Traffic Sign Detection and Recognition for Next-Generation Advanced Driver Assistance Systems for Smart Transportation

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Traffic sign detection and recognition have garnered significant interest due to advancements in autonomous vehicles, intelligent and advanced driver assistance systems, and smart transportation. These systems rely heavily on accurate detection and interpretation of traffic signs to ensure safe and efficient navigation. Research findings indicate that a significant proportion of accidents caused by human errors are due to non-compliance with traffic signs. To mitigate this issue, a robust system capable of accurately recognizing the road environment and detecting traffic signs has been proposed. In this study, 11 traffic and road signs were identified as the most critical based on their impact on driving safety and regulation compliance. An AI-based model capable of identifying these traffic sign classes was developed using the YOLOv8 platform. The model was trained using a dataset comprising 2200 images, and manually annotated to ensure accuracy. Preprocessing steps included resizing, normalization, and data augmentation techniques such as rotation, scaling, and brightness adjustment to increase robustness. The training process involved 10 epochs with a batch size of 1. The model achieved an accuracy of 95% and higher in the detection and classification of all traffic sign categories. Furthermore, the model's performance metrics were evaluated, with an error in class prediction recorded at 0.95, bounding box error calculation of 0.39, and mAP50 of 0.99. The evaluation employed a cross-validation technique with an 80-10-10 train-validation-test split. For implementation, the model was deployed on a Jetson AGX Xavier GPU, which enabled specific optimizations, such as CUDA integration and parallel computations, to achieve real-time detection and recognition, making the system highly suitable for integration into autonomous vehicles and advanced driver assistance systems. Through these advancements, the proposed system represents a significant step forward in traffic sign detection and recognition technology, promising to enhance road safety in smart transportation systems.

Keywords: Deep Learning, Parallel Programming, YOLOv8, Jetson AGX Xavier, Traffic sign detection

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