Vision based Car Turn Signal Detection

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Abstract**—**This paper provides a detailed solution to the problem, detection of car turn signals. For autonomous vehicles especially in India now-a-days autonomous driving vehicles are preferred over the driver based driving cars due to the heavy traffic and the lack of systematicness while driving on the roads. The system stated here can identify the turn signals namely left turn and right turn. The motive behind this project was to increase the accuracy and robustness of the drivers assistance systems in autonomous vehicles.The important aspects of the collision avoidance and the driver's assistance is detecting the car turn signals. Unfortunately the previously studied systems have lacked robustness due to huge variability in the shapes and size of the vehicles, variations in the day brightness due to variable environments, cluttered environment and drivers misbehavioural intentions. We have developed a system that will detect the turn signals of the front vehicles and give alert signals. The proposed system uses ORB and DAISY feature extractor to extract the features from the images. The feature vector generated from ORB and DAISY is furthermore optimized using K-Means clustering algorithm. This huge feature vector is converted into 16 clusters. This optimized feature vector is trained on 5 different classifiers namely SVM, Decision Tree, Logistic Regression, KNN, Random forest . The accuracy obtained from these classifiers is as follow 82.79%, 68.23%, 57.90%, 84.34%, 80.55% respectively

Keywords— Akaze, Kmeans, PCA, KNN, Decision Tree.

I. Introduction

Alert signals detecting for vehicles, like turn and brake signals in the robust and lightweight manner is very difficult especially in Autonomous vehicles. For human beings it is very useful as such automatic detection of these turn and brake signals can add up the security feature and useful in the prevention of deadly accidents. According to the survey. In today's world, it is necessary to use automatic turn detection signal features to avoid accidents and to increase the safety of car passengers. Detection of alert signals mainly involves two scenarios: day time turn signal detection and night time turn signal detection. From the complexity point of view, detection of turn signals in day time is more difficult than night time because during day time due to various conditions such as bright sunlight, the reflection of light from the turn signal might not be clearly visible, so it makes it hard to know whether the turn signal is active or not. But in case of night time detection of a turn signal is easy. The detection of night time turn signals are hectic to both the assistant driving systems or the autonomous vehicle driving systems. Main concern about the project is to detect the vehicle during the night time which is quite difficult due to the challenging problems like low visibility , light distortion caused by the motion of the car and the illuminations in the urban areas.

II. Literature Review

Lane changing is frequently used in the naturalistic driving mode. These operations could be reasoned for the frequent traffic fatalities. Driver shows some lane changing intentions before he turns on the turn signal and the experiment was carried out with the study of these intentions before and after 5 sec of turning the signals on . During these studies , eye movement was studied thoroughly . Using Markov theory gaze transition attributes were obtained. These all characteristics including eye movement characteristics stated in the visual attention graph while lane changing.[1] The system stated in [2] is based on low power consumption and uses a vehicle mounted camera. Whole system is running on the microprocessor of the embedded camera and contributes to the detection of the vehicle tail lights and common alert signals. It also keeps the track of the vehicles passed nearby which are very useful for the colligence avoidance. Also in the field of autonomous vehicles traffic sign detection is an important aspect. The survey provided in [3] gives information about some European traffic sign detection systems and also the availability of dataset for these kinds of projects. For any system , driver assisted or autonomous systems it seems that detection of the vehicle turn signal is difficult at night time.The research work provided deals with this problem using Nakagami-image-based method which is mainly used for locating the regions of the vehicles including the lights. The proposed system used a CNN based neural network featured maps. These two combined for generating the region of interest. Then the vehicle candidates are extracted by using a softmax classifier with CNN based features. This research work provided the accuracy of 95% for the front side while providing 90% with night scene recognition. In addition the research work conducted in [4] the same work and seems to deploy a front mounted optical camera and mainly focuses on the heuristic features like symmetry and size of the vehicles and Nakagami-m distribution was used. To bypass the night scattering, a scattering model was developed for tail lights. The project work [5] related to traffic light mapping and detection was studied where the outdoor perception problem was discussed. The work relates to the three dimensional mapping of the positions of traffic lights and robust detection of these traffic lights on boards of the cars. The other state-of-the art project [6] works on the multiparameter prediction of drivers turning behavior or lane-changing behavior using neural networks. A model was developed for predicting the drivers lane changing intentions by experimenting from the results of the naturalistic on road analysis used in the lane changing assistance system. A lane changing intent window was generated by taking an account of the visual characteristics that are collected from rear-view mirrors. From this information an index based system was developed to predict the left lane changes and was developed by taking into consideration the drivers visual search behaviors, operative behaviors , motion states and the changing driving states. A back-propagation neural network model was used for this project and the model can predict the lane changing intent upto 1.5 sec in advance. The project work conducted [7] uses an IOT based approach for tracking and detection of vehicles. This project has discussed the traditional and modern approaches for the detection of vehicles. The paper [8] discusses the methods related to statistical methods, which is the traditional one and the blob detection and its analysis and also discusses the single shot detector techniques like (YOLO-v3) which is capable of fully optimized and enhancement of the exposure capabilities of very small scale targets. Also gives the information regarding some modern deep learning based techniques. The main aim of this research work is to detect and track vehicles in Car Video on the basis of Motion Model. The project work mainly emphasizes on the approach to localize the target vehicles within various conditions in the video. The geometric features extracted from here are continuously appended on the 1D profile and tracked continuously. Mainly reliable on the information from the features for the identification of vehicles which creates the complexity in recognizing the vehicle shapes and colors.Hidden markov Model was used to segregate the target vehicle from the background and track them probabilistically. Model was tested on the different roads day and night-time to check the accuracy of the model.

The real time vehicle tracking system provided in [9] provides the main task of detecting the vehicle at night-time. The system proposed here mainly works on two aspects, making a relative interface which informs the driver real-time relative velocity and position of other vehicles and generates the real time danger alarm when any dangerous situation occurs. The study [10] aims to develop onboard driving assistance which aims to develop the alert signals about the driving environment and the possibility of collision.The main focus of this review paper was to study the system where the camera is mounted on the vehicle and provides a real time interface. The research work [11] emphasizes lack of the features in the previously developed systems like robustness, cluttered environment. Also explains information about the different sensors and the selection of the sensors an modern collision avoidance system should have. Main contributions that we can take from these papers are the motorcycle detection techniques and the detailed survey of different sensors including cost and range parameters. The state-of-art research work [12] mainly aims to modernize the advanced driver assistance systems and the cruise control system. An innovative image processing technique was presented in [13] to detect and track vehicle rear lamp pairs in forward facing video. A camera with (Cmos) sensors and (RGB) color filter was taken into consideration. Advanced camera configurations and different thresholds were used to optimize the results.

III. METHODOLOGY

The work stated in this paper mainly focuses on the front side car turn signal detection. System stated here is capable of detecting both the left and right turn signals . The block diagram Fig.1. shown below describes the whole system.

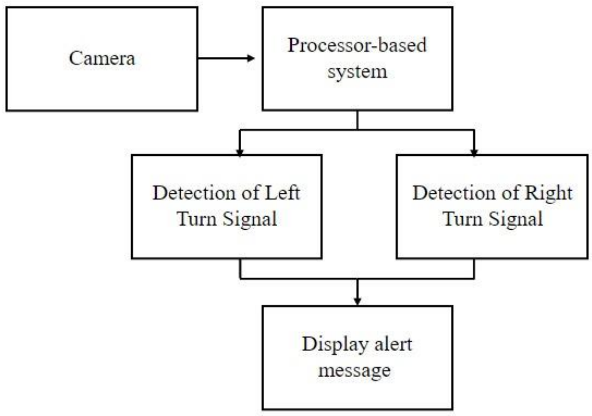


Fig.1. Diagram to describe complete system

Input for the system is taken from the camera mounted on the vehicle and provided to the preprocessor block.

3.1 Dataset And Preprocessing

The dataset which was collected for this project comprises total images of 24,526. This dataset is divided into three classes: left side , right side and negative class. The images in which the car has left turn signal ON these are included in left class and similarly for right class. The images having none of the turn signals ON are included in negative class. The Tables included below gives detailed information of the dataset

Table 1 : Details of the images in the dataset

Different classes in Dataset	No. of images
Left Turn Signal	7709
Right Turn Signal	8141
Non turn	8676
Total no of images	24526

This entire dataset was collected physically on the roads. Following image Fig.2. shows the sample images for the dataset.

Image preprocessing on these images includes the resizing of the images into 300*300 pixels. Next step includes converting all the images into grayscale.

3.2 Feature Extraction and Feature vector compilation :

Feature Detection mainly includes one of the following steps: Detention of corners, edges, blobs, junctions, etc. These features are logically represented as unique patterns composed by comparing nearby pixels. Feature description implies description of one-to-one feature with special identity. This helps for the recognition of these features for matching.

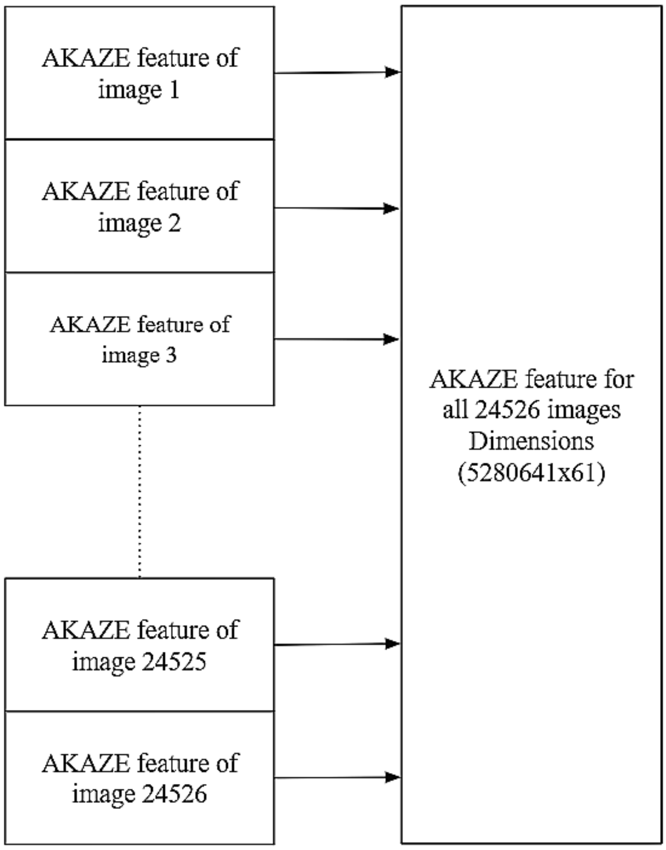
In this project, AKAZE feature extractor was used to extract the descriptive features from the images in the dataset. For feature mapping Hamming Distance for binary features were used.

Like the KAZE algorithm, AKAZE(Accelerated-kaze) is based on nonlinear diffusion filtering. Fast Explicit Diffusion (FED) is used to construct the non-linear-scale spaces in AKAZE. Determinants of the Hessian Matrix were used for AKAZE detectors. Quality of the rotation variance is improved using Scharr filters. Feature points are picked from the maxima of the locator responses in the mapping region. Algorithms used by descriptors in AKAZE are based on the Modified Local Difference Binary(MLDB) algorithm. Because of the nonlinear scale spaces, AKAZE characteristics are scale, rotation, and limited affine invariant. They also have higher distinctness at different scales.

Features are extracted from every image from the dataset using this AKAZE extractor. These features are appended to a CSV file. An array is generated of size Mx61for every image, 'M' is the number of descriptors generated from an image. The total size of these feature vectors generated for an entire dataset was 5280641x61.

K-Means clustering was used to convert such a large feature vector array into 16 clusters. The Elbow method was used to find the optimum number of clusters. The outputs of each image are appended to a CSV file . Thus, feature vectors are reduced to 24522x16 after applying the K-means clustering algorithm.

The steps for dimensionality reduction and feature vector compilation are stated in the fig.4. and the algorithms used for the same are stated below.



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Algorithm:Dimensionality Reduction

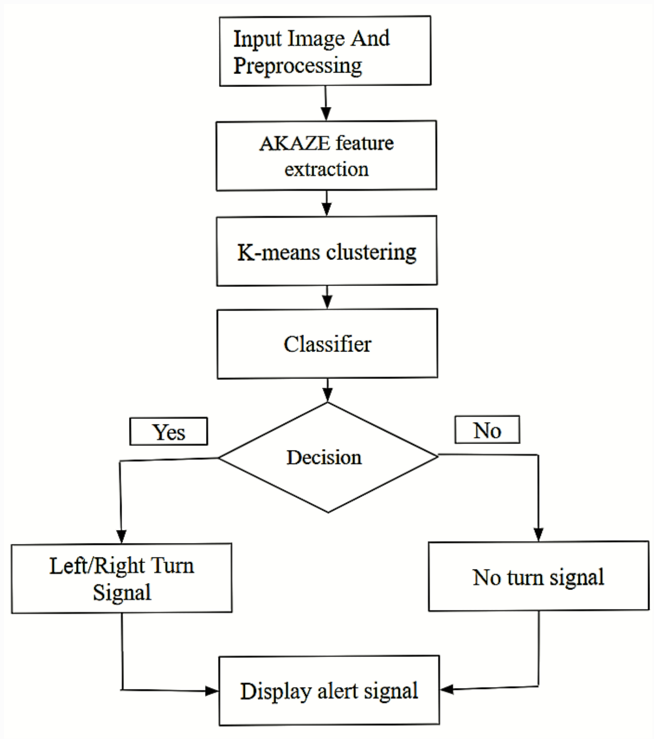
Input : Input is a feature vector of 2022457 rows and 61 columns.
Output: Optimized feature vector of 24522 row and 16 columns.

This is a Loop process.
1: for each and every image in the dataset **do**
2:Use the pre-trained k-means clustering to make predictions.
3: Data normalization.
4: Append normalized data to the feature vector.
5: end for
6: Standardization using standard scalar.
7: Apply PCA (n_components = 16).
8: Apply PCA transform.
9: return the Optimized feature vector of 25522 rows x 16 columns

All of the processes are stated in the flow diagram given below and the overall algorithm is stated below.

2.4 Classification Models Incorporated:

The proposed project uses three different classifiers to detect the car turn signals accurately. These three classifiers are namely decision tree, random forest, K-Nearest Neighbor(KNN). Performance parameters such as training accuracy and testing accuracy were assessed for the correct detection of the car turn signal.



Algorithm 3 : Classification and Detection of Turn Signal

Input : Optimized feature vector of 24522 row and 16 columns
Output: Classified left and right turn signal.

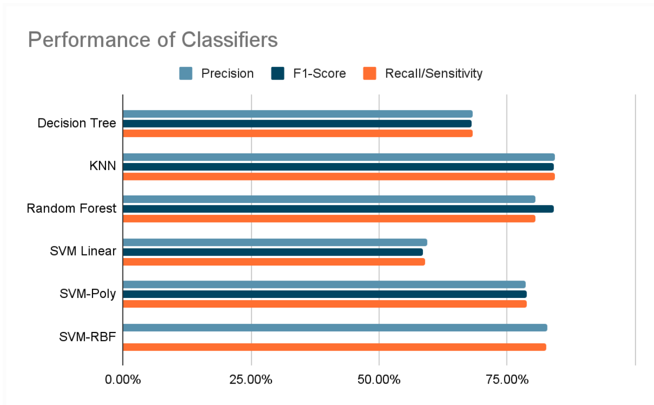
Procedure :
1: Fit the random forest classifier model with the training data.
2: Using this pre-trained model, make predictions for the test data.
3: if (accuracy >= minimumAccuracy && predicted class label == 0)
4: return Left turn signal detected
5: if (accuracy >= minimumAccuracy && predicted class label == 1)
6: return Right turn signal detected
7: if (accuracy >= minimumAccuracy && predicted class label == 2)
8: return Neither left nor right turn signal
9: else unable to classify the scene performance metrics

Result:

In total three classifiers were used for the assessment of vehicle turn signal detection. The training and testing results of all three models are shown in the below table.

The entire dataset was divided into two parts: training and testing. a total 80% of the data was optimized for training and the remaining 20% was used for testing purposes. The performance of classifiers was evaluated using a total of 4000 test photos. The majority of photos were correctly identified by all classifiers. The K-Nearest Neighbor has the highest training and testing accuracy of all the classifiers, at 89.98 percent and 84.34 percent, respectively. For anticipating the vehicle's left and right turn signals, this model employs a Random Forest classifier.

	Classifier Performance		
Classifiers	Precision	Recall/Sensitivity	F1-Score
Decision Tree	68.16%	68.15%	68.13%
KNN	84.32%	84.30%	84.16%
Random Forest	80.58%	80.48%	84.16%
SVM Linear	59.35%	58.9%	58.5%
SVM-Poly	78.5%	78.82%	78.81%
SVM-RBF	82.71%	82.7%	82.7%



Conclusion:
The proposed system was able to detect two different types of car turn signals. The signals are left and right turn signals. In the car automation technology or in self driving car technology this system can be of great help. Even in normal cars if this system is implemented then it can help drivers to drive cars safely and can avoid accidents.

If the intensity of the car turn signal is not high or the intensity of the surroundings is higher than the intensity of the turn signal then the accuracy of the system reduces. If there are multiple cars in a single frame with turn signals then also the accuracy of the system reduces.
Currently this system only shows if the car turn signal is left or right, but this functionality can be extended. If the vehicle in front suddenly starts the turn signal then this system can automatically reduce the speed of the car. This can help in preventing car accidents.

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