iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 14 **Issue:** I **Month of publication:** January 2026

DOI: https://doi.org/10.22214/ijraset.2026.77223

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 14 Issue I Jan 2026- Available at www.ijraset.com

Campus Guidance System

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Abstract: ***The Campus Guidance System is a user-friendly web application aimed at simplifying campus navigation, staff interaction, and visitor management. It addresses common challenges by integrating essential features such as staff location identification, appointment scheduling, and visitor pass issuance. With a focus on enhancing the user experience, this system offers intuitive functionalities that cater to the needs of visitors, students, and staff. The system comprises three key modules. The Meet the Staff module allows users to filter staff by department, view their details, and locate them using an interactive 3D model, providing an immersive navigation experience. The Get Appointment module enables users to schedule appointments with staff through automated email requests, streamlining communication. The Get Visitor Pass module facilitates visitor pass issuance by allowing real-time photo capture and generating digitally signed passes for seamless entry management. By integrating modern technologies like 3D modeling, email automation, and real-time data capture, the Campus Guidance System ensures efficiency and ease of use. Its user-centric design reduces confusion, minimizes manual administrative tasks, and supports digital transformation in campus operations. Scalable and customizable, the system serves as a robust framework for educational institutions, fostering a tech-savvy environment and improving the overall experience for campus visitors and stakeholders.***

Keywords: Campus Navigation, Visitor Management System, Staff Appointment Scheduling, 3D Location Visualization, User-Centric Design, Educational Institution Services, Email Automation, Real-Time Data Capture, Interactive Web Application.

I. INTRODUCTION

The increasing complexity of campus environments and the need for efficient navigation and management systems have led to the development of digital solutions that simplify access to campus facilities and enhance user experience. In large institutions, visitors, students, and staff often face challenges in locating individuals, booking appointments, and managing visitor credentials. This has created a demand for a unified system that integrates these functionalities into a single, user-friendly platform.

The Campus Guidance System is a web-based application designed to address these challenges by providing seamless navigation, appointment scheduling, and visitor management capabilities. The system comprises three main modules: Meet the Staff, Get Appointment, and Get Visitor Pass, each tailored to specific user needs. The "Meet the Staff" module enables users to filter staff by department and locate them via a 3D interactive model, offering an immersive and precise navigation experience. The "Get Appointment" module simplifies the process of scheduling appointments with staff by sending automated email requests, reducing the reliance on manual communication. The "Get Visitor Pass" module streamlines the process of visitor registration by allowing users to select staff or management personnel, capture real-time photographs, and generate digitally signed passes.

This project leverages modern technologies such as 3D modeling, email automation, and real-time data capture to create a robust system. It integrates intuitive user interfaces with efficient back-end processes to ensure a seamless experience for users. The proposed solution enhances the operational efficiency of educational institutions, minimizes administrative workload, and improves visitor engagement.By addressing common pain points in campus navigation and management, this project aims to provide a scalable and adaptable framework for educational institutions, laying the foundation for future enhancements such as real-time location tracking and advanced analytics for campus resource optimization.

II. METHODOLOGY

The "Campus Guidance" system is developed as an interactive web-based platform to streamline campus navigation, staff engagement, and visitor management. The architecture combines modern web technologies like React for building a dynamic and responsive user interface, with Node.js and Express.js for handling backend processes. Firebase serves as the real-time database to store and retrieve essential data, ensuring scalability and fast synchronization for all system functionalities.

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The platform offers a range of features to improve the user experience. The Meet the Staff module enables users to explore detailed information about staff members categorized by department. A database stores staff profiles, including their names, designations, and office locations, while a 3D campus model provides a visual representation of the institute, helping users identify specific locations with ease. To facilitate scheduling, the Book Appointment feature provides a seamless process for users to request meetings with staff. Inputs such as name, email, and preferred time slots are validated server-side before storing the data in the database. Upon successful submission, an email confirmation is automatically sent to the user using the Nodemailer library. Similarly, the Visitor Pass Generation module simplifies the visitor management process by allowing visitors to fill out an online form and capture their image through the WebRTC API. The collected data is stored securely in Firebase, and a visitor pass is generated in PDF format using PDFKit, which can be emailed or printed for convenience.

Data flows seamlessly between the frontend and backend through RESTful APIs, ensuring sanitized and validated user inputs. Security measures, including encryption, XSS, and SQL injection protection, along with role-based authentication, safeguard user information. Preprocessing techniques like input validation and encryption enhance system robustness.

The system is tested for compatibility across devices and browsers, ensuring smooth functionality for features like real-time updates and data synchronization. Designed for scalability, the "Campus Guidance" platform supports future enhancements like GPS-based navigation and event management, making it a valuable tool for improving institutional efficiency and engagement.

Flowchart

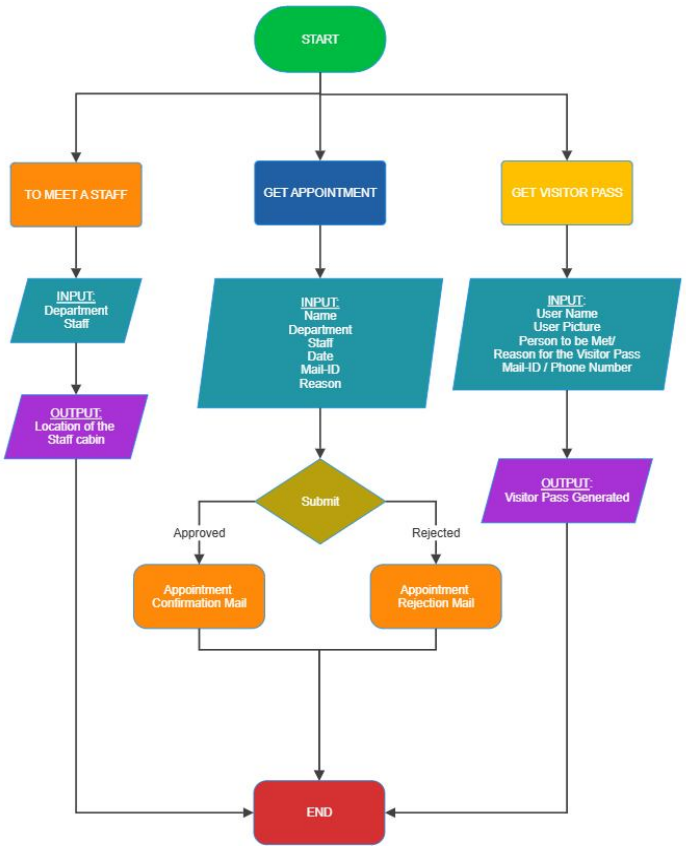


Fig. 1 Overall workflow of the Campus Guidance Management System.

III. PREPROCESSING AND DATA HANDLING

The preprocessing phase in the Campus Guidance system is a critical step that ensures the accurate handling of data across all modules, such as Meet Staff, Book Appointment, Book Visitor Pass, and About Institute. The process begins with user inputs captured on the React-based front end. These inputs are validated for completeness and correctness both on the client side and server side using Node.js. For example, fields such as email addresses are checked for proper formatting, appointment dates are validated to avoid conflicts, and mandatory fields are enforced.

Captured data is then preprocessed to ensure consistency and standardization before being stored in MongoDB. For textual inputs, such as department names or visitor purposes, all text is converted to a uniform format, such as capitalization, and trimmed to remove unnecessary spaces. This ensures consistency in database records and prevents mismatches during searches. Timestamp generation is another crucial step, where all appointments and visitor pass requests are assigned accurate timestamps to facilitate scheduling and tracking.

For visitor passes, if an image is uploaded or captured, it undergoes preprocessing to ensure quality and consistency. Images are resized to a standard resolution using libraries such as sharp or OpenCV and are subjected to noise reduction techniques like Gaussian blur or brightness normalization. This process enhances clarity and ensures a professional appearance for the generated passes.

The MongoDB database is designed to handle the structured data efficiently. It includes collections such as staff details, appointments, and visitor passes. Staff data is indexed to enable quick searching and filtering, while the appointment collection is equipped with conflict detection mechanisms to ensure no two appointments overlap for the same staff member. Visitor pass details, including uploaded images, are securely stored, and retrieval is optimized for quick access during visitor check-ins.

Real-time functionality is integrated to enhance user experience. Dynamic updates, such as staff location rendering on an interactive map, are powered by WebSocket connections, ensuring instant reflections of any changes. Visitor pass generation is further streamlined with QR codes, which are dynamically created upon approval of the pass request. These QR codes can be scanned at entry points, simplifying the check-in process and reducing manual effort.

Security is a top priority in the system. Sensitive information such as visitor pass images and appointment details is encrypted before being stored in MongoDB. Server-side APIs use token-based authentication with JWT to ensure secure communication between the React front end and the Node.js back end.

By implementing these preprocessing techniques and handling data systematically, the Campus Guidance system provides an efficient, secure, and user-friendly solution for managing campus operations.

IV. PROCESS FLOW

The Campus Guidance System implements a comprehensive workflow that orchestrates multiple interconnected processes to deliver a seamless campus management solution. At its core, the system begins with the user interface stage, where visitors and campus members interact with the web-based platform through an intuitive interface. This interface serves as the gateway to the system's three primary modules: Meet the Staff, Get Appointment, and Get Visitor Pass, each designed to address specific campus management needs while maintaining a cohesive user experience.

Upon accessing the system, users encounter a sophisticated data acquisition process that handles various types of inputs across different modules. The Meet the Staff module processes user queries for staff information, filtering and retrieving relevant data based on departmental classifications and staff availability. Simultaneously, the Get Appointment module manages the collection of scheduling details, including preferred meeting times and purposes, while the Get Visitor Pass module facilitates the capture of visitor information and photographs through integrated device cameras.

The preprocessing stage forms a crucial component of the system's architecture, where all incoming data undergoes rigorous validation and standardization. This includes the sanitization of text inputs, optimization of captured images, and verification of critical information such as email addresses and contact details. The system employs sophisticated algorithms to ensure data consistency and prevent scheduling conflicts, particularly in the appointment management module where time slot availability is critically important.

Database operations within the system are designed to maintain data integrity while facilitating quick access and real-time updates. The platform utilizes MongoDB to store and manage various data types, from staff profiles to appointment schedules and visitor credentials. Advanced indexing techniques ensure rapid retrieval of information, while real-time synchronization capabilities keep all system components updated with the latest data changes.

The execution phase of the process flow demonstrates the system's capability to handle multiple concurrent operations. In the Meet the Staff module, the system seamlessly renders 3D campus models while updating staff availability status in real-time. The Get Appointment module processes scheduling requests, generates automated notifications, and maintains calendar synchronization. Meanwhile, the Visitor Pass module creates digital credentials complete with QR codes and manages the distribution of passes through email systems.

Throughout all operations, the system maintains robust security measures through JWT-based authentication, encrypted data transmission, and role-based access control. This comprehensive security framework ensures that sensitive information remains protected while allowing authorized users to access necessary features and data. The entire process flow is monitored by sophisticated error handling mechanisms that provide immediate feedback and maintain system stability.

The system's output generation phase delivers various forms of processed information to users, from interactive 3D visualizations for campus navigation to digital visitor passes and appointment confirmations. Each output is carefully formatted and optimized for the intended delivery method, whether it's through email, web interface, or mobile display. This attention to output quality ensures that users receive clear, actionable information regardless of their device or platform. This carefully orchestrated process flow enables the Campus Guidance System to efficiently manage complex campus operations while providing an intuitive user experience. The modular design of the system allows for seamless integration of new features and capabilities, making it a scalable and future-proof solution for educational institutions of varying sizes. Through this comprehensive approach to process management, the system effectively streamlines campus navigation, staff interaction, and visitor management while maintaining high standards of security and user satisfaction.

V. STAFF LOCATION AND STAFF ROOM MAPPING SYSTEM

The Campus Guidance System employs a straightforward room mapping system to help users locate staff members within the campus. Each staff member is assigned a specific room or office location in the database, which is then mapped to the corresponding position in the 3D campus model. This static mapping ensures consistent and reliable location information for visitors and students seeking to meet with staff members.

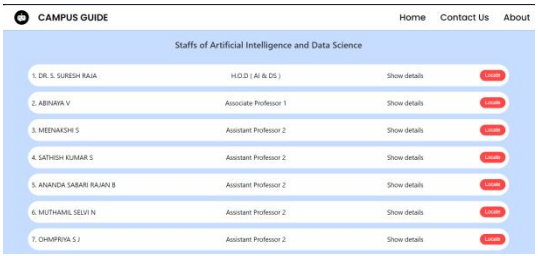


Fig. 2 Staff directory interface displaying department-wise faculty details

The system uses a simple yet effective room mapping function:

$$RM(s) = \{D(s), B(s), F(s), R(s)\} \rightarrow (1)$$

Where,
RM(s) - Room mapping for staff member s
D(s) - Department assignment
B(s) - Building identifier
F(s) - Floor number
R(s) - Room number

The mapping system provides location information through a hierarchy of identifiers:

1) First identifying the department
2) Locating the specific building
3) Determining the floor level
4) Pinpointing the exact room number

When a user searches for a staff member, the system retrieves this static location data and highlights the corresponding room in the 3D campus model. This visualization helps users understand exactly where to find the staff member's office, making navigation more intuitive.

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To ensure accurate room identification, each location is assigned a unique identifier:

RID = BD + FL + RN → (2)

Where,
RID - Room Identifier
BD - Building Code
FL - Floor Level
RN - Room Number



Fig. 3 3D campus map showing building layout and location guidance

This simple yet effective mapping system provides users with clear and accurate information about staff locations, enabling them to navigate the campus efficiently and locate the desired staff member's office with minimal confusion.

VI. APPOINTMENT BOOKING, SCHEDULING AND COMMUNICATION SYSTEM

The Campus Guidance System Features an efficient and intuitive appointment booking and scheduling system that allows users to easily schedule meetings with staff members. The system ensures streamlined coordination by providing availability checks, conflict resolution, and automated email notifications, all while maintaining data integrity and user security.

Users begin the booking process by selecting a preferred staff member, date, and time for the appointment. The system performs an availability check to confirm if the staff member is available at the requested time. If the chosen time slot is unavailable due to an overlap or scheduling conflict, users are prompted with alternative available times. Once the appointment time is confirmed, the system generates a unique appointment identifier (APID) and stores the details in the database, including the staff member's information, user details, and appointment specifics such as date, time, and duration.

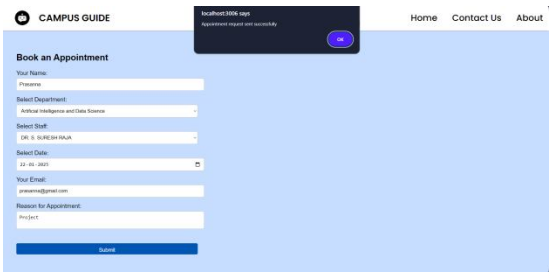


Fig. 4 Appointment booking interface for scheduling meetings with staff

To avoid double bookings, the system includes conflict detection mechanisms. When an appointment is requested, the system cross-references the proposed time with the staff member's existing appointments to ensure there are no overlaps. In the event of a conflict, alternative time slots are automatically suggested to the user. Once an appointment is successfully booked, both the user and staff member receive automated confirmation emails that include appointment details and a unique APID for easy reference. Additionally, email reminders are sent 24 hours before the appointment to ensure that both parties are prepared.

After the appointment has taken place, both the user and staff member are prompted to provide feedback through an automated email survey. This feedback helps assess the quality of the meeting and identify areas for improvement in the scheduling process. All sensitive data, including appointment details and personal information, is encrypted before being stored in the MongoDB database to ensure privacy and comply with data protection regulations. Secure token-based authentication is also used to ensure that only authorized users can access their appointment data.

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The Campus Guidance appointment system is designed to be intuitive and user-friendly, allowing users to easily book and manage appointments. With automated conflict resolution, real-time availability checking, and seamless communication via email, the system provides an efficient and professional experience for both users and staff.

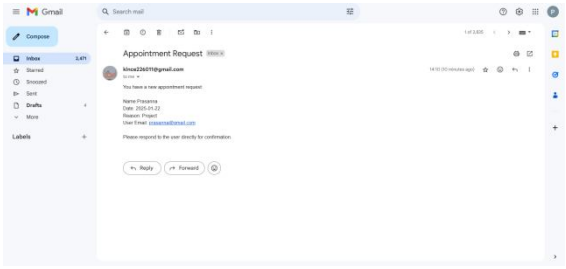


Fig. 5 Automated email notification for appointment confirmation

Through this robust appointment system, the Campus Guidance platform streamlines campus operations, reduces administrative workload, and enhances the overall user experience.

VII. VISITOR PASS MANAGEMENT SYSTEM

The Campus Guidance System includes a streamlined visitor pass management system designed to facilitate smooth entry and access for visitors to meet with staff members. This system allows users to request visitor passes easily, ensuring secure and efficient handling of visitor data while maintaining operational integrity.

Users initiate the visitor pass request by providing their personal information, the staff member they intend to meet, and the purpose of their visit. The system checks the validity of the details and ensures that all required fields are filled out accurately. Upon approval, a unique Visitor Pass Identifier (VPID) is generated and the request details are stored in the database, including the visitor's information, the staff member's details, visit date and time, and any associated notes.

To ensure security and proper identification, the system allows for image uploads for the visitor pass, and these images undergo preprocessing to maintain clarity and uniformity. Image quality enhancement techniques, such as resizing, noise reduction, and contrast adjustment, are applied to ensure a professional and readable pass.

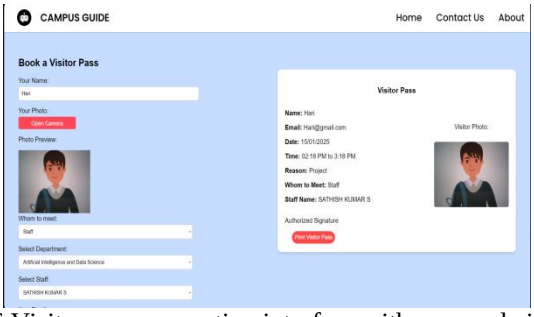


Fig. 6 Visitor pass generation interface with user and visit details

Once the visitor pass is approved, both the user (visitor) and the staff member receive automated email notifications confirming the approval and including the unique VPID for reference. These notifications also include the details of the visit, including time, date, and the staff member's office location, to ensure clear communication and proper coordination.

As the visit approaches, reminder emails are sent 24 hours prior to the appointment to ensure the visitor is prepared and the staff member is informed of the upcoming meeting. The system also sends a follow-up email after the visit to gather feedback, helping to improve the visitor pass process and identify areas for better service. All sensitive visitor data, including personal details and uploaded images, is encrypted before being stored in the MongoDB database to ensure privacy and comply with data protection regulations. Secure authentication mechanisms ensure that only authorized personnel can access visitor pass details. The Campus **Guidance System's** visitor pass management functionality is designed to be user-friendly and efficient. By automating the approval process, sending timely reminders, and providing clear communication between users and staff, the system enhances campus security while improving the overall visitor experience. This robust visitor pass system helps streamline campus operations, reduces administrative overhead, and ensures a smooth and professional process for visitors and staff alike.

VIII. PERFORMANCE ENHANCEMENT

The Campus Guidance system incorporates various strategies to enhance performance and ensure efficient and seamless operation across its modules, such as Meet Staff, Book Appointment, Book Visitor Pass, and About Institute. By leveraging effective preprocessing techniques and advanced technologies, the system achieves optimal responsiveness and reliability.

For data processing, preprocessing methods like input validation, text standardization, and image optimization play a vital role. Input fields are validated both on the client and server sides to avoid unnecessary server requests and ensure data consistency. Text data is standardized by trimming and formatting, while images uploaded for visitor passes undergo resizing and compression to reduce file sizes without compromising quality. These techniques enhance the speed and efficiency of the data handling process, ensuring smooth communication between the React front end and the Node.js back end.

To manage high user traffic and ensure real-time updates, the system utilizes WebSocket connections. This enables instant data synchronization, such as reflecting changes in appointment schedules or updating visitor pass statuses. MongoDB's indexing and optimized query performance further contribute to the rapid retrieval of staff details, appointment records, and visitor pass data, even during peak usage.

Authentication and security measures also play a crucial role in enhancing system reliability. The use of token-based authentication with JSON Web Tokens (JWT) ensures secure access to APIs, while data encryption guarantees the protection of sensitive information such as visitor details and appointment records. These measures maintain data integrity and foster user trust in the system.

The system's performance is further enhanced by load balancing and caching mechanisms, which distribute server loads evenly and reduce response times for frequently accessed data. These strategies ensure consistent performance, even when multiple users interact with the system simultaneously.

By combining advanced preprocessing techniques, real-time updates, robust security, and efficient database management, the Campus Guidance system demonstrates excellent performance, making it a reliable solution for modern campus operations.

IX. VALIDATION AND PERFORMANCE TESTING

The Campus Guidance system underwent thorough validation and performance testing to ensure its reliability, accuracy, and adaptability across various scenarios. Each module, including *Meet Staff*, *Book Appointment*, and *Book Visitor Pass*, was tested under real-world conditions to evaluate its effectiveness in handling user interactions and data processing efficiently.

For the *Meet Staff* feature, tests were conducted to validate the accuracy of filtering and locating staff based on departmental queries. The system's ability to fetch and display staff details dynamically from the MongoDB database was compared against pre-verified data to ensure consistency and correctness. Additionally, the 3D staff location model was tested for precision in navigation and user interaction, confirming that the rendered locations matched their real-world counterparts.

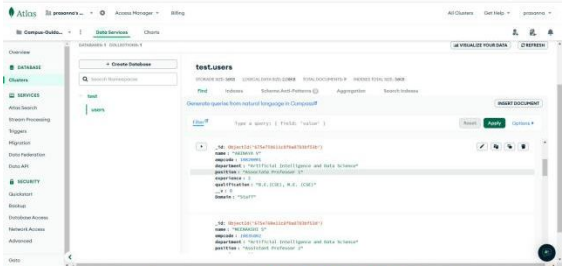


Fig. 7 Backend database structure for storing and managing system data

The *Book Appointment* module was validated by comparing automated email confirmations with user-submitted requests. Performance tests simulated high user traffic to ensure that the system could handle simultaneous appointment bookings without delays or errors. Appointment scheduling was also cross-verified to ensure no overlaps or conflicting time slots, maintaining the integrity of staff schedules.

For the *Book Visitor Pass* module, the process of capturing visitor details, including real-time image uploads, was extensively tested. The generated visitor passes, including the QR codes, were validated for accuracy and usability during entry. The system was tested under varying load conditions to ensure that multiple visitor pass requests could be processed concurrently without compromising performance.

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Performance metrics, such as response time, data retrieval speed, and user interaction latency, were measured and optimized. Any discrepancies, such as slow data synchronization or inconsistencies in filtering results, were identified and addressed. The MongoDB database queries were fine-tuned to handle large datasets efficiently, and caching mechanisms were validated to ensure quick access to frequently used data.

By conducting comprehensive testing and validation across all modules, the Campus Guidance system demonstrated its ability to operate effectively in diverse campus environments. The rigorous testing process confirmed the system's practicality and reliability, ensuring it meets the needs of modern educational institutions.

X. RESULT AND DISCUSSION

The Campus Guidance system has proven to be an effective and user-friendly solution for streamlining campus operations, offering significant improvements in navigation, appointment scheduling, and visitor management. The system's modular approach enables seamless handling of diverse functionalities while maintaining accuracy and efficiency. Each module—*Meet Staff*, *Book Appointment*, and *Book Visitor Pass*—delivers precise and reliable results, facilitating an enhanced user experience.

The *Meet Staff* module demonstrated high accuracy in filtering and locating staff by department. The integration of a 3D campus model allowed users to visualize staff locations effectively, providing a practical and immersive navigation solution. Validation tests confirmed the system's ability to render accurate locations and respond dynamically to user queries, ensuring a smooth experience for visitors and students alike.

The *Book Appointment* feature provided a streamlined process for scheduling meetings with staff. Testing under varying traffic conditions showed that the system efficiently handled simultaneous appointment requests without delays. Automated email confirmations ensured that users received immediate feedback on their submissions, enhancing communication between staff and visitors. The system's scheduling algorithm effectively managed potential conflicts, ensuring no overlapping appointments, which was critical for maintaining operational integrity.

The *Book Visitor Pass* module also performed exceptionally well in managing visitor registrations. The integrated camera feature allowed for real-time image capture, producing high-quality images optimized for visitor passes. The generated passes, complete with QR codes, streamlined entry processes and reduced manual intervention. Testing scenarios validated the module's ability to handle multiple requests concurrently while maintaining high performance and reliability.

Despite the system's success, some challenges were observed during testing. For example, minor delays occurred during data retrieval under heavy loads, which were mitigated by implementing caching and optimizing database queries. The QR code scanning feature was fine-tuned to improve its response time, ensuring a seamless check-in process for visitors.

The Campus Guidance system is a scalable, cost-effective solution tailored for educational institutions. It combines user-centric design, advanced technologies, and robust data management to address common campus challenges efficiently. Future enhancements, such as integrating real-time GPS-based navigation or advanced analytics for campus resource optimization, could further expand the system's capabilities, solidifying its role as an indispensable tool for campus operations.

XI. CONCLUSION

The Campus Guidance system is a comprehensive, scalable, and user-friendly platform designed to address common challenges in campus navigation, staff engagement, and visitor management. Developed using React for a dynamic user interface, Node.js for efficient back-end processing, and MongoDB for secure data management, the system integrates advanced technologies to provide a seamless and interactive experience.

Through its *Meet Staff* module, the system allows users to filter staff by department, access detailed profiles, and locate offices using an engaging 3D campus model. This feature not only enhances campus navigation but also fosters better interactions between visitors and staff. The *Book Appointment* module offers a streamlined scheduling process, ensuring effective communication with staff via automated email confirmations while managing overlapping requests with precision. The *Book Visitor Pass* module simplifies visitor registration by integrating real-time image capturing and QR code-enabled pass generation, reducing manual effort and ensuring a quick and efficient check-in process.

Extensive validation and performance testing confirmed the system's reliability and scalability, demonstrating its ability to handle simultaneous user interactions without compromising accuracy or speed. Advanced preprocessing techniques, such as input validation and image optimization, ensure that all data entering the system is accurate and consistent, while MongoDB's efficient querying and indexing allow for rapid data retrieval and updates. Security measures, including encryption and token-based authentication, safeguard sensitive information, enhancing user trust.

Despite its robust performance, areas for future improvement have been identified. Enhancing real-time responsiveness during high traffic loads and expanding functionality to include GPS-based campus navigation or advanced analytics for campus operations could further strengthen the system. Moreover, incorporating machine learning algorithms for predictive analytics, such as forecasting visitor traffic, could enhance campus resource planning. The Campus Guidance system offers a practical, cost-effective, and highly adaptable solution for modern educational institutions, contributing significantly to the digital transformation of campus operations. By addressing the immediate needs of users while remaining flexible for future advancements, this system establishes itself as a critical tool for improving campus management and user satisfaction.

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XII. ACKNOWLEDGMENT

The authors express their sincere gratitude to the management of K.L.N. College of Engineering, Sivagangai, K.L.N. INNIVATION & RESEARCH PARK (KLN.IRP) for providing the facilities and continuous encouragement required to carry out this work. They would like to thank the Department of Artificial Intelligence and Data Science and the Department of Electrical and Electronics Engineering for their valuable academic support and for creating a conducive environment for research and development. The authors are especially thankful to their project guides and coordinators for their constructive feedback, guidance, and motivation throughout the design and implementation of the Campus Guidance System.

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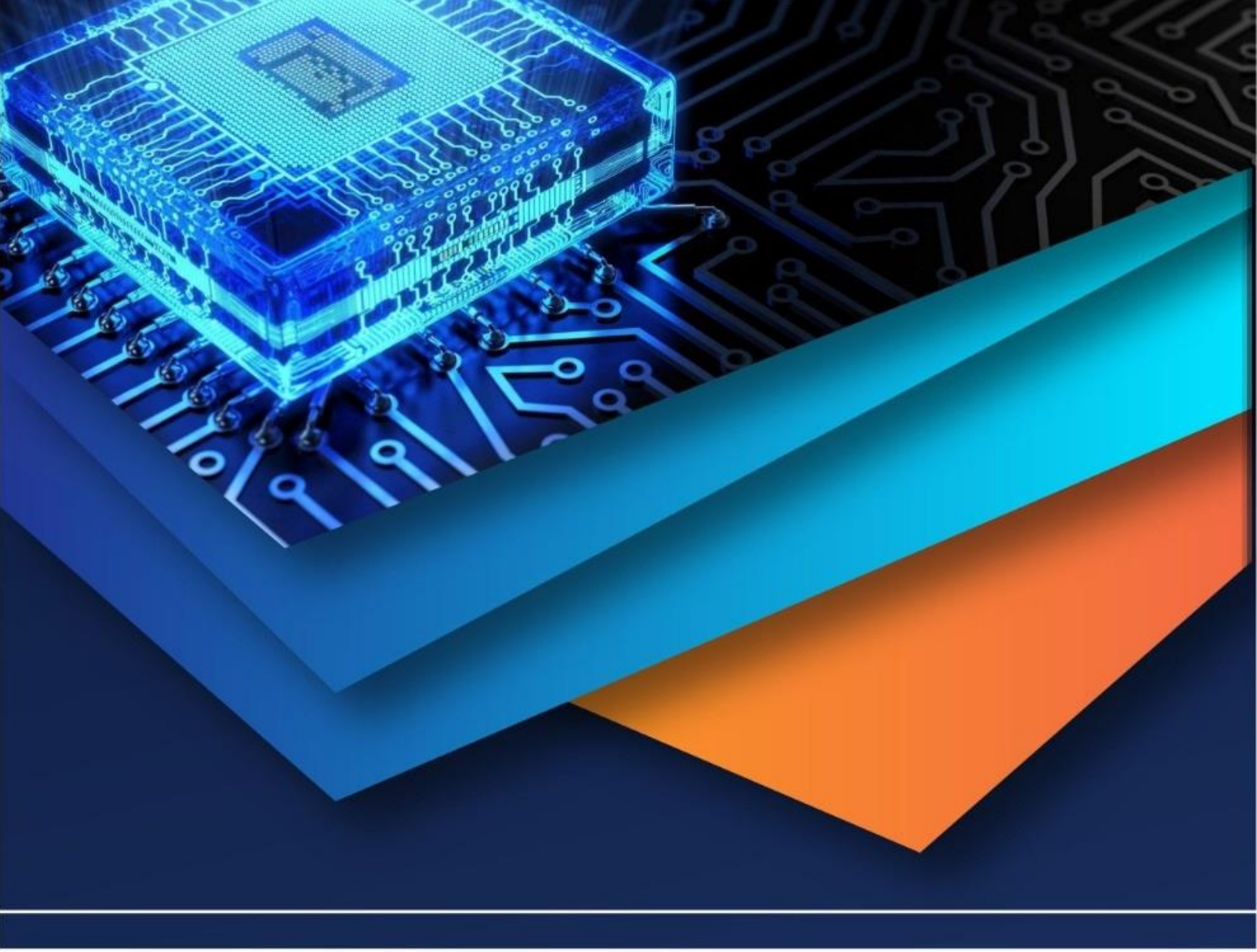
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