Edge Detection Algorithm

Edge detection algorithm is followed by linking procedures to assemble edge pixels into meaningful edges.

Basic approaches

Local Processing

2. Global Processing via the Hough Transform
3. Global Processing via Graph-Theoretic Techniques

1. Local processing

Analyze the characteristics of pixels in a small neighborhood (say, 3x3, 5x5) about every edge pixels (x,y) in an image. All points that are similar according to a set of predefined criteria are linked, forming an edge of pixels that share those criteria

Criteria

1.The strength of the response of the gradient operator used to produce the edge pixel

an edge pixel with coordinates (x_0,y_0) in a predefined neighborhood of (x,y) is similar in magnitude to the pixel at (x,y)if

$|\square f(x,y) - \square f(x_0,y_0)| \square E$

2.The direction of the gradient vector an edge pixel with coordinates (x_0,y_0) in a predefined neighborhood of (x,y) is similar in angle to the pixel at (x,y)if

$|\square(x,y) - \square(x_0,y_0)| < A$

3.A Point in the predefined neighborhood of (x,y) is linked to the pixel at (x,y) if **both magnitude and direction criteria are satisfied**.

4. The process is repeated at every location in the image

5.A record must be kept

6. Simply by assigning a different gray level to each set of linked edge pixels.

7. find rectangles whose sizes makes them suitable candidates for license plates

Use horizontal and vertical Sobel operators , eliminate isolated short segments

- Link conditions: gradient value > 25 , gradient direction differs <15□

2. GLOBAL PROCESSING VIA THE HOUGHTRANSFORM

Suppose that we have an image consisting of several samples of a straight line, Hough [1962] proposed a method (commonly referred as *Hough transform*) for finding the line (or lines) among these samples (or edge pixels). Consider a point (x_i, y_i). There is an infinite number of lines passing through this point, however, they all can be described by $y_i = a \cdot x_i + b$

This means that all the lines passing (x_i, y_i) are defined by two parameters, *a* and *b*. This equation can be rewritten as

$$b = -x_i \cdot a + y_i$$

Now, if we consider *b* as a function of *a*, where x_i and y_i are two constant the parameters can be represented by a single line in the *ab*-plane. The Hough transform is a process where each pixel sample in the original *xy*-plane is transformed to a line in the *ab*- plane. Consider two pixels (x_1, y_1) and (x_2, y_2). Suppose that we draw a line *L* across these points. The transformed lines of (x_1, y_1) and (x_2, y_2) in the *ab*-plane intersect each other in the point (*a*', *b*'), which is the description of the line *L*, see Figure . In general, the more lines cross point (a, b) the stronger indication that is that there is a line $y = a \cdot x + b$ image

To implement the Hough transform a two-dimensional matrix is needed, see Figure. In each cell of the matrix there is a counter of how many lines cross that point. Each line in the ab- plane increases the counter of the cells that are along its way. A problem in this implementation is that both the slope (a) and intercept (b) approach infinity as the line approaches the vertical. One way around this difficulty is to use the normal representation of a line

$$x \cos\theta + y \sin\theta = d$$

Here d represents the shortest distance between origin and the line. represents the angle of the shortest path in respect to the x-axis. Their corresponding ranges are [0, 2D], and [- 90, 90], where D is the distance between corners in the image.Although the focus has been on straight lines, the Hough transform is applicable to any other shape. For example, the points lying on the circle

$$(x - c_1)^2 + (y - c_2)^2 = c_3^2$$

can be detected by using the approach just discussed.

The basic difference is the presence of three parameters (c_1, c_2, c_3), which results in a 3-dimensional parameter space.

HOUGH TRANSFORM STEPS:

1. Compute the gradient of an image and threshold it to obtain a binary image.
2. Specify subdivisions in the $\rho\theta$-plane.
3. Examine the counts of the accumulator cells for high pixel concentrations.
4. Examine the relationship (principally for continuity) between pixels in a chosen cell.
5. based on computing the distance between disconnected pixels identified during traversal of the set of pixels corresponding to a given accumulator cell.
6. a gap at any point is significant if the distance between that point and its closet neighbor exceeds a certain threshold.
7. Link criteria:

1). the pixels belonged to one of the set of pixels linked according to the highest count

2). no gaps were longer than 5pixels