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IDENTIFICATION OF COUNTERFIETED CURRENCY VIA IMAGE PROCESSING TECHNIQUES

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Abstract: Paper currency counterfeiting is a serious problem all around the world. This has had a significant impact on almost every country and it has now become a big issue. The primary purpose of this investigation is to identify Indian paper money. We obtained a dataset of currency notes from the internet, which included both authentic and bogus notes of various values. Using a feature extraction approach on the front side of the currency note to determine whether it is genuine or counterfeit. For classification, we employed the Support Vector Machine (SVM) technique in this research to determine whether the given currency note is genuine or not. The MATLAB image processing toolkit was utilized. Image processing is a technique for improving the visual information in an image for machine or hardware perception. This is an automated system that uses a dataset of currencies and classifiers to sort them into predetermined categories.

***IndexTerms* - SVM(Support Vector Machine, Brisk Features, Image processing, Denomination, Currency Identification**

I. INTRODUCTION

Feature extraction of images is challenging work in digital image processing. The feature extraction of Indian currency notes involves the extraction of features of serial numbers of currency notes. The feature extraction phase is most conveniently defined referring to the purpose it serves. Feature extraction is that of extracting from the raw data the information which is most relevant for classification purposes, in the sense of minimizing the within-class pattern variability while enhancing the between-class pattern variability. During the feature extraction process the dimensionality of data is reduced. This is almost always necessary, due to the technical limits in memory and computation time. A good feature extraction scheme should maintain and enhance those features of the input data which make distinct pattern classes separate from each other. At the same time, the system should be immune to variations produced both by the humans using it and the technical devices used in the data acquisition stage.

DIGITAL IMAGE PROCESSING

The traditional view of image processing tends to embrace one or more of picture processing, pattern recognition, image interpretation and even graphics. 'Graphics' deals with the generation of images from non-pictorial information and covers diverse applications. In the order of increasing complexity, production of plots of functions, composition of displays for the computer games and scenes used in flight simulators are some of the examples of displays. Picture processing deals with problems in which both input and output are pictures. Over exposed, under exposed or blurred pictures can be improved with contrast enhancement techniques.

'Pattern Recognition' deals with methods for producing either a description of the input picture or an assignment of the picture to a particular class. In a sense, it is the inverse problem of computer graphics. It starts with a picture and transforms it into an abstract description, a set of numbers, a string of symbols, etc. Further processing of these forms results in assigning the original picture to one of several classes. An automatic mail sorter that examines the postal code written on an envelope and identifies the digits is atypical example of the application. However, the term 'Image Processing' should be used as a catch all for all these activities and in a much broader context with the implicit understanding that the fundamental underlying activity is that of 'Information Processing'. Increasingly, in The future, much information is going to be represented, and subsequently processed, as digital images, be they X-ray scans, satellite images, video films or whatever. This is no more than a reflection of the fact that our information processing channel with the highest band width, by along way, is the visual one. It is this primacy of images in information representations that renders a digression into the possible social impact of information processing.

Feature Extraction for Bank Note Classification Using Wavelet Transform

In this model, we investigate an approach to feature extraction for bank note classification by exploiting the potential of wavelet transform. In the proposed method, high spatial frequency coefficients taken from the wavelet domain are examined to extract features. We first perform edge detection on bill images to facilitate the wavelet feature extraction. The construction of feature vectors is then conducted by thresholding and counting of wavelet coefficients. The proposed feature extraction method can be applied to classifying any kind of bank note. However, in this model we examine Korean won bills of 1000, 5000 and 10000won types. Experimental results with a set of 10,800 bill images show that the proposed feature extraction method provides a correct classification rate of 99% even by using the Euclidean minimum distance matching as classifier. The textured regions of different bill images can be easily discriminated by decomposing the texture into several frequency subbands. In particular, the use of a wavelet transform is an attractive possibility due to its flexible frequency splitting at different scales and orientations. In the proposed method, high spatial frequency subbands are explored to extract features from transformed images [1].

Invariant Features Extraction for Banknote Classification

An invariant feature extraction method is proposed for banknote classification. The movement of bank note is complex in the channel of financial instruments. The scale is various. The rotation and translation are also to occur. The method of feature extraction is insensitive to the variety of scale, rotation and translation. It decreases the data variety and improves there liability of bank note classification. Furthermore, the computation complexity is low in order to meet to the requirement of real-time banknote image processing and classification. The invariant feature extraction method has performed very well when they are applied in banknote sorters. This model shows an effective method to classify banknote. First, a rotation, translation and scale invariant feature extraction method is proposed. This feature extraction method is suit for the low quality images which are acquired at high speed banknote channel. Furthermore, the computation is sample in order to finish the banknote image processing and classification in real-time. Then, a3-layer BP neural networks is used predict the face and value of a banknote. The feature extraction method has performed very well when they are applied in banknote sorters [2].

High Speed Paper Currency Recognition by Neural Networks

This model compare two types of datasets, time series data and Fourier power spectra, are used in this study. In both cases, they are directly used as inputs to the neural network. Still more we also refer a new evaluation method of recognition ability. Meanwhile; a technique is proposed to reduce the input scale of the neural network without preventing the growth of recognition. This model is applied the NN to paper currency recognition and showed the effectiveness compared with a conventional manual method. Furthermore, it has proposed a structure reduction method of the NN using random masks and showed its effectiveness for time series data and its Fourier power spectra [3].

A Neural Network-Based Model for Paper Currency Recognition and Verification

This model describes the neural- based recognition and verification techniques used in a banknote machine, recently implemented for accepting paper currency of different countries. The perception mechanism is based on low-cost optoelectronic devices which produce a signal associated with the light refracted by the banknotes. The classification and verification steps are carried out by a society of multilayer perceptions whose operation is properly scheduled by an external controlling algorithm, which guarantees real-time implementation on a standard microcontroller-based platform. The verification relies mainly on the property of autoassociators to generate closed separation surfaces in the pattern space. The experimental results are very interesting, particularly when considering that the recognition and verification steps are based on low-cost sensors [4].

New Recognition Algorithm for Various Kinds of Euro Banknotes

This model proposed a new point extraction and recognition algorithm for banknotes. For distinctive point extraction we use a coordinate data extraction method from specific parts of banknote representing the same colour. To recognize banknotes, the author trained 5 NN. One is for inserting direction and the others are for the face value. The algorithm is designed to minimize recognition time. The simulated results show the high recognition rate and a low training period. The proposed method can be applied to highspeed banknote counting machines. By applying the continuous same coloured area recognition algorithm to the face value of the banknote, it can extract distinctive data to classify the kind of banknotes, as the area is located in the different positions on each kind of banknotes [5].

II.SYSTEM DESIGN

The system is designed by applying image Processing toolbox and other related Matlab toolboxes. This system is divided into some section in order to support the future recognition process.

Block Diagram

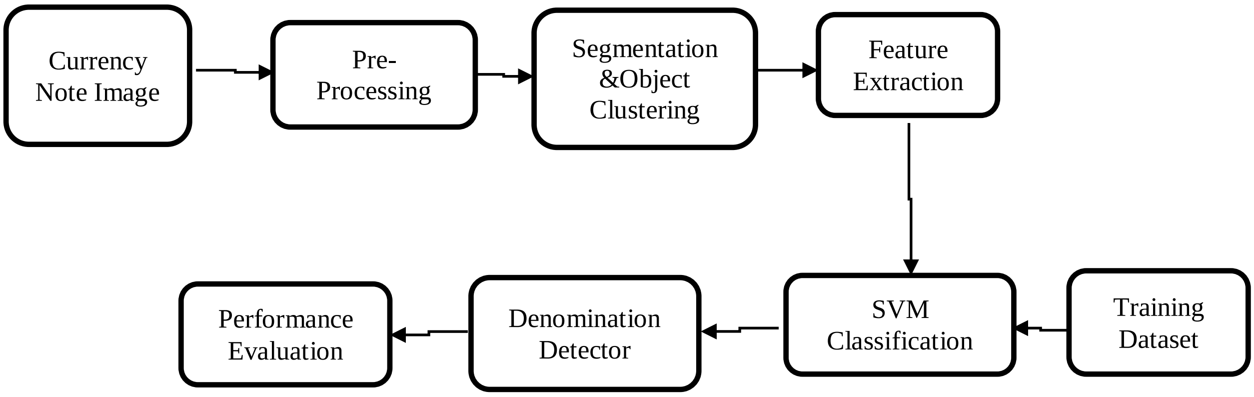

Fig 3.5: Block Diagram of Proposed Methodology

In our work the comparison of the features extracted from the images of the different currency notes plays a very crucial role.In facts, it is the comparison of the features that enables us to differentiate fake notes from the real ones.To compare the performance, we have used mean square error. Mean square error is the average of the square of all the errors and it used for comparison between two images. We first created a database of a number of authentic Indian notes of different denominations. We then extracted their features, converted them into their binary equivalents and then calculated their mean square error.

The schematic block overview of the proposed Fake note detection system is shown above. The proposed system considers the test currency note image and performs the preprocessing operations to remove the noise and other negative artifacts.The preprocessed image is subjected to contrast enhancement and correction using the robust Discrete Wavelet Transform based contrast enhancement algorithm.

After enhancing the contrast and bringing the image into the proper quality, several object features such as security thread, RBI Logo and Identification marks etc are extracted and used for matching with the respective features of the authenticated notes.The matching scores of all the fake detection modules are fused together to detect the duplication of the currency note.

BRISK Algorithm

The BRISK algorithm is a feature point detection and description algorithm with scale invariance and rotation invariance. It obtains the binary feature descriptor by constructing feature descriptor of the local image using the grey scale relationship of random point pairs in the local image's neighbourhood. Unlike BRIEF or ORB, the BRISK descriptor contains a predetermined sampling pattern. Concentric rings are used to sample pixels.

A tiny patch is evaluated surrounding each sampling site. The patch is smoothed with Gaussian smoothing before the process begins.

SVMs are a class of supervised learning methods for classification, regression, and outlier detection. However, it is mostly used in Machine Learning for Classification of difficulties. The SVM algorithm's purpose is to find the decision boundary for classifying n-dimensional space into classes so that additional data points can be readily placed in the correct category in the future.

BRISK accomplishes rotation invariance by attempting to rotate the sample pattern by the measure orientation of the key point. This is accomplished by first computing the local gradient g (pi, pj) between sample pairs (pi,pj), where I(pj, pj) is the smoothed intensity after gaussian smoothing.

g (pi, pj) = (pi - pj). I (pj, j) -I (pj, j) pj - pi2

All local gradients between long pairs are then added, and the angle of the key point is determined by the arctangent (gy/gx) between the y and x components of the sum. Now all we have to do is rotate the short pairs by that angle to make the descriptor more rotation invariant. Intensity comparisons are used to create the description. If the first point has a higher intensity than the second, 1 is written to the relevant bit of the descriptor, otherwise 0 is written.

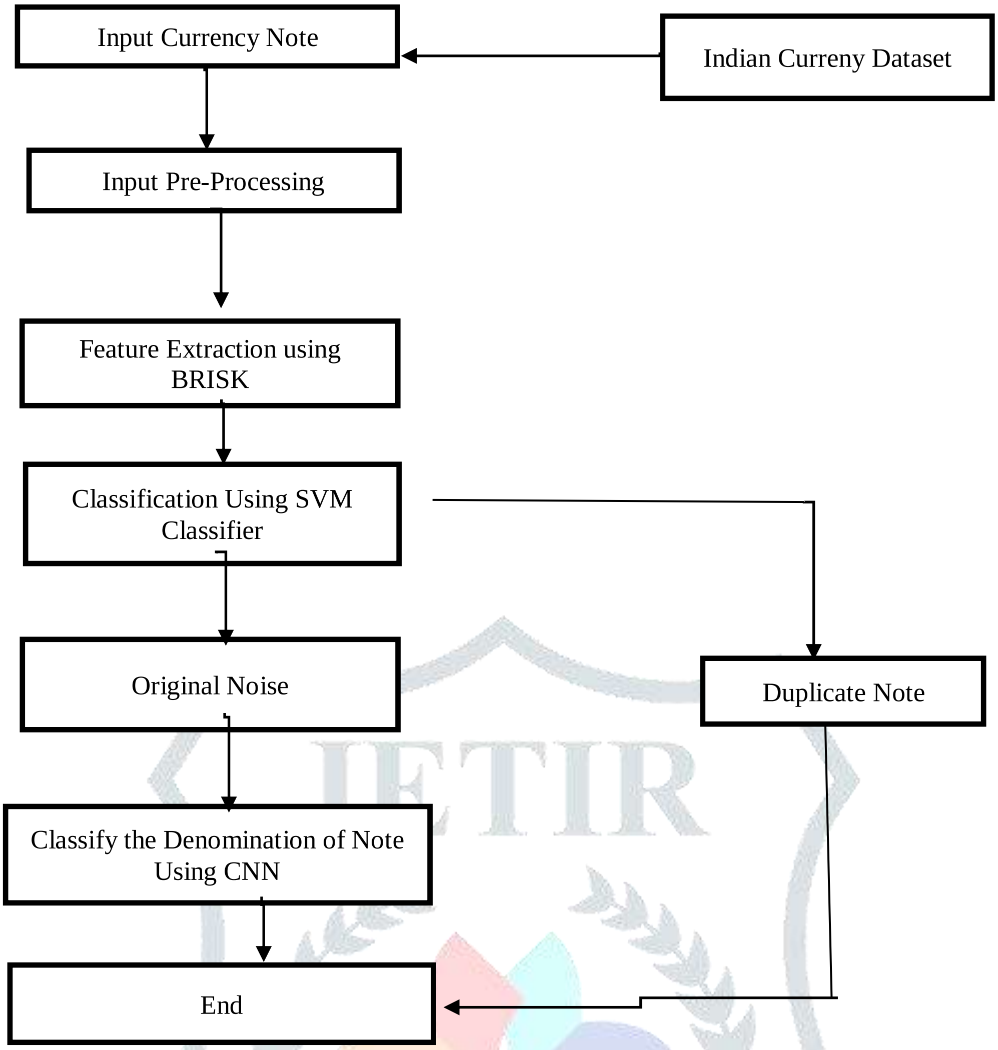

Fig 3.3: BRISK Algorithm

SVM Classification

SVMs are one of the supervised learning methods which are used for classification, regression etc. It is widely used for Classification problems in Machine Learning. The SVM algorithm's purpose is to find the decision boundary for classifying n-dimensional space into classes. So, that additional data points can be placed in the correct category in the future. A hyperplane is another name for the optimal choice boundary. The extreme points that assist for creating the hyperplane are chosen via SVM. Support vectors are the extreme instances for the classification, and the algorithm is called a Support Vector Machine Algorithm.

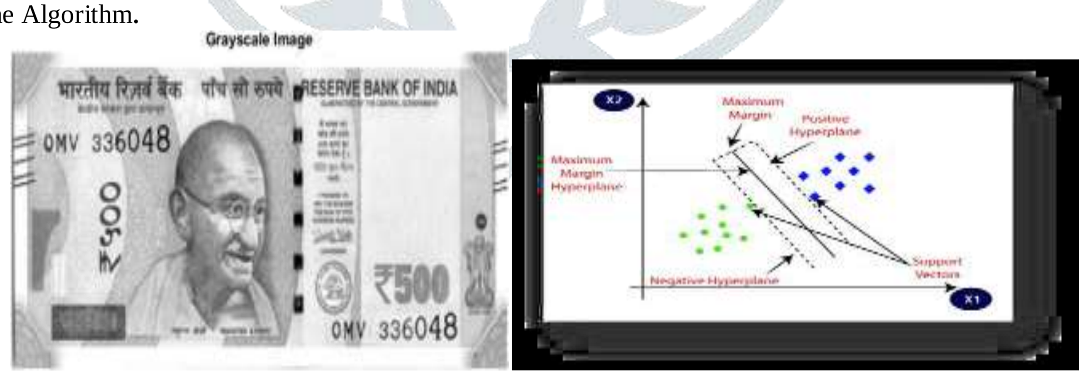

Fig 3: SVM Classification

III PROPOSED ALGORITHM

Step (1): Consider the original currency note images suggested by RBI.
Step (2): Obtain scan templates of all the original currency note images considered in step (1).
Step (3): Preprocess the currency note images.
Step (4): Segment the image.
Step (5): Cluster the objects based on feature similarity and correlation.
Step (6): Construct the Gray Level Co-Occurrence matrix.
Step (7): Apply the spectral transformation.
Step (8): Obtain the various object features from the objects.
Step (9): Store these original currency note features in the data base and make them as reference for comparison.

Step (10): Repeat step (3) to step (9) for all RBI recognized currency note denominations.
Step (11): Now consider the test currency note image.
Step (12): Preprocess the test currency note image.
Step (13): Segment the test currency note image.
Step (14): Cluster the objects based on feature similarity and correlation.
Step (15): Construct the Gray Level Co-Occurrence matrix of the test currency note image.
Step (16): Construct the Gray Level Co-Occurrence matrix of the test currency note image.
Step (17): Apply the spectral transformation on test currency note image.
Step (18): Obtain the various object features from the test currency note objects.
Step (19): Compare the test currency note features with the original currency note features.
Step (20): Fuse the comparison score of all features.
Step (21): Make the decision based on matching score.
Step (22): Display the fakeness status of the image.

IV RESULTS AND DISCUSSION

In the Test base there will be 1rupee, 2rupee, 5rupee, 10rupee, 20rupee, 50rupee, 100rupee, 500rupee, 1000rupee, 2000rupee fake and valid notes.Selecting the any currency note to test whether it is valid or not is shown in the below figure.

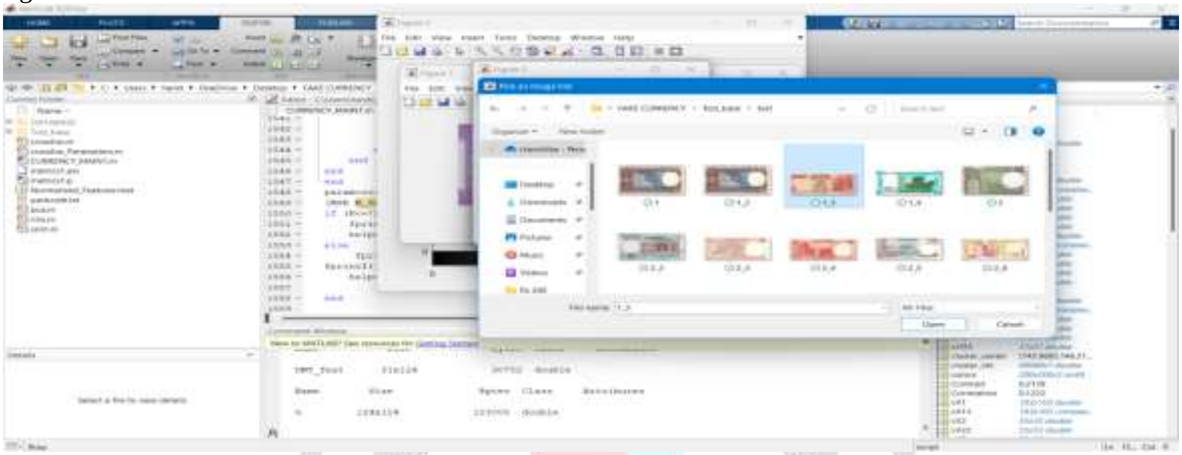

Fig 5.1: Test Image

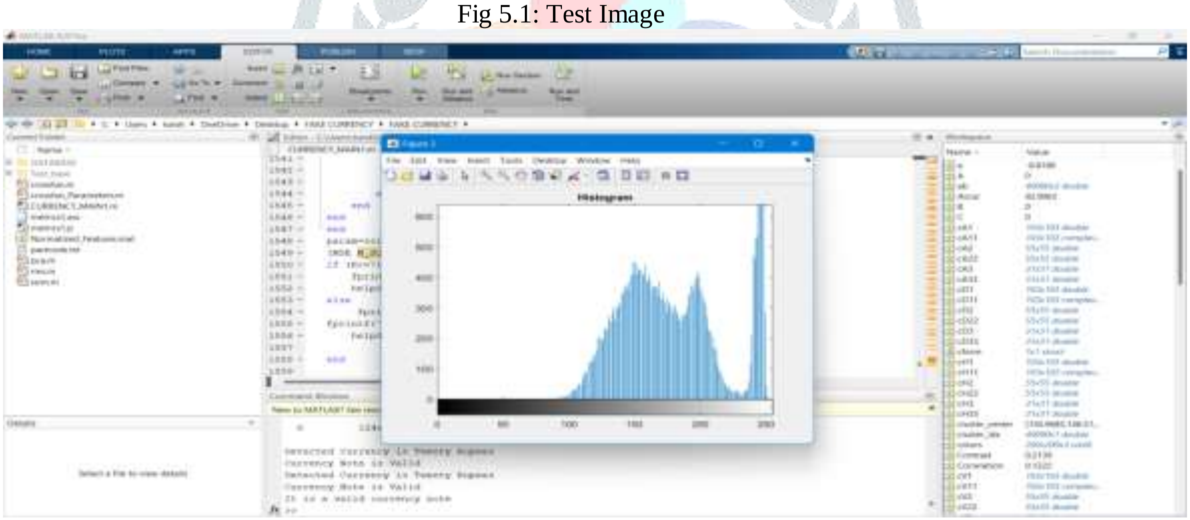

Fig 5.2: Histogram Graph of TestImage

The test currency note undergoes preprocessing in order to remove the noise. After reprocessing the Note undergoes Segmentation process as shown in the figure.

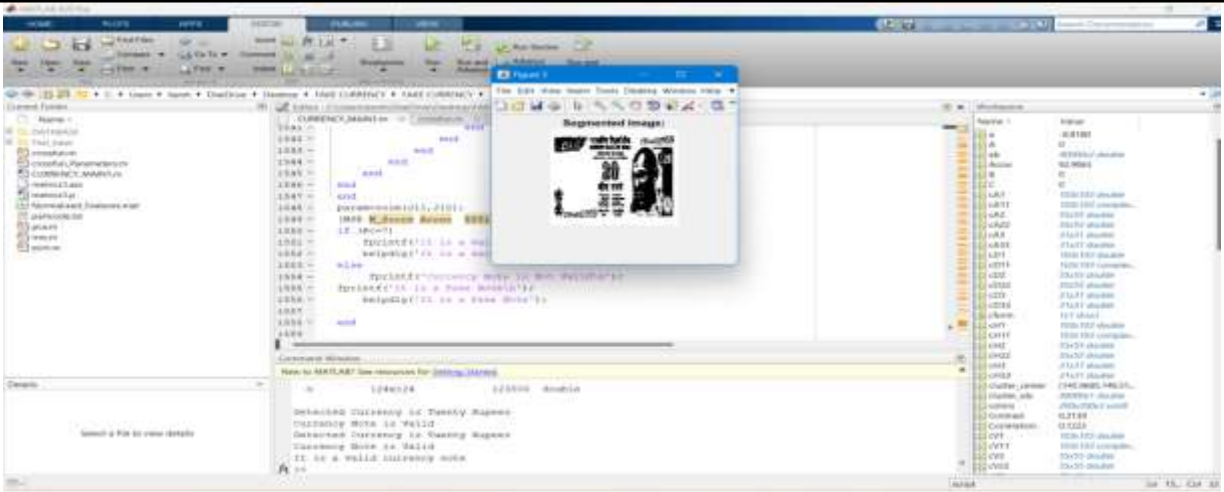

Fig 5.3: Segmented Image

After Segmented Image we should cluster of objects of that image based on feature similarity and correlation. By clustering it is deterimned as groups of pixels.All the pixels in the same group define a class in the segmented image.

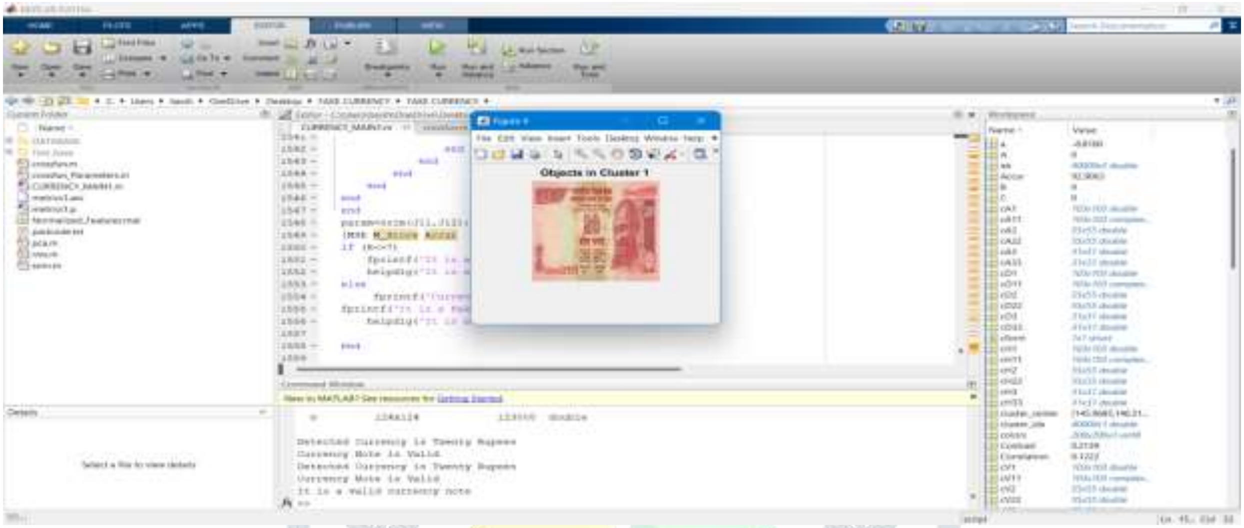

Fig 5.4: Objects In Cluster 1

Applying the spectral transformation and obtaining the various object features from the objects is shown in below figure.

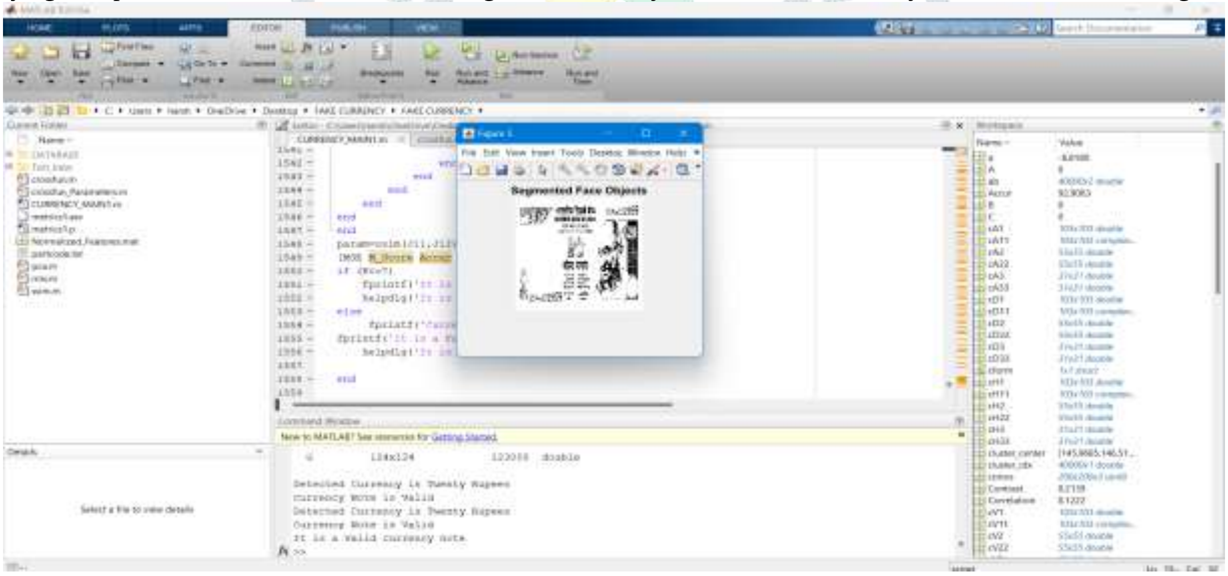

Fig 5.5: Segmented Face Objects

The below figure shows whether the tested currency note is valid or not.

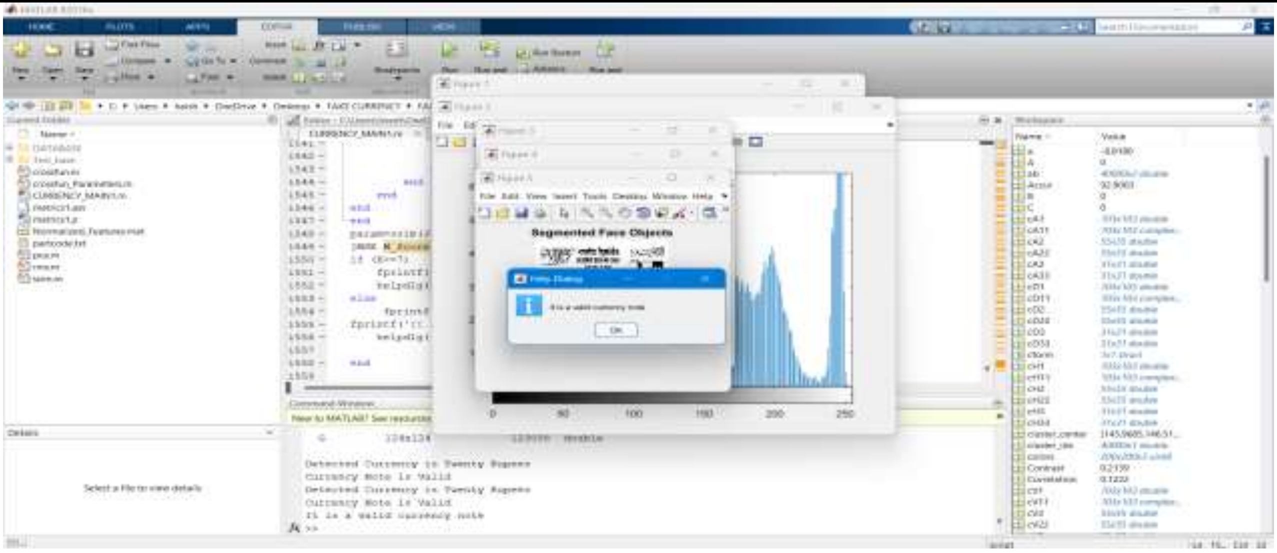

Fig 5.6: Output Of Test Image 1

The considered test image1 does not match with the currency notes in the trained data set. Hence the test image1 is not a valid note. Selecting the currency note to test whether it is valid or not is shown in the below figure.

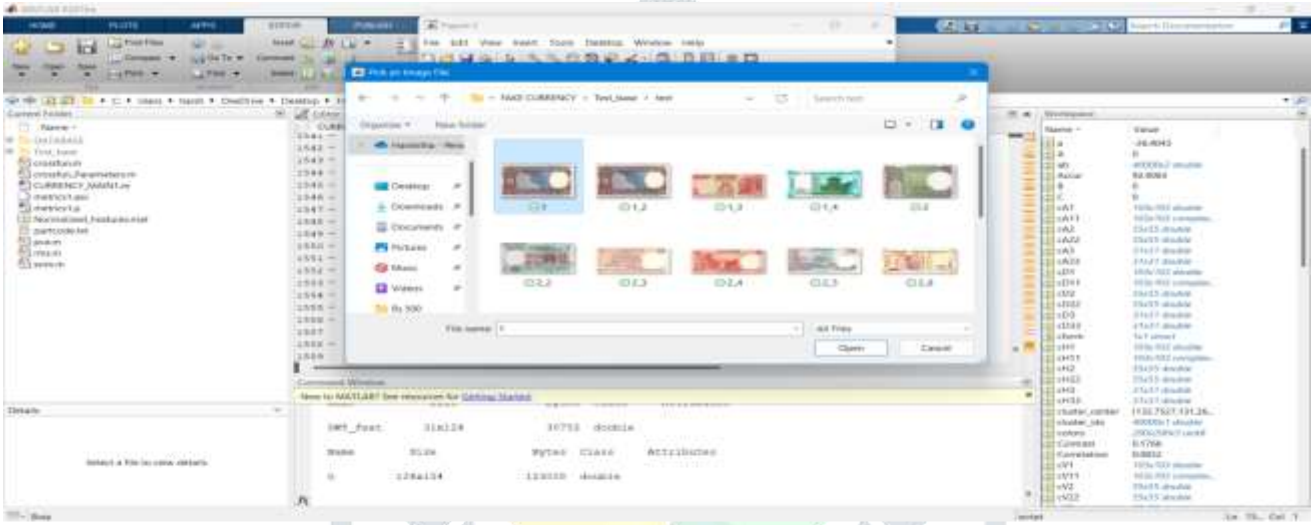

Fig 5.7: Input Test Image 2

The below figure shows whether the tested currency note is valid or not.

Fig 5.8: Output of Test Image 2

The considered test image2 match with the currency notes in the trained data set. Hence the test image2 is a valid note.

V. ACKNOWLEDGMENT

In future, an inclusion of consistent pattern design of the note can help extraction using Neural Network methods with them trained on feature vectors obtained from above system.

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