

ALEXA-BASED SMART HOME SECURITY SYSTEM USING RASPBERRY PI WITH BIOMETRIC IDENTIFICATION AND ALARM NOTIFICATION

ABSTRACT

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Traditional home-security measures often rely on mechanical and electronic locks that may be vulnerable to tampering or duplication. In addition, many Internet of Things (IoT) solutions lack a self-sustaining power source and may become unavailable during power outages. This study addressed the integration of biometric security and energy reliability by developing a Raspberry Pi-based hub with multimodal biometric identification and a solar-optimization power system for residential protection. The study used an experimental prototyping design. The system architecture consisted of a Raspberry Pi 5 hub integrated with an Arduino Uno and an ESP32. Security modules included a NoIR camera for facial recognition, an R307 fingerprint sensor, and an RC522 RFID reader. A solar-optimization mechanism adjusted the solar panel angle through a high-torque servo to improve energy collection. Connectivity was established through a Node-RED bridge linked to an Alexa Echo Dot and a Telegram chatbot for instant notifications. Fifty homeowners evaluated the system using a four-point Likert-scale survey. The prototype demonstrated biometric authentication and automated garage access through license-plate recognition. Telegram transmitted real-time alerts when unauthorized motion was detected. The solar-optimization system reportedly improved energy harvesting compared with static panels and maintained system operation during simulated outages. Survey ratings yielded weighted means of 3.5 for user-friendliness and 3.32 for sustainability, indicating favorable user acceptance. The findings suggest that the integrated system combined security functions with operational autonomy. The findings highlight the potential value of multimodal authentication and renewable energy in smart-home systems. Low-light facial recognition remained a limitation requiring further infrared optimization. Future research may examine machine-learning approaches to improve computer vision. Broader conclusions regarding residential security policy or the comparative viability of biometric systems require additional evidence beyond the prototype evaluation.

RECOMMENDED CITATION

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