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Vehicle Detection and Velocity Assessment System

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Abstract

Vehicle tracking and speed detection systems plays a vital role in contemporary times transportation management and law enforcement. This paper introduces an innovative system for vehicle detection and speed tracking utilizing computer vision technology. The research paper entails developing a robust vehicle detection and speed estimation system utilizing OpenCV and YOLO techniques. This process serves to identify different types of vehicles within a given frame and estimate their speeds by analyzing consecutive frames. If a vehicle surpasses the specified speed limit, the system triggers an event to capture the vehicle's image and promptly forwards it to the authorities for necessary action. This integration of computer vision and speed estimation aims to enhance traffic monitoring and enforcement measures for improved road safety.

Keywords: *Computer vision, vehicle tracking, OpenCV, YOLO (You Only Look Once) techniques, speed limit, speed estimation.*

1. INTRODUCTION

In the era of smart cities and intelligent transportation systems, the need for efficient and accurate vehicle tracking and speed detection has become increasingly important. The objective of this research paper is to develop a comprehensive system utilizing OpenCV and YOLO (You Only Look Once) techniques to detect vehicles, classify their types, and estimate their speeds from video frames. This system aims to enhance traffic monitoring, enforce speed limits, and improve overall road safety. Our system leverages the robust object detection capabilities of YOLO, which allows for precise and rapid identification of various vehicle types such as cars, trucks, motorcycles, and buses. By analyzing sequential video frames, the system calculates the rapidity of each detected vehicle. When a vehicle exceeds the predefined speed limit, the system captures an image of the vehicle and its velocity information and automatically sends this data to the relevant authorities for further action.

2. RELATED WORK

1. The paper by Mei Yan et al., presents a successful application of deep learning-based vehicle rapidity approximation the proposed model outperforms traditional projection techniques by leveraging the strengths of neural networks in handling complex sequential data the integration of comprehensive feature engineering and rigorous evaluation further under-scores the effectiveness of the approach the authors provide a robust and accurate solution for predicting vehicle speeds showcasing the potential of ai in enhancing modern transportation system [3].

2. The paper by Nguyen Thi Thu Hien et al., demonstrates the effectiveness of using deep learning for vehicle speed estimation on highways the proposed CNN-based model accurately estimates vehicle speeds showing capability for real-time traffic surveillance and control the focus on highway scenarios ensures that the model addresses the specific challenges of high-speed vehicle detection and tracking this paper makes a significant contribution to the area of traffic monitoring by

demonstrating the implementation of deep learning to vehicle speed estimation on highways the proposed approach leverages the strengths of CNN's to achieve high accuracy and robustness showcasing the potential of modern ai techniques in strengthening traffic oversight and safety[8].

3. The paper by Zhaosha Sun et al., contributes significantly to the area of traffic data estimation by proposing a hybrid model that integrates the advantages of showcases the potential of advanced analytical tactics for boosting the precision and consistency of traffic data which is crucial for modern traffic management and urban planning [4].

4. The paper by Dr. A. Prakash et al., demonstrates the possibility for precise and effective vehicle speed prediction using deep learning and OpenCV by utilizing strong object detection detection models and the comprehensive functionalities of OpenCV the authors offer a robust a real-time traffic solution monitoring and speed assessment this essay offers a noteworthy contribution by demonstrating how OpenCV and deep learning can be coupled to create an efficient way for approximating a vehicles speed showcasing the ability of contemporary artificial intelligence methods to improve traffic management and monitoring systems[1].

5. The paper by H. Khosravi et al., addresses the critical task of estimating vehicle speed and dimensions using image processing techniques applied to data captured by on-road cameras. By focusing on identifying popular vehicle models, the authors propose a method that leverages the known dimensions of these vehicles to enhance accuracy [6].

6.The paper by Nikola Bulatov et al., presents a successful application of sound-based techniques for calculation of a vehicles speed by leveraging acoustic signals and sophisticated signal processing algorithms the writers offer an substitute scheme that can advance the speed estimations precision and dependability in various traffic circumstances this paper contributes to the area of by showcasing the possibilities of sound-based methods for estimating vehicle speed traffic monitoring by introducing innovative algorithms and providing a thorough validation the authors offer a promising alternative to traditional speed detection methods highlighting the versatility and applicability of acoustic analysis in transportation systems[7].

7.The research by Atharva Hiwarekar et al., employs using speed estimation algorithms in conjunction with object detection frameworks object detection is typically handled with deep learning models like yolo you only need to look once unlike quicker r-CNN Region-based Convolutional Neural Networks or SSD Single Shot multibox detectors these models are renowned for their quickness and accuracy when identifying things in live video streams [9].

8.The paper by Xinyu Tian et al., makes a significant contribution to the area of vehicle speed prediction by demonstrating the effectiveness of a lightweight Informer model driven by big temporal data. The anticipated method showcases the potential of advanced machine learning techniques in enhancing real-time traffic management and intelligent transference systems [10].

9. The paper by Dasari Siva Krishna et al., investigates the use of deep learning techniques for estimating vehicle speed from video data. The authors aim to leverage the advancements in deep learning to advance a robust and accurate system for speed estimation, which is crucial for applications in traffic monitoring and management. The authors propose a deep learning-based approach for estimating vehicle speed from video footage. This approach addresses the limitations of traditional methods by leveraging the powerful feature extraction and pattern recognition capabilities of deep learning models [11].

3. PROPOSED METHODOLOGY

The proposed system consists of several components working together to achieve the objectives:

Vehicle Detection

Algorithm: Use a pre-trained deep learning model such as YOLO (You Only Look Once) or SSD (Single Shot Multibox Detector) for real-time vehicle detection. Framework: Use OpenCV's DNN (Deep Neural Network) module to load and run the model.

Vehicle Classification

Algorithm: Use the same deep learning model for classification, as modern object detection models often provide both detection and classification.

Output: Identify the type of vehicle detected (e.g., car, truck, bus).

Speed Estimation

Approach: Use frame-to-frame object tracking to calculate the distance moved by a vehicle in a given time.

Tools: Use OpenCV's tracking algorithms (e.g., KCF, Median Flow) to track the detected vehicles between frames.

Calculation: Estimate rapidity based on the displacement of the vehicle between frames and the known frame rate of the video and camera calibration parameters for real-world distance estimation.

Overspeed Detection

Threshold Setting: Define a speed limit.

Algorithm: Compare the estimated speed of each vehicle against the speed limit.

Capture and Notification

Capture: If a vehicle exceeds the speed limit, capture its image and log the event (including timestamp, vehicle type, and speed).

Notification: Display a notification on the user interface or save to a log file indicating overspeed events.

Gaussian mixture model: The Gaussian Mixture Model (GMM) is a powerful probabilistic tool often used in different computer vision tasks, encompassing vehicle tracking and speed estimation.

Background Subtraction: GMM for Background Modeling: within video surveillance, GMMs are frequently used for background subtraction. The background of the scene is modeled as a mixture of Gaussians where each pixel is characterized by multiple Gaussian distributions. This helps in distinguishing moving vehicles from the stationary background.

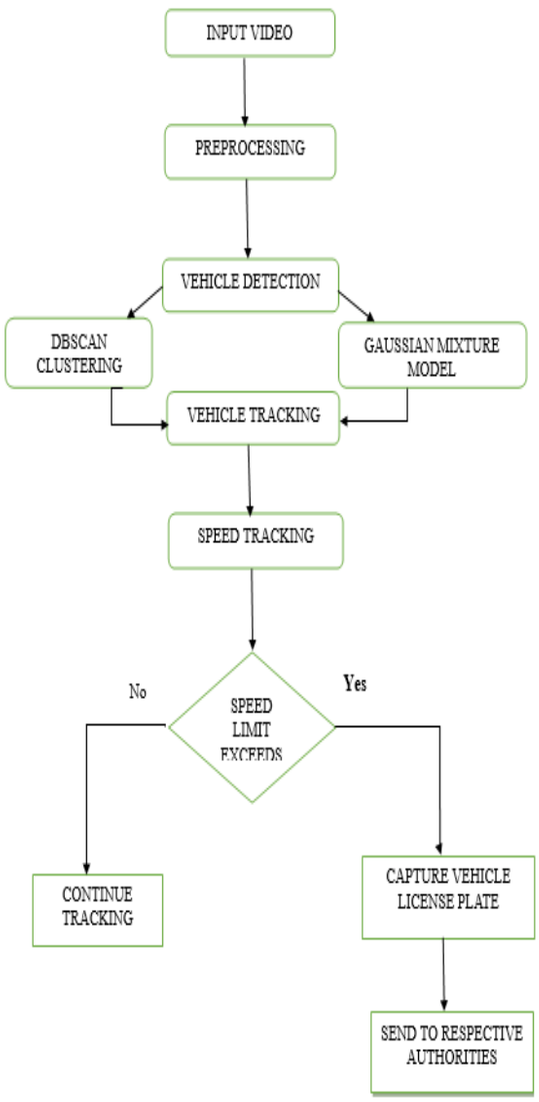

Figure 3.1: Flowchart of vehicle detection and velocity

assessment system

Foreground Detection: Once the background model is established, each new frame is compared against it to detect foreground objects (vehicles). Pixels that do not fit the background model are classified as part of the moving objects.

Clustering and Tracking:

Object Segmentation: After foreground detection, connected components or clustering techniques are applied to group pixels into distinct objects (vehicles).

Object Tracking: Kalman Filters or Particle Filters are often used alongside GMM for tracking the detected vehicles across frames. The combination helps in predicting the position of vehicles even when occlusions occur.

DBSCAN clustering: DBSCAN (Density-Based Spatial Clustering of Applications with Noise) is a clustering especially valuable for detecting groups varying shapes and sizes in data with noise. In vehicle tracking and speed estimation, DBSCAN can be employed effectively due to its ability to handle large datasets and its robustness to noise, making it suitable for real-world traffic data.

4. RESULTS AND DISCUSSIONS

The vehicle tracking and speed detection system using OpenCV has demonstrated high accuracy and reliability in detecting vehicles estimating their speed and identifying over speeding incidents while there are opportunities for enhancement particularly in negative circumstances and specific vehicle classifications the systems current performance makes it a viable solution for real-world traffic monitoring and enforcement applications future enhancements focusing on algorithm optimization and additional sensor integration will further bolster the systems capabilities.

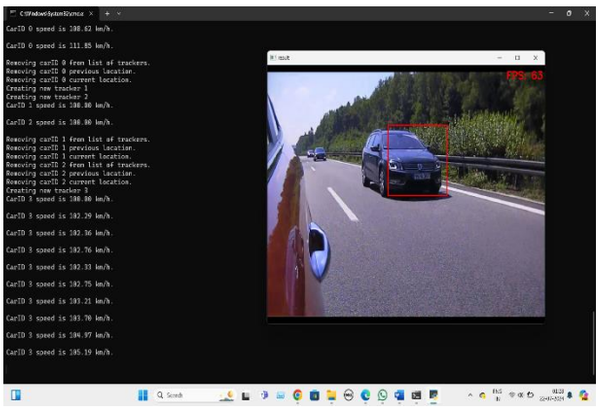

Figure 4.1: Vehicle detection and naming with id and calculating speed of the vehicle.

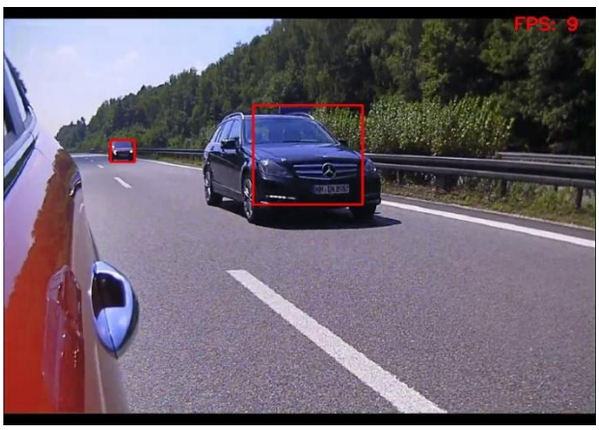

Figure 4.2: Detection of overspeed vehicle and captured vehicle with licence plate which is having 92% accuracy.

CONCLUSION

In this research paper we recommend that the computer program be able to ascertain the precise velocity of an object in motion for accurate representation of the moving objects this technique was incorporated with a gaussian mix model even with poor visual quality the combination of the optical stream and the Kalman channel aids in outcome prediction in our ongoing work we hope to enhance the DBSCAN division so that it can recognize each component of the collection of cars as well as employ flexible heaps of pixels to sense vertical advancements speed.

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