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Evaluate and Propose a Novel Technique to Check Genuineness of the Currency Using Image Processing

Sunetra Chandel [1], Mahendra Tyagi [2]
ECE, L.R.I.E.T, Solan
Assistant Professor [2], ECE, L.R.I.E.T, and Solan
Himachal Pradesh – India

ABSTRACT
Currency recognition is an image processing technology that is used to check whether the currency under analysis is genuine or not. Counterfeiting of whatever kind has been occurring ever since humans realized the concept of valuable items. Since then there has been an ongoing race between the certifiers and counterfeiters. Methods such as checking currency genuiness helps in easing human life. The growing improvement in computers has made it easier for illegal people to produce counterfeit money using advancements in technology. Various methodologies are applied on the image under analysis. The processing is carried out on MATLAB. It's a high performance language for technical computing. It's user friendly and easy to use.

Keywords :— Currency, Counterfeiting, SIFT.

I. INTRODUCTION

Currency has great importance in our day to day life. Currency in general is a token that is exchanged for purchasing goods or services. Currency is available in different forms. Currency can be in various forms such as metal, paper, polymer, etc. [1]. There are more than two hundred different currencies used in various countries around the world. All the currencies used around the world are different from each other. The difference may be in the material of the paper used, the size of the paper, colour of the paper and pattern [2]. With the advent of money started it's counterfeiting. The imitation currency produced without legal sanction of government is called fake currency or counterfeit money. Producing or using such currency is illegal. It's a fraud. Counterfeiting is as old as money itself. It has been so prevalent since ancient times that it has been called as "the world's second oldest profession." Use of such money increases corruption and hinders the growth and development of country [3]. Paper currency is the widely accepted mode of money transaction besides so many alternatives present. Fake notes are a problem to every country, but India has been hit really hard and the problem has become a major one. Currency detection means finding fake notes from the genuine ones [4]. Currency recognition can be used in various areas such as banking, business, railways, shopping malls, stores, organizations, etc. Here in this work recognition of paper currency with the help of Digital Image Processing techniques is described. The image processing approach is combined with MATLAB to detect the features of paper currency. The currency recognition with good accuracy and speedy processing is of good importance. The characteristic extraction is performed on test image and it is compared with the characteristics of the genuine currency. The proposed method has advantage of high speed of processing and good accuracy. The results show that this approach is effective and efficient and meets the requirements of the system.

II. SIFT ALGORITHM

SIFT algorithm was published by David Lowe in 1999. SIFT is scale invariant feature transform that provides motion tracking, multiview geometry and recognition. Applications include object recognition, robotic mapping and navigation, image stitching, 3D modelling, gesture recognition, video tracking, individual identification of wildlife and match moving. Features of SIFT are highly distinctive, relatively easy to extract and allow for correct object identification with low probability of mismatch. They are relatively easy to match against a large database of local features. Different algorithms can also be used but SIFT algorithm is less time consuming algorithm and produce results better than any other algorithms .SIFT is local descriptor which is consists of four major stages. These stages are:

Scale-space Peak Selection: At particular stage and location points are identify by scanning the image. To search at a multiple scale space is used with the help of Gaussian functions. The SIFT detector construct scale space. It is multiple signal representation theory. Gaussian kernels are also used in it. The framework of scale space makes it space variant. Gaussian pyramids are constructed efficiently in it. For the local key points in the series of Differentiate of images (DOG) are also constructed efficiently. Mainly it is used to decrease the space. The main function is to resize the image according to first image or comparative image. Gaussian function is attached with the resize function.

Key Point Localization: It is the second stage of the SIFT function. It the candidate of the main pixel into sub pixels to find out the accuracy and remove the unstable particles or key points. It is used to improve the pixels and remove the bad pixels. It is point descriptor like rings. In this process all the points are scans so that to improve its accuracy and remove unwanted points. It is used to find out the points and mark them as circles. It removes the large edges.

Orientation Assignment: The assigned orientation, location and scale for all key point enables SIFT to create a canonical view for the candidate points that are invariant to similarity transforms. Its orientation depends upon the identification of the local images patches. It removes the effect of scaling and rotation according the requirement. Here set the good points and scale them and rotate them according the requirement we needed. Scale of point is used to find out the good points. Using different types of differentiation find out orientations and gradient magnitude.

Key Point Descriptor: Descriptor means to mark point. In this process all the points are scans so that to improve its accuracy and remove unwanted points. It is used to find out the points and mark them as circles. It removes the large edges. This final stage creates the local images based upon the local image patches present in its local neighbourhood. Each point has its own value. Each particular region has different types of values.

Verbosity: It displays the code which is used in it. It specifies the code after the generation of the result. The time value may vary. Its value can either increase or decrease. If the value is 1 means result is producing means continuing of the result and if value is 0 means result produced.

Threshold: In it grayscale is used which is less then binary. It has two types of value. If the grayscale values are greater than 1 then pixel is white and if value is less than 1 then pixel is black.

Grayscale >1 means white pixel
Grayscale <1 means black pixel

Frame is used in it. Frame means cropping the picture according to the requirement so that two images matches. Suppose in an image we have two persons picture. We want to choose head of one person so choose one frame for this. For the selection of second head choose second frame and so on.

III. TECHNICAL AND THEORETCAL BACKGROUND

A. THEORETICAL BACKGROUND

An image is stored as a matrix using standard MATLAB matrix conversions. There are many types of images supported by MATLAB.

- **Intensity Images:** These are the simplest format for grayscale images. An intensity image is a data matrix whose values represent intensities within some range
- **Binary Images:** A binary image is a digital image that has only two possible values for each pixel. Typically the two colors used for a binary image are black and white, though any two colors can be used. The color used for the object in the image is the foreground color while the rest is the background color. Binary images are also called bi-level or two-level. Binary images often arise in digital image processing as masks or as result of certain operations such as segmentation, thresholding, etc.
- **Indexed Images:** In computing, indexed color is a technique to manage digital images' colors in a limited fashion in order to save computers memory and file storage. When an image is encode in this way, the color information is not directly carried by the image pixel data, but its stored into a separate piece of data called a palette. A palette is an array of color elements, in which every element, a color, is indexed by its position within the array. This way, each pixel does not contain the full information to represent its color, but only it's index into the palette. This technique is sometimes referred to as pseudocolor or indirect color.
- **RGB images:** The RGB color model is an additive color model in which red, green and blue light are added together in various ways to reproduce a broad array of colors. The name of the model comes from the initials of the three additive primary colors red, green and blue. RGB is a device dependent color space: different devices detect or reproduce a given RGB value differently. The main purpose of the RGB color model is for sensing, representation and display of images in electronic systems such as computers and television.
- **Image Format:** The images used for reference in this work are of format .jpg and .bmp which are joint photographic experts group and bitmap respectively. JPEG is a group of experts that se standards for computer images. The bmp images are the basic image format which later developed into other formats.

B. B.TECHNICAL BACKGROUND

The aim of the currency recognition technology is to search and extract the visible and hidden marks on paper currency for efficient classification. A much simpler way is to make use of visible features of paper currency like we can get to know from size and color of paper currency. But this may have serious issues as with time the paper currency gets worn and torn and even get soiled and dirty [6]. The techniques of image processing we use on our test images are described further.

- **Image Acquisition**

The first stage of any vision system is this technique. This is so because without any image no processing is possible. In this first and foremost step image is acquired from any camera or scanner. After obtaining the image various methods of processing can be applied. The acquired image should be such that it retains all its features. We can choose from various analog and digital cameras. A scanner is a device that optically scans handwriting, images, and printed texts and converts them into digital images [7] [8].

- **Image Pre-processing**

Pre-processing of image involves those operations which are required prior to main data analysis and extraction of information. The main goal of pre-processing is to enhance the visual appearance of

images [9]. Image pre-processing suppresses undesired distortions present in image. It can also be used to enhance desired features that are important for further processing and analysis. Image restoration is another word for pre-processing. It involves the correction of distortion, degradation, and noise that may be introduced.

- **Image Adjusting:** when we acquire an image the size of image is too big. In order to reduce the calculation we resize image according to our requirements. Resizing of images saves memory. The processed images must be of same size. Image adjustment is carried out with the help of Interpolation. Interpolation is a technique that is basically employed for various tasks such as rotating, zooming, shrinking, geometric corrections etc. Interpolation can be bilinear and bicubic. In bilinear the concept of four nearest is used to estimate the intensity at a given location. We assume that (x, y) denote the coordinates of the location where we want to assign intensity at a given value and Z(x, y) denotes intensity value. To evaluate assigned value we use the following equation

$$Z(x, y) = ax + by + cxy + d \quad (1.1)$$

- **Image Smoothening**: while acquiring image noise appears. Image noise is the random variation of brightness in images. Removal of noise is important during pre-processing. Image smoothening can be done with the help of median filter. Median filter replaces a pixel via the median pixel of all the neighbourhoods. W represents a neighbourhood which is centred on the location.

$$Y[m, n] = median\{x(i, j) \quad ; (i, j) \in W\} \quad (1.2)$$

- **Edge Detection**

Edge detection is a set of mathematical models that aim at identifying points in a digital image at which the image brightness changes sharply or has discontinuities. Edges are the points at which image brightness changes sharply. The problem of finding discontinuities in 1-D signals is termed as step detection. Edge detection can be used to locate boundaries of objects within images.

- **Image Segmentation**

Partioning of a digital image into multiple segments is segmentation. This is done to distinguish objects from backgrounds [9]. The segments are set of pixels also known as super pixels. The goal of segmentation is simplification of an image into something that is more meaningful and easier to analyze. We can locate objects and boundaries (lines, curves, etc.) in images by using segmentation. In precise image segmentation is a process in which a label is assigned to every pixel in the image so that the pixels that have same label share certain characteristics [8].

- **Feature Extraction:** Feature extraction is a very challenging technique of image processing where the dimensionality of data is reduced. Extraction of more number of features not only increases the cost but also sometimes lowers the system performance in terms of execution time. The main task is to find the effective features among many [7]. If the features to be extracted are chosen carefully then it's expected to extract relevant information from input data in order to perform desired task.

- **Colour Feature**

The image we acquire is in RGB format. After resizing it changes to HSV colour space. The advantage of using HSV color space is that it closely resembles the human conceptual understanding of colours. It too has the ability of separating chromatic and achromatic components. The feature extraction of a colour image can be done by analysing its colour histogram, hue, saturation, intensity (or value). In HSV (Hue, Saturation, Value) space hue distinguishes colour, saturation is the amount of white light added to pure colour and value represents perceived light intensity [7].

- **Size:** The size of the banknote is being considered because during circulation of banknote wear and tear leads to reduction in size. Size may also increase slightly while rejoining torn bank notes [7].

IV. PROPOSED WORK

The SIFT algorithm takes an image and transforms it into a collection of local feature vectors. Each of these feature vectors is distinctive and invariant to any scaling, rotation or translation of image. The invariant features detected from images have been used for reliable matching of features of currency notes. In the proposed technique, currency images are taken and its seen that each currency have their unique identification. It means that whether it is whatever denomination note the features are different. The proposed system matches various features of the currency note to declare whether currency is genuine or not. The features font, shape, RBI seal latent seal etc. All these features are extracted using SIFT. The features are matched using nearest neighbour classifier. In this improvement is proposed in which neighbour classifier is replaced with Bayesian classifier. This leads to improvement in accuracy of currency detection. The improvement in SIFT algorithm is proposed to match internal features of the currency while earlier only external features were matched. In this work, existing base paper technique is implemented for currency recognition. In this work, the image is taken as input and that input image is converted into gray scale. To detect font of the character, SIFT algorithm is used which analyses the whole image. On the basis of properties of the image, edges are detected. Image segmentation is applied in to detect numeric's from the input image. In the last step the numeric text is extracted and compared with the genuine numeric and define that whether currency is genuine or fake.

V. RESULTS OF EXPERIMENTAL GRAPHS

Fig.1 input image

As shown in Fig.1, this image is input to the proposed technique. In the proposed technique take two inputs the take image and real image. The RGB bands of the both images are extracted to identify that legitimacy of the input image

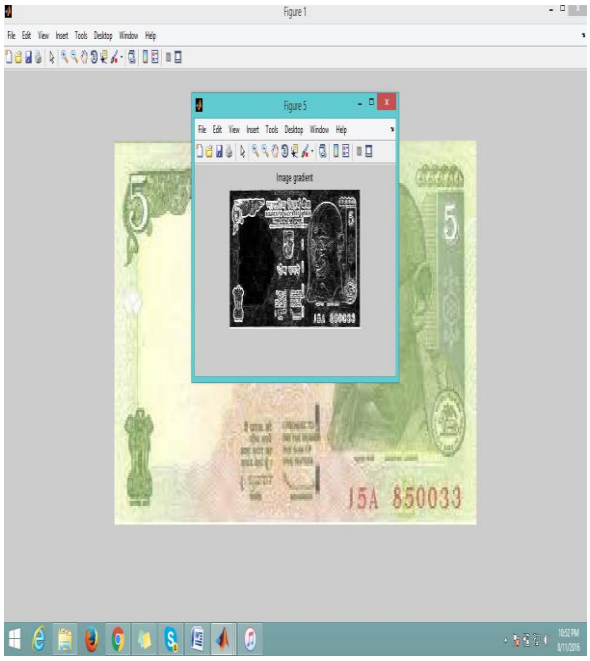

Fig.2 image gradient

As shown in Fig.2, In the proposed technique two images are taken as input the first image is real image and second image is take image. The RED, GREEN and BLUE colours of the image are masked and from these image intensity of the colours are calculated using gradient function .

Fig.3 strip extraction

As shown in Fig.3, the image which is taken as input, on that image features are analysed using morphological scanning. The DWT technique is applied to extract features of this image. The strip part of the image is extracted for batter analysis of the image.

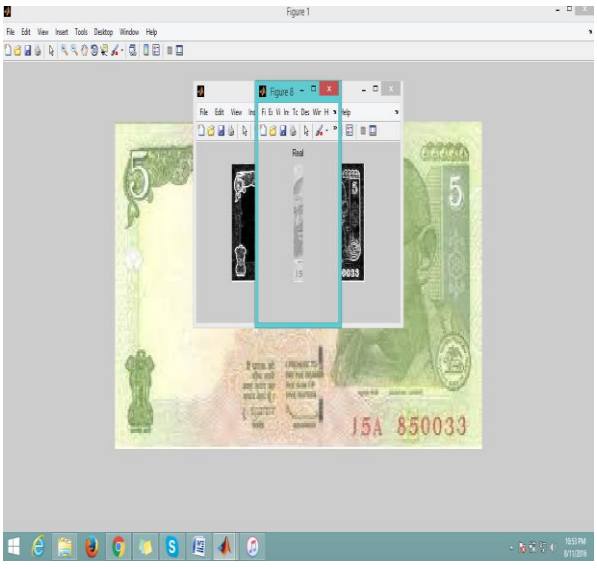

Fig.4 strip extraction grayscale

As shown in Fig.4, the image which is taken as input, on that image features are analyzed using morphological scanning.

The DWT technique is applied to extract features of this image. The strip part of the image is extracted for batter analysis of the image.

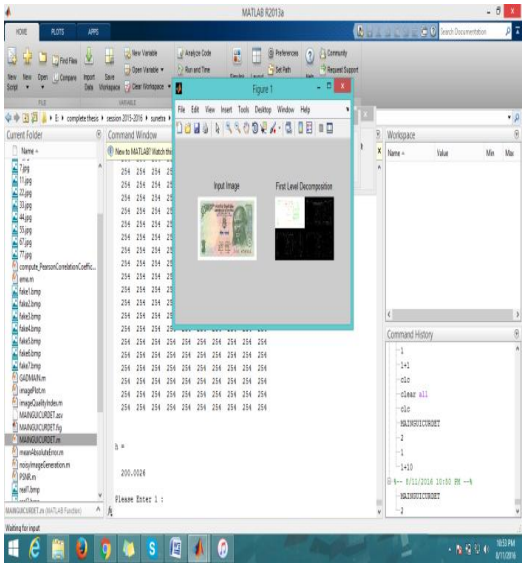

Fig.5 decomposition of input image

As shown in Fig.5, the image which is taken as input, technique of morphological scanning and DWT is applied and on that technique classifier is applied to classify extracted image features.

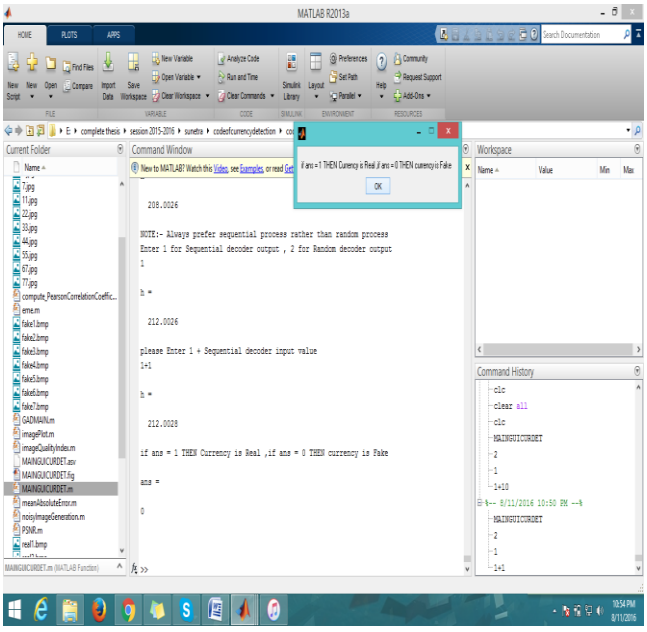

Fig.6 currency recognition

As shown in Fig.6, the image which is taken as input, technique of morphological scanning and DWT is applied and on that technique classifier is applied to classify extracted image features. The variable ans is defined, if the value of ans is 0 then currency is fake and if ans variable value 1 then it is real.

VI. CONCLUSIONS

Various techniques have been proposed up to existing time to analyze various features of the image. The SIFT algorithm is broadly used in the previous times to analyze external features of the image. The currency detection is the application of image analysis, in which SIFT algorithm is applied to analyze external features of the image. The detected features gave output that whether input currency image is genuine or fake. In this work, it is concluded that due to analysis of external features accuracy of currency detection is reduced. In this work, new technique has been proposed which is based on Bayesian classifier for the currency detection. The new technique analyzes internal features of the image for detection. The simulation is performed in MATLAB and results show an increase in accuracy up to 10 percent.

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