Recognition of Blurring Alphabet Character on Timing Pulley Drawing Based on Halcon Image Processing Technology

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Abstract. In order to solve the problem of Inefficiency in the use of manual detection of the information on the engineering drawings in synchronous belt manufacturers. This paper present a method of image processing based on HALCON. Firstly, the image will be inputted to the software platform, then the image will be processing by the means of Image enhancement, threshold segmentation and so on. Thus, the information on the engineering drawings can be recognized. This experience shows that blurring alphabet character on the engineering drawings can be recognized quickly and accurately based on Halcon. It can effectively reduce the workload, increasing the productivity.

Keywords: Machine Vision, OCR, Image Processing

1. Introduction

Engineering drawings are technical documents for the production process in the manufacturers, which cover dimensions, tolerances, operation and other technical information, and play an important role in the mass production. With the development of digital technology, the current production mode of manufacturers is gradually turned to digital ones. However, the digital production is accompanied by the digital documents and related technical data, but large numbers of technical documents in the manufacturers are still in paper files or drawings for a long time, especially the engineering drawings in the mass production lines. It is a heavy and urgent task to convert all technical documents into digital forms. The common practice is that engineers or technicians use mouse and keyboard to enter a text file into the computer. However, this will greatly increase the time and labor, with the relatively low efficiency. Besides, there will be unavoidable to have some operator errors, such as spelling errors and input errors caused by misunderstanding. The digital conversion of text files by machine visual image processing can solve these issues of manual conversion and improve the efficiency.

This paper mainly introduces the recognition of blurring alphabet character in engineering drawings through Halcon image processing software. First, it introduces the related research status of machine vision
image processing technology and the software used in this study. Later, it introduces the flow of the experiment, the steps of image pre-processing, the selection of regions of interest and the recognition of blurring alphabet characters. Finally, the paper gives a brief introduction to the multi-layer perceptual neural network, and points out the direction of further improvement for the program.

2. Machine vision image processing technology
Machine vision image processing technology uses machine vision products to simulate human’s vision, extracting information from images and processing and work out the information. Machine vision technology is mainly characterized by a high efficiency, a high quality and a large amount of information processed, which has been widely used in various industries. On the other hand, since there is an urgent trend of digitization in the industrial field and large amount of paper technical documents need to be converted into digital documents in a short time, researchers have carried out a lot of research in this area. M. Sheppard made the first GISMO machine for visual recognition back in the 1950s. Since then, the researchers have deeply studied recognition in input images and converted them into American Standard Code for Information Interchange (ASCII) or other equivalent forms that can be edited by machine [1-6]. On the recognition of blurring alphabet character, Zhao et al proposed an identification results classification and post-processing method to make the recognition results more reliable and accurate, but it only works on a certain area. However, seldom reports mentioned the recognition of blurring alphabet character via Halcon.

3. Halcon image processing software
Halcon is a complete package of standard machine vision algorithms developed by German MVtec Company, which features a widely applied integrated development environment of machine vision. It saves product cost, and shortens software development cycle. The flexible framework of Halcon is convenient for the rapid development of machine vision, medical images and image analysis applications. Halcon has the characteristics of fastness, comprehensiveness, preciseness and robustness. The robustness of Halcon is reflected in its wide acceptance in the industry, which has been recognized as the most effective Machine Vision software in the industrial communities of Europe and Japan. The Hdevelop in Halcon software is a development environment that can interact with users and integrates program, analysis, design and programming language. It mainly consists of image window, variable window, operator window and program editor window. Hdevelop can export programs such as C++, help integrate programs in related software such as Visual Studio, with a user-friendly interface.

4. Recognition of blurring alphabet character on timing pulley drawing
Engineering drawings are common technical documents in enterprises. In this paper, an engineering drawing of timing pulley is visually identified with the Halcon software. The recogition flow chart of the blurring alphabet characters is shown in Figure 1.

![Image](image)

Figure 1. Recognition flow chart

4.1. Read the image
Halcon software provides two ways to get images. First, an image is grabbed directly from image acquisition device through the operator grab_image. Second, load the collected image of the engineering drawing through operator read_image. Halcon supports various image formats such as BMP, PNG and JPEG. In industrial assembly lines, images are obtained with image acquisition devices. For the purpose of convenience, this experiment uses the operator read_image to load the collected image, as shown in Figure 2.

4.2. Image pro-processing

There are many factors affecting image quality in the process of image acquisition, such as the line overlapping, blur on the paper documents, etc. Usually the quality of the image obtained is not high, which brings noise to alphabet character recognition. Therefore before the recognition of blurring alphabet characters on engineering drawing, the image needs to be pre-processed. According to actual conditions, in this experiment, a RGB images is selected and convert into single-channel images with the operator decompose3, in other words, a three-channel image was converted into three single-channel images [8]. The specific code is decompose3, (Image1, Image2, and Image3). The Image is the input colored image. Image1, Image2, and Image3 are the three single-channel images that were exported. After observation, Image3 was chosen as the image to process in the next step in this experiment. The image Image3 was enhanced through the operator scale_image. By enhancing the single-channel image, it can be seen that the alphabet characters on the drawing are more distinct from the background pattern, which facilitates our threshold segmentation of the image and enables us to obtain more precise target regions [9].

4.3. Select the region of interest

In the application of machine vision image processing, the regions of interest refer to the regions to be processed, which are outlined from the processed image in the forms such as square, circle, ellipse, and irregular polygon.

Image is converted from RGB mode to single channel image. However, the noise dot on the background may disturb the recognition by the classifier. The regions that disturb the recognition are called disturbing regions. Therefore, it is necessary to select the regions to be identified, namely regions of interest. Through the observation of the image, rectangular box is the best option for engineering drawing, so a rectangular box is used to select the regions of interest, with the operator gen_rectangle1. The specific code is gen_rectangle1 (ROI0/0.49/0.91/0.58/0.78), ROI0 is the selected region of interest and 0.49 is the row
coordinate at the top left corner and 0.91 is the column coordinate at the top left corner; 0.58 and 0.78 are respectively the row and column coordinates at the lower right corner; as shown in Figure 3.

![Figure 3. Region of interest](image)

4.4. **Threshold segmentation**

Threshold segmentation is a region-based image segmentation technology, whose principle is to divide image pixels into several categories. Threshold segmentation is one of the most fundamental image segmentation methods and widely used segmentation technology because of its easy handling, small amount of computation and stable performance. It is especially suitable for images with different gray levels occupied by target and background. It can not only greatly compress the amount of data, but also greatly simplify the analysis and processing. Therefore, in many cases, it is a necessary image pre-processing process before image analysis, feature extraction and pattern recognition. The simplest form of threshold segmentation method is single-threshold image segmentation. Given a gray level of the original image at \( f(XY) \), get a gray threshold through its gray histogram \( t \). The application formula is

\[
g(x,y) = \begin{cases} 
b_0, & f(x,y) < t \\
b_1, & f(x,y) \geq t 
\end{cases}
\]

A segmented binary image will be obtained, with the operator of threshold. The specific code is threshold (ImageReduced, Regions, 0, 150), where ImageReduced is the input image, the Regions are the regions after segmentation, the parameter 3 is the minimum value of the threshold, the parameter 4 is the maximum value of the threshold. The threshold selected is between 0–150. The effect achieved is shown in Fig.4.

![Figure 4. Threshold segmentation effect](image)

4.5. **Optical Character Recognition (OCR)**

Through the above threshold segmentation, the target region can be screen out. In some cases, the images need to be further processed when there is a more disturbing background. For example, some image requires corrosion and expansion. OCR technology is the combination system of recognition, in which an electronic device (such as scanner or digital camera) is used to check characters printed on the paper, determine their shapes by detecting dark and bright patterns, and then translate the shapes into computer texts with the
method of character recognition. The characters in the paper documents is optically converted into an image file with black-and-white dot matrix, and then converted into text format by recognition software for further editing and processing. The essence of the OCR is to compare the features extracted by the characters with the template in the system and return the value with maximum confidence coefficient in order to achieve the purpose of recognition [9].

In the Halcon recognition process, the blurring alphabet characters are sort by the sort_region operator in Halcon system primarily. The trained optical character repertoire word_omc is then loaded through the operator read_ocr_class_mlp with a code is read_ocr_class_mlp (FortFile, OCRHandle1), and FontFile is the directory of the omc file. Finally, the blurring alphabet characters will be recognized by multi-layer perceptual neural network, with a code of do_ocr_multi_class_mlp (SortedRegions, ImageReduced, OCRHandle, Class, Confidence). After that, the recognition process is over. In order to check the result, the recognized results can be displayed in the image window, as shown in Figure 5.

The classifier used in this study for recognition is a multi-layer perceptron (MLP), which is an artificial neural network with a forward structure with s a set of input vectors map to a set of output vectors. MLP can be viewed as a directed graph consisting of multiple node layers, each layer fully connected to the next. In addition to the input nodes, each node is a neuron (or processing unit) with a nonlinear activation function, as shown in Figure 6. A supervised learning method called back-propagation algorithm is often used to train
MLP [10]. MLP is the generalization of perceptron, which has overcome the shortage [11] that perceptron cannot recognize linear indivisible data.

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\text{Figure 6. Multi-layer perceptron diagram}
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5. Conclusion
According the research above, the digital image processing method based on Halcon can effectively identify the text information on the engineering drawings of synchronous belt, with high speed and high accuracy. Because the specific conditions of different engineering drawings are different and the recognition results are different, the processing method in this paper cannot be used in all engineering drawings. Usually, according to the conditions of the engineering drawing, different image processing methods should be adopted. The improvement direction of this paper is how to use the same scheme to identify the text information on the engineering drawing in different situations.

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