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VEHICLE ANALYSIS ON TOLL

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ABSTRACT

Vehicle analysis at toll plazas plays an important responsibility in understanding traffic flow, vehicle classification, & toll funds management. Toll plazas handle large volumes of vehicles daily, containing two-wheelers, cars, buses, trucks, & multi-axle vehicles. Efficient monitoring & sorting of these vehicles help decrease congestion, increase toll collection efficiency, & improve traffic management. This study concentrates on analyzing vehicle motion through toll booths using automated detection and identification technologies. The system integrates sensors, RFID/FASTag readers, Automatic Number Plate Recognition (ANPR) cameras, & weigh-in-motion sensors to detect vehicle existence, classify & identify vehicle types, measure weight, & process toll payments automatically. The collected data is examined to determine peak traffic hours, average waiting time, & congestion levels. This system enhances toll collection efficiency, reduces manual intervention, & supports intelligent traffic management at highways & expressways.

INTRODUCTION

Vehicle analysis at toll plazas helps in understanding traffic patterns, vehicle distribution, & congestion trends. By collecting & analyzing data related to vehicle types, traffic volume, & toll transactions, authorities can optimize toll plaza operations, enhances infrastructure planning, & increase road safety.The integration of intelligent systems allows automatic

vehicle classification, real-time monitoring, & digital record management, making toll operations high efficient & reliable.

Toll plazas are necessary infrastructure elements used for compiling road use fees on highways & expressways. With enhancing numbers of vehicles on roads, toll booths often experience heavy congestion, long waiting times, & operational deficiencies. Manual toll collection systems can trigger delays, errors, & revenue leakage.

To overcome these challenges, modern toll plazas execute automated techniques like vehicle detection sensors, RFID-based toll payment systems, & ANPR cameras. These systems enable faster vehicle detection & identification, automatic toll reduction, & efficient traffic management.

LITERATURE SURVEY

Recent research emphasizes on automated toll systems using RFID technology like FASTag, which enables contactless toll payment. Studies published by IEEE highlight that RFID-based toll systems significantly decrease waiting time & traffic congestion at toll plazas.

Several researchers have studied intelligent toll systems to enhance traffic management & toll collection efficiency. Early toll systems relied on manual ticket collection & manually-operated gates, which resulted in delays & errors.

Modern systems also include Weigh-in-Motion (WIM) sensors to measure vehicle weight while in motion, supporting authorities identify overloaded trucks & enforce road safety regulations. The literature illustrates that integrating multiple technologies like RFID, ANPR, sensors, & intelligent software platforms gives a reliable & efficient toll management system.

PROPOSED SYSTEM

The proposed system is developed to automate vehicle detection & identification, classification, toll collection, & traffic analysis at toll plazas using advanced sensing & monitoring technologies.

A. System Overview

1. Vehicle detection sensors detect the existence of a vehicle entering the toll lane.
2. Vehicle sorting systems verify the type of vehicle (car, truck, bus, etc.).
3. RFID / FASTag reader scans the vehicle tag for automated toll payment.
4. ANPR camera records the vehicle license plate for authentication & record keeping.
5. Weigh-in-Motion sensors measure the vehicle's weight while it crosses the toll.
6. Toll management software measures the toll amount & records transaction data.

7. Barrier control system unlocks the gate once payment is verified.
8. Collected data is examined for traffic flow, congestion patterns, & toll income.

B. Key Components

- **Vehicle Detection Sensor –** Detects vehicle entry in toll lane.
- **Vehicle Classification System** – Identifies vehicle category.
- **Barrier Control System –** Controls opening & closing of toll gate.
- **Toll Management Software –** Processes transactions & saves traffic data.
- **RFID / FASTag Reader –** Allows automatic toll payment**.**
- **ANPR Camera System –** Records vehicle number plates.
- **Weigh-in-Motion Sensor –** Measures vehicle weight.

C. Working Principle

1. When a vehicle approaches the toll plaza, vehicle detection sensors identify its presence.
2. The vehicle sorting system defines the vehicle type using sensors or image processing.
3. The RFID / FASTag reader scans the vehicle's FASTag for automatic toll payment reduction.
4. Simultaneously, the ANPR camera records the vehicle's number plate for verification & record keeping.
5. The Weigh-in-Motion sensor measures the vehicle weight to detect overloaded vehicles.
6. Toll management software evaluates the toll amount based on vehicle type & records transaction details.
7. Once payment is verified, the barrier control system automatically unlocks the gate.
8. If the FASTag is improper or deficient balance is identified, manual payment options may be triggered.
9. All collected data is stored & saved for traffic analysis & toll income management.

D. Advantages

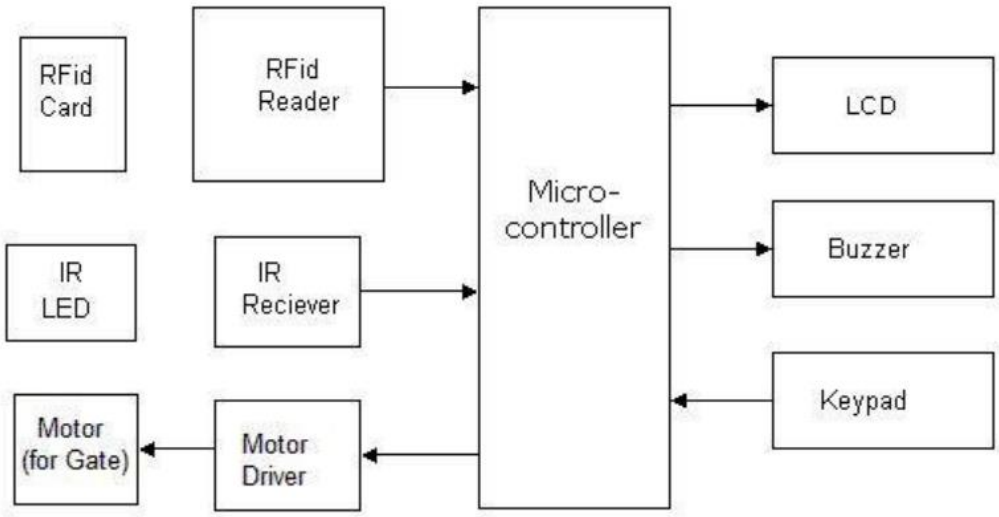
- Gives real-time traffic monitoring
- Identifies overloaded vehicles for safety implementation
- Enhances toll revenue transparency
- Improves highway traffic management
- Decreases traffic congestion at toll plazas
- Allows faster toll collection

- Reduces human errors & manual intervention

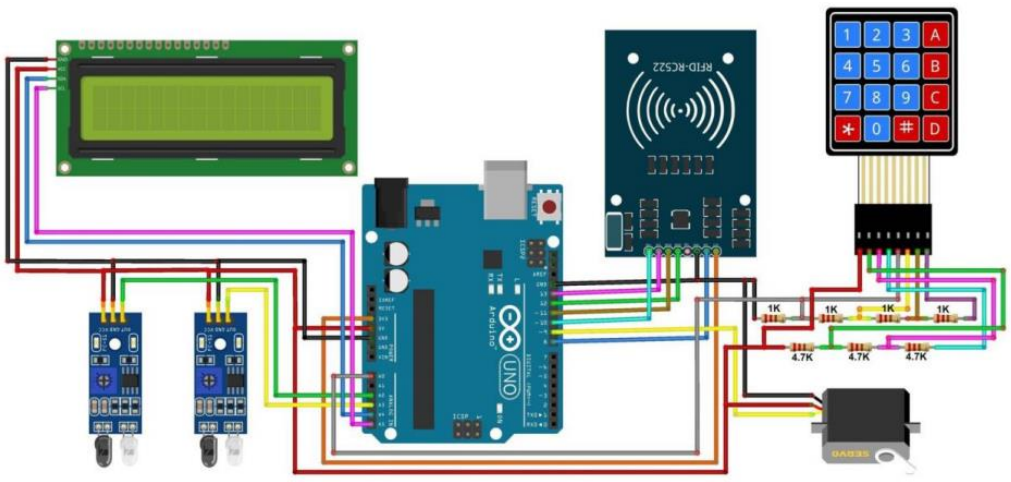
E. Application

- Smart city traffic management
- Traffic monitoring & analysis systems
- Highway safety Implementation systems
- National highway toll plazas
- Expressway toll collection systems
- Smart transportation infrastructure

Block Diagram:



Circuit Diagram:



RESULTS AND DISCUSSION

The Introduced vehicle analysis system for toll plazas was examined based on traffic monitoring efficiency & toll processing speed. The vehicle detection sensors precisely detected vehicles entering the toll lane, while the classification & sorting system successfully identified vehicle categories like cars, buses, & trucks. The RFID/FASTag reader allowed fast & contactless toll payment, significantly decreasing waiting time at toll booths. The ANPR camera system captured vehicle license plates efficiently, ensuring proper record maintenance & enhancing security monitoring. The Weigh-in-Motion sensor precisely measured vehicle weight, enabling authorities to identify overloaded vehicles. The toll management software effectively processed transaction data & generated traffic reports, containing peak traffic hours & congestion levels. The results display that the system can significantly enhance toll plaza efficiency, decrease vehicle waiting time, & Improve traffic analysis abilities. However, system operation depends on accurate sensor calibration, steady network connectivity, & clear camera visibility.

CONCLUSION

The Vehicle Analysis System for Toll Plazas gives an effective solution for monitoring & managing highway traffic. By integrating vehicle detection sensors, RFID-based toll payment, ANPR camera systems, & weight measurement sensors, the system allows automatic vehicle identification & toll processing. The usage of automated technologies decreases congestion, reduces manual errors, & enhances toll collection efficiency. Additionally, the collected data gives useful insights into traffic patterns & vehicle distribution, which can help transportation authorities optimize infrastructure planning. The system promotes to smarter transportation management & helps the advancement of intelligent highway systems.

FUTURE WORK

- Incorporation with smart city traffic management platforms.
- Execution of real-time traffic congestion alerts.
- Solar-powered toll systems for energy efficiency.
- Integration with artificial intelligence for advanced traffic prediction.
- Development of mobile applications for toll payment & traffic updates.

- Integration with national transportation databases for vehicle tracking.
- Use of high-speed cameras for enhanced ANPR accuracy.

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