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Harris-Hessian Algorithm for Coin Apprehension

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***Abstract*— Coins square measure integral a part of our day to day life. We tend to use coins everyplace like grocery market, banks, buses, trains etc. Therefore it is a basic want that coin is recognized and counted. The target of this paper is to classify the Indian coins of different denomination discharged recently. The objective is to notice the Indian coins and count its total worth. The system is projected to design coin recognition by applying Advanced Harris-Hessian Algorithm, supported the parameters of Indian coins such as size, shape, weight, surface and so on . This paper presents a coin recognition methodology with rotation invariance. For circle detection use Hough Transform.**

***Keywords*-smoothing, Interest point detection, Hough Transform technique**

I. Introduction

We cannot imagine our life while not coins. We tend to use coins in our existence virtually every place like in banks, supermarkets, grocery stores etc. They need been the integral a part of our day to day life. Therefore there is basic want of extremely correct and economical automatic coin recognition system. Coin recognition systems can also be used for the analysis purpose by the institutes or organizations that alter the traditional coins. There are three types of coin recognition systems available in the market based on different methods:

- Mechanical methodology primarily based systems
- Electromagnetic methodology primarily based systems
- Image process primarily based systems

The mechanical methodology primarily based systems use parameters like diameter or radius, thickness, heaviness and magnetism of the coin to differentiate between the coins. However these parameters cannot be wont to differentiate between the various materials of the coins. It means if we offer two coins one original and different pretend having same diameter, thickness, weight and magnetism however with completely different materials to mechanical methodology primarily based coin recognition system then it will treat each the coins as original coin so these systems can be fooled easily.

The electromagnetic method based systems can differentiate between different materials because in these systems the coins are passed through an oscillating coil at a certain frequency and different materials bring different changes in the amplitude and direction of frequency. So these changes and the other characteristics like diameter, thickness, weight and magnetism can be used to differentiate between coins. The electromagnetic method based coin recognition systems improve the accuracy of recognition but still they can be fooled by some game coins.

Nowadays banks usually use the bill counting machine to enumerate the money they have received. Obviously this is a more efficient method than counting the cash by hands. However, when the customer wants to pay a large number of cash into the bank, they still have to wait for quite a while. Particularly, there is large number of coins inside. And it is also easy to make mistakes for the bank staffs to calculate. Some coins from completely different foreign currency look similar. Therefore, generally it is tough to distinguish them by using human eyes, especially for large amount of coins. Moreover, attributable to the globalization, the banks usually receive foreign currency that the workers might not acknowledge. The charities face the constant state of affairs, because the donators come from all over the world. So it is necessary to develop a system that may help facilitate them to recognize and calculate the money that they receive.

In 2002 there are twelve countries in Europe that modified their local currencies to the Euro. That means, great volumes of money had to be physically come back to the national banks of the member states. National banks want such a tool that can sort and recirculate these high volumes of coins. Therefore in 2003 a coin sorting device referred to as Dagobert was developed by ARC Seibersdorf analysis GmbH in step with the necessities of nation banks. The coins from more than 100 countries were sorted by Dagobert among two years. In total more than 2000 different coin faces of over 600 different coin types had to be trained and comprise the backbone of the recognition unit of Dagobert. This can be a extremely sensible starting point for developing automatic coins counting system (Nölle 2004, p.284). There are several similar methods around. One is coin images Seibersdorf-Benchmark method. The second one is called automatic coin counter that was designed by J. Provine, Mike McClintock, Kristen Murray, and Angela Chau, who were students from Rice University in Houston.
The main goals of this project are:

- Recognize the coins on the image.
- Count the coins, and then get the total value.

The sub-goals for the project are:

- Group the coins according to their features (such as size, shapes).
- Distinguish the coins in the same group according to the size or shape.
- Count the coins within the group.
- Calculate the total worth of the coins that are displayed on the image.

II. RELATED WORK

In 1992 [6] Minoru Fukumi et al. given a rotational invariant neural pattern recognition system for coin recognition. They performed experiments taking 500 yen coin and 500 won coin. During this work they need created a multilayered neural network and a preprocessor consisting of many slabs of neurons to supply rotation invariance. They additional extended their work in 1993 [7] and tried to attain 100% accuracy for coins. During this work they need used BP (Back Propagation) and GA (Genetic Algorithm) to design neural network for coin recognition. Adnan Khashman et al. given associated an Intelligent Coin Identification System (ICIS) in 2006. ICIS introduced neural network and pattern averaging for recognizing rotated coins at various degrees. It shows 96.3% correct identification i.e. 77 out of 80 variably rotated coin images were correctly identified. Mohamed Roushdy proposed Generalized Hough Transform to detect coins in image. Many serious problems like shape of the coin, peak detection in surface of the coins are attempted by Reinhold Huber, but, it does not yield much result. Hence, it is introduced to use Robert's edge detection method, Laplacian of Gaussion edge detection method, Canny edge detection method and Multi-Level Counter Propagation Neural Network (ML-CPNN) using the coin parameters to recognize all the coin images with good precision.

In our work we have combined Hough Transform and Harris-Hessian algorithm to extract features from image. Then, these features are used to recognize the coins. In section 3 implementation details are given. In section 4 we have presented conclusion and results. Then, in section 5 the future work provided.

III. PROPOSED SOLUTION

The set-up includes a low end digital video camera and a computer. The camera is placed at the distance from the coin so that the image of the coin can be captured easily. 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. Harris-Hessian Algorithm has the capability of extracting features and CHT (Circular Hough Transform) has the capability of identifying the coin even when only portion of the coin is visible. Figure 1 shows the block diagram of the detection and recognition system.

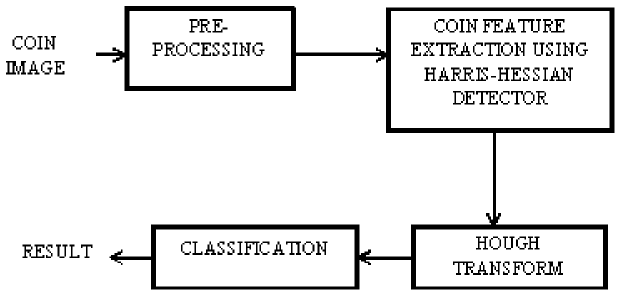

Figure1: Block Diagram

A. Pre-Processing*:*

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. Pre-processing methods use a small neighborhood of a pixel in an input image to get a new brightness value in the output image. Therefore, this type of pre-processing operations is also called filtration. Local pre-processing methods can be divided into the two groups according to the goal of the processing: Smoothing suppresses noise or other small fluctuations in the image; equivalent to the suppression of high frequencies in the frequency domain. Sadly, smoothing conjointly blurs all sharp edges that bear necessary info regarding the image, and then we tend to shall think about smoothing techniques which is edge protective. They are based on the general idea that the average is computed only from those points in the neighborhood which have similar properties to the processed point. Local image smoothing can effectively eliminate impulsive noise or degradations appearing as thin stripes, but does not work if degradations are large blobs or thick stripes.

B. Coin Feature Extraction using Harris-Hessian (H-H) Detector:

Harris-Hessian detector is based on Harris-Hessian algorithm and it extracted features from the original image of coin and usually, interest points are used as the feature points. Figure 2 represents the different denomination of Indian coins- five rupee coin, 10 rupee coin, 2 rupee coin, 1 rupee coin and 25 paisa coin

Harris-Hessian Algorithm steps:

For a given gray scale image of coin perform the following

a. Candidate Points Detection
   i. Set pre-selected scales 2, 4, 6, 8, 12, 16, 20, 24, which denote successive levels of the scale-space.
   ii Perform histogram analysis and store the point coordinates to the variable
   iii Calculate redirect intersect point of the database images
   - Perform scalng
   - Store it to database
   - Until pixel equals EOP perform step 1
   - Else return image
   - Store in data base

b. False Detection Elimination and Scale Confirmation:
   i. Calculate determinant point of the given image (user images) by applying the following formula

$$H = \begin{bmatrix} Ixx & Ixy \\ Ixy & Iyy \end{bmatrix} \qquad (1)$$

Where *Ixx*, *Iyy*,and *Ixy* are the second order derivatives. The determinant value of H is

$$DET(H) = |Ixx * Iyy - Ixy^2| \qquad (2)$$

Determinant value should be maximum. Therefore it detect maximum point values as feature points. After the detection calculate the threshold value of feature points of coins. It depends on the parameters of coin shown in table 1.

C. Circle detection using Hough Transform(HT*)*:

Let the task be to notice a circle of a illustrious radius r in an image. The technique starts with a quest for dark image pixel, when such pixel is found a locus potential center points of the circle related to it is determined. Such a locus potential center points forms a circle with the radius r. If the loci of potential circle center are created for all dark pixel identified in the image, created for all dark pixels identified in the image, the frequency can be determined with

Figure 2: Indian coins of different denominations- five rupee coin, 10 rupee coin, 2 rupee coin, 1 rupee coin and 25 paisa coin

that every pixel of the image area happens as part of the circle-center loci. The middle point of the circle being sought is represented by the pixel with the highest frequency of occurrence in the circle-center

A static r belongs to a 2-D parameter space A(a,b), a variable r belongs to a 3-D parameter space A(a,b,r). If we wish to seek out both light and dark circles, two sides of every edge must be viewed. If we consider two edges in an image then the number of possible (a,b,r) values are decrease strongly. The local maximum within the parameter space are easier to seek out. Within edge points in the image, there are n(n-1)/2 pairs to be viewed. Boundaries on r and testing on the ϕ' s can restrict the number of (a,b,r) values to be calculated.

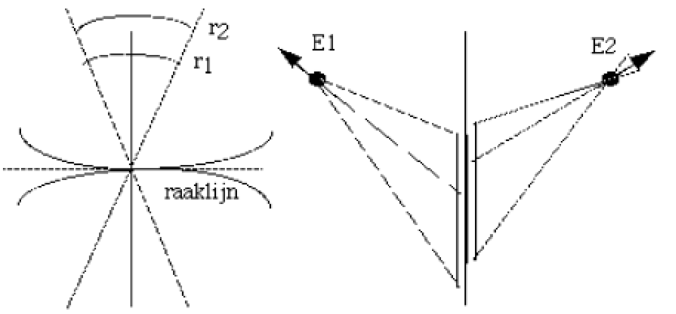

Figure 3: Catalogue of Hungarian denomination

Algorithm for Curve detection using the HT

Step 1. Quantize parameter space among the boundaries of parameters a. The dimensionality *n* of the parameter space is determined by the amount of parameters of the vector **a**.

loci. Thus, the middle of the searched circle is determined. From the known circle radius, the coin image segmentation is performed.

Step 2. Form an n-dimensional accumulator array *A(**a**)* with structure matching the quantization of parameter space; set all elements to zero.

Step 3. For each image point *(x1, x2)* within the appropriately threshold gradient image, increase all accumulator cells *A(**a**)*,

$$\text{if } f(x, \mathbf{a}) = 0, \quad A(\mathbf{a}) = A(\mathbf{a}) + \Delta A$$

for all **a** inside the boundaries used in step 1.

Step 4. Local maxima in the accumulator array *A(**a**)* correspond to realizations of curves *f(x,* **a**) that are present in the original image.

D. Classification:

After circle detection, classify the coin according to the radius and threshold values. That is, each coin has its own radius. Then we count the total values of the coin.

IV. CONCLUSION AND RESULTS

In this paper Harris-Hessian based coin recognition system has been developed using MATLAB. In this system, firstly pre-processing of the image is done and then these pre-processed images are fed to the Harris-Hessian detector, it detect interest points. These features are fed to the Hough Transform it detect circles and calculate the radius of coins.

The HT is extremely strong within the presence of extra structures in the image as further being robust to image noise. Moreover, it may search for several occurrences of particular shape during the processing. The conventional sequential approach requires a lot of storage and extensive computation.

In this paper, the subsequent three points are taken into the consideration for decreasing the maintenance cost. The perfect image of a coin is employed for learning and recognition. The implementation to a real system ensures the following important points:

a) The Recognition rate is close to 100 percent.
b) It is a low cost system.
c) Recognition time is very less.

V. FUTURE WORK

There are so many approaches available for recognition of contemporary coins. New approaches/ techniques developed for recognition of stack of coins.

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Table 1: Parameters of Indian coin

Coin Value in Paisa	Type of Coin	Coin Diameter/side in mm	Coin Shape	Coin Weight (grams)	Coin area In Cm2	Coin average gray value	Coin Thickness In mm
1	Old	12	Square	1.15	1.5000	250	0.7000
2	Old	15	Octagon	1.55	1.9600	249	0.9000
3	Old	17	Hexagonal	1.89	2.4100	245	1.0000
5	Old	18	Square	2.00	2.4500	250	1.1000
5	New	18	Square	2.00	2.4500	250	1.1000
10	Old-1	26	Octagon	2.24	5.3114	225	1.0000
10	Old-2	24	Polygon	1.73	4.5257	225	1.0000
10	New	16	Circle	1.99	2.0114	75	1.0000
20	Old	25	Hexagonal	2.21	4.0595	240	1.2000
20	New	25	Circle	2.30	4.5590	240	1.2000
25	Old	20	Circle	2.95	3.1428	90	1.0000
25	New	21	Circle	2.82	3.1467	90	1.0000
50	Old	24	Circle	4.98	4.5257	100	1.6000
50	New	22	Circle	3.72	3.8028	100	1.6000
100	Old	27	Circle	5.97	5.7278	100	1.7000
100	New	26	Circle	4.93	5.3114	100	1.7000
200	Old	27	Polygon	5.91	5.7278	110	1.8000
200	New	27	Circle	7.72	6.1600	110	1.8000
500	Old	24	Circle	9.03	4.5257	200	3.0000
500	New	24	Circle	6.14	4.5257	200	1.5000
1000	New	26	Circle	6.20	4.7257	210	1.7000

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