Real Time Road Edges Detection And Road Signs Recognition

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***Abstract*—In this study, it is aimed to detect the stripes and objects in a road image with the help of image processing methods in MATLAB environment. A minimum number of methods were tried to be selected that could meet all requirements. The methods are: Canny edge detection, Hough method, and SURF-algorithm.**

Keywords—image processing, edge of the road detection, road signs, canny edge detection, hough transform, speeded up robust features

I. INTRODUCTION

Image Processing military industry, underwater imaging, robotics, astronomy, physics, art, biomedical and geographic information systems, remote sensing, observation and forecasting applications, animal husbandry, oil exploration, newspaper and photography industry, traffic, radar, medicine, security, crime laboratories It is used in many areas such as. Image processing is known as enhancing existing images saved and processing images by computer. An image processing system includes the stages of capturing the image, digitizing and processing it to produce a suitable output. In this project, road edge detection and road sign recognition were attempted using image processing. This topic has been studied by many researchers. Because this issue plays an important role in the safety of our lives.[5] The purpose of this project is to achieve the expected level of results with minimum functionality. The work consists of two parts: road edge detection and road sign detection. A widely used and effective method, canny edge detection was used for detect edges. Then the strips were detected with the hough transform. In order to detect road signs, the SURF method, which is usually used in face recognition, was tried. The study was done in MATLAB environment. In the other part of the paper, information will be given about the materials and methods used during the study, and the results obtained will be explained in the last section.

II. IMAGE PRE-PROCESSING

The aim here is to achieve good results in later stages. So the image must be converted from color to gray. Then, since numerical operations will be performed on the image, *im2double* function was used. Later Gaussian Filter was used. Gaussian Filter is a good method to reduce this interference. This helps to smoothen an image. Smoothing or blurring, is a simple and frequently used operation in image processing. The Gauss filter result is given in Figure 1.

Fig. 1. Gaussian filter result

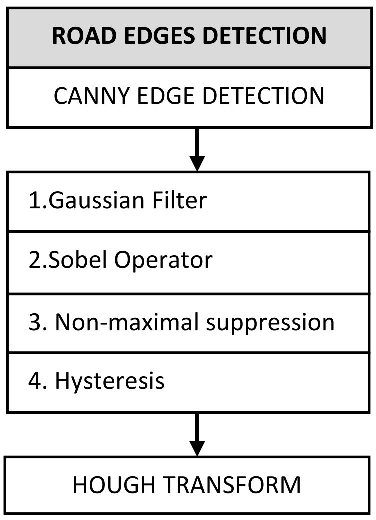
III. DETECTION OF ROAD EDGES

This section describes the method for detection of road edges. The recommended method is to use the edge detection method. The use of edge detection algorithm to an image may significantly reduce the amount of data that will be processed and may filter out unnecessary information, while preserving the important structural properties of an image. There are many methods for edge detection. Canny edge detection was used in this study. Later, hough transform was also used for lane detection.

A. *Canny Edge Detection*

Canny edge detection algorithm; It is a step-by-step algorithm developed by John F. Canny to find sharply defined edges in the image. It is an algorithm that is used very effectively in finding an edge. Steps; gaussian filter, operator, non-maximal suppression, hysteresis.[1]

B. *Method Implementation*



The first step is the image should be smooted for edge detection. The Gaussian filter is used to blur / soften images and remove noise on the image. This process takes place as a result of the convolution of the image with the Gaussian filter coefficient. The Gaussian matrix is as shown below.

$$B = \frac{1}{159}\begin{bmatrix} 2 & 4 & 5 & 4 & 2 \\ 4 & 9 & 12 & 9 & 4 \\ 5 & 12 & 15 & 12 & 5 \\ 4 & 9 & 12 & 9 & 4 \\ 2 & 4 & 5 & 4 & 2 \end{bmatrix} * A \qquad (1)$$

Where A is the source image, *- denotes two dimensional convolution operation.

The next step is to find the edge strength by taking the gradient of the image. 3 operators are used to determine the edges. The Sobel operator, the Prewitt operator, and the Robert operators. In this project, we will use the Sobel operator. The Sobel operator performs a 2-D spatial gradient measurement on the image. Then approximate the gradient magnitude (edge strength) at each point can be found. The Sobel operator uses a pair of 3x3 convolution masks: evaluation of the gradient in the x-direction (columns) and the evaluation of the gradient in the y-direction (rows).These masks allow to identify places in the image where there is a sudden change in light intensity. The masks are as shown below.[3]

-1	0	+1
-2	0	+2
-1	0	+1

Gx

+1	+2	+1
0	0	0
-1	-2	-1

Gy

(2)

Where Gx and Gy — two images, where each point contains the approximate derivative in x and y. (The image is convolved with the masks for find Gx and Gy)

After the edges obtained by the operator are thick. Non-maximal pixels are suppressed to make the edges thinner. Working principle: The image is scanned in theta direction and set to zero if the pixels are not part of the local maximum.[2]

$$G = \sqrt{G_x^2 + G_y^2} \qquad (3)$$

$$\theta = \arctan\left(\frac{G_y}{G_x}\right) \qquad (4)$$

G is the gradient magnitude, theta is the gradient direction Respectively

- Gradient size and direction are calculated.
- Directions are set to the nearest 0, 45, 90 or 135 degrees.
- All non-maximal pixels are suppressed.

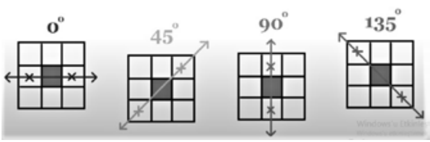


Fig. 2. Axes affected by angles

Finally, the hysteresis method is used to remove unwanted details from the image. Method implementation:

- Two threshold levels are determined (high and low level).

Case 1: If the pixel value is below the low threshold, it is set to 0.

Case 2: If it is above the high threshold, it is pulled to 1.

Case 3: If it is between two thresholds, if this pixel does not have a neighbor that exceeds the high threshold, it is pulled to zero and eliminated from the edge image.

C. Hough Method

Hough transform is an approximation method used to detect shapes in an image. Nonzero points in the image are transformed into sinusoids in hough space. Conversely, each point in the hough space corresponds to a straight line in the image.

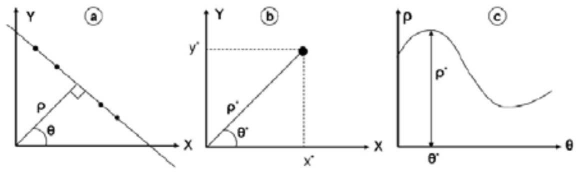


Fig. 3. Hough transform result for two input image

It is a technique that can find any shape that can be explained mathematically, even if there are some defects in the image. The formula of a line is expressed as $y = mx + c$.

Another form of expression is represented by the equation *rho = xcos(theta) + ysin(theta)*, depending on the angle and distance to the origin.

Hence, this technique scans all points on an image and examines rho and theta values. And this way, it is understood that there is a line in whichever rho and theta the pixels hold enough. This qualification part depends on the given threshold.

IV. Recognition Of Traffic Signs

This section describes the method for recognition of road signs. Proposed method is based on next features:

- A search is used to find feasible matches between object features and image features.
- The primary constraint is that a single position of the object must account for all of the feasible matches.
- Methods that extract features from the objects to be recognized and the images to be searched: surface patches, corners, linear edges

A. Speeded Up Robust Features

SURF method is a robust image detector and descriptor. The standard version is several times faster than SIFT and more robust against different image transformations than SIFT. SURF uses the binary approach of Gaussian Laplacian (Fast-Hessian).The algorithm has three main parts:

- Interest point detection
- Local neighborhood description
- Matching

The feature descriptor is based on the sum of the haar wavelet response around the point of interest.[4]

V. Experimental Results

A. The Result of Canny Edge Detection

This method was tested on data consisting of road images and showed good results. Figure 4 show that sharply defined edges are found in the image as a result of the calculations.

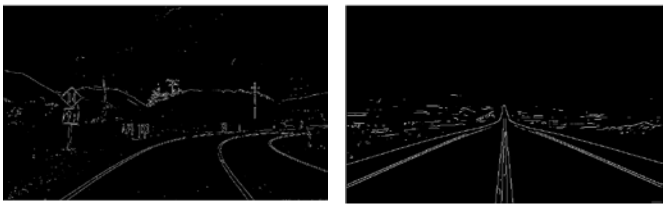


Fig. 4. Canny edge detection result for input images

B. The Result of Hough Transform

Figure 5 show that the stripes in the image are found. The Hough Transform was implemented using Matlab's hough, houghpeaks and houghlines functions. A very good result could not be obtained on curvy roads.

Fig. 5. Hough Transform result for input images

C. The Result of SURF Method

The SURF method was implemented using Matlab's detectSURFFeatures, extractFeatures, matchFeatures and showMatchedFeatures functions. Figure 6 shows the points of interest detected. Figure 7 shows the match result. This method has shown good result for road sign recognition.

Fig. 6. Detected interest points

Fig. 7. SURF method result for input image.

VI. Conclusion

This project considers the problem of determining the edges of the road and recognition of road signs. However, it was selected the minimum number of methods that can fulfill all the requirements, which greatly saves the time for data processing.

This project consists of two parts that contain completely different tasks. The first part deals with road edges detection and the second part deals with road signs recognition. Often times, researchers work on one.

In the first part, the result in canny edge detection met the expectation. The Hough transformation did not do well on curved roads. To solve this problem, these functions can be written more sensitive to the desired properties.

In the second part, the SURF method is used. Usually this method is used to detect other objects such as faces, the silhouette of a man, etc. This method has shown good result for road sign recognition.

The work is carried out on a system with processor.
Intel Core i7, CPU @ 2.7 GHz, with RAM 8 GB.
Programming environment – Matlab R2020b.

References

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