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Traffic Sign Recognition Using SVM

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Abstract*— *Traffic signs are used developing for required data that could assist the highway engineers for updating and maintaining them. It uses bunch of images taken by a video camera from moving vehicle.

The Four color segmentation & recognition algorithms are developed and checked. They are a shadow and highlighted even, a dynamic threshold, a improvisation of de la Escalera's algorithm and a Fuzzy color segmentation. All the algorithms are goes from verification process & tested using many of images and the shadow-highlight invariant is eventually chosen as the best algorithm. This is because it is more resistive to shadows and highlights. It is also durable as it was tested in different environmental conditions. Near about 96.99% successful segmentation rate was achieved using this type of algorithm.

Recognition of traffic signs is held out using a fuzzy shape recognizer. On shape based fuzzy rules were developed to determine the shape of the sign. Among these shape measures octangonality has been involved in this research paper. The final decision of the recognizer is based on the combination of both the color and shape of the sign. The recognizer was tested in a many of testing conditions giving an overall performance of approximately 88.01%.

Classification was carried out using a SVM classifier. The classification is done in 2 stages: rim's shape classification followed by the classification of interior of the sign.

Keywords—Segmentation; SVM; highlighted invariant,BOLb,Otsu

1. INTRODUCTION

1. Background

Road and traffic signs used in this thesis are those that use a symbolic language about the road(s) A type of sign that is NOT considered in this thesis is the direction sign, in which the upcoming directions for getting to named towns or on numbered routes are shown not symbolically but essentially by text.

Road and traffic signs must be legitimately introduced in the vital areas and a stock of them is ideally needed to help ensure adequate updating and maintenance. An automatic means of detecting and recognizing traffic signs can make a significant contribution to this goal by providing a fast method of detecting, classifying and logging signs. This method helps to develop the inventory accurately and consistently. Once this is done, the detection of disfigured or obscured signs becomes easier for human operator.

Road and traffic sign recognition is the field of study that can be used to aid the development of an inventory system (for which real-time recognition is not required) or aid the development of an in-car advisory system (when real-time recognition is necessary). Both road sign inventory and road sign recognition is concerned with traffic signs, face similar challenges and use automatic detection and recognition.

A road and traffic sign recognition framework could on a fundamental level be produced as a major aspect of an Intelligent. Transport Systems (ITS) systems can include road sensors, in-vehicle route administrations, electronic message, and traffic management and monitoring. This thesis aims to develop a system to recognize and classify street and movement signs with the end goal of building up an inventory which could assist the highway authorities to update and maintain the traffic signs. It is based on taking images by a camera from a moving vehicle and invoking color segmentation, shape recognition, and classification to detect the signs in these images.

1.2 Aims and Objectives of the Research

This system will help to all authorities in the task of maintaining and updating their road and traffic signs by automatically detecting and classifying one or more traffic signs from a complex scene when captured by a camera from a vehicle.

The main strategy is to find the right combination of colors in the scene so that one color is located inside the convex hull of another color and combine this with the right shape. If a candidate is found, the system tries to classify the object according to the rim-pictogram combination and give the result of this classification. The objectives are thus:

1. To understand the properties of road and traffic signs and their implications for image processing for the recognition task.
2. To understand color, color spaces and it's conversion
3. To develop robust color segmentation algorithms that can be used in a wide range of environmental conditions.
4. To develop a recognizer that will invariant to in-plane transformations such as translation, rotation, and scaling based on invariant shape measures.
5. To identify the most appropriate approach for feature extraction from road signs.
6. To develop an appropriate road sign classification algorithm.
7. To evaluate the performance of the aforementioned methods for robustness under different conditions of weather, lighting geometry, and sign.

2. TRAFFIC SIGNS

Road and traffic signs, traffic lights and other traffic devices are used to regulate, warn, guide or inform road users. They help achieve an acceptable level of road traffic quality and increase safety with orderly and predictable movement of all traffic, both vehicular and pedestrian.

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2.1 Properties of Road and Traffic Signs

Road traffic signs are characterized by a number of features which made them recognizable with respect to the environment:

Road signs are designed, manufactured and installed according to strict regulations

They are designed in fixed 2-D shapes such as triangles, circles, octagons, or rectangles

The colors of the signs are chosen to contrast with the surroundings, which make them easily recognizable by drivers

The colors are regulated by the sign category

The information on the sign has one color and the rest of the sign has another color. The tint of the color paint which is used for the sign should correspond to a specific wavelength in the visible spectrum

The signs are located in well-defined locations with respect to the road, so that the driver can, more or less, anticipate the location of these signs

They may contain a pictogram, a string of characters or both

1. **Mandatory signs**:

   These signs are used to inform road users of certain laws and regulations to provide safety and free flow of traffic.

Fig 2.1 Mandatory Traffic signs in India

2. **Informatory Signs**:

   These signs are used to guide road users along routes, inform them about destination and distance, and identify points of geographical and historical.

Fig 2.2 Informatory Traffic signs in India

3. **Cautionary Signs**:

   These signs are used to warn the road users of the existence of certain hazardous condition either on or adjacent to the roadway, so that the motorists are cautious and take the desired action. Some of the signs, which fall under this category, are provided as follows

Fig2.3 Cautionary Traffic Signs in India

3. PROBLEM FORMULATION

Considering the object recognition and interpretation abilities of humans, it is a hard task to try to develop a computer based system which should be able to support people in everyday life. There are a lot of conditions which are changing continuously such as luminance and visibility, which are handled by the human recognition system with ease but present serious problems for computer based recognition.

Looking at the problem of road and traffic sign recognition shows that the goal is well defined and it seems to be a simple problem. Road signs are located in standard positions and they have standard shapes, standard colors, and their pictograms are known.

To see the problem in its full scale, however, a number of parameters that affect the performance of the detection system need to be studied carefully. Road sign images are acquired using a digital camera for the purpose of the current analysis. However, still images captured from a moving camera may suffer from motion blur. Moreover, these images can contain road signs which are partially or totally occluded by other objects such as vehicles or pedestrians. Other problems, such as the presence of objects similar to road signs, such as buildings or billboards, can affect the system and make sign detection difficult. The system should be able to deal with traffic and road signs in a wide range of weather and illumination variant environments such as different seasons, different weather condition e.g. sunny, foggy, rainy and snowy conditions. Different potential difficulties are depicted in one section of this chapter.

Using the system in different countries can make the problem even worse. Diverse nations use distinctive hues and diverse pictograms. The system should also be adaptive, which means it should allow continuous learning otherwise the training should be repeated for every country.

To deal with all these constraints, road sign recognition should be provided with a large number of sign examples to allow the system to respond correctly when a traffic sign is encountered.

3.1 What is Road Sign Recognition?

It is a technique which uses computer vision and artificial intelligence to extract the road signs from outdoor images taken in uncontrolled lighting conditions where these signs may be occluded by other objects, and may suffer from different problems such as color fading, disorientation, and variations in shape and size.

The identification of the road signs is achieved through two main stages:

1. ***Detection***- In the discovery stage, the picture is pre-handled, improved, and fragmented by sign properties, for example, shading or shape or both. The yield is a sectioned picture containing potential areas which could be perceived as would be prudent street signs. The effectiveness and velocity of the identification are imperative variables since they lessen the inquiry space and demonstrate just potential locales.
2. ***Recognition.*** **-** In the acknowledgment organize, each of the applicants is tried against a specific arrangement of components (an example) to choose whether it is in the gathering of street signs or not, and afterward as indicated by these elements they are characterized into various gatherings. These elements are picked in order to stress the distinctions among the classes. The state of the sign assumes a focal part in this stage and the signs are characterized into various classes, for example, triangles, circles, octagons. Pictogram investigation permits a further phase of grouping. By breaking down pictogram shapes together with the content accessible in the inside of the sign, it is anything but difficult to choose the individual class of the sign under thought. A model of street Sign identification and acknowledgment framework. The framework can be actualized by shading data, shape data, or both. Consolidating shading and shape may give better results if the two elements are accessible, yet numerous studies have demonstrated that identification and acknowledgment can be accomplished regardless of the possibility that one segment, shading or shape, is absent.

3.2 Road Sign Recognition Applications

Driver Support System (DSS) can distinguish and perceive street signs continuously. This enhances movement stream and security and stay away from dangerous driving conditions, for example, impacts. Research bunches have concentrated on different parts of sign location, more identified with the advancement of a programmed pilot, for example, the identification of the street outskirts and/or the acknowledgment of impediments in the vehicle's way. Different frameworks can offer notices to drivers when they surpass as far as possible. Future Intelligent Vehicles would take a few choices about their rate, direction, and so forth relying upon the signs recognized. In spite of the fact that, later on, it can be a piece of a completely computerized vehicle, now it can be a backing as far as possible the velocity of the vehicle, send a notice signal showing overabundance speed, caution or cutoff unlawful man oeuvres or demonstrate prior the nearness of a sign to the driver. The general thought is to bolster the driver in a few errands, permitting him or her to focus on driving.

Highway maintenance: This is used to check the presence and condition of the signs. Instead of an operator watching a video tape, which is a tedious work because the signs appear from time to time and the operator should pay a great attention to find the damaged ones, the road-sign detection and recognition system can do this job automatically for the signs with good conditions and alerts the operator when the sign is located but not classified.

Sign inventory. The many millions of roadway signs necessary to keep roadways safe and traffic flowing present a particular logistical challenge for those responsible for the installation and maintenance of those signs. Road signs must be properly installed in the necessary locations and an inventory of those signs must be maintained for future reference.

Mobile Robots: Landmarks similar to road and traffic signs can be used to automatically mobilize robots depending on the detection and recognition of these landmarks by the robot

3.3 Potential Difficulties

Street signs can be found in various conditions, for example, matured, harmed, confused and so forth and subsequently the discovery and acknowledgment of these signs may confront one or a greater amount of the accompanying troubles:

The shade of the sign blurs with time as a consequence of long introduction to daylight, and the response of the paint with the air harmed signs. Awful climate conditions (Rain and Snow).The nearness of obstructions in the scene.

Size of signs relies on upon the separation between the camera and the sign. Comparable articles in the scene or comparative foundation shading. , hues in various nations, Motion obscure issue, Reflection from sign board; different pictograms are utilized as a part of various nations stickers which harmed the pictogram of a sign.

4. SYSTEM OVERVIEW

The proposed approach comprises of the accompanying two stages:

The street signs are catch by video securing then this video is changed over into picture outlines utilizing outline transformation, after this these pictures edges are upgrade utilizing middle channel. Pictures are go to division process utilizing Blob examination or Otsus Thresholding .The Feature are removed from the Segmented pictures utilizing highlight extraction techniques like Gabor channel and shading histogram. The SVM classifier use for the grouping and basic leadership with the information base as of now put away. The Fig 4.1 shows the process flowchart for whole process of traffic sign detection & recognition

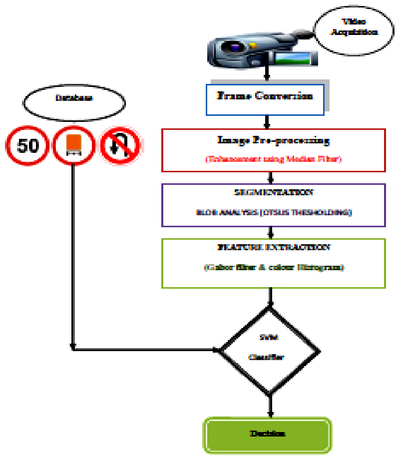

Figure 4.1: Process flowchart

4.1 Median Filter

Median filtering is a nonlinear strategy used to expel clamor from pictures. It is generally utilized as it is exceptionally powerful at expelling commotion while protecting edges. It is especially viable at expelling 'salt and pepper' sort commotion. The middle channel works by traveling through the picture pixel by pixel, supplanting every worth with the middle benefit of neighboring pixels. The example of neighbors is known as the "window", which slides, pixel by pixel over the whole picture 2 pixels, over the whole picture. The middle is computed by first sorting all the pixel values from the window into numerical request, and afterward supplanting the pixel being considered with the center (middle) pixel esteem.

4.1.1 Image filtering

Image filtering consists of basically two stages one is noise detection & second is noise cancellation as described below:

Stage 1: Noise Detection: This stage is expected to recognize the "noise pixel" applicants from an image of size M*N pixels. It is known that for an picture with L power levels, the pixels defiled by the impulse noise are usually digitized into either the minimum on the other hand the most extreme estimations of the element range(i. e 0 or L-1).Therefore, at each pixel location (x, y),we can mask alpha by using the following equation:

$$\alpha(x,y)=\begin{cases}1 & : \quad f(x,y)=0 \text{ or } L-1\\ 0 & : \quad \text{otherwise}\end{cases} \qquad 1)$$

Where f is the input image, and the value 1 and 0 represent the "noisy pixel" and "noise free pixel".

Stage 2: Noise Cancellation: In this stage, the output image g is obtained by using the switching median filter framework as defined by,

$$g(x,y)=\begin{cases}f(x,y) & : \quad \alpha(x,y)=0\\ m(x,y) & : \quad \text{otherwise}\end{cases} \qquad 2)$$

Where m is the median value obtained from our adaptive method. The implementation of SAM filter, CSAM filter, WSAM filter, WCSAM filter.

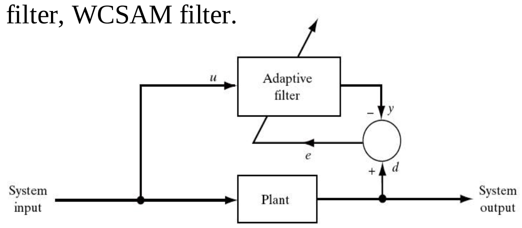

Figure 4.2: Adaptive Median Filter

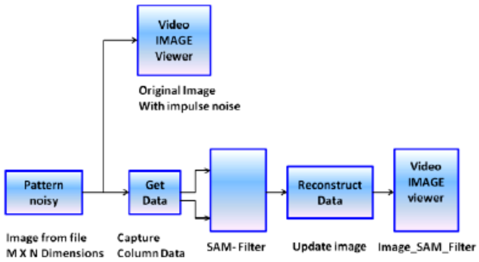

Figure 4.3: Methodology for SAM

Figure 4.4: Illustration of image enhancement by applying a filter to an image: (a) original, (b) enhanced image

4.2 Blob analysis or Otsu Thresholding

4.2.1 Blob Analysis

Objects can be found in a logical image by searching the connected areas of true pixels. The pixels of each connected area are mapped to an integer number greater than zero. All pixels of the same area have the same number whereas pixels belonging to different areas have different numbers. All false pixels are mapped to zero.

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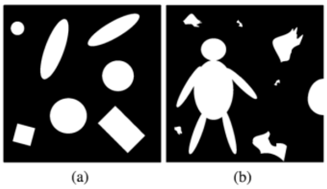

Figure.4.5 :(a) A binary image containing different shapes. (b) A binary image containing a human and some noise

BLOB mean Binary Large protest and suggests to a gathering of associated pixels in a double picture. "Huge" shows that lone objects of a specific size are of interest and that "little" double questions are typically clamor.

This is identified with breaking down paired pictures by first extricating the BLOBs, then speaking to them minimalistically, and characterizing the sort of every BLOB. The goal of BLOB extraction is to confine the BLOBs (objects) in a paired picture. A BLOB comprises of a gathering of associated pixels. Regardless of whether two pixels are associated is characterized by the availability, that is, which pixels are neighbors and which are most certainly not. The two frequently connected sorts of network are outlined in Fig. 4.6 the 8-availability is more precise than the 4-network, however the 4-availability is regularly connected since it requires less calculations, thus it can prepare the picture speedier.

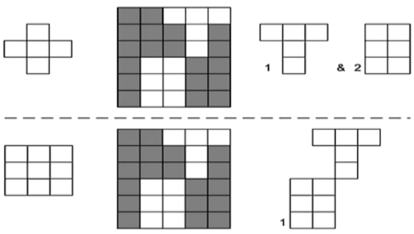

Figure 4.6: 4- and 8-connectivity.

4.2.2 Otsu Thresholding

Gray level image can be segmented by comparing the gray value with a threshold at each pixel. In Scilab, pixels that have a gray value greater than or equal to the threshold are mapped to true, whereas all other pixels are mapped to false. Thresholding helps to find objects in an image if these objects are significantly brighter or darker than the background. In this case there is a gray level range typical for object pixels and another gray level range typical for background pixels. A gray level between these ranges can be a threshold. A good candidate for a threshold is a local minimum of the histogram.

A well-known example for automated threshold calculation is the Otsu method: The value *k* that maximizes the between-class variance $\sigma_{between}$ is chosen as threshold. The between-class variance is defined by the following equations

$$\sigma^2_{between} = \omega_{dark}(\mu_{dark} - \mu_{image})^2 + \omega_{bright}(\mu_{bright} - \mu_{image})^2 \qquad 1)$$

$$\omega_{dark} = \sum_{q=0}^{k-1} p(r_q) \qquad 2)$$

$$\omega_{bright} = \sum_{q=k}^{L-1} p(r_q) \qquad 3)$$

$$\mu_{dark} = \frac{\sum_{q=0}^{k-1} r_q p(r_q)}{\omega_{dark}} \qquad 4)$$

$$\mu_{bright} = \frac{\sum_{q=k}^{L-1} r_q p(r_q)}{\omega_{bright}} \qquad 5)$$

$$\mu_{image} = \sum_{q=0}^{L-1} r_q\, p(r_q) \qquad 6)$$

$$p(r_q) = \frac{n(r_q)}{N} \qquad 7)$$

4.3 Feature Extraction

4.3.1 Gabor filter

It is a linear filter used for edge detection in image processing. Frequency and orientation Representations of Gabor channels are like those of the human neural – visual network, and it is also an appropriate model for texture representation

*Gabor = Gaussian * Fourier*

$$G(x,y) = e^{\{-\frac{1}{2}\left[\frac{x^2}{\delta_x{}^2}+\frac{y^2}{\delta_y{}^2}\right]\}} \cos(2\pi f x)$$

A Gabor channel is a straight channel whose motivation reaction is characterized by a consonant capacity increased by a Gaussian capacity. In view of the duplication convolution property (Convolution hypothesis), the Fourier change of a Gabor channel's drive reaction is the convolution of the Fourier change of the symphonious capacity and the Fourier change of the Gaussian capacity. A Gabor channel is a direct channel utilized for edge discovery as a part of picture preparing which is named after Dennis Gabor. Gabor channel recurrence and introduction representations are like those of human visual framework, for surface representation and separation it has been observed to be amazingly fitting. A sinusoidal plane wave has been adjusting a 2D Gabor channel which is a Gaussian part work in the spatial area. From one guardian wavelet all channels can be produced by expansion and revolution, along these lines the Gabor channels are self-comparative. With eight distinct introductions of Gabor channel, elements of the unique mark are separating and are joined. Where f speaks to the edge recurrence and the decision of $\delta x2$ and $\delta y2$ decides the shape of the channel envelope furthermore the exchange of between improvement and spurious artifacts.

4.3.2 Color Histogram

One of the basic essentials in picture recuperation, indexing, grouping, bunching and so on is separating effective highlights from pictures. The shading highlight is a champion amongst the most generally utilized visual elements. Utilization of shading histogram is the most widely recognized path for speaking to shading highlight. One of drawback of the shading histogram is that it doesn't take the shading spatial appropriation into thought. In this paper dynamic shading conveyance entropy of neighborhoods technique in view of shading dispersion entropy is displayed, which successfully depicts the spatial data of hues.

Utilization of shading histogram is the most well-known path for speaking to shading highlight regardless of a few downsides, It had been utilized as a part of numerous investigates and extraordinary endeavors were accomplished for beating its shortcoming one of inconvenience of the shading histogram strategy is that it is not strong to noteworthy appearance changes since it does exclude any spatial data. A few plans including spatial data have been proposed. Pass et al. recommended arranging every pixel as intelligible or no sound in light of whether the pixel and its neighbors have comparable hues. At that point, a split histogram called shading lucidness vector (CCV) is utilized to speak to this characterization for every shading in a picture. Huang proposed a shading correlogram strategy, which gathers insights of the co-event of two hues a few separations separated.In individually presented annular shading histogram, spatial-chromatic histogram (SCH) and geostat to portray how pixels of indistinguishable shading are dispersed in the picture. Sun et al propose shading circulation entropy (CDE) technique, which assesses the relationship of the shading spatial dispersion in a picture. This element depends on annular shading histogram that draws some concentric circles from pictures and after that the annular shading histogram is ascertained by tallying the pixels of each shading container inside each circle. The quantity of circles is a predefined consistent and for each picture is the same paying little respect to its substance.

4.4 Training Database of the SVM Classifier

Warning and Prohibitory signs are characterized by a red rim and a pictogram which has a different color. For Swedish traffic signs, the pictograms have a yellow background with black shape or text. Figure illustrates this model of a traffic sign.

Classification is carried out in two stages; in the first stage the shape of the sign's rim is classified and if the desired shape is found then the next stage is carried out by initiating the pictogram classification. This concept is illustrated in Figure 4.8. For this reason, two databases are created: one for the sign's rims and the other for the pictograms.

Figure 4.7: A traffic sign is a rim and a pictogram.

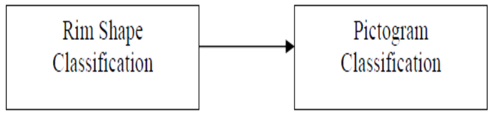

Figure 4.8: Classification is carried out by rim classifier and pictogram classifier.

Every image in this database is 36x36 pixels and is invariant to in-plane transformations, which include scale, translation and rotation. The binary image output of

Color segmentation is normalized to 36x36 pixels. This is done to standardize the size of the ROI (Region of Interest) irrespective of its scale in the original RGB image. This will also improve the reliability of the shape and pictogram classifier at a later stage. Normalized images are created as follows:

1) Apply the connected component labeling algorithm to label each object in the binary image and select the desired sign for the database, then compute the convex hull of the object under consideration using Graham's algorithm.

2) To carry out the translation invariance, the object's area *a* and centroid (x_{cen} , y_{cen}) are computed from the following equations:

$$a = \sum_x \sum_y f(x, y) \qquad 1)$$

$$x_{cen} = \frac{1}{a} \sum_x x f(x, y) \qquad 2)$$

$$y_{cen} = \frac{1}{a} \sum_y y f(x, y) \qquad 3)$$

3) Find the radius of the minimum circle containing the object by calculating the furthest object's pixel from the centroid (x_{cen} , y_{cen}) denoted *r*min , using Euclidean distance.

$$r_{min} = \sqrt{(x - x_{cen})^2 + (y - y_{cen})^2} \qquad 4)$$

4) Use *r*min to calculate the coordinates of the four corners *x*min , *x*max , *y*min and *y*max of the rectangle containing the object.

5) Calculate the new coordinates of all pixels inside the convex hull of the object to the normalized size; say NxN pixels by using the following formulas:

$$x' = N \frac{x - x_{min}}{x_{max} - x_{min}} \qquad 5)$$

$$y' = N \frac{y - y_{min}}{y_{max} - y_{min}} \qquad 6)$$

Where (x′, y′) are the directions of a nonspecific point in the new 36x36 matrix corresponding to the (*x*, *y*) coordinates of the pixel of the original matrix.

A convex hull is invoked in order to preserve all the details of the object under consideration. Figure depicts the importance of using convex hull in the creation of normalized images. The data set which is built using this method contains 350 binary images classified in seven categories of traffic sign shapes and 250 binary images classified in five categories of

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Speed-Limit signs each road sign category has 50 data samples

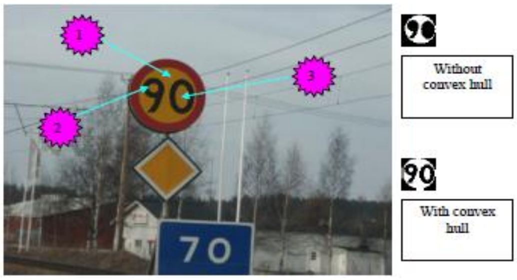


Figure 4.9: Convex hull is used to preserve objects details

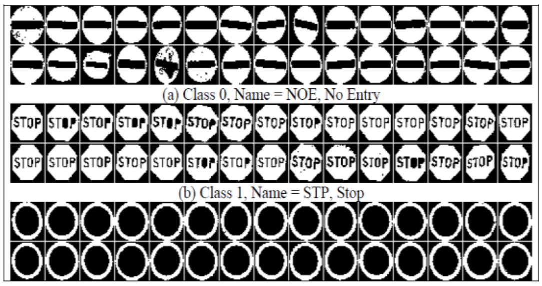


Figure 4.10: Part of the training database

5. Simulation & Result

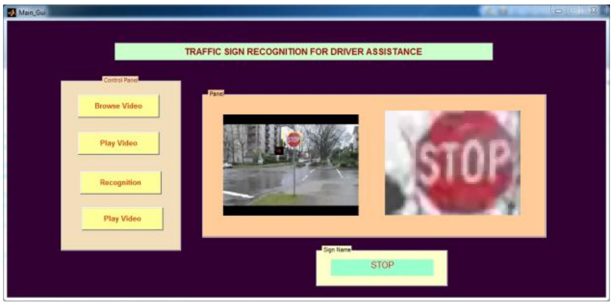
In this topic, the techniques used for traffic sign recognition are evaluated. The problem of traffic sign recognition was divided into three steps: color segmentation, shape recognition and classification. Different color segmentation algorithms were tested by four different experiments which include the global performance of each algorithm, the specific tests of different image or sign conditions, the quality of segmentation, and processing times. The Shadow and Highlight invariant algorithm performed better than others. The algorithm was faster than the others and showed high robustness in different weather and lighting conditions.

Similar tests were used to evaluate the performance of the recognition algorithm. It is evaluated by a large set of images which reflect the overall performance of the recognition algorithm.

It was also evaluated by another set of images taken under specific weather conditions. The algorithm was robust to a substantial variety of weather conditions, but there was a drop in performance in the case of occluded signs and fog conditions.

The last stage of this analysis was the evaluation of the performance of the SVM classifier. It is important to illustrate the conditions under which the classification takes place and which parameters affect the classification. In this analysis five types of tests are involved including classification with different features, classification with different SVM types and different kernels, classification with different moment orders, and searching for optimum parameters. Finally, a comparison between exhaustive search and simulated annealing search was presented which showed that using Simulated Annealing reduces the computational time down to 20% of the grid search without reducing the classification rate

a)



b)

Figure .6.1: Simulation Result a) Initial b) after recognition

6. Conclusion

In this Paper a road and traffic sign recognition system which can help in creating a road sign inventory was developed, implemented and evaluated. This system, which involves a mixture of computer vision and pattern recognition problems, could remove street signs from still pictures of complex scenes subject to uncontrollable illumination. In the computer vision part, algorithms were developed to segment the image by using colors and to recognize the sign by color-shape combinations as a priori knowledge. In the pattern recognition part, two SVM classifiers were invoked to put the unknown sign in one of the traffic sign categories depending on the sign rim and interior.

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