Neural network based currency recognition on an Android OS based mobile

Project Report

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Abstract

The aim of this project is to recognise Indian currency notes using a image obtained from a phone camera in realtime. This java based application will help recognise a bank-note based on its denomination on a mobile with android OS. The application will be build using Opencv which has android support built in it in the latest version.The method will be based on image based pre-processing followed by a 3 layer neural network for classification of note. The application will be trained on 10 samples of each note denomination in indian currency before testing.

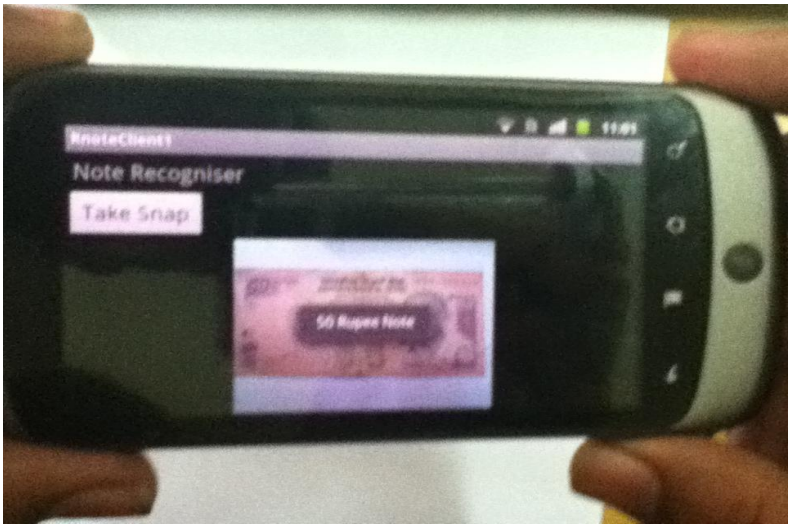
Introduction

Automatic currency note recognition technology is specific to a country and can be generalised with standard banknotes of each country. Major problems in recognising a banknote are blurness, color change due to heavy usage, torn parts, writing on notes which gives rise to addition of noise when in circulation. Many methods have been used to recognise banknotes using optical, magnetic and weight sensors.

Motivation

In general, mobile application development has been revolutionised by Android and Iphone utilities. I have tried to develop a robust note recognition application using an Android application. There are many additional uses of the application, such as recognition of banknotes for visually impaired, used to identify foreign currency notes in different language. It can also be extended to standard currency counters using only image analysis. This application is easy to use, it is very user friendly in nature and gives output runtime.

The application usage at a glance.



Prior Work

The main paper [1], I have being referring to paper uses image based methods to classify the currency note. The method is based on edge detection technique which is passed through a neural network to obtain the final results. Edge detection uses all the features on the note which reduces local region based errors making the recognition more efficient. But the neural network gave results of about 50 percent accuracy in 5 denominations which was not as effective as thought.

Other reference helped is using other features of the note such as the denomination in the corners, these images only consisted of the bank note hence localisation was not an issue. But it helped in giving a wide perspective for note recognition.

Implementation

The implementation is divided into three parts:

1. Network Connection
2. Android Application (Client)
3. Image Analysis (Backend)

Network Connection

This part of the application uses socket programming which creates a TCP connection between the device and the Server. The device requires network capability for using this application.

Clientside

The android device acts as a client. Functionality is provided to take a snap shot and send it to a server. The server in turn analyses the image sent and replies with the denomination of the note in the image. The image is transferred using a TCP connection.

The first screen will appear to capture a picture, which when selected will open the second screen. This screen shows a screenshot of the image and waits for the server to respond the denomination which is displayed as a Toast on the screen.

Serverside

The server listens for the incoming socket connection. Once a connection is opened, it invokes the note recognising application which gives the denomination of the note as output. It then sends this output to the client, which displays the result.

Backend

The backend attains the image through the server and the process is triggered by the server and output is feed to the server which relays it to the client. The backend consists of implementation in OpenCV for image analysis, which is also passed through a neural network for verification.

The image analysis, neural network and the probabilistic model for identification will be given in detail in the algorithm.

Algorithm

The method is mainly divided into 5 steps.

Pre-processing

The pre-processing starts with the conversion of the image into a greyscale format image as the colour is not colour based.

After this the image is passed through a linear transformation

f(x) = fa* x + fb;

This gives the image a reappearance which is more refined for edge detection. This step also removes the noise component (blurriness, intensity, etc.). The constant and scaling in the equation above is specific to a note system followed by a country and is obtained by heuristics.

Edge Detection

Edge detection is carried out on the image obtained from pre-processing. The algorithm used is canny edge detection algorithm due to its low error rate and low time complexity. The final image obtained is divided into horizontal segments, which are feed to the neural network using their norm values as the dimensions of the vector.

****Localisation****

Using the image obtained by the edge detection, we detect the initial and final horizontal edges of the note. But as the orientation is not exactly horizontal of the image, a width of 3 pixels is taken and the edge distributed over this region is detected.

Then the vertical limits are set using the window obtained above and finding the leftmost and right most pixels to define the edge.

Neural Network

The neural network is a 3-layer back propagation network which classifies the banknote into the denomination note it represents. It has 20 input nodes and 12 hidden layers with 5 output nodes. The neural network has learning rate equal to 0.1 using normalised inputs.

****Co-relation Model****

As the inputs from the neural network do not have good results, we also obtain the co-relations for other features of the note in overall. The width and height ratio is taken as a standard parameter during note recognition. For the RGB and greyscale values, we have developed a bin sized approach for their co-relation to be given.

The correlation is found using the results obtained standard images of the bank notes published by Reserve Bank of India.

IF the co-relational model gives and optimum result, we can detect our note.

Database

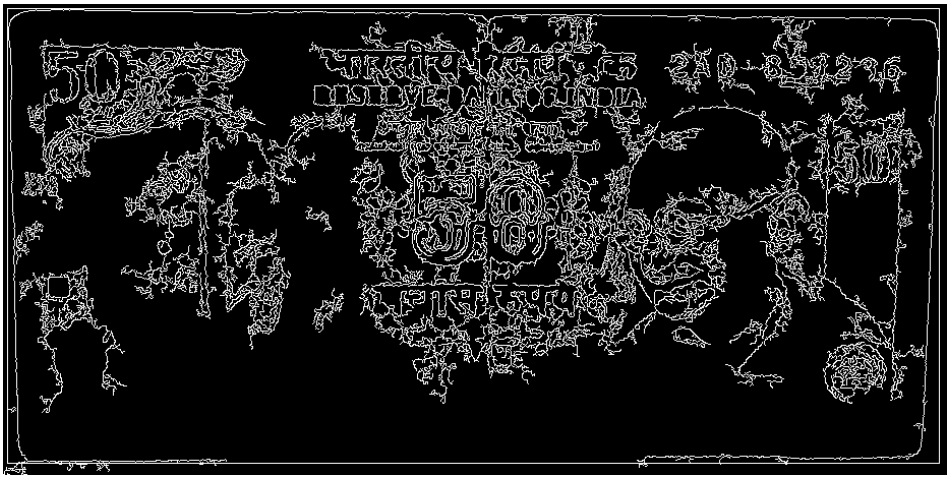
The database consists of images of Indian currency notes. The database is created manually using the bank notes in daily usage. The dataset has the note in a horizontal position which is a must for our analysis, and contains a blank background. The analysis (training) will be carried on bank notes with the denominations:

1. Rs 10
2. Rs 20
3. Rs 50
4. Rs 100
5. Rs 500

The system has been trained on about 110 images for 5 denominations. The database consists of notes with their front side and back side in horizontal position. Even notes consisting of front side and back side in vertical position were obtained but were left uncategorised due to no use in the method. The images were captures using a glass above the currency note to have flat note, captured in ambient indoor light conditions.

Results


भारतीय रिज़र्व बैंक
RESERVE BANK OF INDIA
2AD 851236
50
50
पचास रुपये
50
2AD 851236



Conclusion

The application works perfectly in sync with the backend. It gives real time output too. The system is still has not obtained high level of accuracy and the constants of the co-relational model have to be obtained to produce refined results. Usage of other faces of the note can be added as an extra feature to the implementation. The best results were obtained using following parameters

1. Canny edge detection
    a. Threshold : 30 and 220
    b. Aperture Size: 3
2. Linear Transformation
    a. Fa = 1.5 and Fb= 100

3. Neural Network
    a. Input layer: 20 , Output layer: 5 and Hidden layer: 12
    b. Learning rate: 0.1

References

[1] D. Gunaratna, N. Kodikara and H. Premarantne, “ANN Based Currency Recognition System using Compressed Gray Scale and Application for Sri Lankan Currency Notes-SLCRec”, Proceedings of World academy of science, engineering and technology, vol. 35, ISSN 2070-3740, pp. 235-240, Nov 2008

[2]Smartphone Recognition of the U.S. Banknotes’ Denomination, for Visually Impaired People Felipe Grijalva, J.C. Rodríguez, Julio Larco and Luis Orozco, ANDESCON, 2010 IEEE - ieeexplore.ieee.org