Automotive Dashboard Identification System

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Keywords: Feature extraction, image processing, automotive instrument clusters, reading recognition, ROI area, template matching.

Abstract: In order to improve the efficiency and accuracy of manual detection of automotive dashboard testing, it is particularly important to use computer vision-related technology to identify pointer readings and icon information of automobile dashboard in automotive dashboard function detection. In this paper, the traditional computer vision technology is applied to identify the automobile dashboard. The pointer reading is recognized by the Hough line detection, and the template matching is applied in each ROI area to determine the lighting and extinguishing of the dashboard indicator. The method realizes the reading of the tread gauge, the speedometer and other pointer instruments of the auto dashboard, as well as the lighting and extinguishing of the steering lights, fog lights and other automotive indicators. The experimental results show that the accuracy of the algorithm's recognition of pointer readings on the dashboard is more than 90%, the accuracy of the identification of indicators is more than 75%, and the average time of frame processing is currently 4.516s, which still needs to be improved.

1. Introduction

Since the birth of the world's first car in 1886, not only has the function of the car become more and more complex and powerful, the car style is also more and more.The automobile dashboards are more and more diverse with the car brand. The automobile dashboard is an important channel for the vehicle to give feedback to the outside, which can reflect the various state information of the car, such as speed, engine speed, oil volume and other states. Due to the diversity of automotive dashboards, some alarm or warning lights may not be known to the driver or car maintenance personnel, at which point the system that automatically recognizes the vehicle dashboard information becomes very meaningful. It can not only make the driver timely understanding of the car situation, but also can make the maintenance personnel out of the detection of the car dashboard, thereby reducing the burden of work.

All along, automobile instrument testing is mainly human testing,which is low efficiency, slow and boring. Manpower often leads to a decrease in the accuracy of work after a lot of work. With the development of Internet and multimedia technology, the application of computers is more and more extensive. And with the gradual development of science and technology, the dashboard display information is gradually increased. The information displayed is not only the same as the earlier dashboard, only need to show the speed, oil and other basic information, but also contains more indicators and other information, which makes manual testing more difficult. In recent years, artificial intelligence has gradually developed,which has replaced a lot of human work. In addition, the technology of image recognition is becoming more and more developed, which is developing rapidly. However, it is not widely used in the digital information recognition of automobile dashboard.Relying on the computer to automatically identify the car dashboard information can make people out of this boring work and improve work efficiency and detection accuracy. And the learning ability of the computer can also be enhanced with the increase of workload.So in this respect, the application of computer-related technology to solve this problem is a good choice.

2. Specific Algorithm Implementation

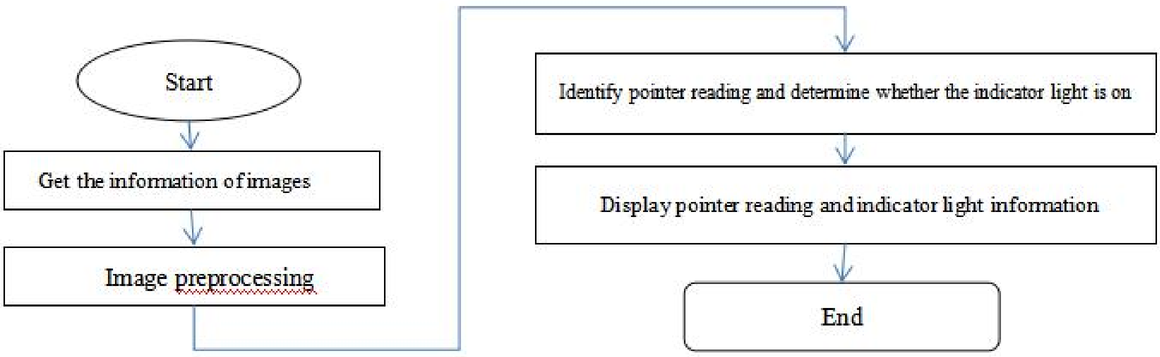

Figure 1: Flow chart.

The system further recognizes the reading of the pointer and the on-off state of the indicator by extracting useful information after the image is pre-processed, and displays the information obtained.

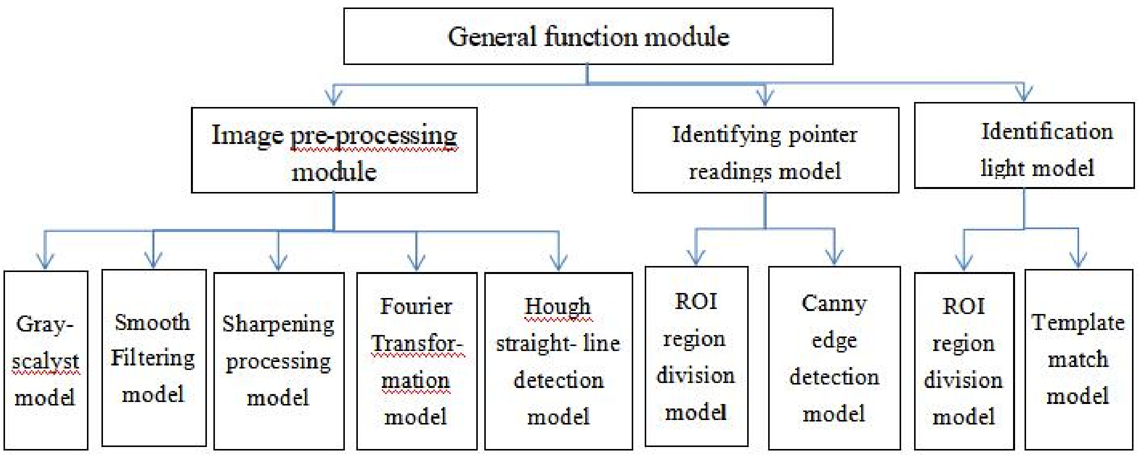

Figure 2: Design module hierarchy graph.

The main design algorithm of the image pre-processing module is to enhance and extract the image information, to grayscale, smooth, sharpen, discrete Fourier transform, Hof straight-line correction to facilitate further feature extraction reading recognition; The recognition pointer reading module first divides the ROI region to remove a large amount of irrelevant information, and uses the method of canny edge detection to highlight the pointer information, and finally determines the angle of the pointer through the Hof linear detection, and then performs the angle conversion to determine the pointer reading; Determining that the LED on-off module also requires the division of ROI areas to remove irrelevant information, and then the template image is scaled for template matching to determine the on-off situation of the corresponding LED.

2.1. Image Pre-processing Model

In the process of image recognition, the pre-processing of images has a great effect, and a large amount of information unrelated to research can be filtered out, thus laying the foundation for further realization.

2.1.1. Sharpening Processing Model

Image sharpening is the reduction of blur in the image by high frequency weight. Image sharpening can effectively highlight the edge contours of objects on the image and the characteristics of research targets.

We can find out how quickly the pixel value of the image changes through the second-order trace of the function. When the pixel value of a pixel is lower than the average of other pixel values in the neighborhood, the pixel value of that point should be further reduced, and conversely, when the pixel value is higher than the average value in the neighborhood.

The differential of bivariate function, that is, Laplacian operator, is as follows (four neighborhoods are selected)

$$\nabla^2 f(x,y) = 4f(x,y) - f(x-1,y) - f(x,y-1) - f(x,y+1) - f(x+1,y) \tag{1}$$

Replace the pixel value of the point with the new pixel value according to the following formula:

$$H(x) = f(x,y) - \nabla\text{^}2 f(x,y) \quad (\nabla\text{^}2 f(x,y) < 0)$$

$$H(x) = f(x,y) + \nabla^2 f(x,y) \quad (\nabla^2 f(x,y) \geq 0) \tag{2}$$

2.1.2. Fourier Transformation Model

Fourier transformation is done by converting an image from a spatial domain to a frequency domain, processing it in a frequency domain, and then converting it to an image's spatial domain.
The Fourier transformation formula for two-dimensional images is

$$F(a,b) = \sum_{i=0}^{M-1} \sum_{j=0}^{N-1} f(i,j) e^{-2\pi(\frac{ai}{M} + \frac{bj}{N})i} \tag{3}$$

f:Spatial domain value F: Frequency domain value.

In the frequency domain, high frequency can reflect the local detail information of the image, while low frequency can reflect the outline information of the image. After the Fourier transformation of the image finished, the image enhancement can be realized by filtering the image at different frequencies, and the effect of noise can be removed.

We should note that the size of the image needs to be filled with pixels, because Fourier transformations are calculated the fastest when the graphic size is 2,3,5 times.

2.1.3. Hough Straight-line Detection Model

In mathematics, a straight line can be represented by the equation: y=ax-b, where ‘a’ represents the slope and ‘b’ represents the intercept. This equation is about the equation of points(x,y). Similarly, we can convert this equation to equations about a and b. That is, convert to:

$$b = ax + y \tag{4}$$

We can look at (a,b) as a point in another space, that is, the parameter space of a-b. For x-y image space, all straight lines passing through each point (x,y) correspond to the trajectory of the point (a, b) corresponding to the a-b parameter space. This converts each line in the original figure to a point in the parameter space.

In practical application, we add up the points in the parameter space, take the local maximum, set a fixed threshold, when the local maximum value of a point in the parameter space is greater than the threshold, we can determine the existence of the point in the a-b parameter space, that is to say, the point corresponds to the original image space there is such a straight line, so as to detect the straight line in the target image.

Hough transformation is through the above principle, the use of image space and parameter space line-to-point pairing, the detection problem transplanted to the parameter space in the middle.

We use the Hough straight line detection method to identify the angle of the straight line in the image. Then the whole picture is rotated at an angle to achieve the correction of the picture.

Figure 3: Initial image.

Figure 4: Processed graph.

2.2. Identifying Pointer Readings Model

2.2.1. ROI Region Division Model and Canny Edge Detection Model

ROI region is the region of interest. In machine vision and image processing,it is often necessary to select rectangles, circles and other areas to be processed in the target graph.

In this experiment, for the detection of the automobile dashboard, because the installation position of the camera is fixed, that is to say, the position of the car's tachometer,speedometer and alarm lights and other information in the target image captured by the camera is fixed, we can circle the corresponding ROI area according to this point, so as to carry out the next step of identification processing.

Even after filter sharpening smoothing, the edge features of the image are not obvious enough, and we need edge detection.

Edge detection can greatly reduce the amount of data, eliminate a large number of irrelevant information, and retain the important structural properties of the image. The application of edge detection can effectively identify the contours of the pointer, which plays an important role in the subsequent recognition of pointer readings.

After that, we still use the Hough straight-line detection method to directly detect the extracted ROI area image to obtain the lines array, through the lines array of all the straight-line angles to average the angle of the pointer.

```
for each i in lines.size() do
  rho ← lines[i][0]
  theta ← lines[i][1]
  m ← cos (theta)
  n ← sin (theta)
  k1.x ← cvRound(m * rho + 1000 * (−b))
  k1.y ← cvRound(n * rho + 1000 * (a))
  k2.x ← cvRound(m * rho − 1000 * (−b))
  k2.y ← cvRound(n * rho − 1000 * (a))
  sum ← sum + theta
repeat
  average ← sum / lines.size()
  angle ← DegreeTrans(average) − 90
```

After the angle is obtained,the indication of the instrument panel can be obtained according to the indication conversion method of different instrument panels

Figure 5: Reading recognition of pointer type instrument panel.

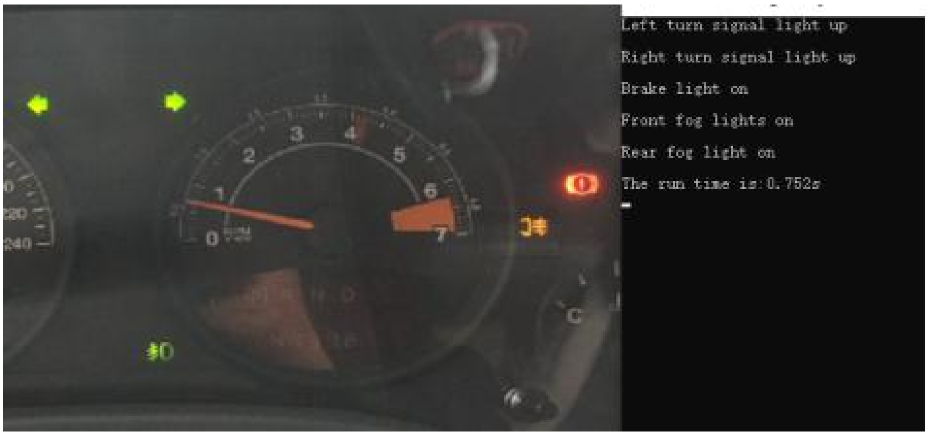

Figure 6: LED identifies.

2.3. Identification Light

For the identification of indicators also need to divide each LED ROI area, and then make a template match, through the template map to scale and get the map in the ROI to match, and the template matching method is through the template map and the pixels of the pending chart square difference, if less than the threshold we set, that is, to judge the success of the match.

3. Conclusions and Shortcomings

This software is able to recognize the traditional pointer dashboard readings and judge the light on and out of the software, through the image pre-processing, in order to achieve the strengthening and extraction of features. Further identify the readings and indicators on and off the pointer dashboard. Effectively speed up the traditional manual judgment, reduce the labor burden of manual work, in the production has practical significance.

There are also many shortcomings in the software designed outside that require subsequent improvements, and for each frame picture recognition speed is still somewhat slow, Figures 7 and 8 show the time of recognition of each frame of image three times and the time (the vertical axis unit). In addition, when identifying the LED, the identification of the indicator needs to be strengthened, and there are still insufficient processing in the process of considering the influence of light on the indicator, resulting in sometimes deviation of the experimental effect obtained.

Figure 7: Image recognition time per frame.

Figure 8: Average frame image recognition time.

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