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A Survey on Vehicle Classification Techniques

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Abstract: **- Vehicle classification has emerged as a significant field of study because of its importance in the variety of applications like surveillance, security system, traffic congestion, avoidance, accident prevention etc. So far numerous algorithms have been implemented for classifying vehicles; the aim of this paper is to give the opportunity to the researcher to become closely familiar with the methods used for classification of vehicles. Methods based on Image Processing, Neural Networks, and Data Mining are reviewed, discussed and compared. This survey emphasizes that Canny Edge Detection technique gives the better solution than other edge detective techniques in terms of vehicle identification. The Fuzzy c-means clustering and K nearest neighbor algorithms prove better for extracting the features of a vehicle like an area, length-width ratio etc.**

Keywords: **Vehicle classification, Neural Networks, Canny Edge Detection, Fuzzy c-means clustering, K nearest neighbor.**

I. INTRODUCTION

An Intelligent Transportation System (ITS) plays a significant role in the emerging transportation system. It establishes the route to resolve or at least minimize the traffic problems. The significant application prospects of ITS systems have motivated researchers to achieve a certain effective solution. The ITS applications are electronic toll collection, emergency vehicle notification, automatic road enforcement, collision avoidance system reducing congestion, etc... A vehicle is a mobile machine that transports people from one location to other. Vehicle classification has emerged as a major component of much contemporary traffic management and operational systems. The vehicle classification has a large number of real world applications in numerous fields such as traffic surveillance, toll plaza, traffic congestion avoidance, and accident prevention, etc. The vehicle classification is used to classify the vehicle into different categories. The vehicle classification systems used are FHWA, IDOT and EO-WB. The FHWA classifies the vehicle into 13 categories such as motorcycle, car, bus etc. The main goal of vehicle classification is to categorize vehicles into their respective types and to provide better traffic surveillance to reduce the accidents, ability to identify the class of the passing vehicle. This paper is organized as follows. Section II presents the survey of various vehicle classification techniques; Section III compares different vehicle classification techniques with their merits and demerits and finally concludes the paper.

II. LITERATURE SURVEY

K Sowjanya and G Chakravarthy proposed "Vehicle Detection and Classification Using Consecutive Neighbouring Frame Difference Method". The main objective of this paper is to present a robust traffic surveillance system and to avoid occlusions. The morphological operations are used to remove the blobs and to detect the moving vehicle. The number of blobs is sufficient to count the number of vehicles is present in the road. The K Nearest Neighborhood Classification [KNN] algorithm is used to classify the different type of classes (2W, 3W, 4W & 6W). The features Extraction is done by calculating the area, length-width ratio, centroid and rectangularity. The fuzzy c-means [FCM] clustering algorithm is used to classify the vehicle like motor cycle, car, van, truck and so on [1].

Saeid Fazli, Shahram Mohammadi and Morteza Rahmani proposed "Neural Network Based Vehicle Classification for Intelligent Traffic Control". In this paper; the algorithm has two different phases. The input is captured by a camera and the video input is converted into number of frames and each frame is converted to gray scale image. The first phase works background subtraction, edge detection and perform morphological operation included in image processing. The second phase has extracted the special features of the vehicle and these features to applying the Multilayer Perceptron [MLP] in neural network and classified the vehicle in three types of classes like heavy vehicle, light vehicle and motor cycle [2].

Hazim Hamza and Paul Whelan proposed "Night Time Car Recognition using Matlab" is based on the night time road environment. The input image has to segment the tail

lights of the vehicle and to eliminate the non red color components and converted into gray scale image. The median filter is used to filter out the noise in an image and converted to binary image. The holes are isolated using image processing techniques which give white blob in place of red light in the image. When the break is not applied in vehicle this process is performed but the break is applied in a vehicle all the lights are profusely illuminated. So, the dilation is performed in morphological operation. To training the extracted features by using Support Vector Machine [SVM]. The SVM is supervised learning models is associated with algorithm used to analyze the data for the process of regression and classification [3].

Zezhi Chen, Nick Pears, Michael Freeman and Jim Austin proposed "Road Vehicle Classification Using Support Vector Machines" is to provide a robust, accurate and effective technique for classification. The support vector machine is supervised learning method is used to analyze the data and classification. In this paper, the Gaussian Mixture background subtraction algorithm obtains two step processes. First one is vehicle color recognition and the second is vehicle type recognition. The generation of feature vector by using 3D color histograms consist the vehicle color is based on the SVM. It is not only describes the vehicle color and also classify its types. This feature vector is to classify the type of vehicles like car, van or truck [4].

Jyotsna Tripathi, Kavita Chaudhary, Akanksha Joshi and J B Jawale proposed "Automatic Vehicle Counting and Classification" gives accurate information about vehicle density on a highway. Background Subtraction and morphological operation is used to detect the foreground mask of the object. Segmentation and thresholding operations are performed to convert binary image. For counting the counting register was maintained by using blob detection and tracking. To compute area, perimeter, centroid and diameter for classify the type of vehicles like small, medium or big [5].

Jun Yee Ng and Yong Haur Tay proposed "Image based Vehicle Classification System" is image based vehicle classification system include Scale-Invariant Feature Transform [SIFT], Canny edge detector, K-means clustering and Euclidean distance matching techniques. In this paper, classification is divided into two types. They are Inter-class classification [car, van] and Intra-class classification [sedan, taxi] which each have training and matching scheme. The matching scheme input is the output of training scheme. The pre-processing and segmentation includes RGB to grayscale conversion. The clustering algorithm is used to extract the vehicle features and classify the vehicle using Euclidean distance matching algorithm [6].

Ankit Kumar singh and Nemi Chand Bajiya proposed "Image Vehicle Classification Based on Adaptive Edge Detection & PCA Method". In this Paper is divided into three stages. The first stage is normalization to improve the image features and second is processed the normalized image to extract the image features by using Canny edge detection algorithm. And third stage is to perform vehicle classification using PCA [Principal Component Analysis] method. This method is applied to perform the image recognition based on extracted feature. Finally the vehicle is classified into three different types are light vehicle, medium vehicle and heavy vehicle and to improve recognition rate [7].

WEI Wu Member, IEEE, Zhang Qisen and Wang Mingjun proposed "A Method of Vehicle Classification Using Models and Neural Networks". In this paper proposed the parameterized model to describe the vehicle features and classify the vehicles using neural network. The model express the vehicle position using three parameters and network consist Multi-layer Perceptron Networks [MLPN] and Least Exponential Function Error [LEFE]. The input is captured in CCD camera is fixed in toll collection station and extract the vehicle features. The topological structure of neural network for vehicle classification has mixture of three layers MLPN and maximum network [MN] The neural network is classified into vehicle type such as car, small carriage, large carriage, small truck, large truck and other vehicles [8].

Susmita A Meshram and A V Malviya are proposed "Traffic Surveillance by Counting and Classification of Vehicles from Video using Image Processing". The objective of this paper is to count and classify the vehicles by using various methods like edge detection, background subtraction and thresholding techniques. The canny edge detection algorithm is used to detect the edges of the vehicle after filter out the noise and the background subtraction technique is used to detect the foreground parts in an object. To compute the centroid and threshold value is used to count number of large, medium and small vehicles and to classify the size of vehicle such as large, medium and small [9].

Hazem Refai proposed "Accurate Vehicle Classification Including Motorcycles using Piezoelectric Sensors". The single and multi element piezoelectric sensors are placed diagonally on the road way to accurate identifying

vehicles. The inductive loop and piezoelectric sensors provide two measurements for accurate motorcycle detection and classification. This paper consist three modules such as data acquisition, socket server and initial processing, feature extraction and classification. The vehicle classification algorithm has separated into two phases: feature extraction and classification. In this classification, number of axels, shape and size is categorized for identify the motorcycle [10].

Wen Xiao, Bruno Vallet, Konrad Schindler and Nicolas Paparoditis proposed "Street side Vehicle detection, Classification and change detection using Mobile Laser Scanning Data" is only focused on on-street car park monitoring. Mobile Laser Scanning [MLS] systems are utilized for urban street environment with high accuracy and movability. The high frequency laser scanner scans the street vertically along the road. The Support Vector Machine [SVM] and Random Forest [RF] classifiers are used to extract features and classification. The detected vehicle can be localized in boundary box by using 3D coordinates. To extract the vehicle features by using object dimension [length, width & height], volumetric feature [area, volume] and relative position [maximum height, mean height]. The vehicles are grouped in four categories such as subcompact (mini or small), compact (hatchback), full size vehicles (sedan, station wagon, SUV, MPV) and vans [11].

Ghada S Moussa is proposed "Vehicle Type Classification with Geometric and Appearance Attributes" is based on Support Vector Machine. In this paper having two approaches for vehicle classification such as geometric based and appearance based. In geometric based feature extraction of vehicle has two main types such as Scale Invariant Feature Transform [SIFT] and Speeded-Up Robust Feature [SURF] and appearance based the feature is extracted by using Bag-of-Words [BoW] model. These two approaches are performing two tasks like multi-class and intra class vehicle classification. In the multi class vehicle classification is to classify the vehicle in three main classes such as small, medium and large and the intra class vehicle classification has the sub class of medium size vehicle such as pickup (PU), sport utility vehicle (SUV) and van [12].

K Priya and R B Jayanthi rajee proposed "Length Based Vehicle Classification Using Digital Image Processing" is based on vehicle sizes. The sobel edge detection algorithm is used to detect the contour and the morphological dilation has two level binary operations. The first level binary dilation is performed in three directions such as vertical, horizontal and 45 degree is to enlarge the boundary region. The second level dilation has the diamond structure which is one of the most morphological erosion and dilation operations. The objects are isolated by using 8 connectivity neighborhoods and the object is assigned a label indicating the vehicle location. To compute the measurement range such as area and length of the vehicle and each type is assigned this range. The final result is classified into two types of tables. First table consist the vehicle type and wheelbase such as passenger car, van, SUV and pickup truck. Second table display the count of small, medium and large number of vehicles [13].

S Sri Harsha and K R Anne proposed "Gaussian Mixture Model and Deep Neural Network Based Vehicle Detection and Classification" is based on video surveillance systems [9]. In this paper the Gaussian Mixture Model [GMM] algorithm is used to background subtraction of multilane traffic data. The Linear Discriminant Analysis [LDA] and Principle Component Analysis [PCA] algorithm is to provide 91.40% and 96.30% accuracy rate for classification. The GMM algorithm and Connected Component Analysis [CCA] is developed for optimal vehicle region. The Support Vector Machine [SVM] algorithm used to classify the vehicles is two classes such as passenger and other. Again the passenger class is classified into SUV, van, bus and cars [14].

Mohammad Abdul Hannan, Chew Teik Gee and Mohammad Saleh Javadi proposed "Automatic Vehicle Classification using Fast Neural Network and Classical Neural Network for traffic monitoring". The FNN extracts the positive detection and false detection and CNN verify the detected regions. The bootstrap algorithm is used to enhance the neural network performance by adding non-vehicle images into database and also remove the false detections. The Fast Fourier transform is used to detect the vehicle The FNN is a primary classifier and CNN is final classifier to achieve a vehicle classification [15].

P Abinaya, K S Ravichandran and B Santhi proposed "Watershed Segmentation for Vehicle Classification and Counting" for the traffic surveillance system. The background subtraction is used to detect the foreground parts in an object. The Gabor filter is used to measure the vehicle path in video sequences. The Support Vector Machine [SVP] is the supervised learning system used to classify the vehicle like light vehicle such as two wheeler, car and heavy vehicle such as bus and truck [16].

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III COMPARATIVE ANALYSIS OF VEHICLE CLASSIFICATION TECHNIQUES

In vehicle classification, each algorithm follows unique methodology or technique on the basis of recognizing the vehicles. Various types of vehicles are identified by the vehicle classification algorithms. Each technique contains different vehicle samples in order to obtain the overall accuracy rate of the vehicles. The recognition rate or the accuracy of techniques is different depending upon the methodology being adopted by algorithms. The complete details of the classification algorithms and its advantages and disadvantages are shown in Table I.

Table: I Comparative Analysis of Vehicle Classification Algorithms S.No Author Title Algorithm Merits Demerits

S.NO	AUTHOR	TITLE	ALGORITHM	MERITS	DEMERITS
1	K.Sowjanya and G.Chakravarthy	Vehicle Detection and Classification Using Consecutive Neighbouring Frame Difference Method	K Nearest Neighbor Classification [KNN] Fuzzy C-means Clustering	The consecutive methods are used to ensure the reduction in complexity. Reduce Occlusions. Result obtained same accuracy during different weather conditions.	The performance of this system is affected by the selected thresholds.
2	Saied Fazli, Shahram Mohammad and MortezaRahmani	Neural Network based Vehicle Classification for Intelligent Traffic Control	Neural Network Multilayer Perceptron [MLP]	Detect and classify the number of crossing vehicle Increase confidence and reduce road crashes in highways	System only classifies the kind of vehicle like heavy, light and motorcycle, but not clearly identifies the type of vehicles such as car, van, truck etc.
3	Hazim Hamza and PaulWhelan	Night Time Car Recognition Using MATLAB	Segmentation Median Filter Support Vector Machine	Each attributes of HSV directly corresponds to the basic color.	The system is only recognized a car not other vehicles at night time.
4	Zezhi Chen, Nick Pears, Michael Freeman and Jim Austin	Road Vehicle Classification Using Support Vector Machines	Gaussian Mixture model Background Subtraction 3D color histogram	Color and shape classification is involved.	This paper only identifies black, white and red color vehicles.
5	Jyotsna Tripathi, Kavita Chaudhary, Akanksha joshi and J B Jawale	Automatic Vehicle Counting and Classification	Adaptive Background Subtraction Color Based Classification	Single system provides multiple domain outputs. Tracking criminal vehicles by the help of color and type of vehicle.	More work is needed to reduce occlusions. Only classify the vehicles like small, medium and heavy not identify its type of vehicles.
6	Jun Yee Ng and Yong Haur Tay	Image Based Vehicle Classification System	Modified SIFT K-means Clustering Canny Edge Detection Euclidean Distance Matching	The modified SIFT algorithm give robustness. Its similar like human DNA	Images are captured in a mid range surveillance camera with low quality and resolution. Only classify the limited type of vehicles.
7	Ankit Kumar Singh and Nemi Chand Bajiya	Image Vehicle Classification Based on Adaptive Edge Detection & PCA Method	Canny Edge Detection Adaptive PCA Model	The work is testing on multiple datasets. The accuracy rate for vehicle class recognition is 100%	More specific vehicle classes will be needed.
8	WEI Wu Member, IEEE, Zhang Qisen and Wang Mingjun	A Method of Vehicle Classification Using Models and Neural Networks	Parameterized Model MLP Network LEFE	Image quantity is good Computational cost is very small. The classification gives 91% accuracy.	A range of vehicles in a given frame is not clear.
9	Susmita A.Meshram	Traffic Surveillance	Canny Edge	System provides multiple	System does not

	and A.V.Malviya	by Counting and Classification of Vehicles from Video using Image Processing	Detection Segmentation Automatic threshold	outputs like vehicle count and classification.	provide type of classification.
10	Hazem Refai	Accurate Vehicle Classification Including Motorcycles using Piezoelectric Sensors	Vehicle Classification algorithm	Ability to identify only motorcycles.	Hardware implementation is required.
11	Wen Xiao, Bruno Vallet, Konrad Schindler and Nicolas Paparoditis	Street-side Vehicle Detection, Classification and change Detection using Mobile Laser Scanning data	SVM and RF classifiers h-Maxima filter	The Supervised learning method is adapted to different environments. The result of the classifier which yields the best accuracy at 86.0%	Segmentation error is not completely avoided.
12	Ghada S.Moussa	Vehicle Type Classification with Geometric and Appearance Attributes	Support Vector Machine	Multi class & Intra class classification is considered.	Classification not identifies type vehicles.
13	K.Priya and Jayanthi Rajee	Length Based Vehicle Classification Using Digital Image Processing	Sobel Edge Detector Threshold Median filter	Median filter used to remove noise without affecting edges. The algorithm provide more than 85% success rate.	System not classifies motorcycle, auto and heavy truck.
14	S Sri Harsha and K.R.Anne	Gaussian Mixture Model and Deep Neural Network Based Vehicle Detection and Classification	Gaussian Mixture Model [GMM] Polynomial based SVM classifier	Occlusion is avoided in multilane traffic conditions. The highest vehicle classification accuracy is 97.80%.	Only classify the Passenger vehicles like bus, cab etc.
15	Mohammad Abdul HANNAN, Chew Teik GEE & Mohammad Saleh JAVADI	Automatic Vehicle Classification using Fast Neural Network and Classical Neural Network for Traffic Monitoring	Bootstrap algorithm Fast Neural Network [FNN] Classical Neural Network [CNN]	System performance can be improved in increasing number of images. System provides 95.83% accuracy.	Not clearly classified in any type of vehicles.
16	P.Abinaya, K.S.Ravichandran and B.Santhi	Watershed Segmentation for Vehicle Classification and Counting	Watershed Segmentation Gabor filter SVM	Watershed algorithm overcomes the partial occlusion. System gives 80% accuracy	Increase accuracy for vehicle detection at night time.

IV. CONCLUSION

This survey emphasis the Canny Edge Detection technique gives better solution than other edge detective techniques in vehicle identification. . The Fuzzy c-means clustering prove better for grouping the vehicle type of extracting the features of vehicle like area, length, width, ratio etc. The K Nearest Neighbor algorithm is the best classification algorithm is compared to other classification algorithms.

Vehicle Classification has been comprehensively used for identify the vehicle along the road. From this literature survey, various techniques and transformation have been discussed for edge detection, extracting feature and vehicle classification. But, most of the algorithms classify the vehicles like small, medium and heavy classes of vehicles but not identify its types such as car, bus, truck etc.

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