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Express Barcode Image Extraction based on Machine Vision

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Abstract

Due to creases, blurring, scratches, and reflections on the surface of express delivery labels, it is not possible to quickly extract the barcodes, leading to the accumulation of packages and resulting in losses. This paper optimizes the images by using image restoration with generative adversarial networks (GANs) and adaptive adjustment enhancement algorithms. Secondly, after initially locating the barcode section using color and shape features, three major segmentation methods are employed to separate it out. Furthermore, this paper introduces a feature extraction method based on machine vision, which combines image processing techniques and machine learning algorithms. This method effectively extracts the features of express delivery barcodes and outperforms traditional methods.

Keywords

Machine Vision; Express Barcodes; Image Processing; Feature Extraction; Image Segmentation.

1. Introduction

The rapid development of the express delivery business has brought about the demand for barcode image extraction technology. A barcode is a pattern used to represent numbers and characters, and is widely used on parcels, letters, and other items to achieve tracking and management of items. However, due to the uneven quality of express barcode images in practical applications, such as uneven lighting, blurring, deformation and other problems, it is difficult for traditional barcode recognition algorithms to achieve ideal results. Therefore, express barcode image extraction based on machine vision has become a research hotspot.

At present, with the continuous development of image processing technology and machine vision technology, more and more researchers have turned their attention to the field of express barcode image extraction. Kaifeng Peng preprocessed the images, divided the images by adaptive block technology, used principal component analysis (PCA) to screen the image blocks with the same gradient direction, and used morphological methods to locate and identify the barcodes [1]. Man Zhang first used the selective search method to screen the candidate regions, then used the designed 7-layer CNN network model to classify the candidate boxes, and finally used the non-maximum suppression algorithm and the border regression algorithm to eliminate the cross window to achieve the purpose of accurate positioning[2]. Qiang Zhao proposed a preprocessing method for image filtering enhancement in order to solve the problem that the oblique barcode is not easy to locate accurately, and proposed a preprocessing method for image filtering enhancement to use the Adaptive Manifolds (AM) filter for the blurry image to enhance the blurred image, and then perform direction correction[3]. Ai Chenproposed a Support Vector Machine (SVM) based on Hough Transform and Local Binary Pattern (LBP) in order to solve the problems existing in the existing barcode positioning algorithms in complex backgrounds, especially in the case of multiple barcodes at the same time and in the case of rotation and deformation of entries The barcode positioning algorithm to

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improve the positioning accuracy of the barcode and provide good conditions for the subsequent barcode identification[4].

By using advanced image processing technology and machine vision algorithms, the extraction accuracy and efficiency of express barcode images can be effectively improved. This not only helps to speed up the sorting of parcels and improve logistics efficiency, but also increases the competitiveness of the express delivery industry.

The purpose of this paper is to study the machine vision-based delivery barcode image extraction method, and explore how to use image preprocessing, feature extraction and image segmentation technologies to improve the extraction accuracy and robustness of express barcode images. Through the research of this paper, it will provide an efficient and accurate barcode image extraction scheme for the express delivery industry, and provide strong support for the development and improvement of the logistics industry.

2. Related Work

2.1. Overview of Image Processing Techniques

Image processing technology is a technology that uses computer methods to acquire, process, and analyze images. With the continuous advancement of computer technology, image processing technology plays an increasingly important role in various fields. In general, it can be divided into two categories: analog image processing and digital image processing [5,6]. Analog image processing is mainly for continuously changing analog image signals and is realized by analog electronic circuits, while digital image processing is to sample and quantify image signals and process them digitally.

In image processing techniques, common methods include image enhancement, image restoration, image compression, image segmentation, and feature extraction. Image enhancement aims to improve image quality, such as increasing brightness, contrast, and sharpness. Image restoration aims to remove noise, blur, and other distractions from an image to restore it to its original clear state [7]. Image compression reduces storage space and transmission bandwidth through encoding and compression.

Image segmentation is an important task to divide an image into different regions or objects, which can be achieved by methods such as threshold segmentation, edge detection, and clustering [8-10]. Feature extraction extracts distinguishing and representative features from images to assist in subsequent image recognition and classification. In the field of machine vision, image processing technology is widely used, such as express barcode image extraction. Through image processing technology, it can automatically extract and identify the barcode on the express package, and realize the automatic management and processing of express information.

With the continuous progress of science and technology, image processing technology will continue to develop, bringing more convenience and benefits to various fields.

2.2. Application of Machine Vision Technology in Image Processing

In the express delivery industry, machine vision technology, as a technology that uses computers and cameras to perceive and analyze objects, scenes or behaviors, plays an important role in express barcode image extraction. A barcode is a commonly used identification code that is essential for identifying and tracking courier items [11]. Through the application of machine vision technology, the fast and accurate extraction of express barcodes can be realized, so as to promote the key steps of express automation processing.

In the application of machine vision technology, the main steps of image processing include image preprocessing, feature extraction, and image segmentation. Image preprocessing improves image quality and clarity by denoising, enhancing, and adjusting image brightness,

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feature extraction focuses on extracting key information from an image, such as the edges, lines, and corners of a barcode, and finally, image segmentation divides an image into small regions or sets of regions for better analysis and processing.

Although machine vision technology has many advantages in express barcode image extraction, such as automated processing, improved efficiency, reduced manpower input, and improved extraction accuracy, it still faces some challenges and problems. For example, factors such as the shape, size, and background lighting of barcodes may affect the extraction effect, and the diversity and complexity of the barcode may also make extraction difficult [12-14]. Future research can focus on improving machine vision technology algorithms, introducing advanced technologies such as deep learning and artificial intelligence, and exploring cross-domain collaborations to improve the overall effect of barcode extraction [15].

Through continuous research and technological improvement, it is believed that this technology will play a more important role in the express delivery industry, realize automated processing, improve efficiency and accuracy, and promote the express delivery industry to move towards a more intelligent and efficient direction.

2.3. Research Status of Express Barcode Image Extraction

The rapid development of the express delivery industry has brought about the demand for express barcode image extraction. At present, the research on express barcode image extraction is in a stage of rapid development. This section will review the existing research results, mainly introducing the application of image processing and machine vision technology in express barcode image extraction.

In the field of express barcode image extraction, image processing technology plays a key role. Common image preprocessing methods include image enhancement, image denoising, and image rotation correction. Image enhancement technology can improve the contrast and clarity of images, which helps to improve the recognition accuracy of barcodes. Image denoising technology can effectively remove noise from the image, improve the edge clarity of the barcode, and thus improve the recognition rate [16]. The image rotation correction technology can adapt the image to eliminate the tilt caused by the irregular placement of the express package. The development and application of these pre-processing technologies have effectively improved the quality of express barcode images.

The application of machine vision technology in express barcode image extraction has also been widely studied. Machine vision technology can automatically identify and detect the image of the express package. The main methods include fast edge detection, template matching, and feature extraction. Fast edge detection technology can improve the edge positioning accuracy of barcodes, and template matching technology can match barcodes according to the pre-established template library, so as to improve the recognition speed and accuracy. Feature extraction technology can extract key features in the image, such as the stripes and gaps of the barcode, to help the recognition algorithm accurately extract the barcode information. The application of these machine vision technologies has greatly improved the automatic extraction of express barcodes.

Although some progress has been made in the research of express barcode image extraction, there are still some problems and challenges. First of all, the quality of the express barcode image may be affected by a variety of factors, such as light conditions, shooting angles and image blur, etc., which brings certain difficulties to the extraction of the barcode. Secondly, there are various types of barcodes, such as one-dimensional codes, two-dimensional codes, and QR codes, etc., each type of barcode has different characteristics and recognition difficulties, and needs to be optimized for different types of barcodes. In addition, the rapid development of the express delivery industry also puts forward higher requirements for the accuracy and

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real-time performance of barcode recognition, and the performance of the algorithm needs to be further improved.

Future research directions mainly focus on the following aspects. First of all, image preprocessing techniques can be further studied and improved to improve the quality and clarity of barcode images. Secondly, more efficient and accurate feature extraction and image segmentation algorithms can be explored to improve the recognition speed and accuracy of barcodes. In addition, a more intelligent and adaptive barcode image extraction algorithm can be proposed by combining deep learning and neural network methods. Finally, the application scenarios and development prospects can be further studied, and the application potential of express barcode image extraction technology in other fields can be explored.

At present, the research on express barcode image extraction has achieved certain results, and with the support of image processing and machine vision technology, the automatic extraction of express barcode has been realized. However, there are still some challenges

3. Express Barcode Image Extraction Method

3.1. Introduction to Datasets

In the entire dataset, we collected a total of 50 images of courier barcodes. We have collected courier barcode images from multiple channels, such as on the courier company's warehouse, courier locker, etc. The images were taken at different angles, distances, and sizes, and covered a variety of different background and noise situations. This ensures that our datasets have a wide range of application scenarios and are able to meet different types of barcode image extraction needs.

3.2. Image Preprocessing

Image pre-processing refers to a series of pre-processing operations on an image before image analysis and processing to improve image quality, reduce noise, and enhance image information. In the study of express barcode image extraction, it can remove the interference information in the image to a certain extent, and improve the accuracy and effect of subsequent feature extraction and image segmentation.

Figure 1. Barcodes collected by yourself

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In the process of image preprocessing, we need to carry out the following main steps.

3.2.1. Optimize Images

First, based on OpenCv we read the input image (named 'input_image.jpg') via the cv2.imread() function. Then, use the cv2.cvtColor() function to convert the image from the BGR color space to a grayscale image. Finally, the cv2.imshow() function is used to display the original image and convert it into a grayscale image.

Figure 2. Optimized image

The second is image enhancement. In view of the low contrast and blur of the express barcode image, the image can be enhanced by histogram equalization, Laplace sharpening and other technologies to make the edges and details of the barcode clearer, which is conducive to subsequent feature extraction and image segmentation. We use generative adversarial network (GAN)-based image inpainting, and for damaged or blurry barcode images, GAN can be used for image inpainting to restore clear barcode images. At the same time, the enhancement algorithm is adaptively adjusted according to the image quality, such as contrast enhancement, brightness adjustment, etc., to improve the image quality and improve the accuracy of subsequent processing.

Due to sensor noise, image acquisition equipment failure, or interference in the process of image transmission, express barcode images may produce various noises, affecting the clarity and readability of the barcode. Therefore, it is necessary to use appropriate denoising algorithms, such as median filtering, mean filtering, or wavelet denoising, to reduce the impact of noise on image quality. Here we use a Gaussian filter, which in OpenCv can be implemented using the cv2.GaussianBlur() function.

3.2.2. Image Binarization

The conversion of the preprocessed image into a binary image is one of the key steps in the extraction of express barcode images. By applying appropriate binarization algorithms, such as threshold segmentation, adaptive threshold segmentation, or edge detection-based algorithms Binarization can effectively separate the barcode area from the background area in the image and extract the shape and structure of the barcode.

3.2.3. Image Morphology Manipulation

Apply morphological operations such as corrosion, expansion, open and closed operations to remove small noise and glitches, as well as enhance barcode connectivity. In opencvzhong it is implemented with the cv2.morphologyEx function.

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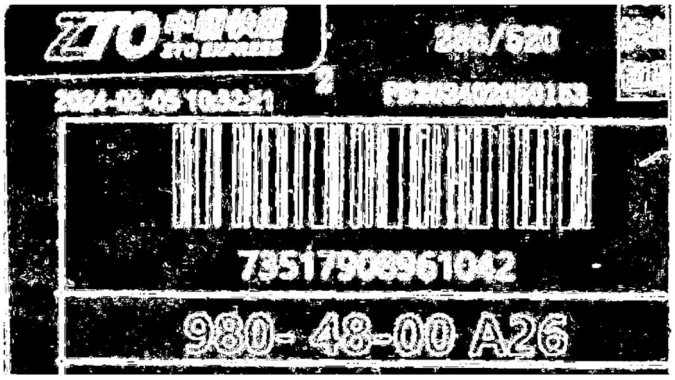

Figure 3. After binarization

3.3. Image Segmentation

In view of the characteristics of express barcode images, firstly, based on the positioning of color and shape features, we use the characteristics of barcodes that usually have specific black and white colors and rectangular shapes, and use edge detection, contour extraction and other methods to preliminarily locate the areas that may contain barcodes through color space conversion and threshold processing. Second, we can use the threshold segmentation method to separate the barcode area in the image from the background. By selecting a suitable threshold, the black and white stripes of the barcode can be separated from the background, and the barcode area can be extracted. We then use edge detection technology to detect the edge of the barcode. By detecting the edge information in the image, the outline of the barcode can be accurately extracted, and the barcode can be segmented. Finally, we can employ a region growth algorithm to further extract the barcode region. The region growth algorithm is an image segmentation method based on pixel similarity, which can merge the similar regions of adjacent pixels into a whole, so as to achieve accurate extraction of the barcode region.

```
sobelx = cv2.Sobel(blurred_image, cv2.CV_64F, 1, 0, ksize=5)
sobely = cv2.Sobel(blurred_image, cv2.CV_64F, 0, 1, ksize=5)
sobel_edges = cv2.magnitude(sobelx, sobely)
sobel_edges = np.uint8(sobel_edges > 100)  # 设置合适的阈值

# 找到边缘上的点作为种子点
seed_points = np.where(sobel_edges == 255)

# 初始化区域生长算法的参数
connectivity = 8  # 8邻域连接
output_mask = np.zeros_like(sobel_edges)
max_size = 10000  # 设置区域生长的最大像素数

# 应用区域生长算法
ret, labels, stats, centroids = cv2.connectedComponentsWithStats(sobel_edges, connectivity, cv2.CV_32S)
```

Figure 4. Simplified code

3.4. Feature Extraction

In this study, we used a machine vision-based feature extraction method that combines image processing technology and machine learning algorithms to efficiently extract the features of express barcodes.

First of all, we have pre-processed the express barcode image before, including denoising, grayscale, binarization and other steps, so as to make the image clearer and more accurate. Next, we used an edge detection-based method to extract the edge information of the barcode, and by detecting the edge pixels in the image, we were able to find the edge of the barcode. Then, we used a shape descriptor-based method to extract the shape features of the barcode, and by

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calculating the shape descriptor of the barcode, we were able to obtain the shape information of the barcode. Finally, we used a color feature-based method to extract the color information of the barcode, and by analyzing the color distribution in the image, we were able to obtain the color characteristics of the barcode.

Through the above feature extraction steps, we can extract the key information about the barcode from the express barcode image, which provides effective features for the subsequent image recognition and object detection tasks. Compared with traditional methods, this method has the advantages of high efficiency and accuracy, and can effectively extract the features of barcodes in complex backgrounds.

4. Summary of the Study

In this study, we first performed pre-processing of the image, including denoising, grayscale, and binarization steps, and optimized the image to improve the accuracy and stability of subsequent image processing through generative adversarial network (GAN)-based image inpainting and adaptive image enhancement. Then, we carried out preliminary positioning according to the color and shape features, and used the three major image segmentation technologies to separate the barcode in the image from the background, so as to facilitate the subsequent recognition and decoding process. Then, we used a machine vision-based feature extraction method that combines image processing technology and machine learning algorithms to effectively extract the features of express barcodes.

Through experiments and analysis of a large number of express barcode images, we find that the proposed method achieves good results in extracting express barcodes. Experimental results show that the more comprehensive image segmentation technology and a machine vision-based feature extraction method are better than the traditional methods in terms of accuracy and robustness.

By improving the accuracy and speed of barcode recognition, the efficiency of the logistics industry can be improved, and the error rate of manual operation can be reduced, thereby improving the quality of logistics services and customer satisfaction.

However, we also found some problems and areas for improvement. First of all, our method may have some identification errors for barcodes in some special cases. Therefore, we need to further improve the algorithm to enhance the recognition ability of different types of barcodes. Secondly, our method still has certain limitations in dealing with barcodes in complex backgrounds, and the image segmentation algorithm needs to be optimized. In addition, we can also consider introducing emerging technologies such as deep learning to improve the accuracy and efficiency of barcode image extraction.

In conclusion, this study proposes a method for extracting express barcode images based on machine vision technology, and has achieved certain results in experiments. The research summary shows that the proposed method has certain application prospects and development potential in the express logistics industry. Future research directions can further improve the proposed method, improve the accuracy and efficiency of barcode image extraction, and apply it to a wider range of fields.

References

[1] Peng, K.F., Zhu, H.Y., Shi, D.D., Deng, Q.W., Ma, L.H. (2020). Barcode localization and recognition method based on PCA. Mechanical and Electrical Engineering Technology (06), 82-84.

[2] Zhang M., Zhang J., Gu Y.P. (2019). Research on Barcode Localization Technology Based on Convolutional Neural Networks. Network New Media Technology (05), 50-55.

ISSN: 2710-0588

[3] Zhao, Q. (2017). Master's degree in research on barcode detection and localization algorithms. Thesis of Hangzhou University of Electronic Science and Technology.

[4] Chen, A. (2016). Master's degree in research on target image localization algorithms based on machine learning. Thesis of Hangzhou University of Electronic Science and Technology.

[5] Gan, Y. (2021). Exploration of Innovative Applications of Image Processing Technology. Information Recording Materials (08), 233-235.

[6] Gu, X.S. (2022). Binary processing of barcode images based on digital image processing technology. Wireless Internet Technology (23), 97-99.

[7] Ji, Q.Q., Huang, L. (2019). One dimensional barcode fast positioning technology based on image processing. Journal of University of Chinese Academy of Sciences (05), 716-720.

[8] Liu, G.Y., Wang, S., Cao, Y., Zhao, E.M., Zhang, L., Su, L., Xing, C.X. (2022). Research on the Application of Several Classic Threshold Segmentation Methods in Image Processing. Journal of Huanggang Vocational and Technical College (04), 99-103.

[9] Yu, X.S., Meng, X.Y., Jin, T.F. &Luo, J.Z. (2023). Object edge detection algorithm based on improved Canny algorithm. Progress in Laser and Optoelectronics (22), 221-230.

[10] Gao, X.B., Xie, W.X. (1999). Research progress in the development and application of fuzzy clustering theory. Scientific Bulletin (21), 2241-2251.

[11] He, J., Kang, J.L. (2002). Computer Encoding and Recognition of Barcodes. Computer Automatic Measurement and Control (04), 263-266.

[12] Liao, W.J., Yang, X.Z., Lv, X., Ao, J., Fan, Y.F., Yu, X.M. &Zhao, X.M. (2020). An improved barcode image enhancement and localization algorithm in complex environments. Modern Computer (11), 36-44.

[13] Wang, N., Jiang, Q.C. &Jiang, L.H. (2019). Rapid positioning, segmentation and recognition of express package barcodes in high noise environments. Software (07), 80-83.

[14] Wang, H. (2015). Master's degree in research on localization and recognition methods for barcode images in complex backgrounds. Thesis of Dalian University of Technology.

[15] Sun, Z.J., Xue, L., Xu, Y.M., Wang, Z. (2012). Review of Deep Learning Research. Computer Application Research (08), 2806-2810.

[16] Fang, L., Zhang, P. (2010). Review of classic image denoising algorithms. Industrial Control Computer (11), 73-74.