Dr. Seema Bawa and Shatrughan Modi (2011) have developed System for the recognition of Indian Coins. They have used Hough Transform and Pattern Averaging techniques for extracting the features from the image.97.74% recognition rate has been achieved using this network [6].

C.M.VELU and P.VIVEKANANDAN (2011) developed system for recognizing the coins and counting the total value of the coin. They have developed Multi-Level Counter Propagation Neural Network (ML-CPNN). The system mainly considers affine transformations which include, simple gray level scaling, rotation, shearing etc. They have used Robert Edge detection, LoG edge detection and canny edge detection and also shown the accuracy achieved with the three detection techniques [7].

J Prakash and K Rajesh (2009) proposed A Novel Approach for Coin Identification using Hough Transform ,Eigen values of Covariance Matrix, and Raster Scan Algorithms. Here coin image is converted into grayscale image and edge detection technique is applied on this image. Covariance matrix is then calculated. Now small and large Eigen values are obtained. Then sparse matrix technique is used for obtaining CHT for Eigen value images. Next, neighborhood suppression scheme is applied to find the meaningful set of distinct Hough peaks. Then they have obtained circumference pixel locations using Bresenham's Raster scan algorithm. After the extraction of circular objects coins get identified [8].

Ming Ma, Dong-Won Park ,Kulwinder Singh, Juno Chang (2005) developed region-oriented segmentation technique for coin recognition. They have used an improved K-means clustering algorithm, which speed up the automatic determination of the optimal number of classes, and all the gray-levels are grouped into several clusters. Then a label image is obtained. Then features are extracted from the label image [9].

Michael Nolle, Harald Penz and Michael Rubik (2003) developed a new coin recognition system called Degobert. This system consists of three parts namely Coin detection, Pre-selection and Coin verification. The main purpose of this system is to sort high volumes of coins [10].

Minoru Fukumi et al.(1992) developed a system which has a fixed invariance network and trainable multilayered network. 500 yen coin and 500 won coins were used in this system [11].

3. Methodology

We have developed Indian Coin Recognition System with rotation invariance approach. We are using Radial Blur Technique which reduces the processing time of the system.

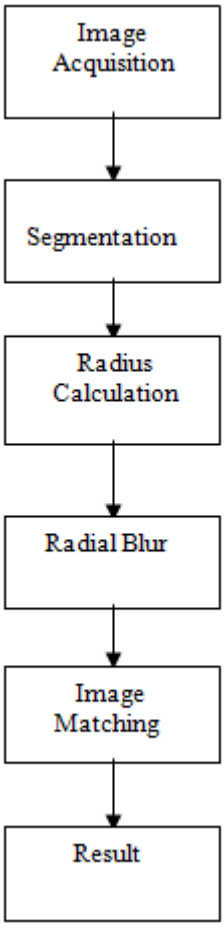

Figure 1: Developed Architecture

Figure 1 shows the developed architecture which consists of following components:

3.1 Image Acquisition

Here an image of the coin is acquired. This is an object image. This image is then converted into grayscale image and next into binary image for further processing. An image is 2D array of pixels in which each color pixel is described by the triple of intensities of Red, Green and Blue color. i.e. each pixel has three different intensity values. But in grayscale image these values are converted into single value.

Color image is converted into grayscale image using following formula [12]:

gray = (0.299*r + 0.587*g + 0.114*b)

3.2 Segmentation

It is a process in which an image is divided into segments. This process changes the representation of the image so that it is easier to recognize and analyze. Segmentation is used to locate boundaries in an image. Here we are separating the coin image from the background so that we can concentrate only on coin. In our work we are using Canny edge detector which involves:

- Noise Reduction
- Finding the intensity gradient of the image

Licensed Under Creative Commons Attribution CC BY

- Non-maximum suppression [13].

In Noise Reduction phase Gaussian Filter is used to remove the noise. If there is a 5x5 Gaussian filter, used to create an image, with σ =1.4.

(The asterisk denotes a convolution operation.)

$$\mathbf{B} = \frac{1}{159}\begin{bmatrix} 2 & 4 & 5 & 4 & 2 \\ 4 & 9 & 12 & 9 & 4 \\ 5 & 12 & 15 & 12 & 5 \\ 4 & 9 & 12 & 9 & 4 \\ 2 & 4 & 5 & 4 & 2 \end{bmatrix} * \mathbf{A}.$$

In the second phase, four filters are used to detect vertical, horizontal, and diagonal edges in the blurred image. The edge detection operator now returns a value for the first derivative in the vertical and horizontal direction.

Horizontal direction = G_x
Vertical direction = G_y

Here edge gradient and direction is calculated as:

$$\mathbf{G} = \sqrt{\mathbf{G}_x^2 + \mathbf{G}_y^2}$$
$$\mathbf{\Theta} = \operatorname{atan2}(\mathbf{G}_y, \mathbf{G}_x),$$

atan2 is the arctangent function with two arguments.

Third phase is non maximum suppression which is used for thinning purpose. At every pixel, the edge strength of the center pixel gets suppressed if this magnitude is not greater than the magnitude of the two neighbors in the gradient direction [13].

Steps of Canny edge detection algorithm:

1. Acquire the source image. This image may be noisy. To reduce noise use Gaussian Filter.
2. Now take the blurred image and find the edge gradient and direction. Here value for first derivative in both axes is obtained.
3. Now non maxima suppression is done for thinning the edge. Only local maxima should be marked as edges
4. Final Edges are determined through tracing and hysteresis thresholding

3.3 Radius Calculation

Now we are having centre of the coin image so from that we can calculate the radius of the coin image. This object image is then given as input to radial blur technique.

3.4 Radial Blur

This technique blurs the image according to user defined angle and points. We are applying this technique on the object image. Here brightness value of each pixel is averaged with all pixels at the same distance. We are following rotation invariance approach, so it is not necessary to place the coin at certain angle.

3.5 Image Matching

Here object image is compared with test image present in the database. We csn see object image in image verification column. Only threshold value is considered in this step.\

3.6 Result

If coin is accepted then we are showing a result that coin is detected. Here we are also showing the value of minimum score and angle.

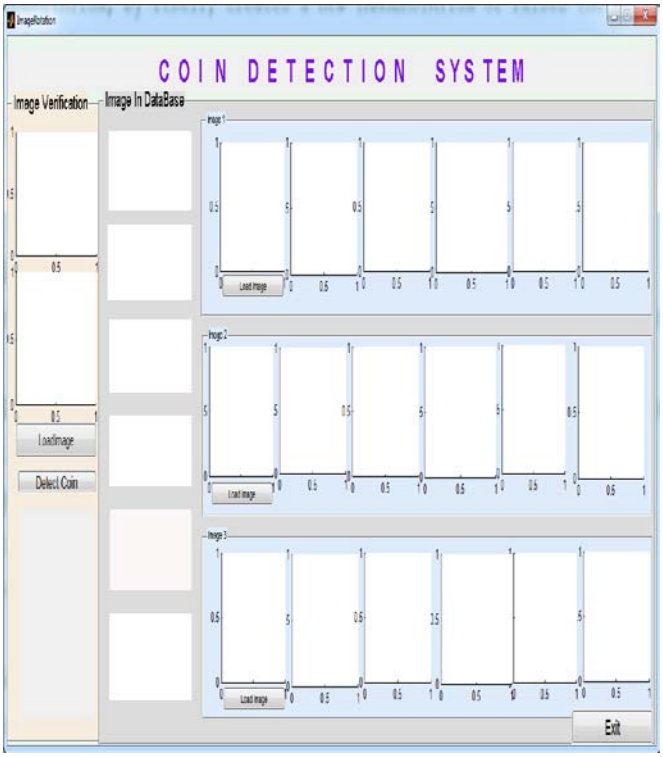

Figure 2: Coin Recognition System

Fig 2 shows our coin recognition system, in which we are loading the coin image in image verification column. This is an object image.

Licensed Under Creative Commons Attribution CC BY

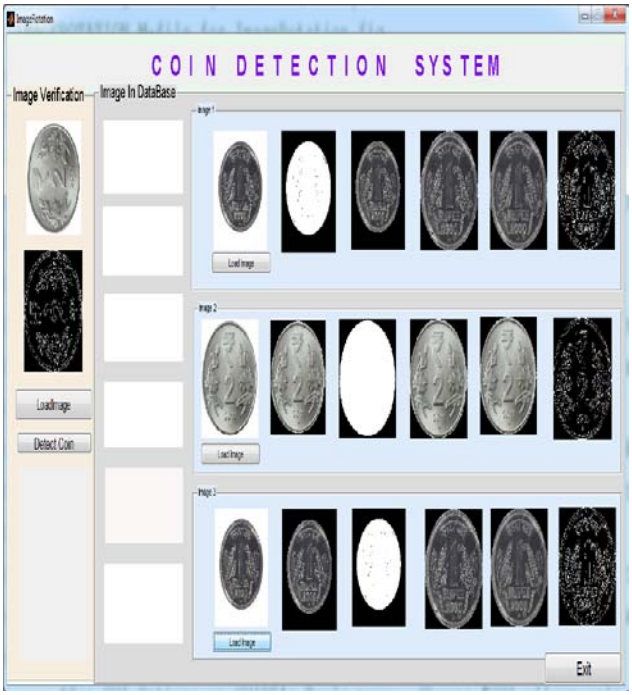

Figure 3: Loading object image

As shown in fig 3 object image gets loaded into verification column. The second coin image in the verification column is the result of edge detection technique.

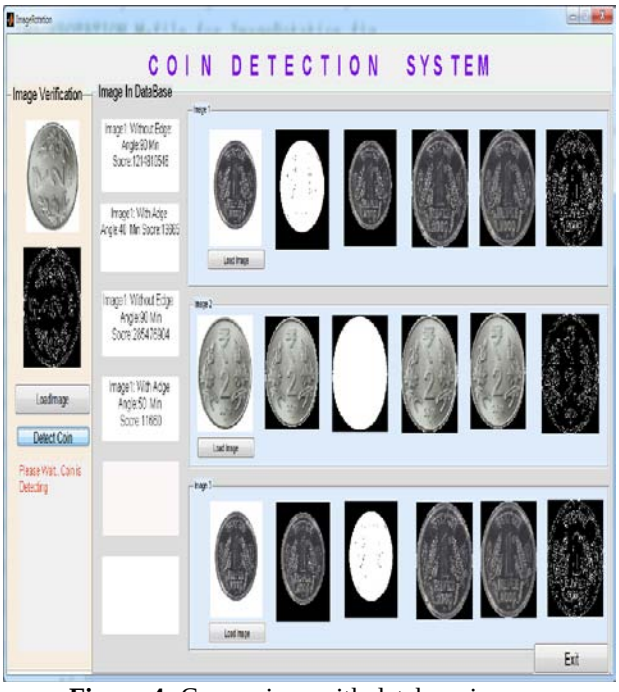

Figure 4: Comparison with database images

As shown in fig 4 now we are comparing object image with database images. In second column we are showing the minimum score and the angle. Here when we press Detect coin button, system gives the result whether coin is detected or not.

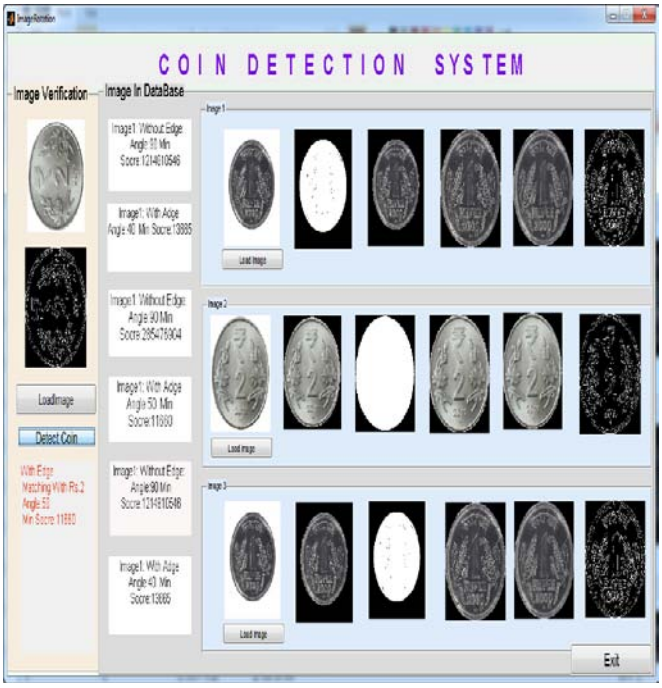

Figure 5: Final Result

Fig 5 shows the final result. Here we are showing the angle at which coin is matching with database coin and also the minimum score at which coin gets detected.

4. Conclusion

Our Coin recognition system takes an Indian coin of any denomination and detects whether the coin is original or fake. In our work we are following rotation invariance approach so it is not necessary to place the coin at specific angle. Image Segmentation is used as one important step which reduces the amount of data required for processing. Our system takes less time for processing and gives the best results.

References

[1] Nikita Shelgikar, Prof. L.M.R.J. Lobo, “Indian Coin Recognition with Rotation Invariance using Radial Blur Technique” , IJAIEM 2014
[2] Harveen Kaur and Neetu Sharma, “Modified coin identification using Neural Network”, IJETAE 2014
[3] Sabita Pal, Gaurav Kumar and Sovan Raj Meher, “Indian Coin Recognition using Image Subtraction Technique”, IJCAES 2014
[4] Saranya das.Y. M and R.Pugazhenthi, “Harris-Hessian Algorithm for coin Apprehension”, IJARCET 2013
[5] Tushar N.Nimbhorkar and M.M.Bartere, “Coin Recognition by using Artificial Neural Network”, IJCITB 2013
[6] Shatrughan Modi and Dr. Seema Bawa, “Automated Coin Recognition System using ANN”, IJCA 2011
[7] C.M.VELU and P.VIVEKANANDAN, “Indian Coin Recognition and Sum Counting System of Image Data Mining Using Artificial Neural Networks”, IJAST 2011
[8] J Prakash and K Rajesh,”A Novel Approach for Coin Identification using Eigenvalues of Covariance Matrix, Hough Transform and Rastar Scan Algorithms”, International Journal of Electrical and Computer Engineering 2009

Licensed Under Creative Commons Attribution CC BY

[9] Ming Ma*, Kulwinder Singh*, Dong-Won Park*, Juno Chang **, "Use of Region Oriented Segmentation in Coin Recognition", 2005
[10] Michael Nolle, Harald Penz and Michael Rubik, "Dagobert- A New Coin Recognition and Sorting System", 2003
[11] Minoru Fukumi,"Rotation –invariant neural pattern recognition system with application to coin recognition ", IEEE 1992
[12] Vaibhav Gupta, Rachit Puri and Monir Verma,"Prompt Indian Coin Recognition with Rotation Invariance using Image Subtraction Technique", IEEE 2011
[13] Canny Edge Detection http://en.wikipedia.org/wiki/Canny_edge_detector

Author Profile

Miss Nikita Shelgikar, received B.E degree in Information Technology in 2012 from Pimpri Chinchwad College of Engineering Pune. Pune University, Maharashtra, India and pursuing the M. E. degree in Computer Science and Engineering in Walchand Institute of Technology, Solapur, India. She is doing her dissertation work under the guidance of Mr. Lobo L.M.R.J, Associate Professor& Head, Department of IT, Walchand Institute of Technology, Solapur Maharashtra, India. Her research area is Image Processing.

Mr. Lobo L. M. R. J, received the B.E degree in Computer Engineering in 1989 from Shivaji University, Kolhapur, India and M. Tech degree in Computer and Information Technology in 1997 from IIT, Kharagpur, India. He is registered for Ph.D in Computer Science and Engineering at SGGS, Nanded of Sant Ramanand Teerth Marathawada University, Nanded, India. Under the guidance of Dr. R.S. Bichkar. He is presently working as an Associate Professor & Head, Department of IT Walchand Institute of Technology, Solapur, Maharashtra, India. His research interests include Evolutionary Computation, Genetic Algorithms and Data Mining.

Licensed Under Creative Commons Attribution CC BY