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Vehicle Detection and Tracking

Manish Kumar Yadav, Ashutosh Singh, Atharv More, Anand Bhingardive
Department of Computer Science
Smt. Kashibai Navale College of Engineering, Pune, India
Savitribai Phule Pune University, Pune, India

Abstract: *Abstract Speed detection of vehicle and its tracking plays an important role for safety of civilian lives, thus preventing many mishaps. This module plays a very significant role in the monitoring of traffic where efficient management and safety of citizens is the main concern. In this paper, we discuss about potential methods for detecting vehicle and its speed. Various research has already been conducted and various papers have also been published in this area. The proposed method consists of mainly three steps background subtraction, feature extraction and vehicle tracking. The speed is determined using distance travelled by vehicle over number of frames and frame rate. For vehicle detection, we use various techniques and algorithms like Background Subtraction Method, Feature Based Method, Frame Differencing and motion-based method, Gaussian mixture model and Blob Detection algorithm. Vehicle detection is a part of speed detection where, the vehicle is located using various algorithms and later determination of speed takes place.*

Keywords: Vehicle Detection and Tracking

I. INTRODUCTION

Vehicle detection and statistics in highway monitoring video scenes are of considerable significance to intelligent traffic management and control of the highway. With the popular installation of traffic surveillance cameras, a vast database of traffic video footage has been obtained for analysis. Generally, at a high viewing angle, a more-distant road surface can be considered. The object size of the vehicle changes greatly at this viewing angle, and the detection accuracy of a small object far away from the road is low. In the face of complex camera scenes, it is essential to effectively solve the above problems and further apply them. In this article, we focus on the above issues to propose a viable solution, and we apply the vehicle detection results to multi-object tracking and vehicle counting.

One of the significant applications of video-based supervision systems is the traffic surveillance. So, for many years the researches have investigated in the Vision-Based Intelligent Transportation System (ITS), transportation planning and traffic engineering applications to extract useful and precise traffic information for traffic image analysis and traffic flow control like vehicle count, vehicle trajectory, vehicle tracking, vehicle flow, vehicle classification, traffic density, vehicle velocity, traffic lane changes, license plate recognition, etc. [1-4]. In the past, the vehicle detection, segmentation and tracking systems used to determine the charge for various kinds of vehicles for automation toll levy system [5]. Recently, vehicle recognition system is used to detect (the vehicles) or detect the traffic lanes [6-10] or classify the type of vehicle class on highway roads like cars, motorbikes, vans, heavy goods vehicles (HGVs), buses and etc. [5, 7, 11-15].

However, the traditional vehicle systems may be declines and not recognized well due to the vehicles are occluded by other vehicles or by background obstacles such as road signals, trees, weather conditions, and etc., and the performance of these systems depend on a good traffic image analysis approaches to detect, track and classify the vehicles.

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In this review paper, the traffic image analysis comprises of three parts:
(1) Motion Vehicle Detection and Segmentation Approaches
(2) Camera Calibration Approaches and
(3) Vehicle Tracking Approaches

II. PYHTON LIBRARIES

OpenCV: OpenCV (Open Source Computer Vision Library) is a popular computer vision library that provides a wide range of functions and tools for image and video processing. It is often used for tasks such as reading and displaying images, video capture, and drawing bounding boxes on detected objects.

NumPy: NumPy is a fundamental library for scientific computing in Python. It provides support for large, multi-dimensional arrays and matrices, along with a collection of mathematical functions. NumPy is frequently used for handling image data, performing array operations, and mathematical calculations.

Darknet: Darknet is the framework on which YOLOv7 is built. It is written in C and CUDA and includes Python bindings. The Darknet library is used for loading the pre-trained YOLOv7 model, making predictions on images or videos, and extracting bounding box information.

PyTorch or TensorFlow: PyTorch and TensorFlow are popular deep learning frameworks. They provide tools and functionalities for building and training neural networks, including YOLOv7. These libraries are used for loading the YOLOv7 model, performing inference, and training the model if required.

Matplotlib: Matplotlib is a plotting library that enables the visualization of data and results. It is often used to visualize images with bounding boxes, display tracked vehicles, and plot evaluation metrics or performance measures.

Scikit-learn: scikit-learn is a machine learning library that provides various tools for data preprocessing, model selection, and evaluation. It can be used for tasks like pre-processing training data, splitting datasets, and evaluating the performance of the vehicle detection and tracking system.

Pandas: pandas is a library that provides data structures and data analysis tools. It can be used for managing and manipulating data during the vehicle detection and tracking process. For example, it can help with organizing and analyzing tracking results, storing metadata, or generating reports.

III. LITERATURE REVIEW

Multiple Object Tracking Performance

The Clear Mot metrics Metrics that describe, he quality and key characteristics in numerous object tracking systems must be studied and compared in accordance to carefully analyse and evaluate their performance. Regrettably, there has yet to be agreement on such a range of generally valid measures. They present two new measures for evaluating MOT systems in this paper. Multiple object tracking precision (MOTP) as well as multiple object tracking accuracy (MOTA) are suggested benchmarks that can be used for a variety of monitoring activities
& permit for objective contrast of tracking systems' primary features, like accuracy targets, precision at recognising target configurations, but also way to detect targets on consistent bases. They put the proposed metrics to the test in a series of global evaluation workshops to see how useful and expressive they were. The CLEAR workshops in 2006 and 2007 featured a wide range of monitoring activities whereby a big number of models were tested & evaluated. Their

studies findings reveal that its suggested measures accurately reflect the numerous methods' qualities and shortcomings in a simple and direct manner, helps in easy evaluation in performance, thus relevant toward a wide range of circumstances.

2. Fully-Convolutional Siamese Networks for Object Tracking

Traditionally, the problem of arbitrary target tracking was tackled by developing a system of the targets arrival entirely online, with only the video as training data. Despite their effectiveness, these approaches' online-only methodology limits using depth information which can be studied. Many efforts have actually been developed towards harnessing deep The convolutional networks' descriptive ability. Once the target to monitor isn't determined ahead of time, Stochastic Gradient Descent online is required in adjusting the network's parameters, risking overall system's speed. For object detection in video, a basic tracking method is combined with a novel fully-convolutional Siamese network that has been trained end-to-end on the ILSVRC15 dataset. The tracker reaches state of art success in various tests with the minimal brevity. It works at fps that are faster than actual.

3. Simple Online And Realtime Tracking

This research looks at a realistic approach for monitoring many items, with the primary objective of associating objects successfully for online and real-time operations.The study claims that recognition ability is a critical component in determining detection accuracy, with modifying its detector boosting tracking efficiency by up as 18.9 percentage. In contrast to many batch-based tracking systems, this research focuses on online tracking, where the tracker is only shown detections from the previous and current frames. Despite just employing a simple mix of existing techniques such as the Kalman Filter and the Hungarian algorithm for the tracking components, this approach achieves tracking accuracy similar to state-ofthe-art online trackers. This research looks at a realistic approach for monitoring many items, with the primary objective of associating objects successfully for online and real-time applications

IV. ARCHITECTURE

The architecture used for vehicle detection and tracking using YOLOv7 is based on the YOLO (You Only Look Once) object detection framework. YOLOv7 is an extension or variant of the YOLO series, and it refers to the seventh version of the YOLO model. Here are the key components and concepts in the YOLOv7 architecture for vehicle detection and tracking:

Backbone Network: YOLOv7 typically uses a deep convolutional neural network (CNN) as its backbone network. This network is responsible for extracting features from the input image. Common choices for the backbone network include Darknet, Darknet-53, or other architectures based on the Darknet framework.

Feature Extraction: The backbone network is designed to extract hierarchical features from the input image, capturing both low-level and high-level visual information. These features are important for accurately detecting and localizing objects, including vehicles.

Grid Cell Division: The input image is divided into a grid of cells, where each cell is responsible for detecting objects. In YOLOv7, the grid cell division can be adjusted based on the specific application requirements.

Bounding Box Prediction: Within each grid cell, the model predicts bounding boxes that enclose the detected vehicles. Each bounding box consists of coordinates (x, y) representing the box's center and its width and height (w, h).

Object Classification: Along with the bounding box predictions, YOLOv7 performs object classification to assign a class label to each detected vehicle. The model is typically trained on a dataset that includes vehicle classes (e.g., car, truck, motorcycle) to enable accurate classification.

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Non-Maximum Suppression (NMS): YOLOv7 employs NMS as a post-processing step to remove duplicate or overlapping bounding boxes and retain only the most confident and accurate detections. NMS ensures that each vehicle is represented by a single bounding box.

Tracking: For vehicle tracking, additional techniques are used in conjunction with YOLOv7. These can include algorithms such as Kalman filtering, Hungarian algorithm, or other object tracking approaches to associate bounding boxes across consecutive frames and maintain the identity of each tracked vehicle.

V. METHODOLOGY

An implementation methodology is a collection of practices, procedures and rules that must be applied to perform a specific operation to provide deliverables at the end of each stage. The eight principles listed below is built from a collection of procedures to establish an effective implementation methodology framework. This framework provides flexibility to react and adapt to the unique requirements of every project, incorporating the principles of:

1. Project Management & Planning
2. Scope & Requirements Specification
3. Risk & Issues Management
4. Communication & Training
5. Quality Management
6. Post-Implementation Review
7. Documentation
8. Experience

Project Management & Planning

Project management is the art and science of communicating between individuals with different responsibilities, perspectives, and expectations so that the project team and the sponsoring organization perceive value and quality in the end product The implementation process should be driven by solid project management principles and the concept of people working in tandem. The project manager drives the collaborative process so team members work together to accomplish agreed goals.

Scope and Requirements Specification

The implementation approach should have an outcomes-based focus. This means that the process emphasizes on identifying the business requirements that target an organization's specific goals and objectives. This is achieved through a systematic manner which sets out a solution roadmap that transforms goals and objectives into functional requirements (critical success factors, csf's).

Quality Management

Quality management ensures that the system meets or exceeds the customer expectations. It is a method for ensuring that all the activities, procedures and documentation required to implement a project are effective and efficient with respect to the system and its performance. The focus is not only on the product but also on "how" to achieve it.

VI. CONCLUSION

This paper provides a summarizing study on the proposed techniques which have used in traffic video
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with appearance of shadow and partial occlusion. Also, we present and classify the traffic surveillance systems to three types
based on specific methods which used for developing it. These types shows the detailed information about how the traffic surveillance systems used the image processing methods and analysis tools for detect, segment, and track the

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vehicles. In addition, shadow and partial occlusion matters and its available solutions are discussed. More specifically, this review gives better understanding and highlights the issues and its solutions for traffic surveillance systems.

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