# Campus Travel QR Portal using IOT

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**Abstract**

This paper presents the development of a Campus Travel QR Portal, integrating Internet of Things (IoT) technology for efficient campus transportation management. Leveraging components such as the ESP32-CAM module and software tools like Arduino IDE, C++, and Python, the system offers real-time monitoring, QR code-based authentication, reservation capabilities, and enhanced security features. The ESP32-CAM module enables visual data capture and processing, facilitating user authentication and vehicle tracking. The portal provides users with real-time updates on vehicle availability and location, allowing informed travel decisions and seamless access to campus facilities. Programming in C++ using Arduino IDE is utilized for ESP32-CAM firmware development, while Python is employed for backend server management and data processing. The system incorporates encryption protocols to safeguard user data and prevent unauthorized access. Through seamless integration with campus facilities, the portal enhances convenience, security, and efficiency in campus transportation management. This project contributes to the advancement of smart transportation systems in campus environments, addressing the evolving needs of modern educational institutions.

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**Keywords**

IoT (Internet of Things), Campus Transportation, QR Portal, ESP32-CAM Module, Real-time Monitoring, Authentication, Security.

## 1. Introduction

In the rapidly evolving landscape of technology, integrating multiple systems to create cohesive, automated solutions has become increasingly vital for enhancing efficiency and user experience. This project aims to develop an advanced system for managing bus pass applications and fines using QR code scanning and live video streaming technology. The solution leverages Python's robust Tkinter library to design a user-friendly interface, allowing administrators to seamlessly add, delete, and edit user details. The backend is supported by SQLite, a reliable and lightweight database management system, ensuring efficient storage, retrieval, and management of user data. The database schema is meticulously designed to include essential fields such as user ID, name, email, and bus pass status, facilitating structured and efficient data handling. The ESP32 module, a powerful microcontroller with built-in Wi-Fi capabilities, is configured to connect to a specified Wi-Fi network. This enables the ESP32 to act as a local server, hosting a unique IP address dedicated to streaming live video from an attached camera module. The camera module is configured to capture high-quality video, ensuring clear and stable footage that can be accessed over the local network. This setup is crucial for the real-time processing of visual data. The real-time processing of the live video stream is handled by Python libraries like OpenCV and Pyzbar. These libraries are essential for detecting and decoding QR codes within the video feed. When a QR code is detected, the system extracts the encoded information, such as the user ID or bus pass status. This data is then used to query the SQLite database, verifying whether the student has applied for the bus pass facility. If the database indicates that the student has not applied, the system automatically adds a fine to their fees and displays a notification explaining the reason for the fine. This immediate feedback loop ensures that fines are levied promptly and based on the most current data, enhancing the system's effectiveness and accountability. To ensure the system is robust and user-friendly, extensive error handling mechanisms are integrated throughout the QR code scanning process. These mechanisms manage exceptions effectively, providing clear and actionable feedback to users. For instance, if the QR code is not recognized or there is an issue with the database query, the system will display an appropriate error message, guiding the user on how to resolve the

issue. This attention to detail in error handling helps in maintaining the system's reliability and user satisfaction. The entire system undergoes thorough testing to ensure all functionalities work as intended. This testing phase includes validating the user interface for usability, verifying the accuracy and reliability of database operations, ensuring the stability and clarity of the live video stream, and confirming the real-time QR code processing capabilities. User testing is also conducted to gather feedback on the system's performance and usability, making necessary adjustments based on user input. This iterative testing and feedback loop is crucial for refining the system and ensuring it meets the users' needs effectively. Once the testing phase confirms the system's stability and reliability, it is prepared for deployment. The deployment process involves setting up the system in its intended operational environment, providing comprehensive training to users to ensure they understand how to use the system effectively, and offering ongoing support to address any issues that may arise post-deployment. Continuous monitoring of the system is conducted to ensure it remains functional and reliable, with periodic updates made as needed to address any emerging issues or to incorporate new features. This comprehensive approach ensures that the system is not only robust and user-friendly but also scalable and adaptable to various applications beyond bus pass management. By integrating advanced technologies and focusing on user-centric design, this project represents a significant step forward in utilizing integrated systems to streamline administrative tasks and enhance operational efficiency. It underscores the potential of combining hardware and software innovations to create intelligent, automated solutions that address real-world challenges effectively.

## 2. Related Work

S. Desai, R. Suthar, V. Yadav, V. Ankar and V. Gupta, [1] "This proposed system for bus transportation is a commendable effort towards addressing key issues in the industry. The integration of GPS, RFID, and PIR technologies, coupled with a Raspberry Pi and Firebase server, demonstrates a thorough approach to real-time data collection and management. By providing passengers with access to crucial information like arrival times and vehicle status, you're enhancing their overall experience and satisfaction. Fleet managers stand to benefit greatly from the ability to monitor and optimize operations in real-time, while the inclusion of RFID for passenger tracking adds an important layer of safety and security. Making the data accessible via a website ensures convenience and transparency for all stakeholders. Overall, your system shows promise in improving the efficiency, reliability, and user experience of bus transportation services."

M. J. Shah, R. P. Prasad and A. S. Singh [2] "In Smart Bus System proposal presents a comprehensive solution to modernizing bus transportation. The automated ticket booking feature, utilizing RFID technology at entry and exit gates, coupled with GPS tracking, ensures accurate fare calculation based on distance traveled. Integration with an E-wallet system through a mobile application adds convenience for passengers. The ability to track live bus locations enhances trip planning for users. Moreover, the system's data analysis capabilities offer insights for optimizing bus schedules and determining fleet requirements. The emphasis on digitalization reduces paper usage and streamlines planning efforts. Overall, the Smart Bus System promises efficiency, convenience, and reliability, ultimately improving the passenger experience and operational efficiency."

Y. Punarvit, K. Sawant, K. P. k. R. Shankar and V. Kumar [3] "In proposal for an RFID-based ticketing system stems from thorough research into modernizing ticketing processes within the transportation sector. Recognizing the limitations of conventional ticketing systems, your study delved into the potential benefits of adopting RFID technology. Through extensive investigation and analysis, you identified RFID as a promising solution for optimizing ticketing operations, streamlining passenger flow, and enhancing overall efficiency. By leveraging RFID tags with unique identifiers linked to passenger data, your research underscores the system's ability to automate ticket generation upon entry, simplifying the boarding process for passengers and operators alike. Furthermore, the incorporation of GPS and GSM modules reflects a strategic integration of location tracking and database communication, facilitating accurate fare calculation and seamless transaction management. Embracing digitalization, cashless transactions, and sustainability, your research aligns with broader societal goals and technological advancements. The proposed online payment system, utilizing IoT technology, demonstrates a forward-thinking approach to secure and efficient transactions, reflecting a commitment to enhancing the passenger experience while embracing innovation. Overall, your research lays a solid foundation for the development of an RFID-based ticketing system that promises to revolutionize ticketing processes and contribute to the advancement of the transportation industry."

X. Feng, J. Zhang, J. Chen, G. Wang, L. Zhang and R. Li [4] The study delves into the development of an intelligent bus positioning system leveraging Internet of Things (IoT) technology to revolutionize bus dispatch, operational efficiency, and campus functionality. It begins by exploring IoT node location awareness and multi-source positioning for comprehensive environmental perception. The design entails a three-tier network hierarchy

comprising the perception, network, and application layers. Utilizing RFID technology, buses are tracked, located, and monitored, while touch screens at bus stops enable passenger counting and electronic boards display arrival times. Zigbee wireless network technology facilitates seamless communication between vehicle terminals, platform systems, and dispatch monitoring centers. Ultimately, the integration of a simulated annealing algorithm for intelligent bus scheduling aims to elevate the quality and efficiency of bus services, meeting the diverse travel needs of citizens while paving the way for a smarter, more responsive campus environment.

V. Vedanarayanan, R. Raman, S. R. Pujar and T. Sivakumar [5] The research proposes a system aimed at addressing challenges encountered by passengers utilizing public transit, particularly focusing on the cost factor. The system introduces a novel approach by incorporating a fingerprint sensor mechanism for tracking passenger entry and exit, thereby enabling accurate fare calculation based on the distance traveled. This innovative concept not only offers convenience to passengers but also streamlines fare collection processes for bus companies. Furthermore, the integration of an online payment method enhances the system's functionality and accessibility, allowing for seamless transactions and eliminating the need for physical tickets. The continuous and automatic updating of records on the server ensures real-time tracking and management of passenger data, contributing to operational efficiency. Moreover, the inclusion of a web-based platform provides passengers with valuable insights into bus routes, status, passenger count, and distance statistics, enhancing their overall experience and facilitating informed decision-making. Overall, the system presents a comprehensive solution to the challenges associated with public transit, leveraging IoT technology to optimize fare management, passenger tracking, and service delivery.

R. S. Krishnan, A. Kannan, G. Manikandan, S. S. KB, V. K. Sankar and K. L. Narayanan [6] The introduction of the Secured College Bus Management System (SCBMS) marks a significant step forward in ensuring the safety and well-being of students amidst the challenges posed by the COVID-19 pandemic. By implementing stringent health screenings and safety protocols before boarding, SCBMS prioritizes student health while minimizing the risk of disease transmission. With alert mechanisms in place to notify parents and college management of any deviations from safety measures, the system fosters transparency and accountability. Real-time vehicle location updates enable parents to prepare their children for school on time, while efficient bus attendance monitoring facilitates seamless communication with college authorities. SCBMS not only addresses immediate pandemic-related concerns

but also enhances the overall safety and efficiency of college bus transportation, underscoring its commitment to student welfare and academic continuity.

Y. Punarvit, K. Sawant, K. P. k. R. Shankar and V. Kumar [7] The RFID-based ticketing system presents a paradigm shift in the realm of transportation, offering unparalleled efficiency and convenience compared to traditional ticketing methods. By seamlessly integrating RFID technology with GPS and GSM modules, the system enables automatic fare calculation based on distance traveled, ensuring accurate and hassle-free transactions for passengers. Embracing digitalization and cashless transactions, the system aligns with the vision of a "Digital India" while also promoting sustainability by reducing paper usage. Furthermore, the implementation of an online payment system utilizing IoT technology enhances security and expedites transactions, further enhancing the overall passenger experience. In essence, the RFID-based ticketing system represents a forward-thinking solution that not only enhances operational efficiency but also enhances the overall passenger experience, marking a significant advancement in modern transportation systems.

## 3. Motivation of work

The motivation behind implementing QR code generation for student pass issuance lies in the need to modernize and optimize transportation systems within educational institutions. As demands for efficiency and streamlined procedures increase, there is a growing recognition of the potential of QR code technology to revolutionize the authentication process. By transitioning from traditional physical passes to digital QR-coded ones, this approach aims to enhance the overall student experience by providing a secure, user-friendly, and technologically advanced means of pass validation. Furthermore, the integration of QR code generation aligns with the broader trend of incorporating technology into education, offering a cutting-edge solution that not only streamlines authentication but also enhances security and reliability.

In the context of campus transportation, the shift to QR code-based student passes represents a significant advancement in how educational institutions manage and facilitate mobility. Traditional physical passes often come with various challenges, such as the potential for loss, damage, or forgery. These issues can lead to increased administrative burdens and security concerns, as well as inconvenience for students who must replace lost or damaged passes. By adopting QR code technology, educational institutions can address these challenges head-on. QR codes, which can be easily generated and scanned, provide a more durable and secure

alternative to physical passes. Each QR code can serve as a unique identifier for a student, containing encrypted information that can be quickly and securely verified.

The implementation of QR code generation for student pass issuance also offers substantial benefits in terms of efficiency. The process of issuing and validating passes becomes significantly faster and more streamlined. For students, this means a reduction in the time spent waiting to board transportation, as QR codes can be quickly scanned using smartphones or dedicated scanners. This speed and efficiency not only improve the overall user experience but also enhance the operational efficiency of the transportation system itself. Transportation personnel can process and verify passes more swiftly, reducing bottlenecks and ensuring a smoother flow of passengers.

Another critical aspect of QR code technology is its contribution to enhanced security. With QR codes, the risk of forgery or unauthorized use of passes is greatly diminished. Each QR code is uniquely generated and linked to a specific student, making it difficult for counterfeit passes to be created or used. Additionally, the encrypted nature of the information contained within the QR code ensures that sensitive student data is protected during the authentication process. This heightened level of security fosters greater trust in the transportation system among students and staff, reassuring them that their personal information and access privileges are safeguarded.

The convenience and accessibility afforded by QR codes further underscore their suitability for modern educational institutions. Unlike traditional physical passes, which can be cumbersome to carry and easy to misplace, QR codes can be stored and accessed on students' smartphones. This eliminates the need for students to keep track of a separate physical item, reducing the likelihood of loss or forgetfulness. Moreover, the widespread adoption of smartphones means that most students already possess the necessary technology to utilize QR codes, making the transition to digital passes seamless and intuitive.

The integration of QR code technology also brings with it the advantage of centralized data management. A centralized database that records and monitors pass utilization in real-time allows educational institutions to gain valuable insights into transportation patterns and trends. This data-driven approach enables institutions to make informed decisions about resource allocation, route optimization, and service improvements. For example, real-time data on the number of students using a particular bus route can help administrators adjust schedules or deploy additional vehicles during peak times, enhancing the overall efficiency and responsiveness of the transportation system.

Beyond the immediate benefits of efficiency, security, and convenience, the adoption of QR code-based student passes reflects a broader trend of embracing technological innovation within education. As educational institutions strive to stay at the forefront of technological advancements, the incorporation of QR code technology into transportation systems exemplifies a commitment to modernization and continuous improvement. This forward-thinking approach not only addresses current challenges but also positions institutions to adapt to future needs and opportunities.

Furthermore, the implementation of QR code generation for student pass issuance aligns with the growing emphasis on sustainability within educational institutions. Digital passes reduce the need for physical materials, such as plastic cards or paper tickets, contributing to a reduction in waste and the institution's overall environmental footprint. This eco-friendly aspect of QR code technology resonates with the increasing awareness and commitment to sustainability among students and staff, enhancing the institution's reputation as a responsible and forward-looking entity.

## 4. Contribution of work

The development of the Campus Travel QR Portal represents a pioneering contribution to campus transportation management, driven by a fusion of innovative technologies and a user-centric approach. By seamlessly integrating IoT capabilities, QR code authentication, and real-time monitoring, the project offers a transformative solution to longstanding challenges in campus mobility. Through its emphasis on efficiency, sustainability, and user experience, the portal not only streamlines transportation operations but also enhances the overall quality of campus life. Moreover, its robust security measures ensure the protection of user data, fostering trust and confidence among stakeholders. Beyond its immediate impact on campus transportation, the project generates valuable insights and methodologies that contribute to the broader discourse on smart campus initiatives and IoT applications in educational settings. As institutions strive to adapt to the evolving needs of modern campuses, the Campus Travel QR Portal stands as a beacon of innovation, paving the way for more intelligent, accessible, and sustainable transportation solutions.One of the standout features of the Campus Travel QR Portal is its integration of IoT capabilities. The Internet of Things (IoT) has revolutionized the way devices communicate and interact, creating a network of connected devices that can share data and optimize operations in real time. By harnessing this technology, the portal ensures that various components of campus transportation—from

buses and shuttles to bicycles and pedestrian pathways—are seamlessly connected. This interconnectedness enables real-time monitoring and management of transportation resources, reducing wait times, optimizing routes, and enhancing the overall efficiency of the system.QR code authentication adds another layer of convenience and security to the Campus Travel QR Portal. QR codes are a versatile and widely adopted technology that can be easily scanned using smartphones and other devices. By incorporating QR code authentication, the portal simplifies the process of accessing transportation services, allowing users to quickly and securely verify their identity and access the services they need. This not only streamlines the user experience but also reduces the likelihood of unauthorized access, ensuring that only authorized individuals can utilize the transportation resources.

Real-time monitoring is a critical component of the Campus Travel QR Portal, enabling continuous oversight of transportation operations. By providing real-time data on the location, status, and availability of transportation resources, the portal allows for dynamic adjustments and responsive management. This capability is particularly valuable in addressing the fluctuating demands of campus transportation, ensuring that resources are allocated efficiently and that any issues or disruptions are promptly addressed. Real-time monitoring also enhances safety, as it allows for immediate detection and response to any incidents or emergencies. The emphasis on efficiency is a core tenet of the Campus Travel QR Portal. By optimizing transportation operations and reducing wait times, the portal significantly enhances the convenience and reliability of campus transportation. This is particularly important in a campus setting, where students, faculty, and staff rely on timely and dependable transportation to navigate between classes, meetings, and other activities. The portal's ability to streamline operations not only improves the daily experience of campus users but also contributes to a more productive and engaged campus community. Sustainability is another key focus of the Campus Travel QR Portal. By promoting the use of efficient and eco-friendly transportation options, the portal supports the broader goal of reducing the campus's carbon footprint. This is achieved through a combination of strategies, including optimizing vehicle routes to minimize fuel consumption, encouraging the use of bicycles and other low-emission transportation modes, and providing real-time data to help users make environmentally conscious transportation choices. The portal's commitment to sustainability aligns with the growing emphasis on environmental responsibility and positions the campus as a leader in sustainable transportation practices. User experience is at the heart of the Campus Travel QR Portal's design. By prioritizing the needs and preferences of

campus users, the portal ensures that transportation services are not only efficient and sustainable but also user-friendly and accessible. Features such as intuitive interfaces, easy-to-use QR code authentication, and responsive real-time updates contribute to a positive and seamless user experience. This focus on user experience fosters greater adoption and satisfaction, encouraging more users to take advantage of the campus transportation services. Security is a paramount consideration in the development of the Campus Travel QR Portal. With robust security measures in place, the portal protects user data and ensures the privacy and confidentiality of sensitive information. This is achieved through the implementation of advanced encryption technologies, secure authentication protocols, and continuous monitoring for potential security threats. By safeguarding user data, the portal builds trust and confidence among stakeholders, reinforcing the integrity and reliability of the campus transportation system.

The impact of the Campus Travel QR Portal extends beyond the immediate context of campus transportation. By generating valuable insights and methodologies, the project contributes to the broader discourse on smart campus initiatives and the application of IoT technologies in educational settings. The lessons learned and best practices developed through the implementation of the portal can inform future projects and initiatives, driving innovation and progress in the realm of smart campuses. This broader contribution underscores the significance of the Campus Travel QR Portal as a model for intelligent, accessible, and sustainable transportation solutions.

## 5. Technologies

**Tkinter for Frontend Development:** Tkinter is a Python library used for creating graphical user interfaces (GUIs). It provides a simple and easy-to-use interface for building interactive applications. In this project, Tkinter is employed to design the frontend of the administrative portal and user interface for the bus pass system. With Tkinter, developers can create windows, buttons, labels, and other GUI elements, facilitating seamless interaction with the system. Its integration with Python makes it a popular choice for developing desktop applications with minimal complexity

**SQLite for Backend Database Management:** SQLite is a lightweight relational database management system (RDBMS) that is widely used in embedded systems and applications requiring local data storage. In this project, SQLite serves as the backend database management system for storing student information, bus pass data, and fine records. It offers

simplicity, portability, and ease of integration, making it suitable for embedded applications like the bus pass system. With SQLite, developers can create and manage databases using SQL queries, ensuring efficient data storage and retrieval within the Raspberry Pi environment.

**ESP32 Microcontroller for IoT Integration:** The ESP32 microcontroller is instrumental in the campus travel QR portal project, facilitating QR code scanning, wireless communication, data processing, and real-time updates. Its integration enables the system to scan QR codes presented by students for bus pass authentication, ensuring only authorized users access the buses. The ESP32's built-in Wi-Fi allows it to connect to the internet and communicate with a central server, enabling QR code validation, bus pass updates, and real-time bus route information. Additionally, its processing power and memory enable efficient data processing and storage, reducing the load on the central server. Overall, the ESP32 enhances the project's functionality, providing essential features that improve user experience and streamline the bus pass authentication process.

**Camera Module for Scanning System:** The camera module is an essential component integrated with Raspberry Pi for capturing images of QR codes presented by students during boarding. It provides the capability to visually identify and extract QR code data, enabling automated bus pass authentication. The camera's resolution, frame rate, and image processing capabilities play a crucial role in ensuring accurate and efficient QR code recognition. By interfacing with Raspberry Pi, the camera module facilitates real-time image capture and processing, enhancing the overall functionality of the bus pass system.

**OV2604 Camera Sensor:** The OV2640 camera sensor can be directly related to the campus travel QR portal project by enabling the ESP32 microcontroller to scan QR codes. The OV2640 is a popular 31 camera sensor that can be easily interfaced with the ESP32 to capture images. In the context of the project, the OV2640 camera sensor would be used to capture the QR codes displayed by students for bus pass authentication. The ESP32, with the help of the OV2640 camera sensor, can capture images of QR codes, which are then processed to extract the encoded information. This information is crucial for validating bus passes and ensuring that only authorized users board the buses. Overall, the OV2640 camera sensor enhances the functionality of the project by providing a reliable and efficient means of capturing QR codes for authentication purposes, ultimately improving the user experience and efficiency of the campus travel system.

**Security Protocols:** Security protocols form an integral part of the Campus Travel QR Portal, ensuring the confidentiality, integrity, and availability of user data and system resources. These protocols encompass a wide range of measures, including encryption techniques, secure communication protocols (such as HTTPS), access control mechanisms, and authentication protocols. By implementing robust security measures, the portal mitigates the risk of unauthorized access, data breaches, and malicious attacks, safeguarding the privacy and security of users and system assets.

## 6. Proposed Work

The integration of QR code generation for student pass issuance stands as a pivotal advancement in modernizing educational transportation systems. By leveraging QR code technology, educational institutions can transition from conventional physical passes to digital ones, offering a secure and efficient means of pass authentication. QR codes, encoded with encrypted information, streamline the verification process, eliminating the need for manual checks and reducing boarding times. Moreover, their encrypted nature enhances security, mitigating the risk of fraudulent pass usage. This digitalization also enhances convenience for students, as passes can be easily stored on mobile devices, reducing the risk of loss or damage. Real-time tracking capabilities enable proactive management of transportation resources, facilitating efficient resource allocation and improved service delivery. Overall, the adoption of QR code generation not only enhances security and efficiency but also prioritizes the needs and preferences of students, ushering in a more user-centric approach to student pass issuance and authentication.
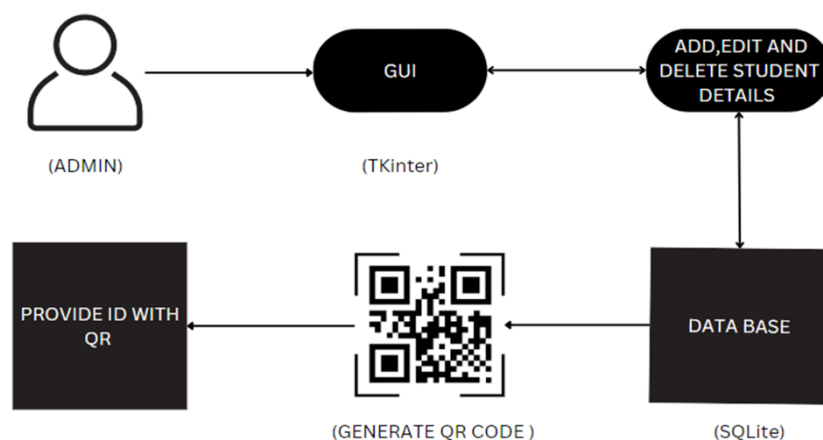
**Administrative Interface**

The administrative interface of the bus facility management system provides authorized administrators with a user-friendly platform to oversee and manage various aspects of student transportation. From registering students and generating their unique QR codes to maintaining accurate records and handling system configurations, administrators have comprehensive control. Through advanced reporting and analytics tools, administrators gain valuable insights into usage patterns and trends, enabling informed decision-making to optimize bus facility operations. With proactive notification systems and customizable settings, administrators can efficiently address issues and tailor the system to meet the specific needs of the educational institution, ultimately ensuring a seamless and efficient transportation experience for students.

The admin side of the system initiates with a user-friendly Graphical User Interface (GUI) accessible to authorized administrators. Through this interface, administrators handle various tasks related to managing the bus facility. Firstly, administrators register students for bus facility access via the GUI. They input essential student details such as name, student ID, contact information, and transportation preferences into the system. Once registered, student information is securely stored in the system's database. This centralized repository serves as a comprehensive record of student eligibility for bus facility usage.
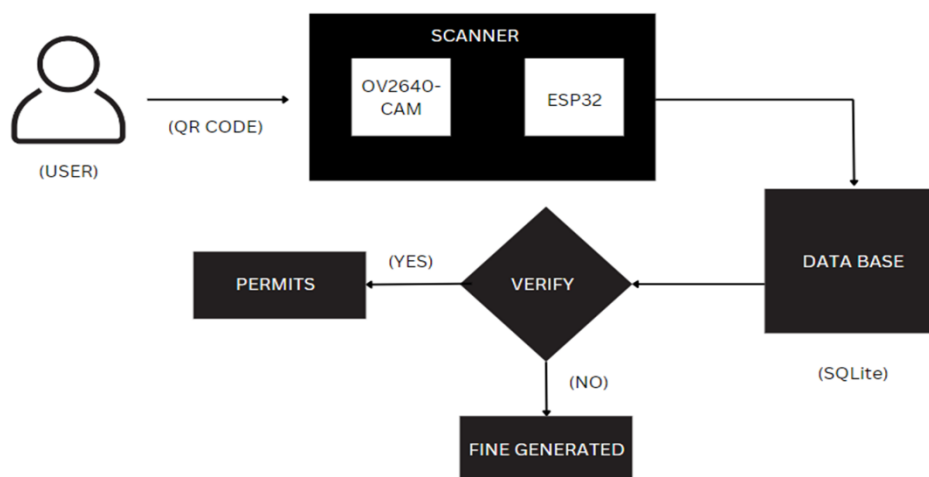


The user side process for accessing the bus facility at the educational institution is meticulously designed to offer students a seamless and efficient experience. Through a designated portal or mobile application, students effortlessly obtain their unique QR code, serving as their bus pass. Upon boarding, a quick scan of this QR code by the bus scanner initiates real-time verification, swiftly granting eligible students permission to ride. Should

any discrepancies arise, such as expired access or mismatched codes, the system promptly notifies students, allowing for resolution and reinstatement of bus facility access upon payment. Furthermore, the interface facilitates student feedback, fostering continuous enhancement of the system's functionality. In essence, the user side process prioritizes convenience, compliance, and user satisfaction, ensuring a hassle-free transportation experience for all students.

The integration of the OV2640 camera sensor with the ESP32 microcontroller is a pivotal advancement within the campus travel QR portal project, significantly augmenting its functionality and efficacy. At the core of this integration lies the imperative need for efficient and reliable bus pass authentication, a cornerstone of ensuring smooth and secure transportation for students within educational institutions. The OV2640 camera sensor's role in this context is paramount, offering the capability to capture high-resolution images of QR codes presented by students for authentication purposes. This ability to capture clear and detailed images of QR codes is instrumental in facilitating accurate extraction of the encoded information, which is crucial for validating bus passes and regulating access to transportation services. Leveraging the advanced imaging capabilities of the OV2640, the project ensures the integrity and security of the authentication process, thereby enhancing the overall user experience for both students and administrative personnel. The reliability and efficiency of the OV2640 camera sensor extend beyond its imaging capabilities, encompassing its adaptability to various lighting conditions and its seamless integration with the ESP32 microcontroller. These features are indispensable for maintaining the efficiency of the bus pass authentication process, minimizing errors, and optimizing boarding procedures. The high-resolution imaging offered by the OV2640 ensures that QR codes are captured with precision, enabling swift and accurate validation of bus passes. Additionally, its compatibility with the ESP32 microcontroller facilitates smooth communication and coordination within the project's hardware architecture, enabling seamless operation and interaction between different system components.The integration of the OV2640 camera sensor aligns with the broader objectives of the campus travel QR portal project, which seeks to modernize and optimize transportation systems within educational institutions. By providing a reliable and efficient means of capturing QR codes for authentication purposes, the OV2640 contributes to the project's overarching goal of enhancing the user experience and efficiency of the campus travel system. This enhanced functionality not only streamlines the bus pass authentication process but also underscores the project's commitment to leveraging cutting-

edge technology to address evolving needs and challenges within educational transportation systems. In essence, the integration of the OV2640 camera sensor represents a critical milestone in the project's journey towards delivering a modern, secure, and user-centric transportation solution for educational institutions.
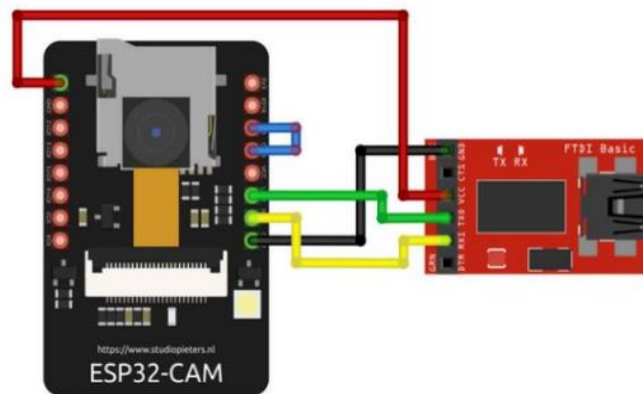
## 7. Implementation

To implement the described system for managing bus pass applications and fines through QR code scanning and live video streaming, we will undertake a multi-faceted approach that integrates user interface design, database management, microcontroller configuration, live video streaming, and real-time data processing. The first step involves designing a user-friendly interface using Python's Tkinter library. This interface will allow users to add, delete, and edit user details efficiently. The UI will be designed to be intuitive, ensuring that users can navigate through the options without difficulty. Each action taken in the UI, such as adding a new user or editing an existing user's details, will be reflected in an SQLite database, ensuring data consistency and integrity. The database schema will be meticulously designed to include fields such as user ID, name, email, and bus pass status, facilitating efficient storage and retrieval of user information. Simultaneously, we will configure the ESP32 module to connect to a specified Wi-Fi network, enabling it to act as a local server with an IP address dedicated to streaming live video. The ESP32 will be equipped with the necessary libraries and firmware to ensure seamless communication with the attached camera module. This setup will allow the ESP32 to capture and stream live video, providing a clear and stable feed accessible over the local network. The camera module will be carefully configured to maintain optimal video quality, ensuring that the QR codes displayed in the video stream can be accurately detected and decoded. On the software side, we will use Python libraries such as OpenCV and Pyzbar to process the live video stream. These libraries will enable the system to detect QR codes in real-time, extracting the encoded information such as user ID or bus pass status. The extracted data will then be used to query the SQLite database to verify if the student has applied for the bus pass facility. If the database indicates that the student has not applied, the system will automatically add a fine to their fees and display a notification explaining the reason for the fine. This real-time processing will ensure that fines are levied promptly and accurately, based on the latest data. To handle any potential issues that may arise during the QR code scanning process, we will implement robust error handling mechanisms. These mechanisms will manage exceptions effectively, providing clear and actionable feedback to users. For instance, if the QR code is not recognized or if there is

an issue with the database query, the system will display an appropriate error message, guiding the user on how to resolve the issue. The entire system will undergo thorough testing to ensure that all functionalities work as intended. This will include testing the UI for usability, verifying the accuracy of database operations, ensuring the stability of the live video stream,

and validating the real-time QR code processing. We will also conduct user testing to gather feedback on the system's performance and usability, making necessary adjustments based on user input. Once testing is complete and the system is deemed stable, we will proceed with deployment. This will involve setting up the system in its intended environment, providing training to users to ensure they understand how to use the system effectively, and offering ongoing support to address any issues that may arise post-deployment. Continuous monitoring of the system will be conducted to ensure it remains functional and reliable, with periodic updates made as needed to address any emerging issues or to incorporate new features. This comprehensive approach will ensure that the system is robust, user-friendly, and capable of efficiently managing bus pass applications and fines through QR code scanning and live video streaming.



## 8. Result and Output

The result of implementing the described system is an efficient and user-friendly solution for managing user details and authenticating bus passes using IoT technology. On the user interface side, the Python Tkinter application provides a simple and intuitive interface for adding, deleting, and editing user details. Users can easily manage user information, enhancing the overall user experience. The SQLite database stores user details securely and allows for efficient retrieval and manipulation of data. The ESP32 module, combined with the camera module, enables real-time scanning of QR codes displayed by students boarding

the bus. The ESP32 connects to a Wi-Fi network and creates a local host for streaming video from the camera module. The Python program processes the live stream, extracts QR code information, and checks the database for bus pass status. If a student has not applied for the bus facility, a fine is added to their fees. Overall, the implemented system streamlines the process of managing user details and authenticating bus passes. It improves efficiency, reduces manual effort, and enhances user experience, making it a valuable addition to campus transportation services.

For future enhancements, several opportunities exist to further improve the system. One potential enhancement is the integration of additional security features to ensure the authenticity and integrity of the QR codes and user data. Implementing encryption and authentication mechanisms can enhance the security of the system, preventing unauthorized access and data breaches.
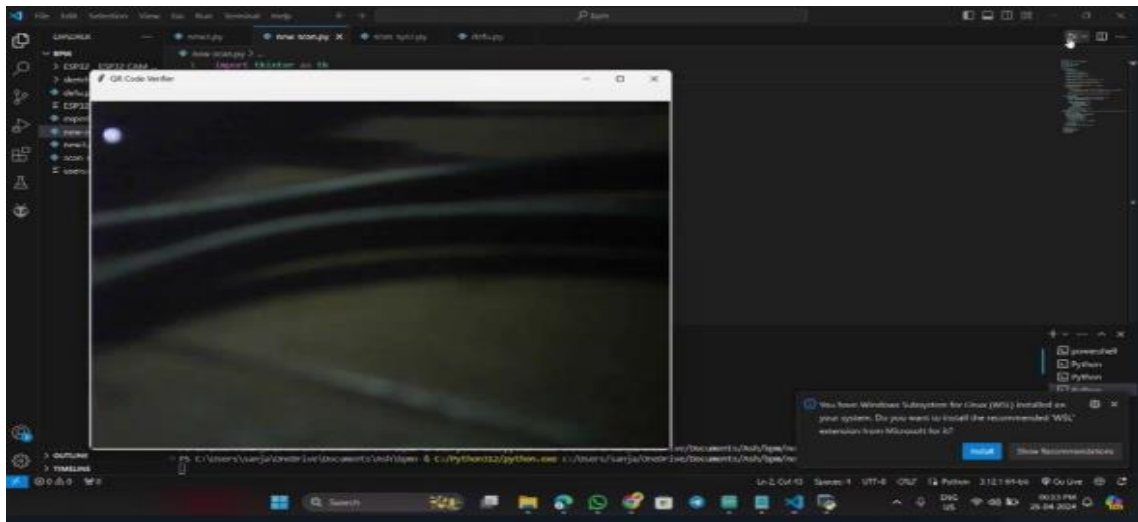


Scanning The QR
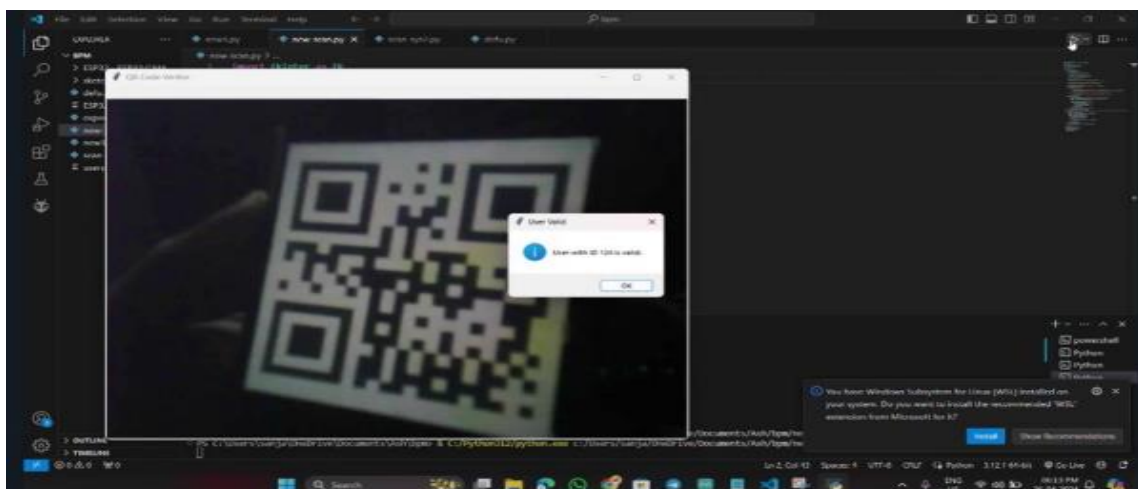


QR Creation

## 9. Conclusion and Future Work

In conclusion, the implemented system demonstrates the successful integration of IoT technology to enhance campus transportation services. The combination of Python Tkinter for the user interface, SQLite for the database, and ESP32 with a camera module for real-time QR code scanning provides a robust and efficient solution for managing user details and authenticating bus passes. The system improves efficiency, reduces manual effort, and enhances user experience, making it a valuable addition to campus transportation services. For future enhancements, several opportunities exist to further improve the system. One potential enhancement is the integration of additional security features to ensure the authenticity and integrity of the QR codes and user data. Implementing encryption and authentication mechanisms can enhance the security of the system, preventing unauthorized access and data breaches. Furthermore, enhancing the user interface to provide more functionalities and a more visually appealing design can improve the overall user experience. Adding features such as real-time notifications, user feedback mechanisms, and personalized settings can make the system more user-friendly and engaging. Additionally, integrating machine learning algorithms for advanced data analysis can

provide valuable insights into user behavior and preferences. This can help transportation administrators optimize bus routes, improve resource allocation, and enhance overall transportation efficiency. Overall, the implemented system provides a solid foundation for future enhancements and improvements, showcasing the potential of IoT technology to revolutionize campus transportation services.

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