



A NOVEL APPROACH IN REAL TIME VEHICLE DETECTION AND TRACKING USING RASPBERRY -PI

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Abstract : Real-time vehicle recognition, tracking, and counting are of tremendous interest to researchers and are required by society at large for convenient, easy, and secure vehicle movements in cities. We suggest a vehicle count detection, tracking, and discovery technique for video image processing. We convert the RGB video frame into the HSV colour space, which makes it easier to distinguish the colours of the automobiles. Each frame is cleaned of noise. Vehicle detection is solely based on color-related characteristics of the vehicles. Kalman filter is used for vehicle tracking together with data association. It is decided how many cars are running in a certain lane or in a movie. We suggest an innovative approach to identifying, following, and counting the vehicles on a road. OpenCV has been used to implement it on the Raspberry Pi 3. The suggested methodology outperforms the rear-view vehicle recognition and tracking method (Bin et al., 2014) and the morphological operation method (Zezhong et al., 2013) in terms of vehicle detection accuracy and cost, according to our comparison of their respective results.

IndexTerms - Motion Analysis ,Moving vehicle detection,Tracking ,Raspberry pi and urban environment

I. INTRODUCTION

Video processing systems use high performance computers and application-oriented circuits in the most modern technologies. It is because processing such a large amount of data in real time is hard and requires a lot of resources. It is necessary to continuously monitor the traffic area to minimise congestion since there are more vehicles on the road, but there is also a rapid increase in the number of vehicles on the same amount of space. Analysing surveillance footage and knowing the number of vehicles on the road are both very useful for traffic management systems. Many different methods have been suggested to locate and follow the automobiles on desktop PCs. The research's authors [1] utilise a specialist traffic surveillance camera to recognise cars by their licence plate and back lamp. The device uses a stationary camera to capture traffic video. They separate individual video frames from the sequences and edit each frame separately. Different methods are being investigated for detecting the licence plate and rear lamp. A Markov Random Field is then utilised to mix the parts and replicate the relationship after the vehicle parts have been localised. Later Kalman filters are used to track the cars for improved results.

II. RELATED WORKS

Literature Review

[1]. "A Comprehensive Survey of Vehicle Detection and Tracking Techniques" This literature review provides a comprehensive overview of various vehicle detection and tracking techniques. It covers both classical and deep learning-based approaches, discussing their strengths, limitations, and performance evaluation metrics. The survey emphasizes the importance of accurate and efficient vehicle detection and tracking for applications in intelligent transportation systems. It also highlights recent advancements in the field, such as the integration of multiple sensors and the use of convolutional neural networks for improved accuracy. The review concludes by discussing challenges faced in real-world scenarios, including occlusion, lighting conditions, and complex traffic environments, and suggests potential directions for future research.

[2]. "Recent Advances in Vehicle Detection and Tracking: A Survey" This literature review focuses on recent advances in vehicle detection and tracking. It provides a comprehensive analysis of various algorithms and methods employed in the field, including feature-based approaches, machine learning techniques, and sensor fusion. The survey discusses the impact of factors like occlusion, illumination, and environmental conditions on detection and tracking performance. It highlights the progress made in real-time vehicle tracking systems and explores emerging trends such as the use of deep learning models for robust detection. The review also discusses challenges related to scalability, computational efficiency, and the need for accurate motion estimation.

[3]. "A Survey on Real-time Vehicle Detection and Tracking Systems" This literature review focuses on real-time vehicle detection and tracking systems. It examines the state-of-the-art methods, hardware platforms, and optimization techniques used to achieve real-time performance. The survey explores different approaches, such as background subtraction, feature-based methods, and deep learning models, along with their respective advantages and limitations. It discusses challenges related to computational efficiency,

robustness, and scalability in real-world scenarios. The review also highlights the importance of hardware acceleration, parallel processing, and algorithm optimization to achieve real-time performance in resource-constrained environments.

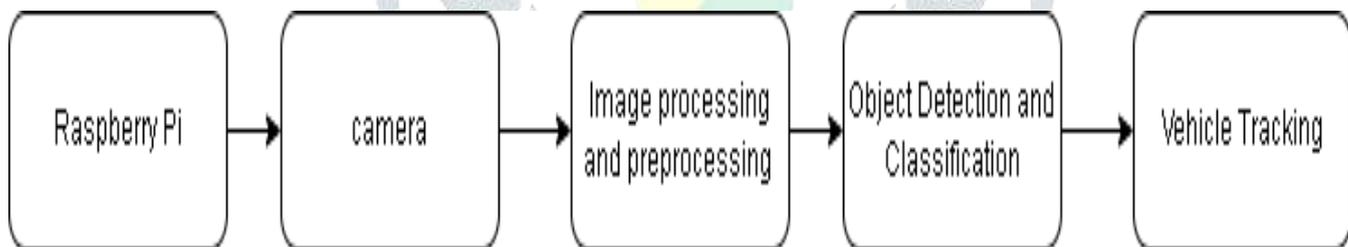
[4]. "A Comparative Study of Vehicle Detection and Tracking Algorithms" This literature review presents a comparative study of various vehicle detection and tracking algorithms. It analyzes the strengths, weaknesses, and computational requirements of different approaches, including template matching, Viola-Jones, and deep learning-based methods. The survey evaluates the performance trade-offs and practical considerations in selecting suitable algorithms for different scenarios. It discusses the challenges associated with varying environmental conditions, object occlusion, and complex traffic scenarios. The review also explores the impact of dataset selection, feature extraction, and training strategies on algorithm performance. It concludes by providing insights into the current state of the field and suggesting future research directions.

III. MATERIALS AND METHODS

The proposed Menties report generating system is designed to provide a comprehensive platform for faculty, coordinators, and students to manage and view information related to mentoring, news updates, and placement details. The proposed system aims to develop a real-time vehicle detection and tracking system using Raspberry Pi. It will leverage computer vision algorithms and machine learning techniques for accurate detection and tracking of vehicles. The hardware setup will include a Raspberry Pi board and a compatible camera module. Software implementation will utilize computer vision libraries like OpenCV for vehicle detection and tracking algorithms. Optimizations such as model quantization and hardware acceleration will be applied to achieve real-time performance. The system will feature a user-friendly interface for configuration and monitoring, allowing users to adjust parameters and visualize detected vehicles. Extensive testing will be conducted to evaluate performance under different conditions. Privacy and security considerations will be addressed to protect sensitive data. The system will be designed for easy deployment and scalability, supporting multiple cameras for monitoring larger areas. Overall, the proposed system aims to provide an affordable, compact, and energy-efficient solution for enhanced traffic management and improved safety.

System Architecture

The system architecture for vehicle detection and tracking using Raspberry Pi typically involves several components working together. At the core, there is the Raspberry Pi board, serving as the central processing unit. The system requires a camera module to capture video frames for analysis. The captured frames are then processed by a vehicle detection algorithm, such as a deep learning-based model, which identifies potential vehicles in the scene. Once the vehicles are detected, a tracking algorithm is employed to track their movement across consecutive frames. The tracking algorithm may utilize techniques like Kalman filtering or optical flow to estimate the vehicle's position and motion. The tracked vehicles are then annotated with bounding boxes for visualization and further analysis. The system may also include post-processing modules for tasks like vehicle classification or counting. The output of the system can be displayed on a monitor or transmitted to a remote device for monitoring or analysis. Communication protocols like Wi-Fi or Ethernet can facilitate data transfer. The entire system architecture is designed to leverage the computational capabilities of the Raspberry Pi while ensuring real-time or near real-time performance for efficient vehicle detection and tracking.



MODULES

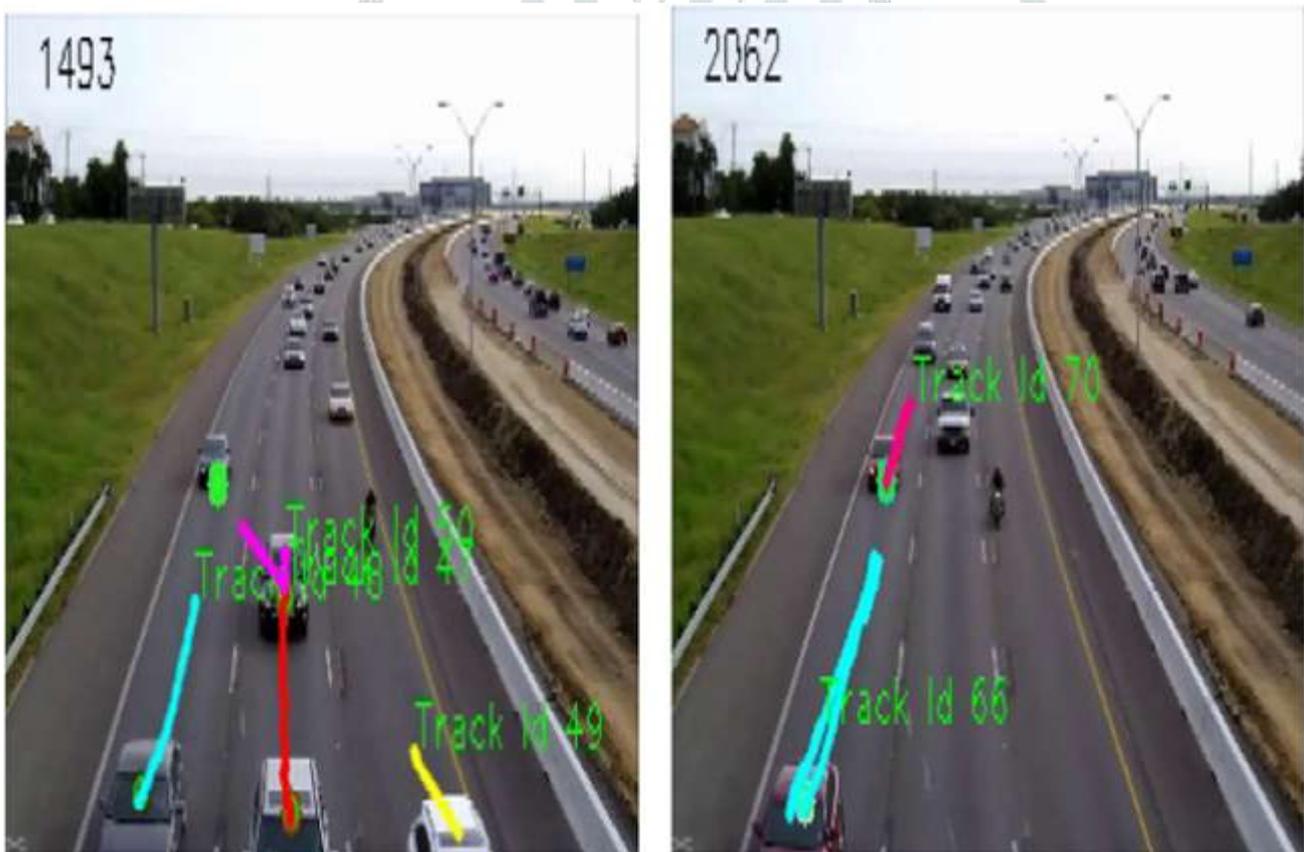
Raspberry pi with pi camera: The Raspberry Pi is a diminutive credit card-sized computer featuring an ARMv8 quad-core CPU running at 1.2 GHz, 1 GB of RAM, and a 16 GB (expandable to 128 GB) hard drive. The operating system known as "Raspbian Jessie" requires around 6 GB of hard disc capacity to install. It can multi-program and aids users in discovering a variety of things. It is capable of exchanging information with other auxiliary devices including sensors, motors, and LEDs. The Raspberry Pi has Wireless Lan 802.11n. A USB or Pi camera can be attached to a Raspberry Pi. In the suggested setup, a dedicated camera and a Raspberry Pi are utilised to explore and benefit from each device's capabilities in analysing traffic flow. The Raspberry Pi has an operating system dubbed "NOOBS - New Out Of Box Software" loaded. In addition to picture capture, the Pi Camera supports 1080p30, 720p60, and VGA90 video modes. The Raspberry Pi has a Camera Serial Interface (CSI) port that can be used to attach the Pi camera.

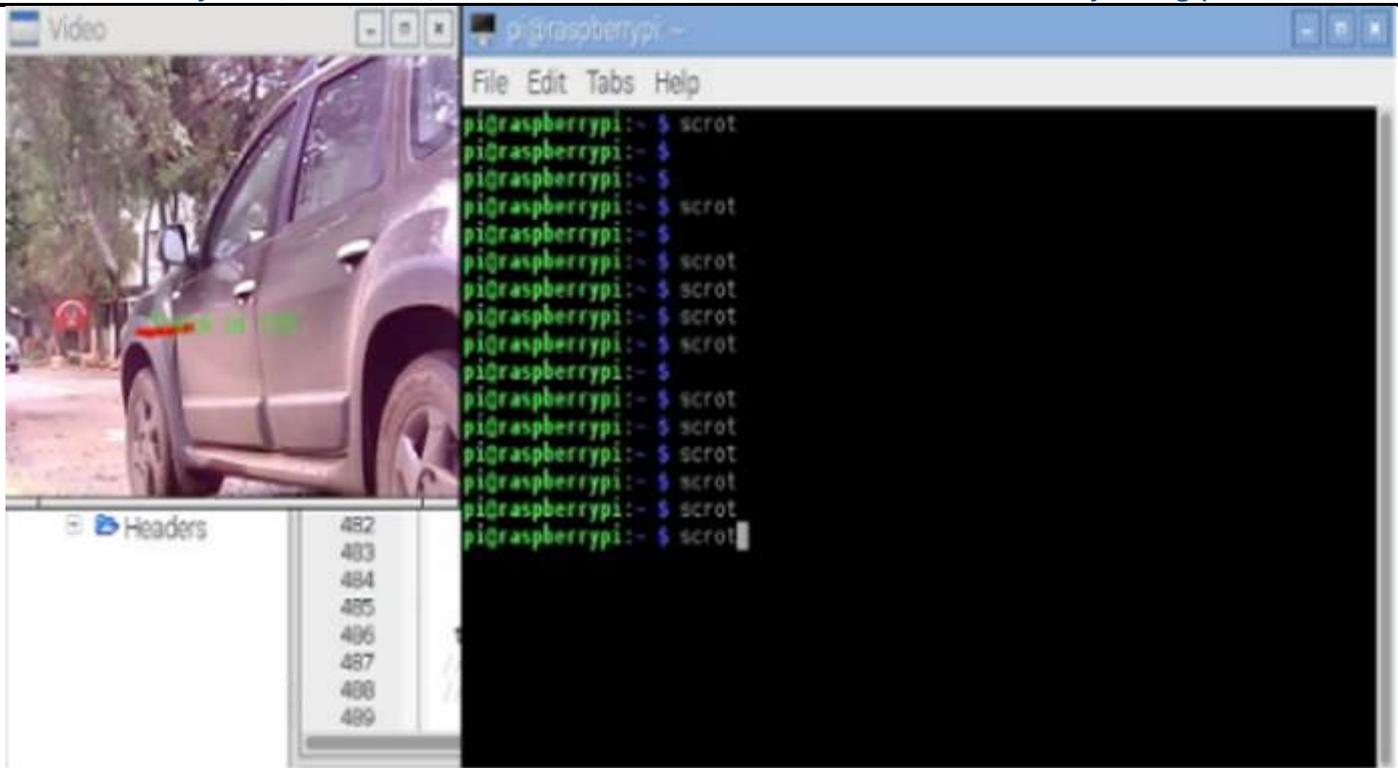
Conversion and Filtering : when a video is recorded using a USB camera or the Pi camera in the RGB colour space at the specified frame rate. We convert RGB format to HSV in order to more precisely segment the colours of the automobile. Due to its vast range of colour space and ease of differentiation, HSV colour space is highly suited for segmenting the absolute colours of automobiles. Hue (colour) is defined by H, saturation (colour intensity) by S, and luminosity (lightness) by V [8]. The HSV format image is converted, then it is divided into three channels and processed. The results of each channel of the HSV format are in binary, and an OR operation is carried out on these channels to obtain the final resultant image. Vehicle colours are segmented, and each channel is handled separately.

Convex Hull: The coordinator can upload the latest news or updates by clicking the "News" button, which displays the "News Form". Using the defined facial feature collection offered as implementations, which allows the user to alter the size and we may change the position according to the description provided by the eye-witness, an accurate face sketch can be made in this application. The CNN Algorithm will understand, it will try to suggest the facial characteristic, and it will assist in much better completing the face sketch creation. It is extremely effective at providing tips. With the algorithm, accuracy is increased. The mathematical technique of image reconstruction in CT produces tomographic images from X-ray projection data collected from numerous angles all around the subject. The fundamental effects of image reconstruction on picture quality and, consequently, radiation dose. Suspects' fingerprints are checked in a database as well.

Kalman Filter : In the Kalman filter, there are two steps: prediction and measurement. The measurement state assesses the expected estimate and changes the equation in accordance with the prediction step's estimation of the present state. The recursive algorithm supports real-time data [16]. The CNN Algorithm will understand, it will try to suggest the facial characteristic, and it will assist in much better completing the face sketch creation. It is extremely effective at providing tips. With the algorithm, accuracy is increased. The mathematical technique of image reconstruction in CT produces tomographic images from X-ray projection data collected from numerous angles all around the subject. It can multi-program and aids users in discovering a variety of things. It is capable of exchanging information with other auxiliary devices including sensors, motors, and LEDs. The Raspberry Pi has Wireless Lan 802.11n. A USB or Pi camera can be attached to a Raspberry Pi. In the suggested system, a Raspberry Pi camera and a USB camera are utilised to investigate and take use of the Raspberry Pi and specialised camera's benefits in analysing traffic flow for the patient. It can multi-program and aids users in discovering a variety of things.

IV. SAMPLE OUTPUT





EVALUATION METRICS

Evaluation metrics play a crucial role in assessing the performance of vehicle detection and tracking algorithms on a Raspberry Pi. Intersection over Union (IoU) measures the accuracy of bounding box predictions by calculating the overlap between predicted and ground truth boxes. Precision and recall provide insights into the algorithm's ability to correctly identify and track vehicles. Average Precision (AP) quantifies the precision-recall trade-off across different confidence thresholds. Mean Average Precision (mAP) calculates the average AP across multiple object classes. Frame accuracy determines the accuracy of detection and tracking at the frame level. Tracking precision and recall assess the accuracy and consistency of object tracking over time. Frames per Second (FPS) measures the algorithm's speed in processing video frames on the Raspberry Pi. Finally, computational cost evaluates the resource utilization, including CPU and memory usage, required to run the detection and tracking algorithms on the Raspberry Pi platform.

V. CONCLUSION

Real-time vehicle recognition, tracking, and counting are done using a Raspberry Pi and USB camera setup. Real-time calculations are made on the vehicle density on the specific road. When compared to the rear-view vehicle detection and tracking method [1] and the morphological operation approach, the results of the suggested method perform better in terms of accuracy and processing time. We are able to communicate with other distant computers using the Raspberry Pi system's static IP address. When compared to the morphological operation approach and the rear view vehicle identification and tracking method, the performance of the suggested system is determined to be superior by 6% to 8%. It has been observed that the proposed system is considerably less expensive than the current systems. The system's tracking and vehicle detection are accurate. The suggested solution replaced current methods and simply took into account the vehicle's colour attributes. Real-time calculations are made of the number of vehicles shown in the video. According to related studies in this sector, a very good rate is defined as an average accuracy of more than 90% with a confidence level of 100% when tested with diverse test cases, test scenarios, and data sets. By being unique among the similar studies and technologies that have been suggested in this field, we can increase the overall security and accuracy.

VI. FUTURE SCOPE

Future developments in the realm of vehicle detection and tracking are very possible. Researchers can concentrate on improving current algorithms or creating brand-new approaches that can deal with difficult situations like occlusion, dim lighting, and complex traffic scenes in order to further increase accuracy. Real-time performance is still a crucial need, thus hardware platforms and algorithms must be optimised for quick processing and low latency. Future research can focus on creating reliable algorithms to follow numerous vehicles at once, especially in congested and chaotic traffic circumstances. Multi-object tracking provides additional issue. Through the use of sensor fusion techniques, the robustness and dependability of a system can be improved by integrating various sensors like cameras, LiDAR, radar, and GPS. promise for real-time analytics, distributed processing, and smooth vehicle-to-infrastructure communication. Furthermore, edge computing and IoT infrastructure integration with vehicle detection and tracking systems offers promise for dispersed processing, real-time analytics, and seamless communication between vehicles and infrastructure. To accurately compare and evaluate system performance, standardised benchmark datasets and assessment metrics must be created. Future research will also need to address issues of data security, privacy protection, and responsible use of gathered data, and these issues will be of utmost importance. In general, real-time performance, multi-object tracking, sensor fusion, edge computing integration, benchmark datasets, and ethical considerations are what will shape the future of vehicle detection and tracking.

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