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Improved image processing fusion HOG-SVM digital display instrument digital recognition method

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Abstract

For their own light color to red, green, blue three colors of the digital display instrument digital identification, traditional image processing operations and trival, processing threshold need to change many times, threading method identifying number problem of low efficiency and accuracy, this paper proposed an improved image processing combined with the gradient direction histogram (HOG) and support vector machine (SVM) identification method.The method is based on the new gray weighted combination for image processing, HOG extract image features, and finally SVM for digital recognition.In order to verify the effectiveness of the proposed method, three comparative experiments were carried out.Experimental results show that compared with traditional image processing, the improved image processing greatly improves the efficiency and accuracy of digital segmentation.Compared with threading method, HOG-SVM greatly improves the efficiency and accuracy of digital recognition.The combined effect is better than the traditional method.

Keywords

Digital instrument;Image processing;Digital Recognition;Stringing method;SVM;HOG.

1. Introduction

Digital display instrument is widely used in various life and industrial scenes and is an important part of various electrical equipment. With the continuous development of science and technology, the traditional management mode is gradually from manual management to semi-automatic or automatic management mode, which is the inevitable trend of industrial development. At the present stage, manual method is still used for digital instrument reading, with low efficiency and high error rate [1]. At present, the method of machine vision can be used for digital instrument recognition, and the recording and transmission of relevant data can be more convenient and fast [2-3]. As image processing, artificial intelligence and other related technologies are widely used in digital display instrument digital recognition, image information is transformed into text information by computer, so as to complete image processing and recognition. Therefore, image processing and recognition algorithm has great practical value, and plays an important role and significance in digital display instrument digital recognition [4-5].

Digital recognition of digital display instrument is divided into two parts: image processing and digital recognition. Single digital gray image is obtained by image processing and segmentation, and then digital recognition is carried out. Among them, the effect of image processing has a great influence on the subsequent digital recognition. At present, most digital display instruments themselves have obvious luminous color characteristics, which will greatly affect the operations such as median filtering, edge detection and morphological processing in image processing. As a result, the image processing effect is poor, and a single digital gray image cannot be effectively segmented, affecting the subsequent digital recognition.

At present, digital recognition mainly adopts threading method, machine learning and other methods. Threading method is simple in principle and fast in operation, but it is susceptible to factors such as uneven illumination and character skew, resulting in low recognition accuracy [6-7]. For example, the threading method is adopted in literature [8] for identification, which has high efficiency but low accuracy, and does not solve the influence of factors such as uneven illumination and character skew. Current machine learning mainly USES the support vector machine (SVM) is used to identify the digital, the SVM is a structure in high dimensional or infinite dimensional space hyperplane or hyperplane collection, in order to realize the classification and regression or other problems of supervised learning, strong generalization ability, the method is suitable for small sample analysis, but the method also has certain limitation. For example, in literature [9], SVM is used to identify instrument numbers, and its accuracy is greatly improved compared with threading method. However, relevant features need to be specially designed and extracted, which results in slow operation speed and generalization ability susceptible to the influence of data volume, making it difficult to obtain accurate recognition effect in practical application.

With the further study of machine learning, the selection and extraction of image features have also received great attention. Histogram of directional gradient (HOG) has been used for pedestrian detection before, but has not been applied in the field of digital recognition. HOG is a kind of computer vision and image processing for object detection in the characteristics of description, through calculation and statistical local area of the image gradient direction histogram to form characteristics, through the image of local grid unit operation, can the geometric and optical image deformation keep good invariance, less affected by the factors such as noise and light, Good robustness [10]. By using the huge advantage of HOG to extract features and replacing the manual feature extraction method of SVM, the problem of low recognition efficiency of SVM can be effectively solved. At present, HOG combined with SVM has not been applied in the field of digital display instrument digital recognition.

Based on the above research, this paper proposes an improved image processing combined with HOG-SVM recognition method for the digital display instrument whose luminous colors are red, green and blue. The method is based on the new gray weighted combination for image processing, HOG extract image features, and finally SVM for digital recognition. Compared with traditional image processing, this method can realize digital segmentation more quickly and accurately. Compared with threading method, digital recognition can be realized faster and more accurately.

2. Research method

2.1. Image processing

Through image processing of digital display instrument image, a single digital gray image is obtained for digital recognition. The traditional image processing process is shown in Figure 1, which can be described as preprocessing the original image first to locate the digital display area. Secondly, the digital display area is extracted from the whole image. Finally, each digit in the digital display area is segmented to obtain a single digital gray image. But for their own light color to red, green, blue three colors of digital display instrument, because of the influence of the self luminous color, traditional median filter in image processing, edge detection and morphological processing operation must change threshold to highlights the display area for many times, if the threshold setting is not appropriate, will appear many interference or digital display is not obvious in the region and influence subsequent digital division. Therefore, traditional image processing efficiency is low, and the segmentation accuracy of single digital gray image is not high.

This paper proposes an improved image processing (as shown in FIG. 2) for the digital display instrument whose luminous colors are red, green and blue. By analyzing the color characteristics of the instrument, it is found that the color component has an obvious clustering center, which is obviously different from the background area. On the basis of analyzing the common gray method, a new gray weighted combination is proposed for image processing. By eliminating the traditional median filter in image processing, edge detection and morphological processing operations, such as the new gray weighted combination of direct effects on the original image, can effectively restrain noise interference, at the same time without artificial and change the threshold, the more effectively highlight the display area, single digital image processing is more efficient and gray image segmentation accuracy is higher.

The grayscale weighting formula proposed in this paper for the digital display instrument with red, green and blue luminous colors is as follows:

$$ExG(x,y)=2.0G(x,y)-R(x,y)-B(x,y) \quad (1)$$

$$ExG(x,y)=2.0R(x,y)-G(x,y)-B(x,y) \quad (2)$$

$$ExG(x,y)=2.0B(x,y)-R(x,y)-G(x,y) \quad (3)$$

Where, ExG(x,y) is gray weighted combination; R(x, y), G(x, y) and B(x, y) are the gray values of the three channels.

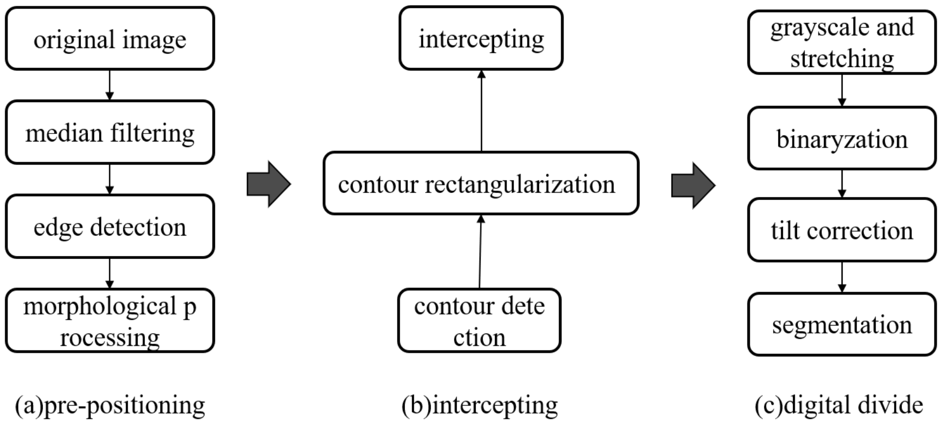

Fig.1 Flow chart of traditional image processing

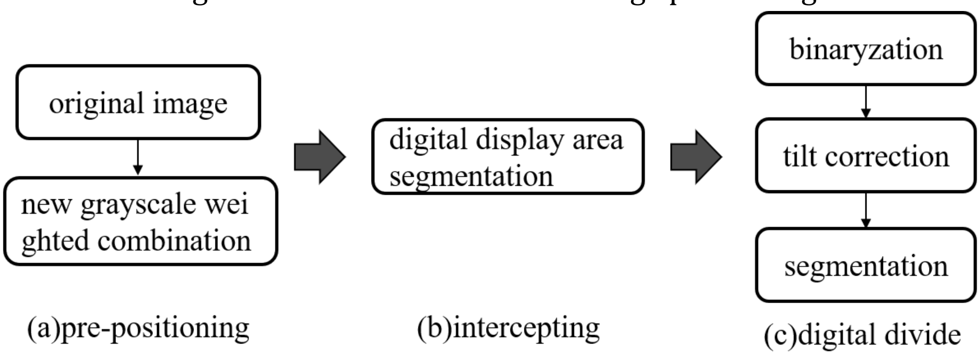

Fig.2 Flow chart of Improved image processing

2.2. Digital recognition

This paper adopts HOG combined with SVM method for digital recognition. Different from threading method and SVM, which require manual selection and feature extraction for digital recognition, this paper uses HOG's great advantages in feature extraction to input the extracted features into SVM model (as shown in Figure 3) for recognition. The specific steps of HOG feature extraction are as follows:

(1) Normalize and de-mean the input single digital grayscale image data;

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(2) Calculate the gradient of each pixel of the image, and divide the image into small modules of 10*10 pixels;

(3) Every 4 small modules are formed into a large module, and the number of different gradients in the gradient histogram of each small module in each large module is calculated, that is, the characteristics of each large module are obtained;

(4) The features of the whole image are obtained by connecting the features of all large modules in series, which are input into the SVM model for recognition.

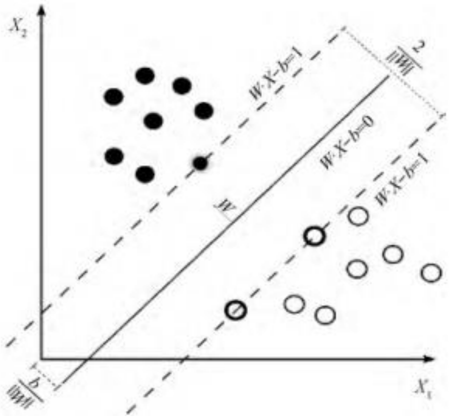


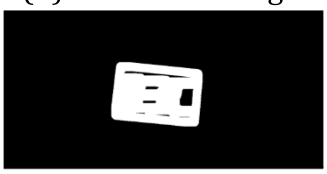
Fig.3 SVM model structure diagram

3. Experiment and analysis

3.1. Image processing experiment

In order to verify the improved image processing performance of this paper, a large number of digital display instrument images with red, green and blue colors were collected in this paper, and an experimental data set containing 1000 images was constructed. This time, a comparison experiment was conducted between traditional image processing and improved image processing. An electrical image in daily life was selected and image processing was carried out according to the process shown in Figure 1 and Figure 2 respectively. The effect diagrams of the two methods are shown in Figure 4, Figure 5, Figure 6 and Figure 7:


(a)original image (b)median filtering

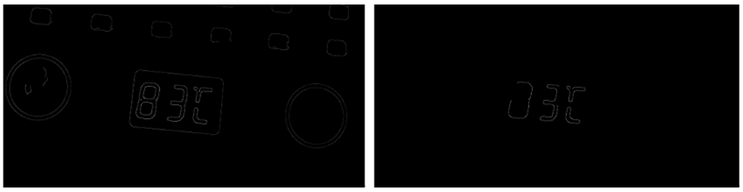
(c)edge detection (d)morphological processing


(e)contour detection (f)Rectangular

(g)intercepting (h)graying (i)gray stretch

(j)binaryzation (k)tilt correction (l)Digital divide

Fig.4 Traditional image processing renderings



(a) (b)

Fig.5 Edge detection failure diagram

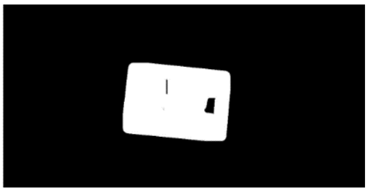
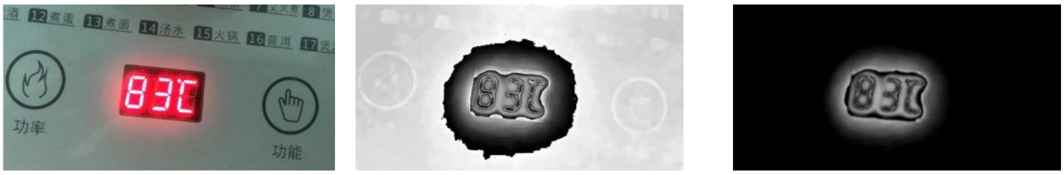


Fig.6 Morphological processing failure diagram



(a)original image (b)Improved grayscale (c)Digital display area segmentation

(d)binaryzation (e)tilt correction (f)Digital divide

Fig.7 Improved image processing renderings

At the same time to better validation to improve the effectiveness of the image processing, this paper will improve the traditional image processing and image processing, data set for this article separately image processing experiments, ten times ten times experiments are summed up the last average, adopting digital average segmentation time, number average segmentation accuracy as the evaluation index, the experimental results such as table 1, as shown in figure 8 and figure 9:

Table.1 Comparison of image processing methods

	Average split time/s	Average segmentation accuracy/%
Improved image processing	571.9	98.11

Traditional image processing	1184.03	90.55

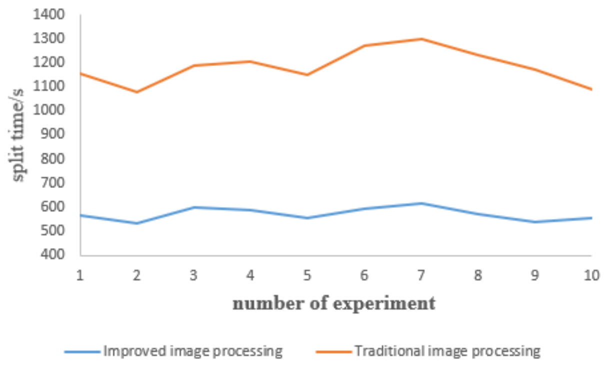


Fig.8 Digital segmentation time chart

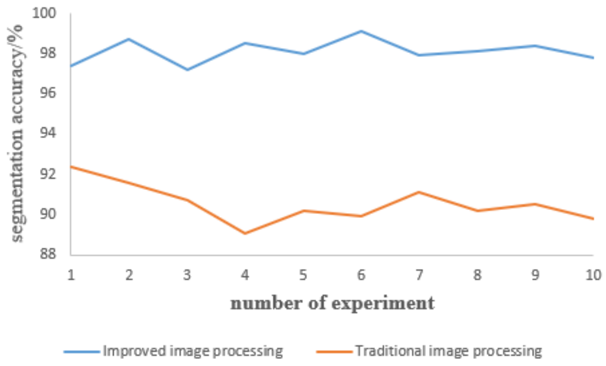


Fig.9 Digital segmentation accuracy chart

Above, the experimental results show that compared with the traditional image processing, this paper improved the image processing has been cancelled the median filtering, edge detection and morphological processing operations, such as the new gray weighted combination of direct effects on the original image, without the artificial and change the threshold, greatly simplifies the operation steps, more effectively highlight the display area. In the aspect of average digital segmentation accuracy, the improved image processing is nearly 8% higher than the traditional image processing, and the digital segmentation is more accurate and more conducive to the subsequent digital recognition; Although the average digital segmentation time is only 612.13s less than that of traditional image processing, this is because the traditional method does not include the time of changing the threshold of median filtering, edge detection and morphological processing into the total time, so the time difference between the two methods is far more than 612.13s. Meanwhile, the method in this paper is more stable. Therefore, for the digital display instrument with red, green and blue colors, the method presented in this paper has a better effect on image processing.

3.2. Digital recognition experiment

Nearly 2000 single digital grayscale images were obtained through the above image processing experiments, and the HOG-SVM and threading method in this paper were used for the comparative experiment of digital recognition. At the same time, in order to better verify the effectiveness of HOG-SVM in this paper, the two methods were tested for ten times respectively. Finally, average digital recognition time and average digital recognition accuracy were used as evaluation indexes. The experimental results are shown in Table 2, Figure 10 and Figure 11:

The above experimental results show that the HOG-SVM in this paper is much more accurate than the threading method in average number recognition. Although the average number recognition time is increased by 89.32s, this is because the threading method does not include the time used for manual selection and feature extraction into the total time, which is far more than 416.34s, so the total time is still less than the method in this paper. At the same time, with the increase of the number of experiments, the method in this paper is more stable. Therefore, the method presented in this paper has better effect on digital recognition.

Table.2 Comparison of digital recognition methods

	Average recognition time/s	Average recognition accuracy/%
HOG-SVM	416.34	99.16
Stringing method	327.02	89.6

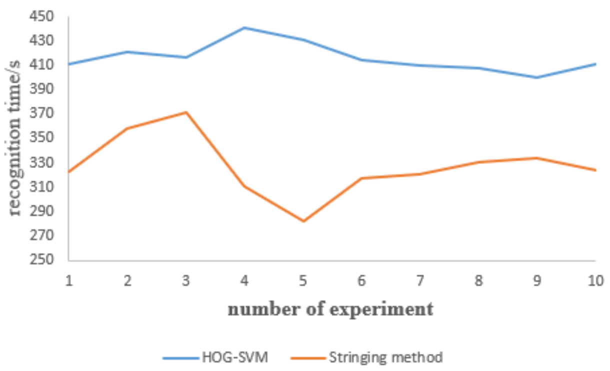


Fig.10 Digital recognition time chart

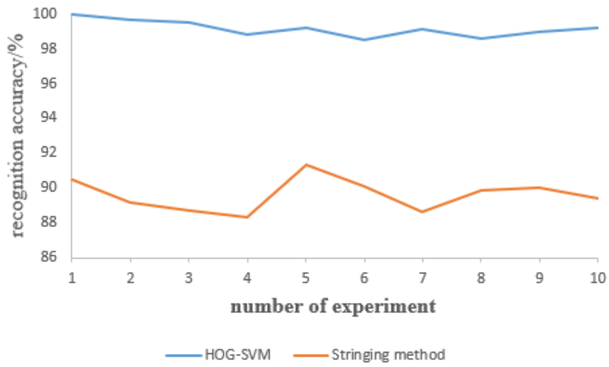


Fig.11 Digital recognition accuracy chart

3.3. Comprehensive contrast experimen

In order to better verify the effectiveness of the improved image processing and HOG-SVM digital display instrument digital recognition method in this paper, the hybrid combination of the improved image processing and traditional image processing with HOG+SVM and threading method was carried out for the comparative experiment of digital recognition. Finally, the average digital recognition time and average digital recognition accuracy were used as evaluation indexes. In this experiment, 1000 digital display instrument image data sets constructed in this paper with red, green and blue light emitting colors are used. The experimental results are shown in Table 3, Figure 12 and Figure 13:

Table.3 Comparison of hybrid number recognition methods

	Average recognition time/s	Average recognition accuracy/%
Improved image processing +HOG-SVM	976.43	98.44
Improved image processing + threading method	936.69	88.5
Traditional image processing +HOG-SVM	1604.74	98.03
Traditional image processing + threading method	1549.93	85.8

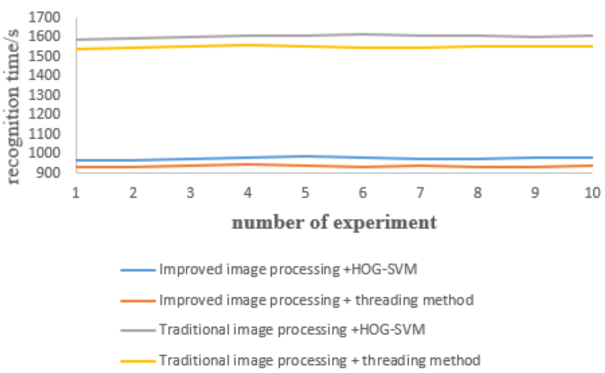


Fig.12 Digital recognition time chart

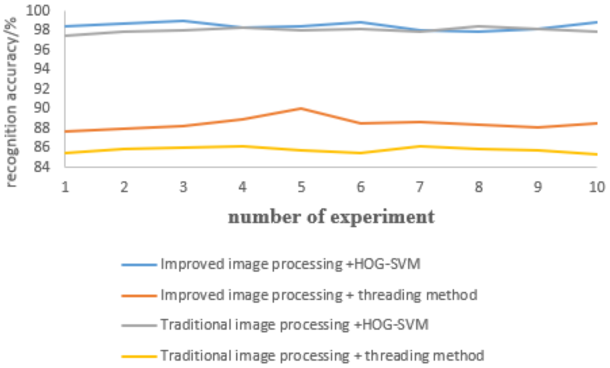


Fig.13 Digital recognition accuracy chart

Above, the experimental results show that compared with the improved image processing + threading method and the traditional image processing + threading method, this paper improved combination of image processing and HOG - the SVM method has obvious advantage, recognition time more than the improvement of image processing + threading method because its threading method is not used by artificial selection and feature extraction time included in the total time, Therefore, there are fewer methods in this paper in total time. Compared with traditional image processing +HOG-SVM, the average recognition time of this method is 1.64 times that of the method in this paper, although it has little advantage in average recognition accuracy. Based on the above comparison, this method has incomparable advantages in image processing, feature selection and extraction, and digital recognition. At the same time, with the increase of the number of experiments, this method becomes more stable. Therefore, the method presented in this paper has better effect on digital recognition of digital display instrument with red, green and blue light color.

4. Summary

This paper proposes an improved image processing combined WITH HOG and SVM recognition method for the digital display instrument with red, green and blue light colors. The method is based on the new gray weighted combination for image processing, and the digital segmentation efficiency and accuracy are higher. It is more efficient and stable to select and extract image features through HOG. Finally, SVM is used for digital recognition, which is more efficient and more accurate. In order to verify the effectiveness of the proposed method, a series of comparative experiments were carried out by constructing a data set containing 1000 digital display instrument images with red, green and blue colors. The experimental results show that the method presented in this paper can accurately identify the digital display instrument with red, green and blue light colors, which is of great significance to the online recognition of this type of instrument.

Because the method in this paper is only experimented with small-scale data sets, but not with relevant large-scale data sets, it does not reflect the advantages of the improved image processing and digital recognition method in this paper. Therefore, it is hoped that in the future research, relevant large-scale data sets can be constructed for experiments, so as to carry out in-depth improvement and research on the method in this paper.

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