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An Improved Binarization Method for Passenger Car Limited-load Character Area

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Abstract

There is important information in the body text. In order to effectively extract the text area of the passenger car body, a modified binarization algorithm based on the bernsen algorithm is proposed for the body text characteristics. The algorithm is carried out on the sample of the passenger car. Experiments, and compared with the classical local threshold binarization methods bernsen, Niblack, Sauvola, etc., subjective visual assessment and objective image quality assessment (IQA) results show that the proposed method performs better in terms of preservation and differentiation of character regions.

Keywords

Binarization, unicom domain, threshold, preprocessing.

1. Introduction

According to the mandatory regulations of the vehicle management, the body of the bus must be sprayed with load-limiting characters, and the traffic system such as the toll station is classified into the classification of the passenger car by the number of restrictions. Based on this, the vehicle type can be identified from the vehicle body. Due to the complex background of the sample under natural conditions, the pre-processing operation is essential to accurately identify the number of people in the load. Since there is no uniform printing standard for the character area of the passenger car, the gray value of the text area after graying is not fixed with the gray value of the surrounding background. The size relationship is severely affected by light and shadow. Binarization is an extremely important part for the convenience of subsequent identification.

Binarization[1]refers to distinguishing the target area and the background area in the image by a threshold. The threshold is very famous in the fields of image enhancement, target detection and segmentation. The threshold generates a binary image (0 or 1), where 0 (black) indicates pixels belonging to printing or drawing, and 1 (white) indicates background. A successful binary result retains meaningful information while discarding noisy information [1][2]. In the current binarization method, the spatial region division according to the threshold value is mainly divided into two categories: a global threshold algorithm and a local threshold algorithm. The global threshold algorithm uses the gray value of the entire image to calculate a threshold. The commonly used global threshold algorithms mainly include the Large Law (OSTU) [3], the Maximum Entropy Method and the Iterative Threshold Method[4]. The algorithm is simple, the calculation is small, and the processing speed is fast. It is suitable for gray histograms. An image of a bimodal and uniform illumination class, but for an image with uneven illumination or a very complex background, the gray histogram often has no obvious double peaks or multiple peaks, and it is extremely difficult to select the optimal threshold, resulting in binarization. poor effect. The local threshold method includes sauvola algorithm [5], bernsen algorithm[6] and niblack algorithm [7]. When dealing with uneven illumination

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images, the effect of binarization is better than the former, and the anti-noise ability is stronger, but the above three commonly used The methods have their own shortcomings: The first method has the problem of poor processing of weak target image; the second method is applicable under the condition that the illumination block is more clear, for the absence of obvious gray value boundary The picture is invalid; the third method is computationally intensive, and there are often overestimation or underestimation for background estimation. For weak target images with uneven illumination and small difference between target and background, the processing effect is not good. In [8], a new binarization method combining the local threshold Niblack method with the global threshold OTSU method is proposed. Compared with the local threshold algorithm or the global threshold algorithm alone, the new binarization method achieves better image segmentation effect. However, the complexity of the algorithm is increased, and the processing speed is not dominant. The literature [9]uses the Bernsen algorithm to obtain the thresholds for the original image and the Gaussian filtered image, and then weights the two types of thresholds to obtain binary values for the image. The threshold of the algorithm, which combines the original information and the filtered information to binarize the image, can eliminate the noise interference to a certain extent, but does not solve the defect that the Bernsen algorithm will force the binarization. In this paper, we mainly study how to binarize text text regions by using improved binarization algorithm and reasonable text region and background region gray value judgment criteria. According to the characteristics of the passenger car sample character area and the same character width, the original 3*3 neighborhood block is changed into the 9*9 neighborhood block [10], which is more suitable for the binarization of the character region; The threshold condition in the block is changed from the mean value of the maximum value and the minimum value of the pixel gray value to the mean value of all pixels in the neighborhood block to reduce the influence of illumination[10]; finally, the character according to the grayed-out sample The difference between the gray value of the area and the gray value of the surrounding background area is as follows. If the difference between the maximum gray value and the minimum gray value in the neighborhood block is less than a certain threshold (12 in this paper) , then all the pixels in the neighborhood block are set to 0, in order to highlight the text area.

2. Proposed binary method

The algorithm is inspired by the bernsen method。 The bernsen algorithm is based on an estimate of the local threshold for each pixel. This value is assigned as a local threshold only if the difference between the lowest and highest gray values is greater than the threshold (k). Otherwise, assume that the window area contains pixels of a class (foreground or background). The default window size (w) is 3*3 and k is 15. The final formula is as follows：

$$T(x,y) = \frac{Z\max + Z\min}{2}$$

Among them, Zmin and Zmax are the lowest and highest gray pixel values; for the bernsen algorithm used in this experiment, the parameters are set as follows: K value is consistent with the algorithm of this paper, both are 12, and the window size is also set to 9×9 pixels.

In this paper, we propose a proposition of the binarized character region. This method is characterized by a significant difference between the character region of the passenger car sample and the gray value of the surrounding background region, and can work better. The bernsen method can solve the problem of uneven illumination by using a series of gray values[11] in the image, depending on the size of the window. However, if there are multiple levels of grayscale regions between the foreground and the background, or there are factors such as strong illumination, the bernsen method cannot effectively segment the specified region [10]. Therefore, an improved bernsen method is proposed to suppress the illumination problem by taking the average of all the pixels in the window as a threshold. In addition, compared with bernse, another main advantage of this method is that only the gray value is different in the sliding window. Large pixels, and the gray-scale contrast is compared by the communication field in the text area, and the assignment rule is determined. The character area can

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be binarized into the target area regardless of the gray value of the character area and the gray value of the surrounding background area. Conducive to the subsequent unified operation. Combining the characteristics of the grayscale contrast between the text area of the bus sample and the background, and the character width is about the same, the appropriate assignment rule is established by setting the appropriate window size to realize the binarization of the character region. The algorithm proposed in this paper is written by matlab, and the specific processing steps are as follows：

2.1 Character area initial positioning

First, a pre-processing operation, including gradation processing, cropping, smoothing filtering, is performed, and then a grayscale image I1 is obtained, as shown in Fig. 1b. The edge operator is then used to extract the I1 edge to obtain a binary image BW1, as shown in Figure 1c. Then, the morphological opening operation is performed on BW1, and the region of interest is extracted through the connected domain: the interference connectivity domain connected with the edge is initially excluded; the structural elements that are laterally expanded are constructed to connect the text regions, and then the basic geometric constraints and vertical and horizontal constraints are utilized. The connected fields of similar text area features are filtered out, such as the ratio of the number of black and white pixels, as shown in Figure 1d. Finally, the smallest rectangular box containing all connected fields is drawn, as shown in Figure 1d, corresponding to the grayscale and The position of the smallest rectangle of the connected domain graph is taken out to obtain BW3 and I2, as shown in Fig. 1e and Fig. 1f.

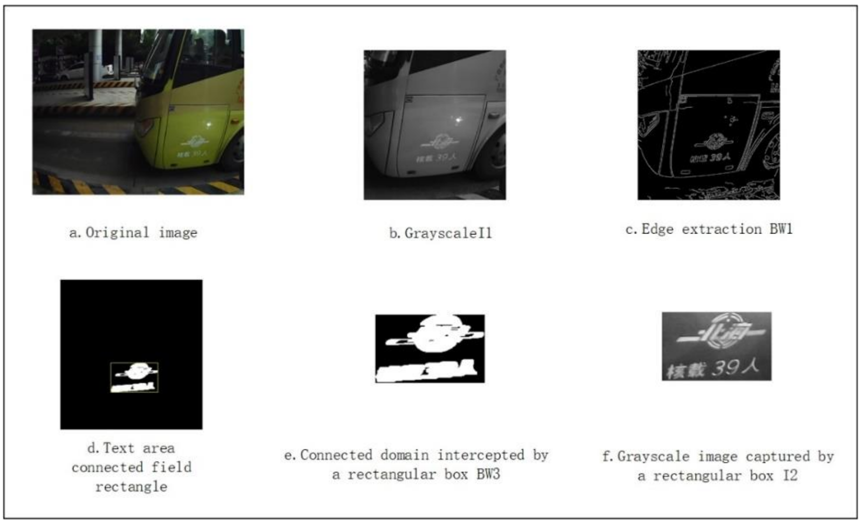

Fig. 1: Sub-diagrams of preprocessing

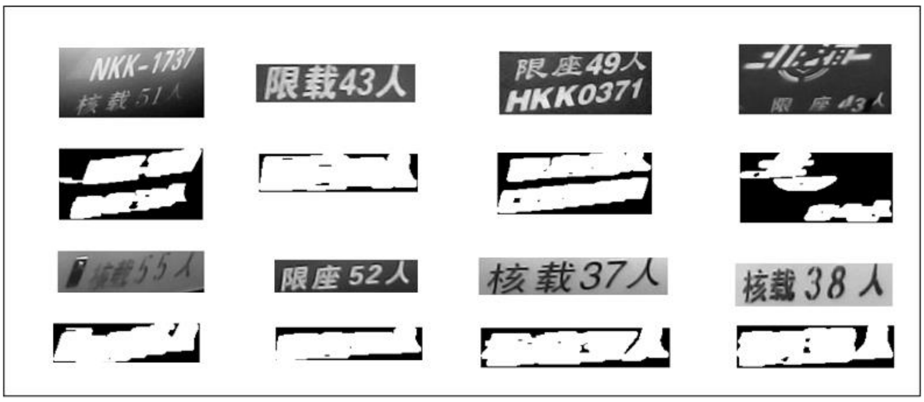

Fig. 2 partially connected domain diagrams and grayscale diagrams initially positioned

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Figure 2 shows the text area initially located in the beginning. It can be seen that there are gray (black) white characters and gray (white) bottom black characters in the text area. Therefore, it is necessary to determine the magnitude of the gray value of the text area compared to the gray value of the surrounding background.

2.2 Comparison of the gray value of the text area and the background area

For each white pixel in BW3 (Fig. 1e), correspondingly in I2 (Fig. 1f), the sum of the gray values of all the pixels at the corresponding positions is found.

$$A=\{(I_1, j_1) \mid BW3(i_1, j_1)=1\} \quad (1)$$

Where A represents the coordinate set with a value of 1 in BW3, and (i_1, j_1) represents the coordinates of the BW3 matrix;

$$B=\{V(i_2, j_2) \mid (i_2, j_2) \in A\} \quad (2)$$

(i_2, j_2) represents the matrix coordinates of I2, $V(i_2, j_2)$ represents the gray value corresponding to the pixel in the coordinate; B denotes a corresponding set of gray values of pixels in all I2 matrix coordinates conforming to $(i_2, j_2) \in A$.

$$q=sum(B)/card(B); \quad (3)$$

$$p=sum(I2)/(m*n); \quad (4)$$

Sum(B) represents the sum of the gray values of all the pixels in the B set, card(B) represents the number of elements in the B set; sum(I2) represents the sum of the gray values of all the pixels in I2; m and n respectively represent The number of rows and columns of matrix I2. Comparing the size of p and q is obvious and easy to understand. When p>q, the gray value of the text area is larger than the gray value of the surrounding background area, and vice versa.

2.3 Binarization

The maximum gray value Lmax, the minimum gray value Lmin, and the average gray value Lmean in each window L are calculated by traversing I1 with a window L of 9 × 9 pixels. For a window in which the maximum and minimum gray values in the window differ by less than 12 (experience value, the best effect, the least noise, and the highest sensitivity), all the pixels in the window are set to 255, which is set as the background; The maximum and minimum gray values in the window differ by more than 12, then traverse each pixel L(i, j) in the window:

a. If L(i, j)>Lmean, and p>q, assign L(i, j) to 0;

b. If L(i, j)>Lmean, and p<q, assign L(i, j) to 255;

c. If L(i, j)<Lmean, and p>q, assign L(i, j) to 255;

d. If L(i , j) < Lmean, and p < q, assign L(i, j) to 0.

among them:

$$L_{mean}=mean(L); \quad (5)$$

The binarization formula is as shown in the formula:

$$L(i,j)=\begin{cases} \begin{matrix} 255, L(i,j)<L_{mean} \\ 0, L(i,j)>L_{mean} \end{matrix}, p>q \\ \begin{matrix} 0, L(i,j)<L_{mean} \\ 255, L(i,j)>L_{mean} \end{matrix}, p<q \end{matrix} , & L_{max}-L_{min}>12 \\ 0, & L_{max}-L_{min}>12 \end{cases} \quad (6)$$

Where L(i,j) represents the pixel in the 9*9 sliding window, L_{mean} represents the average gray value of all pixels in the sliding window;L_{max} and L_{min} respectively represent the maximum and minimum gray value of the pixel in the window; p represents Figure 1e The pixel point of the China Unicom field corresponds to the average gray value of the pixel in Figure 1f, and q represents the average gray

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value of all the pixels in I2. If p>q, the gray value of the text area is greater than the gray value of the background area, and vice versa. Of course. By using this algorithm, problems such as over-segmentation and blockiness can be solved, and the character region is automatically binarized.

3. Experimental analysis and discussion

3.1 Experimental sample and parameter settings

The method is tested on 10 sets of passenger car pictures. The pictures are collected from Guangxi Gaoling Toll Station. They are all triggered by ordinary usb camera. Each photo is taken in the same position, the photo resolution is 1024×768, the picture format is JPG, all programs. They are all written in MATLAB with Acer laptops, equipped with Intel core i5 quad-core processor 1.6GHz and 8.00GB RAM. Figures 3 and 4 show the six sample images selected. The parameters of several sets of classical local threshold binarization algorithms are set as follows: the window sizes of Niblack, Bernens and sauvola are also set to 9*9 pixels, and the rest of the parameters are default values. Several methods and the binarization effect of this method As shown in Figure 3;

3.2 Subjective visual assessment

The first line of Figure 3 shows the illumination and shadow of the original image. The second is the effect of binarization of the sample using the bernsen, Niblack, and sauvola algorithms. Finally, the binarization of the method proposed in this paper. Based on the observations in Figure 3:

The Niblack method and the Bernsen method are prone to over-segmentation and blockiness. For the bernsen algorithm, as shown in Figures 3b1 and c1, when the illumination is strong, the over-segmentation phenomenon is extremely obvious, and the text area is seriously affected. Carry out subsequent operations;

While the niblack method is not affected by light, its block effect phenomenon is not conducive to subsequent processing;

The sauvola method shows satisfactory results, but when the background area gray scale is larger than the surrounding background area gray scale, as shown in Fig. 3b3, the binarization result can only highlight the edge of the text area, and can not effectively segment the text area. Come out, and as shown in Fig. 3c3, there is a phenomenon that characters are not broken.

Based on visual criteria, the algorithm appears to be superior to other methods in terms of image quality and preservation of text areas. In addition, the effect of the proposed algorithm shows that the use of this algorithm has overcome the problems of over-segmentation and blockiness of the Bernen method for segmentation of bus text regions.

3.3 Experimental results objective assessment criteria

In order to prove the quality of the binarized image, for the samples processed by several binarization methods, the same size is cut for the text area. As shown in Fig. 4, the cut image can be regarded as a document image, according to H. -DIBCO[12], calculated some objective evaluation methods, and compared several methods on 10 groups of passenger cars. Table 1 gives the results of the three binarization methods and the proposed method, and Figure 5 is the average histogram of the evaluation results. The evaluation method is based on f-measure (f value), psnr (peak signal to noise ratio), MSE (mean square error), and sensitivity (sensitivity). Compared with other methods, the method achieves f-measure (0.92) and sensitivity. (0.92) the best results. However, in terms of mean square error, the sauvola method yields the smallest result of 0.85, and then the proposed method is 0.91. In addition, the psnr of this method is slightly lower (9.81) than the sauvola method (9.82), but the difference is small. Overall, based on Figures 2, 3, 4, and Table 1, the proposed algorithm has the best performance compared to several classical threshold methods, providing acceptable and high f-measure and sensitivity values.

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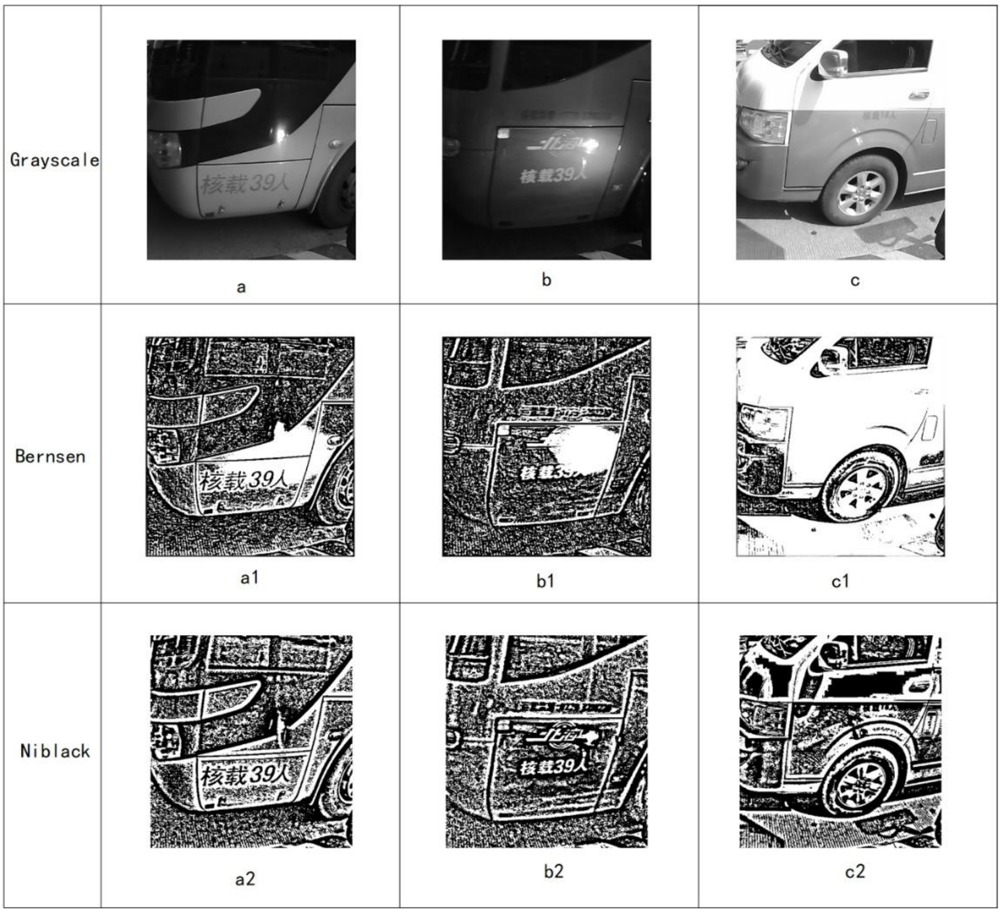

Fig.3 Several two-valued algorithm renderings

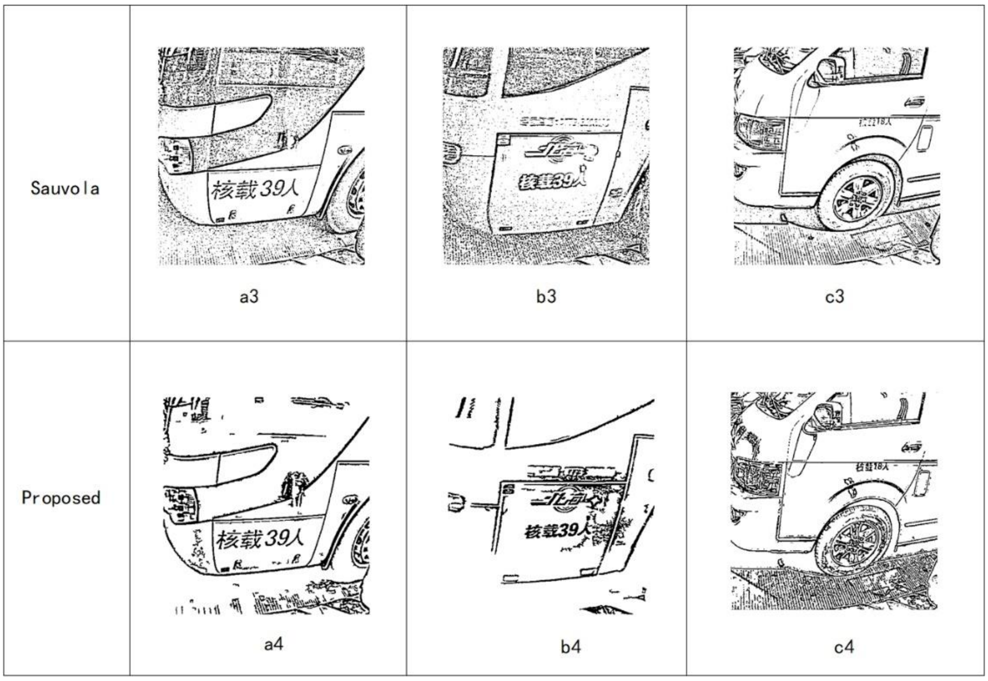

Fig.3(continued) Several two-valued algorithm renderings

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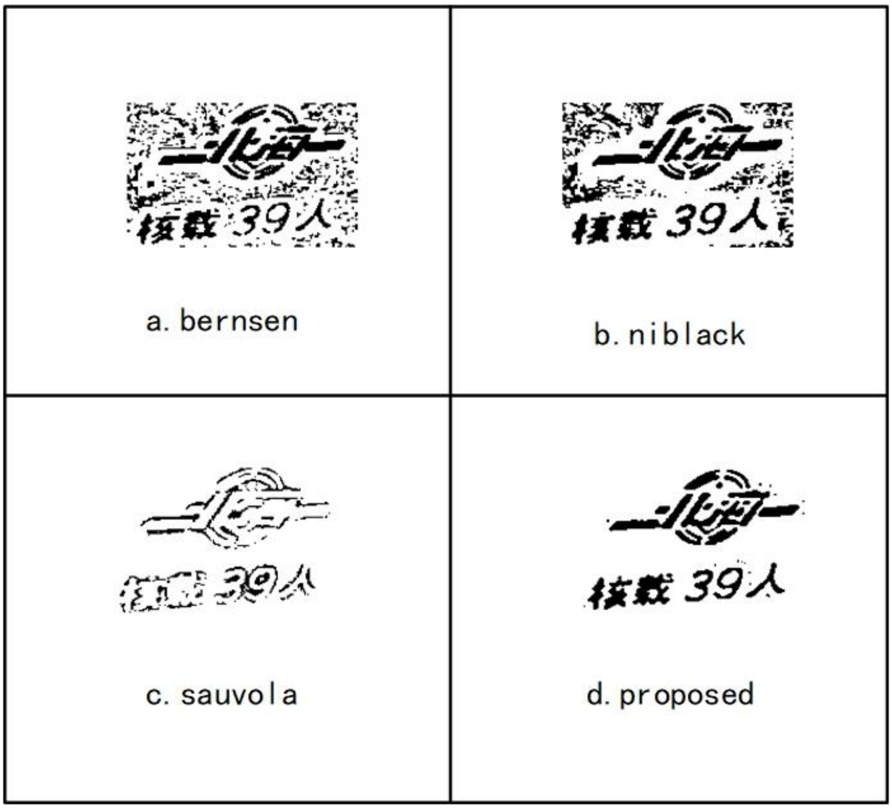

Fig.4. Image quality assessment of different binarization methods

Table 1. Comparison of the methods proposed in this paper with the results of image quality evaluation of the remaining methods

		1	2	3	4	5	6	7	8	9	10	Ave
Nib	f-measure	0.42	0.95	0.95	0.75	0.58	0.75	0.67	0.96	0.94	0.94	0.79
	psnr	5.45	3.06	3.21	4.51	5.03	5.15	4.90	4.88	2.84	2.02	4.10
	MSE（$\times 10^4$）	1.82	3.22	3.10	2.30	2.04	1.99	2.11	2.11	3.38	4.09	2.62
	sensitivity	0.71	0.96	0.93	0.72	0.94	0.63	0.51	0.95	0.97	1.00	0.83
Ber	f-measure	0.35	0.92	0.92	0.65	0.63	0.57	0.61	0.96	0.95	0.95	0.75
	psnr	5.54	3.32	3.45	4.69	4.65	5.59	5.29	4.92	2.08	2.04	4.16
	MSE（$\times 10^4$）	1.82	3.03	2.94	2.21	2.23	1.80	1.93	2.10	3.41	4.07	2.55
	sensitivity	0.80	0.98	0.97	0.63	0.95	0.50	0.48	1.00	0.97	1.00	0.83
Sau	f-measure	0.95	0.63	0.70	0.81	0.95	0.92	0.94	0.55	0.55	0.51	0.75
	psnr	7.63	6.56	6.70	7.89	13.95	12.19	15.32	6.06	10.97	10.97	9.82
	MSE（$\times 10^4$）	1.43	1.12	1.39	1.07	0.26	0.39	0.19	1.61	0.52	0.52	0.85
	sensitivity	0.95	0.47	0.57	0.69	1.00	0.86	0.91	0.49	0.58	0.50	0.70
Pro	f-measure	0.92	0.92	0.92	0.84	0.88	0.93	0.94	0.95	0.94	0.93	0.92
	psnr	6.56	7.60	6.68	7.88	13.93	12.18	15.31	6.04	10.95	10.95	9.81
	MSE（$\times 10^4$）	1.44	1.73	1.40	1.06	0.26	0.39	0.19	1.62	0.52	0.52	0.91
	sensitivity	0.99	0.94	0.91	0.75	1.00	0.91	0.95	0.94	0.95	0.88	0.92

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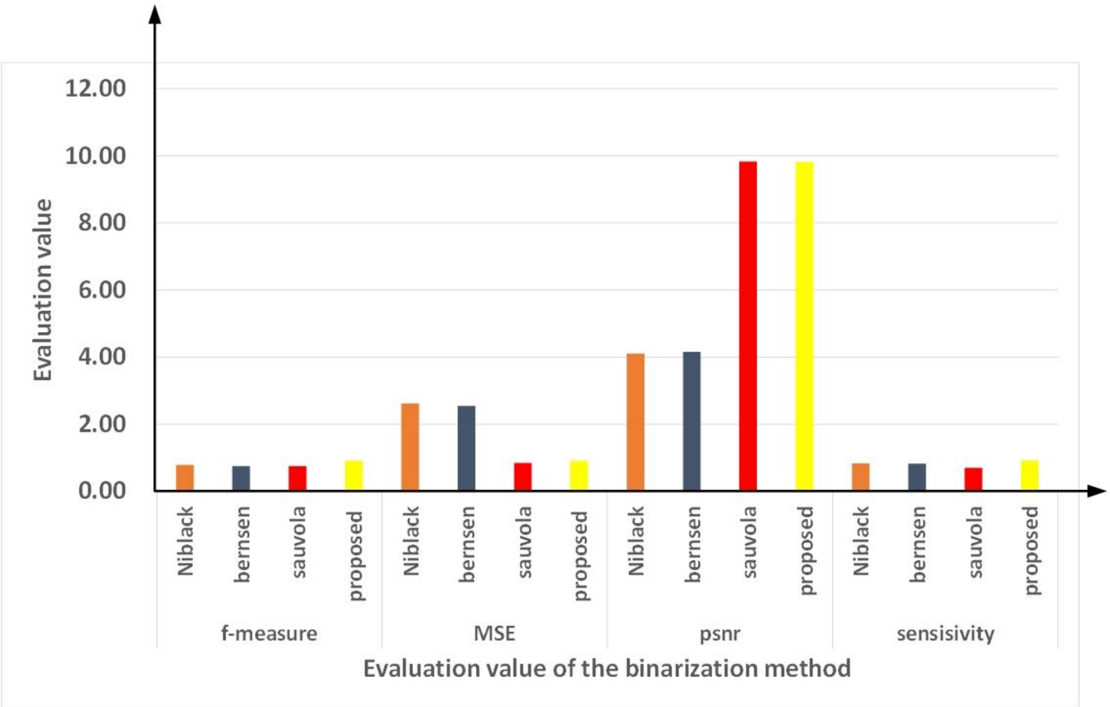

Fig.5. Image quality assessment of different binarization methods

4. Conclusion

In this paper, based on the characteristics of Bernen algorithm, an improved binarization algorithm is proposed based on the difference between the gray value of the character area of the passenger car and the surrounding background gray value and the difference of the character width.

(1) Compared with several binarization methods of sauvola, bernsen and Niblack, a better binarization effect is achieved for the character region. This method is better than the classical local threshold method, which eliminates the influence of over-segmentation and blockiness, and can effectively binarize the text area regardless of the gray value between the text area and the background.

(2) On the basis of the results, the method compares the image quality with sauvola, bernsen and Niblack on the binarization effect map of the shear, and has achieved good results in f-measure and psnr, although both In terms of square error and sensitivity, there are some gaps with the sauvola method, but the difference is minimal.

(3) Compared with the sauvola method, the binarized image of this method is easier to find the cutting point in projection, which is more conducive to subsequent character segmentation.

In the future work, we will continue to improve the performance of related algorithms, in order to provide some reference for practical engineering applications such as future vehicle identification.

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