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A NEURO FUZZY BASED COIN RECOGNITION WITH COLLABORATION OF MULTI-FEATURE EXTRACTION TECHNIQUES

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Abstract —*Coin has a major role in daily life of a human as it is used in various financial organization or institutes like banks, supermarket and vending machines etc. Along with the enhancements in the technology, most of the human works get rely upon machines. Similarly, the coin recognition is also done by machines or software since it is mandatory to recognize the coins rather than counting coins manually. The coin recognition is done by using image preprocessing technique. For this purpose, various techniques have been developed by different authors. This study provides a coin recognition system by using Gabor Wavelet, Canny Edge detection and Artificial Neuro Fuzzy Inference System (ANFIS). The Gabor-ANFIS is evaluated to be the best coin recognition mechanism than Scale Invariant Feature Transform-Artificial Neural Network (SIFT-ANN) with respect to Accuracy and Error percentage.*

Keywords*- Image based coin recognition, Gabor Wavelet, Canny Edge Detection, Artificial Neuro Fuzzy Inference System(ANFIS).*

I. INTRODUCTION

The Coin recognition systems plays important role in our daily life. This system is widely used in various fields like banks, grocery stores, supermarkets, vending machines etc. In addition to this, the coin recognition can also be implemented for dealing with ancient coins [1]. Coin recognition system can be classified into three categories as follow: first is mechanical method based recognition technique, second is EM method based systems and third is image processing dependant systems. In the first system that is mechanical implements various factors such as diameter, thickness, weight and magnetism in order to make the differences between different coins [2]. But in this technique there is o ne disadvantage that if the coins are made up of different materials then this technique cannot be implemented. For example; if we are having two coins, one is original and other is fake. These two coins are having similar weight size and diameter but made up of different material then this technique cannot be used to find out the original one. Now in the second method that is based on EM technique can easily find out the difference between the coins that are made up of different materials [3]. It is due to the fact that the coins are moved through the oscillating coil with the known frequency and due to the different material of coins various variations in amplitude and frequency are introduced. Hence, coins can be differentiated on the basis of variations in amplitude and frequency and with the help of other parameters such as radius, thickness, weight and magnetism. With this technique of coin recognition system, efficiency in recognition system has been improved significantly [4]. But it also has one disadvantage that some game coins cannot be differentiated with this technique. In past few years, the image based coin recognition system has been introduced. In image based coin recognition system, firstly the picture of coin should be taken by high quality camera. After this different image processing techniques such as FFT, DCT, edge detection, segmentation etc. then different features are obtained from the coins images captured from high quality cameras [5].

II. PROBLEM FORMULATION

Object recognition is the process of identifying an object being examined in a digital image for a set of known features or labels. Humans have ability to identify a large number of objects in any image with little efforts, even when these appear in different perspective or rotated at different degrees. Logically, objects are recognized from a number of different perspectives (like color, size, shape or appearance), in many different sizes. Various coins recognition techniques have been proposed by many researchers in several countries, but still a lot of challenges are there to recognize a coin in noisy, scattered and low illumination environment. Recently a SIFT based approach was proposed to extract the features from the samples and then ANN was used for the classification purpose. But still as SIFT Approach has some disadvantages as

1. The performance of SIFT algorithm for feature extraction process is quite slow
2. SIFT algorithm doesn't work well with lighting changes and blur on images.
3. The mathematically complicated and computationally heavy of SIFT approach.

So there is need to propose a new approach for the feature extraction which will remove the problems faced in traditional approaches.

III. PROPOSED WORK

As per literature study it was analyzed that the traditional approach for the feature extraction was quite slow and complex enough along with this it is not successful for lightened images. As it was slow so need to propose the algorithm which will be less complex and fast enough. So n the proposed model the enhanced version of Gabor filters with the wavelets will be used also edge detected algorithm will be there for the feature extraction. Also one of the advancement which will be done in the proposed work is that the classifier will be enhanced by using the NEUROFUZZY system combination of neural network and fuzzy logics.

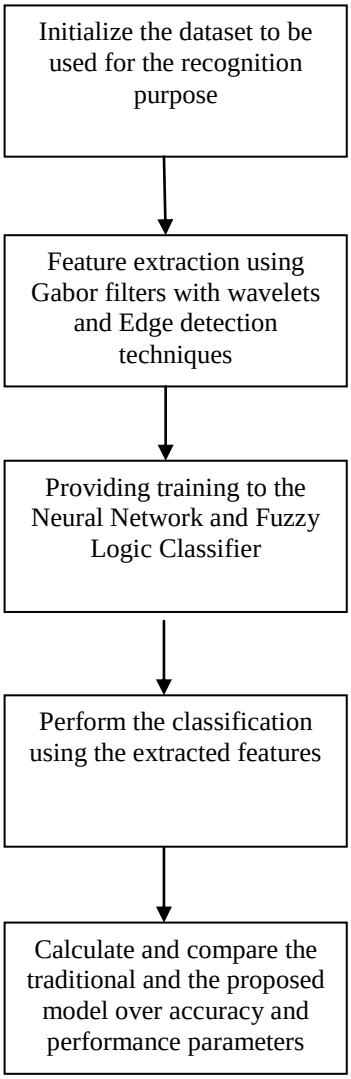

Figure 1 Framework for proposed work

1. First step is to create a database for applying further processing like feature extraction and classification etc. The database used in this work is comprised of the images of coins of rupees 1, 2, 5 and 10.
2. After creating a dataset, next step is to extract the features from the images of coin. Gabor wavelet and Canny Edge detection is applied in proposed work. The motive behind applying Gabor and Canny is to extract the features efficiently.
3. In this step the training of the ANFIS is done on the basis of the extracted features. The training and testing of the data set is done by categorizing it to the three different cases. The cases are derived on the basis of the variations in number of coins used for testing session.
4. Next step is to perform classification by arranging the testing session of the ANFIS model. In this the ANFI is model is designed by using three inputs and 27 set of rules.
5. Last step is to perform the evaluation of obtained results in the term of accuracy and error. The comparison of Gabor-ANFIS and SIFT-ANN is also performed under this step.

IV. RESULTS AND DISCUSSIONS

As per the proposed model defined in this work, it is expected that the proposed model will provide better recognition rate with respect to traditional one. As the feature extraction techniques used in the proposed model are canny edge detection and Gabor wavelet are very advanced and fast it will provide better training module in the proposed model along with that the neuro fuzzy (ANFIS) classifier enhances the decision capability of the proposed model. The simulation of the proposed technique is done on the basis of three different case studies. The cases are categorized on the basis of the variations in the training and testing module. The decision making is done by using ANFIS. It performs the testing and training on the data set in which three input membership functions such as Gabor wavelet mean, Gabor wavelet STD and edge detections are used to generate the output. The performance of the proposed work is evaluated in the terms of following performance parameters:

1. Error
2. Accuracy

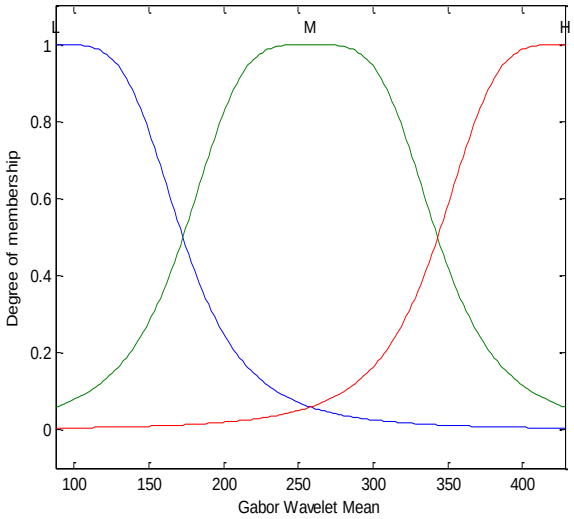

Figure 2 Membership Functions 1

Figure 2 depicts the input membership function corresponding to the Gabor wavelet mean. The degree of this input membership function also ranges from 0 to 1. The value for Gabor mean starts from 100 and ends at 400.

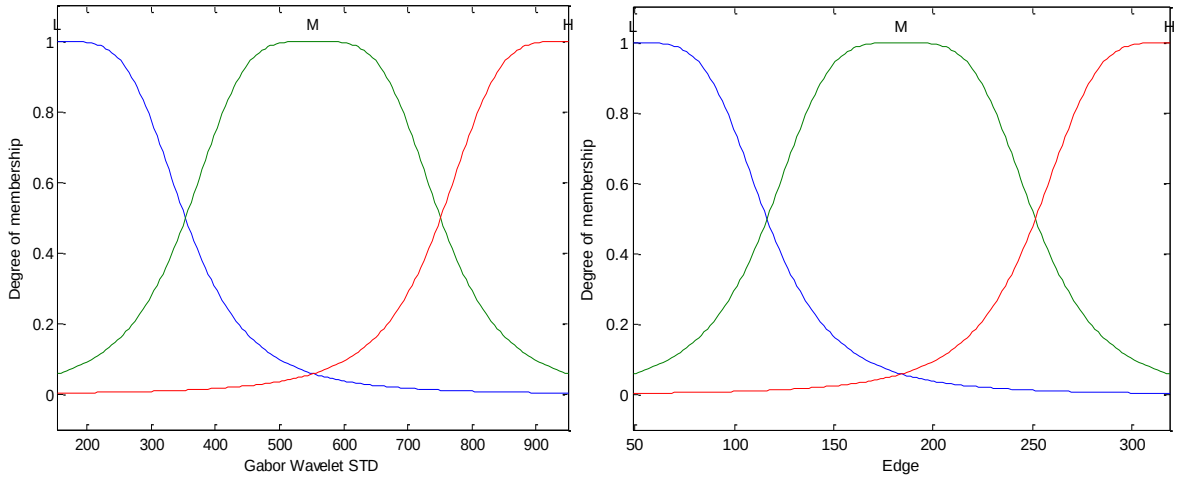

Figure 3 Membership Functions 2 and 3

Figure 3 depicts the input membership function corresponding to the Gabor wavelet STD and of edge detection The degree of this input membership function also ranges from 0 to 1. The value for Gabor STD starts from 200 and ends at 900. Similarly the range of edge shown by x axis varies from 50 to 300. The degree of membership function lies in 0 to 1.

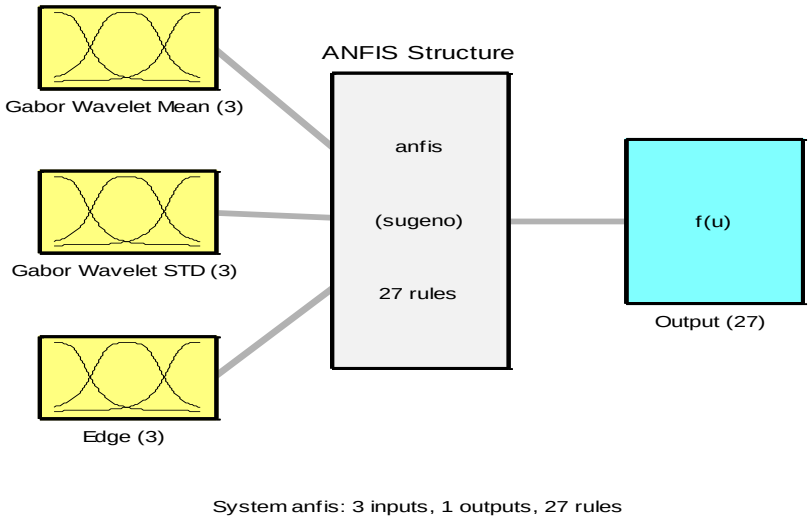

Figure 5 Proposed Fuzzy Model

The figure 5 delineates the proposed fuzzy model. The proposed fuzzy model is works upon the basis of three input membership function i.e. Gabor Wavelet Mean , Gabor Wavelet STD and Edge. On the basis of the input membership functions a set of 27 rules has been generated by using Sugeno fuzzy inference system.

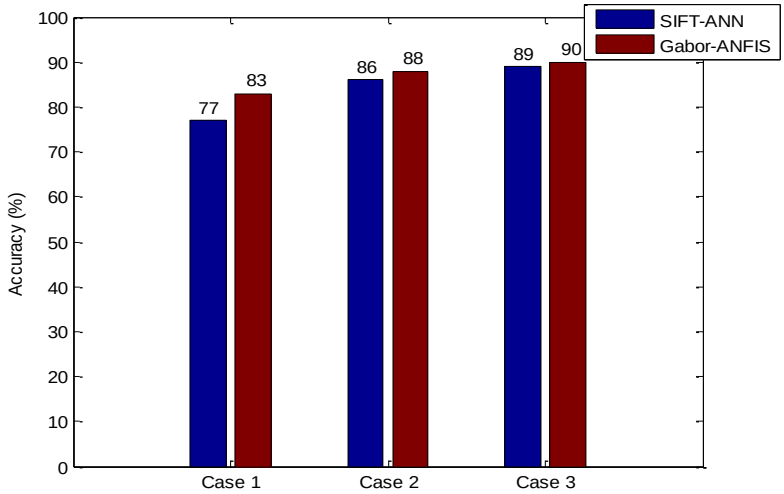

Figure 6 Comparison of accuracy Level.

The graph in figure 6 renders the comparison of case 1, 2 and 3 in terms of accuracy of the obtains results. The bar in blue refers to SIFT-ANN and bar in brown represents the accuracy of Gabor-ANFIS. The x axis shows the number of cases and y axis calibrates the data in terms of accuracy that ranges from 0% to 100%. The comparison of different cases is done by considering traditional and proposed work. As per the observations of the graph, it is proved that the accuracy of Gabor-ANFIS is higher in all of the cases. For SIFT-ANN the level accuracy is comparatively low. Table 1 comprises the evaluated percentage of accuracy in SIFT-ANN and Gabor-ANFIS technique. On the basis of the table it is perceived that the accuracy level of Gabor-ANFIS in case 1 is 83, case 2 is 88 and case 3 is 90 and it is the highest evaluated accuracy level in contrast to the SIFT –ANN.

Table 1 Accuracy (%) of SIFT-ANN and Gabor-ANFIS

S. No.	Cases	SIFT-ANN	Gabor-ANN
1.	Case 1	77	83
2.	Case 2	86	88
3.	Case 3	89	90

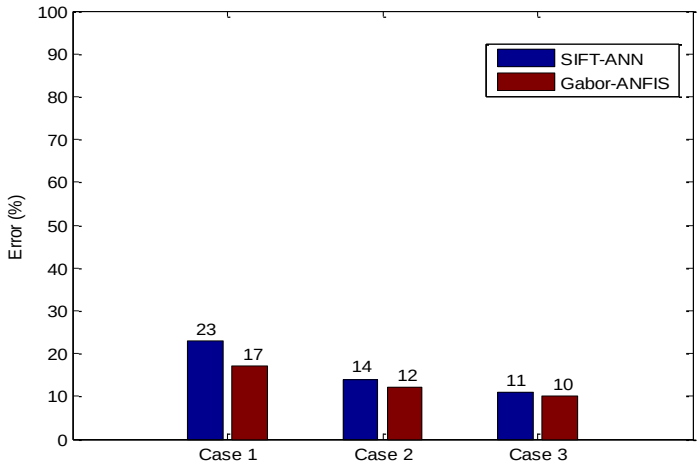

Figure 7 Comparison of Error Percentage

Figure 7 frames the comparison of different cases for SIFT-ANN and Gabor-ANFIS. The contrast is driven on the basis of the Error percentage. The y axis shows the error that ranges from 0% to 100%. The x axis is arranged to represents the different cases.

The error percentage should be low always so that results can be obtained with high efficiency. The error in case of proposed work is 17%, 12%, 10% for case 1, 2 and 3 respectively. In case of SIFT-ANN it is 13%, 14%, 11% for respective cases.

Table 2 Error (%) of SIFT-ANN and Gabor-ANFIS

S. No.	Cases	SIFT-ANN	Gabor-ANN
1.	Case 1	17	23
2.	Case 2	14	12
3.	Case 3	11	10

V. CONCLUSION

This study is organized to achieve the motive of developing an enhanced coin recognition system by using advanced techniques. The traditional coin recognition system utilized the Scale Invariant Feature Transform (SIFT) to perform feature extraction process and the classification was done on the basis of Artificial Neural Network. It was concluded that the traditional system was not capable enough to generate the effective results as it was quite complex. The Gabor-ANFIS is proposed in this work to overcome the issues of traditional work. The result section gave a proof that the accuracy of proposed work is higher than the traditional work i.e. 83%, 88% and 90% in all cases respectively. Similarly, the evaluated error percentage of proposed work is 23%, 125 and 10% in case 1, 2 and 3 respectively. The obtained error level is observed to lower in comparison o the SIFT-ANN mechanism.

In future more amendments can be done to enhance the observed results and performance of the coin recognition system. This study replaces the ANN with ANFIS for improving the results. Similarly, in future ANFIS can be applied with optimization techniques for optimizing the results.

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