

Smart Home Security Project

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Abstract

The Intelligent Building is clearly the building of the future. The goal of having an intelligent building only starts with early planning in the design stage. In many ways, this mirrors the design and fulfillment of many green projects today, but it uses technology to provide for a superior space. The intelligent building uses eco-friendly construction materials with proper water management system provided. In the intelligent building, proper orientation and landscaping is provided. However, other benefits, e.g., reduced staff levels and improved occupant satisfaction, are often overlooked. The degree of confidence in intelligent building technologies is inadequate largely because of a lack of awareness and understanding of its value. There is a lack of properly assessable intelligent building technology reference projects. Intelligent building technologies are generally available, but not yet widely adopted and many changes and initiatives are needed for use of these technologies to become widespread.

Keywords: Arduino-based automation, RFID gate control, motion sensor lighting, fire detection with MQ3 sensor, GSM alert system, keypad-based security, and energy-efficient smart building security.

1. Introduction

Security is a primary concern in residential and commercial spaces. Traditional security systems often lack automation and intelligence, making them inefficient in some scenarios. This paper introduces a cost-effective and intelligent home security system using Arduino, providing real-time monitoring and automated responses to various security threats. [1]

2. The Proposed System Includes

Smart Gate System: An RFID-based access control system that uses an RFID card and reader. When a valid card is detected, a servo motor operates to open the gate.
Smart Lighting in Parking Area: A PIR motion sensor installed in the parking area detects movement of humans or vehicles, automatically turning on the lights for better visibility.
Smart Keypad System: A secure keypad is installed on the door for access control, allowing users to enter a predefined passcode to unlock the door.
Smart Fire Detection: The MQ-3 sensor is utilized to detect smoke or harmful. [2]

3. Methods

3.1. Sensor Integration

PIR motion sensors are used to detect human

movement within the monitored environment. These sensors detect infrared radiation emitted by moving objects (humans or animals). When motion is detected, an electrical signal is sent to the microcontroller. Magnetic door/window sensors are used to detect the opening or closing of doors and windows. These consist of a magnet and a switch; when the circuit is broken (i.e., door opens), a signal is sent to the controller. [3]

3.2. Microcontroller Operation

An Arduino Uno microcontroller serves as the central processing unit. It collects input signals from the sensors and initiates predefined actions such as triggering alarms, activating the camera module, or sending alerts. The microcontroller is programmed using Arduino IDE with C/C++ language.

3.3. Communication and Notification

A Wi-Fi module (ESP8266) is used to enable wireless communication between the system and cloud services or mobile apps. It sends data such as sensor status and captured images to a cloud platform like Firebase or via MQTT protocols for real-time updates. [4]

3.4. Camera and Image Processing

A USB or Pi camera module is used to capture real-time images or stream video upon detecting motion. In systems with advanced functionality, OpenCV is integrated to perform face recognition, comparing captured faces against a database of known users. [5]

3.5. Alarm System

When unauthorized motion or intrusion is detected, the system activates a buzzer or alarm to warn inhabitants and deter intruders. The buzzer is triggered via a digital output pin from the microcontroller.

3.6. Mobile Application Interface (Optional)

A custom mobile application or web interface can be developed using platforms like Android Studio. This app allows users to: Arm/disarm the system. [6]

4. Results and Discussion

4.1. Results

The Smart Home Security System was evaluated under various test conditions to determine its reliability, response time, and accuracy. The system demonstrated successful performance across the following functional aspects:

4.2. Motion Detection

The PIR sensors consistently detected human motion within the defined range. The response time from motion detection to alert generation was observed to be under 2 seconds. [7]

4.3. Intrusion Alerting

When a door or window was opened unexpectedly, the magnetic sensor triggered the buzzer and sent a notification to the user's mobile device or email via the connected Wi-Fi module. Alerts were accurately delivered in real time.

4.4. Face Recognition (If Implemented)

Face detection using OpenCV correctly identified known users in most lighting conditions, achieving an average recognition accuracy of around 90%. However, recognition errors increased under poor lighting or with obstructed faces.

4.5. System Control

The system could be armed/disarmed through a mobile application, ensuring ease of control and user accessibility.

4.6. Remote Monitoring

Live video streaming was functional via the

integrated camera module. Video and image capture were triggered only during security events, which optimizes resource use.

4.7. Discussion

The results of the Smart Home Security System validate its effectiveness in enhancing residential safety using affordable components and open-source software. The integration of sensors with wireless communication provides a scalable platform for home automation. Several key observations were made during testing: The motion sensors showed high sensitivity and low false-negative rates. However, false positives were occasionally triggered by pets or rapid environmental changes, such as sunlight fluctuations. Wireless alerts were mostly consistent, though occasional delays occurred due to network instability. A more robust connection or local alert storage could mitigate The face recognition module, while effective in daylight, exhibited reduced accuracy in dim conditions. Improvements could be made by integrating infrared cameras or more advanced deep learning models for face detection. The hardware-software integration was smooth, and the modular design allows for future enhancements like integrating temperature, gas leak sensors, or smart locks. In summary, the system met its objectives by providing automated monitoring and alerting features, and offers a strong foundation for future development in the field of IoT-based home security. [8]

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