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Sample Coin Recognition System using Artificial Neural Network on Static Image Dataset

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ABSTRACT
Coins are frequently used in everyday life at various places like in banks, grocery stores, supermarkets, automated weighing machines, vending machines etc. So, there is a basic need to automate the counting and sorting of coins. However, currently available algorithms focus basically on the recognition of modern coins. To date, no optical recognition system for coins has been researched successfully. In this paper, an algorithm based on unequally spaced frequency fourier transform is proposed for the recognition of coins. The performance of proposed algorithm is measured in terms of mean square error and peak signal to noise ratio.
***Keywords*—**Coin, Feature Extraction, Neural Network, Recognition, Mean Square Error (MSE), Peak Signal to Noise Ratio (PSNR)

I. INTRODUCTION

Coin recognition systems and coin sorting machines have become a vital part of our life. They are used in banks, supermarkets, grocery stores, vending machines etc. In-spite of daily uses, coin recognition systems can also be used for the research purpose by the organizations that deal with the ancient coins. The three main coin recognition systems are mechanical method based systems, electromagnetic method based systems and image processing based systems [4] [5]. The mechanical method based systems use parameters like diameter or radius, thickness, weight and magnetism of the coin to differentiate between the coins. But these parameters cannot be used to differentiate between the different materials of the coins i.e. if we provide two coins original and the fake having same diameter, thickness, weight and magnetism but with different materials then such system will not be able to differentiate the original coin.

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 parameters like diameter, thickness, weight and magnetism can be used to differentiate between coins. The electromagnetic based coin recognition systems improve the accuracy of recognition but still they can be fooled by some game coins.

In the recent years coin recognition systems based on images have also come into picture [8]. In these systems, first of all the image of the coin to be recognized is taken either by camera or by some scanning. Then these images are processed by various image processing techniques like FFT, DCT, edge detection, segmentation etc. and further various features are extracted from the images which are used to recognize different coins.

II. LITERATURE SURVEY

An ANN (Artificial Neural Network) based Automated Coin Recognition System [2] is proposed for the recognition of Indian Coins of denomination `1, `2, `5 and `10 with rotation invariance. Since the images are taken from both sides of coin, so this system is capable of recognizing coins from both sides. Features are extracted from images using techniques of Hough Transformation, Pattern Averaging etc. and then the extracted features are passed as input to a trained Neural Network. An algorithm for recognition of the coins of different denomination is presented [3]. The proposed system first uses a canny edge detection to generate an edge map and then uses CHT (Circular Hough transform) to recognize the coins and further find the radii of them. In [1], authors presented an approach based on image subtraction technique for recognition of Indian

Coins. In [7], authors presented the coin identification approach in which images of coin are taken from different angles and a databank is created. By using this databank, data is providing to the neural network for its training. An image based approach for coin recognition using gabor wavelet for feature extraction is provided [6].

III PROPOSED COIN RECOGNITION SYSTEM

The following steps are performed in the proposed coin recognition system:

Step 1: Develop a RGB code for loading database of coin image in MATLAB.

Step 2: The Pre-processing of a coin image is performed for recognizing the type of coin.

Step 3: Unequally spaced frequency fourier transform is applied.

Step 4: The training & testing phase of neural network with rotation invariance is applied during coin recognition.

Step 5: The results are displayed in the form of MSE and PSNR

In this section we present recent approaches for coin recognition techniques, namely algorithms based on the eigenspace approach, gradient features, contour and texture features. Finally, we discuss some preliminary results of tests performed on the MUSCLE CIS coin dataset.

3.1 COIN 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 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.

Fig. 2 shows the result of applying Sobel filters to given input image (Fig. 1). The canny edge detector 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 as 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.

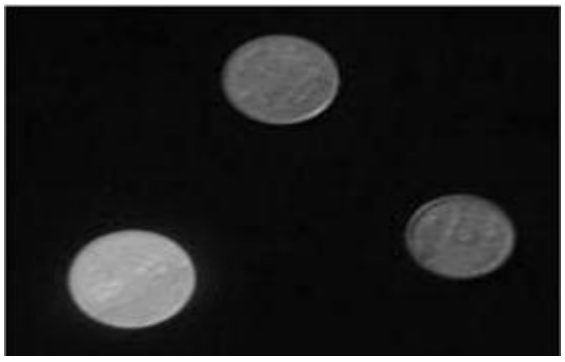

Figure 1: Sample Coin image

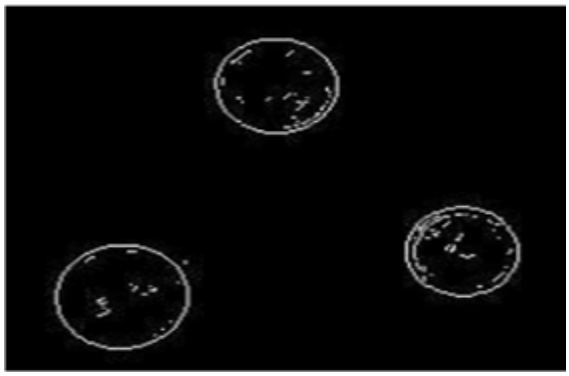

Figure 2: Result of Sobel Filter

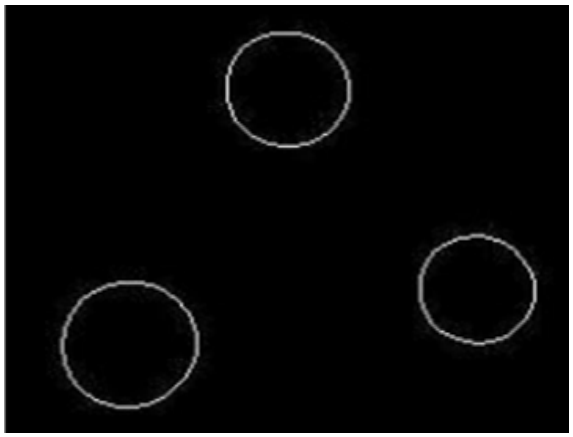

Figure 3: Result of Canny Edge Detection.

The final step in the canny edge detector is to use hysteresis operator, in which pixels are marked as edges, non edges and in-between 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. 3.

3.2 COIN VERIFICATION

In general the appearance of one coin pattern varies considerably with respect to its grey values. These variations frequently are inhomogeneous and this suggests that for recognition purposes, grey values by themselves will not give us appropriate results. On the other hand, edge information remains more or less stable or at least degrades gracefully.

So the proposed research work is based on the detection on edges. In principle any edge detector may be used for this purpose but Canny edge operator and the Laplacian of Gaussian method provides more satisfactory results. As a result of the edge operator we either get a binary (edge) image or a list of coordinates at edge pixel locations.

Let I : M× N → R[0,1] be an intensity image. M× N gives the index space and R[0,1] are the intensity values taken from the closed interval [0, 1].

$E(x, y)$ ={ 1, if $I(x, y)$ is an edge point
0, else

3.3 COIN RECOGNITION

Neural networks give effective results for solving multiple class classification problems. Neural network has three types of layers: input layer, output layers and hidden layers. Hidden layer does intermediate computation before directing the input to output layer. Back propagation can also be considered as a generalization of delta rule. When back propagation network is cycled, an input pattern is propagated forward to the output units through the intervening input to hidden and hidden to output weights. Neural network have been widely used in image and signal processing. In our proposed work, neural network with rotation invariance is applied during coin recognition.

IV RESULTS & DISCUSSION

4.1 PERFORMANCE METRICS

MSE and PSNR are the two error metrics used to compare image quality. The MSE represents the cumulative squared error between the compressed and the original image, whereas PSNR represents a measure of the peak error and these can be computed as:

$$MSE = \frac{\sum_{M,N}[\, I_1(m,n) - I_2(m,n)]^2}{M * N}$$

In above equation, M and N are the number of rows and columns in the input images, respectively. PSNR can be calculated as:

$$PSNR = 10 \log_{10}\left(\frac{R^2}{MSE}\right)$$

In the previous equation, R is the maximum fluctuation in the input image e.g. if the input image has a double-precision floating data type, then R is 1. If it has an 8-bit unsigned integer data type, R is 255.

4.2 EXPERIMENTAL RESULTS

Fig. 4, Fig. 5, Fig. 6 and Fig. 7 shows the snapshots of the outcomes of the proposed coin recognition system used for identifying the coin by using the neural networks.

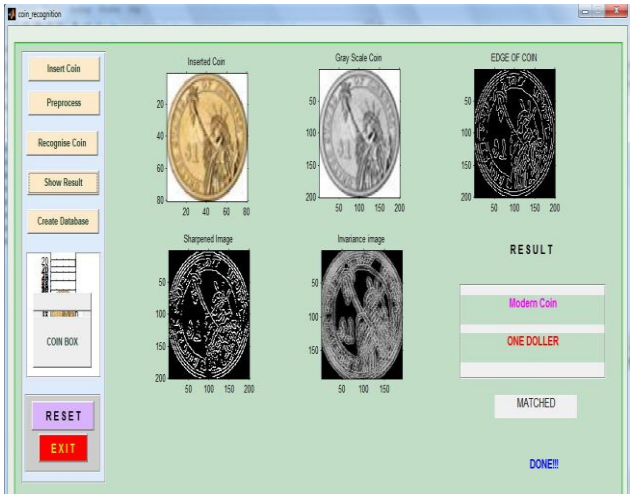

Figure 4: The final outcome of the proposed coin recognition system

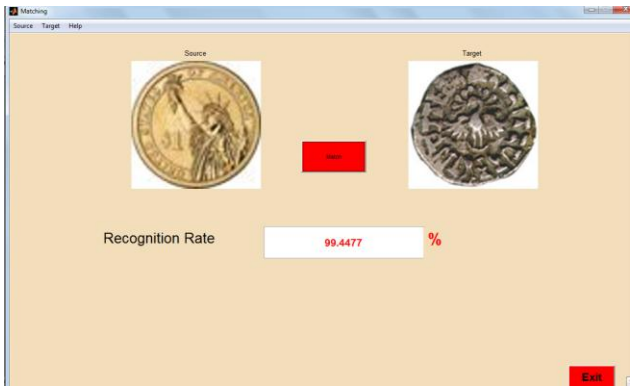

Figure 5: Calculation of matching rate

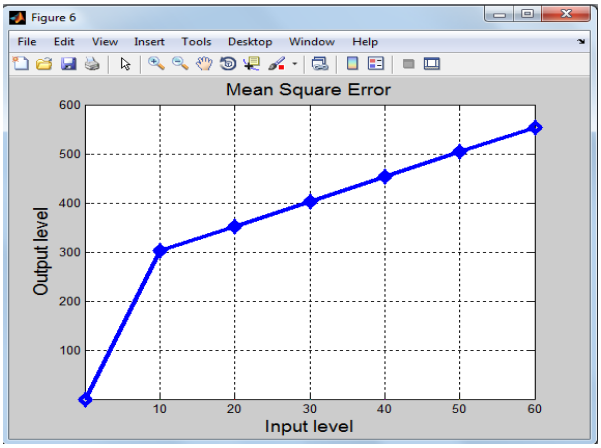

Figure 6: Calculation of Mean Square Error

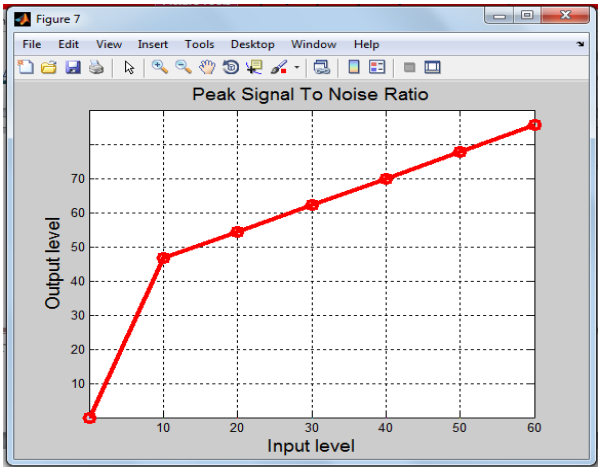

Figure 7: Calculation of Peak Signal To Noise Ratio

V CONCLUSION

In this paper, existing techniques for coin recognition based on image processing are discussed. The proposed research work is directed towards coin recognition using classification. Further research will be carried out to improve the system in terms of speed along with accuracy.

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