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# Reach on Sobel Operator for Vehicle Recognition

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***Abstract*—Vehicle type recognition is an active subject in the area of computer pattern recognition, which has been a focus in reach for the last couple of decades because of its wide potential application. And Edge detection is an important step for vehicle type recognition, a vehicle type recognition method based on Sobel was proposed. Also discussed are the vehicle vector and the vehicle recognize process. Experiments have been conducted for vehicle video. The result shows that the vehicle edge could be detected easily by the Sobel operator, and the vehicle feature can be extracted in short time. So, the Sobel operator can be good fit for vehicle type recognition.**

***Keywords-vehicl type; edge detection; Sobel operator; vehicle recognition;boundary***

## I. INTRODUCTION

The edges of images have the following advantages: describing the figure of the objects in the image, transferring the main information of the objects feature of the image. So, the edge detection is an important process in the area of computer image processing, which has been a focus in reach for the last couple of decades because of its wide use potential applications. It is applied to the following area: image segmentation, feature extracting, texture analyzing, etc..

Edge diction strategies seek out obvious edges in an image. The technology of vehicle edge detection accounts for importance function in modern Intelligent Transportation System (ITS). Traditional edge detection approaches, like Roberts or Canny operators, commonly extract edges by adopting specific templates, or in combination with smoothing functions.

A vehicle type recognition approach based on the edge detection of Sobel operator is introduced in this paper. The paper shows the reader the basic principle of the Sobel operator, the vector of the vehicle type, the architecture of the vehicle type recognition system, the implement of the detection operator in vehicle type recognition system, and the experiment of this operator.

## II. SOBEL OPERATOR

### *A. Gradient and Egde Direction*

An edge is a property attached to an individual pixel and is calculated from the image function behavior in a neighborhood of that pixel. It is a vector variable with two components, magnitude and direction. The edge magnitude is magnitude of gradient, and the edge direction $\Phi$ is rotated with respect to the gradient direction $\Psi$ by $-90^{o}$. The gradient direction gives the direction of maximum growth of the function, e.g., from black [*f( i, j)* =0] to white [*f( i, j)*=255]. It is shown in Figure 1.

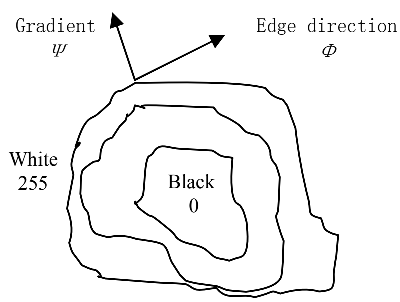


Fig 1 Gradient and Edge Direction

Edges are often used in image analysis for finding region boundaries. Provided that the region has homogeneous brightness, its boundary is at the pixels where the image function varies and so in the ideal case without noise consists of pixels with high edge magnitude. It can be seen that the boundary and its parts (edges) are perpendicular to the direction of the gradient.

### *B. Edge Detection*

Edge detection is one of the most important steps in images processing, analysis and pattern recognition system. Its importance arises from the fact that edge often provides an indication of the physical extent of object within the image. Sufficient information to characteristic feature is provided by the detection of edge because the size of the image data is reduced into a size that is more suitable for image analysis. The performance of the later tasks such as image segmentation, boundary detection, object recognition and classification, image registration, and so on are depend on the success of the edge characterization step[1][2][3].

The image intensity shows abrupt changes at edges. Therefore, edge detection usually involves the calculation of the derivative of the image intensity function at a given pixel location. If the magnitude of the derivative of the image intensity function is relatively high at a given pixel location, then the pixel at that image location is classified as an edge pixel [1][2][3].

### *C. Sobel Operator*

The Sobel operator is used in image processing, particularly within edge detection algorithms. It performs a 2-D spatial gradient measurement on an image and so emphasizes regions of high spatial frequency that correspond to edges. Typically it is used to find the approximate absolute gradient magnitude at each point in

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an input grayscale image. It is based on convolving the image with a small, separable, and integer valued filter in horizontal and vertical direction and is therefore relatively inexpensive in terms of computations.

Mathematically, the operator uses two 3×3 kernels which are convolved with the original image to calculate approximations of the derivatives, one for horizontal changes, and one for vertical. The operator is very easy to compute as follows:

$$G_x = \begin{bmatrix} +1 & +2 & +1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix} * A \qquad (1)$$

$$G_y = \begin{bmatrix} +1 & 0 & -1 \\ +2 & 0 & -2 \\ +1 & 0 & -1 \end{bmatrix} * A \qquad (2)$$

Where $A$ is the source image, $G_x$ and $G_y$ are two images which at each point contain the horizontal and vertical derivative approximations.

The kernels can be applied separately to the input image, to produce separate measurements of the gradient component in each orientation. These can then be combined together to find the absolute magnitude of the gradient at each point and the orientation of that gradient. The gradient magnitude is given by:

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

Typically, an approximate magnitude is computed using:

$$|G| = |G_x| + |G_y| \qquad (4)$$

This is much faster to compute.

The angle of orientation of the edge (relative to the pixel) giving rise to the spatial gradient is give by:

$$\theta = \arctan(\frac{G_x}{G_y}) \qquad (5)$$

In this case, orientation 0 is taken to mean that the direction of maximum contrast from black to white runs from left to right on the image, and other angles are measured anti-clockwise from this.

## III. VECTOR AND RECOGNITION SYSTEM

### A. *Architecture of Vehicle Type Recognigtion*

The four major components of this vehicle type recognition system are Pre-processing, Sobel Edge Detection, feature extraction, and recognition. Figure 2 illustrates the proposed overall vehicle type recognition system architecture.

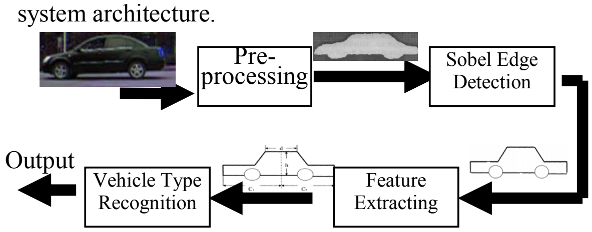


Fig 2 Architecture of Vehicle Type Recognition System

### B. *Gray-scale Transformation*

Pre-processing of vehicle images prior to vehicle recognition is essential. Pre-processing commonly comprises a series of sequential operations, including gray conversion and size normalization.

Any image from a scanner, or from a digital camera, or in a computer, is a color image. A digital color image pixel is just a RGB data value (Red, Green and Blue), each pixel's color sample has three numerical RGB component (Red, Green and Blue) to present the color, these three RGB components are three 8-bit numbers for each pixel, three 8-bit bytes is called 24 bit color. But each pixel is only stored as one 8-byte in gray-scale image. So the first step is the gray conversion. We use $f(x, y)$ denote the gray value of the position $(x, y)$. And we use the following expression to covert the RGB image to Gray-Scale image.

$$f(x, y) = 0.299 \times r + 0.587 \times \mathrm{g} + 0.144 \times b + 0.5 \qquad (6)$$

Where $r$, $g$ and $b$ are the Red, the Green and the Blue values of the color image pixel. The following image in Figure 3 shows an example of the gray-scale image obtained using the expression, the left image is a RGB image, the right image is the Gray-Scale image, which was obtained by upper processing.

Figure 3 Gray-scale Transformation

The size normalization is another important pre-processing technique in face recognition. In order to define the numbers of the input nodes of the neural networks, the data of the input images must be passed the standardize process. In most case, the basic recognition algorithm performs best foe a predefined nominal size of images. Therefore, after some basic filtering is done on the images signal, it is usually desirable to scale the images to a standard size such that the overall recognition becomes size independent.

### C. *Vehicle Feature Vector*

Before feature extracting, first trace the vehicle edge obtained by the above process. An edge tracing algorithm for vehicle type recognition was proposed in [4], which is validated to trace the vehicle edge. The purpose of the edge tracing algorithm is obtaining the vectors of the region edge of the objects in an image, and a queue can be used to save the vectors of the region edges. First, let us assume that the first coordinate of an image is (0, 0). Figure 4 shows a region border of an object in an image was obtained by boundary detection algorithm. And Figure 5 shows the vector queue of the upper object obtained by edge tracing step in [4].

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 |
| 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

0 --Background 1 --Boundary

Fig 4 Region Boundary of an Object

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| (1, 2) | (2, 1) | (3, 1) | (4, 1) | (5, 2) | (5, 3) | (5, 4) | (6, 5) |

| | | | | | | |
|---|---|---|---|---|---|---|
| (5, 6) | (4, 6) | (3, 6) | (2, 6) | (2, 5) | (2, 4) | (1, 3) |

Fig 5 Vector of an Object

## IV. EXPERIMENT AND RESULTS

### A. Vehicle Images

In order to evaluate the performance of the technique, extensive experiments are conduced on many vehicle images. All of the vehicle images are obtained from a video acquired by a modest speed of monitor.

### B. Experiments

Figure 6 shows some examples of the vehicle images obtained from the experiment video.

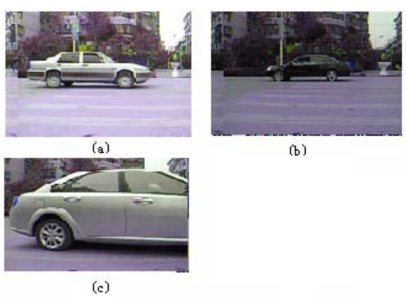

Fig 6 Some Example Vehicle Images

The following image in Figure 7 shows an example of the experiment in this paper. Figure 7(a) is the background image in this experiment, Figure 7(b) is the color image described by RGB, Figure 7(c) is the vehicle object, and the Figure 7(d) is contour of the upper vehicle object obtained by the Sobel operator.

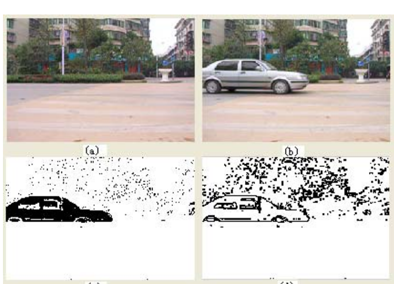

Fig 7 Experiment

### C. Results

Table 1 shows the results of the vehicle objects detected by the Sobel operator algorithm in this paper.

TABLE I. RESULTE OF VEHICLE DETECTION

| Image | Vehicle Number | Detected Vehicle number | Detection time(millisecond) |
|---|---|---|---|
| 1 | 1 | 1 | 3.123 |
| 2 | 2 | 2 | 3.123 |
| 3 | 3 | 3 | 3.123 |
| 4 | 5 | 5 | 3.124 |

The experiment demonstrated that the method proposed in this paper outperforms all the others with a recognition rate of 89.22%.

## V. CONCLUSION AND FUTURE WORKS

Edge detection is an important technology in image processing. In this paper, a vehicle edge detection based on Sobel operator was proposed. I hope this paper can provide the reader a better understanding about vehicle edge detection based on Sobel operator, and I encourage the readers who are interest in this topic to go to the references for more detailed study.

In addition, the implement of this approach is simpler, and it is easy to detect the edge of the vehicle object. The disadvantage of this method is: The Sobel operator represents a rather inaccurate approximation of the image gradient, and the noise is not been filtered effectually by Sobel operator. Keystone for my future works is resolving the upper problem.


## ACKNOWLEDGMENT

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