Computer Vision Based Helmet Traffic Violation, Detection and Person Identification in Smart Cities.

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Introduction:

In today's rapidly evolving urban landscape, ensuring road safety is a global concern, particularly with the emergence of smart cities. Our project seeks to address this challenge by harnessing cutting-edge technologies like computer vision and machine learning. We focus on enhancing road safety in both metropolitan and non-metropolitan areas by targeting helmet violations among riders, a critical factor in reducing head injuries during accidents. Additionally, efficient traffic management is essential for mitigating congestion andimproving overall transportation efficiency.

By seamlessly integrating our solution with existing surveillance infrastructure at traffic signals, we aim to streamline the detection of helmet violations and individual identification in urban traffic scenarios. This integration not only minimizes the need for manual intervention but also enables real-time monitoring and enforcement of traffic regulations. Through advanced techniques such as the YOLOv8 model enriched with machine learning algorithms, our system achieves precise detection of helmet-wearing individuals, facilitating swift identification of violations as vehicles approach intersections. Moreover, the inclusion of person identification functionality strengthens law enforcement efforts and enhances security measures withinurban environments.

Objectives:

- Creation of real time traffic dataset of 2-wheeler riders containing bothhelmet and non-helmet riders.
- Development of an efficient AI algorithm to detect helmet violationdetection.

- Implementing the algorithm for real time traffic violation detection onedge computing devices like NVIDIA jetson AI embedded hardware(Industry End Objective)
- Testing and validation of the system to improve the performance.

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Methodology:

Data Sources: Real time data collection and Synthetic data generation Language used: Python.
Method Used: Vehicle Detection, Rider Localisation, Helmet Detection, Number plate Localisation, Number Plate Detection.
Software used: LabelImg, PyCharm, Google Collab.

Data collection

We collected 1500 images in various urban environments in Belagavi city to representreal-world helmet usage scenarios.
These environments included:

- Streets
- Intersections
- Traffic lights

The aim was to capture data under a wide range of conditions, fostering a model that can adapt to real world complexities.

A two-stage deep learning architecture for helmet detection in real-world traffic environments. This approach deviates from a single, monolithic model by employing separate modules for distinct detection tasks. This section delves into the rationale behind this design choice and its benefits.
Two-Stage Solution:

To address these challenges and enhance overall detection performance, we propose atwo-stage deep learning architecture:

Stage 1: Rider Localization Module (Module 1)

- **Focus:** Module 1 concentrates on a specific task - detecting and isolating two- wheeler riders from other vehicles within the traffic scene.

- **Training Data:** This stage utilizes a dataset specifically curated to contain various two-wheeler riders in diverse traffic scenarios. The focus here is on training the modelto recognize and create bounding boxes around riders.

- **Output:** Following successful training, Module 1 outputs the identified rider regions as cropped images or bounding box coordinates. This information serves as the input for the subsequent stage.

Stage 2: Helmet and Number Plate Localisation and Detection (Module 2)

• **Focus:** Module 2 leverages the output from Stage 1 (rider regions) to perform moretargeted detection tasks:

- Identifying and classifying helmets within the rider region.
- Distinguishing riders without helmets.
- Detecting Number plate

• **Training Data:** Module 2 utilizes a separate dataset focusing on rider regions. This dataset is labelled using the Stage 2 labelling strategy, providing information about helmets, "no helmet" cases, and Number plate.

Conclusion:

Overall, the innovation lies in the strategic use of a two-stage deep learning architecture that leverages targeted training and potentially improves detection accuracy and efficiency compared to a single-stage approach.

Scope for future work:

YOLOv8's lightweight design, efficient architecture, and balance between speed and accuracy make it a strong choice for object detection tasks on Nvidia Edge AI devices like the Jetson Nano/Orin. This combination can facilitate real-time helmet detection and potentially pave the way for future advancements in our project.

For deployment, optimizing the model for real-time processing with minimal latency on edge computing devices like NVIDIA Jetson Nano is crucial. Developing an API (Application Programming Interface) would allow for seamless integration with existing traffic management platforms.