Transformada de Hough (detecção de círculos & Outras Formas)

ES235 - Aula 15

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Definição

- Funciona de maneira “parcialmente” análoga à transformada de Hough de linhas
- Originalmente, 3 parâmetros seriam necessários (grid volumétrico)

$$(x - x_{center})^2 + (y - y_{center})^2 = r^2 \text{ where } (x_{center}, y_{center})$$

- Utiliza informação de gradiente das arestas ao invés de 3 parâmetros (Hough Gradient Method)

Hough Gradient Method :: Step by Step

- Edge detection in the image, such as Canny edge detection.
- Calculate the local gradient for the edge points using Sobel operator.
- Use an accumulator to count the possible circle center on the normal direction of edge points’ tangent.
- Choose the peak circle center and circle radius for the circle general equation.

Exemplos

Generalized Hough Transform

1. In detecting lines

– The parameters r and q were found out relative to the origin (0,0)

2. In detecting circles

– The radius and center were found out

3. In both the cases we have knowledge of **the shape**

4. We aim to find out its location and orientation in the image

5. The idea can be extended to shapes like ellipses, parabolas, etc.

Generalized Hough Transform

Analytic Form	Parameters	Equation
Line	ρ, θ	$x\cos\theta + y\sin\theta = \rho$
Circle	x_0, y_0, ρ	$(x-x_o)^2 + (y-y_0)^2 = r^2$
Parabola	x_0, y_0, ρ, θ	$(y-y_0)^2 = 4\rho(x-x_o)$
Ellipse	x_0, y_0, a, b, θ	$(x-x_o)^2/a^2 + (y-y_0)^2/b^2 = 1$

Generalized Hough Transform

1. The Generalized Hough transform can be used to detect ***arbitrary*** shapes
2. Complete specification of the exact shape of the target object is required
3. The Shape is specified in the form of the R-Table
4. Information that can be extracted are
    1. Location
    2. Size
    3. Orientation
    4. Number of occurrences of that particular shape

Generalized Hough Transform

- Algorithm to create the R-Table

  1. Choose a reference point

  2. Draw a vector from the reference point to an edge point on the boundary

  3. Store the information of the vector against the gradient angle in the R-Table

  4. There may be more than one entry in the R-Table corresponding to a gradient value

Generalized Hough Transform

1. Form an Accumulator array to hold the candidate locations of the reference point
2. For each point on the edge
    1. Compute the gradient direction and determine the row of the R-Table it corresponds to
    2. For each entry on the row calculate the candidate location of the reference point

$$x_c = x_i + r\cos\theta$$

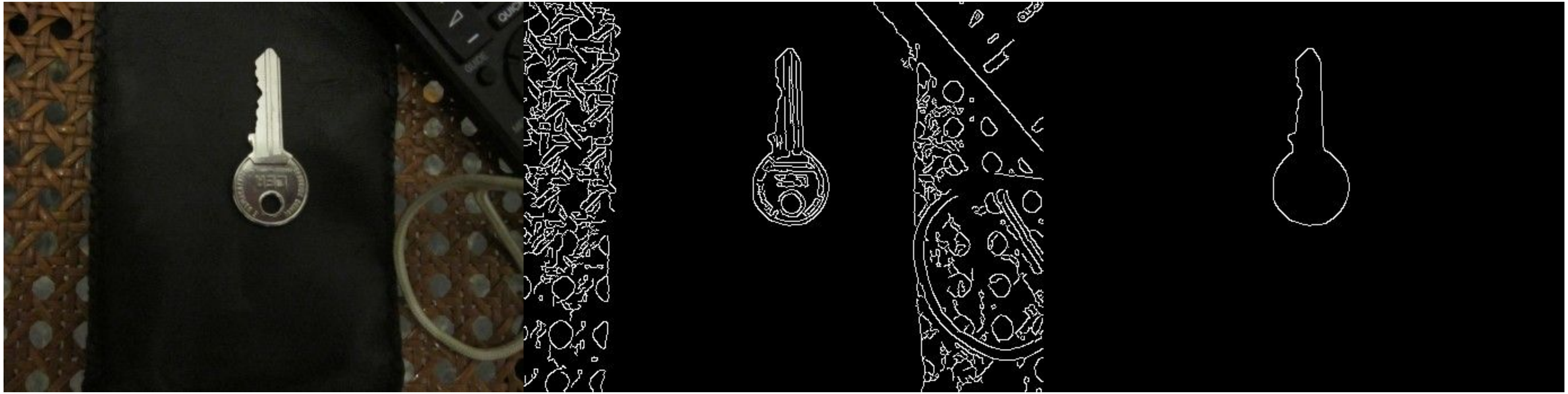
$$y_c = y_i + r\sin\theta$$

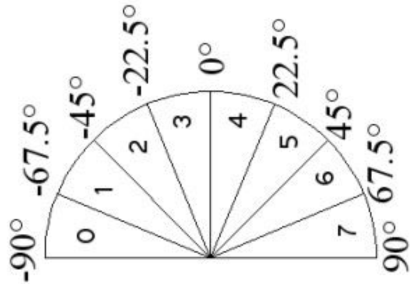
    3. Increase the Accumulator value for that
3. The reference point location is given by the highest value in the accumulator array

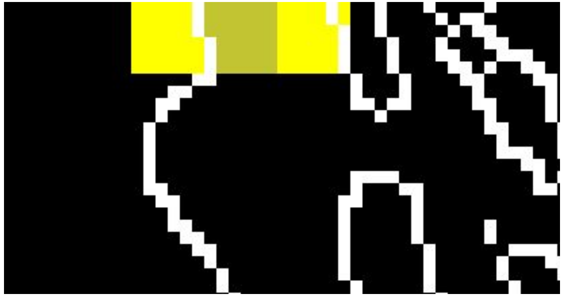
Generalized Hough Transform

1. The size and orientation of the shape can be found out by simply manipulating the R-Table
2. For scaling by factor *S* multiply the R-Table vectors by *S*
3. For rotation by angle q, rotate the vectors in the R-Table by angle q

Generalized Hough Transform







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