RECOGNITION OF COINS USING ARTIFICIAL NEURAL NETWORK TRAINED BY GENETICAL ALGORITHM

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***Abstract*— Coins are integral part of our day to day life. We use coins everywhere like grocery store, banks, buses, trains etc. So it becomes a basic need that coins can be sorted and counted automatically. For this it is necessary that coins can be recognized automatically**.

The main aim of this paper is to recognize and identify the coin; the recognition of coins will be based on Image processing and neural network with genetic algorithm. All Coins have two sides and are released with different values and are classified based on different parameters of coin such as shape, size, surface, value and so on. Some countries' coins are having same parameters, but with different value. In this paper, canny edge detector and Gabor wavelet filter techniques are used for pre-processing of image so that it helps detection of coin image easily.

Keywords— **Artificial Neural network, Genetic algorithm, Gabor filter, Coin recognition and verification**

1. INTRODUCTION

We cannot imagine our life without coins. We use coins in our daily life almost everywhere like in banks, supermarkets, grocery stores etc. They have been the integral part of our day to day life. So there is basic need of highly accurate and efficient automatic coin recognition system. In-spite of daily uses coin recognition systems can also be used for the research purpose by the institutes or organizations that deal with the ancient coins. There are three types of coin recognition systems available in the market based on different methods:

1. Mechanical method based systems
2. Electromagnetic method based systems
3. Image processing based systems

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. It means if we provide two coins one original and other fake having same diameter, thickness, weight and magnetism but with different materials to mechanical method based coin recognition system then it will treat both the coins as original coin so these systems can be fooled easily.

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 method 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. 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 using various techniques of image processing like FFT [1, 2], Gabor Wavelets [3], DCT, edge detection, segmentation, image subtraction [4], decision trees [5] etc and various features are extracted from the images. Then based on these features different coins are recognized.

This paper describes neural networking with genetic algorithm for recognition of various coins from different countries. Genetic algorithm GA is used to reduce the size of network by varying the architecture and it is used as a search algorithm to achieve 100% recognition accuracy rate and using pattern recognition all features of coins are extracted from the images. Then, these features are used to recognize the coins.

2. LITERATURE REVIEW

In 1992 [6] Minoru Fukumi et al. presented a rotational invariant neural pattern recognition system for coin recognition. They performed experiments using 500 yen coin and 500 won coin. In this work they have created a multilayered neural network and a pre-processor consisting of many slabs of neurons to provide rotation invariance. They further extended their work in 1993 [7] and tried to achieve 100% accuracy for coins. In this work they have used BP (Back Propagation) and GA (Genetic Algorithm) to design neural network for coin recognition. Adnan Khashman et al. [8] presented an Intelligent Coin Identification System (ICIS) in 2006. ICIS uses neural network and pattern averaging for recognizing rotated coins at various degrees. It shows 96.3% correct identification i.e. 77 out of 80 variably rotated coin images were correctly identified. Mohamed Roushdy [9] had used Generalized Hough Transform to detect coins in image. In our work we have combined Hough Transform and Pattern Averaging to extract features from image. Then, these features are used to recognize the coins.

In this paper, the section 3 shows the introduction of ANN. In section 4 we have introduce the Genetic Algorithm. Then, in section 5 the experimental results of coin recognition are provided. Then, in section 6 we have concluded the work.

3. ARTIFICIAL NEURAL NETWORK

An Artificial Neural Network (ANN) is an information processing paradigm that is inspired by the way biological nervous systems, such as the brain, process information. The key element of this paradigm is the novel structure of the information processing system. It is composed of a large number of highly interconnected processing elements (neurones) working in unison to solve specific problems. ANNs, like people, learn by example. An ANN is configured for a specific application, such as pattern recognition or data classification, through a learning process. Learning in biological systems involves adjustments to the synaptic connections that exist between the neurones. This is true of ANNs as well. A feedforward network is one whose topology has no closed paths. Its input nodes are the ones with no arcs to them, and its output nodes have no arcs away from them. All other nodes are hidden nodes. When the states of all the input nodes are set, all the other nodes in the network can also set their states as values propagate through the network. The operation of a feedforward network consists of calculating outputs given a set of inputs in this manner. A layered feedforward network is one such that any path from an input node to an output node traverses the same number of arcs. The nth layer of such a network consists of all nodes which are n arc traversals from an input node. A hidden layer is one which contains hidden nodes [10].

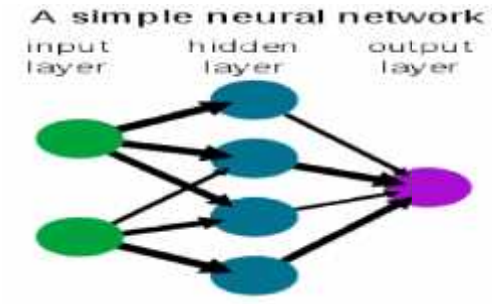

Figure 1 Artificial Neural Network

4. GENETICAL ALGORITHM

In the computer science field of artificial intelligence, a **genetic algorithm (GA)** is a search heuristic that mimics the process of natural evolution. This heuristic is routinely used to generate useful solutions to optimization and search problems. Genetic algorithms belong to the larger class of evolutionary algorithms (EA), which generate solutions to optimization problems using techniques inspired by natural evolution, such as inheritance, mutation, selection, and crossover.

In a genetic algorithm, a population of strings (called chromosomes or the genotype of the genome), which encode candidate solutions (called individuals, creatures, or phenotypes) to an optimization problem, is evolved toward better solutions. Traditionally, solutions are represented in binary as strings of 0s and 1s, but other encodings are also possible. The evolution usually starts from a population of randomly generated individuals and happens in generations. In each generation, the fitness of every individual in the population is evaluated, multiple individuals are stochastically selected from the current population (based on their fitness), and modified (recombined and possibly randomly mutated) to form a new population. The new population is then used in the next iteration of the algorithm. Commonly, the algorithm terminates when either a maximum number of generations has been produced, or a satisfactory fitness level has been reached for the population. If the algorithm has terminated due to a maximum number of generations, a satisfactory solution may or may not have been reached.

5.COIN RECOGNITION

Coin recognition process is divided into nine steps. The architecture of Coin Recognition Process is shown in Figure.2

Figure 2 Coin Recognition Process

1. **Input Image**: Select Coin images of front & back side. For example the input image have six coin as shown in figure.3.

Figure 3 Input Image

2. **Enhance Image**: In this process first load the input image, then denoise the image using Gabor wavelet filter as shown in figure.4. Calculate PSNR of wavelet denoise image with respect to input image.

Figure 4 Enhance Image

3. First load the enhance image Then calculate the centroid of image. From figure.5 shwos the centroid of each coin image.

Figure 5 Centroid of the input image

4. Segment the input image and detect the edges of image using canny edge detector.

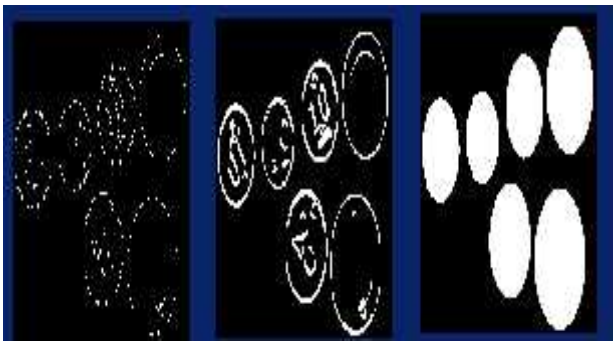

Figure 6 Edge Detected, Dilated Image & binary Image

5. Segment the template image i.e. the images which are in the database, segment that images and pass to the neural network.
6. Train the edges of image in neural network using genetic algorithm and generate the fitness weights and create the neural network file and save it.

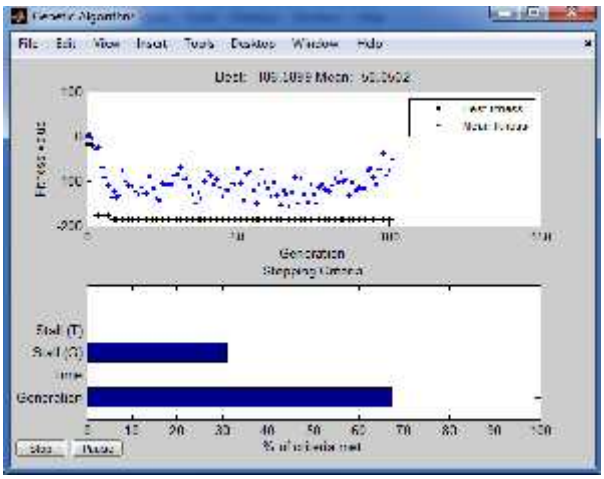

Figure 7 Train ANN using GA and generates fitness value

7. Open the trained artificial neural network file. In this step, a feature vector is generated from the pattern Averaged coin image. Suppose The 20×20 image generates a feature vector of dimension 400×1 i.e. all the pixel values are put into a vector of 1 column. Then, this feature vector of 400 features is passed as input to trained neural network.
8. Load the input image segment and start coin detection. ANN will locate patterns from train images directory into input coin image.
9. Result: Detect area of coin in an input image and show result. Coins are classified into different categories. The neural network classifies the given coin image into one of these class and based on the classification the results get generated. Similarly, for other classes we give an appropriate result.

6. EXPERIMENTAL RESULT

The following table shows the coin recognition rate. There are various five types of input image and there are number of coins present in input image i.e. Actual Coins Present in Input image. Pre-processing of that image i.e. enhancement of image, calculate the centroid and segmentation of the image.

Then Segment the images which are in database and pass to the neural network. Train neural network using genetic algorithm. Search the segment input image in segment template image Detect area of coin in an input image. It shows the number of coins detected from the input image. Maximum 100% coins are recognized.

Sr. No	Input Image Name	Actual Coins Present in Input image	Coins Detected	Recognition Rate
1	Indiancoin.jpg	06	06	100%
2	Image1.jpg	04	04	100%
3	Image2.jpg	04	03	75%
4	Image3.jpg	11	10	99%
5	Image4.jpg	02	02	100%

Table: Coin Recognition Rate

7. CONCLUSION

We use coins in our daily life almost everywhere like in banks, supermarkets, grocery stores etc. They have been the integral part of our day to day life. So there is basic need of highly accurate and efficient automatic coin recognition system.

This paper presents an efficient and accurate method for coin detection. The input images are gone through preprocessing and then these preprocessed images are fed to the trained neural network. This neural network tests the input images with the given images which are trained by genetic algorithm. If it is matched then show the accurate coin and display their characters, otherwise test will continue. If all images are scanned, then end otherwise scanning will continue. It gives the correct recognition rate. Maximum 100% coins are recognized

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