in Wi-Fi module. It is responsible for:

Interfacing with sensors via Digital and Analog pins.

Establishing a secure connection to the local Wi-Fi network.

Executing HTTP requests to transfer data to the PHP web server.

B. DHT11 (Temperature & Humidity Sensor)

The DHT11 is a composite sensor that provides a digital signal output. It utilizes a capacitive humidity sensor and a thermistor to measure the surrounding air.

Measurement Range: 20-90% humidity and 0-50°C temperature.

Accuracy: $\pm 5\%$ for humidity and $\pm 2°C$ for temperature.

Significance: It allows the system to monitor the indoor climate and trigger cooling or heating systems automatically.

C. LDR (Light Dependent Resistor)

The LDR or photoresistor is an analog sensor whose resistance decreases as the intensity of light falling on it increases.

Function: It acts as a light sensor for the "Smart Lighting" feature.

Integration: The analog output is read by the ESP8266's ADC (Analog-to-Digital Converter) pin to determine whether it is day or night.

D. Relay Module (5V/1-Channel)

Since microcontrollers operate at low voltages (3.3V - 5V) and household appliances operate at high voltages (230V AC), a Relay Module acts as an electrically operated switch.

Isolation: It provides opto-isolation to protect the ESP8266 from high-voltage surges.

Control: It allows the system to physically turn "ON" or "OFF" devices like bulbs, fans, or motors.

E. Power Supply Unit

To ensure stable operation, a regulated power source is required.
Input: 230V AC.
Output: 5V DC (via a mobile adapter or buck converter) to power the NodeMCU and the Relay module simultaneously.

IV. SOFTWARE IMPLEMENTATION

The software framework is the most critical part of the system, acting as the intelligence that manages data flow between hardware and the user interface. It is divided into three distinct modules: the Firmware, the Backend Server, and the Database.

A. ESP8266 Firmware (C++ / Arduino IDE)

The firmware is developed using the Arduino framework. Its primary function is to initialize the Wi-Fi connection and establish a continuous loop for data polling.
Initialization: The code configures the SSID and Password to join the local network. It also initializes the DHT11 library and sets the pin modes for the LDR and Relay.
Data Processing: The microcontroller reads digital pulses from the DHT11 and converts them into temperature (°C) and humidity (%) variables. Simultaneously, the LDR value is read via the `analogRead(A0)` function.
Transmission: Using the `ESP8266HTTPClient` library, the device formats a URL string and sends an HTTP GET request to the PHP server.
Example: `http://server-ip/save.php?t=28&h=65&l=450`

B. Backend Logic (PHP)

The server-side logic is handled by PHP scripts hosted on a local or cloud-based Apache server.
`conn.php`: Contains the credentials (hostname, username, password) to establish a connection with the MySQL database.
`insert_data.php`: This script captures the variables sent by the ESP8266 using the `$_GET` global array. It performs a basic data validation check to ensure the values are within range and then executes an `INSERT INTO` SQL command to store the values in a timestamped table.
`index.php`: The user interface (UI). It uses PHP to fetch the most recent entry from the database and displays it using HTML and CSS. To make the dashboard dynamic, AJAX is utilized to refresh the sensor values every few seconds without reloading the entire page.

C. Database Management (MySQL)

A relational database is used to keep a record of all sensor activities.
Schema Design: The table typically consists of five columns: `id` (Auto-increment), `temperature`, `humidity`, `light_level`, and `reading_time` (Current Timestamp).
Efficiency: By storing data in MySQL, the system allows the user to view historical trends, which is essential for analyzing energy consumption or climate patterns over weeks or months.

V. METHODOLOGY

The methodology adopted for this project follows a systematic approach, ranging from hardware integration to the development of the web-based management system. The process is divided into four critical phases:

A. Hardware Interfacing and Circuit Design

The first phase involves the physical integration of sensors with the ESP8266 NodeMCU.
Thermal Sensing: The DHT11 is connected to a digital GPIO pin to transmit data using a single-wire protocol.
Optical Sensing: The LDR is configured in a voltage divider circuit, with its output directed to the A0 (Analog) pin of the ESP8266 to convert light intensity into a digital value ranging from 0 to 1024.
Load Control: A 5V relay module is interfaced with a digital output pin to manage the switching of external AC appliances.

B. Network Configuration

Once the hardware is assembled, the ESP8266 is programmed to function as a Station (STA). It searches for a pre-configured SSID and establishes a secure WPA2 connection. Upon a successful connection, the device is assigned a local IP address, enabling it to communicate with the PHP Web Server within the same network or over the internet.

C. Data Transmission and Server-Side Processing

The communication follows the Client-Server Architecture:

1) Request: The ESP8266 acts as a client, capturing sensor readings every 5 seconds.
2) API Call: The data is appended to an HTTP request as query parameters.
3) Reception: The PHP script on the server intercepts the request, parses the temperature, humidity, and light data, and performs a sanitization check to prevent SQL injection.
4) Storage: The sanitized data is committed to the MySQL database with a precise timestamp.

D. Automation Logic and Visualization

The final phase focuses on the "Smart" aspect of the system. Two types of control logic are implemented:

Hardware-Level Automation: The ESP8266 executes local logic (e.g., if LDR value is below 300, the relay turns the light "ON") to ensure functionality even if the server connection is momentarily lost.

User-Level Control: The Web Dashboard fetches the latest data from the MySQL table. Using AJAX (Asynchronous JavaScript and XML), the dashboard updates the temperature and light status in real-time, providing the user with a seamless monitoring experience without requiring manual page refreshes.

VI. RESULTS AND DISCUSSION

The performance of the IoT-Based Smart Automation System was evaluated based on data accuracy, transmission reliability, and the responsiveness of the PHP-based web interface. The following observations were recorded during the testing phase:

A. Data Accuracy and Monitoring

The DHT11 sensor provided stable readings for both temperature and humidity. When compared against a standard digital thermometer, the temperature variance was within ±1.5°C. The LDR successfully mapped light intensity changes, providing a clear distinction between "Day" and "Night" conditions.

Temperature Range Recorded: 24°C to 32°C.

Humidity Range Recorded: 45% to 70%.

LDR Threshold: The automation logic was set to trigger the relay when the LDR value exceeded 600 (indicating darkness).

B. System Latency and Connectivity

The ESP8266 maintained a consistent connection to the local Wi-Fi network. The average time taken for a data packet to be read from the sensors, sent via HTTP, and stored in the MySQL database was approximately 1.2 seconds. This latency is well within acceptable limits for home automation, ensuring that the web dashboard reflects near real-time conditions.

C. Web Server Performance

The PHP-based dashboard proved to be a robust alternative to commercial IoT clouds. By hosting the server locally, data privacy was maintained, and the system operated without the costs associated with premium API tiers. The use of AJAX allowed the dashboard to refresh sensor values every 5 seconds without a full page reload, providing a smooth user experience.

D. Automation and Load Control

The Relay Module responded instantly to changes in sensor values. The local logic implemented in the ESP8266 firmware ensured that the "Smart Light" (controlled by the LDR) functioned even during brief server downtimes, demonstrating the system's reliability as a standalone automation unit.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 14 Issue V May 2026- Available at www.ijraset.com

VII. CONCLUSION

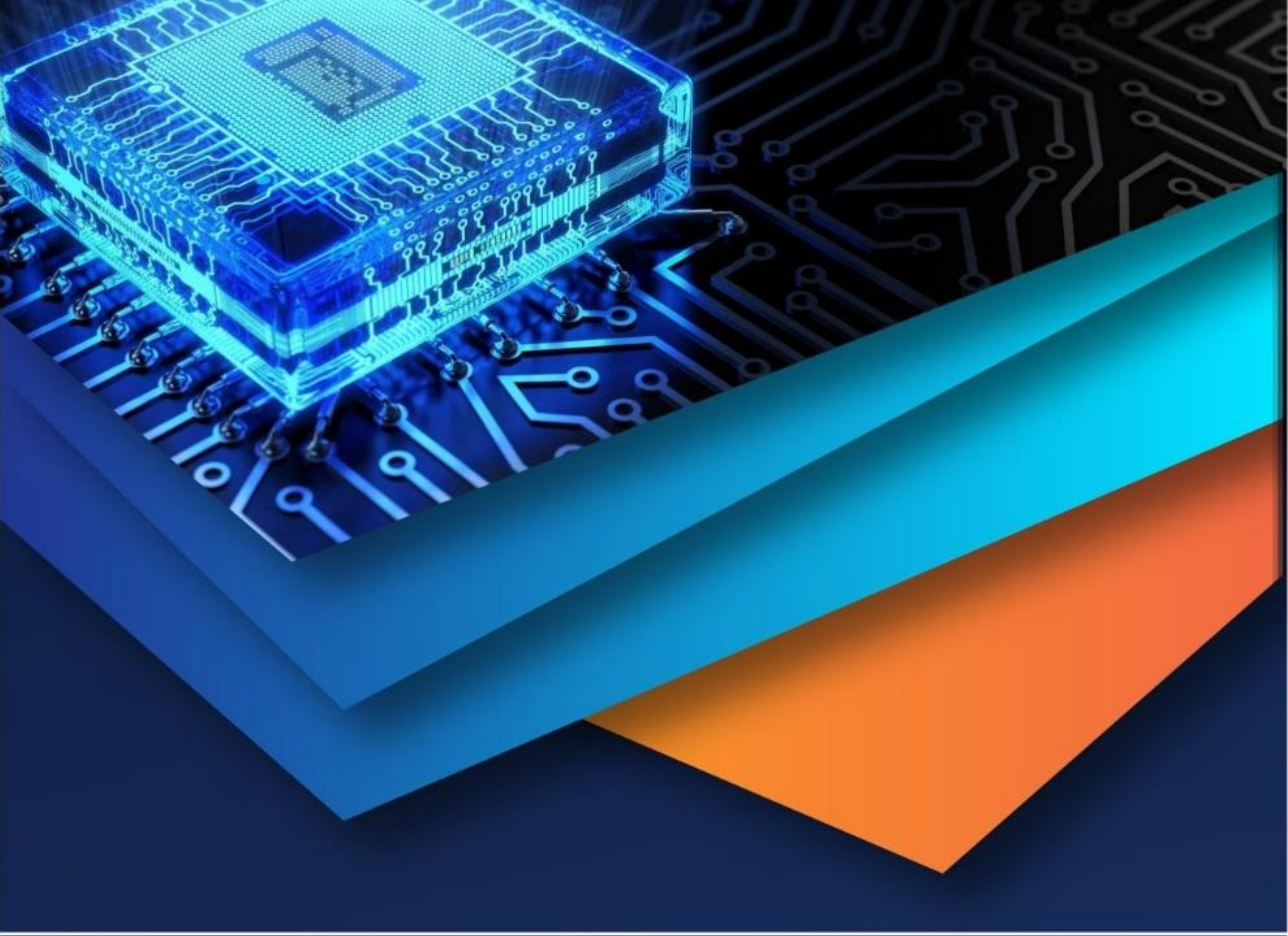
The development of this IoT-Based Smart Automation System successfully demonstrates the synergy between affordable hardware and versatile web technologies. By integrating the ESP8266 with DHT11 and LDR sensors, the project provides an efficient solution for real-time environmental monitoring and automated appliance control. The implementation of a dedicated PHP and MySQL backend proved to be a critical advantage, offering superior data privacy, no subscription costs, and complete ownership of the automation logic compared to third-party cloud platforms.

The experimental results confirm that the system is highly responsive, with minimal latency in data transmission and a high degree of reliability in triggering localized actions via the relay module. The ability to monitor domestic conditions through a custom web dashboard from any internet-enabled device enhances user convenience and promotes energy conservation by ensuring appliances are only active when necessary.

In conclusion, this system serves as a robust framework for scalable smart home applications. Future enhancements could include the integration of AES encryption for more secure data transmission, the addition of voice command capabilities, and the use of Machine Learning algorithms to predict user behavior and optimize energy consumption further. This research contributes a cost-effective and adaptable model for the growing field of home automation, making "smart" living accessible to a wider demographic.

REFERENCES

[1] R. Piyare, “Internet of Things: Ubiquitous Home Control and Monitoring System,” International Journal of Internet of Things (IJIT), 2013.
[2] S. R. Al-Ali, Imran Zualkernan, Fadi Aloul, “A Mobile GPRS-Sensors Array for Air Pollution Monitoring,” IEEE Sensors Journal, IEEE Publications.
[3] M. Palaniappan, N. Hariharan, “IoT Based Smart Home Automation System,” International Journal for Research in Applied Science & Engineering Technology (IJRASET), 2018.
[4] A. R. Al-Ali, M. Qasaimeh, “Smart Home Automation Using IoT Technologies,” International Journal of Computer Applications, 2017.
[5] K. S. K. Ramesh, R. Suresh, “A Survey on IoT-Based Smart Home Automation Systems,” Journal of Net-work Communications and Emerging Technologies (JNCET), 2019.
[6] P. V. Nikam, A. R. Patil, “IoT Based Home Automation Using ESP8266,” International Journal of Advanced Research in Computer and Communication Engineering (IJARCCE), 2017.
[7] S. S. Manjare, S. R. Patil, “Review on IoT Based Smart Home Automation System,” International Journal of Engineering Research and Applications (IJERA), 2016.
[8] ThingSpeak IoT Platform, “IoT Analytics and Cloud Services,” MathWorks, 2020.
[9] Blynk IoT Platform, “Mobile App Based IoT Control,” Blynk Inc., 2019.
[10] Arduino IDE, “Arduino Software for Microcontroller Programming,” Arduino.cc, 2021.
[11] M. S. Kharwade, A. Deharkar, and P. Tandekar, “Smart Home Automation System Based on IoT” International Journal of Future Internet and Artificial Intelligence in Healthcare Management, vol. 4, no. 2, pp. 1–6, 2024.
[12] K. Swathi, G. Sravya, P. Sowmya, J. Sahithi, and L. S. Sarayu, “IoT Based Smart Home Automation System” International Journal for Research in Applied Science and Engineering Technology (IJRASET) , vol. 10, no. 5, pp. 1550–1555, 2022.
[13] [I. Ahmed, A. Amjad, and M. A. Mehmood, “Review Paper on IoT Based Smart Applicationsand Home Automation” LC International Journal of STEM, vol. 3, no. 1, pp. 45–50, 2021.



10.22214/IJRASET

INDEX COPERNICUS

45.98

ISRA JIF

IMPACT FACTOR:
7.129

TOGETHER WE REACH THE GOAL

IMPACT FACTOR:
7.429

ISI

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY