PROJECT REPORT

TITLE: Vehicle Movement Analysis and Insight Generation Project

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UNDER THE GUIDENCE OF

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ACKNOWLEDGEMENT

We deem it a pleasure to acknowledge our sense of gratitude to our project guide Assistant Professor. Vishnuprabha Krishnakumar Department of Artificial intelligence and Data science under whom we have carried out the project work.

Her incisive and objective guidance and timely advice encouraged us with constant flow of energy to continue the work.

We would like to express our gratitude to our Intel mentor, for their guidance and support throughout the project. Your expertise in edge AI and computer vision were invaluable in shaping our project and helping us overcome challenges. Thank you for your timely feedback, constructive criticism, and mentorship. We appreciate your contributions and look forward to working with you on future projects.

We are also grateful to our colleagues who provided valuable feedback, suggestions, and support throughout the project. Your contributions have been invaluable, and we appreciate the time and effort you invested in this project.

Finally, we must say that no height is ever achieved without some sacrifices made at some end and it is here where we owe our special debt to our parents and our friends for showing their generous love and care throughout the entire period of time.

ABSTRACT

This project explores the application of Edge AI for analyzing vehicle movement and generating insights within a college campus. It leverages a combination of image data, historical vehicle activity data (entry/exit times, occupancy), and a database of authorized license plates. The system employs data preprocessing techniques and extracts valuable information through functionalities like License Plate Recognition (LPR). By analyzing timestamps and occupancy data, the project provides insights into movement patterns and parking behavior. The code outlines the development of a Convolutional Neural Network (CNN) model for potential tasks like vehicle detection or classification, along with its conversion for deployment on edge devices. Finally, the groundwork for a web application for LPR interaction is presented.

The main objectives of this project using Edge AI for vehicle movement analysis in a college campus are:

1. Real-time Analysis of Vehicle Activity and Parking Behavior:
2. Improved Parking Management:
3. Enhanced Security with License Plate Recognition (LPR)
4. Generation of Valuable Insights
5. Exploration of Additional Applications

Overall, the project aims to leverage Edge AI for real-time vehicle movement analysis, generate valuable insights for improved parking management and campus security, and explore the potential for further applications.
This project demonstrates the potential of Edge AI for real-time campus vehicle movement analysis and paves the way for future developments in parking management, traffic flow optimization, and security applications.

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INTRODUCTION

College campuses are dynamic environments with a constant flow of vehicles. Understanding these movement patterns can be crucial for optimizing parking allocation, improving traffic flow, and enhancing campus security. This project explores the potential of Edge AI, a technology that processes data at the source, for vehicle movement analysis and insight generation within a college campus setting. By leveraging computer vision techniques on edge devices like cameras, the project aims to extract valuable data on vehicle activity and parking behavior in real-time without relying on centralized cloud processing.

DATASET DESCRIPTION

The code utilizes a rich dataset to train and evaluate the Edge AI system:

1. **Image Data:** A collection of images (presumably containing vehicles) serves as the foundation for training the computer vision models. The code references a location "C:\Users\jayapriya\OneDrive\Desktop\intel\cars_train" which likely holds these training images.
2. **CSV Data:** A dataset in CSV format located at "C:\Users\jayapriya\OneDrive\Desktop\intel\train image dataset.csv" plays a critical role in understanding vehicle movement patterns. This data likely holds information related to

vehicle entries, exits, timestamps, and potentially parking lot occupancy. It allows the system to correlate timestamps from camera footage with real-world vehicle activity data.

Structure: Each row in the CSV file likely represents data for a single car's entry or exit event. Columns within the file might include:

- **Unique Identifier:** This could be an ID assigned to each car for tracking purposes.
- **Vehicle Entry Time:** Timestamp recording the time a car enters the campus.
- **Vehicle Exit Time:** Timestamp recording the time a car leaves the campus.
- **Parking Lot No.:** This column might indicate the specific parking lot where the car was parked. Depending on the data collection setup, it could be a numerical identifier for the parking lot or a descriptive label (e.g., "Lot A", "Lot B").

3. **Approved Vehicles Database:** Another CSV file at "C:\Users\jayapriya\OneDrive\Desktop\intel\Licplatesrecognition_train.csv" provides a list of authorized license plates. This database allows the system to identify authorized vehicles on campus, potentially enabling functionalities like permit verification or restricted area access control.
4. **License Plate Images:** A folder containing preprocessed license plate images located at "C:\Users\jayapriya\OneDrive\Desktop\intel\license_plates_detection_train" aids in the development of the License Plate Recognition (LPR) module. These preprocessed images likely involve steps like cropping, resizing, or noise reduction to optimize the performance of the LPR model.

METHODOLOGY

The code implements a multi-stage approach to leverage Edge AI for vehicle movement analysis:

1. **Data Preprocessing:** For effective analysis, the code performs preprocessing on the image and CSV data. It likely involves techniques like image resizing, normalization, and handling missing values in the CSV data. The code also explores data visualization to understand existing trends in vehicle entry/exit times and parking occupancy. These visualizations can help identify areas requiring further analysis or model optimization.
2. **License Plate Recognition (LPR):** The project incorporates LPR for potential applications like authorized vehicle identification or restricted area access control. The code utilizes Tesseract, an open-source OCR engine, to extract text from preprocessed license plate images. It then compares the extracted license plate numbers against the approved vehicles database to determine if a vehicle is authorized to be on campus.
3. **Movement Pattern Analysis:** By analyzing the timestamps within the CSV data, the code can identify movement patterns for each vehicle. It groups entries based on vehicle ID and calculates entry/exit times, allowing for the calculation of parking duration. This analysis can provide insights into how long vehicles typically stay parked on campus and identify areas with high parking turnover.
4. **Parking Occupancy Insights:** The code calculates average parking occupancy per vehicle likely based on timestamps within the CSV data. It then visualizes these occupancy rates to identify parking lots with consistently high or low utilization. This information can be valuable for optimizing parking allocation strategies and potentially implementing dynamic pricing models.

5. **Model Creation :**The code outlines the creation of a convolutional neural network (CNN) model, a type of deep learning architecture commonly used for image recognition and classification. It could be intended for tasks like vehicle detection, vehicle type classification (car, motorcycle, etc.), or even anomaly detection (identifying unusual parked vehicles).
6. **TensorFlow Lite Conversion :** The code includes steps to convert the CNN model (presumably after training) to a TensorFlow Lite format. TensorFlow Lite is a lightweight framework optimized for deployment on edge devices with limited processing power. This conversion would allow the model to run directly on cameras or other edge devices, enabling real-time analysis without relying on a constant connection to the cloud.
7. **Web Application:** The groundwork for a Flask web application is included in the code. This application could allow users to upload license plate images for recognition. It defines routes for handling image uploads, performing OCR with Tesseract, and displaying results. Deploying such a web application would provide a user-friendly interface for interacting with the LPR functionality.

RESULTS AND DISCUSSION

The code primarily focuses on data exploration and visualization. It generates plots for vehicle entry/exit times, parking occupancy trends, and average parking occupancy per vehicle. However, without executing the model creation or web application sections, it's difficult to discuss specific results or their implications.

CONCLUSION

This code demonstrates the potential of Edge AI for analyzing vehicle movement and generating insights within a college campus. It showcases data exploration techniques and outlines a framework for license plate recognition and web-based interaction. Future work could involve training and deploying the CNN model for tasks like vehicle detection or classification, and launching the web application for real-world license plate recognition.