A Survey on the Techniques for Traffic Sign Detection and Workzone Identification

Arya Krishnan G, Nishy Reshmi S

Abstract— Road Sign Recognition is a field of computer vision. Fast real-time and robust automatic traffic sign detection can significantly increase driving safety and comfort. Automatic detection and recognition of traffic sign is also important for an automated intelligent driving vehicle or for driver assistance systems. This paper provides a comprehensive survey on traffic sign detection and recognition techniques based on image and video data on automated driving vehicles and a comparative study between different methods used by various researchers. This also contains a new challenge faced by an autonomous vehicle that how they respond to an unexpected road conditions, such as highway work zones ,because such unusual events can alter previously known traffic rules and road geometry..

Index Terms— Computer Vision, Highway work zone recognition, Traffic sign recognition

I. INTRODUCTION

Traffic Sign Recognition (TSR) and detection is an important feature in an automated intelligent driving vehicle. Fast, robust and real-time automatic traffic sign detection and recognition can significantly increase driving safety and comfort since traffic signs has provide important visual information such as; driving on proper lanes, speed limitations, presence of other vehicles, nearby, pedestrian crossing lane, current traffic condition etc. Main challenges faced during recognition is identification of traffic signs with respect to varying natural background viewing conditions. Traffic sign recognition systems consists of mainly two phases :Detection and Recognition[7].That is detection of traffic sign from an input image and recognize of those detected signs, by using the concept of neural network[1-8].Detection algorithms are normally based on shape or color segmentation.

A. Color Based Detection

Most of the road sign recognition system depends on color segmentation process that extracts out the color road sign objects from the background for recognition. Colors can be an important source of information because colors are distinguishing features of traffic signs thus they can simplify the process. Color processing can significantly reduce the amount of false edge points produced by low-level image processing operations. The colors used in the road signs are commonly primary colors. But this image is not suitable for detection because any variation in the light intensity affects the RGB system by shifting the cluster of colors towards the white or the black corners.HSI/HSV Transformation, Color Neural Network, Color Thresholding Segmentation, Region Growing etc have been developed for color-based recognition.

B. Shape Based Detection

Another method is based on the concept of shape of the road signs. This detection method can overcome the problems faced by color based detection. Centroidal approach is one method for shape detection. Shape based detection may has to face various problems like[9] ,

- Imperfect shape.
- Variance in scale.
- Variation in size.
- Sign may appear in cluttered scenes.

Moreover the shape can be confused with several other man- made objects like commercial sign and building windows. But these techniques are more robust to changing illumination because they detect shapes using boundary information. The commonly used shape based approaches are, Shape Neural Network, Template Matching ,Similarity Detection etc[3].

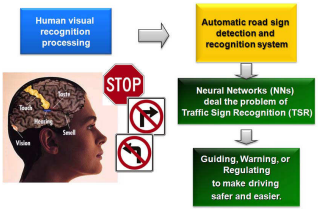

Fig 1

Many techniques have been developed for road sign recognition. Special color barcodes under road signs were used for recognition[9].But this took a lot of time and resources. Ayogya and Askura [4] was also proposed an algorithm known as Genetic algorithm, but it is not guaranteed to achieve results. For obtain an accurate result, the search space is to be reduced and for improving efficiency ,potential regions of the image is to be identified. Detection subsystem is to search for corresponding road signs, where the acquisition image is preprocessed, enhanced and segmented according to the sign properties. The traffic sign images are investigated to detect potential pixel regions which could be recognized as possible road signs from the complex background [3].The potential objects are then normalized to a specified size, and input to recognition phase.

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II. IMAGE PROCESSING STAGES

Image processing includes data acquisition, preprocessing, feature extraction, classification and post-processing, in which preprocessing is the most crucial phase, to modify the data to correct deficiencies in the acquisition process or to prepare the data for subsequent activities. Preprocessing describes any type of processing performed on raw data to prepare it for another processing procedure [2].The main task in preprocessing is to increase the recognition rate and decrease the complexities.

After acquisition, Image Extraction and Sign Detection is to be performed. The Sign Detection and Extraction stage extracts all the traffic signs contained in each image and generates the small images called blobs[3].Each blob will be a valuable parameter to Recognition Stage.Fig.2 illustrates the system configuration.

A. Image Preprocessing

Images captured during acquisition process may be degraded by noise. Noise removal is an important task in preprocessing. Filters are required for removing the noise [8].Linear and non-linear filters like Adaptive filter, Linear smoothing filters, Median filters, Fuzzy filters etc are available .Most commonly occupying noise are,

- Impulse Noise
- Additive Noise
- Multiplicative Noise

Linear filters are not able to effectively eliminate impulse noise as they have a tendency to blur the edges of an image. Non-linear filters are suited for dealing with impulse noise .

B. Feature Extraction

Input image from the video sequence must be an image with natural background. This image is read in both color and black and white mode[3].The recognition phase starts with feature extraction [7].Black and white mode acts as the base image to find the threshold of this image. This threshold is essential for changing an image from black and white to binary image. Feature extraction stage includes for finding corners and edges. Thresholding is a generalized form of edge detection. Binary images are used to find contours and the interesting region. Before the image is changed to binary, the technique of smooth image with Gaussians filter and Canny edge detection is used. Smooth technique led to enhance the image for obtaining the region of interest

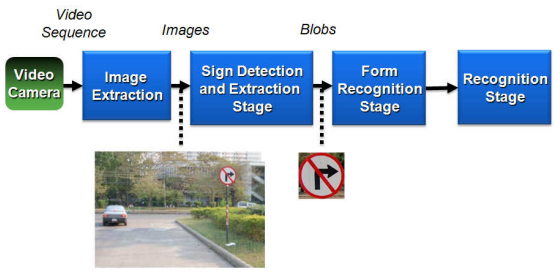

Fig 2 : System Configuration

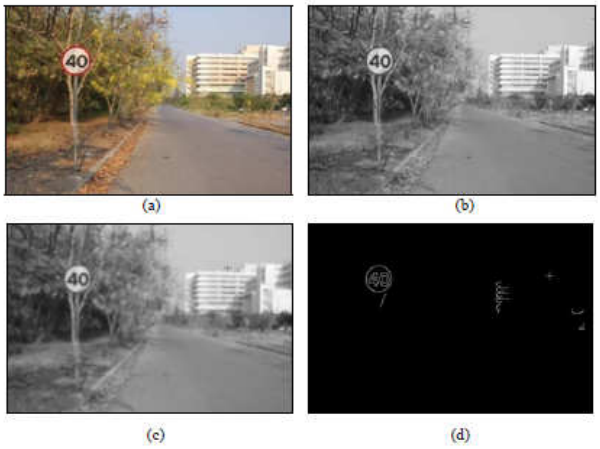

Fig 3 : (a) Color Mode Image,(b) Black and White Mode Image,(c) Smooth Image, (d) Binary Image

III. IMAGE CLASSIFICATION

After detecting the traffic sign region from the input image, next step is to classify the extracted regions of interest into the suitable road-sign category. Artificial Neural Network (ANN),Support Vector Machines (SVM),Fuzzy measures, Genetic Algorithms (GA) and Genetic Algorithms with Neural Networks are different techniques used in image classification, developed for road sign recognition and classification.

IV. WORZONE IDENTIFICATION

Autonomous vehicles should have the capability for identifying unusual and exceptional road conditions like highway workzones, because such events can alter the previously known traffic rules and road geometry. Various computer vision methods are available ,which recognize through identification of workzone signs, the bounds of a highway workzone and temporary changes in highway driving environments under various weather conditions[9].To effectively handle unexpected road events, an autonomous vehicle should have the capability for detection and recognition and should be respond to them accordingly. To meet such a problem, vehicle has to be provided with such perception and behavioral capabilities. The study of Jongho and Wende [9] shows various computer vision algorithms, by recognizing traffic signs in the input images, aim at identifying the workzone boundaries and recognizing the temporary changes. Their study depends on various traffic sign recognition techniques like SVM,ANN,KNN,Adaboost and Meanshift algorithm. The system is illustrated in the fig.4.

V. COMPARATIVE STUDY OF TECHNIQUES

By comparing various classification techniques like Artificial Neural Networks, K-Nearest Neighbor ,Support Vector Machines, Fuzzy Logic and Genetic Algorithms with respect to several parameters, we can reached to several conclusions. ANN is useful for classification and regression and more tolerant to noisy inputs, and also over-fitting may result if too many attributes/features are used. K-NN is one of the simplest classification methods, based on the use of distance measures.

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However, the K-NN rule doesn't take the fact that different neighbors may give different evidences into consideration [9].

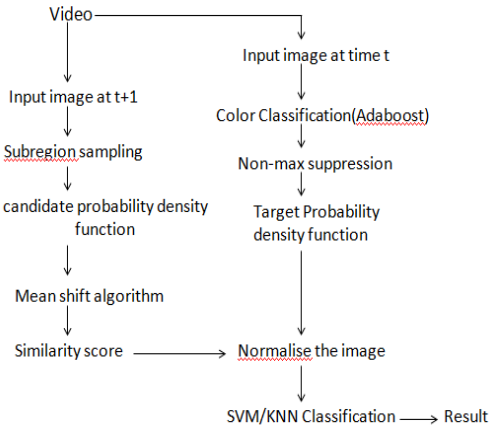

Fig 4:

The objects which are close together will belong to the same category and so to have a more robust classification. A distance weighted K-NN classifier can be used to assign an unknown object to that class for which the weights of the representatives among the k nearest neighbors sum to the greatest value.SVM are based on the concept of decision planes that define decision boundaries and model non-linear class boundaries. Over-fitting is unlikely to occur in SVM. For taking Fuzzy measures, prior knowledge is essential to obtain good results. Genetic algorithms have a good solution [5].But the computation of scoring function is non-trivial.In the case of workzone identification, by using Adaboost and Mean shift algorithm ,it was able to perfectly identify the workzone boundaries and can easily detect a majority of driving condition changes.

VI. Conclusion

Traffic sign recognition is an important goal of almost all road environment understanding systems, especially in the case of automated vehicles. Color based or shape based detection methods are available,each having their own advantages as well as disadvantages. In the detection phase, each input image is first segmented into some regions. After color-classification each region in a labeled image is checked whether it satisfies certain constraints on its size and color combinations with neighbor regions etc. and only if these constraints are satisfied the region can be marked as a region of interest(ROI) for the next stage, recognition phase. In this phase, extracted sign image is correctly classified under suitable category. In the case of workzone identification, Adaboost and mean shift algorithms are effectively localize, detect and classify the workzone signs. These are highly efficient as compared to other algorithms.

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