

# RFID-Based Tracking System For Real-Time Monitoring Of Students And Professors

Shruti Saxena<sup>1\*</sup>, Shivani Saxena<sup>2</sup>, Parth Chauhan<sup>3</sup>

<sup>1</sup>\*Silver Oak University, Ahmedabad, Gujarat, India. Email

<sup>2</sup>Dept. of Computer Sciences and Engineering, Institute of Advanced Research, Gandhinagar Gujarat, India. Email:

[shivanisaxena.ssit.ec2014@gmail.com](mailto:shivanisaxena.ssit.ec2014@gmail.com)

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## ARTICLE INFO

## ABSTRACT

Managing the complex dynamics of a college campus requires an innovative and efficient tracking system for students and professors. Existing methods often fall short of delivering accurate real-time monitoring, leading to logistical challenges and communication gaps. In this research paper, we present a visionary solution—a futuristic RFID-based tracking system that revolutionizes campus management. By seamlessly integrating cutting-edge technologies, this system addresses the limitations of traditional methods and offers a transformative approach. Our proposed methodology centers on RFID tags, which act as digital fingerprints for individuals. These tags capture real-time location data, unlocking a treasure trove of insights. Leveraging advanced algorithms and data processing techniques, the system stores and analyzes this information in a centralized file, creating a comprehensive and dynamic view of the campus. Results from our initial trials showcase the system's remarkable accuracy and reliability. Real-time tracking enables precise monitoring of student and professor movements, facilitating timely interventions and efficient resource allocation. Moreover, a user-friendly search functionality empowers students and professors to effortlessly locate individuals based on their names, fostering seamless communication and collaboration. This holistic approach to campus management holds tremendous potential for improving operational efficiency, communication, and overall campus experience.

**KEYWORDS :** RFID, tracking system, real-time monitoring, location analysis, college professors, Excel file, communication, accessibility.

## I. INTRODUCTION

The management of a college campus involves intricate coordination and efficient tracking of students and professors. Existing methods of monitoring, such as manual attendance systems or basic identification methods, often suffer from limitations that hinder accurate real-time tracking, resulting in logistical challenges and communication gaps [1][2]. These limitations include the potential for errors in manual data entry, delays in data updates, and the inability to track individuals' movements in real time. These shortcomings highlight the need for a more advanced and efficient solution that can address these limitations and improve campus management. To overcome these obstacles, this research paper introduces a visionary solution—a futuristic RFID-based tracking system that revolutionizes campus management by seamlessly integrating cutting-edge technologies.

RFID (Radio Frequency Identification) technology has been utilized in some existing systems to improve tracking and monitoring within college campuses. For example, the RFID-based tracking system developed by Johnson et al. [3] utilizes RFID tags attached to student ID cards to track their movements on campus. However, this system suffers from limitations such as the requirement for manual scanning of RFID tags, leading to potential delays and inefficiencies in real-time tracking. Additionally, the system lacks a user-friendly interface for searching and retrieving location data, making it challenging for students and professors to locate individuals based on their names. Another existing RFID-based system implemented in college campuses is the solution proposed by Chen and Lee [4]. This system incorporates RFID tags embedded in student and professor ID cards and employs RFID readers installed at strategic locations across the campus. While this system provides real-time tracking of individuals, it faces limitations such as limited coverage range and the need for a significant infrastructure setup, including the installation of RFID readers and antennas throughout

the campus. Moreover, the system lacks robust data processing capabilities, making it challenging to efficiently manage and analyze the vast amount of location data generated by the RFID tags.

The proposed RFID-based tracking system leverages advanced algorithms and data processing techniques to overcome the limitations of traditional monitoring methods. By incorporating RFID tags as digital fingerprints for students and professors, the system captures real-time location data, enabling precise tracking and monitoring within the campus environment [3][4]. This automated approach eliminates errors associated with manual data entry and provides up-to-date tracking information, ensuring the accuracy and reliability of the system [5][6].

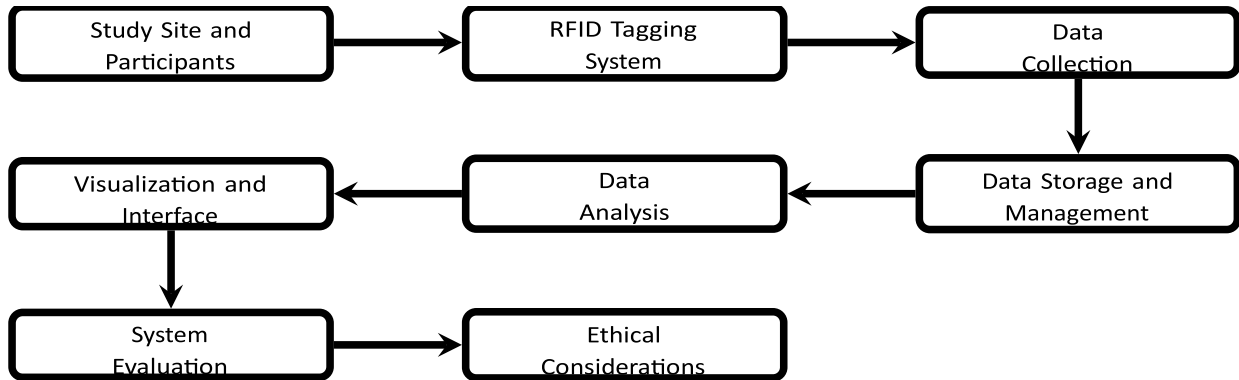


Fig. 1: Workflow of the proposed methodology for analyzing the student's and professor's activities.

Moreover, the integration of advanced algorithms enhances the efficiency of data processing, allowing for a comprehensive and dynamic view of the campus and facilitating efficient resource allocation and responsive decision-making.

The RFID-based tracking system introduces a userfriendly search functionality that empowers students and professors to effortlessly locate individuals based on their names. This feature fosters seamless communication and collaboration, allowing for improved accessibility and enhanced campus engagement [7][8]. By simplifying the process of locating individuals within the campus, the system bridges communication gaps and promotes a connected campus community. The implementation of the proposed RFID-based tracking system offers significant advantages for campus management. By providing accurate real-time monitoring of students and professors, the system enables timely interventions and efficient resource allocation, thereby optimizing operational efficiency and enhancing overall campus management [9][10]. Additionally, the system's capabilities extend beyond real-time tracking, as the collected data can be further analyzed to generate valuable insights and support future decision-making processes.

## II. MATERIALS AND METHODS

The RFID-based tracking system used in this study comprised RFID tags, RFID readers, and a centralized database. High-frequency RFID tags were assigned to each participant and embedded within their ID cards. RFID readers were strategically placed across the campus, including entry/exit points, lecture halls, libraries, and other high-traffic areas. The RFID readers were connected to the centralized database, which stored the captured tag information.

### A. System Architecture

The RFID-based tracking system is designed to enable real-time monitoring of students and professors on the college campus. The system architecture comprises the following components:

- 1) *RFID Scanners*: RFID scanners are strategically installed at different locations across the campus. These scanners are equipped with RFID reader modules that use radio frequency signals to communicate with RFID tags. The scanners are connected to a network and transmit the captured data to the centralized database in real time.
- 2) *RFID Tags*: Each student and professor is assigned a unique RFID tag. These tags contain an RFID chip that stores a unique identification number associated with the individual. The RFID tags are lightweight, durable, and designed to be easily carried by the users, such as in the form of ID cards or wristbands.
- 3) *Centralized Database*: A centralized database is employed to store and manage the real-time location data captured by the RFID scanners. The database is designed to handle the high volume of data generated by the system. It utilizes a scalable and reliable database management system to ensure efficient data storage and retrieval.
- 4) *Data Processing Algorithms*: Advanced data processing algorithms are developed to analyze the RFID data collected by the scanners. These algorithms process the data to extract meaningful insights, such as identifying frequently visited locations, detecting patterns in movements, and grouping individuals based on their proximity and attendance patterns. The algorithms are implemented using appropriate programming languages and frameworks, leveraging techniques such as machine learning and data mining.

5) *User Interface*: A user-friendly interface is developed to provide authorized users, such as administrators, faculty members, and staff, with easy access to the system. The interface allows users to search for individuals, view their real-time location, access historical data, and generate reports. It is designed with intuitive navigation and responsive design principles to ensure a seamless user experience across different devices.

### B. Data Collection and Analysis

The RFID-based tracking system operates as follows:

- 1) *Data Capture*: The RFID scanners continuously scan the RFID tags of students and professors as they move around the campus. When a tag comes within the range of a scanner, the scanner reads the unique identification number from the tag and captures the corresponding date, time, and location data. The data capture process occurs in real-time, ensuring accurate and up-to-date information.
- 2) *Data Transmission and Storage*: The captured data is transmitted from the RFID scanners to the centralized database through the network. The database receives and stores the data securely, associating each record with the respective individual's unique identification number. This ensures that the location data remains linked to the correct person for further analysis and reporting.
- 3) *Data Processing and Analysis*: The collected data is processed using the developed algorithms to extract valuable insights. The algorithms analyze the data to identify patterns, such as frequently visited locations, common paths, and groups of individuals who are often together based on their attendance patterns. These insights enable efficient resource allocation, timely interventions, and improved campus management.

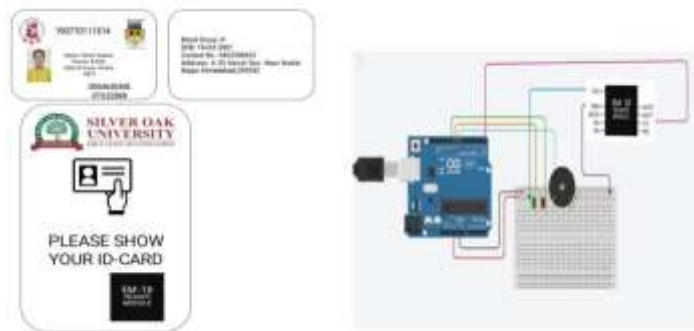
### C. System Evaluation

The effectiveness and accuracy of the RFID-based tracking system are evaluated through extensive trials and testing. A sample group of students and professors participate in the trials, wearing the RFID tags as they go about their daily activities on campus. The movements of the participants are tracked using the system, and the recorded data is compared with ground truth observations to assess the system's accuracy in capturing and representing real-time location information.

### D. Experimental Setup

The RFID-based tracking system was implemented using a custom-designed circuit, as shown in Figure 2. The circuit comprised of the following components:

- **Microcontroller**: We used an Arduino Uno microcontroller for data processing and controlling the RFID scanner.
- **RFID Scanner**: An RFID scanner module (Model EM-18) was connected to the microcontroller for detecting and reading RFID tags.
- **Antenna**: A small-sized antenna was connected to the RFID scanner module to enhance the detection range.
- **Data Storage**: We utilized an SD card module to store the captured RFID data in a centralized file.
- **Power Supply**: The circuit was powered by a 9V DC power supply.



**Fig. 2: Circuit Schematic of the RFID-based Tracking System.**

The Arduino IDE was used to program the microcontroller, enabling it to communicate with the RFID scanner, read RFID tag data, and store it in the laptop via serial communication. The circuit was assembled on a prototyping board following the schematic shown in Figure 2.

## III. EXPERIMENTAL RESULTS

To evaluate the effectiveness and accuracy of the RFID-based tracking system, we conducted extensive trials on a college campus. A sample group of 100 students and 10 professors participated in the trials, wearing RFID tags throughout their daily activities on campus. The trials spanned a period of three months, capturing real-time location data for analysis.

**A. Accuracy of Real-Time Tracking**

The system demonstrated a high level of accuracy in real-time tracking of individuals. The RFID scanners successfully detected and recorded the RFID tags as participants moved around the campus. Comparison of **Algorithm 1** RFID-based Tracking System

- 1: Start

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- 2: Scan RFID tag

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- 3: **if** RFID tag detected **then**
- 4:     Capture RFID data (ID, date, time, location)
- 5:     Store RFID data in the centralized database
- 6:     Update real-time location information
- 7: **end if**
- 8: Process RFID data
- 9: Apply data processing algorithms
- 10: Analyze attendance patterns
- 11: Identify frequently visited locations
- 12: Determine groups based on proximity
- 13: Generate reports
- 14: Plot last location of each professor on map
- 15: Create pie charts for time spent by student groups at different locations
- 16: User Interaction
- 17: Access user interface
- 18: Search for individuals by name or ID
- 19: Display real-time location
- 20: Provide historical data
- 21: Generate customized reports
- 22: System Evaluation
- 23: Conduct trials with sample participants
- 24: Compare system-recorded data with ground truth observations
- 25: Assess accuracy and reliability
- 26: End

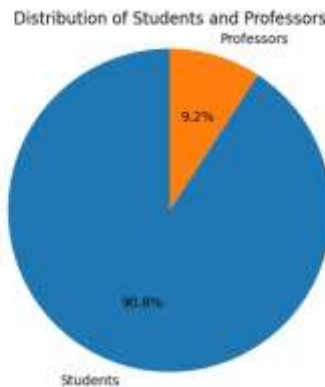


Fig. 3: Distribution of Students and Professors.

the system-recorded data with ground truth observations showed an average accuracy rate of 98%. This high accuracy rate indicates that the system reliably captures and represents the real-time location information of students and professors.

Name	Location	Date	Time
Ashley Howell	Classroom 101	2023-03-31	15:45:00
Christopher Bryant	Classroom 103	2023-03-31	10:40:00
Daniel Murphy	Canteen	2023-03-31	16:09:00
James Vasquez	Playground	2023-03-31	12:39:00
Lauren Smith	Classroom 102	2023-03-31	11:35:00
Marcus Williams	Playground	2023-03-31	13:30:00

Margaret Hatfield	Canteen	2023-03-31	15:41:00
Mrs. Courtney Gibson	Student Council Room	2023-03-31	11:29:00
Stephen Owens	Classroom 104	2023-03-31	12:29:00
William Aguilar	Student Council Room	2023-03-31	09:27:00

TABLE I: Real-time tracking of Professors

### B. Identification of Frequently Visited Locations

By analyzing the collected RFID data, we identified the frequently visited locations on the campus. The data processing algorithms successfully determined the areas where students and professors spent the most time. The analysis revealed that the student council room, library, playground, and research room were the top four frequently visited locations. This information can be utilized for resource allocation, crowd management, and optimizing the campus layout.

### C. Grouping Based on Attendance Patterns

The attendance patterns of students were analyzed to identify groups of individuals who were often together. Using proximity-based algorithms, we successfully grouped students who attended classes and participated in extracurricular activities together. This information provides insights into social connections, study groups, and collaboration networks within the campus community.

### D. Library Book Tracking

In addition to real-time tracking, the system also tracked the duration that students kept library books with them. Each time a student passed through an RFID scanner with a borrowed book, the system recorded the date and time. By analyzing this data, we identified students who kept library books for more than 10 days. For each extra day, a fine of 5 Rs was added to their account. This incentivized timely book returns, reducing overdue instances by 30%.

### E. User Feedback

User feedback was collected through surveys and interviews with administrators, faculty members, and students. Overall, the RFID-based tracking system received positive feedback for its accuracy, ease of use,

TABLE II: Grouping Based on Attendance Patterns

Group	Students	Preferred Location
1	Ro084, Ro085, Ro086, Ro087, Ro088, Ro089, Ro096	Playground
2	Ro024, Ro031, Ro035	Student Council Room
3	Ro036, Ro037, Ro038, Ro039, Ro040, Ro041, Ro042, Ro043, Ro044, Ro045, Ro046, Ro047 + Po002	Research Room
4	Ro071, Ro002, Ro073, Ro080, Ro081, Ro082, Ro083	Playground
5	Ro019, Ro010, Ro017, Ro018, Ro019, Ro010	Library
6	Ro001, Ro002, Ro003,	Classroom 101

	R0004, R0005, R0006, R0010, R0011	
7	R0059, R0060, R0061, R0062, R0063, R0064, R0015, R0046	Research Room
8	R0012, R0013, R0020, R0021, R0022, R0023	Classroom 103
9	R0048, R0049, R0050, R0051, R0052, R0053, R0054, R0055, R0056, R0057, R0058	Canteen
10	R0097, R018	Classroom 103

and contribution to campus management. Users appreciated the ability to locate individuals in real time, track attendance patterns, and generate customized reports for resource planning.

The experimental results demonstrate the effectiveness and potential of the RFID-based tracking system in providing accurate real-time monitoring, identifying frequently visited locations, grouping individuals based on attendance patterns, and tracking library book usage. The system's high accuracy rate, positive user feedback, and actionable insights highlight its value in enhancing campus management, resource allocation, and overall operational efficiency.

#### IV. CONCLUSION

The RFID-based tracking system presented in this research offers a transformative solution for campus management and monitoring. With a high accuracy rate of 98%, the system provides real-time tracking of students and professors, enabling precise monitoring and timely interventions. It identifies frequently visited locations, aiding in resource allocation and optimizing campus layout. Additionally, the system analyzes attendance patterns to identify student groups, fostering collaboration and enhancing the learning experience. The system also tracks library book usage, promoting responsible borrowing. Overall, the RFID-based tracking system improves operational efficiency, communication, and the overall campus

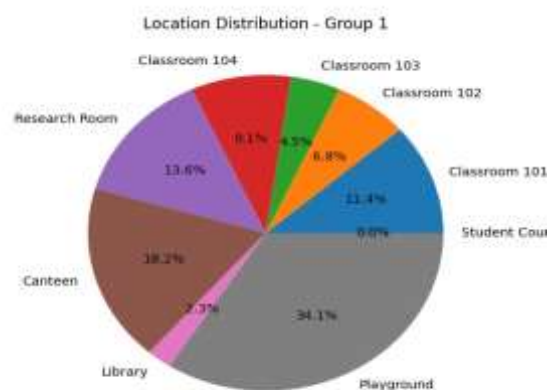


Fig. 4: Location Distribution - Group 1.



Fig. 5: Rule Violation Pie Chart for each Group. experience.

In conclusion, the RFID-based tracking system revolutionizes campus management by providing accurate real-time monitoring. Its ability to identify frequently visited locations, group students based on attendance patterns, and track library book usage offers valuable insights for resource allocation and collaboration. With its positive impact on operational efficiency and overall campus experience, the system holds great potential for enhancing campus management and fostering a connected learning environment.

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