Research on Automatic Programming of Cross Stitch Equipment Based on Machine Vision Technology

Dalu Guo\textsuperscript{1,a}, Feng Liu\textsuperscript{2,b}, Quan Zhou\textsuperscript{3,c} and Xujie Hou\textsuperscript{4,d}

\textsuperscript{1}Department of electrical and mechanical engineering, Weifang vocational college, No. 06588, Haian road, science and education innovation park, binhai economic and technological development zone, weifang city, shandong province.
\textsuperscript{2}Department of electrical and mechanical engineering, Weifang vocational college, No. 06588, Haian road, science and education innovation park, binhai economic and technological development zone, weifang city, shandong province.
\textsuperscript{3}Department of electrical and mechanical engineering, Weifang vocational college, No. 06588, Haian road, science and education innovation park, binhai economic and technological development zone, weifang city, shandong province.
\textsuperscript{4}Department of electrical and mechanical engineering, Weifang vocational college, No. 06588, Haian road, science and education innovation park, binhai economic and technological development zone, weifang city, shandong province.

Email: kyd1981cn@163.com

Abstract. In the past, cross-stitch was mainly mainly by manual embroidery. It has a large workload, long time-consuming and easy to make mistakes. With the development of artificial intelligence and image recognition in recent years, the application scene is very wide.

1. Introduction
Cross-stitch is a traditional hand-embroidered technique, using cross-embroidered color thread on the standard cloth for warp and weft embroidery process, low technical threshold, strong operability, strong expressiveness, young and old, loved by countless people, cross-embroidered is a common embroidery technique, popular with the masses, enriched the the life of many embroidery lovers, according to market research, the market for Chinese traditional large-scale landscape figure painting, such as : "Riverside Scene at Qingming Festival"," Twelve Gold Hairpins"," Eight Jun Quan "," plum blossoms, orchid, bamboo and chrysanthemum ", " lofty mountains and flowing water".

Hand embroidery has the problems of low efficiency, poor back thread, poor viewing effect and single product image, which affects the promotion of cross stitch in the market. This paper combines image recognition, image location, artificial intelligence and automation equipment, uses single pixel image edge, small space high image location measurement technology, realizes full stitch image extraction recognition, automatic needle weaving, positioning high efficiency, fast embroidery function extraction technology, enriches cross stitch and computer embroidery product types, improves product launch time, and speeds up product iterative updating.

2. Intelligent Application of Image Recognition Technology
The application of image recognition technology in cross stitch is divided into the following steps: Image sampling recognition, image grayscale processing, image data enhancement, image edge feature extraction, image feature segmentation. The display image is more clearly and recognizable by processing the image recognition processing technique.
2.1. Sample Image Recognition

Cross stitch is a cross stitch method, embroidery on the grid of standard embroidery cloth, the finished product shows rich color, with a better artistic appreciation, so how to identify a cross stitch base map by taking pictures? It's basically an abstract process, with a limited number of many screen-recognized colors as possible in a limited space. Image recognition must satisfy three characteristics: The contour of the image is clear and obvious; the texture features of the image are clearly displayed; the color of the image has a sense of hierarchy and contrast so that we can use the digital image processing method to generate a cross-stitch base map.

Firstly, the sampling, processing and pixel-lowering elements of sample images are taken. By K-mean group set algorithm, k points are concentrated in the main body closest to its classification. By iterative method, the value of each continuous updating cluster center is updated.

Computer Image Model Software

(1) Choose a k value at the initial center of the sample image
(2) The data[0]….data[k-n], and a[0]…a[k-n] are compared one by one and the a[i] difference is set to be the least, marked as i, add all the i values together.
(3) a[i]=data[i]/i of calculation, Determine the final change threshold

Finally, the local optimal value and the k value are obtained to complete the intelligent recognition of the sample image and form the data model.

2.2. Image Grayscale

The image grayscale is to equalize the values of R, G and blue in the original color image, that is, R=G=B. After the image is grayscale, the color information of the sample is converted into black and white gray information. After the image processing of gray scale, although the size of the data matrix drops, the information of image gradient, greatly improve the speed of computer operation, so that the rapid processing of image data.

Image grayscale processing is the pre-processing of image recognition and the basis of image recognition. It is the basic processing for data enhancement and edge feature extraction of subsequent images. At present, there are many methods for image grayscale processing. this system is the direction of image recognition and cross-stitch computer embroidery technology, cross-stitch products belong to art products, in order to improve the appreciation of the market, combined with the principle of low blue sensitivity and high green sensitivity of human eyes in ergonomics, the system uses weighted average method to process image grayscale.

2.3. Image Edge Extraction

This is one of the basic features of edge images, but the difference between edge and contour extraction is very difficult to work, among them, the pixel value generator is an edge transition, which is one of the salient features of the image, and plays an important role in image feature extraction, object detection and so on.

There are changes in the image will have a gradient of gray value, resulting in edges, at edges, with varying intensity and direction. In this case, some basic common image recognition algorithms, such as pigs, are SIFT, based on gradients.

The edges are divided into three categories, step edge, slope edge and peak edge, which are the differential (first or second order) of the three types of edges below its shape, as shown in (figure 1).
Depending on the sample image suture edge feature, the system automatically determines the gradient using the first or second derivative. Calculate the first order, higher order derivative for the sample base map, and get many peaks. When these peaks exceed the specified threshold, it is determined that the picture corresponding to these peaks is edge feature.

Image is used for convolution, we determine a special level factor to calculate the rate of change of adjacent pixels detected by image edge. The mathematical model is established for edge detection. Based on one medium operator, the second derivative, the edge features of the image are extracted by using the gray difference between the pixel's decentralized upper and lower points adjacent to the pixel. Therefore, we use the fully convolutional neural network structure to realize the fast extraction of the image-specific edges.

After image recognition and image grayscale, a large number of neural network image data with edge refinement are obtained. Combined with fully convolutional neural network, the transmitted image data are encoded and decoded, the auxiliary training is carried out through the auxiliary layer, and the convolution operation and the maximization operation are constantly superimposed to gradually obtain the larger area and encode, and gradually restore to the input image resolution size to achieve the final semantic segmentation.

Because the image is grayscale in the early stage, the definition is low, but the image edge feature can be extracted quickly. At this time, the auxiliary output layer can speed up the training speed of the neural network, improve the classification performance of the shallow layer of the neural network, prevent overfitting to a certain extent, and achieve the effect of improving the clarity and accuracy.

2.4. Image Feature Effect Segmentation

Image feature effect segmentation is mainly the key step of image edge feature extraction, which is an important part of image recognition and one of the most difficult problems. The system grayscale image, enhanced image data, image texture, geometric conditions, in which the image is cut into several disjoint regions.

2.4.1. DeepLab Act. DeepLab depth is a combination of convolutional neural networks and probabilistic graph models. In the application of semantic segmentation tasks, object categories are pixels processed by pixels. In general image segmentation, FCN is a well-known routine operation, first segment the previous part of the data to weaken edge characteristics, then fill obvious feature requirements, then convolution first pool after data smoothing, so feel domain increase, while reducing image size, but early process reduce image size (outer circle), then increase size (sample) must have some information loss, so there is room for improvement. So the system numbers In the model, priority is given to hierarchical sampling, using different acquisition rates to form hollow neural convolution, highlighting the data.

The dimension of deeds convolution kernel is to obtain 1- dilated conv, and ordinary convolution data calculation operation in the range of 3 mmx3mm, image 3, and to obtain 2- dilated conv, image
acquisition field in the range of 3mmx7mm; When 4-dilated conv is obtained, its image field reaches 15. In the case of hollow convolution, the receptive field is enlarged, and each convolution output contains the whole series of image feature information.

2.4.2. Edge Detection Method. The gray value of a pixel is usually a more intense boundary of different regions, if converted from an image in the spatial domain by fourier to correspond to the high frequency part, which is a frequency domain on the edge of a very simple edge detection algorithm. Using the edge detection method, we can effectively reduce the influence of image impurities, establish a Gaussian filter digital model, smooth the edge impurities of the image, calculate the step intensity and feature direction of each pixel point of the image special, use the non-limit maximum value inversion, eliminate the edge image pull response, use the double threshold to determine the image edge truth and virtual judgment, enhance the accuracy of edge detection.

The visual model continuously contrasts the multiple image regions after multiple segmentation to obtain the data value. By applying the first and second derivative calculation method of micro-molecule in mathematics, the segmented gray image is detected quickly and a large number of edge data points are obtained.

3. Robot Vision Detection and Positioning

3.1. Visual Detection System

The computer embroidery equipment is a modern mechanical equipment with high speed and multi-function. After investigation, in order to make the research equipment conform to the universal computer embroidery equipment of the market, the G-WH10 type equipment of ELMO company is regarded as the main research object, which can realize the of equipment in the market.

The image acquisition unit of the visual detection system is set at the front end of the computer embroidery equipment, which is composed of industrial camera and ring light source. The operating distance of the camera is about 250 mm. The field of view range of industrial camera is about 50 mm*50mm, precision is 0.2 mm, the light source adopts ring light source to ensure sufficient light source of the visual detection system in the field of view.

3.2. Visual Positioning

An image acquisition unit for computer embroidery is completed by an industrial camera, setting the show cloth as a two-dimensional space, and establishing a custom image origin between the embroidery needle and the cross stitch through an industrial camera, and within the pixel range of the origin range (50 mm*50mm).

Computer embroidery needle and cross show cloth are obtained by taking pictures of the camera of the image acquisition unit, through image analysis, input into the mathematical model, automatically calculate the pixel length, pixel size and image equal volume migration in the two-dimensional space, calculate the pixel distance in the X,Y direction of the two-dimensional space target origin, transmit the calculation results for the drive of the computer embroidery equipment, and realize the computer automatic embroidery action.

3.3. Coordinate Setting and Attitude Analysis

3.3.1. Conversion of Machine Pixel and Embroidery Needle Coordinate. After systematic data acquisition analysis, the image pixel coordinates and embroidery needle coordinates have about three times the relationship, although there is a gap, but we can use the mathematical model definition in the model to carry out the equivalent transformation an image coordinate of a pixel located in the column and the number of rows of the digital image, without a representation of the actual position of the object, thus establishing the x-y coordinates of the computer embroidery in the actual physical unit. Denote by (x,y) the actual pixel coordinates of the computer embroidery. When the deviation is expressed by the inclination factor s in the embroidery x-y coordinate system, the relationship between the pixel coordinate and the mechanical coordinate of the embroidery is as
follows: \[ \begin{bmatrix} 1/d_x & s_y & 0 \\ 0 & 1/d_y & d_y \\ d_x & 0 & 0 \end{bmatrix} \]

3.3.2. Position and Error Analysis. For computer embroidery equipment, the precision in the embroidery process is not enough, often will cause errors, this error is divided into two types, first, the error inside the equipment, the precision of the parts inside the equipment is not enough or the error caused by the assembly. Second, the error caused by external factors, factory light source, image recognition accuracy, external external force. Therefore, it is necessary to analyze the pose error of this system.

In the visual positioning and automatic knitting system of computer embroidery equipment, the image is recognized, the image is grayscale, the image edge is extracted, and the image effect is segmented, then the mathematical model of the system is imported to form the machine data, and input to the cross-stitch computer embroidery equipment through the converter for embroidery. After analysis, the equipment produces errors in the process of motion. By establishing differential conversion formula to reduce the transformation matrix in vision, according to the coordinate formula mentioned above, the system mathematical model constantly patching the external data to reduce the error of the equipment itself, the error of external factors of the system, etc., the positioning accuracy reaches 98%, and the fast positioning is realized.

4. Epilogue
This article is based on the big data environment, combined with artificial intelligence, the application of machine vision, machine positioning technology, combined with industrial vision camera and cross stitch computer embroidery equipment, is a typical combination of soft and hard technology under the new discipline development of intelligent mechanization in embroidery and computer embroidery industries.

5. Reference
[1] Li Xun, Zhang Weijun, Xu Zhiqing, Huang Shunzhou. Design and Research on Visual Positioning Method of Robot with Hole Height Measurement in Narrow Space [J]. Machinery and Electronics, 2019,37(12):60-63 68.
[2] Liu Chang, Zhang Jian, Lin Jianping. Image single pixel edge extraction based on improved fully convolutional neural network [J]. Computer Engineering, 2020, 46(01):262-270.
[3] Chen Zhixin, Liang Shixiao, Dong Ruixue, Wang Yibin, Li Zihao. A study on visual localization of manipulator based on image processing and pose error correction [J]. Technology and Industry, 2019, 19(11):160-166.
[4] Tang Dawei, Lu Dongming, Yang Bing, Xu Duanqing. A measure of the similarity of fresco images constrained by the overall structure of contour [J]. Chinese Journal of Image Graphics, 2013,18(08):968-975.
[5] Li Junwei. Application of Intelligent Image Processing Technology in Auto-generated Sketch Drawing [J]. Automation and Instrumentation, 2019(07):219-221.
[6] Jiang Yicheng, Wu Guihua. Image feature extraction based on edge detection of wiper blade test [J]. Computer Engineering and Applications, 2013,49(15):184-187.
[7] Junna Zhang, Yunzhi Feng. Image segmentation based on quantum maximum entropy multi-threshold algorithm [J]. Laser and IR, 2013,43(05):578-582.