Enhanced vehicle detection mechanism for traffic management in smart cities

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Enhanced vehicle detection mechanism for traffic management in smart cities

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Abstract Nowadays Road traffic is major issue of developing and under developing countries. With the rampant increase of traffic, the society faces major traffic threats including life threats and environmental threat, thus traffic management is gruesome problem to address. The consequences of poor traffic management include road accidents, jamming of traffic, pollution and many more that can be life threatening. Living in 21st century with the emergence of technology and applicability of smart cities provides a perfect solution to curb traffic issues. Keeping in view the deadlock and congestion in traffic, this work provides solution by indigently detecting and prioritizing the vehicles and non-vehicles. The research involves implementation and comparison of two state of art algorithms Aggregated channel feature and Point Tracker. Further, the algorithms are enhanced by improving traffic management in terms of identifying category of transport, prioritizing the traffic which contains vehicle and non-vehicles on basis of size of vehicle, type of vehicle, emergency situation and provide the priority to resolve the deadlock. Further, the proposed enhanced point tracker algorithm includes the emergency detection in case of accident and provide an alternative route to neighboring vehicles and non-vehicles. Enhanced ACF has detected true positive rate of 80%, 89%, has detected true positive rate of 69% and 79% having non-vehicle detected with assigned priority. Enhanced point tracker has detected true positive rate of 88%, 94%, and 86% having vehicles, non- vehicles and assigned priority.

Keywords Smart Traffic · Congestion · deadlock· Priority based traffic solution · Vehicle detection

1 Introduction

Traffic becomes most challenging area to address. By the increase in populace around the globe and metropolitan flexibility in urban cities, the transportation jamming mostly seen on roads which give birth many diseases as well as, become reasons of accident and most important emission of carbon dioxide becomes cancerous factor in climate change. In order to tackle concerns for handling traffic on infrastructures and to assistance officials in proper development, “Intelligent Traffic Handling System for Smart Cities” is planned. Congestion of rush-hour traffic on roads is nothing more than accumulative trip time, causes noise and air pollution, slower the speed and increase queuing of vehicles on the roads. By means of the swift development of populace of the world the number of automobiles increases accordingly, the amount of traffic congestions also upsurges as the number of vehicles increases. Traffic jams are not only wasting the time but also it adds to illegitimate activities like mobile stealing at transportation indications also happened. On the other hand, Traffic blocking upsurge vehicle emission and worsens ambient air.

The aforementioned is therefore recognized that traffic organization system becomes essential. In the metropolitan cities traffic crowding is major issue, which becomes more gruesome in case of emergency like flood, fire, ambulance or any other natural disaster. Traffic bottleneck occurs when the demand sur- passes the existing road capacity. Countries around the world looking forward to implement smart “traffic management system” the recent advancement in wireless

sensors networks and low-cost power consumption sensors have bolstered the system towards creating “an effective and efficient smart traffic management system”. The initiation of internet of thing and high accessibility of cloud resources are facilitating us creating tool that can automate the smart transportation system and can augment utilization of prevailing infrastructure.

In smart municipalities around the creation, smart transportation management system is deployed to curb the traffic concerns. “Smart traffic management system”, examines road stream of traffic moves in actual spell mode also recommend driver to opt for most optimized direction for traffic with assistance of Google map embedded in proposed system. It also enables grabbing the traffic recording notifying the up-to-date transportation incidences to appropriate participants, so long as traffic data for disconnected examination, signal control, display sign, warning and essential message and emergency situation updates. It must provide previous warnings for transportation approaching hazardous turns, rail crossing, work zones, groups, and restricted overpass and off ramps.

We have discussed “Point Tracker and Improved Aggregated Channel Feature Algorithm for smart traffic” that satisfies all traffic associated concerns of smart city. Traffic management algorithm is applied to identify the emergency on road with the help of revised speed detection formula. This paper will discuss traffic monitoring as well, which is root component of “smart traffic”. Traffic monitoring permits the local consultants to monitor the flow of traffic relating to local area, or street. Emergency detection is one of crucial part of “Intelligent Traffic Handling system” for which Emergency detection algorithm is discussed. In order to cope the flow of traffic the situation of road traffic has to capture. The algorithm will prioritize the vehicle on basis of size of vehicle, type of vehicle, emergency factor, speed and time factor.

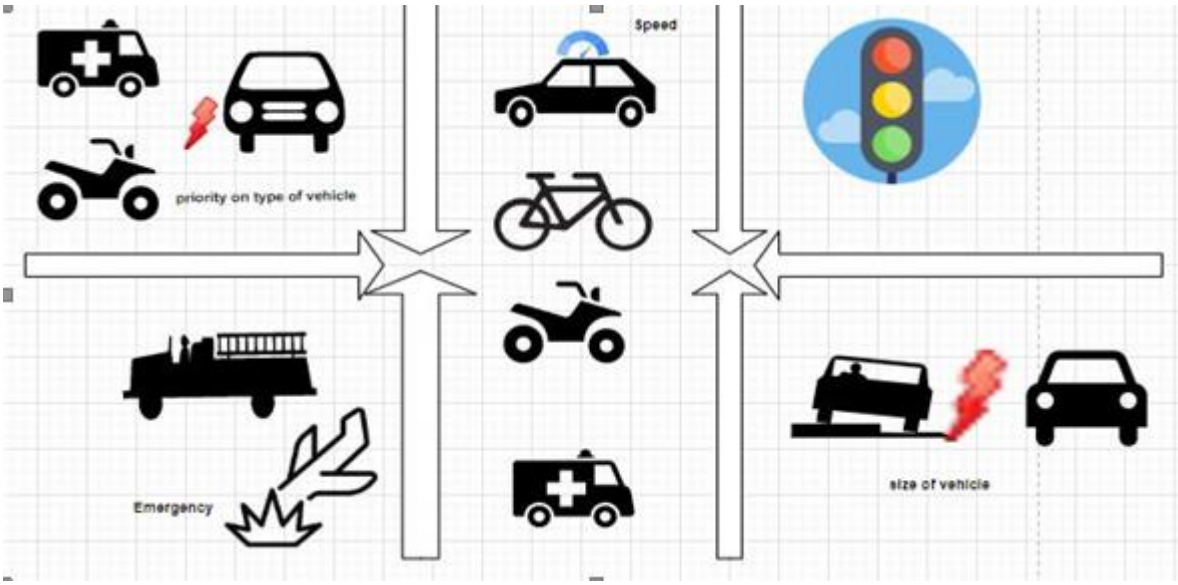


Fig. 1 Factors of priority on which the algorithm will work

2 Literature Review

2.1 Intelligent Traffic and Smart Cities

Traffic deadlock on road is gruesome for both developing and underdeveloped countries. This congestion on roads is nothing more than wastage of time, life- threatening in case of emergency, and the biggest threat to the environment due to emission of poisonous gasses [1]. This has a direct impact on the economy of countries too because of the increase in the amount of fuel utilization. This deadlock increases the time to travel from one end to the other [1] [2]. The composite system of transportation has taken equally gains and shortcomings: though the tools of transportation devise more reasonable, the deadlock on roads have appeared far additional as a result. Consequently, organized as well as proficient planning of transportation and prioritizing the traffic from different factors are vital to discuss and to provide a solution for the intricate system of transportation [4] In most of the countries traffic signals strategy is adopted to curb the traffic congestion and to control the life- threatening situation, in present-day innovative techniques are used to handle the traffic deadlock by following adaptive signals for the traffic jam most of the researchers has suggested the algorithms with implementation detail. An enlarged rate of population is bludgeoning every day which creates congestion in traffic. order to curb the issue of traffic many authors have worked to curb the flow of traffic by designing and implementing Algorithms.

2.2 Characteristics of Intelligent Traffic

Traffic signal management [3] is the most perplexing problem, senthil kimar Janahan [4] has discussed "IoT based smart traffic signal monitoring system [5]" by means of vehicles and non-vehicles total count and their characteristic [6]. They have discuses internet of thing as an intelligent and decision-making transportation system [7], the author has worked on the characteristic of intelligent traffic to improve "vehicle to vehicle [1]" and "vehicle to organization statement [2]" to enhance traffic jams. The authors have developed android application to transfer fata to micro controllers, technique of clustering [8] is used to perform computation for innovative infrastructure from implemented algorithms.

2.3 Infrastructure Development

An increase in population and traffic concerns compel the researchers to mold traditional transportation to smart transportation. Therefore, many authors have work on Infrastructure of smart traffic. Smart cities provide optimal infrastructure to development authorities in order to augment social, economic, and urban development of cities.

[Table 1 Characteristics of Intelligent Traffic in Medium and Large size Cities]

Features	**Factors in medium size of cities**	**Factors in large size of cities**
Smart Mobility (Transportation and information of the ICT i.e., Information and communication technology)	National Level Accessibility International accessibility	National Level Accessibility International accessibility
Intelligent Economy (Effectiveness, affordability, competitiveness)	Entrepreneurship Constructiveness State-of-the-art spirit	Entrepreneurship Constructiveness State-of-the-art spirit
Intelligent Environment (Natural Possessions and resources)	Condition of Environment Quality of air (no pollution environment)	Condition of Environment Awareness about ecology
Smart Life style (Quality of living standards)	Improved health conditions Cultural facilities Quality of housing	Improved health conditions Cultural facilities and leisure facility Quality of housing

Intelligent Ascendency and Governance (Contribution)	Contribution in public life Transparent Governance	Political awareness Social and public services

2.4 Intelligent Traffic and Current Traffic Infrastructure

The congestion of traffic is increasing like a bursting balloon every day. The issues of traffic are growing to the momentous range. For the period of daytime or school hours, in Urban areas traffic is at the peak that could be through street via particular means of transportation, certainly proceeds about the distance of one hour aimed at a distance about ten to fifteen Km. The problem of dynamic undeviating route finding is a subdivision of dynamic problem in transportation which includes active transportation consignment etc. Therefore, computer scientists are focusing on the system as key to implement smart traffic handlers in real-time. Which require fewer resources, minimal time, and easy to implement. The world traffic itself has become a cause of tension for all individuals, which requires a system for proper allocation of resources to develop a system of road infrastructure it will give as ease of transportation is the top priority of municipal department these days [9] [10].

An Intelligent traffic study by the use of a machine learning algorithm is suggested by [2]. According to the author's perspective for the selection and prediction of the best possible routes which depends on the patterns of traffic mobilization, classification of vehicle, emergency, and for a level of precipitation different Machine Learning Algorithms can be used [3] [10].

The Algorithm for intelligent traffic control makes sure that the transportation means is dynamically dispersed to diverse areas, users, and vehicles which depends upon the priority assigned to the vehicle type. This paper proposes a dynamic vehicle prioritized traffic control system, using the multi-agent system for urban cities with coordinated flow splits [2] [11].

3 Methodology

In order to prioritize the vehicle, the Initial step is to detect the vehicle. Vehicle detection plays a significant part in intelligent Transportation. Study likens two algorithms for the detection, tracking and for the priority of vehicles according to different parameters. Vehicles are track and categorize according to type of vehicle. As mention in Figure 7 Initial step is to load the Video data for the purpose to train by applying Train Aggregated Channel Feature (ACF) in MATLAB [16] 2018a. Two algorithms are proposed ACF and Point Tracker for the priority of vehicles and make them work intelligently for the accident detection and emergency scenario.

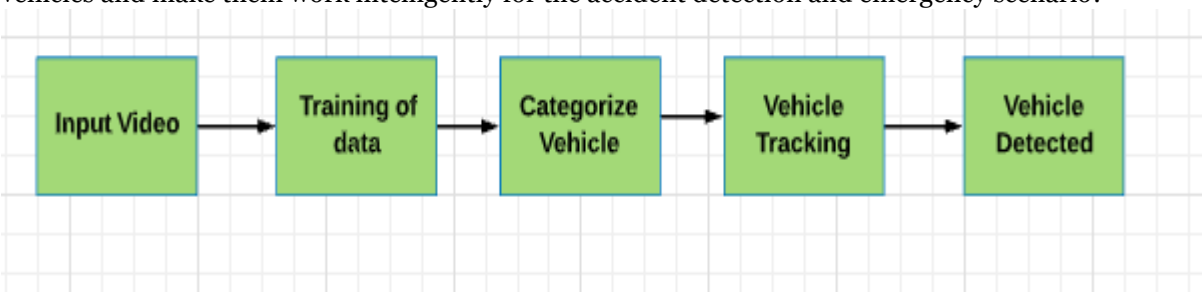


Figure 2 Tracking and detecting vehicle Framework

All the vehicles detected by applying Aggregated Channel Feature (ACF) and point tracker Algorithm. All the vehicles are detected and trained as the algorithm is applied. The proposed method follows following steps.

- Detection of Vehicle.
- Tracking of Vehicle
- Categorizing Label according to Type of vehicle.
- Identify the priority of Vehicle.

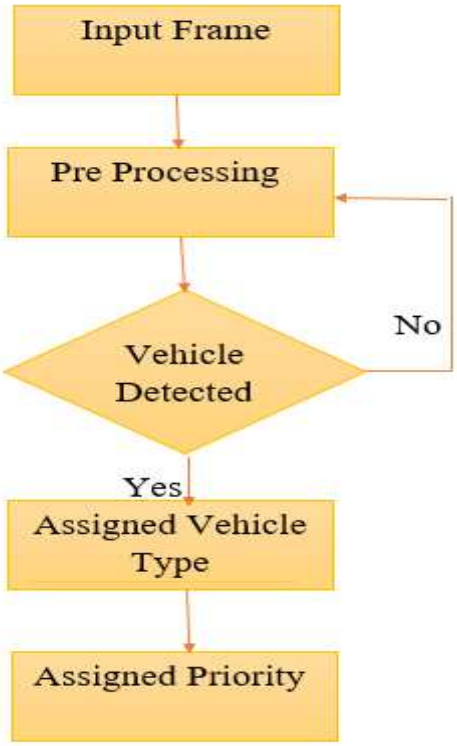


Figure 3 Flow Diagram of Proposed study

3.1 ACF Object Detection Algorithm

The algorithm first detects the Vehicle and non-vehicles like bike, ambulances and pedestrians. For detection. First, the features of diverse frequencies under the same resolution are gained through numerous changes of the identical Image which is input. After that, in order to remove for noise suppression smoothing filter is applied. Lastly, every picture element in the feature map is mark as an Aggregated Channel Feature. "ACF object detection algorithm [2]" provides higher precision as compared to algorithms of single channel feature. Pedestrians and other non-vehicles are easily detected by the proposed algorithm. This algorithm uses "vehicledetectorACF" function. For pedestrian detection "peopledetectorACF" function. This algorithm easily detected the vehicle, non-vehicle and pedestrians without losing the image resolution. As mentioned in figure once the vehicles are detected and labels the proposed study will assign the priority according to category of the vehicle. "Aggregated Channel feature [21]" extraction method is representing the feature of an objects.

It provides the best characteristics of extracting fracture from the moving object, uniquely from the image. For quick extraction of data from ACF algorithm firstly input image is generated aa a pyramid of multi resolution of the extracted image at high speed. The feature information which are extracted by following this algorithm contains the similar and unique features from the image of high resolution to the image of low resolution.

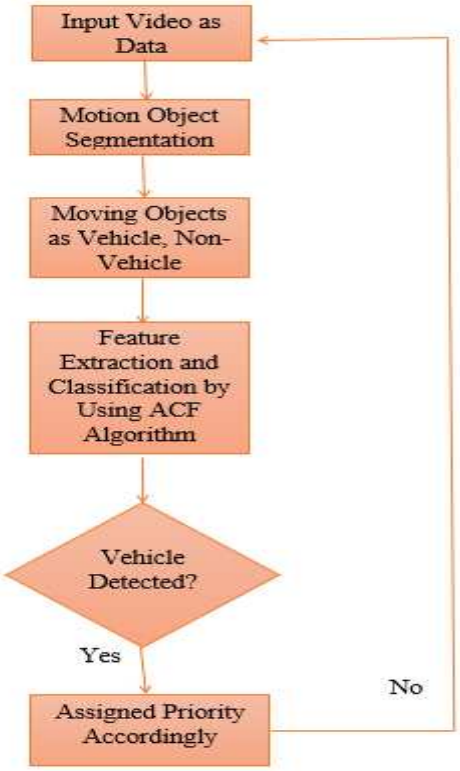


Figure 1 Flow chart of the proposed study

3.1.1 Algorithm of implemented IACF

V_t: General Transport indicator

P_d: person detection

T: Movement tracker

F: Frame of a video sequence at a time t

P: ACF algorithm

V_C: Assigned bounding boxes according to category of vehicles and non-vehicles

P: Assigning Priority to Vehicles and non-vehicles.

E: Emergency handler

Output:

V_d: detected vehicle and non-vehicle

V_c: detected category of vehicles and assigned bounding boxes with priority prompt.

A_d: Accident detected as Emergency handler

Processing:

$V_d \leftarrow \{\}$

$BBox_G \leftarrow$ *{detections by V_t in F}*

$ROIp \leftarrow getROI(T)$

$BBox_S$ *+- detection by V_t in ROIp*

$BBox_T$ *+- predicted location of P by T in F*

if $BBox_S \neq \{\}$ then

if bbox coincides with $BBox_G$: bbox ϵ BBoxG

Update T

{V_t} ← update V_t (bbox)

$V_d \leftarrow$ *connected bounding box of bbox U BBoxs*

else if, $BBox_T$ coincides with BBoxs then

Update T

$V_d \leftarrow$ *connected bounding box of $BBoX_T$ U $BBox_S$*

end if

end if

$BBox_S$ is bounding box of specific vehicle and non-vehicle, equivalent bounding boxes is represented as $BBox_T$. this is how proposed technique is detecting, categorizing and prioritizing the transportation.

3.2 Point Tracker Algorithm

The algorithm first develops the sequence of the image. In order to detect the image and to minimize the distance between tracking point of two descriptors where the sequence of every image is engaged. The result depends upon the sequence of the image by capturing the scaling of the numerous geographical shapes of the vehicles. "Vision.pointTracker" is function which detect the vehicles. It need point to detect, without assigning label to each vehicle. Point tracker algorithm detects the point by using "Kanada-Lucas-Tornasi KLT" which is a featuring algorithm. Video data is passed as input and algorithm detect the estimation of motion, tracking of objects, and provide stability to data. It did not change shape like ACF algorithm and for those images which display visual texture.

In detection of vehicle, first step is to initialize the process of tracking, first we Initialized and specify the initial location of every point and video frame was initialized.

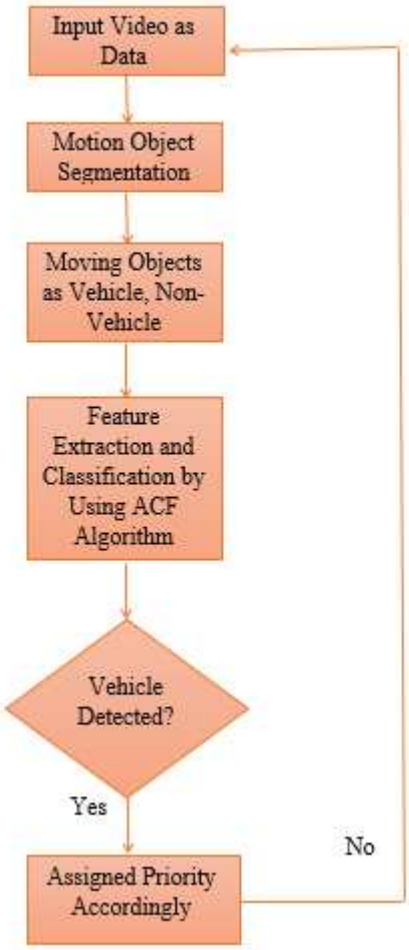


Figure 2 Diagrammatic Representation of Point Tracker Algorithm

3.2.1 Algorithm of proposed point tracker Algorithm

Initialization of classifier

Load object classifier: Cl_{OBJ}

Load Tracking classifier: Cl_{TRA}

Initialization of Input frame as target

G=get target_id

ROI=image(target.rectangle)

Image initialization

Get input frame as image I_M

I_{Gray}*=Convert (*I_M*, greyscale)*

I_{Gray}*= hist_equalise (*I_{Gray}*)*

Image detection

Vec det_vehicle=detect_multiscale (Cl_{OBJ}*,* Cl_{TRA}*))*

Assigning priority for Intelligent traffic

Vec det_vehicle=detect_multiscale

Assign bounding boxes according to category

Check whether bounding boxes are equal to detected vehicle

For all (det_vehicle)

If (det_vehicle>detect_multiscale)

    image[v]=det_vehicle

    priority[v]=det_vehicle

Emergency handling as criterion of Intelligent Traffic Handling

If det_vehicle≠det_path

    Generate imaginary value[i]==det_vehicle

    Notify other vehicles for alternative routes

Target achieved

If(detected_vehicles==properly_prioritized)

    Input(k)

Target_id=k

Else

    repeat

The algorithm, is initialized by loading object classifier as Cl_{OBJ} and $Cl_{TRA,}$ then main target is to initialized an input video frame, conversion of grayscale is made by using (I_M, greyscale), once the conversion is done the detection and assigning priority to vehicles takes place. Bounding boxes are assigned to detected and prioritized vehicles. Emergency handling is made by checking whether detected vehicles is out of path. If the desired criterion is not met, the algorithm will redirect to repeat from initial phase.

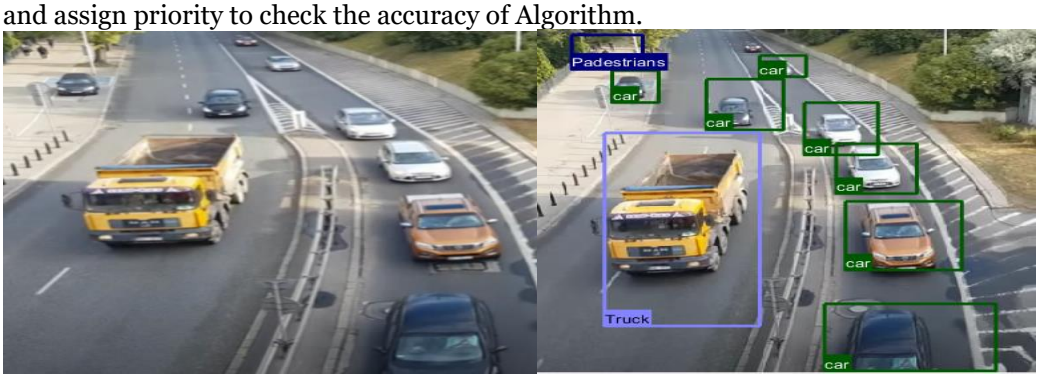
4. Results

Different datasets of vehicles, non-vehicles and pedestrians are used to assess the robustness and the methodology. The experiments are conducted by applying two algorithms IACF Algorithm and point tracker to carried out the more accurate results. The first experiment is conducted on different data sets from input video and displayed process positively spotted the moving transportation of every type where IACF algorithm is applied for vehicle and pedestrian detection. In second experiment Point tracker algorithm is applied. Then showed the comparison of both Algorithm according to their accuracy and show the improved performance.

In both algorithms first the result is displayed with detected vehicles, non-vehicles and pedestrians with different dataset than the result is displayed with the priority. Different videos are used, which contain different vehicles and objects to make an environment further multifaceted to test the accuracy of the process. Two experiments are conducted with four data set in each algorithm.

4.1 Experiment

Experiments are carried out on four different input video dataset and assess the accuracy of the planned method is experienced. The video consists of different types of vehicles and non-vehicles such as motorcycles, cars and tracks, the video also comprises persons and static vehicles. ACF algorithm is applied on every video dataset. In first dataset vehicles with detected vehicle type is mentioned. In second data set vehicle and non-vehicle data is mentioned with identified their type. In third data and forth data set vehicle and non-vehicles is mentioned with their priority details in forth dataset input is given from back side of the road and assign priority to check the accuracy of Algorithm.



(a) (b)

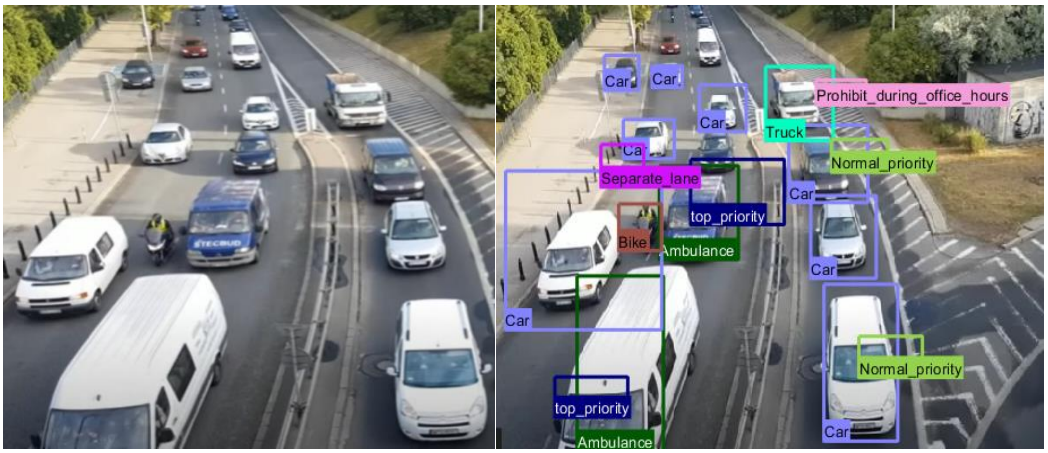
(c) (d)

Image (a) is representation of original image, image (b) is representation of detected vehicles and prioritized (c) another original image from dataset (d) is representation of detected vehicles with priority.

4.2 Experiment II

The second experimentation is comprised on four different videos dataset and examine performance of the conducted method. Video consists of different types of vehicles as used in first Experiment such as bikes, cars and tracks, Ambulance the video also comprises pedestrians and static and dynamic vehicles and non-vehicles. Point Tracker algorithm is applied on every video dataset. In first dataset vehicles with detected vehicle type is mentioned. In second data set vehicle and non-vehicle data is mentioned with identified their type. In third data and forth data set vehicle and non-vehicles is mentioned with their priority details in forth dataset input is given from back side of the road and assign priority to check the accuracy of Algorithm as done in Experiment 1 here we check the rate of false positive and true positive. In last the comparison will be made between results of both Algorithms with assigned priority to vehicles and non-vehicles.

(a) (b)

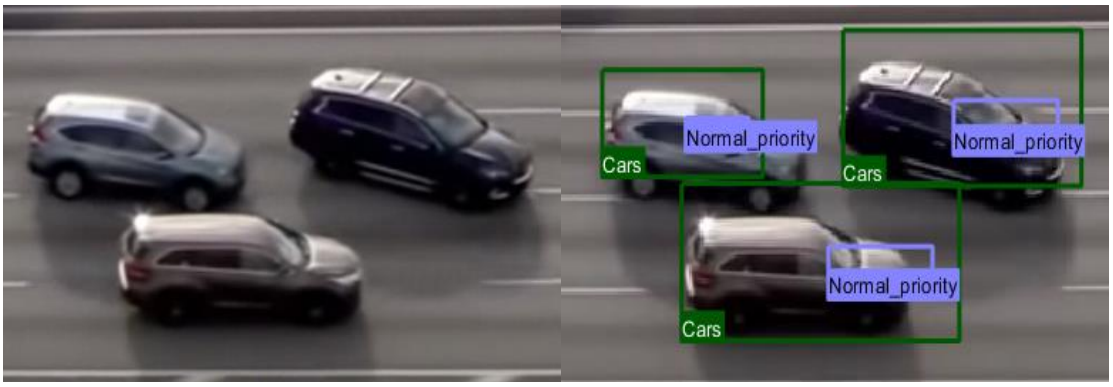


(c) (d)

Figure 6 Prioritized Image by using Point Tracker Algorithm

4.3 Accident or Collision Detection

Similar IACF and point tracker Algorithms are applied for the detection of Accidents, as the road accident is important criterion to consider for intelligent traffic. The proposed architecture projected an augmented delivery of emergency handling and road accidents safety in a collaborative way. The proposed technique depends upon both IACF and point tracker algorithm, which could alter the traffic in neighbors of an accident or affected area. The moving transport control and congestion control approach considers incoming and outgoing rate to form a traffic indicator. This bounding box is automatically assigned to affected vehicle with the regular bottleneck influence of segment of road, the bounding box will notify to vicinity vehicle about the congested area.



(a) Original Image (b) Detected Vehicles

Figure 7 Detection of Accident

4.4 Final Compilated Result from Experiment 1

The Table contain data from dataset 1 to dataset IV. The result values are represented in form of true positive and false positive. As the experiment 1 contain the result by applying ACF Algorithm. The entire table 2 is based on result by applying ACF Algorithm.

Table 1 Result Compiled from Experiment 1 by using IACF Algorithm

Datasets	Number of Vehicles	True Positive (Detected Vehicles)	Rate of True Positive	False Positive (Undetected Vehicles)	Rate of False Positive
Result of Dataset1 Without assigning Priority	15	12	80%	3	20%
Result of Dataset II Without assigning Priority	19	17	89%	2	11%
Result of Dataset III With assigned Priority	42	29	69%	13	31%
Result of Dataset IV With assigned Priority	54	42	78%	12	22%

4.5 Final Compilated Result from Experiment II

The Table contain data from dataset 1 to dataset IV from Experiment II. The result values are represented in form of true positive and false positive. As the experiment 2 contain the result by applying Point Tracker Algorithm. The entire table is based on result by applying Point Tracker Algorithm on MATLAB. As the point tracker algorithm consider the vehicle or non-vehicle from point to point till the same frame. This has more accuracy as compare to ACF algorithm.

Table 2 Result Compiled from Experiment 2 by using Point Tracker Algorithm

Datasets	Number of Vehicles	True Positive (Detected Vehicles)	Rate of True Positive	False Positive (Undetected Vehicles)	Rate of False Positive
Result of Dataset 1 Without assigning Priority	16	14	88%	2	12%
Result of Dataset II Without assigning Priority	52	49	94%	3	6%
Result of Dataset III With assigned Priority	66	57	86%	9	14%
Result of Dataset IV With assigned Priority	36	31	86%	5	14%

4.6 Graphical representation of Implemented Algorithms

Graph (a) represents actual working of IACF algorithm, as just detected the vehicles on other hand graph (b) is representation of implemented algorithm has detected vehicles and non-vehicle, priority to vehicles is assigned with the diamond. Graph (c) is representation of point tracker algorithm as it detects every point of given frame. On other hand graph (d) is representation of implemented Algorithm where vehicle and non-vehicles are detected where priority is also added which is directed towards intelligent traffic handling system with assigned priority.

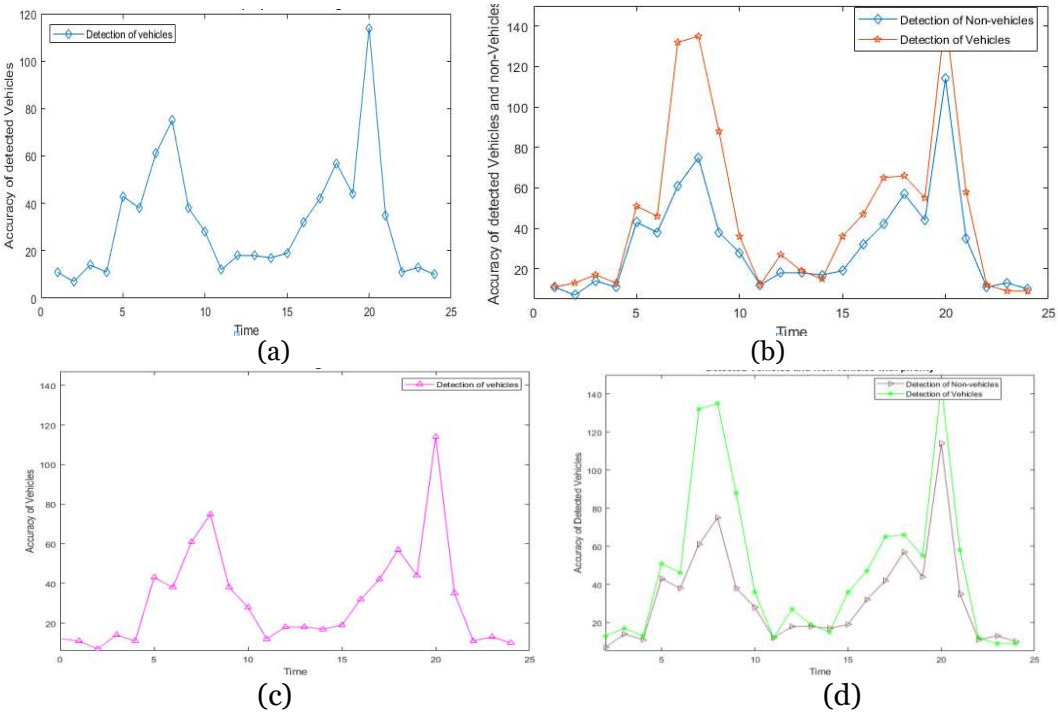


Figure 8 Figure a and b is Graphical representation of IACF, while c and d are representation of Point Tracker algorithm

5.Conclusion and Future Works

In study, a method is proposed to detect, classify and prioritize the vehicle according to the category, size and type of vehicle and non-vehicle along with pedestrians on the road in real-time visualization. Two algorithms Aggregated Channel Feature and point Tracker Algorithms are implemented to check the authenticity of tracking algorithms. ACF followed trained detector function to detect the vehicles, but according to implemented algorithm priority is assigned to every vehicle and non-vehicle. Point tracker algorithm has more accuracy as compare to ACF because it detects the vehicle till last point, Accident detection is added for handling the emergency situation by using both algorithms, an alternative route is successfully suggested to neighboring transports. Providing a substitute route to neighboring vehicles will reduce the delay of traffic in flash point areas, and reduces the congestion. we do not need to train the data for every frame. Overall, the experimental results display that planned method clearly progresses the results and outperform the current state of the art approaches. Two experiments are conducted with four datasets of each experiment, have successful result. The result has depicted the efficiency of proposed techniques.

5.1 Future Work

The future of Intelligent Traffic has new dynamics, autonomous vehicles has taken place of traditional vehicles but there are still needs a accuracy. Keeping in my thesis works following are the consideration for future work:

- For future, speed and velocity of vehicle can be detected as priority factor.
- Distance between source to destination can be detected in order to make the Transportation more Intelligent.
- Lanes can be identified for separate vehicle and during emergency.

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Authors Contribution

All the authors equally contributed in the accomplishment of paper, the tasks are successfully

assigned to every author, according to their specialty and domains. Data analysis is performed by Wania Tahir, Collection of data is prepared by Dr, Raja Asif Wagan, Dr, Bushra Naeem, and Dr Atiq Ahmed, Jawad Hussain, Dr Mahmood Barlayai, Mirza Aamir and Shumaila Hussain supported in the Data Accusation and data verification.

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Code Availability

The Coding and software presented in this study are available on request from the corresponding authors. The coding use in this research is not publicly available.

Declarations

Conflict of Interest

The authors declare no conflict of interest. The funding is made by one of Co-author Dr Raja Asif Wagan.

Ethical approval

After completing the baseline characteristics, the subjects were provided with a detailed explanation about the procedures.

Consent to participate

The subjects are first detailed about the procedures and then after an informed consent.

Consent for publication

The results are obtained from the compiled results on MATLAB.

Code Availability

The used in study will be available on request. The code is not available publicly.

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