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AutoCasa: An IoT-Based Smart Home Automation Application

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Abstract: This research presents AutoCasa, a smart home automation application designed to enhance home security and optimize remote control of household electrical appliances. Implemented using the ESP8266 microcontroller, a relay module, a Passive Infrared (PIR) sensor, and a Light Dependent Resistor (LDR) sensor, AutoCasa integrates with the Blynk IoT platform to enable users to manage devices such as lights, fans, and air conditioners via internet-connected devices. The PIR sensor bolsters security by detecting unauthorized movement at night and triggering alarms, while the LDR sensor automates outdoor lighting for energy efficiency. AutoCasa demonstrates an efficient, user-friendly approach to smart home automation, leveraging IoT technology to improve convenience, security, and sustainability.
Keywords: Smart Home Automation, ESP8266 Control System, Relay Module, Wireless Control, Internet of Things(IoT), Blynk IoT application.

I. INTRODUCTION

The advent of the Internet of Things (IoT) has revolutionized human interaction with physical environments, particularly through home automation systems that enhance convenience, energy efficiency, and security (Hui et al., 2017). These systems enable remote control of household appliances and real-time monitoring, addressing the growing demand for smart, connected homes (Gubbi et al., 2013). IoT-based home automation integrates devices like smartphones, sensors, and microcontrollers to create intelligent ecosystems that improve living standards (Zanella et al., 2014).

This research introduces AutoCasa, a smart home automation system built around the ESP8266 microcontroller and the Blynk IoT platform. AutoCasa enables remote control of electrical appliances such as lights, fans, and air conditioners, while incorporating security and energy-saving features. A Passive Infrared (PIR) sensor detects unauthorized movement to enhance home security, and a Light Dependent Resistor (LDR) sensor automates outdoor lighting to conserve energy. The system's user-friendly interface, accessible via the Blynk app, allows seamless management from any internet-connected device.

The motivation for AutoCasa stems from the need to reduce electricity wastage and improve home security. For instance, forgotten appliances like fans or lights can be remotely switched off, saving energy (Lee et al., 2018). Additionally, integrating motion detection and automated lighting addresses both safety and sustainability concerns (Al-Fuqaha et al., 2015). This work contributes to the growing field of IoT by presenting a cost-effective, scalable solution for smart homes, aligning with global trends toward intelligent and energy-efficient living spaces (Atzori et al., 2010).

II. METHODOLOGY

The AutoCasa system was designed and implemented using a combination of hardware and software components, with a focus on modularity and scalability. The methodology encompasses system architecture, sensor interfacing, cloud integration, and programming.

A. *System Architecture*

The core of AutoCasa is the ESP8266 microcontroller, a low-cost Wi-Fi-enabled device developed by Espressif Systems (Kolban, 2016). The ESP8266 features a 32-bit RISC processor, 4 MB flash memory, and support for GPIO, ADC, and PWM pins, making it ideal for IoT applications (Rashid et al., 2019). It interfaces with a relay module to control high-voltage appliances, a PIR sensor for motion detection, and an LDR sensor for light-dependent automation. The Blynk IoT platform serves as the user interface, enabling remote control and monitoring via a mobile app (Blynk, 2020).

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B. Sensor Interfacing

1) PIR Sensor: The PIR sensor detects infrared radiation from moving objects, such as humans, within its field of view (Sharma et al., 2021). Connected to the ESP8266, it triggers a security alarm (buzzer) when motion is detected at night, provided the user has activated the security feature via the Blynk app.
2) LDR Sensor: The LDR sensor measures ambient light intensity and sends analog signals to the ESP8266 (Kumar et al., 2020). It automates outdoor street lights, turning them on at dusk and off at dawn, thus optimizing energy consumption.

C. Cloud Interface

The Blynk platform facilitates seamless communication between the ESP8266 and the user's smartphone (Blynk, 2020). Users create a custom dashboard in the Blynk app, adding buttons to control appliances. A unique authentication token ensures secure data exchange between the ESP8266 and the Blynk cloud server (Paret & Huon, 2018). The ESP8266 connects to a Wi-Fi router, configured with a static SSID and password, to relay commands and sensor data.

D. Implementation

The system was programmed using the Arduino IDE with the Blynk library integrated (Arduino, 2021). The code processes inputs from the PIR and LDR sensors, controls the relay module, and communicates with the Blynk app. The relay module interfaces the ESP8266 with high-voltage appliances, enabling on/off functionality (Patel et al., 2019). The PIR sensor's logic activates the alarm only when the security mode is enabled, while the LDR sensor's threshold-based algorithm ensures accurate lighting control.

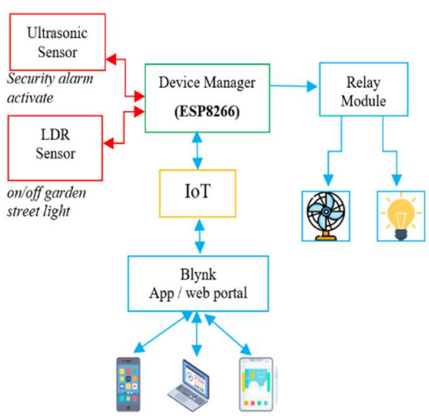

Figure 1: Work Flow

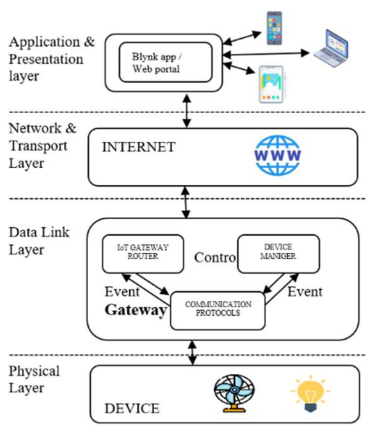

Figure 2: Layers of IoT

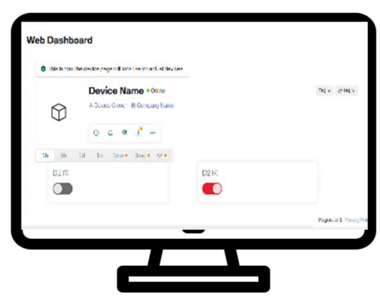

Figure 3: Blynk Web Portal

The entire system followed a layered architecture comprising the physical layer (sensors and appliances), the data link layer (ESP8266 as the gateway device), the network layer (Wi-Fi and internet connectivity), and the application layer (Blynk app interface). This layered approach facilitated robust communication, easy maintenance, and future scalability of the system (Zanella et al., 2014; Sethi & Sarangi, 2017).

III. RESULTS AND DISCUSSION

The implementation of AutoCasa successfully demonstrated the feasibility of creating a cost-effective and scalable smart home automation system. Through the integration of the ESP8266 microcontroller and the Blynk IoT platform, the system enabled reliable remote control of household appliances such as lights, fans, and air conditioners. Users could seamlessly operate these devices through the Blynk app, confirming stable communication between the microcontroller and the cloud interface (Blynk, 2020). The PIR sensor effectively enhanced home security by detecting unauthorized movement and activating a buzzer alarm when the security mode was enabled. The sensor exhibited accurate motion detection with minimal false positives, validating its suitability for residential environments (Sharma et al., 2021). Simultaneously, the LDR sensor demonstrated reliable automation of outdoor lighting, turning lights on at dusk and off at dawn based on ambient light levels. This functionality contributed to energy conservation and operational efficiency (Kumar et al., 2020).

```
#define BLYNK_TEMPLATE_ID "YourTemplateID"
#define BLYNK_TEMPLATE_NAME "YourTemplateName"
#define BLYNK_AUTH_TOKEN "YourAuthToken"

#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>
```

Figure 4: Authentication Token

```
char ssid[] = "your_SSID";
char pass[] = "your_PASSWORD";
```

Figure 5: Wi-Fi SSID and Password

The layered architectural design ensured robust and scalable system performance. Additional sensors and appliances were integrated without compromising system stability, underscoring the flexibility of the modular approach (Zanella et al., 2014; Sethi & Sarangi, 2017). Furthermore, the system's user interface—customized within the Blynk app—provided a responsive and intuitive experience for end-users, allowing real-time control and status monitoring with minimal technical complexity (Paret & Huon, 2018). The combined outcomes of this project highlight AutoCasa as a viable smart home solution that meets contemporary needs for enhanced security, reduced energy consumption, and remote accessibility. These findings align with the global movement toward intelligent, sustainable living environments supported by IoT technologies (Atzori et al., 2010; Gubbi et al., 2013; Lee et al., 2018).

IV. FUTURE WORK AND CONCLUSION

This While AutoCasa demonstrates significant potential, several avenues for enhancement exist. First, integrating machine learning algorithms could enable predictive control of appliances based on user behavior, improving energy efficiency (Machorro-Cano et al., 2020). Second, incorporating advanced security features, such as facial recognition or biometric authentication, could further strengthen intrusion detection (Li et al., 2021). Third, expanding the system to support additional sensors, such as temperature or humidity sensors, could enable environmental monitoring and climate control (Hassan et al., 2020). Finally, exploring energy harvesting techniques, such as solar-powered sensors, could enhance sustainability (Shaikh & Zeadally, 2016). Future iterations will also focus on compatibility with emerging IoT protocols like Matter to ensure interoperability with other smart home ecosystems (Matter, 2022).

AutoCasa represents a significant step toward accessible and efficient smart home automation. By leveraging the ESP8266 microcontroller, Blynk IoT platform, and sensors like PIR and LDR, the system offers remote appliance control, enhanced security, and energy-efficient lighting automation. The integration of IoT technology ensures a user-friendly experience, addressing modern demands for convenience and sustainability. Experimental results validate the system's reliability in detecting motion, controlling appliances, and automating lighting based on environmental conditions. AutoCasa's modular design makes it adaptable for future enhancements, positioning it as a viable solution for smart homes. This research underscores the transformative potential of IoT in creating intelligent, secure, and energy-conscious living environments.

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