Currency Recognition with Denomination based on Edge Detection and Neural Networks

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Abstract

In this paper we have proposed an algorithm based on image processing that can efficiently recognize different currencies all over the world with edge detection and artificial neural networks which helps in decision making.
Keyword- Image Processing, Currency Recognition, Neural Networks, MATLAB Software

I. INTRODUCTION

Currency Recognition has always been a problem let it be in FOREX or a software for Automated Teller Machines. People working in FOREX have a hard time remembering every currency's symbols to distinguish them and remembering 50 different symbols especially for currencies from Indonesia, china and japan has always been hard to recognize and led to Manual errors. Similarly ATMs in airports don't support different currency exchange as well which is a burden for tourists to find a forex to exchange their home country's currency to the desired currency they want. Our main Objective of this paper is to develop an algorithm as a simple MATLAB program that can recognize different Currency along with their denomination that can help both FOREX and ATMs in Airports as well.

This paper takes a unique symbol identification approach where a given symbol that uniquely identifies a given currency is first analyzed and stored in the database and then given a currency it scans to find that symbol in that given currency along with its computed histogram being compared to the histogram stored in the database and based on neural networks selects the currency with the highest probability.

II. ALGORITHM

The decision making is divided into four stages where the first two stages determines the probability of what the given currency could be and the third stage takes those probabilities to recognize the currency based on neural networks .The final stage takes a color dominance approach to distinguish itself from other denominations of the same currency and the final output gives the currency along with its denomination.

A. Stage 1

The first stage of the recognition is to compare the histogram of the given currency with the one stored in the database .This is basically a training process where a given currency's different image samples are stored in the database. A clean data structure is chosen for storing and retrieving data .The main point in stage 1 is that the given image is converted from RGB color space to LUV color space the reason is being multiple color being mapped to a given color pixel making it easier to compute and perform analysis . Once the LUV color space histogram of multiple image samples of a given currency is stored A minimum threshold is fixed which marks the maximum difference allowed to decide for the given currency .However this method on choosing a given currency marks only 0.25 probability of the given currency to be decided as the currency given by this method .The main problem with this approach is if the given currency is scribbled or dirty a wrong decision could easily be made and that's why the lowest probability is chosen for this method however this method cannot be completely ignored as it can help in many cases aiding to a better decision making.

$$d(p,q) = \sqrt{(L2-L1)+(U2-U1)+(V2-V1)}$$

Where, (L1, U1, V1) = Target image feature set (L2, U2, V2) = Ideal feature set.

If the distance falls below the threshold fixed then the system assumes that the given currency is the currency being compared against.

B. Stage 2

This part of the recognition process contributes to the highest probability in the decision making. The reason behind assigning the highest probability to this method is being that this method is highly unlikely to be wrong since it works on unique symbol identification. To train the system a given currency is passed through the canny operator, the canny operator basically outputs the edges of the images as shown below.

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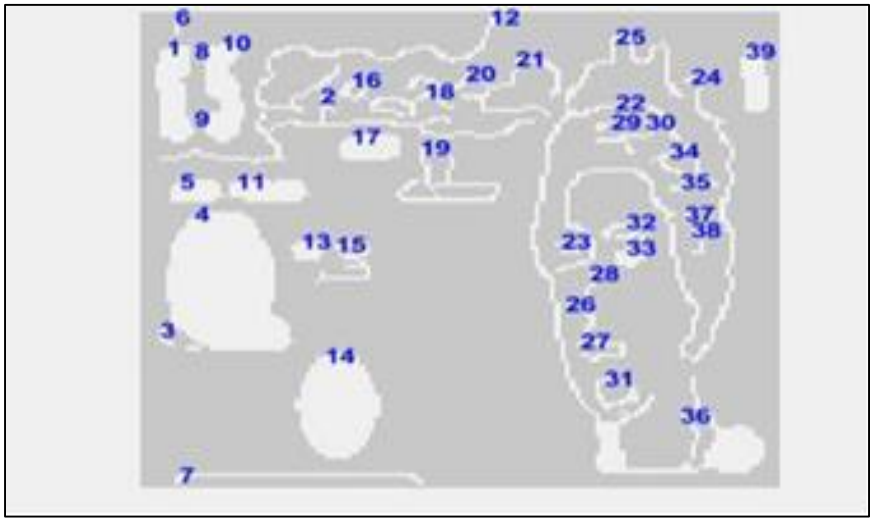
Output of the canny operator for a Pound currency:

Now the output of the canny operator is analyzed and a unique symbol that marks a given currency is chosen. It's often a better decision to store more than one unique symbol for a given currency but for the demonstration of the algorithm only one symbol is chosen .Considering the pound currency the pound symbol is unique and hence it's chosen. Once the symbol is fixed the object's essential features are extracted and stored in the database. Here the centroid's x co-ordinate and y co-ordinate along with its orientation is stored in the database. For the Pound symbol the feature are shown as follows.

Features	*Value*
Centroid (x co-ordinate)	*7.2148*
Centroid(y co-ordinate)	*22.2416*
Orientation	*-88.9284*

The x co-ordinate is the distance of the symbol's centroid along the x axis from the starting point of the image and same applies for y co-ordinate along the Y-axis. The orientation is obtained by drawing an ellipse around the entire object and the angle between the major axis of the ellipse and the x-axis gives it's orientation which ranges from 90 deg to -90 deg.The given image shows every object in the given image and the 1st object is chosen as the unique symbol which is the pound symbol whose features are given in the above table.



Once the chosen symbol's features are stored in the database the recognition procedure will simply cycle through every object in the given image and compare its characteristics with the one stored in the database and if a match is found its most probably the same symbol located at the same place and the cycle stops and the probability of the given currency raises to 0.75 .The output of the algorithm being performed on a 10 pound after training the system with a 5 pound currency is shown below .

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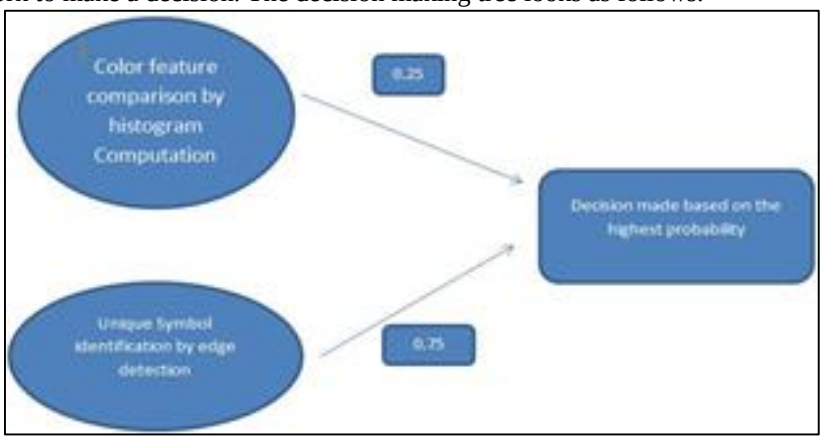
As it can been seen a close match to the object being searched for is found and this is how the algorithm helps in the decision making for the recognition of the currency. Considering a small scratch on the given symbol or a scribble can make the system not recognize the unique symbol and that is why it's better to store more than one symbol in the database for efficient decision making.

C. Stage 3

This part of the recognition procedure is where the actual decision takes place. This stage is fairly simple however most crucial as it simulates a neural network to make a decision. The decision making tree looks as follows.



Thought the decision making tree looks fairly simple compared to a normal neural network tree the significance still remains the same. This way of decision making has two advantages

1) The algorithm doesn't depend on just one feature extraction and comparison with the database making the decision to be of greater accuracy.
2) The algorithm is flexible which implies someone could just enhance the decision making by adding another algorithm for recognition and it would add to the tree and the probability will again be distributed with the added algorithm being considered for the decision making

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The above chart looks fairly simple however the probability of 0.25 is distributed even further with every color feature which aids the stage 1 process.
Similarly in the stage 2 the number of symbols equally divide the 0.75 probability of the decision making.

D. Stage 4

The final stage of the recognition process is to find the denomination of the given currency .This stage has a simpler approach and the reason being all it has to do is differentiate itself with its locally specified other denominations of the same currency. For this recognition we have chosen the color dominance and aspect ratio. The aspect ratio approach works quite well for the indian currency the reason being RBI follows strict length to width ratio for every denomination of the indian currency. However this aspect ratio cannot be guaranteed for all the currency in the world. Therefore in this approach we split the R channel, B channel and the G channel of a given image find the average of those values and store it across the corresponding denomination in the database. This is a s impler and better approach that is guaranteed to work for all currencies, The main drawback is that the input image might be faded or a slight variation in color intensity might be found there it is better to train the system with at least 10 notes of the same denomination to make a better decision for denomination.

TABLE 1: Dominant color of Indian Currency Notes

Denomination	Notation	Dominant Color
	DC_{20}	RED
	DC_{50}	RED
	DC_{100}	BLUE
	DC_{500}	GREEN
	DC_{1000}	RED

The same unique symbol identification approach can also be applied to the denomination considering the following

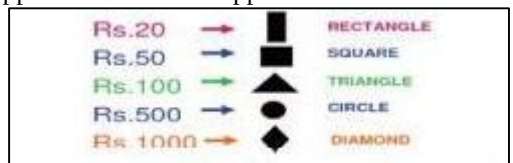
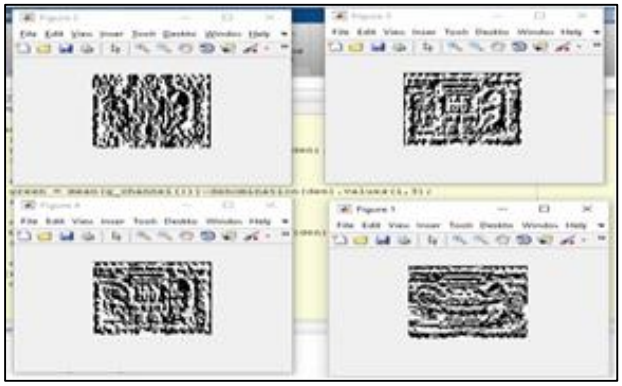


Fig. 2: Identification mark for various denominations [1]

However that would be an overkill as all it has to do is differentiate among its locally specified other denomination of the same currency and that's the reason we adopted for a simpler approach for this stage of the recognition.

III. SIMULATION ON MATLAB

The above algorithm implemented with MATLAB and it's various stages for the recognition of the indian currency (100 rupees) is shown



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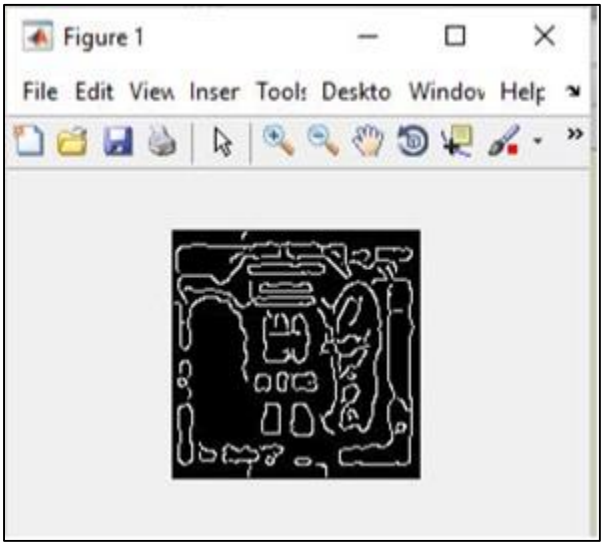
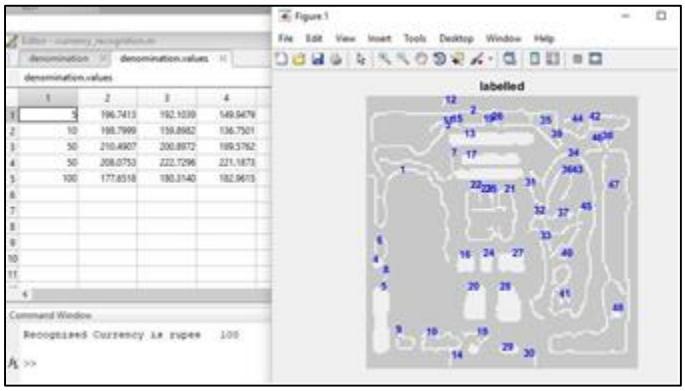
1) Passing through a Sobel Mask



2) Canny Operator



3) Unique Symbol Identification and color Denomination

The final image shows every object in a given currency and the third object is the object that is stored in the database, the left side database table is the sample of the denomination table that stores every denomination of a given currency's red, blue and green channel average value.

IV. CONCLUSION

In this paper we have proposed a simple algorithm based on edge detection and neural networks that can aid software in ATM's to recognize currency along with their denomination all over the world.

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