

Study of Banknote Recognition Methodology to Aid Visually Impaired

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Abstract—Money exchange is an important part of our day to day activities. However, blind people particularly suffer during such situations. They are not able to effectively distinguish between various denominations and may be often deceived by other people. Also, a reliable currency recognition system could be used wherever money exchanges are of concern. Moreover there is a need to design a system that is helpful in recognition of currency notes with fast speed and less time. Currency denomination detection is a vast area of research and significant progress had been achieved over the years. This paper presents a detailed study of various developments in the pre processing and post processing methodologies and to overcome its disadvantage. Moreover, it proposes the idea of implementing it through the android-open source.

Keywords— visually impaired, computer vision, Bank note recognition, techniques.

researchers have worked on this to develop reliable and robust methods. The processes focus to search and extract the region of interest and process them accordingly. Recognition accuracy and processing speed are generally two important targets considered in these methodologies.



Figure 1 Indian Rupee

I. INTRODUCTION

Most of us are fortunate to see the world with our eyes. But many are not that privileged. Visually impaired people may have reduced vision or no vision at all and face difficulties in carrying out day to day activities. Approximately 285 million people are estimated to be visually impaired worldwide [WHO 2014], about 4% of total population. Among these 39 million are blind and 246 have low vision.

The visually impaired are unable to observe the world around them. Moreover they face difficulties in managing and identifying currency notes. Coins can be identified by touch. But values of the currency notes are difficult to identify. Electronic bill identifiers are available but they are not affordable.

Therefore, in order to cope up with the monetary transactions in our day today life automatic method for paper currency recognition is necessary. Many

II. PRE PROCESSING METHODOLOGIES

The basic goal of image pre-processing includes enhancing the features of the image to suppress undesired distortions that are further been used for processing or analysis.

Vipin Kumar Jain and Dr. Ritu Vijay presented paper using Template Matching [1]. In this paper different digital image processing techniques are used to extract ROI. The image is then converted into gray scale. The denominations are obtained by implementing filters. Further Neural Network and Pattern Recognition Techniques are used for matching the pattern.

Hanish Aggarwal and PadamKumar [2] presented a paper for Indian currency recognition on the basis of color. Currency notes has at least one dominant color that is used for

recognition. This kind of recognition is not accurate and hence it is unreliable.

D.A.K.S. Gunaratna, N.D. Kodikara and H.L. Premaratne [3] proposed an Intelligent recognition system for Srilankan Banknotes. In this paper the RGB image is initially converted to gray scale which is further enhanced by linear transformation function where set of values from the converted grayscale image are used to generate a new set of values that is denoted as

$$f(x)=F_a x + F_b$$

where x is input grayscale image $f(x)$ is output image F_a, F_b are constants.

Parker, J. R [4] in his paper the threshold values are calculated for each image. Based on these values the object pixels are then compared and mapped to the background pixels. The object in an image will then result to a small region with a comparatively large intensity gradient at the boundaries of the objects.

Kelkar, D., Gupta.S [5] presented a paper where the splitting and merging techniques are used. Splitting is done on the region recursively until no further splitting is possible. The splitted regions are then merged, This process is continued until when no merging is This is complex and time-consuming method.

Yi-Feng Pan, Xinwen Hou, and Cheng-Lin Liu [6] presented a paper where texture analysis method has been used to detect and localize text regions The component based methods directly segment the text components by using edge detection or color clustering.

Kalyan Kumar Debnath, Sultan Uddin Ahmed, Md. Shahjahan[7] presented a paper on currency recognition using Ensemble Neural Network (ENN). Before feeding the image to the network we need to preprocess it. The RGB image obtained from the scanner is then converted into grayscale image. In order to limit the size of the ensemble the obtained grayscale image can be compressed to 125x80 dimensions or can be done by reducing the network size. The latter is very complicated due to large numbers of individual NN's.

III. POST PROCESSING METHODOLOGIES

Masato Aoba et al., [8] proposed a system for euro banknotes recognition. Three-layered perceptron and Radial Basis Function (RBF) methods are used for paper currency recognition. Three-layered Perceptron method is used for classification of the currency notes that are in turn used for pattern recognition. The Perceptron includes three layers input layer, hidden layer and the output layer. The output of each neuron has been calculated by the sigmoidal function $f(x)$ where each output neuron y_j is expressed as a function of x .

Radial Basis Function (RBF) method is used for validating the currency notes. The RBF network has a potential to reject invalid data because it estimates probability distribution of sample data effectively.

H.Hassanpour and P.Farahabadi presented a paper using Hidden Markov model [9]. This method is robust paper currency recognition method. Employing Hidden Markov Model (HMM) the texture characteristics of paper currencies are modeled as a random process. This method is also used for distinguishing paper currency from different countries.

Hai-dong Wang et al. [10], proposed paper currency number recognition method called fast Adaboost weak classifier training algorithm which sort the Eigen values to an array from small to large, and then traverse the sorted array once to find the best threshold and bias.

Reiff and Sincak presented a paper using SIFT method [11]. This method uses scale invariant feature transform (SIFT) detector and descriptors to classify Slovak banknotes in a well controlled environment. In this method, the summation of non masked pixel values in each banknote is computed and fed to a neural network. This method considers images of both front and back of the paper currency, but only the front image is used for recognition. In this approach, the patterns of an edge on a banknote are used for recognition, and the image of a banknote is vertically divided into a number of equal small parts. Then, the number of pixels associated with edges detected in each part and fed to a three layer back propagation neural network for recognition.

Kalyan Kumar Debnath et al. [7] presented a currency recognition system using ensemble neural network (ENN) for Bangladeshi currency notes. The individual neural networks in is a classifier and trained via negative correlation learning. This negative correlation learning is to expertise the individuals on different parts or portion of input patterns in an ensemble.

In 2003, Ali Ahmadi et al [12] proposed a method to resolve the non-linear dependencies among variables followed by the extraction of the features of data. Initially the data space is partitioned into regions by using a self-organizing map (SOM) model and then the PCA is performed in each region. A learning vector quantization (LVQ) network is employed as the main classifier of the system. In this method the complexity of data and correlation between variables modeled by using a simple linear mode.

IV. INFERENCE FROM LITERATURE

A visually impaired person might be forced to use this application under different circumstances. The algorithm has

to be invariant to the external changes such as point of view, illumination.

Some of the above discussed currency recognition techniques require additional hardware such as an external camera. Most of the processes mentioned in the literature are dynamic in nature and hence edge detection is not enough as they may have a higher effect of noise. Application of many filters can overcome the above problem.

A noise removal technique has to be used without effecting the basic features of images that are important later in the process but loss of lesser features can be accepted for the betterment of recognition. In fact each and every feature is not going to effect the classification when the patterns because considering all of them make itself noisy and confusing.

The proposed methodology should ensure that the results should be consistent even if the currency is wrinkled, torn or in folded state. Also all the algorithms discussed above are noted to be successfully implemented in MATLAB. But in order to make it available for all the people an implementation in a user friendly platform.

The proposed system also may not be affordable to the targeted market. So in order to overcome these drawbacks our proposed methodology includes implementing the techniques in Android OS which is an open source and make it user friendly to all visually impaired. This also ensures that it

would be affordable and overcomes the difficulties of illumination.

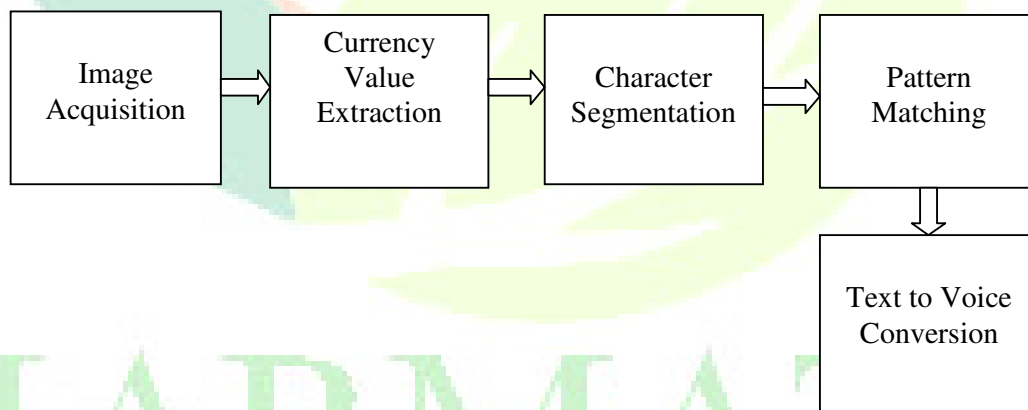
V. PROPOSED METHODOLOGY

This proposed methodology is a mobile based application that can identify the denominations of the Indian Currencies and aid the visually impaired. The basic idea is to embed the image processing techniques and the computer vision algorithms into the mobile devices.

This system requires the user to take picture of the currencies with any android mobile that he/she uses. Preprocessing methodologies are applied to the captured RGB image in order to remove the noise and other unwanted regions. Suitable algorithms are then applied to the preprocessed image and its regions of interests are identified.

The denominations of the currency are obtained by matching the features with the already captured processed and stored datasets. The proposed system aims to recognize the currency notes in whatever perspective the notes may be captured. The recognized results can then be spoken out via the inbuilt mobile speaker.

VI. BLOCK DIAGRAM



The different phases include,

- A) Image acquisition
- B) Currency value extraction
- C) Character Segmentation
- D) Pattern Matching
- E) Text to Voice Conversion

A) Image Acquisition:

This is the initial step in the currency recognition system. A mobile device camera is used to capture the resolutions the captured RGB currency note image is converted to a gray scale image. The next step includes the removal of unwanted noise patterns form the image. This thereby separates the image from the background.



(a) Input image captured by mobile camera



(b) Converted gray scale image

Figure 2: Image Acquisition and Pre-Processing results

B) Currency Value Extraction:

After the source image has been converted into lower resolutions and the unnecessary data has been filtered out, extraction of the denominations take place. The denominations in the currency notes are the region of interest. This step aims to identify and filter out the features of the image which focuses the regions that denotes the value of the currency alone.



Figure 3: Extracted ROI in the gray scale image

C) Character Segmentation:

The next step in character segmentation where the region of interests of the gray scale image is processed .A threshold for the image is calculated dynamically. The character can be extracted by using this threshold or by applying certain classifying algorithms. The output of this step is a extracted value of the denomination.



Figure 4: Segmented denominations

D) Pattern Matching:

This comes under the image post processing techniques. The most common process for implementing this is through supervised learning. A database is created that consists of the Indian currency notes. A sample dataset has been created by taking various pictures of the Indian currencies. Each captured image is then matched with the database for the correct pattern and the results are generated.

E) Text to Voice Conversion:

If the corresponding image is found in database, the text is displayed on the screen. The text is then converted to voice and they are spoken out through mobile speakers.

VII. CONCLUSION AND FUTURE WORKS

Our idea to develop a system that can be used to recognize currency for a visually impaired user has been explained. This can overcome difficulties like limited processing power, and can achieve high accuracy and low reporting time. Also this aims at identifying the currencies even at worst cases of illumination. In future this can be extended to find the currency note is a fake or real and also to find the country it belongs to.

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