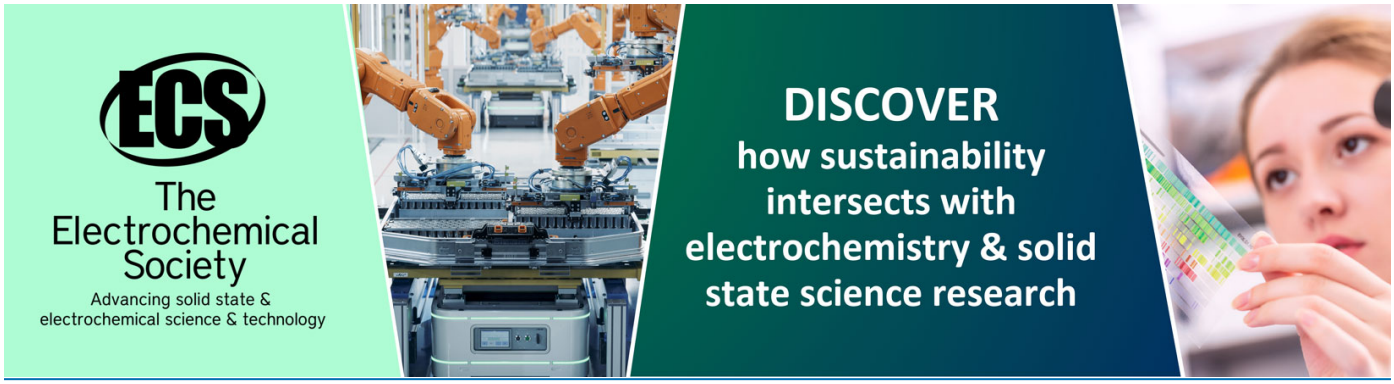
A Simple Algorithm for Identifying the Direction of Arrows



A Simple Algorithm for Identifying the Direction of Arrows

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Abstract. During the development of intelligent drive,the pursue for real-time and precise process of image has been the key point of research. This article introduces a simple way to identify the direction of arrows by means of their length and width.This method has been proven by Matlab.The Terasic's DE1-SoC development board and D5M camera are used to realize the algorithm. The result shows that this method has high performance on both timeliness and robustness.

1. Introduction

With the rapid development of artificial intelligence,smart drive has also got people's attention.One of the key technologies is the identification of arrow direction on the road.

For the oriented arrow recognition, template matching and three levels of detection methods have achieved good results[1].For the traffic sign recognition, Gabor wavelet transform is used to perform principal component analysis[2].Based on the Gabor wavelet transform and two-dimensional independent variable analysis of the characteristics of signs,the nearest neighbor classifier algorithm for identify signs arrow direction also achieved good performance[3].

The main work of this paper is to realize the simple algorithm of recognizing traffic signboard by using the relationship between the length and width of arrows.It not only overcomes the complexity and delay of the above research methods,but also retains the high accuracy.

2. Algorithm Description

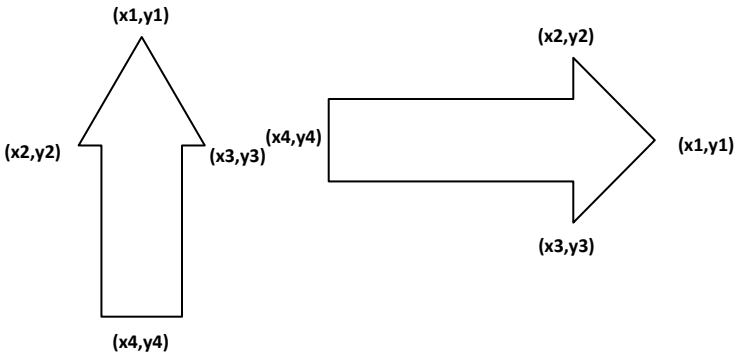


Figure1. Arrow diagram

According to Chinese road traffic signs design rules, the size of the arrow on the traffic signs has a fixed standard..So we can use special points on the standard lens to identify the direction of the arrow[4-6] which is shown in the Figure 1.The detailed analysis is shown as follows.

First of all,the color image of RGB888 mode obtained by camera shall be of binarization.The following process is the binarization of the red arrow .

1.Get three primary color component value of each pixel's RGB,which are decoded from the output of the digital camera.

2.Set a suitable threshold "T".Otherwise,it will loss some arrow information or keep the unwanted red objects in the environment.

3.Compare the magnitude of Red(R),Green(G) and Blue(B).When(R-G)>T and (R-B)>T,the value of R,G,B are all set to 255.In other cases, R,G and B are all set to zero.As the values of R,G,B are same,color image is grayscale.When the values of R,G,B are 255, the pix now shows a white color.As R,G and B are 0,the point appears as a black dot.Then color of picture are set to two values: black and white grayscale.This progress can be seen in the matlab simulation.

The special points in the binary image can be extracted.We can find the minimum point and the maximum point in the X direction and Y direction ,which are shown in the Figure 1 .Because of binary progress in the natural environment,it will inevitably produce some noise to be filtered out.Although these noise points is belong to high-frequency components,it cann't be advisable to use low-pass filters such as mean filter and median filter.It will lead to lose the arrow points of the border ,which will affect the recognition effect.As the 49 pixels(7×7 matrix) around the white point is considered as the white pixel in the arrow,which is used to eliminate the effects of single or small white blocks.The entire image process flow is described above in Figure 2.The position information of the four special points including up,down,left and right position can be obtained.

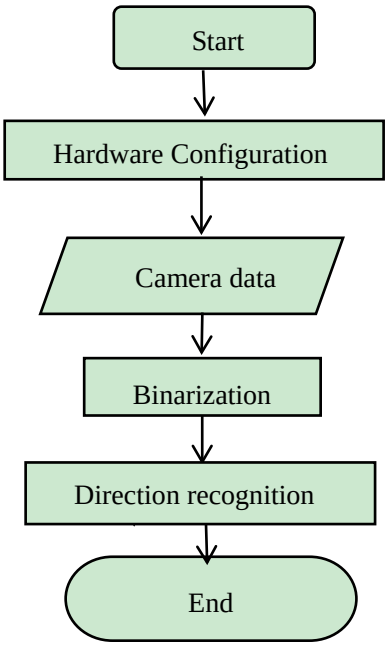


Figure 2. Program flow chart

3. Matlab simulation

Matlab with feature-rich toolbox has a strong power of numerical computing[7].Therefore,we can use Matlab to verify the feasibility of the algorithm, find the bugs in the algorithm and shorten the

development times.Base on the algorithm shown in figure 2,the result of two-value pictures are shown in Figure 3.When the color image is got in the Figure 3(a),the image is first binarized by the program ,which is shown in the Figure 3(b).Then the entire image is processed to get the coordinates of four special points.We will determine the arrow direction according to the difference. The accuracy of the algorithm is shown in simulation .

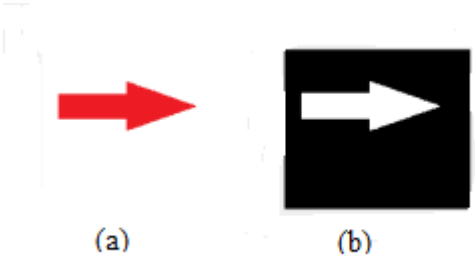
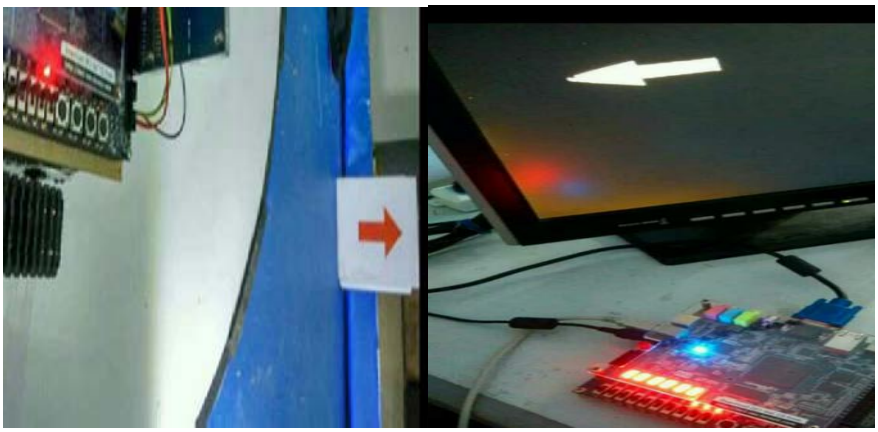


Figure 3. Simulation result of (a)origin graph and (b)binarized graph

4. Hardware implementation



(a) (b)

Figure 4.Physical test result(a) origin graph (b)the obtained result

4.1. The overall design ideas

Taking into account the requirements of real-time processing,Verilog HDL is chosen to implement the algorithm.Experimental equipment contains the development board DE1-SoC and camera D5M of the Friends of Crystal technology.Camera mode is set to VGA640*480@60hz. First of all,the image information collected by the camera is buffered by SDRAM,which are sent to the binarization module with the threshold value varied by switches.Then the direction identification module is used to determine the direction information.At last,the direction code of front,back,left and right are generated as 0001,0011,0111 and 1111 respectively.These output codes are used for subsequent control. LEDs of the development board are used for display direction.When the red arrow is shown in the Figure 4(a),the binarized image and direction code are shown in the Figure 4(b)

4.2. Module introduction

Throughout the experimental project,the key programs of the design is the binary module and the

direction identification module.The principle of the binary module is introduced below. When the difference between the red component value R and the other two component values(G,B) is greater than the threshold T,the variable cmp will be set to 1.Otherwise cmp is set to 0.If the values of cmp is 1,RGB will be set to 255;otherwise they will be set to 0.So we can complete the binarization process of the input color image by using the binary module.Some intermediate variables is define to store the coordinates of the special point of the arrow and the difference.Because the VGA mode is 640*480, all pixels of the arrow are processed.The difference at the turning point of the arrow is compared to one half of the length or width.At last vertical or horizontal direction will be find.Finally the final direction is obtained.Experiment test results are shown in Figure 4.

5. Conclusion

Identification of the arrow on the traffic signs has always been the hot research field of intelligent drive.This paper makes full use of the relative coordinates difference information of special points on the standard arrow for direction recognition.This eliminates the need of locating the signboard and greatly reduces the complexity of algorithm.By using the combination of FPGA and Verilog HDL,the implementation of the algorithm is done. The speed of recognition is improved and a good real-time property is shown.The next step is to achieve automatic threshold adjustment in binarization process.Accurately identification of the direction will be done without human intervention in the natural environment.

Acknowledgments

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