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Comparison Between Circular Hough Transform And Modified Canny Edge Detection Algorithm For Circle Detection

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Abstract: The circle is one of the most common shapes in our daily life, and indeed the universe. Planets, the movement of the planets, natural cycles, natural shapes - there are circles absolutely everywhere. The circle is one of the most complex shapes, and indeed the most difficult for man to create, yet nature manages to do it perfectly. The centers of flowers, eyes, and many more things are circular and we see them in our every-day life. Detection of circles is very important for us. In this paper, first detect a circle with Circular Hough Transform and then with Modified Canny Edge Detection Algorithm. Coding is done in MATLAB R2010a. It proves that Modified Canny Edge Detection Algorithm is best algorithm for circle detection as compared to Circular Hough Transform. The Modified Canny Edge Detection Algorithm is very fast algorithm to detect circles from the images as compared to Circular Hough Transform.

Keywords: Canny Detection, Comparison between Canny and Circular Hough Transform, Circle detection.

1.Introduction:

Digital image processing is the use of computer algorithm to perform image processing on digital images. Image processing operations can be roughly divided into three major categories:

Image Compression, Image Enhancement and Restoration, Image Segmentation.

Image Compression: Image compression means reducing the amount of data required to represent an image.

Image Enhancement and Restoration: Whenever an image is converted from one form to another, such as digitizing, transmitting, scanning, etc, some form of degradation occur at the output. Improvement in the quality of these degraded images can be achieved by the application of restoration and/or enhancement technique. Image enhancement improves the quality (clarity) of images for human viewing. removing blurring and noise, increasing contrast and revealing details are examples of enhancement operations.

Image Segmentation: Segmentation subdivides an image into its constituent regions and objects.

Edge detection is part of image segmentation. Edge detection is very useful in a number of contexts. Edge characterizes object boundaries and are, therefore, useful for segmentation, registration and identification of objects in scenes. The output of edge detection should be an edge image, in which the value of each pixel reflects how strong the corresponding pixel in the original image meets the requirements of being an edge pixel. Many edge detectors have been proposed, such as Sobel, Robert and Prewitt.

Detecting and recognizing the shapes in an image is extremely important in industrial applications in recognizing the object. Detecting circles in an image is one of the problems that is discussed in this paper. Many algorithms, such as Linear Square Method [2], Hough Transform, and Canny Edge Detection Algorithms have been proposed to detect circles. These algorithms detect circles from the edge detected images. Among these algorithms, Early Circular Hough Transform has been widely successful in meeting the real time requirement of being able to detect the circles in noisy environments. Circular Hough Transform and Modified Canny Algorithm are discussed in next section. And also discussed Modified Canny Algorithm is best algorithm to detect circle as compared to Circular Hough Transform.

2. Circular Hough Transform:

One of the most commonly used algorithms to recognize different shapes in an image is Hough Transform [3]. Hough Transform was introduced by Paul Hough in 1962 and patented by IBM. In 1972 Richard Duda and Peter Hart modified Hough Transform, which is used universally today under the name Generalized Hough Transform [4]. An extended form of General Hough Transform, Circular Hough Transform (CHT) [3], is used to detect circles. Flow-chat of Circular Hough Transform is shown in figure 1.

The edge detected from the Canny edge detector forms the input to extract the circle using the Circular Hough Transform.

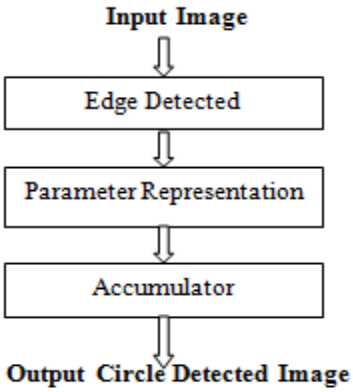


Figure 1. Flow-chat of Circular Hough Transform

2.1 Parameter Representation:

The equation of the circle is :

$$r^2 = (x-a)^2 + (y-b)^2 \quad (1)$$

As it can be seen the circle to get three parameter r, a and b, where a & b are the centre of the circle in the direction x & y respectively and r is the radius.

The parameter representation of the circle is:

$$x=a+r*\cos(\theta) \quad (2)$$

$$y=b+r*\sin(\theta) \quad (3)$$

Thus the parameter space for a circle will belong to R^3. As the number of parameter needed to describe the shape increase as well as the dimension of the parameter space R increase so do the complexity of the Hough transform.

2.2 Accumulator:

At each edge point we draw a circle with centre in the point with the desired radius .This circle is drawn in the parameter space, such that our x-axis is the a-value and y-axis in the b-value and z-axis is the radii. At the coordinates which belongs to the parameter of the drawn circle .We increment the value in our accumulator matrix which essentially has same size as parameter space .In this way we sweep over energy edge point in the input image drawing circle with the desired circle with desired radii and incrementing the value in our accumulator. When every edge point and every desired radius is used we can turn our attention to accumulator will now contain numbers corresponding to the number of circles passing through the individual coordinate. Thus the highest number correspond to the circle of the circle in the image.

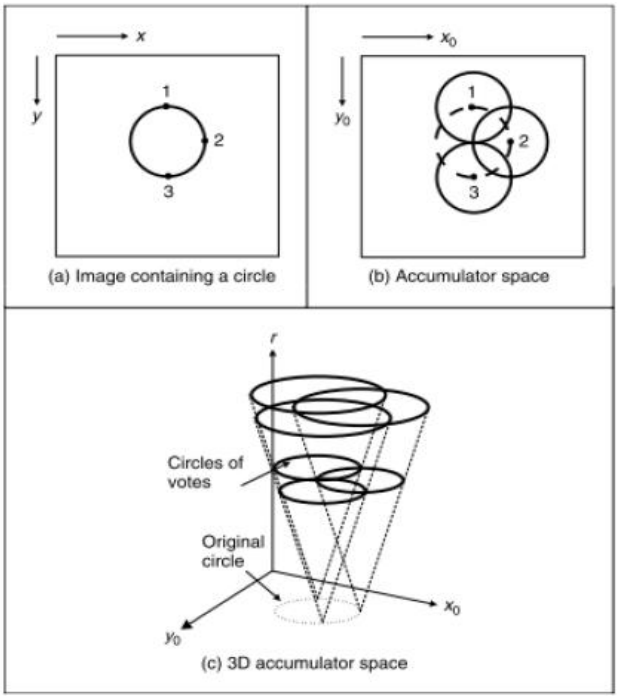


Figure2. Illustration of circular hough transform.

3. Modified Canny Edge Detection Algorithm:

Flow-chat of Modified Canny Edge Detection Algorithm to detect circles from the images is shown in figure no 3.

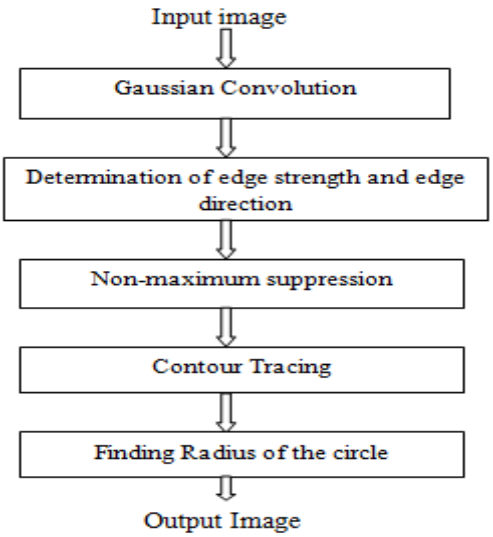


Figure3. Flow-chat of Modified Canny Edge Detection Algorithm

The goal of this algorithm is to locate the circles in an image more quickly and with efficient use of resources by finding the edges.

In the first stage noise is removed from the image by using Gaussian filter. After that Edge strength and Edge Direction is find out at each pixel by using Sobel Operator. Then non-maximum suppression. It is a process for marking all pixels whose intensity is not maximal as zero within a certain local neighborhood[5]. This local neighborhood can be a linear window at different directions. Figure 4. shows four examples of linear windows at angles of 0^o, 45^o, 90^o, and 135^o.

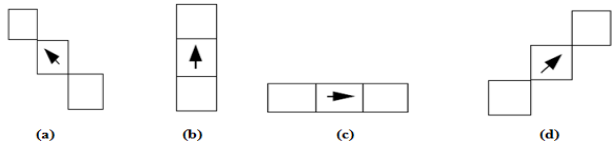


Figure 4. Linear window at the angle of (a) 135^o (b) 90^o (c) 0^o (d) 45^o

From this operation we thereby get thin edges of the objects in an image. These thin edges found can form a boundary of a circular object in the image. In the next section, we use these thin edges found to find the arcs which can be part of a potential circle.

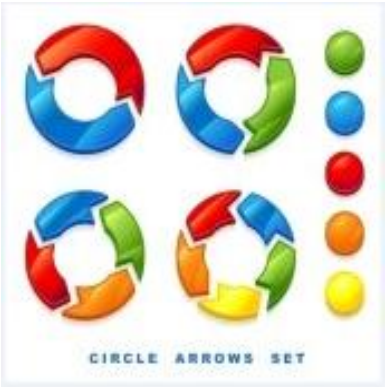
For contour tracing, Freeman Chain Code Algorithm is used. Chain code is a list of codes ranging from 0 to 7 in clockwise direction. These codes represent the direction of the next pixel connected in 3x3 windows. After that we find circle from the images very easily and efficiently.

4. Results:

Comparison between Hough Transform And Modified Canny Edge Detection Algorithm : When apply Hough Transform and Modified Canny Edge Detection algorithm to detect circles than we see these parameters which are shown in Table no 1:

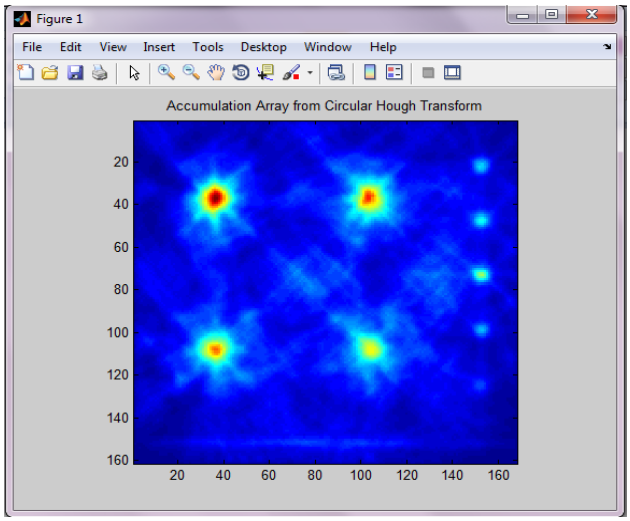
S.No.	Parameters	Hough Transform	Modified Canny Edge Detection Algorithm
1)	Mean Square Error (MSE)	0.015603	0.006836
2)	Peak Signal Noise Ratio (PSNR)	152.5067 db	160.7587 db
3)	Normalized Absolute Error (NAE)	0.000364	0.524588
4)	Cross Corelation	39.29142	83.05369
5)	Average Difference	0.0000348	0.0041113
6)	Maximum Difference	0.720027	0.631108

a). Original Image:

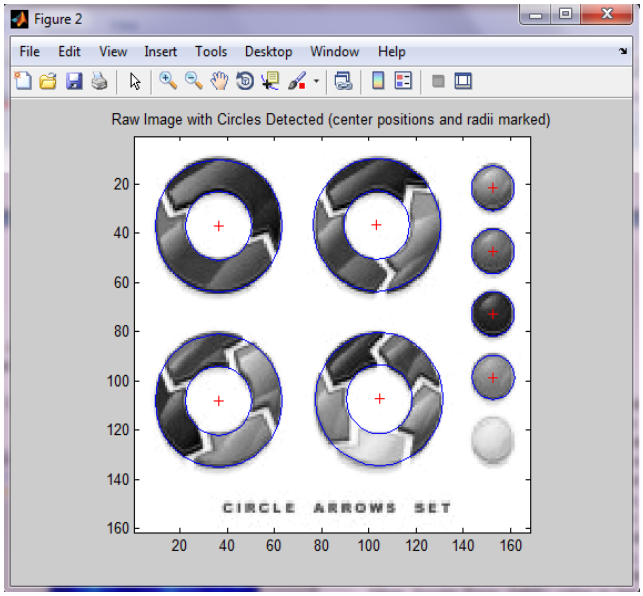


b). After Circle Detection Using Circular Hough Transform:

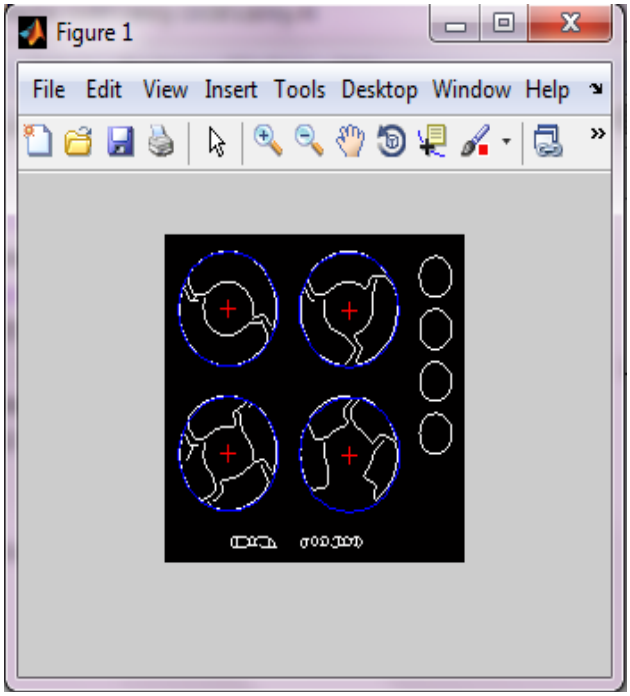
1. 3D Accumulation array of Circular Hough Transform:



2. Circle Detection Image using Circular Hough Transform:



c). Image After Circle detection using Modified Canny Edge Detection Algorithm:



5. Conclusion:

In this paper, we compare Hough transform and Modified Canny Edge Detection Algorithm to detect circles from images. Here we compare various parameters like MSE, PSNR, SC etc. From table we observed that Mean Square Error (MSE) value is less, when we detect circle from images using Modified Canny Edge Detection algorithm and Peak Signal Noise Ratio (PSNR) is large as compared to Circular Hough Transform. There are some more parameters also which we compare for both algorithms. So Modified Canny Edge Detection Algorithm is best as compared to Hough Transform.

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