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Position Recognition in Machining of Mechanical Parts

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Abstract: In the process of automatic manufacturing of industrial manufacturing, for the problem of position recognition in the machining process of mechanical parts, the Canny edge processing algorithm and the modified Hough transform algorithm are used to complete the rapid identification of geometric shapes and coordinates in the image data.For the identification of multiple parts information, an algorithm is designed to classify the identified center and vertex coordinates using distance information and angle information. Then the angle calculation algorithm is designed to calculate the angle information in the part information. Based on the data in DATA1, establish a mathematical model and analyze whether the algorithm for solving the position of parts is accurate and efficient.The simulation is programmed in Python and the simulation platform is pycharm.
Keywords: Components Canny algorithm; Hough transform; Python.

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1. INTRODUCTION

With the rapid development of computer technology and optoelectronic technology, visual inspection technology has been widely used [1]. Based on modern optics, it integrates science and technology such as optoelectronics, computer graphics, information processing, and computer vision, and uses images as a means or carrier for detecting and transmitting information [2]. Due to the high precision and speed of computer vision detection, the relatively stable detection results, and the ability to perform online detection, real-time analysis, and real-time control, it has made important contributions to improving production efficiency, ensuring product quality, and improving product accuracy.

2. MODELS

2.1 2.1 Terms, Definitions and Symbols

n: Number of parts

$C_i = \left(x_{cen\,i}, y_{cen\,i}\right), i = 1, 2, \cdots, n$: The coordinates of the geometric center of the i-th part

$Q_j = \left(x_{q\,j}, y_{q\,j}\right), j = 1, 2, \cdots, 3n$: All circular center coordinates in the image

$\theta_i, i = 1, 2, \cdots, n$: The angle of the i-th part.

d_j : The distance constant from the center of the part to the vertex

d_m : The distance constant from the center of the part's geometry to the center of the circle.

2.2 Assumptions

Make the following assumptions as required:

1) Assume that for multiple parts, multiple parts do not overlap each other.

2) Assume that the part completely exists within the camera's recognition range, regardless of the incomplete information of the parts in the image.

2.3 The Foundation of Model

The general scheme flow chart of part position identification is shown in Fig. 1. Firstly, the Hough transform is used to identify the coordinates of all the circle's center of the circle in the image and calculate the distance between two points. The distance between two points is calculated and the geometric center coordinates of the part are determined and the number of parts is counted. Then calculate the distance between the circular coordinates and each geometric center, and classify the center coordinates of each part by the distance value. Finally, using the center coordinate matrix, the angle of each part is calculated. The geometric center coordinate value and angle value of the output part of the system are used as the positioning reference of the part in the machining process. Machining process.

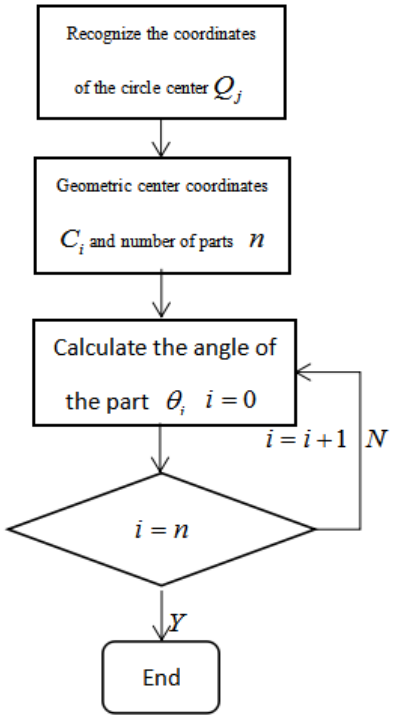

Fig 1. Total system flow chart

2.4 Part edge detection

This article uses canny edge detection, which is a technique for extracting useful structural information from different visual objects and greatly reducing the amount of data to be processed. The canny edge processing is used to process the image to obtain more accurate edge information of the part and filter out most of the noise interference. The comparison of the image before and after canny edge processing is shown in Fig. 2.

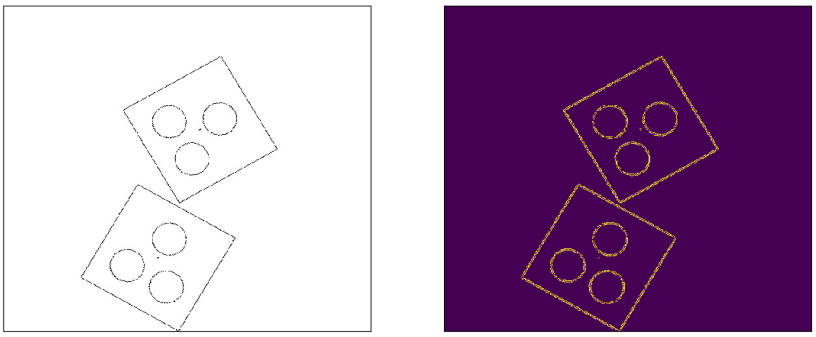

Fig 2. Canny edge processing

2.5 Coordinates Recognition Based on Hough Transform

The Hough transform mainly uses the global feature of the part image to directly detect the outline of the part image. In other words, it is an effective way to connect the edge pixels to form a closed boundary area [3].The Hough transform was originally applied to the detection of straight lines. Due to its excellent characteristics, it was gradually applied to other geometric shapes such as circles and rectangles. The following formula can be used to calculate the circle center coordinates of the circular target:

$$\begin{cases} x_0 = \left(p_{1x} + p_{mx}\right)/2 \\ y_0 = \left(p_{1y} + p_{my}\right)/2 \end{cases} \tag{1}$$

$\left(x_o, y_0\right)$: Center coordinates; $\left(p_{1x}, p_{1y}\right)$: Point P_1 coordinates; $\left(p_{mx}, p_{my}\right)$:Point P_m coordinates. Accumulate the number of coordinates corresponding to the formula with the same (x, y) coordinate value, and the maximum number of (x, y) coordinate values in the two accumulators is the center coordinate of the circle target.

2.6 Part angle calculation

Traverses the calculation of the center point $C_i = \left(x_{cen\,i}, y_{cen\,i}\right), i = 1, 2, \cdots, n$ to the center coordinates of Q_j all circles in the image. And filter points that meet the distance $d = d_m . d_m$ is the distance constant from the center of the part to the center of the circle.The point that meets the conditions is added to the circle's center-of-circle coordinate matrix G, and finally determine the direction. Here is the angle information used to determine the direction. The formula for calculating the angle is:

$$\theta = \arctan \frac{y_1 - y_0}{x_1 - x_0} \tag{2}$$

3. SOLUTION AND RESULT

The simulation is programmed in Python language and the simulation platform is pharm. According to the coordinates of the center of the circle and the coordinates of the vertices provided in DATA1, the simulation result data is finally obtained. As shown in Table 1. From the graph, the scheme provided in this paper can accurately identify the graphics in the image. It can also obtain accurate coordinates and angular position information through calculation.

Table 1. Simulation result data

Data label	DATA1
Origin coordinates	(188,416) (252,374) (248,452) (328,182) (286,246) (256,186)
Vertex coordinates	(118,435) (204,287) (351,373) (266,520) (267,315) (416,230) (182,168) (331,82)
Center coordinates	(235,404) (299,199)
Angle value	60.46^0 30.38^0

4. CONCLUSION

In the process of position recognition in machining of mechanical parts, the canny edge processing is used to process the image to obtain more accurate edge information of the parts. Through the Hough transform algorithm, the geometric shape and coordinates of the image data are quickly identified, and the orientation of the part is identified by the designed algorithm. Through simulation experiments, relatively accurate coordinates and angular position information were obtained. This method of detecting the position of a mechanical part during machining has high efficiency and accuracy and can be widely applied.

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