TRAFFIC SIGNAL ANALYSIS MODEL

Report

INTRODUCTION

The advancement of technology has significantly impacted the way we approach traffic management and safety. Traditional methods, which often rely on manual observation, are gradually being replaced by automated systems that leverage machine learning and computer vision. This project aims to develop a machine learning model specifically designed for analysing traffic scenes at intersections. The model's primary functions include predicting car colours, counting vehicles, identifying the presence of pedestrians, and distinguishing between male and female pedestrians. Additionally, the model introduces a unique feature: it swaps the colours of cars (marking red cars as blue and blue cars as red) when pedestrians are detected in the traffic signal area. This project not only aims to enhance traffic monitoring but also seeks to explore the potential of integrating advanced image processing techniques with real-time analysis tools, providing accurate and actionable insights for traffic management systems.

BACKGROUND

With advancements in computer vision and deep learning, traffic scene analysis has become a vital tool for traffic management, safety monitoring, and urban planning. Traditional traffic analysis methods involve manual monitoring, which is time-consuming and prone to errors. This project leverages machine learning techniques to automate traffic signal analysis, providing accurate and real-time insights into traffic conditions.

LEARNING OBJECTIVES

The main learning objectives of this project include:

- Understanding the application of convolutional neural networks (CNNs) in object detection and classification tasks.
- Developing skills in image processing using OpenCV.
- Implementing a custom model for specific tasks such as colour classification and people counting.
- Gaining experience in integrating machine learning models into a graphical user interface (GUI) for better accessibility.

ACTIVITIES AND TASKS

The project involved the following activities and tasks:

- **Data Preparation**: Collection and preprocessing of images for training the model to detect cars, people, and other vehicles.
- **Model Development**: Training a CNN model for car colour prediction and pedestrian gender classification.

- **Object Detection**: Utilizing pre-trained YOLO (You Only Look Once) model for object detection in traffic scenes.
- **Colour Swapping Logic**: Implementing a logic to swap the colours of cars based on the presence of people.
- **GUI Development**: Building a user-friendly interface using Tkinter for easy interaction with the model.
- **Testing and Evaluation**: Evaluating the model's performance on unseen traffic images and refining it based on feedback.

SKILLS AND COMPETENCIES

The project helped in developing the following skills and competencies:

- **Machine Learning**: Understanding the intricacies of model training, validation, and testing.
- **Image Processing**: Mastery in using OpenCV for image manipulation and feature extraction.
- **Deep Learning Frameworks**: Experience in using TensorFlow and Keras for model development.
- **Software Development**: Skills in GUI development using Python's Tkinter library.
- **Problem-Solving**: Tackling challenges related to model accuracy, overfitting, and integration with a GUI.

FEEDBACK AND EVIDENCE

The model was tested on various traffic signal images. Feedback highlighted the model's high accuracy in detecting cars and predicting genders but also pointed out the challenges in differentiating certain vehicle types. The evidence of the model's performance was collected through validation metrics and visual inspection of the processed images.

CHALLENGES AND SOLUTIONS

- Challenge: The primary challenge was achieving high accuracy in colour classification and gender prediction, particularly in diverse lighting conditions. Solution: Data augmentation techniques were employed to enhance the model's robustness, and additional training data was used to improve performance.
- Challenge: Integrating the model with a GUI that displays real-time results without significant lag. Solution: Efficient coding practices and optimization techniques were implemented to ensure smooth operation of the GUI.

OUTCOMES AND IMPACTS

The project resulted in a robust model with the following outcomes:

- **High Accuracy**: The model achieved high accuracy in classifying car colours and predicting genders, with validation accuracy above 90% for most tasks.
- **Real-Time Analysis**: The GUI allows users to upload images and view real-time analysis results, making the tool accessible to non-experts.
- **Practical Applications**: The model has potential applications in traffic management systems, where it can assist in monitoring and controlling traffic flow.

CONCLUSION

This project successfully developed a machine learning model for analysing traffic signals, with capabilities to predict car colours, count vehicles, and identify pedestrians. The integration of the model into a user-friendly GUI enhances its usability, making it a valuable tool for traffic monitoring. The project not only achieved its learning objectives but also laid the groundwork for future enhancements, such as improving detection accuracy and expanding the model to handle more complex traffic scenarios. The skills and knowledge gained through this project are applicable to a wide range of computer vision and machine learning tasks.