Research and development of icon recognition system based on machine vision

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1. Introduction
In recent years, with the vigorous development of artificial intelligence, computer technology, machine vision technology and other fields, warehousing, logistics, intelligent manufacturing and other industries need human and robots to work together. Because icons are friendly to human eye recognition and machine recognition, as a common form of instructions, icons are indispensable in human-computer interaction. Therefore, efficient and accurate Icon Recognition based on machine vision to better complete the work according to icon instructions is the key research content to ensure human-computer interaction.

Compared with two-dimensional code recognition and barcode recognition in machine vision recognition, icon recognition research is relatively less. In the preliminary study of image recognition, document [1] combines icon recognition with embedded system. After filtering, binarization and extracting eigenvalues of icons recognized by machine vision, neural network algorithm is selected for on-line icon recognition, and the system is used in blind aids. The cost of the system is low, but the effect needs to be mentioned. Document [2] preprocesses the identified icons, designs template matching recognition algorithm based on correlation coefficient and SIFT feature extraction matching recognition algorithm combined with Gabor filter recognition algorithm based on principal component analysis. This recognition system is used in the identification of unmanned road signs, but it is still in the stage of simulation research.

In summary, this paper proposes a kind of image recognition system based on machine vision, which realizes real-time online recognition of icons, thus realizing various detection and control. The experiment proves that this method has high accuracy and good effect in identifying icons. In order to provide reference for intelligent AGV operation, intelligent production line and other operations.

2. Icon Recognition Technology Route
Icons are signs with specific meanings, which are essentially different from two-dimensional codes and bar codes. Icons contain less information, but human eyes can easily identify, so they are often seen in
public places and workplaces with manual work. The icon recognition system designed in this paper can identify icons quickly and accurately through image processing such as feature extraction, image binarization, calculation of center coordinates and template matching.

2.1. Icon Feature Extraction

Icon feature extraction plays an important role in image analysis. In image analysis, it is necessary to locate some geometric features of the image, such as shape, contour, position and other information to determine the image position, which lays the foundation for the next step of recognition. The feature extraction in this paper is to find the coordinate information of the four corners of the icon frame. The icon is illustrated in Figure 1 below.

![Fig. 1 16 icon samples](image)

The outer frame of the icon is a rectangle. The outer frame of the icon can be found by looking for four rectangular boundaries. The point coordinates of the intersection of two boundary lines are the point coordinates \((x_i, y_i)\) of the four corners of the image border.

2.2. Image Binary Processing

At present, most color images are based on RGB color model, so three components need to be processed separately in image processing. Gray-scale image is a special color image with the same R, G and B components. Therefore, compared with black-and-white image, the former has much more image information than the latter. In order to greatly reduce the amount of calculation in image processing, the color image must be grayed first in image processing.

Secondly, binary the image so that the pixels of each point in the image are reassigned according to their different gray values. The result of reassignment is only 0 and 1 levels, so the image with obvious black and white color can be obtained, which reduces the amount of data contained in the image and makes the image processing more efficient.

Let \(g(x, y)\) be the gray image to be processed and \(f(x, y)\) be the image after binarization. Then:

\[
f(x, y) = \begin{cases} 
0, & g(x, y) < T \\
1, & g(x, y) \geq T 
\end{cases}
\] (2.1)

In formula 2.1, \((x, y)\) is the coordinates of pixels, and \(T\) is the range of binarization of gray image. Determining \(T\) value is the key link of binarization. By calculating the function \(f(x, y)\), the result of calculation is 0, which is judged as the background by the system and 1 as the target point. When \(T\) is small, the image enlarges the target, which makes the false component of the image larger; when \(T\) is large, the image enlarges the background, so that the available information is covered. Therefore, the choice of \(T\) value is very important.

2.3. Calculating the Coordinates of the Central Point

After image binarization, in order to read the specific binarization information of the target inside the image eigenvalue and to make the basis for subsequent image processing, it is necessary to divide the image into large and small squares according to the specific conditions of the icon. In this paper,
according to the selected icons, the icons are divided into large 9*9 squares, and the four corner coordinates of the rectangle are used as the reference. By calculating the central coordinates of each small square, and finding the corresponding binary values of the central coordinates, the central coordinates and binary values are bundled and saved as arrays, which is the basis for subsequent image contrast analysis. The calculation method of the center coordinates of 9*9 cells is as follows:

\[
\begin{align*}
    x_{00} &= x_{10} = \cdots = x_{i0} = (x_1 - x_2)/18 \\
    y_{00} &= y_{01} = \cdots = y_{0j} = (y_2 - y_3)/18 \\
    x_{ij} &= \frac{x_1 - x_2}{18} \cdot (2 \cdot j + 1) \\
    y_{ij} &= \frac{y_2 - y_3}{18} \cdot (2 \cdot i + 1)
\end{align*}
\]

The four coordinate values of the upper left corner, the upper right corner, the lower right corner and the lower left corner of the icon, \((x_{ij}, y_{ij})\) are the center coordinates of the small grid.

2.4. template matching
In order to recognize the icons collected by machine vision, the system needs to binarize the known icons and store them into the recognition system in the form of 9*9 cells above as recognition templates to compare the information with the icons to be recognized. If the information value of the pre-stored template binarization is equal to the icon binarization value collected by the machine vision, it is determined that the collected icon is consistent with the template, and vice versa.

3. The composition of the machine vision hardware system
The icon recognition system designed in this paper is an online detection system. In the case of real-time image change, different icons can be identified and a success signal can be sent for subsequent processing.

The system hardware consists of a computer, a camera, an image capture card, a vision processor and a bracket. NI Research's myrio1900 was selected as the image acquisition card and vision processor, and the CMOS camera was used as the camera. Myrio1900 is an embedded system design platform developed by National Instruments. It is powerful and compatible with the vision module in the LabVIEW programming language. It can improve the programming efficiency of the visual processing module and simplify the programming process. The CMOS camera is lightweight, easy to install and low in price.

4. Software system design

4.1. Software interface design
The software system uses LabVIEW2017 as a development tool and win10 as a development platform. After the hardware system collects the image, the data is processed by myrio1900, and the collected image and processing result are transmitted to the computer and displayed on the screen. The system displays the interface in the computer as shown in Figure 2.
4.2. System Program

This system uses the graphical programming language LabVIEW, which directly calls functional modules and does not need to write large blocks of code, so it is more convenient to understand and apply, and can greatly improve the programming efficiency.

To realize the functions required by the system, the program needs to include several modules: image acquisition module, image processing and template matching.

Image acquisition module. This part is used to collect real-time image information uploaded by the camera. Labview software encapsulates the underlying program of the camera acquisition part. It only needs to call the VI module of the image acquisition part to realize the image acquisition of the lower computer. The process is shown in Figure 3.

Image processing. When the image is transferred from the camera to myrio 1900, it needs to be processed. Firstly, the information of the icon outline is bundled in the form of an array and input into the outline search vi, which processes the input information and outputs the processing results in the form of an array. The coordinates of the four corners of the outer frame will be found in the output. The process is shown in Figure 4.
(3) From the coordinates of four outer frame angles, the coordinates of 9*9 cell centers can be calculated. The coordinate value is input into IVA calculation. VI to bind the coordinate value of the center point of the lattice with the binary information of the point. This process is shown in Figure 5.

(4) Image Matching
The results of binarization of the coordinates of the center points of each cell are output in the form of strings by IVA calculation. Therefore, some data processing is needed to convert them into logical values, and the 9*9 logical values are transformed into two-dimensional arrays to match the original template and judge the output results. The process is shown in Figure 6.
5. Recognition effect
The system can identify icons online and real-time, and match with the known icon template to judge whether the match is successful. The recognition effect is shown in Figure 4. In this figure, the binary icon information collected by the system is consistent with the template 2 information, that is to say, the matching results are output.

![Figure 7 System on-line real-time identification Icon](image)

6. Conclusion
This paper presents a machine vision system which can quickly and accurately identify icons. The system binarizes the real-time image of icon and divides it into 9*9 cells according to the coordinates of four points outside the icon. Through calculation, the coordinates of the central points of each cell and their binarization information are obtained, and then matched with the template, and the matching results are given. It can be seen from the experiment that:

1. The system can quickly and accurately identify icon styles and output binary information of icons.
2. The system can match the recognition target with the known template and output the matching result.
3. The matching result output by the system can be used as the control signal of the lower computer for the follow-up action.

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