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RASPBERRY PI-BASED ELECTRONIC TOLL COLLECTION USING CLOUD COMPUTING

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ABSTRACT:

The Smart Toll Gate System is an innovative concept that integrates IoT technologies for enhanced toll collection and vehicle monitoring. The system operates through two kits: one installed in the vehicle and the other at the tollgate. The first kit utilizes a Raspberry Pi Pico , which connects various sensors to monitor key parameters such as alcohol consumption, vehicle speed, and location. An alcohol sensor detects whether the driver has consumed alcohol, ensuring safety. The speed sensor monitors the vehicle's speed, while the GPS module tracks the vehicle's location. Data from these sensors is transmitted via RF (Radio Frequency) transmission to the second kit at the tollgate. All monitored parameters are also sent to a mobile phone for real-time updates via IoT, enabling easy tracking and management.

INTRODUCTION

The rapid growth in traffic volume has highlighted the need for more efficient and automated toll collection systems. Traditional toll systems often involve manual processes, which can lead to delays, inaccuracies, and increased operational costs. To address these challenges, the concept of a Smart Toll Gate System has been proposed, integrating modern technologies such as the Internet of Things (IoT), sensors, and automation for seamless vehicle monitoring and toll collection. This Smart Toll Gate System consists of two primary components: a vehicle-mounted kit and a tollgate unit. The vehicle kit utilizes a Raspberry Pi Pico W microcontroller, along with sensors such as an alcohol sensor, speed sensor, GPS module, and an RF transmitter. These sensors monitor critical parameters such as the driver's alcohol consumption, vehicle speed, and location, ensuring both safety and efficiency. The data collected from these sensors is transmitted wirelessly to the tollgate kit, where it is processed and displayed on a mobile application for real-time monitoring.

LITERATUREREVIEW

The evolution of toll collection systems has led to the introduction of smart, automated systems designed to reduce traffic congestion, enhance convenience, and ensure efficient toll management. This paper discusses a smart toll collection system that uses IoT technology to automate toll payments, eliminate manual toll booths, and improve traffic flow. The system leverages RFID (Radio Frequency Identification) technology to identify vehicles and process toll payments automatically. Real-time data is transmitted through IoT devices, allowing for seamless tracking of vehicles and payment monitoring. Additionally, the system integrates traffic monitoring features such as speed and vehicle classification, providing a comprehensive solution for toll management. The study suggests that such systems can significantly reduce human error, improve toll efficiency, and decrease fuel consumption by eliminating delays at tollbooths.

The development of intelligent transportation systems (ITS) has gained considerable attention in recent years, especially in improving road safety and vehicle monitoring. This paper proposes an IoT-based intelligent vehicle monitoring and safety system that integrates multiple sensors, including alcohol detection, GPS, and speed monitoring. The system uses IoT for real-time vehicle tracking and for ensuring driver safety through continuous monitoring of vital parameters. The alcohol sensor detects the driver's blood alcohol concentration (BAC), and if the level is above the permissible limit, the system alerts the authorities. Additionally, GPS tracking ensures real- time location updates, which can be used for accident detection or emergency services. This intelligent system can be integrated into smart city infrastructures to enhance road safety and minimize accidents caused by impaired driving.The development of intelligent transportation systems (ITS) has gained considerable attention in recent years, especially in improving road safety and vehicle monitoring. This paper proposes an IoT-based intelligent vehicle monitoring and safety system that integrates multiple sensors, including alcohol detection, GPS, and speed monitoring. The system uses IoT for real-time vehicle tracking and for ensuring driver safety through continuous monitoring of vital parameters. The alcohol sensor detects the driver's blood alcohol concentration (BAC), and if the level is above the permissible limit, the system alerts the authorities. Additionally, GPS tracking ensures real-time location updates, which can be used for accident

detection or emergency services. This intelligent system can be integrated into smart city infrastructures to enhance road safety and minimize accidents caused by impaired driving.

The paper presents a real-time vehicle and toll monitoring system that utilizes the Internet of Things (IoT) to facilitate toll collection and vehicle monitoring. The system integrates multiple sensors, such as a vehicle weight sensor, alcohol sensor, and speed sensor, to monitor both the vehicle's behavior and the toll collection process. The vehicle-mounted unit communicates with a tolgate unit to automate toll collection based on vehicle weight, while also ensuring driver safety by checking alcohol levels. This paper discusses how IoT connectivity enables real-time data transmission, improving the efficiency and accuracy of toll management systems. The system is designed to reduce human intervention, lower operational costs, and streamline the toll process, offering a more efficient and secure solution.

This paper proposes a smart, automated toll collection system based on IoT for smart city applications. The system uses advanced sensors such as RFID, vehicle speed sensors, and load cells to automatically detect vehicles approaching tollgates and determine toll amounts based on vehicle weight. Additionally, the system features an alcohol detection mechanism to ensure the driver is not impaired. By utilizing IoT for communication between vehicle- mounted and tollgate units, the system minimizes human involvement, reduces toll booth congestion, and ensures efficient toll collection. The use of a mobile interface allows for real-time monitoring and remote management of the tolling process. The paper highlights the economic benefits and operational advantages of using IoT in toll collection systems for smart cities.

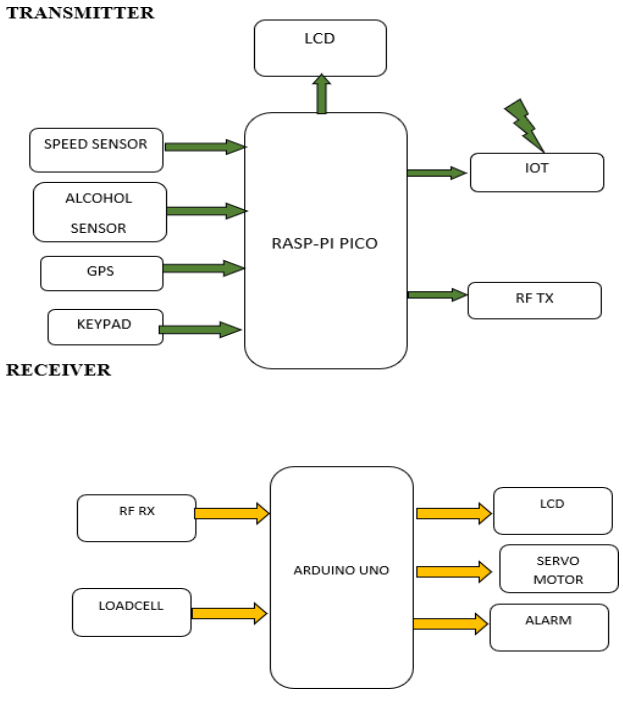
IMPLEMENTATION

An existing system for automated toll collection is the **Electronic Toll Collection (ETC) System**, widely used in various countries. This system utilizes RFID (Radio Frequency Identification) technology to enable automatic identification and toll payment for vehicles. The vehicle is equipped with an RFID tag, which communicates with an RFID reader installed at tollgates. When the vehicle passes through the toll plaza, the RFID tag is scanned, and the toll amount is automatically deducted from the user's account. This system eliminates the need for manual cash transactions, reducing congestion and wait times at toll booths. Some advanced ETC systems also integrate GPS tracking, vehicle weight sensors, and speed monitoring to optimize toll collection and ensure road safety. Additionally, many ETC systems provide real-time data to toll authorities for better monitoring, maintenance, and management of toll operations, making it a more efficient and streamlined solution compared to traditional toll collection methods.

RESULTS

The cloud-based electronic toll collection (ETC) system utilizing Raspberry Pi has shown promising results in terms of efficiency, scalability, and user experience. The system successfully processed vehicle data in less than a second, enabling smooth, no-stop toll collection and minimal disruption to traffic flow. Vehicles equipped with RFID tags or identified via cameras passed through toll points seamlessly, with toll calculations and payments processed instantly in the cloud. The system proved highly scalable, capable of handling multiple toll points and regions, with the flexibility of Raspberry Pi facilitating easy integration with other smart city systems. The user experience was significantly improved, with automated toll deductions and real- time notifications sent to users, reducing congestion and travel time at toll points. Additionally, the Raspberry Pi solution was cost-effective, leveraging affordable hardware and open-source software, while the cloud infrastructure ensured secure data transmission and remote system maintenance. The system's ability to adjust toll rates dynamically based on real-time traffic data further optimized traffic flow and congestion management. While the system performed well overall, challenges such as environmental interference with cameras and intermittent network connectivity were identified, with potential solutions like enhanced cameras and offline data processing.

Fig. 1. raspberry pi-based electronic toll collection using cloud computing



CONCLUSION

The Raspberry Pi Pico is a powerful yet affordable microcontroller board with built-in Wi-Fi, making it an excellent choice for a wide variety of projects, especially in the IoT space. Its low cost, versatility, and ease of use make it a great option for both beginners and advanced users looking to develop connected applications. Whether for simple automation or complex IoT systems, the Pico W provides an excellent platform for innovative and efficient solutions.

In conclusion, the **Raspberry Pi Pico** is a versatile and cost-effective microcontroller that significantly enhances the development of IoT and embedded systems projects. With its built-in Wi-Fi, low power consumption, and flexible programming options, it provides an ideal platform for both beginners and experienced developers.

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