Automated Coin Recognition and Counting by Image Processing Techniques

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***Abstract*:- In all lifestyles, machine automation is essential to make sophisticated approach to the human kind. Of course the machines cannot be replaced by human beings in exact recognition of coins. Nowadays, most of the work of the human being is replaced by machines. The coin classification of various denominations and finding the sum of the coins is a tedious process. There is a need to design a system that is helpful in recognizing coin and sorting coin with high accuracy and in less time. Counting machine must be user friendly and it must make customer operation a breeze. Pattern recognition is employed to recognize coin automatically. Histogram of Oriented Gradients (HOG) is used as a feature and Support Vector Machine (SVM) is used as a classifier. The coins of denominations Rs.1, Rs.2, Rs.5 and Rs.10 are used in the proposed work. The results of the experiments carried out suggest that the pattern recognition approach is an efficient method for the automatic recognition of coin.**

Keywords:- Coin Recognition, Histogram of Oriented Gradients, Support Vector Machine

1. INTRODUCTION

Money is one of the basic needs for the human beings to survive in the society. In our financial ecosystem money can appear in the form of a coin or currency note. Coin plays important role in day to day business. Since the banks, retail shops use the coins and notes for their business if small error occurs, in the matter of money it leads to big problem. Separation of each coin is more difficult compared to notes. Sorting and counting of coins has to be carried out manually which consumes more time and prone to errors. There is a basic need of accurate and efficient automatic coin recognition systems in our daily life. 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. As more and more of our daily transactions become electronic, the prospect of counting more than a few coins begins to feel all the more tedious. For someone who has trouble seeing at all or a traveler unfamiliar with the local currency, counting money quickly and accurately may seem all the more daunting.

The objective is to recognize the coins and count the total value of the coin in terms of Indian National Rupees. Indian Coins are released with different values and are classified based on different parameters of coin such as shape, size, surface, weight and so on. Some countries' coins are having same parameters, but with different value. The recognition system is composed of two parts. The first part is pre-processing which includes the capturing the image of the coin moving on a conveyer belt, segmentation of coin, compressing data dimensionalities and feature extraction. The second part is the recognition, in which the core is a neural network classifier.

2. LITERATURE SURVEY

The automatic coin recognition system can be classified as Mechanical method based systems, Electromagnetic method based systems and 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, Gabor Wavelets, DCT, edge detection, segmentation, image subtraction and various features are extracted from the images. Then based on these features different coins are recognized. Some of the existing methods for automatic coin recognition are tabulated in Table 1.

Table 1.comparition of various approach

SL.NO.	METHOD	AUTHOR	YEAR	ACCURACY
1	Indian Coin recognition and sum counting system of images data mining using artificial neural network	Velu C.M., Vivekanadan P., Kashwan K.R.	2011	99.47
2	Automatic Coin Recognition Using Local Spatial Features	Unnikrishnan G, Sajith Sethu P.	2013	97.43
3	Indian Coin Recognition System of Image Segmentation By Heuristic Approach and Hough Transform	C.M. Velu, Vivekanandan P.	2009	97
4	Identification and Enumeration of Indian coins Value Using Morphological Operation	Malatesh M, Anitha G.	2015	NA
5	To Recognize, Separate And Count Indian Coins From Image Using MAT Lab Programming	Rathod Prahaladsin h Kanubha, Parmar Y.J.	2014	96.5

From the exhaustive literature survey carried out it is found that automatic coin recognition is still challenging.

3. METHODOLOGY

The proposed method for recognition of coins consisting of image segmentation, character recognition and based on the recognized value finally detect, separate and count the total value of coins.

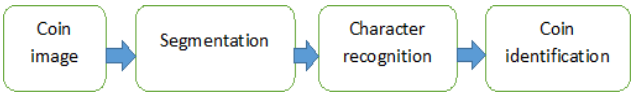

Fig. 1 process flow

In this, we use mainly 2 process to differentiate the coins.

i. Identification of Head and Tail.
ii. Separation of coins

i. *Identification of Head and Tail:*

In this, we differentiate the head and tail parts. To differentiate them we mainly use HOG features and SVM classifier.

ii. *Separation of coins:*

In this, we separate the coins and to separate them we mainly use HOG features and SVM classifier.

3.1 HOG feature:

The proposed method uses HOG feature vectors extracted from training images to train the classifier. Characteristics of local shape or gradient structure are better projected by HOG features. It is relatively invariant to local geometric and photometric transformation such that small pose variation doesn't affect performance of FER system. HOG feature vector provides information about shape and appearance of the face which are better characterized by intensity gradients or edge directions. HOG feature extraction algorithm divides static image of a face into small spatial regions known as "Cells". Cells can be rectangular or circular. The image is divided into cells of size N × N pixels and for each cell, gradients are computed using formulations as shown below.

Let f(x,y) represent a single cell in face window.

$Sh = [-1\ 0\ 1]$ ..... (1)

$Sv = [-1\ 0\ 1]^T$ ..... (2)

$gx = f(x,y) © Sh$ ..... (3)

$gv = f(x,y) © Sv$ ..... (4)

$Orientation = \tan^{-1}(gv / gx)$ ..... (5)

- Sh ─ Horizontal gradient operator
- Sv ─ Vertical gradient operator
- T ─ Matrix transform
- © ─ 2D Convolution
- gx ─ Horizontal gradient of f(x,y)
- gy ─ Vertical gradient of f(x,y)

Orientation provides gradient feature vector for a single cell. Gradient feature vectors so obtained from each cell of a single image are concatenated to form feature vector for a single image. The feature vectors extracted from images representing different facial expressions are then used for training and testing phases of SVM classifier. The extracted HOG features are given as input to a group of Support Vector Machines (SVM).

3.2 Support vector machine

SVM is a popular machine learning algorithm which maps feature vector to a different plane, usually to a higher dimensional plane, through non-linear mapping, and then finds a linear decision hyper plane so as to classify two classes. Since SVM is a binary classifier, one-against-one (OAO) technique has been implemented for multi-class classification. In OAO approach, a classifier is trained between each pair of classes; hence kC2 number of classifiers have been constructed in total, where k is the number of classes. Using voting strategy, a vector can be classified as belonging to a class, having highest number of votes.

SVM is a discriminative classifier defined through a separating hyper plane. SVMs are non-parametric and hence boost the robustness associated with Artificial Neural Networks and other nonparametric classifiers. The purpose of using SVM is to obtain acceptable results in a fast, accurate and easier manner. The model of SVM used in the proposed work is as shown in Fig. 2.1.

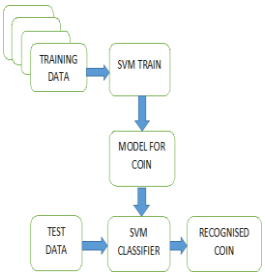

Fig. 2 svm work flow

Linear SVM is employed in the present work. Given some training data D, a set of n points of the form

$D=\{(x_i, y_i) \mid x_i \in R^p , y_i \in \{-1,1\}\}$ for i=1,2 … … …n ……..(6)

Where yi is either 1 or −1, indicating the class to which point xi belongs. Each point xi is a p-dimensional real vector. SVM classifier finds the maximum-margin hyper plane that divides the points having yi=1 from those having yi= -1. Any hyper plane can be written as set of points x satisfying

$w \cdot x - b = 0$ ……..(7)

Where '·' denotes the dot product and 'w' the normal vector to a hyper plane. We need to choose 'w' and 'b', which either maximizes the margin or separates parallel hyper planes such that they are as far apart as possible, while still separating the data. These hyper planes can be described by following set of equations

$w \cdot x - b = 1$ …….(8)

and

$w \cdot x - b = -1$ …….(9)

3.3 Block diagram

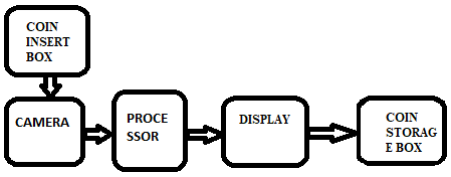

Fig.3 Block diagram

t first, the coins were inserted in the coin box, using the conveyor belt, the coins are moved. The cameras will capture the image of coins and then using DSP processor we will identify the coins and display, which is that coin, is. In coin storage box there will be compartments, after identifying the coins they are moved that particular compartment.

3.4 Proposed algorithm

STEP 1: Read input image.

STEP2: Differentiate head and tails, retain only tails part STEP3: Perform image segmentation to highlight coin area STEP4: Apply character recognition to identify the coin STEP5: Route the count into respective box.

3.5 Flow chart

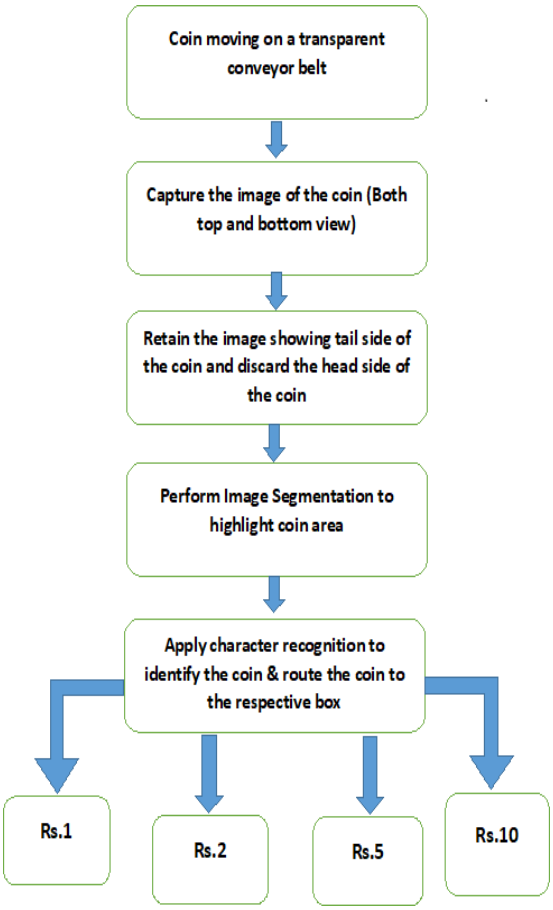

Fig.4 flow chart

4. RESULTS AND DISCUSSION

The Indian coin image database is prepared which comprises of head and tail part images of Rs. 1, Rs. 2, Rs. 5 and Rs. 10 denominations respectively. During the first phase database is split into two modules, wherein the first module consists of head images of all denominations and second module consists of tail images of all denominations respectively. HOG and SVM combination is used to classify the image to head or tail. In the second phase Cross validation approach is employed where in the complete database is randomly divided into 4 modules. In the first attempt first module is used for testing and remaining 3 modules are used for training and similarlly in the second attemp second module is used for testing and remaining 3 modules are used for training. similarly third attempt uses third module and last attempt used fourth module for testing. This cross validation scheme ensures that all the images of the databases are involved in testing phase. Four trails of experiments conducted on this database. For each of the 4 trials, new training and testing data sets are chosen such that most of the subjects have been used in the training and testing phase over the 4 trails of experiments.

Trail 1:

In this, the first module is used for testing and remaining three modules are used for training: (R1)

Trail 2:

In this, the second module is used for testing and remaining three modules are used for training: (R2)

Trail 3:

In this, the third module is used for testing and remaining three modules are used for training: (R3)

Trail 4:

In this, the fourth module is used for testing and remaining three modules are used for training: (R4)

The average result of the four trails of the experiment is as follows

R=(R1+R2+R3+R4)/4

Average result of Rs.1=99 Average result of Rs.2=99 Average result of Rs.5=98 Average result of Rs.10=98

The proposed method is implement using MATLAB 2015, results are and analyzed following snapshot shows the result after MATLAB simulation.

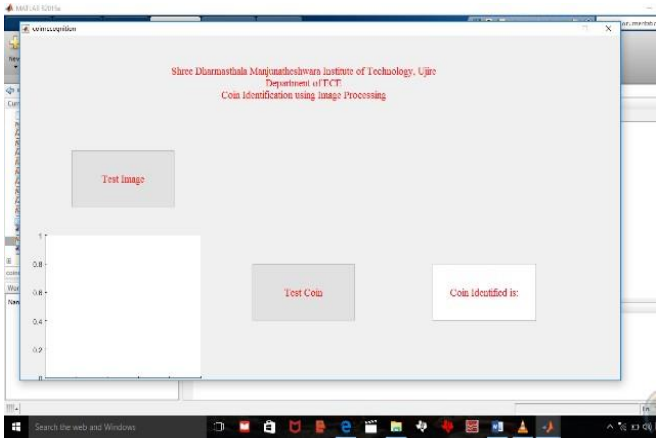

Fig .5

Above snapshot shows the GUI of the proposed system

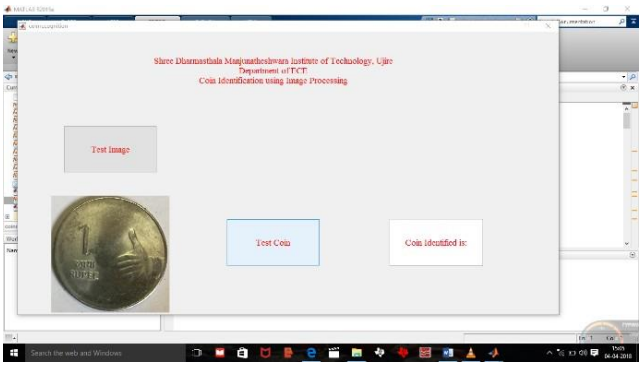

Fig 6.

Above snapshot shows the GUI of the proposed system when the test image is selected.

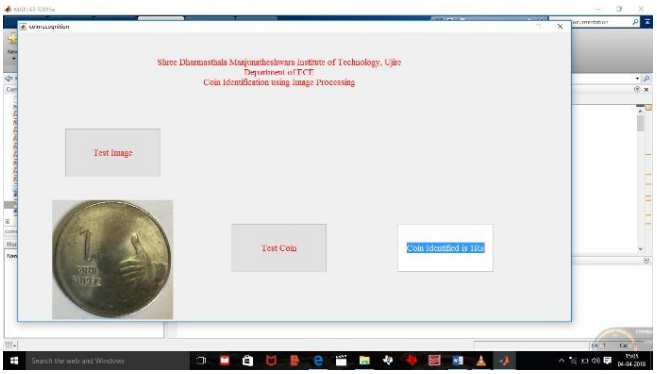

Fig .7

Above snapshot illustrate the result of proposed system for coin denomination Rs. 1.

For 2 rupee:

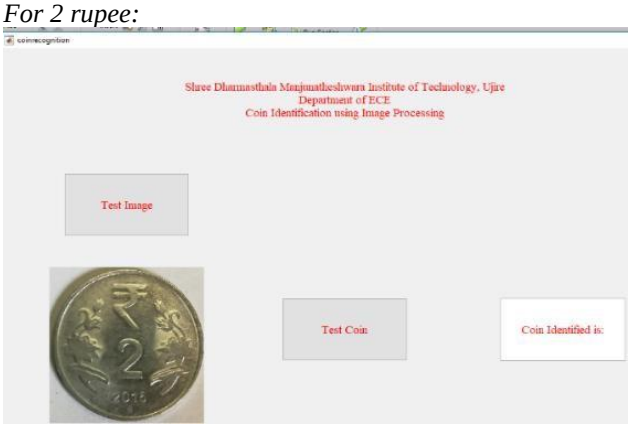

Fig.8

Above snapshot shows the GUI of the proposed system when the test image is selected.

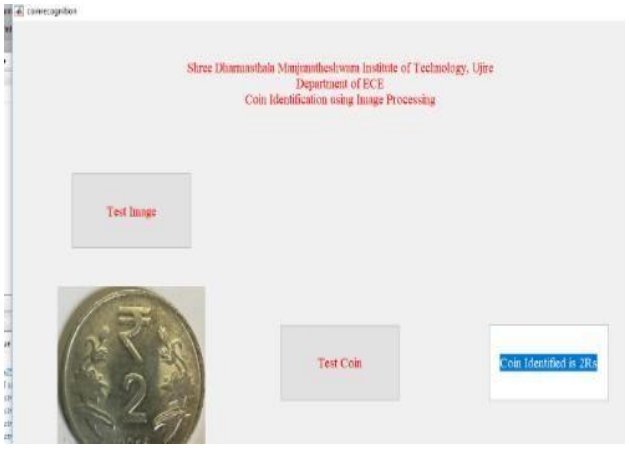

Fig.9

Above snapshot illustrate the result of proposed system for coin denomination Rs. 2.

For 10 rupee:

Fig. 10

Above snapshot shows the GUI of the proposed system when the test image is selected

Fig .11

Above snapshot illustrate the result of proposed system for coin denomination Rs. 10.

For 5 rupee:

Fir.12

Above snapshot shows the GUI of the proposed system when the test image is selected

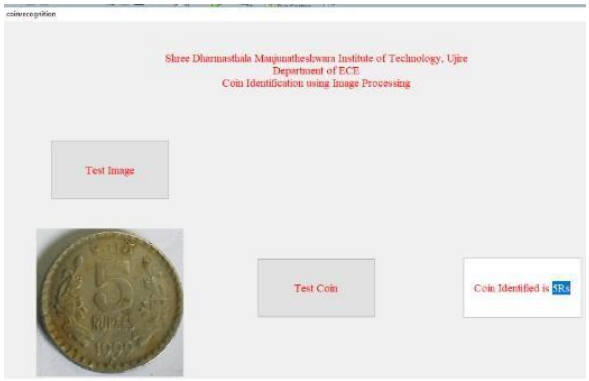

Fig.13

Above snapshot illustrate the result of proposed system for coin denomination Rs. 5.

5. CONCLUSION

There is huge demand in market for a system which replaces the traditional manual method of coin separation and counting. The sample images Rs.1, Rs.2, Rs.5 and Rs.10 denominations are used for the experimentation. The proposed work is implemented using MATLAB 2015a. Combination HOG and SVM classify the test image coin into any one of the four denominations. The proposed coin recognition and counting system reduces the errors during counting, increases the speed of counting, and saves the energy and money. Cross validation approach is employed and the average accuracy of the approach is found to be 98.75. To improve the result we can combine more number of features in a single method. The other features are LBPF and HAN. We can also improve the accuracy by adding more number of images for training; also the classifier can be changed. It can be upgraded to identify foreign currencies like yen, dollar, euros, dinar etc.

6. REFERENCES

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