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Coin Recognition And Classification using DIP Techniques: A Result

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Abstract* — *Coins are a primary need of human life. They are used in everyone's daily routine, like banks, transport, market and these spare changes also has various other uses than realization traded in for cash similar to measurement purpose, in games (toss), in organizations for research point, etc. So, it holds a vast significance that coins can be detected with high accuracy. The goal of this system is to classify high volumes of coins with high accuracy within short time duration. In this paper we discussed a various techniques of coin recognition systems in respective terms of their accuracy. This paper also focused on different coin recognition systems have been planned by different researchers based on image processing techniques. Categorization is based on images from both sides of the coin as well as a radius of the coin.

Keywords- Image Processing, Artificial Neural Networks, Edge detection, thresholding, Edge enhancement, Features extraction

I. INTRODUCTION

Nowadays, antique coins [1] are becoming subject to a very large illegitimate trade. Thus, the interest in reliable automatic coin recognition systems in cultural heritage as well as law enforcement institutions rises rapidly. The usual methods to fight the illicit traffic of ancient coins comprise manual, periodical search in auctions catalogues, field search by authority forces and the periodical controls at expert dealers, also unwieldy and unrewarding internet search, followed by human investigation. There are various applied algorithms which are neural networks, Eigen spaces, decision trees, edge detection as well as gradient directions, and contour with texture features. Tests performed on image collections both of medieval with Indian modern coins show that algorithms performing good quality on Indian modern coins do not necessarily meet the wants for classification of medieval ones. Major difference between ancient and Indian modern coins is that the Indian ancient coins [1] have no rotating symmetry and subsequently their diameter is unknown.

Since ancient coins are all too often in very unfortunate conditions, common recognition algorithms can effortlessly fail. The description that most influence the quality of recognition process are yet unexplored. This project addresses this investigation gap and aims to give an efficient image based algorithms for coin sorting and identification. There is a basic need of highly perfect and efficient automatic coin recognition systems in our everyday life. Coin recognition systems and coin sorting machines are used mainly in banks, vending machines, grocery stores, supermarkets for keeping the coins separately. In-spite of daily uses coin recognition systems can also be used for the investigate purpose by the institutes or organizations that deal with the ancient coins. There are mainly three types of coin recognition systems available in the market now days and they are:

II. PROPOSED METHODOLOGY

As the coin recognition and classification is done by various methods and techniques we proposed a technique which differentiates other methods. The steps required to detect and recognize the coin is described by using the following flow chart (Fig.1). These steps can vary according to the technique used. The proposed Indian coin recognition and classification system implemented in MATLAB. The system is discussed in following sub sections:

A. Acquire RGB Image of Coin

Image acquisition is the first phase of the coin recognition process. RGB images of Indian coins of different denomination are acquired with the help of scanning device. Five samples of denomination `1, `2, `5 and `10 are scanned using color scanner.

B. Convert RGB Image to Gray scale

RGB or Color images usually take more time for processing. To reduce the complexity of processing and time , we convert the RGB image to gray scale image using MATLAB built-in function rgb2gray. It converts the 24-bit RGB image to 8-bit gray scale image.

C. Preprocessing of Image

Gray scale image has been resized to 256X256. The resized image is further passed on to next steps. The edges of the coin image are detected by canny edge detection method.

D. Noise Filtration

If input image of coin is noise affected then various noise filtration techniques are applied to reduce the effect of noise. After noise filtration, image is passed to next step. For Gaussian noise images, the wiener filter is used to remove the noise and if image is affected with salt and- pepper noise then median filter is applied. Noise filtered images are passed to further step.

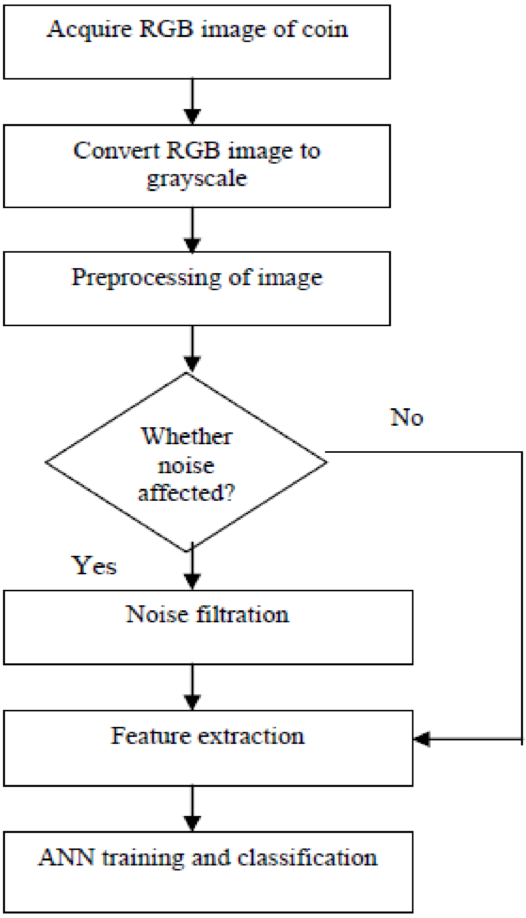

Figure1: Flowchart

2.1 Various Sources of Noise

There are various sources of noise in the images. The noise corrupted image pixels are either set to maximum value or have single bits. There are various conditions under which noise get introduced into images are:

- Environmental conditions during image acquisition.
- Improper light and sensor temperature.
- Interference in transmission channels.
- Electronic transmission.
- By the scanner or capturing device itself.

2.1.1Impulse Noise (Salt-And-Pepper) noise or independent noise. It occurs randomly in black and white pixels, as a result of which an image containing salt-and pepper noise will have tiny black and white dots in it, hence called salt-and-pepper noise.

Impulse noise have many different origins. Images are mainly corrupted by noise, faulty memory locations or timing errors in analog-to-digital conversion.

Salt and- pepper noise is one type of impulse noise which can corrupt the image, where the noisy pixels can take only the maximum and minimum values in the dynamic range. Linear filtering techniques are not effective in removing impulse noise hence they are not used while non-linear filtering techniques are widely used in the restoration process. The standard median filter (SMF) is non-linear filters used to remove salt and pepper noise due to its good de-noising power and computational efficiency. The drawback of the SMF is that, the filter is effective only for low noise densities, and additionally, exhibits blurring if the window size is large and leads to insufficient noise suppression if the window size is small. When the noise level goes above 50%, the edge details of the original image will not be preserved by the median filter. Nevertheless, it is important that during the filtering (restoration) process the edge details have to be preserved without losing the high frequency components of the image edges.

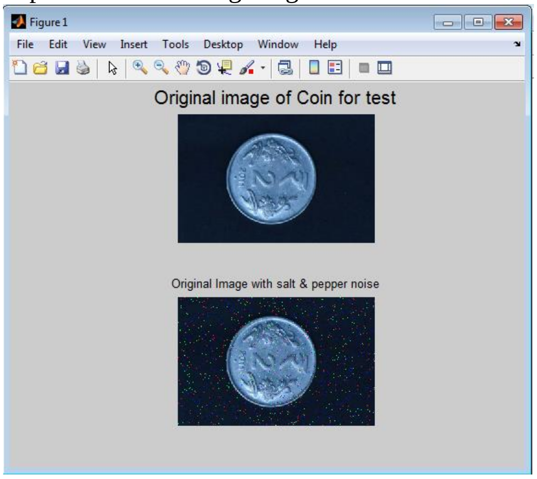

Figure 2.1 Impulse Noise

Mainly we are applying the filtering technique only to noisy pixels, without changing the uncorrupted pixel values. Non-linear filters such as Adaptive Median Filter (AMF), decision–based or switching median filters can be used for discriminating corrupted and uncorrupted pixels, and then apply the filtering technique. Noisy pixels will be replaced by the median value and uncorrupted pixels will be unchanged. AMF performs well at low noise densities since the corrupted pixels which are replaced by the median values are very few. In switching median filter the decision is based on a pre-defined threshold value. The disadvantage of this method is that defining a robust decision measure is difficult. Also these filters will not take into account the local features as a result of which details and edges may not be recovered satisfactorily, especially when the noise level is high.

2.1.2 Noise Removal by Filters

The process of removing unnecessary data from image which got added during acquisition is called as image filtering. When images are sent over transmission channels, they get affected with various kind of noise. Most commonly occurring noises in digital images are Gaussian and impulse noise. Noise reduction of the image before processing is one of the challenging work as one should remove the noise from image, while preserving the details. Noise can be removed from images by using various noise filtration techniques. Noise filtration can be linear or non-linear. Linear filters are simple and fast, while non-linear filters are more efficient.

Figure 2.2: Noise Filtration Process.

2.2 Sobel Edge Detection

In edge detection the aim is to mark the points in an image at which the intensity changes sharply. Sharp changes in image properties reflect important events which include:

(i) Discontinuities in depth. (ii) Changes in material properties. (iii) Variations in scene illumination.

Edge detection is used in the field of image processing and feature extraction. The Sobel operator is such an operator used in edge detection algorithms.

The Sobel edge operand is used to smoothing effect to the random noises in the image. And because it is the differential separated by two rows or two columns, so the edge elements on both sides have been enhanced and make the edge seems thick and bright. Sobel operator is a gradient operator. The first derivative of a digital image is based on a variety of two-dimensional gradient approximation, and generates a peak on the first derivative of the image, or generates a zero-crossing point on the second derivative.

Calculate the horizontal and vertical first-order or second-order gradients and its argument value. But when the image has lots of white Gaussian noises, it is very difficult to get the peak value of the first derivative, the reason is because that the noise points and the useful signals mix up. The algorithm works as follows:

(1) Get wavelet decomposition to the image matrix and get the wavelet coefficients with noises.

(2) Processing decomposition on the wavelet coefficients HL, LH and HH, and keep the low frequency coefficients unchanging.

(3) Select an appropriate threshold to remove Gaussian white noise signals.
(4) Now get Inverse wavelet transformation to the image matrix and get the image matrix after de-noising.
(5) Edge coefficient according to the Sobel operator template showed in Figure.
(6) After given Sobel edge detection operator template, convolute on every pixel of the image

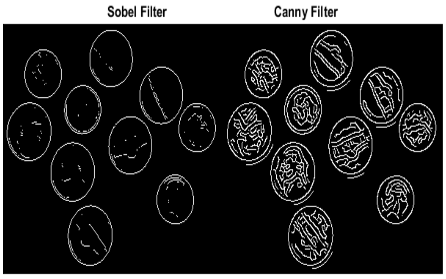

Figure 2.3: Sobel Edge Detection

2.3 Probabilistic Neural Networks (PNN)

A probabilistic neural network is predominantly a classifier**.** PNN uses a supervised training set to develop probability density functions within a pattern layer. This is a model based on competitive learning with a „winner takes all attitude‟ and the core concept based on multivariate probability estimation. Probabilistic (PNN) and General Regression Neural Networks (GRNN) have similar architectures, except there is a fundamental difference. General regression neural networks perform regression where the target variable is continuous, whereas Probabilistic networks perform classification where the target variable is categorical. In a PNN, the operations are organized into a multilayered feed forward network with four layers
1.Input layer
2.Hidden layer
3.Pattern layer/Summation layer
4.Output layer Layers PNN is often used in classification problems.

2.3.1 Architecture of PNN

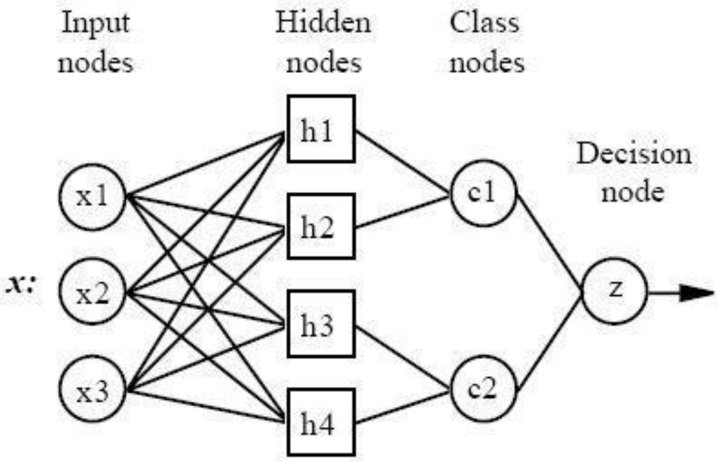

Figure 2.4 Architecture of PNN

All PNN networks have four layers:
1. Input layer: There is one neuron in the input layer for each predictor variable. For the case of categorical variables N-1 neurons are used where N is the number of categories. Input neurons (or processing before the input layer) standardizes the range of the values by subtracting the median and dividing by the inter quartile range. Then input neurons feed the values to each of the neurons in the hidden layer.
2. Hidden layer: This layer has one neuron for each case in the training data set. Neuron stores the values of the predictor variables along with the target value for the case. When presented with the x vector of input values from the input layer, the Euclidean distance of the test case from the neuron's center point is computed by hidden neuron and then using the sigma value(s) apply the RBF kernel function. Resulting value is passed to the neurons in the pattern layer.
3. Pattern layer / Summation layer: The next layer in the network is different for PNN and for GRNN. For PNN networks for each category of the target variable there is one pattern neuron. The actual target category of each training case is stored with each hidden neuron; the weighted value coming out of a hidden neuron is fed only to the pattern neuron that

corresponds to the hidden neuron's type. Pattern neurons add the values for the class they represent (hence, it is a weighted vote for that category).

For GRNN networks, in the pattern layer there are only two neurons. One neuron is the denominator summation unit the other is the numerator summation unit. The weight values coming from each of the hidden neurons adds up by denominator summation unit. Numerator summation unit adds up the weight values multiplied by the actual target value for each hidden neuron.

4. Decision layer: The decision layer is different for PNN and GRNN. For PNN networks the decision layer compares the weighted votes for each target category accumulated in the pattern layer and uses the largest vote to predict the target category.

2.4 Apply DWT to decompose the image

In order to accurately extract the features for training we decompose the image two levels.

The images are decomposed into four sub-bands or sub-sampled, after applying DWT. These sub-bands are labeled as LL1, LH1, HL1 and HH1. LH1, HL1 and HH1 sub-bands represent the finest scale wavelet coefficients, i.e., image details and the sub-band LL1 corresponds to the coarse level coefficients i.e., image approximation. To obtain the next coarse level of wavelet coefficients, the sub-band LL1 can be decomposed and sampled. Similarly, LL2 can be used for further decomposition. This process continues until the final scale. The transformed coefficients, image approximation and image details are exploited for texture analysis, discrimination and statistical feature extraction.

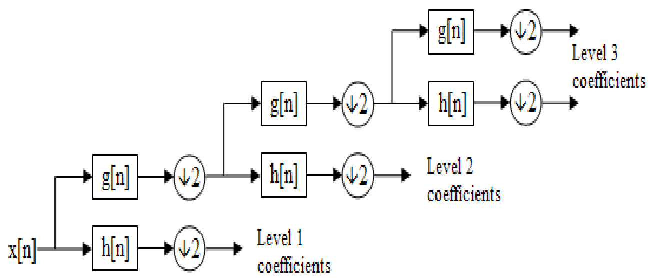

Figure 2.5 DWT level-III

2.5 Feature Extraction

In pattern recognition and image processing, feature extraction is a special form of dimensionality reduction. Transforming the input data into the set of features is called feature extraction. If the features extracted are carefully chosen, it is expected that the features set will perform the desired task using the reduced representation instead of the full size input.

For an image, a feature can be defined as the interest part of the image. These features play a fundamental role in classification. In image processing, image features usually include color, shape and texture features. In our system we are finding statistical features. Transformed coefficients are used to calculate statistical features. Mean, Standard deviation, skewness, kurtosis are the various features which are considered for the classification as per the application. Following equations are used for calculating mean, standard deviation, skewness and kurtosis.

$$\textbf{Mean}=\frac{\sum_{i=1}^{N} fi}{N}$$

$$\textbf{Standard deviation}=\sqrt{\frac{\sum_{i=1}^{N}(fi-\mu)^2}{N}}$$

$$\textbf{Skewness}=3\sqrt{\frac{\sum_{i=1}^{N}(fi-\mu)^3}{N}}$$

$$\textbf{Kurtotis}=4\sqrt{\frac{\sum_{i=1}^{N}(fi-\mu)^4}{N}}$$

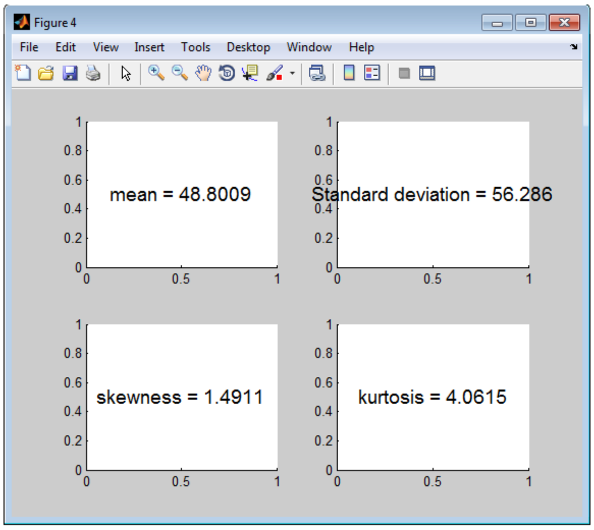

Figure2.6 Statistical Parameters of Coin

3. RESULTS AND PERFORMANCE ANALYSIS

A. Resizing Image

Figure shows the result of resized image with scales.

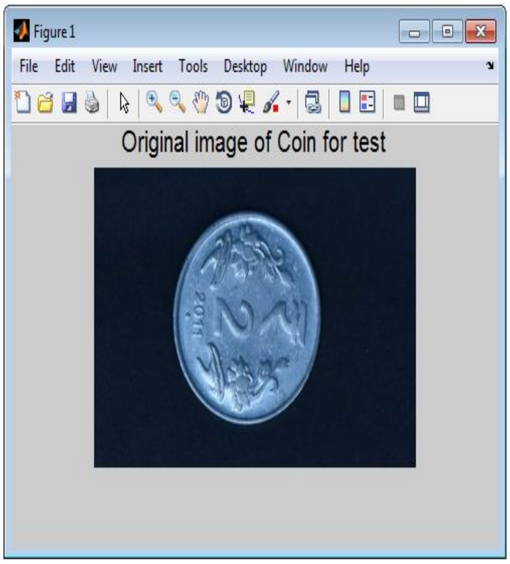

Figure 3.1 Original Image of coin

A. Converting Original Image To Binary Image

From the first step the image we got is a 24-bit RGB image. Image processing of colored images takes more time than the gray scale images. So, to reduce the time required for processing of images in further steps it is good to convert the 24-bit RGB image to 8-bit Gray scale image.

Figure shows the result of original image converted to binary image

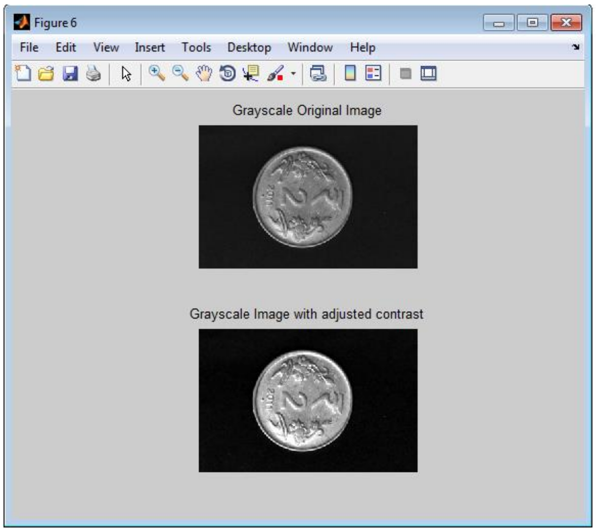

Figure 3.2 Gray scale image

B. Applying Edge Detection

Figure shows physical parameter of coin and shows the result after applying edge detection using Sobel Edge Method

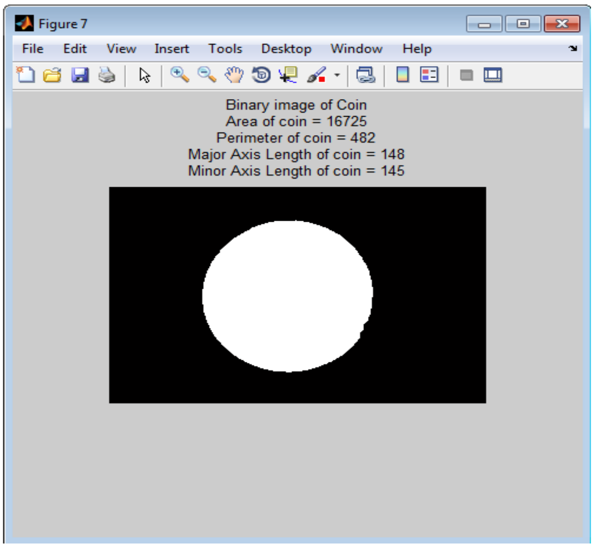

Figure 3.3 Edge Detection of Coin

Remove Shadow of Coin from Image: In this step, shadow of the coin from the Gray scale image is removed. After that, edge of the coin is detected using Sobel Edge Detection and then shadow of the coin from the Grayscale image is removed using Hough Transform for Circle Detection. Now based on the center coordinates and radius, the coin is extracted from the background. So, in this way the shadow of the coin is removed completely.

C. Image Rotation

Image rotation is done by finding region of interest. Rotation of the image is done clockwise or anticlockwise till the equal pixels on both the halves.

D.Applying Edge Detection

Figure shows physical parameter of coin and shows the result after applying edge detection using Sobel Edge method.

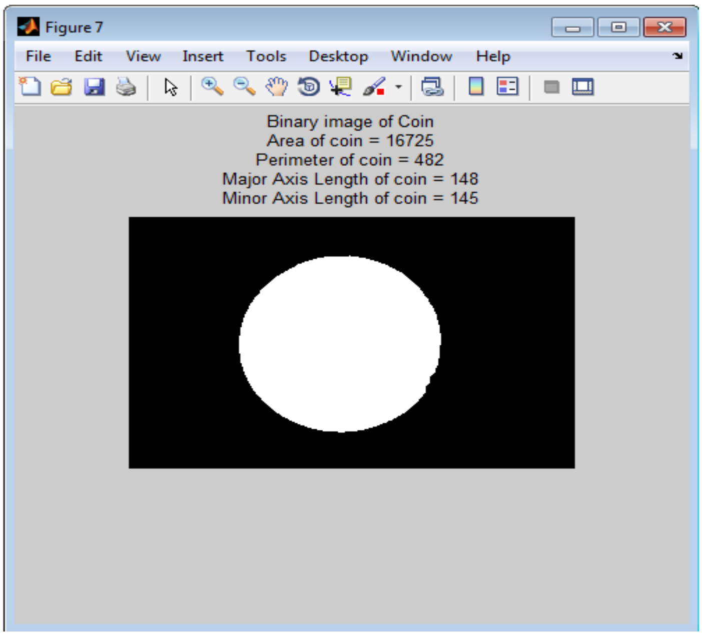

Figure 3.4 Edge Detection with Physical Parameters

Remove Shadow of Coin from Image: In this step, shadow of the coin from the Gray scale image is removed. After that, edge of the coin is detected using Sobel Edge Detection and then shadow of the coin from the Gray scale image is removed using Hough Transform for Circle Detection. Now based on the center coordinates and radius, the coin is extracted from the background. So, in this way the shadow of the coin is removed completely.

E. Applying DWT to decompose image in to 1 level

After applying discrete wavelet transform to 1 level image is decomposed into 4 sub bands.

F. Decomposing image to 2 level

After applying DWT to 2 level decomposition image is decomposed into 8 sub bands.

G. Decomposing image to 3 level

Figure shows applying DWT to Decompose Image Level 3

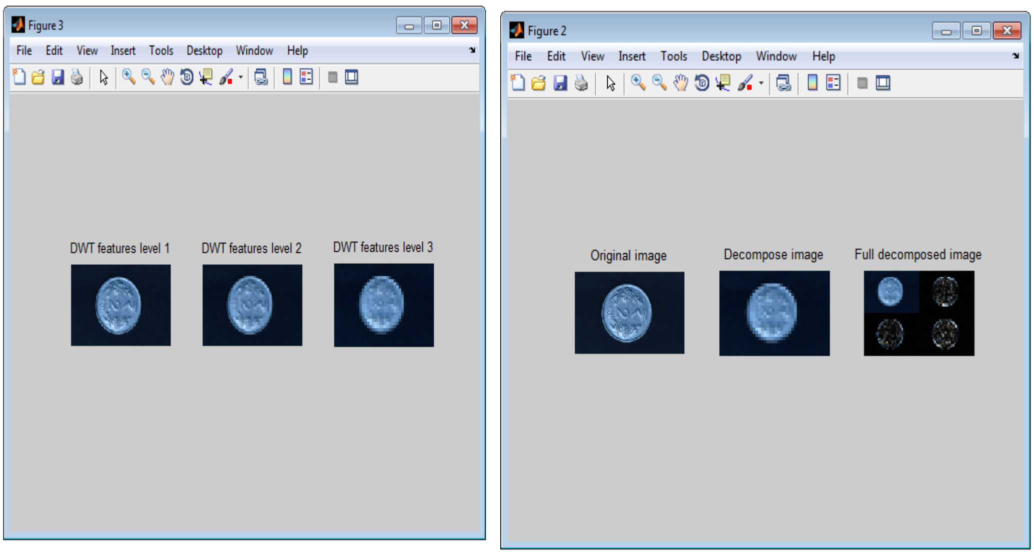

Figure 3.5 Decomposition of Image

4. CONCLUSION

In this paper the area of Currency recognition is introduced. The system developed here is for currency recognition, the development of good classification methods and precise features is very important in order to run the system in real time. Hence proposed approach which is based on ANN got a better results and recognition rate of 97.74%. ANN based classifier is adopted which uses the combination of various features to recognize and identify the currency. A procedure was presented for diagnosis of main coin recognition and classification using two classifiers, namely, KNN and ANN technique. In future we can increase accuracy by using other classification methods or by extracting other features.

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