e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:06/Issue:06/June-2024 Impact Factor- 7.868 www.irjmets.com

ROAD VEHICLE SPEED DETECTION SYSTEM

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ABSTRACT

Detecting the speed of vehicles is an important aspect for observing speed limitation law and traffic condition. This paper gives review on speed detection of vehicle using image processing. Given a sequence of real-time video of traffic images, different approaches like edge extraction, object tracking, motion vector technique, absolute difference, centroid method, background image subtraction are useful in detection of vehicles speed.

Keywords: Gray Thresh, Erosion, Dilation, Gray Scale.

I. INTRODUCTION

Image processing has been widely applied to traffic analysis for a variety of purposes. As traffic research field is very wide and it has many goals that include detection of queue, detection of incident, classification of vehicles, and counting vehicles. One of the most important of these purposes is to estimate the speed of a vehicle, a vehicle. Traffic congestion poses lot of problems for people. Because of this, many accidents occur. To reduce this problem, new approach has been developed for estimating the speed of vehicle. A radar technology was used to determine the speed on highways. But it has a disadvantage of high cost. Then a lidar detector was designed to detect the infrared emissions of law enforcement agencies lidar speed detection devices and warn motorists that their speed is being measured. Its disadvantage is it has to be held or placed at a static point. These drawbacks of speed detection techniques motivated to develop new technique for that purpose. Vehicle detection using image processing is a cutting-edge technology that enables automatic identification and tracking of vehicles in images or videos. This sophisticated system utilizes various techniques from the field of computer vision and image processing to detect, classify, and sometimes even recognize vehicles from visual data.It refers to the utilization of computer vision techniques to identify and locate vehicles within images or video streams. This field has gained significant traction due to its applications in various domains such as traffic management, surveillance, autonomous driving, and smart transportation systems. Vehicle detection using image processing plays a crucial role in modern transportation systems, contributing to improved safety, efficiency, and overall traffic management. Continuous advancements in computer vision algorithms and hardware technology are driving further innovations in this field, enabling more sophisticated and reliable vehicle detection systems.

Each step in the vehicle detection process plays a critical role in achieving accurate and reliable results, contributing to the effectiveness of transportation systems and related applications. Continuous research and development in image processing techniques and detection algorithms further advance the capabilities of vehicle detection systems & effectively highlights the real-world applications of vehicle detection, demonstrating its relevance and importance in various domains such as transportation, surveillance, and autonomous driving. Thus provides a solid foundation for understanding vehicle detection using image processing, covering key concepts comprehensively while maintaining clarity and accessibility. The purpose of vehicle detection using image processing is to enhance transportation efficiency, safety, and security through the accurate and timely detection of vehicles in various environments. By leveraging advanced technologies and algorithms, these systems play a crucial role in modernizing transportation infrastructure and shaping the future By detecting vehicles in real-time, transportation authorities can gather data on traffic density, vehicle speeds, and congestion levels, security personnel can identify suspicious behavior, monitor vehicle movements, and respond promptly to security threats. Automated systems can detect vehicles running red lights, speeding, or violating other traffic laws, enabling law enforcement agencies to enforce compliance and improve road safety.

Problem statement: The aim of this project typically revolves around developing an efficient and accurate system capable of automatically identifying and localizing vehicles within images or video streams. The problem can be defined more specifically based on the application context and requirements. "Design and implement a vehicle detection system using image processing techniques to detect and localize vehicles in real-time from video feeds captured by roadside cameras for traffic monitoring and management purposes".The goal is to contribute to improved traffic management, enhanced safety, and efficiency in transportation systems.

Objective: The objective of vehicle detection using image processing is to develop systems and algorithms capable of automatically identifying and localizing vehicles within images or video streams.to develop advanced solutions that contribute to improved traffic management, enhanced safety, efficiency, and sustainability in transportation systems and its related applications.

II. LITERATURE SURVEY

In image processing morphological operations highly experimented in improving the appearance. To reduce the noise the MM is also applied it uses structuring element to probe the image and thereby useful information from the image can be obtained and noise can be reduced while preserving the features. This paper is on an experiment in which four morphological operations are working to reduce the noise from the gray scale image and thereby enhancing the quality of the images. In the literal, authors introduce the first step towards developing the Speed Detection Radar, where he explains a new approach in object detection technique, which is "adaptive background subtraction". Rad A. G. et al. developed a system in which they used video and image processing toolbox which calculates the speed of vehicle. It resulted in average error of speed +7km/h and -7km/h. various resolutions and different video sequences.

Shedbalkar K. et al. developed a speed estimation technique which was based on extended kalman filter for permanent magnet synchronous. System is developed in MATLAB in SIMULINK model Blockset. Leite A.V. et al. determined a way for estimation of speed in induction motor with sensor less control. Extended kalman filter was used as speed detection technique. This algorithm used reduce order state space model. Kassen N. et al. proposed a vehicle speed estimation technique which was reliable and strong. This helps the user with driving guide and lets him not to join the traffic jam. This approach is based on RF. This system gives accuracy of 100% for speed estimation and with accuracy of 90% in typical streets.

III. METHODOLOGY

Problem Definition: Clearly define the problem statement, including the objectives, scope, and target application of the vehicle detection system.

Specify the requirements and constraints, such as real-time processing, accuracy goals, environmental conditions, and hardware limitations.

Literature Review: Conduct a comprehensive literature review to understand existing approaches, techniques, and algorithms for vehicle detection using image processing.

Identify state-of-the-art methods, key challenges, and emerging trends in the field.

Data Collection and Preparation: Gather a diverse dataset of images or video sequences containing vehicles in various scenarios relevant to the target application. Annotate the dataset with ground truth labels indicating the location and attributes of vehicles for use in training and evaluation.

Preprocessing: Preprocess the acquired images or video frames to enhance quality and facilitate accurate detection.

Apply techniques such as resizing, noise reduction, contrast adjustment, and illumination normalization.

Feature Extraction: Extract relevant features from the preprocessed images that are indicative of vehicles.

Explore feature extraction techniques such as Histogram of Oriented Gradients (HOG), Haar cascades, or deep learning-based feature extraction using Convolutional Neural Networks (CNNs).

Model Selection and Training: Choose an appropriate detection model based on the requirements and characteristics of the problem. Train the selected model using the annotated dataset to learn to detect vehicles from images or video frames. Fine-tune the model and optimize hyperparameters to improve performance.

Detection Algorithm Implementation: Implement the selected detection algorithm using the chosen model architecture and feature extraction techniques. Develop algorithms for vehicle detection, including region

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proposal, classification, and post-processing steps.

Integration and System Development: Integrate the detection algorithm into a comprehensive vehicle detection system. Develop software modules for image/video input, preprocessing, feature extraction, detection, post-processing, and result visualization.

Evaluation and Validation: Evaluate the performance of the developed system using benchmark datasets and real-world scenarios. Measure metrics such as detection accuracy, processing speed, false positive rate, and robustness to variations in environmental conditions.

Optimization and Fine-tuning: Optimize the system for efficiency, scalability, and real-time performance. Fine-tune parameters, algorithms, and models based on feedback from evaluation results and user testing.

Deployment and Application: Deploy the vehicle detection system in the target environment or application domain.

Integrate the system into existing infrastructure or deploy it on appropriate hardware platforms.

Documentation and Maintenance: Document the system architecture, algorithms, implementation details, and evaluation results.

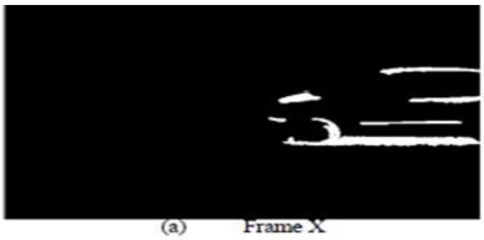
Provide user manuals, guides, and documentation for system operation and maintenance.

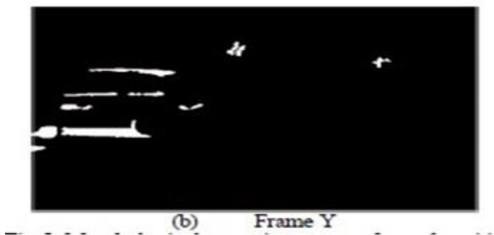
Establish a plan for system maintenance, updates, and future enhancements.

By following this methodology, one can systematically develop a robust and effective vehicle detection system using image processing techniques, contributing to various applications such as traffic management, surveillance, and autonomous driving.

Frame Differencing Operation: One frame is taken as the reference frame and then two different frames are taken to calculate the absolute difference between those two frames with the reference frame as shown in below figures.

(a)FrameX





(b)Frame Y

Fig 1: Result of Frame differencing being performed on (a) Frame X and (b) Frame Y with background frame.

Thresholding Operations: Image Thresholding is a method in which image is effectively partitioned into a foreground and background. This is one of the segmentation types which isolates objects by converting them

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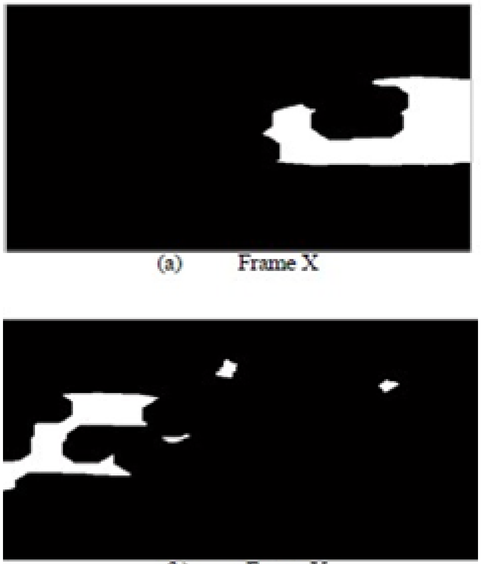
from grayscale images into binary images. It is converted into binary image because it easy to perform the motion operations on the binary image than the grayscale image.

Morphological Operations: This is performed to remove all the isolated points that are observed in the thresholding operations. After removing the isolated points image is left with some disconnected components. All these disconnected components are connected together than calculating centroid of all these disconnected component as in Fig. Then morphological closing is performed to connect the vehicle disconnected components together for Frame X and Frame Y as in Fig2.


(a) Frame X

(b) Frame Y

Fig 2:

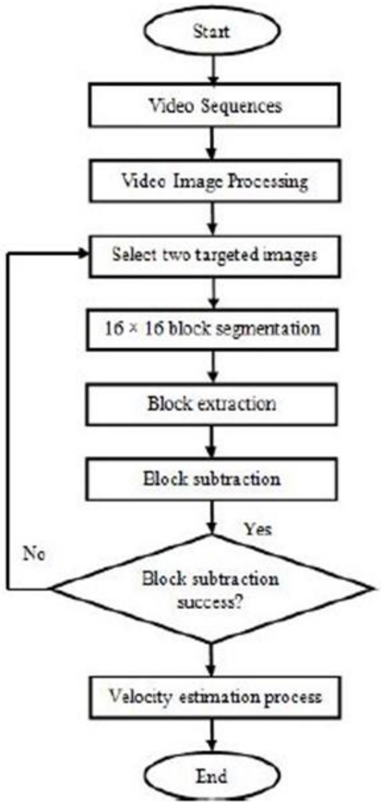


Fig 3: Shows the flowchart

Operation: Morphological closing is performed on (a) Frame X and (b) Frame Y to join the disconnected vehicle components together. The system begins by acquiring input data, which can be images or video streams captured by cameras positioned in the target area, such as roads, intersections, or parking lots. The input data is fed into the vehicle detection system for processing. Preprocessing steps are applied to the input data to enhance its quality and facilitate accurate detection. This may include resizing the images or video frames to a standard size, reducing noise, adjusting contrast, and normalizing lighting conditions. Relevant features are extracted from the preprocessed images or video frames that are indicative of vehicles. Post-processing techniques are applied to refine the detected vehicle regions and remove false positives.

Techniques such as non-maximum suppression, morphological operations, and Kalman filtering may be used to refine the detection results. The final output of the system is generated, which includes the detected vehicle regions overlaid on the input images or video frames.

IV. EXISTING SYSTEM

The existing systems on vehicle detection using image processing encompass a range of methodologies and technologies. Traditional methods often involve handcrafted features and algorithms. These include techniques like edge detection, Hough transforms for line and circle detection, and template matching. While these methods can be effective in certain scenarios, they may struggle with variations in lighting, occlusions, and complex backgrounds. Background subtraction is a common technique used to detect moving objects, including vehicles, in video streams. It involves creating a background model of a scene and then subtracting it from the current frame to identify foreground objects. Adaptive background subtraction methods are often employed to handle changes in illumination and scene dynamics. Feature-based detection methods extract salient features from images, such as corners, edges, or texture patterns, and use them to detect vehicles. Techniques like Histogram of Oriented Gradients (HOG) and Haar cascades are commonly used for feature-based detection. Many existing systems focus on real-time implementation, especially for applications such as traffic monitoring, surveillance, and autonomous driving. Efficient algorithms and hardware acceleration techniques are often used to achieve real-time performance on embedded platforms and specialized hardware.

V. PROPOSED SYSTEM

A proposed system for vehicle detection using image processing can leverage various techniques and methodologies to achieve accurate and efficient detection of vehicles in images or video streams. Here's an outline of a proposed system.

Image Acquisition: The system begins by acquiring images or video frames from cameras or other imaging devices positioned strategically to capture the target area, such as roads, intersections, or parking lots. Preprocess the acquired images to enhance quality and facilitate accurate detection. This may include resizing, noise reduction, contrast adjustment, and normalization of lighting conditions. Extract relevant features from the preprocessed images that are indicative of vehicles. Common features include edges, shapes, colors, texture patterns, and motion information.

Techniques such as Histogram of Oriented Gradients (HOG), Haar cascades, and deep learning-based feature extraction can be employed. Apply a detection algorithm to identify regions in the image that likely contain vehicles. This can include traditional machine learning algorithms or deep learning models.

Deep learning models such as YOLO (You Only Look Once), SSD (Single Shot MultiBox Detector), or Faster R-CNN are known for their accuracy and speed in vehicle detection tasks. Refine the detected vehicle regions using post-processing techniques to remove false positives and improve accuracy.

Techniques such as non-maximum suppression, morphological operations, and Kalman filtering can be used to refine the detection results. Integrate the vehicle detection system into applications such as traffic management, surveillance, autonomous driving, or smart transportation systems. Utilize the detected vehicle information for tasks such as traffic monitoring, vehicle counting, speed estimation, and intelligent driver assistance systems. Optimize the system for real-time performance to enable timely detection of vehicles in video streams. Utilize efficient algorithms, hardware acceleration techniques, and parallel processing to achieve real-time processing on embedded platforms or specialized hardware. Evaluate the performance of the proposed system using benchmark datasets and real-world scenarios. Measure metrics such as detection accuracy, processing speed, and robustness to variations in environmental conditions. Gather feedback from users and stakeholders to identify areas for improvement and potential enhancements.

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Iterate on the system design and implementation to address any shortcomings and optimize performance.

By following this proposed system outline, one can develop an effective vehicle detection system using image processing techniques, contributing to improved traffic management, enhanced safety, and efficiency in transportation systems and related applications. It proposed a real time to detect moving vehicles which violate the speed limit. It makes use of digital signal processing for estimating the speed of the moving vehicles. Partitioning the road into disjoin region: In order to reduce the computational cost, time and the problems occurred in measurement that are caused by multiple vehicles moving side by side or one after each other, the road area is partitioned into disjoint regions. The parts of the image that do not belong to any region are not considered in the calculations. Each region is processed separately to reduce the computational cost. Binary image generation: The speed measurement is performed in binary image in which each pixel is transformed into either "1" or "0" according to its motion information. To binarize the incoming input image and only detect the moving pixels, two different techniques are used: Inter-frame difference and Background subtraction. Tracking the moving object: The sequential approach to track the moving objects and to find the velocity of objects are as follow.

Segmentation: Process which separates multiple regions in image.

Feature Extraction: Process to analyze the regions in image .

Tracking: Used to analyzing the position, velocity and direction of moving object.

VI. RESULTS

Detected vehicles may be indicated by bounding boxes, labels, or other visual cues.The output containing the detected vehicles is displayed on a screen for real-time monitoring or stored for further analysis and processing.

Fig 4: Shows the speed estimation

VII. CONCLUSION

In this a review of existing methodologies for detecting vehicle speed. It likely discusses different algorithms, methodologies, and approaches utilized in the literature to measure the speed of vehicles accurately. This review helps in understanding the strengths and limitations of each technique, providing insights into the most effective approaches for vehicle speed detection. Edge Extraction: Utilizing edge detection algorithms to detect the edges of vehicles in consecutive frames and estimating their motion to calculate speed. Object Tracking: Tracking specific objects (vehicles) across frames and estimating their displacement over time to infer speed. Motion Vector Technique: Analyzing motion vectors between consecutive frames to estimate the speed of moving objects (vehicles). Absolute Method: Directly measuring the distance traveled by vehicles between two points and dividing it by the time taken. Centroid Method: Tracking the centroids (center points) of vehicles and analyzing their movement to determine speed. Background Image Subtraction: Comparing consecutive frames to detect changes in vehicle positions and using this information to calculate speed.

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