

Research on identification method of pointer type instrument in Substation

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Abstract

The field of pattern recognition technology is the research direction in the field of pattern recognition, and it is also an image processing and recognition technology with wide application foreground. The on, at present, the application of pointer type instrument recognition technology main implementation method are summarized, their advantages and disadvantages are analyzed, and a brief description of the basic steps and key technologies of common pointer type instrument recognition system, finally according to the status of research and application at home and abroad pointer type instrument recognition research, points out the development direction.

Keywords

Dial instrument; recognition technology; image processing.

1. Introduction

Because the pointer type instrument can directly reflect the change trend of the measured value, and has the advantages of simple structure, easy maintenance, convenient use, high reliability, low price, waterproof, anti freezing, dust prevention, etc., So it is still used in our country's electric power industry. There are thousands of pointer instruments used to display the current status of the device in a substation. For example, pressure gauge, thermometer, temperature meter, voltmeter, ammeter, arrester table pointer instrument. In substation, the pointer type instrument needs to record a large amount of data from manual records every day. Now the identification of pointer type instrument is basically manual operation, manual operation is not only accurate, low efficiency, reliability, repeatability, but also labor intensity and easy to be affected by external factors. Therefore, it is of great significance to develop a fast, accurate and stable method for the development of substation, which is based on the shortcomings of the traditional method.

2. Research status of pointer instrument identification method

Image recognition technology has a very wide range of applications in industrial production, especially in power operation and production. The pointer recognition based on image processing is an important application direction in power system. The use of image processing methods for the detection of pointer instruments at home and abroad, there are precedents, and more methods. The key point of the identification method of the pointer type instrument is the extraction of the pointer and the measurement of the angle of the pointer. For the processing and recognition of pointer image, some research has been carried out at home and abroad. Some researchers have proposed visual color clustering and fuzzy recognition method to identify, but the process is complex, and the effect is not satisfactory [1,2]. A pointer position recognition algorithm based on is proposed, which is used to determine the position of the pointer by the concentric circle search method. Although the algorithm is simple, but the recognition accuracy is not high, and the recognition error is affected by the camera and the dial target installation angle, which it is difficult to control in the actual operation [3]. In 2003 Yue Guoyi, Bao Shu Li etc [4] proposed the smart pointer type instrument recognition system based on computer vision technology and programmable standard signal source and software of the system consists of camera, image acquisition card, computer, programmable standard signal source and consists of image acquisition interface program, process control standard signal source interface

program, recognition program package. The recognition method of calibration line and pointer is studied, and a new distance criterion is proposed. This method is more reasonable and can reach the requirement of system precision. The result shows that the method is superior to the artificial recognition and has a good application prospect. In 2005 [5], On the basis of a detailed analysis of the automatic recognition algorithm of the pointer type instrument based on the feature recognition, Shake Yang of Shandong University used the development platform to develop the automatic recognition software system of pointer meter. Through the performance test of the automatic recognition system of the pointer type instrument, and compared with the traditional transform detection method, it still has a high recognition rate, accurate reading and strong applicability. In 2006 Hai Long Duan and Cheng Jian [6] proposed the use of Hough transform based instrument pointer position recognition algorithm, which the algorithm through the subtraction algorithm to determine the pointer to the center, and then look for the position of the pointer position identification. This method has high recognition accuracy, but due to the complexity, big amount of computation and occupy a lot of memory of the Hough transform, so it takes a long time and the application range is greatly restricted. In 2007 [7], Sun Fengjie and other scholars proposed a method for the determination of the light of the poor light conditions - the main color extraction method, the algorithm has the advantages of simple calculation, strong adaptability, good processing effect and the Small recognition error, which lays the foundation for accurately determining the position of the pointer and calculating the degree of the pointer. Wei Zheng and Yang Yaoquan etc [8] for the pointer type instrument in automatic reading of pointer extraction proposed an improved Hough transform algorithm, using double threshold linear Hough transform to extract the operation speed is greatly improved, reduce the occupied memory, at the same time, reduce the chance of false lines matching. In the application of pointer meter automatic reading, combined with the actual, with a limited search angle range, improve the speed of the detection pointer, so that the pointer type meter automatic reading pointer detection reached a practical level. But the reliability is not high. In 2009 [9], Yuan Weiqi and other scholars proposed the image processing technology which based on the improved Hough transform method and the center method. The technology not only retains the circular scanning algorithm is simple, high precision and easy to be implemented in hardware but also effectively solves the problems caused by the eccentric circle scanning method in low stability, avoid the scanning radius setting, and realize the automatic recognition of the pointer type instrument. In 2009 the Ze Tao Jiang etc. [10] proposed a method of fitting a straight line based on sub pixel localization based on the basis to determine the approximate location of the pointer point Hough transform fitting the circle center and the radius and center of projection method, it has the high precision of the pointer type instrument automatic detection and positioning, so as to realize the non-contact measurement of the pointer instrument. Compared with Hough transform, the algorithm is improved by about four times. Compared with the central projection method, the recognition accuracy is greatly improved, and the accuracy of the pointer detection and recognition accuracy is improved, and it is a practical method. In 2011 [11], Sun Lin and Wang Yongdong applied machine vision technology to the verification system of the pointer meter. A new image recognition method is proposed for the automatic interpretation of the indicator value of the pointer type instrument. The method is suitable for practical application, with high accuracy and good accuracy, which has certain application significance. In 2014 [12], Electric Power Research Institute of Guangdong Power Grid Corporation personnel designed a new pointer type meter reading recognition method. In the substation power system, a kind of video recognition technology is used to automatically read the pointer meter, the method can detect multiple pointer targets quickly and accurately without any pre-treatment, and can improve the accuracy of the meter reading in the power system of substation.

In foreign countries, the use of pointer instruments is not much, because of the industrial situation and the different image recognition technology, there is not a good image recognition method. Abroad in the field of instrument identification research carried out earlier, in the instrument and meter automatic interpretation and calibration has made a lot of work to learn from the previous work. According to the literature that Palmer PL and Kittler etc studied the recognition method of

pointer type instrument earliest[13].Firstly,they processed the image by gray scale and two value, then the Hough transform is used to determine the position of the pointer and the calibration line, so the computation is small and the time consuming is relatively short.But this method can not distinguish the color information of the image and can not distinguish the different color of the pointer, so it is only suitable for single color dial pointer. Correa Alegria [14]described the process of using machine vision to test the pointer meter In detail in the literature.First use camera to capture global the dial image, then use subtraction method to two different positions of pointer image preserved, the pointer is obtained by using Hough transform angle, after which the image do geometric transformation and get a pointer reading.But this method is more harsh on the shooting environment, that is, in the same kind of light under the conditions of access to two different scales of the dial pointer image, so this method is more ideal and not suitable for the actual project. Sablatning[15]described an identification method of another pointer type instrument in the literature .This type of instrument pointer rotation angle range is 360 degrees, after the image segmentation is completed directly using Hough transform to get the point of view, in order to determine the pointer table reading.In 2000[16], Mantas and Galambos proposed the morphological processing method, but the process is more complicated, which is not conducive to the practical application.

3. Basic steps and key technologies of common pointer type instrument identification system

The implementation method of the pointer type instrument recognition system is divided into the following steps: acquiring image - threshold iteration two value - based on the structure of the pointer type instrument image segmentation - pointer contour extraction - boundary tracking - reading recognition. The whole process is shown in figure 1:

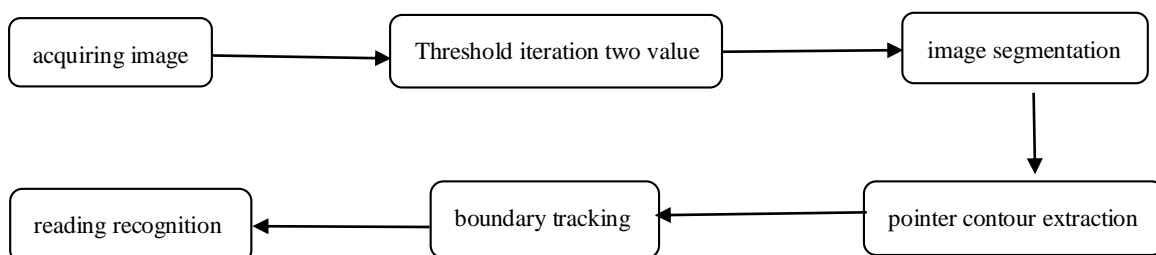


Fig. 1 the process of the identification system of the pointer type instrument

3.1 Get image

The image of the collected image pre-processing, so that identify the late pointer efficient and accurate, and its main steps as shown in figure 2. Image pre-processing mainly includes: two values of image, image filtering, image expansion and refinement.

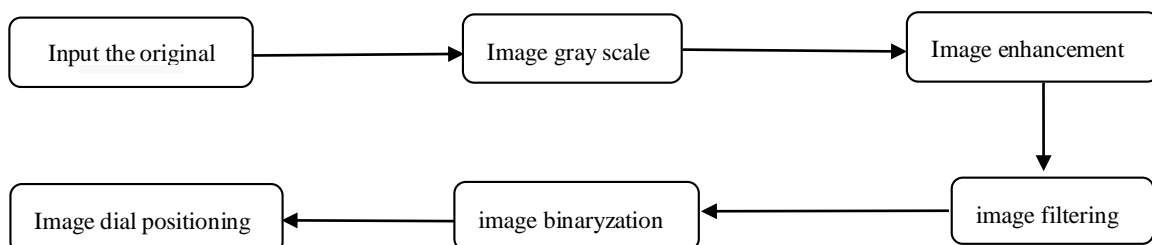


Fig. 2 image pre-treatment process

3.2 Threshold iterative two value method

There are many methods for the image of the instrument dial, including the fixed threshold method and dynamic threshold method, and so on. In the actual interpretation, with measured meter of environment brightness, dial background, case material and watch case curvature different, it will cause the image brightness changes.If the fixed threshold is used for the two value processing and this kind of change can not be used.Therefore generally used in dynamic threshold method, take the

whole image gray value of the maximum value and the minimum value of the average value as the threshold, and thus the image of binarization processing. So even in the event of watchcase brightness changes do not affect interpretation accuracy, can greatly improve the applicability of the system, reduces the requirement for the use of the environment.

3.3 Image segmentation

Image segmentation is to divide the image into several mutually overlap area according to the gray level, such as color, texture and shape features, Which make these features appear similar in the same area and show significant differences between the different regions. The existing image segmentation methods are mainly divided into the following categories: threshold based segmentation method, region based segmentation method, edge based segmentation method, and segmentation method based on specific theory. Image segmentation is the basic step of image recognition and image understanding, image segmentation quality directly affects the effect of subsequent image processing.

3.4 Automatic reading of pointer

The automatic interpretation algorithm of pointer reading has Hough transform, distance method and the improved algorithm based on Hough transform. The basic principle of Hough transform is to use the duality of points and lines, and through the curve expression form of the original image space given points into a parameter space curve. In this way, the detection of a given curve in the original image is transformed into the search for the peak value in the parameter space and the detection of the overall characteristics is transformed into the detection of local characteristics. Hough transform [12] is not only able to detect the linear first-order curve of the target, but also can be tested for all round, elliptic curve of high order meet the analytic formula of $f(x, c) = 0$ goals of all kinds of curve, however its calculation will increase with the number of analytic expressions into the index increased.

4. The difficulty and development direction of pointer instrument identification technology

4.1 The difficulty of pointer instrument identification technology

There are many types of pointer type instrument identification algorithm, but its general performance is not strong. The key to the recognition of pointer type instrument is image pre-processing and the performance of the whole instrument system is affected by the pre-treatment. Due to the majority of the substation's pointer instruments placed outdoors, the collection of the instrument images are usually affected by the environment. In the process of image acquisition, the poor lighting will cause the image to produce reflection, glare, so that the brightness of the image is not uniform and the local information is difficult to identify. Due to the method used in the extraction process, the working principle and the hardware conditions have significant differences, so there is not a unified, widely accepted method of pointer instrument identification. In order to carry out the research on the identification technology of the pointer type instrument, Some researchers have studied a method of pointer extraction and image acquisition, The method has some advantages and disadvantages, because of the difference between the pointer location and feature extraction algorithm, the same pointer recognition algorithm is difficult to be used in different types of pointer type instrument image recognition.

4.2 Main development direction

1) The composition of image acquisition system of the pointer meter in Substation

Image acquisition technology mainly includes light source illumination mode, illumination model and image pre-processing technology, which is the key link of the pointer type instrument identification. At first, the light is projected onto the measured object in a suitable lighting mode, so that the contrast of the measured characteristic part is highlighted, then the collected image is pre-processed to obtain the high quality image. In this process good lighting design can improve the resolution of the whole system and simplify the processing of the software; inappropriate illumination

can cause many problems such as excessive exposure of the image, the contrast between the information and the background, the image point, the noise too much and so on. In view of the acquisition system and processing target to take the corresponding pre-treatment algorithm, which make its adaptability, strong robustness and moderate time.

2) Method for eliminating image noise by eliminating pointer type instrument

In the process of generation, acquisition and transmission, the image is often polluted by noise. In the processing of image edge detection and segmentation feature recognition, because the existence of noise makes the image SNR decreased, as a direct result of some features of the image detail is submerged in the image noise, therefore, the existence of noise not only affects the subjective quality, but also affects the subsequent processing of the image. This makes noise a critical factor on affecting the accuracy of the identification of a pointer type meter in a substation, so it needs to reduce the impact of noise as much as possible.

3) Research on the technique of image segmentation of pointer type instrument

Image segmentation is to divide the image into a number of specific and unique characteristics of the region and put forward the technology and process of the target of interest. It is the key step of image processing to image analysis, which the algorithm of image segmentation can be realized through the Matlab software platform. Instrument image segmentation has a direct impact on the subsequent image processing and recognition results, so the image segmentation method is worthy of research.

5. Conclusion

The key of the identification method of Substation pointer type instrument is the extraction of pointer and the measurement technology of the pointer angle. Solving the interference and error of the pointer extraction and the meter reading can make the pointer instrument testing results more accurate. So far, some domestic and foreign scholars have studied it and put forward the methods to identify the pointer type instrument. The analysis of the results of these studies has advantages and disadvantages. These results has a good reference to keep on studying the substation pointer meter interference and error, which make the results of the pointer meter test more accurate.

Acknowledgment

This work is supported by the graduate students innovative research fund of Northeast Petroleum University (YJSCX2016-027NEPU).

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