TRAFFIC SIGN RECOGNITION USING IMAGE PROCESSING

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Abstract

Traffic sign recognition system helps the user to automatically identify traffic signals based on color. Today, the increase in vehicular traffic has lead to the increasing number of roads and traffic signs. As a result, the drivers are expected to learn all the traffic signs and to pay close attention to the signals while driving. A slight neglect in the driver's part can lead to major consequences. Traffic sign recognition system automatically recognizes traffic signs and reduces traffic accidents and helps in driving safely. Traffic sign recognition system can be used in busy junctions and places such as schools where there are many people commuting on daily basis. Traffic recognition system automatically alerts and informs the driver about the traffic signal ahead. This system is specially designed to help visually impaired and color blind people to recognize signals. Traffic sign recognition system uses color codes to recognize and understand what different signals mean.

This project aims at implementing traffic and road sign recognition system using image processing. Based on the input images the system will be able to recognize the traffic sign depending on color and shape analysis.

Keywords: Traffic signal recognition; color segmentation; centroid; moments; feature vector

I. INTRODUCTION

Driving safely is the best thing we can do, because on road intersections, at one moment you are safe, and in the next one you could meet with an accident. Luckily, there are warning signals, signs, and traffic signals on roads which are beneficial for the safe driving. Traffic signals provide maximum control on the flow of traffic at intersections. These instruct drivers on what should be done and what should be avoided. The primary advantage of traffic signals is that they maintain a constant flow of traffic at reasonable speeds thus avoiding accidents and saving lives.

Traffic signals are primarily detected based on the color codes followed by the different shapes in which they are represented. Because colors are distinguishing features of traffic signals, they can simplify the process. Globally the color code used to detect a stop sign is red and green is used to indicate the normal flow of traffic. Usually the shapes used are a red and green circle or a red circle and green arrows pointing towards different directions based on which lane is free to carry on. While for a person with normal eyesight is able to recognize the colors and shapes easily, it is a difficult task for people with problems such as those with color blindness and poor visibility. Hence it is important to have a system that is able to recognize the signals and interpret them to the driver to ensure safe driving. In the past many years, developing a system that can navigate vehicle autonomously has become an interesting area. Using sensors, such as radar, GPS, and camera the vehicle can sense the surrounding area. Out of these, camera is the most advantageous and frequently utilized sensor because of its ease of usage and low cost. Camera provides enormous amount of information for ease of traffic navigation [6].

Traffic signal recognition is a system based on which a vehicle is able to capture the signals and interpret them to the driver for their understanding. There are two main stages for traffic sign interpretation. The first phase is detection and second is recognition of the signal. In the detection phase the image is acquired and segmented. Followed by recognition phase in which feature vector is calculated using centroid and moments and compared with test images. Color segmentation is used to specify the shapes of signals based on color filtering.

II. RELATED WORK

Many researches have been done previously dealing with traffic sign detection and recognition .In which majority show a two-stage process in which the first stage is detection followed by recognition stage. [1] The process begins with image preprocessing followed by segmentation based on color and then extracting features to identify the image. In [2], the author suggest for road vehicles can have three main roles: a) color thresholding; b) object detection; c) sign verification using Hough transform and d) sign confirmation. [3] uses a) image extraction and pre-processing ; b) color based segmentation; c) shape based filtering and d) classification using neural networks.

III. SYSTEM ARCHITECTURE

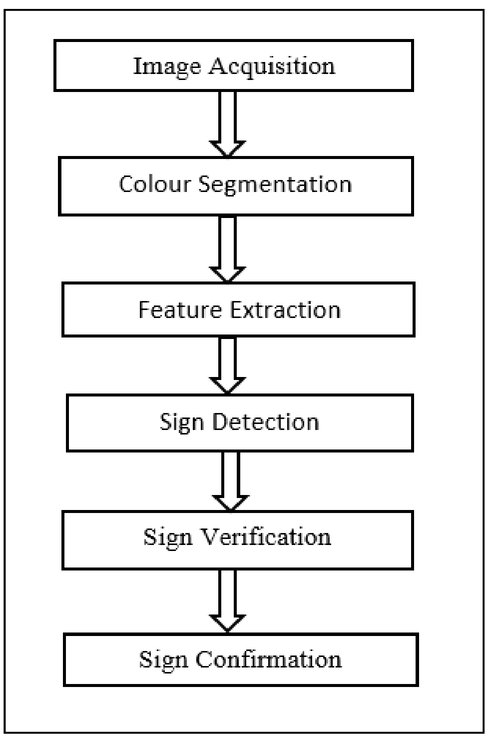

Fig 1: Proposed system flow

IV. METHODOLOGY

This section discusses the process steps in detail.

Step1: Image Acquisition

The first stage of any vision system is the image acquisition stage. After the image has been obtained, various methods of processing can be applied to the image to perform the many different vision tasks required today. However, if the image has not been acquired satisfactorily then the intended tasks may not be achievable, even with the aid of some form of image enhancement.

Step 2: Colour Segmentation

In traffic signals, colors used are mainly categorized into two classes: Red indicates a warning / stop sign and green indicates a go sign. Since colors play an important role in recognizing and understanding the meaning of the signals, it is important to be able to distinguish the signals based on colors. The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain characteristics. The color of every pixel is defined by three colors, red, green and blue. Segmentation is done using following formula:

$$f(x,y) = \begin{cases} Ra & dR > 0.5 \\ Ga & dG > 0.45 \\ Ba & dB > 0.5 \end{cases}$$

Where dR, dB and dG are red, green and blue pixels respectively divided by their intensity.

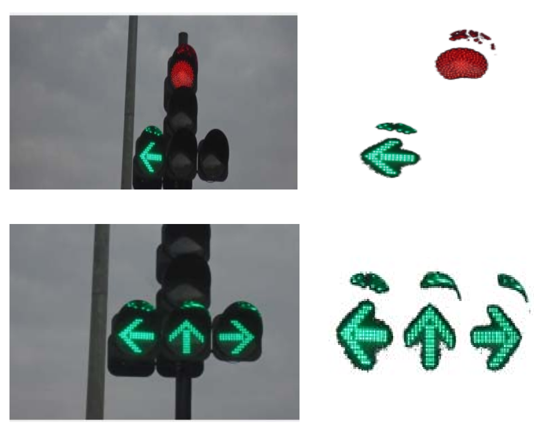

Fig 2: Color Segmentation results.

Step 3: Area Calculation

In order to detect the traffic signal we need to calculate the centroid and moments of the image and our area of interest. In order to calculate the centroid and moments we need to calculate the area of the image. Before calculating the area, the image is divided into smaller blocks. Area is calculated to get the region of interest which is then used for calculation of centroid and moments. Also for each block the minimum and maximum coordinates are calculated.

Step 4: Calculating Centroid of Small Regions

Centroid of an image is the arithmetic mean position of all the points in a shape. The definition extends to any object in *n*-dimensional space: its centroid is the mean position of all the points in all of the coordinate directions

After the image is divided into smaller regions centroid of each region is calculated in this step.

The following table shows output of area and centroid calculation on the segmented images.

TABLE I

AREA AND CENTROID VALUES OF SEGMENTED IMAGE

Area	X-Centroid	Y-Centroid
1338	587	428
1320	770	194
1309	769	168
1236	592	453
1062	722	168
1042	722	194
1018	642	428
932	597	404
787	638	451
645	636	354

Step 5: Calculating Centroid of Entire Image

This step involves calculation of centroid for the entire image. Using centroid calculations of smaller regions.

The formula for calculating centroid is given as:

$$C_x = \frac{\sum C_{ix} A_i}{\sum A_i}, C_y = \frac{\sum C_{iy} A_i}{\sum A_i} \qquad (1)$$

Where C_{ix} is the centroid of x coordinate regions and C_{iy} is the centroid of y coordinate region and Ai is the area.

Step 6: Calculating Moments

In image processing, computer vision and related fields, an image moment is a certain particular weighted average (moment) of the image pixels' intensities, or a function of such moments, usually chosen to have some attractive property or interpretation. Moments of images have been used extensively as they provide efficient local descriptors in image analysis applications. They provide invariant measures of shape which is their main advantage [9].

Image moments are useful to describe objects after segmentation. Simple properties of the image which are found *via* image moments include area (or total intensity), its centroid, and information about its orientation.

Image moments M_{ij} are calculated by

$$M_{ij} = \sum_x \sum_y x^i y^j \qquad (2)$$

Where $x = \frac{x - \bar{x}}{x_{max} - x_{min}}$

And $y = \frac{y - \bar{y}}{y_{max} - y_{min}}$

Here $\bar{x}, \bar{y}$ are centroids of x and y respectively and $x_{max} - x_{min}$ and $y_{max} - y_{min}$ are used for normalization

Step 7: Feature Vector

A feature vector is an n-dimensional vector of numerical features that represent some object. Many algorithms in machine learning require a numerical representation of objects, since such representations facilitate processing and statistical analysis. For example, a color can be described by how much red, blue, and green there is in it. A feature vector for this would be color = [R, G, B]. When representing images the features may represent, as a whole, one mere pixel or an entire image. The granularity depends on what someone is trying to learn or represent about the object. You could describe a 3-dimensional shape with a feature vector indicating its height, width, depth, etc.

The following table shows result of feature vector calculation:

TABLE II

RESULT OF FEATURE VECTOR

Index	Feature Vector
0	-126990.5
1	1868573.25
2	375260.0385
3	-631038.5887
4	4655615.138
5	-9164924.232
6	-2494800.96
7	13705113.62
8	-46808997.78

Step 8: Correlation

Correlation is a method for establishing the degree of probability that a linear relationship exists between two measured quantities. In 1895, Karl Pearson defined the Pearson product-moment correlation coefficient r. Pearson's correlation coefficient, r, was the first formal correlation measure and is widely used in statistical analysis, pattern recognition and image processing. For monochrome digital images, the Pearson's correlation coefficient is defined as [7]

$$r = \frac{\sum_i (x_i - x_m)(y_i - y_m)}{\sqrt{\sum_i (x_i - x_m)^2}\sqrt{\sum_i (y_i - y_m)^2}} \quad (3)$$

Where x_i and y_i are feature vectors at i^{th} position, and x_m and y_m are the average of the two feature vectors.

The correlation coefficient has the value r =1 if the two images are absolutely identical, r = 0 if they are completely uncorrelated and r = -1 if they are completely anti-correlated [8].

Step 9: Text Narration

In this step, text results are converted to speech form and narrated to the driver. This will be especially useful for people with visual impairments.

V. CONCLUSION

The Traffic Signal Recognition System proposed in this paper can be used by visibly impaired and color blind people since they are unable to identify signals correctly. This system will also be useful for autonomous vehicles as more of them are expected to be used in near future. In this system, first color segmentation is applied to the image after image acquisition. Followed by feature extraction which includes calculation of area, centroid, and moments and then calculating correlation between two feature vectors.

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