

# Girls Hostel Security System Using IoT & AI

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**Abstract:** Ensuring the safety of students in girls' hostels is a critical responsibility for educational institutions. Traditional security systems mainly depend on manual verification methods such as registers and security personnel, which can be time-consuming, error-prone, and less effective in preventing unauthorized access. To address these limitations, this project presents a smart and automated Girls Hostel Security System using Internet of Things (IoT) and Artificial Intelligence (AI). The proposed system uses a camera to capture real-time images of individuals entering the hostel premises. These images are processed using a Convolutional Neural Network (CNN) model that is trained to recognize authorized and unauthorized persons. Once a valid identity is confirmed, the system allows entry by controlling a gate mechanism through an ESP32 microcontroller and a servo motor. In case of unauthorized access, the system generates alerts and prevents entry. Additionally, the system maintains a digital record of all entries and sends instant notifications to parents through WhatsApp, ensuring transparency and improved communication. The integration of AI-based facial recognition with IoT-enabled automation makes the system efficient, reliable, and user-friendly. Overall, this project enhances hostel security by reducing human intervention, improving accuracy, and providing real-time monitoring and alert mechanisms

**Keywords:** IoT, Artificial Intelligence, Facial Recognition, Convolutional Neural Network (CNN), ESP32, Smart Security System, Image Processing, Automation, Real-Time Monitoring, Hostel Safety

## I. INTRODUCTION

Ensuring the safety and security of students, especially in girls' hostels, has become a major concern for educational institutions. Conventional security methods such as manual attendance registers, ID card verification, and reliance on security guards are often inefficient, time-consuming, and prone to human errors [1][2]. These traditional systems lack real-time monitoring and fail to provide immediate alerts in case of unauthorized access, thereby increasing security risks [3].

With the rapid advancement in technology, the integration of Artificial Intelligence (AI) and the Internet of Things (IoT) has enabled the development of intelligent and automated security systems [4][5]. AI-based facial recognition systems, particularly those using Convolutional Neural Networks (CNNs), have shown high accuracy in identifying individuals and are widely used in modern surveillance applications [6][7]. These systems can process real-time images, extract unique facial features, and classify individuals as authorized or unauthorized within seconds [8].

IoT plays a significant role in connecting hardware components such as cameras, microcontrollers, and sensors to create a smart and responsive security environment [9]. Devices like the ESP32 microcontroller allow seamless communication between software and hardware, enabling automated actions such as gate control using servo motors [10]. This integration enhances system efficiency and reduces the need for manual intervention [11].

In addition to access control, modern security systems also emphasize real-time communication and transparency. Notification systems using platforms such as WhatsApp or mobile applications help inform parents and authorities about student movements, thereby increasing trust and accountability [12][13]. Furthermore, maintaining digital records of entry and exit activities improves monitoring and provides valuable data for security analysis [14].



The proposed Girls Hostel Security System using IoT and AI aims to address the limitations of traditional systems by providing an automated, accurate, and reliable solution. By combining facial recognition, smart gate control, and instant alert mechanisms, the system enhances overall hostel security and ensures a safer living environment for students [15].

## II. PROBLEM STATEMENT

In many educational institutions, the security of girls' hostels still depends on traditional methods such as manual entry registers, ID card verification, and supervision by security personnel. These approaches are not only time-consuming but also prone to human errors, negligence, and misuse, making them unreliable for ensuring strict access control. Unauthorized individuals may gain entry due to lack of proper identity verification, and there is no efficient system to continuously monitor or record movements within the premises. Additionally, the absence of real-time alert mechanisms prevents immediate action during suspicious activities or emergencies, which raises serious safety concerns. Parents and hostel authorities also face difficulties in tracking the entry and exit status of students, leading to a lack of transparency and trust. Therefore, there is a clear need for an intelligent, automated, and reliable security system that can accurately identify individuals, control access without manual intervention, maintain digital records, and provide instant notifications to enhance the overall safety and monitoring of girls' hostels.

## III. OBJECTIVES

- To develop an automated hostel security system using IoT and AI for secure access control.
- To implement facial recognition using CNN for accurate identification of authorized individuals.
- To enable real-time monitoring and recording of entry and exit activities.
- To provide instant alerts and notifications to parents and authorities.
- To reduce manual intervention and improve overall efficiency and reliability of hostel security.

## IV. LITERATURE SURVEY

**Janavekar et al. (2024)** proposed an "IoT-Based Girl's Hostel Management System", where they integrated IoT devices with biometric authentication methods such as RFID and facial recognition to enhance hostel security. Their system improved access control and monitoring efficiency while reducing manual work. However, the system mainly focuses on identification and lacks advanced AI-based real-time threat detection capabilities.

**Maharajpet et al. (2025)** introduced an "AI-Driven Hostel Monitoring System" that uses facial recognition and geofencing to track student movement and detect unauthorized entry. The system provides real-time attendance and alerts, improving security and automation. However, it involves higher implementation cost and requires strong computational resources for continuous monitoring.

**Faisal & Hossain (2019)** developed a "Smart Security System using Face Recognition and IoT" based on Raspberry Pi. The system detects faces using computer vision techniques and allows access only to authorized individuals while sending alerts for unknown persons. Although it is cost-effective and efficient, its accuracy may decrease in complex environments such as poor lighting or occluded faces.

**Wati & Abadianto (2023)** presented a "Smart Security System using IoT and Face Recognition" where a camera captures facial images and processes them for identity verification. The system enhances automation and reduces human dependency in security tasks. However, it is vulnerable to spoofing attacks and requires additional mechanisms for stronger authentication.

**Saxena & Varshney (2021)** proposed a "Smart Home Security System using Facial and Speech Recognition" that combines AI techniques for dual authentication. The system improves reliability by verifying both face and voice before granting access. However, integrating multiple modalities increases system complexity and may lead to higher processing time.



**Wagh et al. (2025)** discussed an “IoT-based Smart Safety System” that uses machine learning to detect abnormal conditions and generate alerts in real time. The system enhances safety through automated monitoring and intelligent decision-making. However, it requires continuous data processing and may face scalability challenges in large environments.

**Comparison Table**

| Author & Year            | Method Used                               | Advantages                                   | Limitations                                  |
|--------------------------|---|--|--|
| Janavekar et al. (2024)  | IoT with RFID & Face Recognition          | Improves access control, reduces manual work | Lacks advanced AI-based threat detection     |
| Maharajpet et al. (2025) | AI-based Facial Recognition & Geo-fencing | Real-time monitoring and alerts              | High cost and computational requirements     |
| Faisal & Hossain (2019)  | IoT + Face Recognition (Raspberry Pi)     | Cost-effective and automated system          | Performance affected in low light conditions |
| Wati & Abadianto (2023)  | IoT-based Face Recognition System         | Reduces human intervention                   | Vulnerable to spoofing attacks               |
| Saxena & Varshney (2021) | Facial + Speech Recognition               | Dual authentication improves security        | Increased system complexity                  |
| Wagh et al. (2025)       | IoT + Machine Learning                    | Real-time anomaly detection                  | Scalability and data processing challenges   |

**IV. WORKING OF SYSTEM**

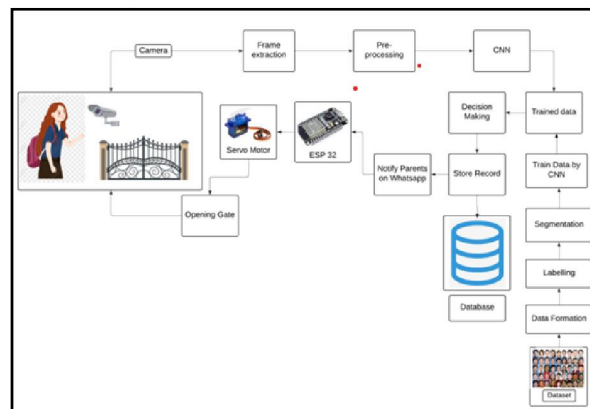


Fig 1: Design of the system

The Girls Hostel Security System using IoT and AI operates through a sequence of automated steps to ensure secure and efficient access control.

**Image Capture:**

When a person approaches the hostel gate, a camera captures real-time video or image frames of the individual.

**Frame Extraction:**

The captured video is divided into individual frames to process the facial data efficiently.

**Pre-processing:**

The extracted frames undergo pre-processing steps such as resizing, noise removal, and normalization to improve image quality for better recognition.



**CNN-Based Recognition:**

The processed image is passed to a Convolutional Neural Network (CNN) model, which analyzes facial features and compares them with the trained dataset.

**Decision Making:**

Based on the CNN output, the system decides whether the person is authorized or unauthorized using predefined rules.

**Authorized Access:**

If the person is recognized, the system sends a signal to the ESP32 microcontroller.

The ESP32 activates the servo motor, which automatically opens the gate.

Simultaneously, the system stores the entry record in the database.

A notification is sent to parents via WhatsApp confirming safe entry.

**Unauthorized Access:**

If the person is not recognized, access is denied.

The system can trigger alerts and notify authorities or parents.

**Database Management:**

All entry details are stored in a centralized database for monitoring, tracking, and future analysis.

**Training Process (Backend):**

The CNN model is trained using a dataset that goes through stages such as data formation, labeling, segmentation, and training to improve accuracy over time.

## V. SYSTEM DESIGN

### 1. System Overview:

The Girls Hostel Security System using IoT and AI is an intelligent and automated solution designed to ensure secure access control and real-time monitoring within hostel premises. The system integrates artificial intelligence for facial recognition with IoT-based hardware components to provide a seamless and reliable security mechanism.

In this system, a camera installed at the entrance captures real-time images of individuals approaching the gate. These images are processed using image pre-processing techniques and then analyzed by a Convolutional Neural Network (CNN) model to identify whether the person is authorized or unauthorized. Based on the classification result, the system makes a decision to either allow or deny access.

### 2. COMPONENTS DESCRIPTION

#### 1. Camera Module

The camera is used to capture real-time images or video frames of individuals at the entrance. It acts as the primary input device for the system and provides visual data for facial recognition.

#### 2. Frame Extraction Module

This module extracts individual frames from the captured video stream, allowing the system to process images efficiently for further analysis

#### 3. Pre-processing Unit

The pre-processing stage improves image quality by performing operations such as resizing, normalization, and noise reduction. This helps in increasing the accuracy of the CNN model.

#### 4. CNN (Convolutional Neural Network)

The CNN model is responsible for facial recognition. It analyzes facial features and compares them with the trained dataset to classify individuals as authorized or unauthorized.

#### 5. Decision Making Module

This module uses the output from the CNN model to make decisions based on predefined rules. It determines whether to allow access or trigger alerts.



## 6. ESP32 Microcontroller



Fig. ESP 32

ESP32 acts as the central controller that connects the software system with hardware components. It receives signals from the decision module and controls the gate mechanism.

## 7. Servo Motor



Fig. Servo Motor

The servo motor is used to control the opening and closing of the gate. It is activated by the ESP32 when an authorized person is detected.

## 8. Database

The database stores all entry and exit records, including time, identity, and status. It helps in monitoring and maintaining security logs.

## 9. Notification System (WhatsApp Alert)

This component sends real-time notifications to parents or authorities when a student enters the hostel or when any unauthorized activity is detected.

## 10. Dataset & Training Module

This module contains labeled images used to train the CNN model. It includes processes like data collection, labeling, segmentation, and training to improve recognition accuracy.

## VI. RESULTS

The proposed Girls Hostel Security System using IoT and AI was successfully implemented and tested to evaluate its performance in real-time conditions. The system demonstrated effective identification of authorized and unauthorized individuals using the CNN-based facial recognition model. During testing, the model was able to accurately classify input images captured through the camera and make quick decisions regarding access control. Authorized users were granted entry automatically through the activation of the servo motor controlled by the ESP32 microcontroller, while unauthorized individuals were denied access, ensuring improved security.

Additionally, the system maintained a digital record of all entry activities in the database, which helped in monitoring and tracking movement within the hostel premises. The notification feature also worked efficiently by sending real-time alerts to parents, thereby enhancing transparency and communication. The system showed stable performance under continuous operation and was capable of processing multiple frames without significant delay. Overall, the



results indicate that the system is reliable, efficient, and capable of providing a secure and automated solution for hostel security management.

### **VII. CONCLUSION**

The Girls Hostel Security System using IoT and AI presents an effective and modern approach to enhancing safety within hostel premises. The system successfully integrates facial recognition technology with IoT-based automation to create a secure, reliable, and user-friendly environment. By replacing traditional manual verification methods, the proposed solution minimizes human errors, reduces dependency on security personnel, and ensures faster and more accurate identification of individuals.

The implementation of the CNN-based model enables precise recognition of authorized and unauthorized persons, while the ESP32-controlled gate mechanism ensures smooth and automated access control. The system also maintains digital records of entry and exit activities, which improves monitoring and accountability. Furthermore, the real-time notification feature strengthens communication between hostel authorities and parents, increasing transparency and trust. The overall performance of the system proves that it is capable of operating efficiently in real-time scenarios and can significantly improve the level of security in girls' hostels. Hence, the proposed system serves as a smart, scalable, and dependable solution for modern security challenges.

### **VIII. FUTURE SCOPE**

The proposed system can be further enhanced by incorporating advanced technologies and additional features to improve its performance and applicability. One possible improvement is the integration of more sophisticated deep learning models, which can provide higher accuracy even in challenging conditions such as low lighting, facial occlusions, or different angles. The system can also be upgraded to include multi-factor authentication methods, such as fingerprint or RFID verification, to add an extra layer of security.

Another area of enhancement is the development of a dedicated mobile application that allows hostel authorities and parents to monitor activities remotely in real time. Cloud-based storage can be implemented for secure data management, enabling easy access to records and better scalability for large hostel environments. Additionally, the system can be extended to include live video surveillance, motion detection, and anomaly detection features for continuous monitoring of suspicious activities.

Future improvements may also focus on integrating emergency alert systems, such as panic buttons for students, which can instantly notify authorities during critical situations. Energy-efficient IoT devices and smart resource management can also be incorporated to make the system more sustainable. Overall, with continuous advancements in AI and IoT, the system can evolve into a more intelligent, adaptive, and comprehensive security solution suitable not only for hostels but also for other residential and institutional environments.

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