Indian Paper Currency Detection using OpenCV3, Python and Digital Image Processing

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Abstract— The growing menace of fake currencies is evident as newspaper reports of huge cache of fake currency notes being seized appear every day. The advancements in technology in the field of computer, scanners and photocopiers have made it very simple to duplicate the currency note, and on the other hand the unsuspecting masses have no mechanism or software to differentiate the fake notes from the genuine ones. In this paper I have discussed a method which uses opencv3, python and digital image processing technique to identify the fake currency notes.

Keywords: Fake Currency, Image Processing, Counterfeit, Detection

I. INTRODUCTION

Fake currency is imitation currency produced without the legal sanction of the state or government. Producing or using Fake currency is a form of fraud or forgery. Counterfeiting is almost as old as money itself. Some of the ill-effects that counterfeit money has on society include a reduction in the value of real money; and increase in prices due to more money getting circulated in the economy an unauthorized artificial increase in the money supply; a decrease in the acceptability of paper money; and losses, when traders are not reimbursed for counterfeit money detected by banks, even if it is confiscated.

According to the Reserve Bank of India's (RBI) annual reports, a huge increase in fake Rs2,000 currency notes was detected in the banking system in the 2017-'18 financial year. The central bank said 17,929 pieces of Rs2,000 notes were detected in 2017-'18 while only 638 fake notes of the same denomination had been detected the year before. Overall 5.22 lakh pieces of counterfeit notes were detected in 2017-'18, 31.4% lower than the previous year. As many as 199 fake currency notes of Rs500 of the new design were discovered in 2016-'17. This increased to 9,892 such notes in 2017-'18. Compared to the previous year, there was an increase of 35% in counterfeit notes detected in the denomination of Rs100, while there was a noticeable increase of 154.3% in counterfeit notes detected in the denomination of Rs50.

			(No. Of pieces)
Denominations	2015-16	2016-17	2017-18
1	2	3	4
2 and 5	2	80	1
10	134	523	287
20	96	324	437
50	6,453	9,222	23,447
100	221,447	177,195	239,182
200	-	-	79
500 (MG SERIES)	261,695	317,567	127,918
500 (NEW DESIGN)	-	199	9,892
1000	143,099	256,324	103,611
2000	-	638	17929
TOTAL	632,926	762,072	522,783

Due to great technological advancement counterfeiting problems have become more and more serious. Therefore, the issue of efficiently distinguishing counterfeit banknotes from genuine ones via automatic machines has become more and more important. The fake currency detection system should be able to recognize the note quickly and correctly. The fake currency detection system should be able to recognize currency note from any side. Currency recognition system can be used in places such as shops, banks counter and automated teller machine, auto seller machines etc.

The benefits of this study for the reader are that this study will provide information about how the fake currency notes can be detected using the image processing technique.

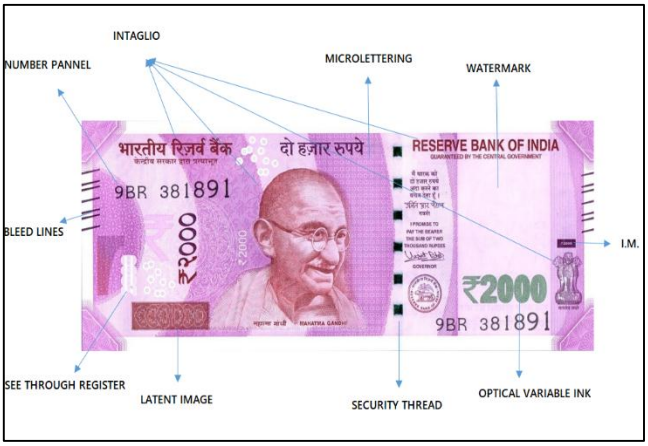
II. RELATED WORKS

There have been numerous attempts to solve the problem of currency detection using image processing and computer vision techniques in the past. Various neural network based system have been used to detect the fake paper currency. Megha Thakur et al. [1] employed Digital Image Processing method and MATLAB technique to detect the fake currency notes. Naina Shende et al. [2] employed the OCR (Optical Character Recognition) technique, image processing technique and the use of neural networks to identify the fake currencies. Yaojia Wang et al. [8] employed the image processing method in which Image Pre-Preprocessing, Edge Detection, Image Segmentation, Color Detection, Conversion to Binary Image and Gaussian Blur process are carried out to identify the fake currencies. Kamesh Santhanam et al. [9] employed UV Detection method using NI-IMAQ. Indian currency notes are coated with a special kind of dye which is visible only in the UV light. The existing device which performs the UV test is capable of testing only one currency at a time, and the process is not automatic, as well as it requires humans to check the genuineness of the currency, which are prone to human errors. Using NI-IMAQ this process can be automated using a computer. The basic logic is developed using Image Acquisition-Laboratory Virtual Instrument Engineering Workbench (IMAQ-LABVIEW). Mohammad H Alshayeji et al. [10] employed Bit Plane Slicing method using MATLAB. First the image is acquired using a scanner or digital camera then pre-processing of the image is done by converting the image to grey scale, smoothing the image using median filter and adjusting the image contrast. Afterwards eight-bit plane of the image are obtained and canny operator on eight-bit plane is applied for edge detection on higher order bits of the planes, and then image segmentation is performed and components are labeled for comparisons. Vipin Venugopal et al. [11] employed MATLAB technique. The system based on the computer communicates with web cam, catches video frames which include a visible image of currency amount and processes

them. Various methodologies are used on the surface of the image. The selected area of the image is processed and analyzed with its parameters. Once the image of the currency amount was detected, its digit is recognized. Each note is then stored in a cabinet reserved for that denomination. If any of the above given parameters doesn't match with the genuine one than the currency is declared as fake. Ravikumar H. Roogi [12]. employed a method which uses bar code technique to detect the fake currencies. Here they have generated a new note which consists of a barcode and the serial number of this barcode is maintained in the governments database. When the user scans the barcode on the note with the help of a barcode scanner and if the serial number matches the number of the database then the note is declared as real or else it is declared as fake. Barani.S [14]. employed a method of recognizing the fake currency for the visually impaired people using the CIID technique. The entire module comprises of three unit's sensor unit, processing unit and output unit. Input is captured from an array of infrared LEDs and corresponding phototransistors. Captured voltage signal from the sensor unit is acquired through microcontroller. Various signal levels are compared from the database Based on their similarities and differences, value of different bills are given in the form of recorded voice. Sonali R. Darade [15] employed a method of automatic detection of fake currency. In this method the results are obtained by performing image processing operations. Other method involved are image acquisition, pre-processing, grey scale conversion, edge detection, image segmentation, feature extraction, comparison and finally the output is displayed on the screen. Mriganka Gogoi et al. [16] employed automatic currency denomination recognition system based on artificial neural network. They used a computer approach by which they extracted the color, aspect ratio and unique identification mark and the accuracy of this system was 97%.

Although several techniques for currency detection have been proposed, most of them employ a single algorithm for the detection of the entire currency note or one or two dominant features. In this paper I have proposed a method which uses opencv3, python and digital image processing for the identification of fake notes.

III. INDIAN BANK NOTE FEATURES



IV. PROPOSED METHOD

A. Open CV3:

OPEN SOURCE COMPUTER VISION (OPEN CV) it is a library of computer functions mainly aimed at real-time computer vision. It is a cross-platform library and is free for use under the open-source BSD license.

Here the openCV is used for mainly following functions.

1) Note Identification
2) Segmentation
3) Recognition

Step by Step Procedure for currency identification using opencv3 and image processing.

The acquire currency note undergoes a projective transformation before feature extraction so as to standardize the size of all banknotes and account for differences in their dimensions. This step is essential so as to know in which dimension category the acquired note falls.

Now the note will be identified according to its dimensions. All Indian currency note have a specific dimension different from each other.

Currency Note	Height(mm)	Width(mm)
2000	66	166
500	66	150
200	66	146
100	66	142
50	66	135

All the Indian currency notes have the same height, it's the width which differentiates them from each other, apart from the other features. The dimensions of this notes are specified in the main code. First the input is provided to the machine using webcam, which is captured and processed the algorithm. The dimensions of the notes are checked and on the basis of that further processing of the currency is carried out. After the dimensions of the notes are obtained it is grouped in the respective note category i.e. either Rs 2000, Rs 500, Rs 200, Rs 100 or Rs 50. Now the next step is feature extraction from the currency note. For feature extraction first the segmentation technique is applied.

V. SEGMENTATION

It is a process of dividing into segments. The main object is divide into smaller sub-segments and then each segment is processed and studied separately. Segmentation is performed using the K-Means Image Segmentation Algorithm.

The Image Segmentation algorithm can be formulated as follows:

1) Create an initial cluster containing an original image and a set of centroid pixels randomly selected from the image. Append the initial cluster built to the array of clusters.
2) Retrieve the current cluster from the array and iterate through the set of those super-pixels (i.e. centroids).
3) For each super-pixel, compute the actual distance to each pixel in the current image. To do this, we'll normally use the variant of Euclidian distance formula that allows us to find the distance between two 3D-vectors of colors (R; G; B) of the either super-pixel or the current pixel in the given image respectively.

4) Perform a linear search to find those pixels which value of distance to the current super-pixel (i.e. centroid) does not exceed a specific boundary.
5) Build a new cluster based on the new image containing all those pixels selected at the previous step and the current value of super-pixel. In this case the super-pixel will serve as a centroid of a newly built cluster. Also, we need to substitute the color of each pixel with the centroid's color .
6) Compute the value of the nearest mean of all super-pixels in the current cluster by using the center of mass formula to find the coordinates of a particular central point for the set of super-pixels of the current cluster.
7) Perform a check if the coordinates of that central point obtained at the previous step are not equal to the coordinates of the super-pixel in the newly built cluster (the central point has not been moved). If not, append the new cluster to the array of clusters.
8) Perform a check if the current cluster is the final cluster in the array of clusters. If so, go to step 9, otherwise return and proceed with step 2.
9) Iterate through the array of clusters and merge each particular cluster image into the entire image being segmented.
10) Save the segmented image to a file.

The next step after segmentation is to extract the features from the sub-divided parts of the currency notes.

A. Ashoka Pillar Emblem Recognition:

The Ashoka Pillar is a distinctive feature on the Indian currency note with a nearly constant aspect ratio (width/height) on each note. The proposed system detects that part of the note which has the emblem symbol and compares it with the emblem symbols stored in the database. Mainly the aspect ratio is checked first and if it matches than the processing is carried forward or else the processing terminates and the note is declared as fake.

B. Colour Recognition:

The colour extraction is done using opencv and python. NumPy is used for numerical processing, argparse to parse our command line arguments and cv2 for the opencv bindings. When the picture of the currency note is provided to the machine using the webcam it is stored at a location on the disk, and that path is first provided to the program. Now we want to detect each of the colours on the note (i.e. here pink for Rs 2000 note). So for that we need to define the colour boundaries in the RGB colour space where each boundary is a list of tuples with two values: a list of lower limits and a list of upper limits. Now a loop is started over the boundaries and they are stored in the NumPy arrays. Now to perform actual colour detection we need to use the cv2.inrange function. The cv2.inrange function asks for three things: the first is the image where we will be performing the colour detection the second is the lower limit of the colour you want to detect and third is the upper limit of the colour you want to detect. After calling the cv2.inrange function a binary mask is returned, where the white pixels represent the pixels that fall in the upper and lower limit range and the black pixels do not. To create the output image now a mask is applied which simply calls the cv2.bitwise_and function showing only those pixels on the image that have corresponding white value in the mask and finally the output image is obtained.

Now after the colour of the input currency note is obtained, it is compared with the pre-stored currency notes in the database. After the comparison is made and If the notes match all the pre- defined criteria's then the output of the note is given through voice. As the note matches with the note in the database it calls the voice () function which gives us the audio output.

VI. CONCLUSION

In this paper I have proposed a method to detect the Indian Currency Notes by using the opencv, python and image processing technique. The currency notes have specific width and height, askhoka emblem and are of different colours which are well extracted and processed here with the help of algorithms. Here the input is the form of image captured with the help of a webcam and undergoes various processing steps and finally the captured image is compared with the real image of the notes stored in the database and then after the comparison the output is obtained in the audio format that what is the amount of the currency note and either it is fake or real.

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