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# Vehicle Detection and Tracking Using Kalman Filter and Hungarian Algorithm for Driving Assistance in VANET's

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A R T I C L E I N F O

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A B S T R A C T

In today's world, the huge increase in automobile vehicles counts on the roads in both rural and urban areas have turned out to create large number of issues which result in the administering and governing of the vehicle on the roads and highways for better driving assistance. Vehicle identification and monitoring by using the information collected from transport monitoring system leads to a defining standard approach for the complex transportation system. In our proposed research Kalman filtering and Hungarian approach used for the identification and tracking of vehicles which mainly focuses on moving vehicles in context of vehicular ad-hoc networks (VANET's). This paper illustrates the identifying and monitoring the multiple vehicles using deep learning for driving assistance. Kalman filtering is used for monitoring the objects with the pre-trained COCO dataset. Pipeline simplifies the object detection by producing the bounding box around the vehicle. This approach quickly detects the moving vehicle from the running video with the bounding box.

## 1. Introduction:

Today, many innovative technological improvements from image processing to computer vision have happened in the transportation system and still challenge in rural and urban road accidents common in everyday life worldwide. It is apparent that different kind of traffic, traffic on highways and urban roads leads to significant issues in the present life. Since no person can't be imagined without driving out every day, road accidents by negligence or not better assistance of technology are viewed as daily routine matter for authorities. Hence, it is basic requirement for any individual who engaged with a car crash to equitably introduce the conceivable deformity circumstances in a technical, lawful, and logical way. Keeping this in view researchers are trying to develop better vehicle recognition and tracking frameworks for a long time, new approaches and techniques are being created with new developments in VANETs structure. [1-2] Table:1 enlists notations and their definitions for this research paper.

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Table 1: List of Notations and their Definitions

| Notations | Definitions |
|---|---|
| VANET | Vehicular Ad-Hoc Network |
| COCO | Common Objects in Context |
| CNN | Convolution Neural Network |
| GMM | Gaussian Mixture Model |
| VIVD | Video Image Vehicle Detection |
| IOU | Intersection over Union |
| LBP | Local Binary Pattern |
| SURF | Speeded-up Robust Features |

Traffic data utilized to evaluate the traffic caught utilizing a camera, in view of manual monitoring process. The procedure of traffic monitoring system can be arranged into three categories. (I) Manual framework, (ii) partial framework and (iii) complete framework. Generally, manual framework is performed by administrator whose job is to observe the traffic changes by checking the different cameras. The main drawback of utilizing such a framework is the need for excessive amount of time by administrator to process by observing all cameras. In addition, administrator should be cautious on notifying the abrupt interruption which is hard for identifying by the human in context of VANET's. [3] The partial framework utilizes both administrator and low-level system vision procedures for traffic observation. The needed data is obtained by filtering or segmentation later used for classification and is completed by manual administrator. Finally, in complete framework the entire identification is done by filtering automatically by system. Such frameworks are easy to install but difficult to work without humans. [4-5]

This research illustrates the identification of multiple vehicles using a camera mounted inside a self-driving car as a major contribution. In the pipeline, detection of vehicle takes a captured image as input and generates the bounding boxes as the output. Kalman filter is used for the prediction of vehicle. We solve maximizing the sum of intersection over union (IOU) assignment problem using the Hungarian algorithm (also known as Munkres algorithm). Based on linear assignment results, two lists for unmatched identification and unmatched trackers, respectively. The COCO dataset is used for identification of vehicle which contains images of 90 classes.

## 2. Literature Survey:

In this section we will present in detail existing work on vehicle detection and tracking for driving assistance considering VANET's. Authors proposed methodology in [6-7] to determine the issues happening due to vehicles in the highways; nevertheless, the goal of continuous identification of the vehicle is lagging in identification and tracking for fast and accurate prediction. Color Segmentation is carried out by utilizing the brake lights detection to obtain the vehicle candidates, later crosschecked by rule-based clustering. The feature selection and matching technique is performed by track-by-detection technique to form a template for vehicle identification linear and motion time in the running video [7].

Multiple vehicle identification is processed from the video using feature extraction, clustering and aggregation. Later, it aggregates a low-level feature extraction, deeper feature extraction and live tracking association [6]. Even the medium running time is approximately 750ms, it is not sufficient to attain live video data. Convolution Neural Networks (CNN) results in contemporary issues in vehicle identification and tracking. At present CNN performs well than the other frameworks by a broad edge in perspective problems such as classification [8] and identification [9]. In CNN learning phase, it starts to learn automatically by filter weight, from which ideas are obtained from the original image data. Information got from the examination of the learning phase are labeled vehicle and non-vehicle models, the identification of vehicles can be done from the given frames.

In [10] authors proposed an approach for identification of vehicle from Gaussian Mixture Model (GMM). GMM is the underlying modeling process to render the background frame rapidly and dependably. Vehicle detection based on texture and color is processed using the image segmentation in the trained detection region. Later, noises from the identified vehicles are removed by post processed, OR mask usage with flood fill method. OR mask performed to compute the logical OR operation. VIVDS [11] performs better than the previous VIVDS at urban areas and satisfies the parameter of computational efficiency and detection rate. It is indicated in [12] major dependency on grouping the different type of vehicles and also counts of vehicles. GMM technique also makes use of the shadow removal technique in proposed work. Identification of Vehicle is performed using the video obtained from CCTV; vehicles in motion are identified from video. After obtaining the perfect result, the background result is updated in the underlying model after the tracking is done using Support Vector Machine Classification. The experimental result shows that UNet accuracy is 96.39% for vehicle detection and classification result is 94.67% for different vehicles by varying weather conditions and illuminations. Figure 1 depicts vehicle detection and tracking in context of VANETs.

In [13] authors proposed the identification of the vehicle which is useful for regulating and organizing traffic in the highways. Symmetrical SURF is proposed for vehicle detection from symmetric features on sides, front, and back. Initially, SURF detector is utilized for obtaining the needed thing from the original image, later, SURF detector is utilized for obtaining the point of interest (POI) from the images. Secondly, finding the same POI from each frame was detected. This process is noted as mirror transformation. The performance result shows better result and suits for all kind of weather conditions. This applies to real-time applications, performs well to detect the vehicle using moving features.

In [14] vehicle identification is performed by the video camera established at the flyover which captures the video in roadways. In this way, the background subtraction detection approach is utilized to perform the framework. This approach will do the subtraction in pair-wise between the underlying frame and the present frame.

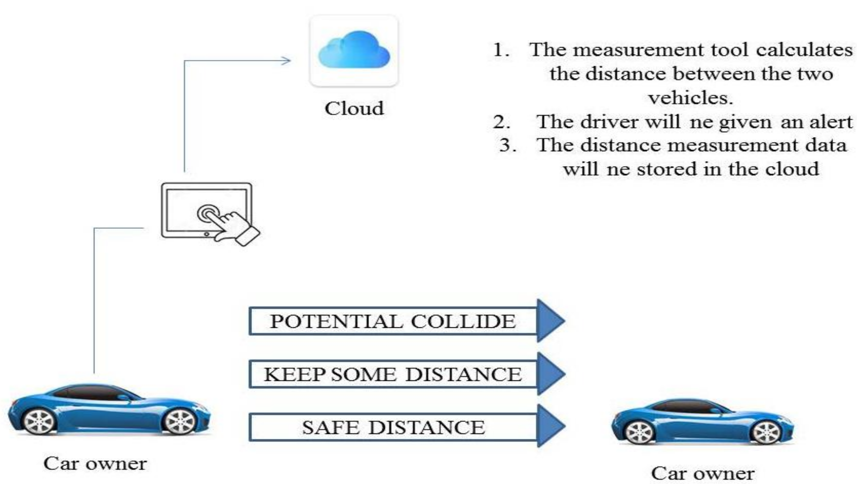


Figure 1. Detection and tracking in context of VANETs

The next step after detecting the vehicle is from filter for the prediction of vehicle state using the dynamic model performed by predicting the observed model. The entire running video is processed in this way to label the vehicle after identifying it. Finally, segmentation of image is carried out by labeled blobs, bounded boxes with classification stages. The feature extraction process is focused here in this paper using the Local Binary Pattern (LBP) to obtain the uniqueness of the vehicle.

## 3. Proposed Methodology:

In this section we will discuss about required dataset for detection and tracking of vehicles in context of VANET's, Kalaman filter for bounding box measurement and Hungarian algorithm for linear assignment.

### 3.1 Dataset & Detection:

In the pipeline, identification of vehicle takes image as input and generates the output as bounding boxes. Tensor flow object detection API is built on the top to generate, train and performs object detection process. Additionally, this API provides the group of pre-trained detection models on the COCO dataset for rapid prototyping. COCO dataset is the lightweight model and depends on single shot multi box detection techniques with minimum changes in it. The Dataset contains 90 classes with the first transportation of bicycle, car, and bus.

### 3.2 Kalman Filter for Bounding Box Measurement:

Tracking the vehicle is performed by Kalman filtering, which predicts the future location of it. Additionally, it performs the alterations in predictions, noise reduction, further associates the multiple objects to the tracks. This filtering can be performed using the two phase such as prediction and update process. The prediction process is performed by obtaining the previous state as the current state. The update process is carried out by current measurement, from the detected bounding box location in correct state.

### 3.3 Linear Assignment and Hungarian (Munkres) algorithm:

Multiple detection leads on matching each of them to the tracker continuously. This utilizes the intersection over union (IOU) of the tracker bounding box by using the identified bounding box as the metric. The sum of the IOU assignment problem can be reduced by the Hungarian Algorithm.

### 3.4 Unmatched identification and trackers:

Based on the linear assignment results, two lists for unmatched detection and unmatched trackers, respectively. If the vehicle is detected in the video frame, and it is not matched with any of the previous detected objects from the list, then it is referred to as an unmatched detection. Additionally, the matching object with overlapping represents the existence of an untracked object. The unmatched track is detected when the vehicle moves out the frames, and the existing established track has no more detection to match. Thus, the tracker and the detection associated in the matching are added to the lists of unmatched trackers and unmatched detection, respectively. Figure 2 represents overall framework or proposed detection and tracking methodology of vehicles.

## 4. Experimental Setup and Results:

We included two important design parameters, minimum number of hits MINhits, and maximum agaeMAXage, in the pipeline. The parameter MINhits is the number of consecutive matches needed to establish a track. The parameter MAXage is a number of consecutive unmatched identification before a track is deleted. The pipeline deals with matched detection, unmatched detection, and unmatched trackers sequentially. We compared performance of our proposed methodology with UNet in terms of classification accuracy and vehicle detection.

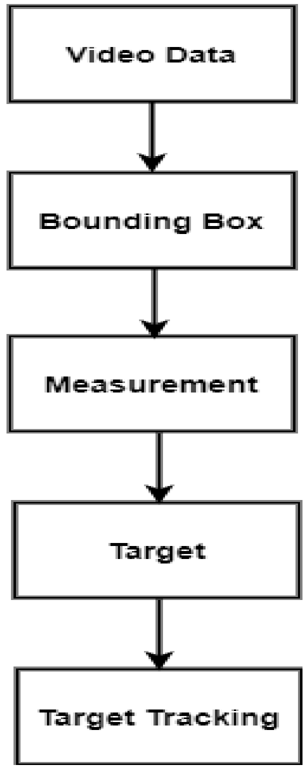


Figure. 2. System Architecture for the entire framework

The experimental setup is performed by using the Python IDE on Intel i3 processor of 3.40 GHz machine with 2 GB RAM. The proposed approach is tested using the COCO dataset which has the collection of vehicle data. The experimental setup identifies the vehicle with dual color blue and red for bounding box on it. Additionally shows the measurement on each of the vehicle by identifying the vehicle on both ways on the video. Based on the experiments, the highest efficiency rate was achieved by solving the assignment problem. Figure 4 depict performance of proposed methodology on terms of classification accuracy and vehicle detection. The experimental result shows that UNet accuracy is 96.39% for vehicle detection and classification result is 94.67% for different vehicles by varying weather conditions and illuminations. The experimental result shows that for proposed methodology accuracy is 98.39% for vehicle detection and classification result is 96.67% for different vehicles by varying weather conditions and illuminations.

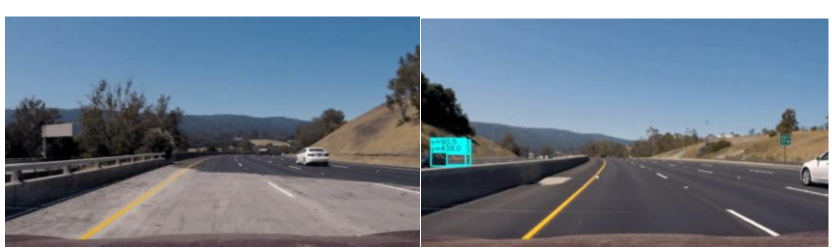

Figure 3. Experimental Results for Proposed Methodology

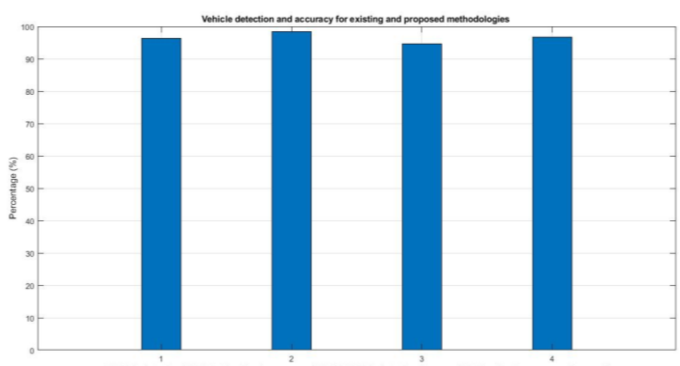


Figure 4. Experimental Result for Proposed Methodology

## 5. Concluding Remarks:

The proposed methodology for multiple identification of vehicle using the Kalman filtering and using COCO dataset outperforms well. The proposed method additionally addressed the complex problem of IOU assignment problem by Hungarian algorithm. This also suits well on real-time implementation where it automatically detects the vehicle and notifying it using the bounding box and measurement in it. This approach is responsive for two ways in urban and rural roadways with satisfiable result on vehicle identification. Finally, experimental images of the proposed framework show that the output is based on the quality of the given video and the position of camera. The experimental result shows that 98.39% for vehicle detection and classification result is 96.67% for different vehicles by varying weather conditions and illuminations.


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## *Data Fabrication/Falsification Statement*

*The author(s) declare that no data have been fabricated, falsified, or manipulated in this study.*

## *Participant Consent*

*The authors confirm that Informed consent was obtained from all participants, and confidentiality was duly maintained.*

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