VISVESVARAYA TECHNOLOGICAL UNIVERSITY
SMART TOLL-EYE: A PAY-PER-KILOMETER SYSTEM WITH SURVEILLANCE

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Introduction:

1. The existing toll collection system charges vehicles a fixed fee irrespective of the distance traveled, which leads to unfair pricing and traffic congestion at toll plazas. This inefficiency creates delays and reduces transparency in toll operations. To overcome these limitations, a smart toll system based on a pay-per-kilometer model is proposed.
2. This project uses ESP32 as the main controller due to its high processing speed and built-in WiFi capability, making it suitable for IoT-based applications. RFID technology is used to identify vehicles and verify user balance at entry points. IR sensors are used to measure the distance traveled by the vehicle between entry and exit points.
3. Additionally, the system integrates a surveillance feature using ESP32-CAM, which captures images of vehicles with insufficient balance. These images are stored in cloud storage (Google Drive) for monitoring purposes. A GSM module (SIM800L) is used to send real-time SMS alerts to users after toll deduction.
4. The proposed system improves efficiency, reduces congestion, and ensures fair toll collection. It also enhances transparency and security, making it suitable for modern smart transportation systems and smart city infrastructure.

Objectives:

- To design and develop a smart toll system based on distance traveled.Use RFID for identification.
- To implement RFID technology for vehicle identification and balance verification.

- To measure the distance traveled using IR sensors.
- To integrate ESP32-CAM for surveillance and image capture
- To provide real-time SMS notifications using GSM module.
- To reduce traffic congestion and improve toll collection efficiency.

Methodology:

1. The proposed system consists of entry and exit points equipped with RFID readers, IR sensors, and an ESP32 microcontroller. When a vehicle arrives at the entry point, the RFID tag is scanned, and the system checks the available balance in the user's account. If sufficient balance is available, the gate opens and the vehicle is allowed to enter.
2. As the vehicle moves between entry and exit points, IR sensors are used to measure the distance traveled. The ESP32 processes this data in real time. At the exit point, the total distance is calculated, and the toll amount is deducted automatically from the user's account.
3. If the system detects insufficient balance, the ESP32-CAM captures an image of the vehicle. This image is uploaded to Google Drive for monitoring and record purposes. Simultaneously, the SIM800L GSM module sends an SMS alert to the user, notifying them about the deduction or insufficient balance.
4. The system uses IoT connectivity to enable efficient communication and real-time monitoring. The integration of multiple components ensures automation, accuracy, and security in toll collection.

Result and Conclusion:

1. The developed system successfully demonstrates a smart toll collection mechanism based on distance traveled. The RFID module accurately identifies vehicles and verifies account balance. The IR sensors effectively measure the distance, ensuring correct toll calculation.
2. The ESP32-CAM enhances the system by capturing images of vehicles with insufficient balance, improving security and monitoring. The GSM module provides real-time SMS notifications, increasing transparency and user awareness.
3. Overall, the system reduces traffic congestion, minimizes manual errors, and ensures fair toll pricing. The project proves to be an efficient and reliable solution for modern toll management systems.

Project Outcome & Industry Relevance:

1. The Smart Toll-Eye system provides a practical and efficient solution for automated toll collection based on distance traveled. It improves fairness and transparency compared to traditional toll systems.

2. This project is highly relevant to industries related to transportation, smart cities, and highway management. It can be implemented in real-world toll plazas to reduce congestion and improve traffic flow.
3. The use of IoT technology enables real-time monitoring and data management, making the system scalable and adaptable. The surveillance feature also supports security and law enforcement applications.

Working Model vs. Simulation/Study:

This project is developed as a **working model** using hardware components such as ESP32, RFID module, IR sensors, ESP32-CAM, and SIM800L GSM module. It demonstrates real-time toll calculation, surveillance, and communication features.

Project Outcomes and Learnings:

1. Through this project, we gained practical knowledge of IoT systems, embedded programming, and hardware integration. We learned how to interface RFID modules, IR sensors, and GSM modules with ESP32.
2. We also developed skills in real-time data processing, cloud storage integration, and system design. The project enhanced our problem-solving abilities, teamwork, and understanding of smart transportation systems.

References:

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Future Scope:

1. The future scope of this project includes integrating GPS technology for more accurate distance measurement. A mobile application can be developed to allow users to check balance and transaction history.
2. Digital payment integration such as UPI can be added to simplify the recharge process. Artificial Intelligence techniques can be used for automatic number plate recognition to enhance surveillance.
3. The system can also be expanded for large-scale deployment with centralized monitoring and cloud-based analytics for better traffic management and decision-making.