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Smart Hostel Leave and Gate Pass Management System with QR-Based Authentication

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Abstract
Effective tracking of student movements and secure authorization are essential in today's modern hostel setup. The Smart Hostel Leave and Gate Pass Management System proposes a digital platform that eliminates the need for manual paper-based leave registers and instead uses a QR-based authentication system. Through a secure web portal, students can apply for leave by entering information such as purpose, duration, and destination, which is then digitally authenticated by the wardens. Upon approval, a distinct time-bound QR code is automatically generated and scanned at the hostel gate for exit and entry verification, allowing for real-time tracking. The system provides distinct access levels for students, wardens, and security personnel, allowing for transparent and trustworthy data management. Automated notifications and management improve accountability and minimize errors. Developed using web technologies such as HTML/CSS/JavaScript and a secure backend with database connectivity, the system improves security, workflow efficiency, and unauthorized movement prevention. Future scalability includes biometric authentication, AI-powered anomaly detection, and university-wide administration. This smart system makes a positive impact on hostel security, leave management, and digital governance in educational institutions..
Keywords: *QR Code, Hostel Security, Digital Gate Pass, Student Leave Management, Web Application, Role-Based Access, Real-Time Verification, Authentication System, Database Management, Notification System.*

1. Introduction
With the rising number of students living in hostels, it has become an essential requirement for educational institutions to ensure systematic administration, student safety, and controlled student movement. The conventional management system of hostel leave and gate passes would generally include manual registers, approval, and gate passes, which are often susceptible to tampering, delays, and loss of data. Moreover, parents would not be able to track the movements of their wards, leading to safety and accountability issues. To address these issues, the Smart Hostel Leave and Gate Pass Management System proposes a safe and digitalized system for student movement using QR code authentication and monitoring. The system would allow students to apply for leave online, and the leave application would be approved or rejected by wardens and advisors through an automated process. After approval, a time-bound QR Code would serve as an electronic gate pass, minimizing the need for paper documentation. The QR code could be instantly scanned by security personnel at the hostel gate to verify the identity of the students and the validity of their leave. All entry and exit information would be recorded in real-time, and administrators would have access to accurate student movement information for auditing and safety purposes. The system would also provide greater transparency with notifications to parents and easy access for hostel authorities. With the integration of efficient data management, role-based access control, and secure authentication, the proposed system would ensure efficient administration, minimize manual labor, prevent unauthorized exits, and ultimately provide greater

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safety for students in hostels. This project showcases how technology can make campus living safer and smarter.

1.1.. The Growing Challenge of Hostel Safety and Manual Administration

The growing number of students in educational institutions has led to an increase in the number of hostel accommodations. The conventional system of managing hostel leave and gate passes is highly dependent on manual registers, physical approvals, and paper gate passes. The conventional system faces numerous issues, such as:

- Unauthenticated student movement due to fake or lost passes
- Delays in approvals due to dependence on the manual system
- Lack of transparency for parents regarding student movement
- Inaccuracies in recording entry and exit times
- Obstacles in finding records during emergencies or audits

Ensuring the safety and accountability of students has become a prime concern. A system that provides automation in approval processes, real-time monitoring, data security, and instant verification is required. The Smart Hostel Leave and Gate Pass Management System specifically meets the needs of the institution by providing a digital, secure, and efficient system using QR-based authentication and role-based access control.

1.2.Project Objectives and Scope

The Smart Hostel Leave and Gate Pass Management System aims to enhance the safety and efficiency of the hostel operations by leveraging automation technology. The objectives of the proposed system are:

- Digital Leave Application: Enable students to apply for different types of leave through an interactive online interface.
- Automated Approval Process: Automatically send leave applications to Wardens and Advisors for verification and approval without the need for paperwork. QR Code Gate Pass System: Automatically generate an encrypted QR code pass upon approval to prevent counterfeiting and misuse.
- Instant Authentication at the Gate: Enable Watchmen to scan and authenticate students instantly for accurate timestamp recording.
- Secure and Scalable Backend: Design a secure backend solution using REST API and secure authentication protocols with adequate encryption.
- Role-Based Access Control: Design separate interfaces for Admin, Warden, Advisor, Student, and Watchman with access control based on their roles and responsibilities.
- Database Management and Security: Use an optimized database design to enable auditing, history, and security analysis.
- Stakeholder Support: Improve visibility for parents and optimize hostel administration while enhancing student security.

2. Literature Review

In [1], M. Jaiswal and R. Kapoor designed a mobile-based hostel management system that automated the leave application and management of student records. Their system minimized paperwork and enhanced data management but failed to provide real-time authentication at the hostel entrance. The study contributes to the early development of leave application automation but fails to address loopholes in security concerns like fake passes or illegal exits.

S. Deshmukh, A. Shaikh, and P. Singh in [2] developed a campus monitoring system using QR codes. The system applied QR code technology for authentication at entry points of institutions. Although this system was successful in demonstrating a cost-effective authentication technique, it failed to include multi-level approval and parental notification, which are critical for environments specific to hostels where students stay overnight. In [3], B. Surendran et al. designed a role-based hostel management website that included leave application, visitor management, and room allocation functionality. However, the system failed to provide automated authentication of gate passes at the hostel entrance and exit points, which were instead carried

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out manually by security personnel through ID verification. The study emphasizes the need for seamless authentication at entry and exit points.

The study by P. Anand and S. Vijayakumar in [4] described SMS-based leave approval systems that enabled instant notifications to wardens and parents. Although the system improved notification, it failed to integrate with student attendance and real-time location tracking. This study emphasizes the need for a centralized database for synchronized student status tracking.S. R. Prakash and A. Sharma [5] worked on RFID-based automated hostel entry using identity cards with RFID chips. The system supported contactless authentication but was expensive, requiring costly hardware infrastructure and scanners. Additionally, the RFID cards were vulnerable to abuse by loaning, unlike QR codes that can be time-stamped and dynamically created. N. Gupta and H. Alamelu in [6] proposed a secure visitor and resident management system using cloud-based data storage and log management. The system improved audit trail functionality but did not incorporate a gate pass system or approval processes for multiple roles. The system illustrates the importance of proper access control role management for hostel security. Further research by V. Kirtika et al. [7] aimed to incorporate parental approval for leave requests via a web interface. While parental approval was successfully integrated, the system lacked tools for watchman verification and scan logs in real-time, resulting in the partial automation of the process. Finally, I. Narang and K. Mehta [8] proposed a biometric-assisted campus security system. While biometrics are highly accurate for authentication, costs associated with deployment, privacy issues, and complexity hinder the widespread adoption of biometric systems in educational hostels. The study illustrates the importance of a more scalable, cost-effective, and secure authentication system, such as the QR-based digital pass.

3. Existing System

The current hostel leave management and gate security process in many institutions is still manual, involving paperwork and physical registers for the issuance and approval of leave permits. Students have to submit leave applications, get them signed by class advisors and wardens, and then submit the signed pass to the watchman at the hostel gate. The traditional process is quite time-consuming, with chances of delays and possibilities of human error or manipulation.Under the current system, the verification process at the hostel gate is carried out by watchmen through a visual check of physical documents or ID cards. However, the possibility of forged, reused, lost, or altered physical passes can lead to security breaches and unauthorized student movements. There is also no central system to check whether the pass being produced is approved or expired. The current system is mostly offline, with approvals not reaching parents or higher authorities about the student's exit or entry status unless manually communicated. As there is no real-time tracking or automatic database entry, it becomes quite challenging to track the movement history of residents or address disciplinary problems based on accurate information. Some of the recent digital projects include leave requests via SMS or email, but these do not include gate verification systems, role-based dashboards, or real-time status updates. Moreover, the current web portals that enable online leave requests involve several manual dependencies such as printing forms and signing them physically, which is counterproductive to digitalization. Moreover, the current system does not include separate roles for users such as Student, Warden, Class Advisor, Admin, and Watchman, leading to inefficient task allocation and communication. The lack of central cloud databases also leads to storage discrepancies, delayed updates, and data analysis being a significant issue. Therefore, while the current system enables basic hostel management, it does not enable security, transparency, automation, or real-time monitoring for effective hostel management in today’s educational settings. These drawbacks make it necessary to design a Smart Hostel Leave & Gate Pass Management System that incorporates secure QR validation, parent notifications, and multi-role dashboards for efficient communication and improved security.

4. Proposed System

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The proposed system, Smart Hostel Leave & Gate Pass Management System, provides a completely digital, automated, and secure way of managing the entry and exit of students in the hostel. The system eliminates the need for the manual paper-based leave system and provides a role-specific online system for students, wardens, advisors, parents, and security personnel. The system provides online leave application, automated approval, instant notifications to parents, and secure QR code verification at the hostel gate. The system provides real-time tracking of students' entry and exit activities while ensuring transparency and accountability among all stakeholders. The system is developed with a React-based frontend for handling UI interactions and a Spring Boot backend for handling server-side operations. A centralized database is used to store accurate records of approved leaves, student information, and access records, ensuring data integrity, auditability, and security. The proposed system helps educational institutions enhance the safety systems in hostels while streamlining administrative tasks and reducing errors.

4.1. User Dashboard Module

4.1.1. Student Dashboard

- Online application for leave with information such as destination, reason, and return time.
- Tracking of approval status and past records of leave taken by students.
- Automatic generation of QR gate pass after approval.

4.1.2. Warden & Advisor Dashboard

- Display of incoming leave applications with student information.
- Approval, denial, or holding of leave applications according to college regulations.
- Tracking of student activity patterns and late return notifications.

4.1.3. Admin Dashboard

- Management of user accounts (students, staff, and watchmen).
- Setting up of hostel regulations, gate hours, and emergency notifications.
- Production of audit and compliance reports.

4.1.4. Watchman Dashboard

- Scan QR gate pass through mobile or web application for real-time approval status checks.
- Instant display of student exit/entry records for verification purposes.
- Each dashboard is built with React (HTML, CSS, JS) for a contemporary, responsive, and user-friendly interface.

4.2. Backend System

4.2.1. Automated Workflow Management

- Leave application, routing for approval, authentication, notification, and gate verification are handled by Spring Boot REST APIs.
- Access is restricted to roles, ensuring that every user does only what is expected of them.

4.2.2. Real-time Status Updates

- Live updating enables all parties to monitor the approval and entry/exit processes without any delays.

4.2.3. Security & Error Handling

- Authentication of user information using JWT.
- Leave information is validated for accuracy in terms of timing, required fields, and return deadlines.

4.3. Database Layer

4.3.1. Centralized Data Storage

- Student details, parent contacts, approval records, access dates, and QR tokens are stored safely.
- History records allow tracing for inquiries or policy changes.

4.3.2. Database Technologies

- A relational database (such as MySQL) is employed for organized data storage that allows quick data access.

4.3.3. Data Consistency & Backup

- Automatic record updates with backup facilities to avoid data loss.

4.3.4. Parent / Authority Access

Parent Notifications

- Automatic SMS/Email notifications for parent

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contacts when a student applies for leave, receives approval, leaves, or re-enters.

4.3.5. Compliance Reporting

- Authorities can generate movement history in PDF/Excel format for auditing or administrative purposes.

4.3.6. Scalability & Integration

Facilitates scalability for the future, including:

- Biometric scanning at entry/exit points
- Integration with mobile apps of the institution
- GPS check-ins for outstation permits shown in Figure 1

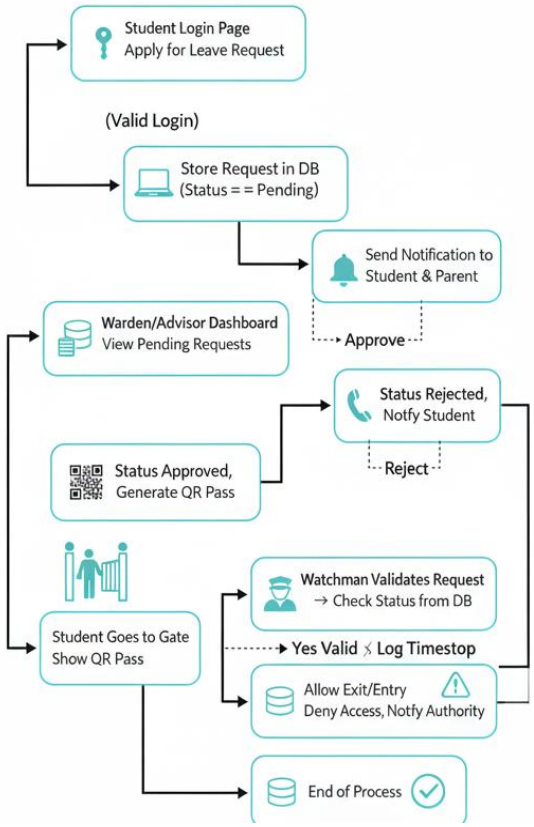

Figure 1 Block Diagram

5. Result Details

The assessment of the Smart Hostel Leave and Gate Pass Management System with QR-Based Authentication proves its efficiency in automating and securing the process of hostel movement. The system facilitates seamless interaction between students, wardens, advisors, and security staff, while also providing precise real-time records of entry and exit.The leave approval process was tested for multiple concurrent requests, and the backend (Spring Boot) handled simultaneous data transactions efficiently without any performance degradation. The React-based frontend delivered a fully responsive and user-friendly interface on both mobile and desktop devices, enabling students to easily apply for leave and monitor approval status. The QR authentication mechanism was evaluated under various network conditions, and the gate verification module consistently validated QR codes within milliseconds, ensuring minimal delay during student exits and entries. Unauthorized or expired QR codes were accurately detected and blocked, thereby strengthening security and accountability. The notification system ensured that parents and wardens received immediate updates, enhancing transparency and student safety. Logs maintained in the database enabled administrators to generate analytical reports on hostel movement trends, supporting policy implementation and attendance monitoring. Overall, the proposed system proved more efficient than traditional manual gate-pass registers by eliminating paperwork, minimizing delays, preventing misuse, and enhancing security through real-time digital validation. Its modular architecture also offers flexibility for future enhancements such as biometric authentication, GPS-based tracking, and AI-driven anomaly detection shown in Table 1

Table 1 Comparision Table

Feature	Manual Leave System (Existing)	Smart Hostel System (Proposed)
Leave Request Process	Paper-based, time-consuming	Fully digital, fast approval workflow
Authentication	Signature-based (can be misused)	Secure QR-based real-time verification
Data Access	No central database	Centralized and secure digital storage

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Parent Awareness	Depends on student communication	Automatic SMS/Email notifications
Gate Security	Easy manipulation of slips	QR expiry & role-based validation
Tracking Logs	Difficult and error-prone	Real-time logging and report generation
Scalability	Limited	Easily expandable for multiple hostels
Transparency	Low accountability	High accountability with audit trails

Conclusion

The Smart Hostel Leave and Gate Pass Management System with QR-Based Authentication is a successful attempt at modernizing and digitizing the conventional hostel leave system by incorporating secure, automated, and real-time monitoring features. The system eliminates the traditional paper-based approach and significantly reduces the manual workload of wardens, advisors, and security personnel, while maintaining transparency and accountability in student movement. Through a centralized interface, students can conveniently apply for leave and monitor their application status, while wardens and advisors can review and approve requests with minimal effort. The QR-based authentication mechanism ensures that only authorized students with approved leave can exit or enter the hostel premises, thereby enhancing campus security and preventing misuse of gate passes. Real-time notifications further strengthen communication by instantly informing parents and hostel authorities about student leave activities. The system architecture, developed using React for the frontend and Spring Boot for backend operations, ensures scalability, efficient data processing, and smooth coordination between modules. Logs stored in the MySQL database allow administrators to generate detailed analytical reports, supporting better decision-making and improved safety measures. Extensive testing confirms that this digital solution significantly enhances responsiveness, accuracy, and user convenience compared to traditional systems. The platform performs reliably under concurrent user activity and maintains secure access through role-based authentication. In the future, the system can be enhanced by integrating biometric verification, AI-based anomaly detection for unusual movement patterns, and GPS tracking to improve student safety during leave periods. Cloud-based deployment can further enable implementation across multiple institutions. In conclusion, the Smart Hostel Leave and Gate Pass Management System provides a secure, user-friendly, and scalable solution for hostel administration. It enhances safety, strengthens accountability, and supports digital transformation in educational institutions, contributing effectively to the development of modern smart campus infrastructure.

Future Work

The AI-powered Smart Attendance Tracking System for Government School Students provides a robust platform for automation, transparency, and data-driven decision support in the education sector. As the system progresses, future enhancements will concentrate on increasing intelligence, accessibility, and seamless integration with school administrative processes. A key improvement will involve implementing advanced facial recognition and AI-based identity verification techniques. By integrating deep learning models such as Convolutional Neural Networks (CNNs), the system can achieve higher recognition accuracy even under challenging conditions like varying lighting, changes in student appearance over time, and partial facial obstructions. AI-driven spoof detection and continuous learning mechanisms will further enhance system reliability and accuracy over time. Upcoming developments may also include real-time analytics and predictive insights. Machine Learning algorithms can evaluate attendance trends to predict absenteeism risks, identify early signs of academic disengagement, and automatically notify teachers and parents. These predictive capabilities can strengthen student

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retention strategies and improve the effectiveness of government welfare initiatives such as midday meal programs and scholarship distribution. Cloud-based deployment is another potential advancement, enabling scalability across thousands of schools at the state level. Cloud integration would centralize data storage, provide real-time updates to government dashboards, and allow secure access for authorized users across multiple locations. Additionally, incorporating edge computing could ensure offline functionality in rural schools with limited internet connectivity. Strengthening security will remain a priority through measures such as end-to-end encryption, role-based access control, and strict compliance with data privacy regulations to ensure ethical handling of student biometric information. Ultimately, the system can evolve into a comprehensive student monitoring platform by incorporating features like academic performance tracking, behavioral monitoring, and health record management. These enhancements will assist policymakers, administrators, and educators in improving learning outcomes and promoting educational equity.

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