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RECOGNITION OF GEOMETRIC SHAPES IN IMAGES

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Abstract. This paper proposes finding optimal ways of recognizing geometric shapes (square, circle, rectangle, etc.) of files in different formats. Shapes recognition is a field of artificial intelligence, which includes all representation and decision techniques to automate the process of identifying similarities between objects or phenomena. An application of shapes recognition requires the definition of descriptors and choosing a distance. An application of shapes recognition is done in two phases: learning and recognition. By learning to calculate the set of descriptors of known (reference). In recognition stage, we calculate the same set of descriptors for unknown form and compared with known shape descriptors. The comparison is made through a distance. Recognition is a decision problem if you say unknown form is the same as the reference shape and if you say unknown form is different form the reference. Classification of forms is done in five steps: Reading and image display, image transformation in binary image and get its negative. Discover crossing thresholds between levels of color. Determine the properties of objects and Classification of objects by shape. Are three methods: Chain codes, the conventional Hough transform, method Harris Corner Detection.

Introduction

The question of recognizing various geometric shapes in an image. These geometric shapes are rectangles, squares and circles. They really are top views of some geometric objects (parallelepipeds and cylinders) placed in various positions on the work of an industrial robot.

A method as the following forms 2D can be described in two different ways. The first method uses contour shape and characteristics such as size, compactness. Other method is to describe the forms by region they occupy, as well as area or structure. Boundary characteristics are extracted from the perimeter and limit shape of the peaks, while regional features are extracted from the area occupied by shape like area. Basic forms have certain characteristics recognized even if they have the same properties. Each form has unique properties. For example, the same angles of the rectangle and the square of the same, but differ in leg length.

The first approach for digital representation limit was introduced using Freeman chain code. In general, any scheme representing the shape that must meet three objectives:

1. Must faithfully keep interest information
2. Allows compact storage
3. Should facilitate any necessary process.

Chain codes

Chain codes are used to represent the boundary of an object composed of pixels, the sequence of regular cells connected linear segments having a length specified direction. Form object is obtained by moving clockwise. It uses the following numbering scheme:

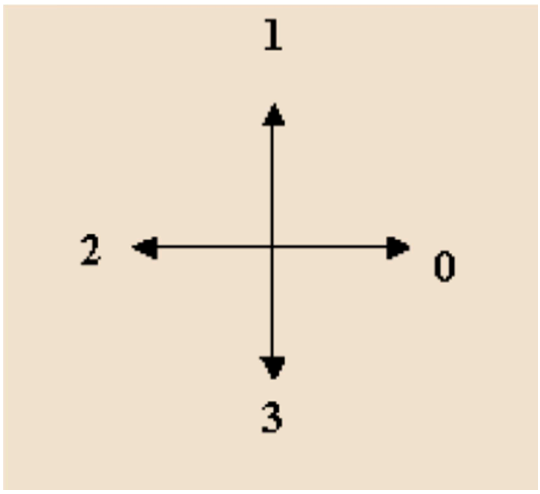
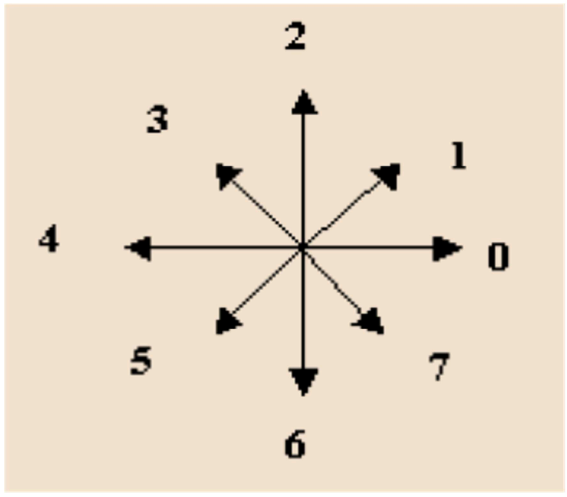


Fig.1. Numbering Scheme 4 connections neighborhood.



Fig, 2. Numbering Scheme 8 connections neighborhood

Figure 1. is present for each segment where they are applied to the 4- neighboring connection, while the connection 8 can be numbered as the neighborhood shown in Figure 2.
This results in the shape of an object if the direction is changed from chain to the other when the top is formed. Chain Codes are widely used because it provides a representation of objects that can be used in recognition. They also provide better compression for each segment to be encoded with 2 or 3 bits. Some characteristics may also be calculated, e.g., area and perimeter.
To solve the problem correctly, smoothing techniques can be applied to obtain forced chain codes of line segments with equal codes. Another problem with line segments can occur when they are thicker than 1 pixel, or when forms are closed.
These problems can be solved by applying an algorithm of the thinning prior to use of the chain codes to define a shape. Other features are compactness, complexity and roundness. The compactness of the perimeter defined by the shape and area to obtain the following formula:

$$Compactness = \frac{(Perimeter)^2}{4\pi Area} \quad (1)$$

Circle has a minimum compactness other complex geometric shapes have high compactness. A circle tends to be compactness equal to 1, the square has a compactness as 4 / π.

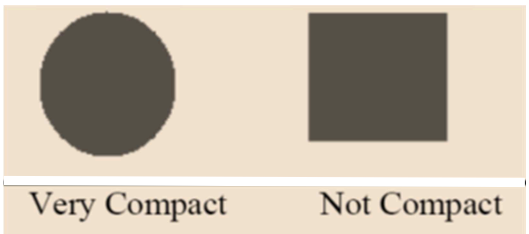


Fig.3. Compactness

The following algorithm is used to distinguish the forms of the base image.
1: It creates a binary image of the original image.
2: Save the image matrix 0 for background and 1 for the object. While this process is ongoing, we can calculate the area of the object by adding each iteration.
3: Calculate chain codes scanned image pixel to find the start of the object. From that pixel, scanning each row of the image and save it as an array or list. This step is repeated until we reach the end pixel. If the pixel does not overlap an end pixel shape is not folded then started. If end pixel overlaps then started form is closed.

4: If the form is closed perimeter is calculated by summing the chain code elements.
5: Calculate the compactness of form by applying the equation. Check if the shape is a circle.
6: If the shape of a circle that is based on the change in direction of the chain codes may be calculated by the number of peaks and determine the size of each angle. Determine the number of sides:

If corner count=0 then => The object is a line.
If corner count =1 => 2-connected lines
If corner count=2 => 3-connected lines
If corner count=3 and start pixel= end pixel => Shape = Triangle
If corner count=4 and startpixel=endpixel=> Shape=Rectangle or square or any other 4-side shape.

To decide the shape, check if the angles are 90 degrees. To differentiate between rectangle and square, check the length of each side per shape based on the chain code sequence.
There is a system based on the above algorithm for recognizing shape. The system checks the images and text displayed as image type of existing forms. It also displays features such as area, perimeter, codebook and number of chain codes. A circle has a compactness between 0.80 - 0.82, while a square and a rectangle are approximately 1.25. The following figures show the result of applying algorithms circle, rectangle, square and line.

Circle area = perimeter = 312 9625pixels --compactness = 0.81
Rectangle area = perimeter = 372 8288pixels --compactness = 1.32
Square area = perimeter = 448 12544pixels --compactness = 1.25
Line length = 116pixels --compactness = 9.16

Pattern recognition using chain codes is suitable for simple shapes composed of line segments and specified direction. Rotation and scaling are not a problem because the algorithm is based on counting the peaks and checking angles. Recognition algorithm can be applied to a large number of forms.

Hough transformation

Another method of determining the geometric shape in the image based on Hough transformation.
Conventional Hough transformation is used to recognize the shape of the detection curves in the image. Hough transform is used for detecting lines in an image.

$$\rho = x\cos\theta + y\sin\theta \quad (2)$$

If x, y pixel coordinates of the image plane x0y, ρ is the perpendicular distance from the origin to straight lines is the image plane x, y, θ is the angle from the x-axis perpendicular to the axis y. A two-dimensional battery cell (i, j), which has been created by the components ρi, θj for each pixel of the image coordinates x, y of all pixels in the same line in the same cell battery. When ρ and θ have the same amount and accumulation in the accumulator cell is greater than the threshold specified, values are converted back to the coordinates x, y. It recognizes that the line is evaluated at the point on the plane x, y. Likewise, CONVENTIONAL HOUGH TRANSFORM (CHT) can find a curve and a circle as given in equation (3).

$$r^2 = (x - C_x)^2 + (y - C_y)^2 \quad (3)$$

When the point (Cx , Cy) of the center of the circle is along the axis x and y, r is the radius of the circle or arc. In the case of a circle, is a battery cell (i, j), the parameters Cx , Cy and R. These parameters are used for the coordinates x, y on the same circle or arc.
It is used as well as the determination of a straight line.

Harris Corner method

Harris method is used to detect peaks of geometric shapes in an image object.
This method is not influenced by the value of scale, noise, rotation, light variation. This function of the correlation considered a measurement signal in different directions as given in equation (4).

$$c(x.y) = \sum[I(x_i, y_i) - I(x_i + \Delta x, y_i + \Delta y)]^2 \quad (4)$$

When w (x , y) is a window function , I (x + u , y + v) is moved intensity and I (x + y) is an intensity . Small windows are displaced approximated by equation (5).

$$E(u, v) \cong M \begin{bmatrix} u \\ v \end{bmatrix} \quad (5)$$

M is a 2x2 matrix that can be calculated from the derivative image, as shown in equation (6).

$$M = \sum_{x,y} w(x, y) \begin{bmatrix} I_x^2 & I_x I_y \\ I_x I_y & I_y^2 \end{bmatrix} \quad (6)$$

If the window was moved, the intensity and the eigenvalue of M (λ1, λ2) are changed. There are three cases to consider:

1) If both λ1, λ2 are small, so the auto - correlation function is locally flat windows image region is approximately constant intensity.

2) If an eigenvalue is high and the other low, auto - correlation function is shaped ridge in the area, then only local changes in one direction (along the ridge) produced little change in C (x , y) and significant changes in the orthogonal direction , this indicates an edge.

3) If both eigenvalues are high, so the auto - correlation function is suddenly reached a local maximum, then changes in either direction will result in a significant increase, this indicates a corner (a peak form).

Conclusions

Experimental study was conducted to determine the effectiveness of last two methods.
The target of the study was to compare the efficiency of recognition of geometric shapes (circle, rectangle, square) using Hough transform and Harris Corner method.
Detection was performed using a software was developed using the OpenCV library and the Microsoft Visual C + +. IRB140 robot arm was used to separate geometric in form, separating items. Experiments were implemented as follows: The three types of objects have been mixed. We take a photo of the work area. Were recognized geometric shapes in the image. This was carried out 100 times. The result is shown in the table 1.

Table 1. PERCENTAGE OF DETECT AND SEPARATE THE THREE OBJECTS

Object	Hough Transform	Corner Detection Harris
circle	98	99
rectangular	97	96
square	98	97

Hough transformation gave better results than Harris method, but not significantly. Hough transform algorithm can be implemented using the robot to recognize and separate objects by geometric shape.

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