# Coin Recognition Using Circular Hough Transform

Dr. Neelu Jain
Assistant Professor, PEC University of Technology, Chandigarh. India
neelujain@pec.ac.in

Neha Jain
Assistant Professor, Rayat Bahra College of Engg. & Bio-Technology for Women, Kharar, Mohali, India
neha47@gmail.com

*Abstract*-- **This paper represents algorithm for recognition of the coins of different denomination. The proposed system first uses a canny edge detection to generate an edge map, then uses CHT (Circular Hough transform) to recognize the coins and further find the radii of them. Based on the radius of the coin, the coins of different denomination are classified. The experimental result shows that the Hough transform is an effective tool for coin detection even in the presence of noise.**

***Keywords**-Circular Hough Transform (CHT); circle detection; coin recognition*

## I. INTRODUCTION

Coin Recognition is a difficult process in machine intelligence and computer vision because of its various rotations and widely changed input pattern. Coin detection and recognition in noisy and cluttered images also poses a great challenge. The goal of this research work is to develop a system to classify the coins of different denominations by finding their radii in real time despite the above mentioned challenges. In this system, CHT (Circular Hough transform) [1, 2] is used to detect the presence of circular shapes like coins from the input image because it has the robustness to deal with the noises in the image. CHT is a kind of HT (Hough transform) [3] that can extract circular objects from an image. The Hough Transform was first introduced by Paul Hough [4] in 1962 to detect straight lines in bubble chamber data, the transform consists of parametric description of a feature at any given location in the original image's space. The HT essentially consists of two stages. In the first stage, edge map of the image is calculated then each edge point contributes a circle to an output accumulator space. In the second stage, the output accumulator space has a peak where these contributed circles overlap at the center of the original circle and then define the coordinates of the circle.

The CHT has been used in several researches in detecting iris and pupil boundaries for face recognition [5], fingertips position detection [6] and automatic ball recognition.

The main advantage of using HT is high reliability and it gives ideal result even in the presence of noises. Also the HT provides parameters to reduce the search time for finding objects based on a set of edge points.

In spite of its advantages, the HT has some disadvantages when it deals with large size image.

When the large size image is used, the quantity of data has become large and processing will be slow. The large amount of storage and high cost of computation are two major drawbacks of using HT in real time applications.

To tackle these problems, many modifications to the CHT have been widely implemented to either increase the detection rate of the coins or more commonly to reduce its computational complexity [7]. In this proposed work, the edge orientation information is used to increase the CHT performance. This method was first suggested by kimme et.al. [8] noting that the orientation of an edge point on the boundary of a circle is in the direction of its centre. This modification reduces computational requirements by plotting arcs in the accumulator space.

## II. PROPOSED SYSTEM

The set-up includes a low end digital video camera and a computer. The camera having the resolution of 320 X 240 pixels has been used throughout this study. The camera is placed at the distance of 20cm from the coin so that the image of the coin can be captured easily. Fig. 2 shows the image captured by the camera.

However, due to the positioning of the camera or that of the coin, the coin image is at times slightly distorted or only a portion of the coin is visible, but nevertheless it still resembles to a circle. CHT has the capability of identifying the coin even when only portion of the coin is visible. Fig. 1 shows the block diagram of the detection and recognition system.

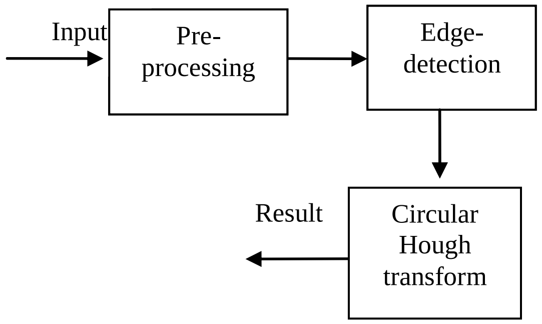



Figure 1. Coin recognition process

Various preprocessing techniques have been used to make the input image suitable for the algorithm. In order to reduce the noise from the image, Gaussian filter has been used to smooth the image, and then an appropriate gray level thresholding is done to obtain a binary image.

### *A. Edge Detection*

Hough transform is based on feature points extracted from the original image and usually, edges are used as the feature points. Various edge detection methods have been used for different applications.

If Sobel filter [9] is used to a coin image, large number of edge points are obtained from texture of the coin can be regarded as noise, which will induce a huge overhead in the execution time of the Hough transform and most importantly will produce measurement errors, so technique to reduce the unwanted edge is sought. Result of applying Sobel filter to an image is shown in Fig. 3.

The canny edge detector [10] is very powerful tool for detecting edges in a noisy environment. Canny edge detector can remove most of the edge points. Canny gives thin edge compared to the Sobel. Hence, canny edge detector has used for eliminating the unwanted edges that can result from Sobel. Based on the smoothed image, derivatives in both the x and y direction are computed, these in turn are used to compute the gradient magnitude of the image.

Once the gradient magnitude of the image has been computed, a process called 'non maximum suppression' is performed; in which pixels are suppressed if they do not constitute a local maximum.

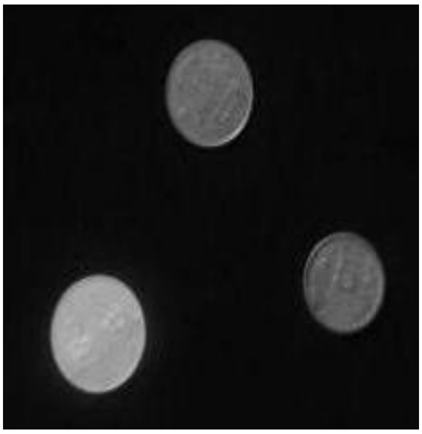


Figure 2. Sample image (Coins.jpg)

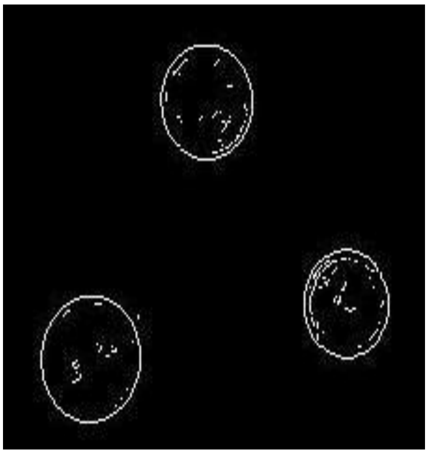


Figure 3. Result of Sobel Filter

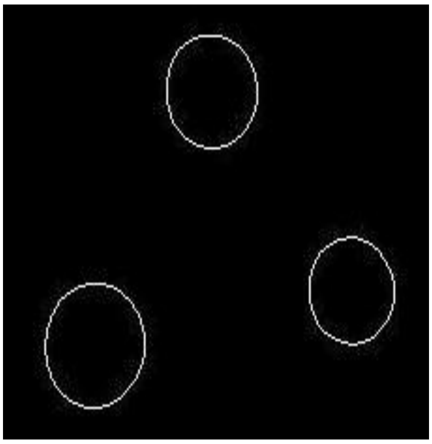


Figure 4. Result of Canny Edge detector

The final step in the canny edge detector is to use hysteresis operator, in which pixels are marked as either edges, non edges and in-between, this is based on threshold values. The next step is to consider each of the pixels that are in-between, if they are connected to edge pixels these are marked as edge pixels as well.

The result of this edge detector is a binary image in which the white pixels closely approximate the true edges of the original image as shown in Fig. 4.

### *B. Circular Hough Transfors*

The Hough transform and several modified versions have been recognized as robust techniques for curve detection. Hough transform for detecting circles is based on the same principle introduced by the Hough transform for line segment. The CHT was sketched by Duda et.al [11]. The CHT aims to find circular patterns within an image. The CHT is used to transform feature points in the image space into accumulated votes in the parameter space, or the Hough space. Then, for each feature point, votes are accumulated in an accumulator array for all parameter combinations. The array elements that contain the highest number of votes are used to indicate the presence of the pattern.

A circle pattern is described by equation given as

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

where a and b are the coordinates of the centre in the x and y direction respectively and r is the radius of the circle. The parametric representation of the circle is given as

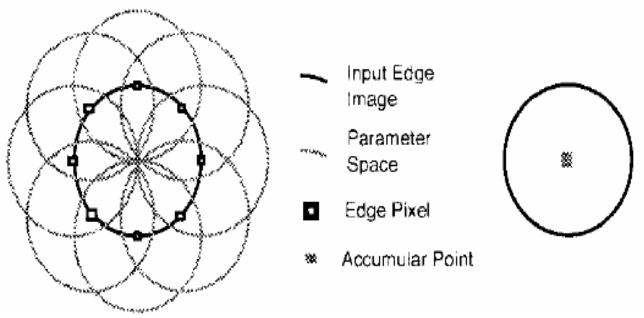
$$x = a + r\cos\theta \quad (2)$$

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

As a circle is defined by the three parameters:-centre coordinates (a, b) and radius (r), the Hough space is a three dimensional space, with the Z-axis representing the radius.

In order to perform a Hough transform, all possible values for the radius can be considered. However, in the proposed system, CHT is used for detecting the coins of different denominations, so a suitable range for radius of the coins can be defined.

An example of circular Hough transform is shown in Fig. 5




(a) (b)

Figure 5. (a) The contribution of the edge points to the accumulated space (b) Edge point contribution to a single accumulator point.

A set of edge points, within the original image, are indicated by the black circle. Each edge point contributes a circle of radius R to an output accumulator space indicated by grey circles. The output accumulator space has a peak where these contributed circles overlap at the centre of the original circle. The location of each peak gives the parameters of each detected circle.

## III. EXPERIMENTAL RESULT

Various images have been used to evaluate the performance of the proposed system. The success rate of the proposed system to recognize the coins of different denomination is 94%. Table1 shows the radius of 3 coins of different denomination.

TABLE I. COINS WITH THEIR RADII

| Denomination (Rs) | Radius[pixels] |
|---|---|
| 2 Rs Coin | 26 |
| 1 Re Coin | 24 |
| 5 Rs Coin | 22 |

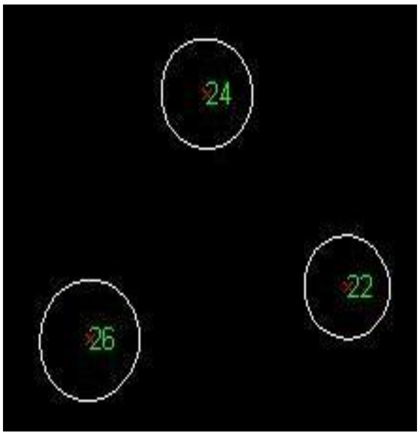



Figure 6. Image after computing radius of coins

## IV. CONCLUSION

The coin of different denomination can be recognized based on the radius of the coin. When coins are placed on a plain surface, the edges of the coins are easily traced and the HT has a much higher chance of success. By using the canny edge detector in conjunction with CHT, the coordinates of the coin are evaluated.

The proposed system can be used in coin operated payphones, vending machines, weighing machines and in many other machines that are based on coin recognition.

The problem arises if the coin image is captured from a distance and the image tends to be small. Besides that, some of the coins are overlapped. These restrictions make the detection process difficult.

Future work may include detection of several coins that are overlapped with each other.

## REFERENCES

[1] Zhang Mingzhu and Cao Huanrong, “A New Method of Circle’s Center and Radius detection in Image Processing”, Proceeding of the IEEE International Conference on Automation and Logistics, Qingdao, China, pp:2239-2242, 2008.

[2] Zhang Xiao, Peng Weij, “Detection of circle based on Hough transform. Transducer and Micro System Technologies”, Vol. 8 pp: 25-34, 2006.

[3] Lam, W.C.Y., Yuen, S.Y, “Efficient technique for circle detection using hypothesis filtering and Hough transform”, IEEE Proceedings of Vision, Image and Signal Processing, Vol. 143, Oct.1996.

[4] Hough P.V.C, “Method and means of recognizing complex patterns”, US patent 3069654, Dec 1962.

[5] Moukhtar E. et.al. “Rejection Analysis of an Iris Recognition System”, pp: 19-21, Dec. 2005.

[6] Yu Tong Hui Wang, Daoying Pi and Qili Zhang, “Fast Algorithm of Hough transform-Based Approaches for fingerprint Matching”, The Sixth World Congree on Intelligent Contral and Automation, Vol. 2, pp: 10425-10429, June 2006.

[7] Xu.L, Oja.E, and Kultanan.P, “A new curve detection method randomized Hough transform (RHT)”, Pattern Recognition Letter, Vol.11, pp: 331338, 1990.

[8] Kimme, C. D. Ballard and J. Sklansky, “Finding circles by an array of accumulators”, Proc. ACM, Vol. 18, pp: 120-122, 1975.

[9] Nick Kanopoulos, Nagesh Vasanthavada and Robert L. Baker “Design of an Image Edge Detection Filter Using the Sobel Operator”, IEEE Journal of solid state circuits, Vol. 23, No. 2, April 1988.

[10] J.Canny, “A Computational Approach to EdgeDetection”, IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol.8, No.6, Nov.1986.

[11] Duda, R.O. and P.E Hart, “Use of the Hough transformation to detect lines and curves in picture”, Commum. ACM, pp: 11-15, 1972.