Abstract - According to statistics, most road accidents take place due to lack of response time to instant traffic events. With the self-driving cars, this problem can be addressed by implementing automated systems to detect these traffic events. To design such recognition system in self-driving automated cars, it is important to monitor and maneuver through real-time traffic events. Traffic signs recognition (TSR) is an important part of some advanced driver-assistance systems (ADASs) and auto driving systems (ADSs). Traffic sign recognition contains two technologies, namely, traffic sign classification (TSC) and traffic sign detection (TSD). As the first key step of TSR, traffic sign detection (TSD) is a challenging problem because of different types, small sizes and complex driving scenes. In today’s world there are many technologies for Traffic sign recognition (TSR).Here is an attempt of understanding and reviewing the different technologies and methods of designing the TSR system.

Key Words: ADAS systems, TSD, Lidars, RGB Color space, Region of Interest (ROI) and Neural Network (NN)

1. INTRODUCTION

Machine vision and pattern recognition are the two main technologies that are used not only in the ADAS systems but also used for other applications like biological and biomedical imaging and interpretation of temporal patterns in seismic array recordings. For any image recognition or detection system the first thing that has to be considered is sensing the image which is done by cameras and LIDARS for an autonomous car. Fig-1 shows the basic block diagram of image detection. In the review process the detection techniques can be classified under three main categories namely color based detection techniques, shape based detection techniques and machine learning based detection techniques. Through the advantages and disadvantages the different techniques have led to new efficient algorithms. Regarding color based detection, there are two approaches, either working on the standard RGB color space [1], or performing a deeper analysis of color information. Shape detection methods are popular methods which are used to obtain the position of the traffic signal and to detect shapes like circle, triangle and octagon. With the development of machine learning methods especially deep learning methodologies, the machine learning based detection methods have gradually become the main stream algorithms. Based on the deep learning methodologies there are three main structures: AdaBoost based detection, Support Vector Machine (SVM) based detection, and Neural Networks (NN) based detection.

2. Detection Methodologies

2.1 Color based detection

Traffic signs are designed in such a way that the colors for particular signal are different which will be easier for the driver to immediately recognize it. This concept is used in the color based detection technique where distinct color characteristics are main attributes for the system. Table-1 shows the color based detection techniques.

The RGB space is the most basic color space for images and videos captured by cameras. Though RGB can be used with no transformation, but are sensitive to illumination changes because the R, G and B channels have high correlation. It is difficult to robustly segment a special color with some fixed thresholds in RGB space [1]. This was eliminated by using normalized version of RGB (NRGB) with respect to R+G+B. In the NRGB space, different illuminations have little effect on the pixel values; and two channels are enough to perform classification because the rest channel can be obtained with these two channels. RGB space is highly sensitive to lightning which is the main drawback of the RGB based thresholding [1].

The hue and saturation channels can be calculated using RGB, which increases with the increase in time[1].The RGB-HSV conversion formulae are non-linear and that’s the reason the computation is difficult [3].However, this problem can be easily avoided by pre-computing the color space conversion and storing it in a look-up table[4].
Thresholding on other spaces are the methods that are designed on some other color spaces, which are Ohta, L*a*b and XYZ. Ohta space is used in extracting red, blue and yellow colors [1]. In [5] L*a*b space used K means clustering method to detect the blue, yellow and green colors.

All the methods used above were finding color pixel value whereas the chromatic/achromatic decomposition method finds pixels with no color information. A detailed description of the categories of this method is given in [1] can be divided into two main categories: chromatic/achromatic index method, RGB difference method, NRGB method, saturation and intensity based method and Ohta components based method. In [5] to detect white color the author combined L*a*b space, HIS space and RGB space.

SVM classification method is used to classify the color from background pixels in [1]. Based on the neural network concept the input pixel values are used to train the network for color pixel classification [6].

Table -1: Color based detection techniques

To overcome this Barnes et al. [8] designed speed shape based detection technique called fast radial symmetry which utilizes radial symmetry voting to detect symmetry shapes. Even the polygon shapes can be detected using this technique [14].

The signs with significant edges can be detected by the analysis and matching of various shapes. Fang et al. [9] designed various complex shapes which were not easy to be detected by the previously stated techniques, hence decomposition method [10] was designed which was supported by maximal supported convex arcs to detect various complex traffic signs.

In 2011 the traffic signs were represented in the form of Fourier transformation to make it easy for detection [15], which became very helpful in detecting signs by combining various measures. In [12] Fourier transformation method which adopted fast Fourier transforms with triangular normalization and reorientation algorithm to locate sign position [11].

Key points detection detects singularities or angular edges of the traffic signs. Scale-invariant and rotation invariant are very well known Feature Transforms [17]. The corners of the signs were detected using Harris corner [16] by selecting the ROI according to the shapes in the corresponding neighborhood. Khan et al. [13] introduced Gabor filter which extracted stable local features of the detected ROI.

Table -2: Color based detection

2.2 Shape Based Detection

Shape based detection techniques are classified as shown in the Table-2. With respect to the shape based techniques some common standard shapes in the traffic sign like circles, triangles, rectangle and octagon can be detected.

The standard shape of traffic sign are usually detected using shape detection. The special shapes are detected using several shape based detection techniques like Hough Detection [7] but whenever there are large number of images Hough based methods don't give much efficiency.
2.3 Neural Networks Based Detection

Feature extraction is the main method in the most of the Support vector machine and AdaBoost methods. In table-3 the various NN methods have been listed. Neural network based methods are the ones which are different from the other detection technologies. Mainly convolutional NN use a classifier to classify the objects from the backgrounds and need R0Is extraction methods to get the image [18][19]. Later along with the CNN AdaBoost classifier extraction came into existence [26]. Zhu et al. [20] proposed text based method along with the two NN (ROI extraction network and fast detection network), the accuracy of these methods depends on the designed ROI’s extraction method. Yang et al [24] proposed a two stage strategy, first stage is Attention Network (AN) and second stage is Fine Region Proposal Network (FRPN). In [21] a new method was proposed fully convolutional network and deep CNN for classification which have their own ROI extraction network. Most of the CNNs are slow to detect the traffic signs. This defect in CNN led to the new concept called You Only Look Once (YOLO) [22] which had YOLOv2 to design the network.

<table>
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3. CONCLUSION

In this review basically we have divided detection methodologies into three main categories: color based detection, shape based detection and neural network based detection methods. Based on the performance of all the detection methods mentioned above it can be concluded that the performance of the neural network based methods is good as far as the best method to detect the traffic signs is considered. Extreme weather has a great impact on the quality of the images captured by cameras. Extreme weather conditions such as heavy fog, heavy rain and heavy snow were also not considered in previous methods. In future, new methods and new datasets that can handle night and extreme weather conditions are needed to improve the ability of camera based TSD methods to deal with these conditions.

REFERENCES


