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Automatic Traffic Sign Detection and Classification

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Abstract: ***Automatic detection and recognition of road traffic signs is an essential task for regulating the traffic, guiding, and warning the drivers and pedestrians. Many challenges like cluttered background, foreground scenery, various geographic, metrological, weather conditions namely cloudy day, rain, snow, fog, changeable and uncontrollable lighting conditions depending on the time of the day exhibits the detection of road signs. The traffic sign may have different sizes and colors. Our goal is to detect the traffic signs with red, blue, yellow colors with any of the available shapes. Then the detected signs, combined with the color and shape information are classified.***

The recognition of Traffic sign involves two stages: detection stage, it finds the region consisting of traffic signs from the image and then the classification stage where the detected signs are categorized into different classes like information, warning, prohibition and so on.

The image is acquired and is processed in CSR block, in which the base features from the image are extricated. The base features extricated from the image are color, shape, and Region of Interest (ROI) position. This pre-processing is very quick, because no special transformation is required. RGB and HSV color space is chosen for color segmentation. By extracting the color, CSR block creates 3 binary maps (red, blue, and yellow). From these binary maps, the shape of the traffic sign is detected. From the image the ROI is segmented, which is the input to the shape detecting block. After the shape is detected, traffic sign is classified according to its detected color and shape.

I. INTRODUCTION

Traffic signs are the signs put up at the side to provide information to all the motorists, passengers, truck driver etc. The signs used in the olden days were simple wooden or stone milestones. Later, the signs with directional arms were initiated. For example,the fingerposts in the United Kingdom and their wooden counterparts in Saxony.

With traffic congestion increasing since the 1930s, many countries have approved pictorial signs or simplified and standardized their signs to overcome language barriers, and improve traffic safety. Such pictorial signs utilize the symbolsplace of words and are usually based on international protocols. Such signs were first progressed in Europe, and have been used by most of the countries.

Traffic signs can be categorized into eight like danger warning signs, priority signs, prohibitory or restrictive signs, mandatory signs, special regulation signs, information, facilities, or service signs, direction, position, or indication signs, additional panels.

Traffic signs are the control devices utilized to control the traffic and furnish useful information to make the driving safe and well timed. Traffic signs define a visual language which helps to convey messages to drivers and to generate user friendly road system which can be understood by everyone. These traffic signs are put forth to the driver that to need to be interpreted while driving. This may look as a simple task, but sometimes thedriver misses the signs. Sometimes these traffic signs may be blocked by other objects and will not be properly visible to the drivers; these situations may lead to dangerous situations like accidents.

II. LITERATURE SURVEY

The Support Vector Machine approach is used for the detection as well as classification. Linear SVMs are utilized as geometric shape classifiers at detection phase. They work on the color segmented image. Blobs of Interest (BoI) are detected, once the color segmentation is done. Distance to Borders is used as the input vectors to execute the Linear SVM. The results show good success rates and few false positives in the final recognition stage. This approach is invariant to translation, rotation, scale and partial occlusions. It can recognize various geometric shapes, i.e., circular, octagonal, triangular and rectangular. But it requires enhancements in the performance to be applicable in real time.

Principle Component Analysis is used as minimized dimensional map. The drawbacks of PCA are high storage space requirement and computational complexity. PCA decomposes an n*n non sparse matrix, when the original space dimension is n. The representation that reduces the post-dimensional is generated by linear mapping as PCA is a linear mapping method.

Two-Dimensional Principle Component Analysis (2D-PCA) has been proposed as a new image recognition method. This method directly extracts feature from original matrix, minimizes computational complexity, training and feature extraction time.

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PCA or 2D-PCA is rarely used to carry out the identification of traffic signs. The feature of traffic sing is extracted by using 2D-PCA and is then combined with the nearest distance classifier. Based on the database of two traffic signs, the traffic sing recognition test is done.

III. METHODOLOGY

An Automatic Traffic Sign Detection and Classification System have been proposed based upon the four main steps: Image Acquisition, Color Segmentation & ROI Identification, Traffic Sign Shape Detection, Sign Classification

The image is acquired or loaded from the database stored in the system. The loaded image is transformed into Hue, Saturation and Value (HSV) model from Red, Green, and Blue (RGB) model for the segmentation of the image. Connected components labelling is applied to the segmented image to identify Region of Interest. Size filtering helps to remove the inappropriate sized objects

The shape of the Traffic Sign is identified by applying shape detection method. The traffic sing is classified according to the detected color and the shape.

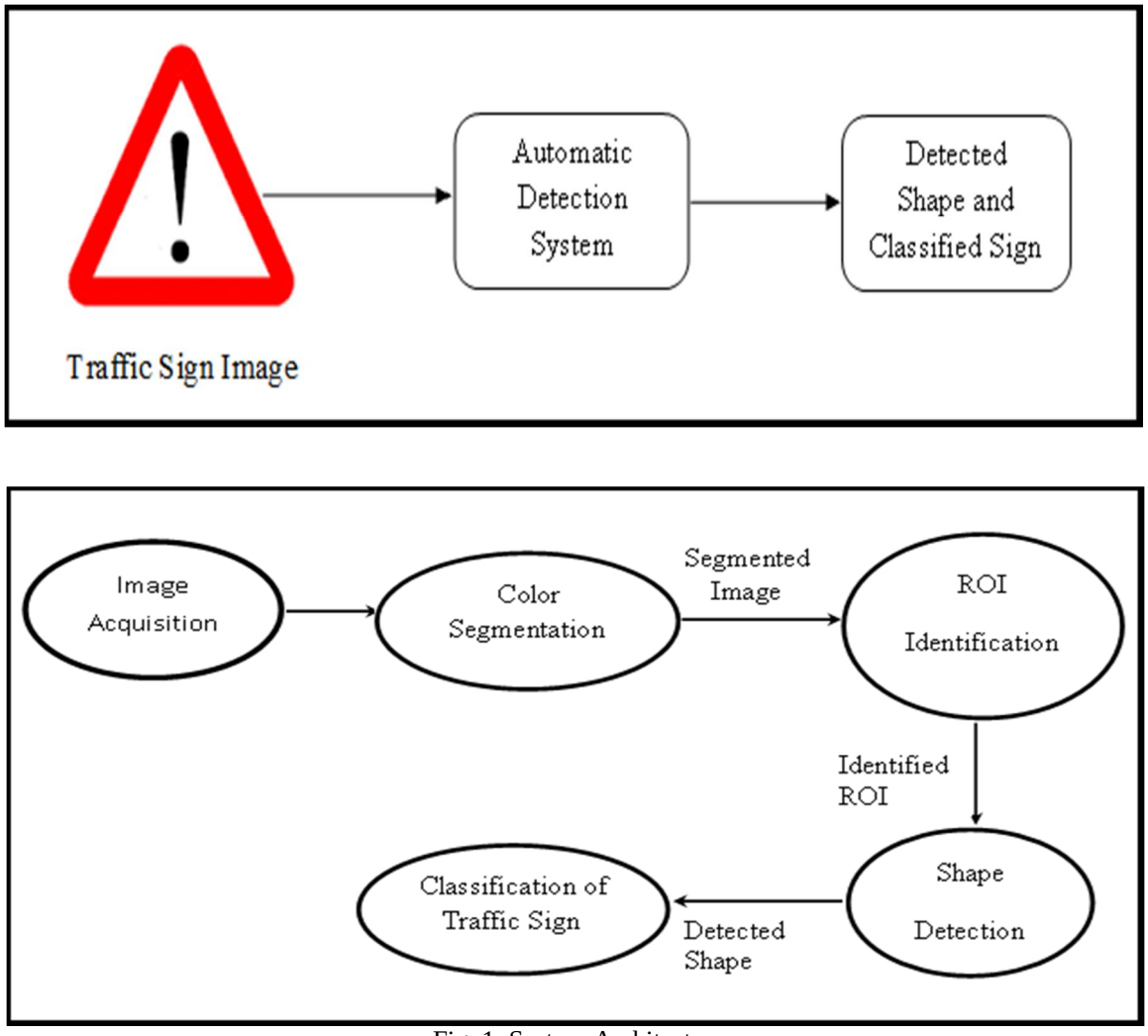


Fig. 1: System Architecture

The system should detect the color of the image and binary map should be generated for the detected colors. Then the ROI is identified from the generated binary image, then the shape of the image is detected and classification should be done based on the detected shape and color.

Based on the color which is saved during the segmentation of the image and the detected shape, the traffic sign images are classified as given in Table 1.

Table 1: Classification of Traffic Sign

Color / Shape	Red	Blue	Yellow
Square/Rectangle	NA	Information	NA
Circle	Prohibition	Regulatory	NA
Rhombus	NA	NA	Highway
Triangle	Danger/Warning	NA	NA
Octagon	Stop Sign	NA	NA

A. Algorithm

1) Convert the image from RGB to HSV color space.

2) The values of HSV are normalized in the range [0, 255].

3) Hue can be calculated as

$$H_{out} = \begin{cases} 255 & H_{min} < H_{in} < H_{max} \\ 0 & \text{otherwise} \end{cases} \quad \ldots\ldots\ldots\ldots\ldots\ldots \text{Eq. 1}$$

4) Saturation can be calculated as

$$S_{out} = \begin{cases} 0 & 0 <= S_{in} <= S_{min} \\ S_{in} & S_{min} <= S_{in} <= S_{max} \\ 255 & S_{max} <= S_{in} <= 255 \end{cases} \quad \ldots\ldots\ldots\ldots\ldots\ldots \text{Eq. 2}$$

Value can be calculated as

$$V_{out} = \begin{cases} 0 & 0 <= V_{in} <= V_{min} \\ V_{in} & V_{min} <= V_{in} <= V_{max} \\ 255 & V_{max} <= V_{in} <= 255 \end{cases} \quad \ldots\ldots\ldots\ldots\ldots\ldots \text{Eq. 3}$$

5) A logical AND between H_{out}, S_{out}, and V_{out}, will produce the binary image of thetraffic sign containing the appropriate color. Red, blue and yellow, are the three main colors and the corresponding HSV values are listed in the table 2.

Table 2: HSV Values

Color	Hue	Saturation	Value
Red	210 - 255, 0 – 10	127 - 255	127 - 255
Yellow	20 – 45	110 - 255	90 - 255
Blue	120 – 180	127 - 255	127 - 255

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IV. RESULTS & DISCUSSION

The database of various traffic signs is created as shown in the Fig. 2



Fig. 2: Images in the Folder

By using Graphic User Interface (GUI), one of the images from the database is loaded as shown in Fig. 3.

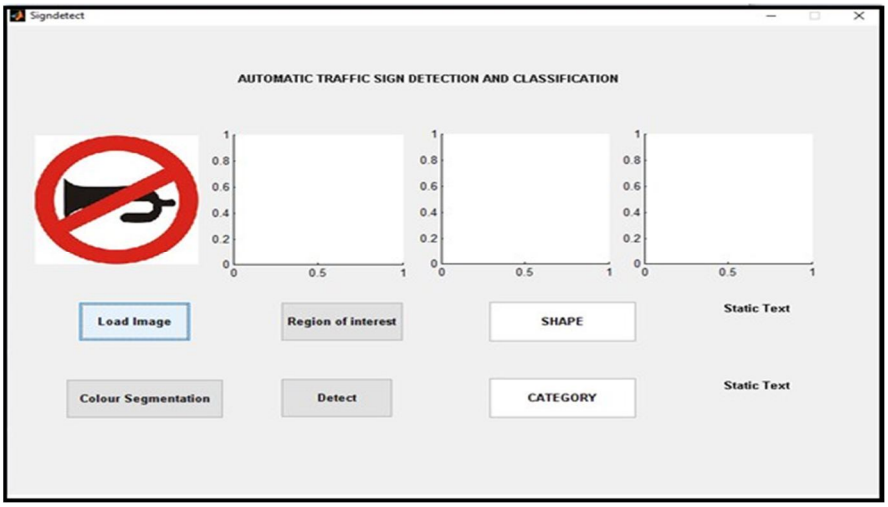


Fig. 3: Load Image

The loaded image is then segmented using Color Segmentation as shown in the Fig. 4.

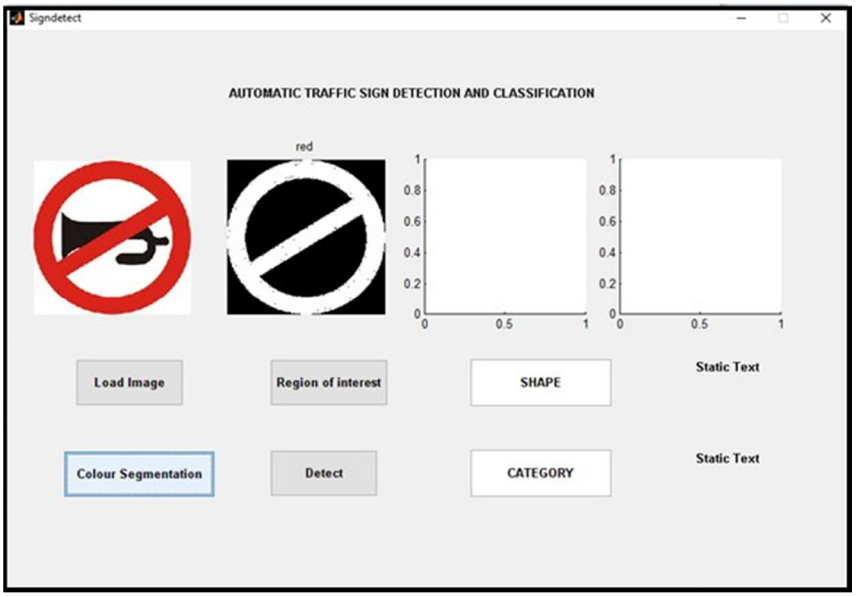


Fig. 4: Colour Segmentation

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The region of interest is found for the segmented image as shown in Fig. 5.

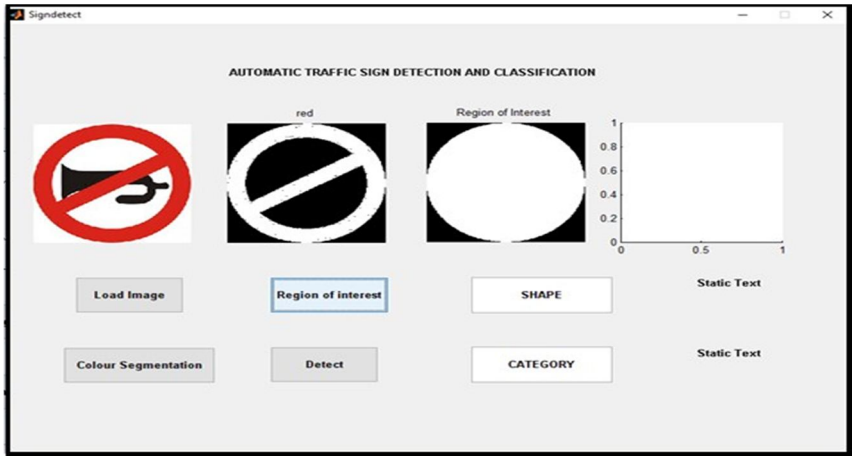


Fig. 5: Region of Interest

After the region of interest is found, the shape is detected and classified for the traffic sign and the same is shown in Fig. 6.



Fig. 6: Detection and Classification

The Fig. 7 & Fig. 8 represents the detection and classification of different traffic signs with triangle and rhombus shapes respectively.

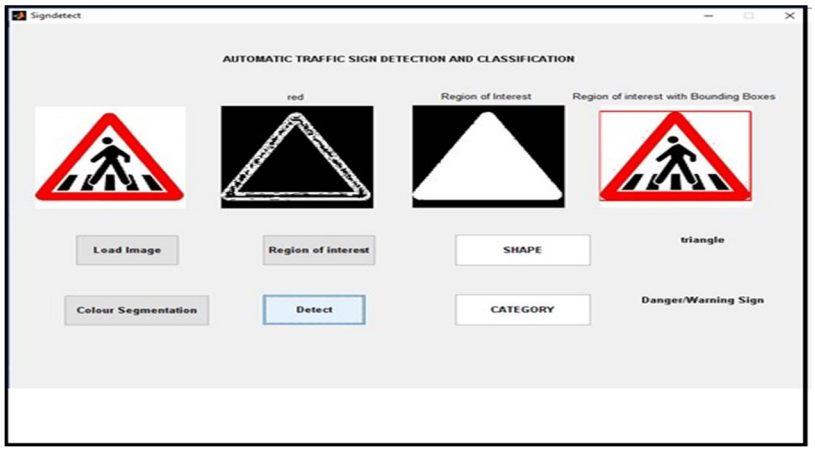


Fig. 7: Triangular Sign Detection and Classification

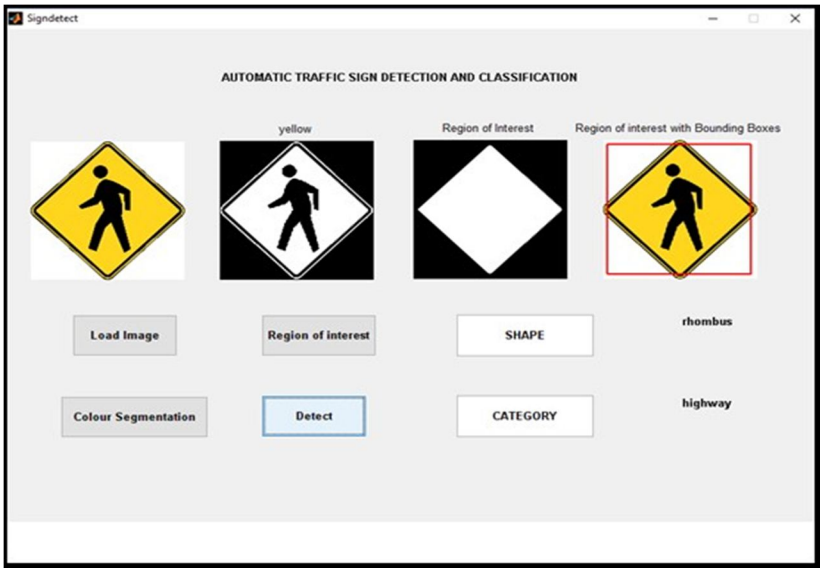


Fig. 8: Rhombus Sign Detection and Classification

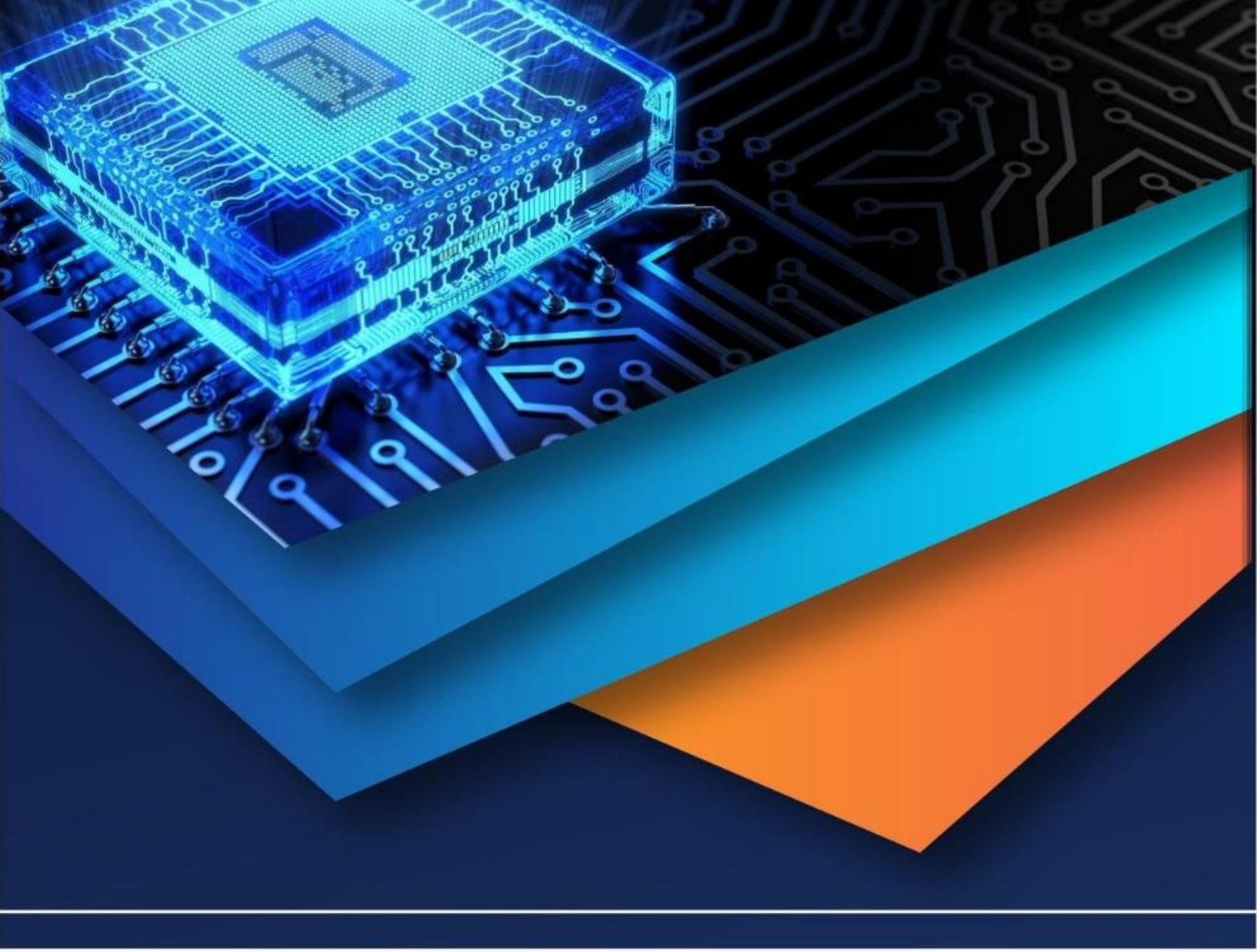
V. CONCLUSIONS

The traffic sign recognition system which helps in detecting and classifying the signs has been implemented. Algorithms were developed to segment the image by using colors and to recognize the sign by color-shape combinations as a priori knowledge. This segmentation algorithm helps to mark the traffic sign as an ROI. Image segmentation appears to be most critical task because of the illumination conditions due to highlight invariant color segmentation algorithmhas been developed. The algorithm helps to achieve color segmentation under wide range of weather, sign and image conditions. Size filtering of the objects also reduce the number of objects present in the image which could be unnecessary information which can waste the recognition time. Thus, the response time of the system can be improved. Algorithm for the shape detection deals only with the ROIs for detecting the shape. Then based on the detected shape and color the traffic sign has been classified correctly.

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