01| Project Deliverable 1 - Road Signs Detection

Danielle S. Raynor, Kevin Allen, Adnan Hasan, Sahad Rafiuzzaman, Noah Roberson

Old Dominion University

CYSE 635: AI Security & Privacy

Dr. Md Morshed Alam

October 30, 2024

Problem Statement

The expansion of urban areas and road networks has led to a significant increase in road signs essential for road safety, driver guidance, and traffic flow. However, accurately recognizing and responding to these signs remains a challenge, especially for autonomous and driver-assistance systems. Failure to detect signs in real-time can result in accidents, traffic violations, and inefficiencies.

Traditional computer vision methods often struggle with varying conditions, such as changes in lighting, weather, partial occlusions, and sign wear. These issues are compounded by the diversity of road signs, which differ in shape, color, and design across regions. Therefore, there is a pressing need for a reliable, adaptive solution capable of real-time, accurate road sign detection to ensure road safety and support autonomous driving technology.

Proposed Solution

This project aims to develop an AI-based road sign detection system using advanced deep learning algorithms to identify and classify road signs across various environments. The system will be designed for high accuracy, adaptability, and real-time performance, making it valuable for autonomous vehicles, driver-assistance systems, and traffic monitoring.

A Convolutional Neural Network (CNN) will be used for detection and classification, leveraging CNNs' strengths in image feature extraction and classification.

Dataset Description

The dataset includes diverse road sign images organized into classes like stop signs, yield signs, and speed limits. Each image serves as a feature, with labels indicating the sign type. The dataset, which consists of varied resolutions and formats, will be enhanced with subtle, altered images to assess the impact of data poisoning on model training.

Tools & Technologies

To implement this project, we will use Python as the primary programming language, supported by several key libraries. TensorFlow and Keras will be employed for building and training the AI model, providing powerful tools for deep learning and neural networks. OpenCV will handle image processing tasks, allowing the model to interpret and preprocess road sign images effectively. To evaluate model performance, scikit-learn will be used for calculating metrics such as accuracy, precision, and recall. Development will take place in Google Colab, a cloud-based platform that enables interactive coding, collaboration, and documentation, providing an ideal environment for iterative model development and testing.

Expected Output

The expected output of this project is a trained AI model that can accurately classify road signs in real-time, even under varied conditions such as different lighting, weather, and partial occlusions. The model's effectiveness will be measured using key performance metrics, including accuracy, precision, and recall. Accuracy will indicate the model's overall correctness in identifying road signs, while precision will measure how well the model distinguishes relevant road signs from non-relevant ones. Recall will assess the model's ability to detect all instances of each road sign type, which is crucial for safety in autonomous driving applications.

In addition to these metrics, the model's adaptability and responsiveness in real-world conditions will also be assessed. Testing will include challenging scenarios that simulate real traffic environments, such as urban and rural roads, various weather patterns, and instances of sign degradation. By meeting these standards, the model will support safer and more efficient autonomous navigation and driver-assistance systems, contributing to a more reliable and scalable solution for road sign recognition across different settings.

References

Mvd, A. (2020). *Road sign detection* [Data set]. Kaggle.

https://www.kaggle.com/datasets/andrewmvd/road-sign-detection