May - June 2020
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Fake Indian Currency Detection using Image Processing

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Abstract
This paper aims to detect counterfeit currency and output the result. The model accepts the image using a mobile camera. The features from the scanned image are extracted and are matched to a set of templates. When a match is found, the result is outputted if it was genuine or not. This paper uses four algorithms: image resizing, image filtering, sobel edge detection and template matching. Even though printing of fake currencies is illegal, counterfeit currencies are still being circulated in places with no means to verify the authenticity of currency. This project is based on the idea to prevent further circulation of illegal notes. The goal of this project is to detect fake, counterfeit notes. It also detects the denomination. It is done by following a set of steps in the same order.
Firstly, the image of the currency note is acquired from mobile phone (camera). Secondly, the acquired image is resized to or scaled down to the dimensions 500 x 300. This is followed by applying bilateral filter to remove noises in image. Then the features which define the authenticity of a currency note are detected by applying sobel operator. The features are matched with those of an authentic note, by applying correlation regression. Lastly, the features are identified and displayed if the note is authentic.

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1. Introduction

Currency is the standardized unit of exchange. The counterfeiting of currency is a widespread phenomenon. currency is an imitation currency without the legal sanction of the central government. It is usually done to fake the currency and deceive the third person. Making or usage of counterfeit currency is considered as a fraud or forgery. Counterfeiting has become attractive to terrorists, as it is very profitable, particularly when comparing the associated risks to those of other criminal activities, currency counterfeiting for the purpose of financing terrorism is seen only in certain regions. The effects a counterfeit currency can have on the society may include the value of money being reduced, inflation in prices because of more money being circulated in the economy. Counterfeit currency is a threat to the economy of a country. As the technology advances on a daily basis the rate of fake notes also increases side by side. So, there comes a need check counterfeiting of currency. The hardware-based method is quiet expensive. Software detection of counterfeit notes is automated and consists of grey scale conversion, edge detection, feature extraction and pattern matching. Therefore, using software implementation eases the expense needed to purchase the hardware needed to check if the note is fake or not.. This method can not only be used in banks but also in small retail shops, which can later be expanded on a larger scale.

May - June 2020
ISSN: 0193-4120 Page No. 4484-4487

2. Literature Survey

The work presented in [1] focuses on detecting fake notes using their sample images. A note image is depicted in the dissimilarity space constructed by comparing the image with a set of prototypes. The key points where recognized using SIFT (Scale-Invariant Feature Transform) detector. The drawback was that this method was used for identifying objects on an image but not for comparing images.

Recognition of paper currency was focused in [2] which was automated to have a vast usage in banking systems and other fields of application. The paper currency recognition was done using digital image processing techniques. The feature extraction is performed on the sample image and compared with the templates of the genuine currency. The feature extraction was done using sobel operator.

Correlation technique using template matching was done in [4]. This method overcame the limitation of matching multiple objects at the same time. It involved comparing the sample template image with the original image. The template and original image are converted to grey scale to reduce the complexity due to processing. The images where then compared using sliding window technique.

A system was proposed [8] in which image processing was used to detect currency. The input was a scanned or a photographed image. The generated output would determined if the note was genuine or not. The process involved pre-processing of image, conversion to grey scale, edge detection, segmentation, feature extraction and its comparison.

The principle idea behind the sobel operator in [9] was proposed which is used to find the various edges of the images where the images were processed in X direction and Y direction. This used a matrix called as a Kernel matrix. The kernel matrix is already predefined for X and Y direction respectively. In this when the image is scanned along X direction then the X direction kernel will be used for the scanning purpose. When the image is scanned across Y direction then the Y direction kernel will be used.

Recognition and verification of various security features and watermarks in [10] gave a brief idea about what all the security features of a note currency should be matched in order to distinguish the given note whether the given note is a genuine or a fake one. The security features can be the detection of green strip on the note and Mahatma Gandhi's hidden image on the note.

3. Theoretical Background

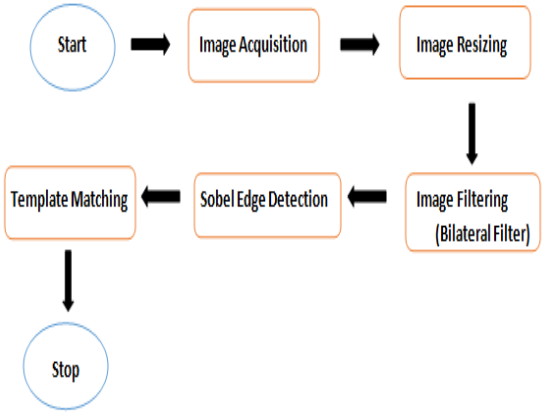

Figure 1: Basic image processing

4. Methodology

In the proposed work, a system is developed which is to detect fraud currency of Indian notes. Firstly take the input of the given image by a webcam or a mobile scanner and pre-process it like image resizing and image filtering. After the pre-processing, apply the sobel algorithm for the edge detection and template matching for detection of various features on the note currency. The various algorithms used are:

1. Image Resizing

Image resizing algorithm is used to resize the original scanned image to the specific dimension or specific resolution. The resolutions for all the images are set to 500 X 300, in order to process all the images in the fixed dimension.

2. Image Filtering

The scanned image contains various distortions or noises. In order to remove these noises, there is a need of smoothening of the image. The BILATERAL FILTER algorithm helps in removing noise from the scanned note. Bilateral filter calculates the each pixel's intensity value by replacing it with the weighted average intensity value of the surrounding pixels. The weights can depend on Euclidean distance, range differences, depth distance of the pixels.

3. Sobel Edge Detection

Edge detection is an image processing technique which is used to find the various boundaries of objects within images. It works with detecting the various discontinuities in the brightness of the image. Here the edge detection algorithms used is SOBEL EDGE DETECTION. In sobel edge detection the image is processed in X and Y directions separately, then both the direction's images are combined to form a new image which is the sum of X direction image and the Y direction

May - June 2020
ISSN: 0193-4120 Page No. 4484-4487

image. In sobel edge detection, the image is firstly converted from RGB colour channel to GRAYSCALE image. After that, the Kernel convolution is calculated which is a 3 X 3 matrix having symmetrically weighted indexes. While scanning across X direction of the image the X Direction kernel will be used to scan and while scanning across Y direction of the image the Y direction kernel will be used.

X- Direction Kernel

-1	0	1
-2	0	2
-1	0	1

Y- Direction Kernel

-1	-2	1
0	0	0
1	2	1

Figure 2: Sobel Edge Detection

4. Template Matching

It is a technique in the computer vision (OpenCV) to find similar features between 2 images. It is a process of finding the template image in the main image. The function cv2.matchTemplate() which is defined in OpenCV is used for template matching. It moves the template image over the main image and compares the template and the patch of main image under the template image. Then it returns a grayscale image, where each of the pixels denotes how much the neighbour pixels are matched with the template. After the result, a function cv2.minMaxLoc() is used to find where the maximum or minimum value is present. A correlation coefficient cv2.TM_CCOEFF (correlation coefficient) is used for template Matching. The formula of cv2.TM_CCOEFF is given by

$$R(x, y) = \sum x', y' (T'(x', y') \cdot I'(x+x', y+y'))$$

in which,

$$T'(x', y') = T(x', y') - 1/(w \cdot h) \cdot \sum x'', y'' T(x'', y'')$$

$$I'(x+x', y+y') = I(x+x', y+y') - 1/(w \cdot h) \cdot \sum x'', y'' I(x+x'', y+y'')$$

Where,
x :pixel value along x-axis
y: pixel value along y-axis
x′ : first pixel value after x
y′ : first pixel value after y
x″ : second pixel value after x
y″ : second pixel value after y
w : width of template image
h : height of template image
R(x,y) : sum of all elements in Matrix
I : source image or main image
T : template image
I′ : resized source or main image
T′ : resized template image

After the template is found, a rectangle box will be drawn on the main image and that will be the region of template.

Figure 3: Template Matching

5. Result

This project portraits the recognition of counterfeit note using image processing with python. This project includes the process that considers both visible and invisible features for verifying original or fake notes, we have used the methods like Image pre-processing for improving the appearance of scanned image, binarisation for converting RGB image into grey scale, edge detection (sobel), image segmentation for extracting the features in simple version and then compared to identify if it's counterfeit note or not .This helps the users to identify original notes easy and fast.

May - June 2020
ISSN: 0193-4120 Page No. 4484-4487

6. Conclusion and Future Work

This project on Fake currency detection using image processing is based on edge detection using sobel operator. The entire code is written in Python programming language by using the OpenCV module - an open-source library for computer vision, machine learning and image processing. The image of the currency note is first acquired, followed by image resizing to the desired dimension (500x300). Bilateral filtering is applied to the resized image to remove noise from the image. Sobel Edge Detection is applied to identify the boundaries of various templates. Finally, we match the identified features in the test image with the actual features of a legit note by using a correlation coefficient cv2.TM_CCOEFF.

This product can be implemented in places involving money transaction like Banks, ATMs, Supermarkets, etc...This project not only identifies the different denominations in the Indian Currency, but also detects for fake or counterfeit notes.

Furthermore, it can be elaborated to identify the currencies of different countries as well along with their denominations. The main goal of this project is to help the visually impaired with their money transaction by assisting them to identify the denominations in Indian Currency.

This project is strictly implemented in identifying currencies in its note form. Hence, coins cannot be identified.

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