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Fake Indian Currency Recognition System by using MATLAB

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Abstract: ***Counterfeit notes are one of the biggest problem occurring in cash transactions. For country like India, it is becoming big hurdle. Because of the advances in printing, scanning technologies it is easily possible for a person to print fake notes with use of latest hardware tools. Detecting fake notes manually becomes time-consuming and untidy process hence there is need of automation techniques with which currency recognition process can be efficiently done. Here we implemented our proposed idea in two ways: one by using analysis through hyper spectral imaging and the second one is the Extraction of different features in fake and real currency notes and through comparing with each other we can able to differentiate the fake note from the real note. We integrated these two systematic approaches in our proposed work. The different colour lights used for hyper spectral imaging are Ultraviolet (UV) light, Normal LED Bulb, Red LED light, Green LED light and Blue LED light with different wavelengths ranging from 360 nm to 800nm respectively. In image processing part, The different features present in the testing input note is identified and compared with the real note and results as the given note is fake or not. Entropy is measured for all the features. The Aspect Ratio is calculated initially for the input notes in order to classify the given note is 100,500 or 2000. This all modules are implemented in MATLAB. We have implemented a fake note detection unit with image processing algorithms. The experimental results indicate that the results achieved are nearly accurate, since the textural background which looks very complex has similar intensity levels.***

Keywords: MATLAB, entropy, hyper spectral imaging,

I. INTRODUCTION

The Reserve Bank is only one which has the sole authority to issue bank notes in India.

Reserve Bank, like other central banks the world over, changes the design of bank notes from time to time. Traditionally, anti-counterfeiting measures involved including fine detail with raised intaglio printing on bills which allows non-experts to easily spot forgeries. On coins, *milled* or marked with parallel grooves edges are used to show that none of the valuable metal has been scraped off. Reserve bank uses several techniques to detect fake currency.

Manual testing of all notes in transactions is very time consuming and untidy process and also there is a chance of tearing while handing notes. Therefore Automatic methods for bank note recognition are required in many applications such as automatic selling-goods and vending machines. Extracting sufficient monetary characteristics from the currency image is essential for accuracy and robustness of the automated system. This is a challenging issue to system designers. Every year RBI (Reserve bank of India) face the counterfeit currency notes or destroyed notes. Handling of large volume of counterfeit notes imposes additional problems. Therefore, involving machines (independently or as assistance to the human experts) makes notes recognition process simpler and efficient.

Counterfeit money is imitation currency produced without the legal sanction of the state or government. Producing or using counterfeit money is a form of fraud or forgery. Counterfeiting is almost as old as money itself. Plated copies have been found of Lydian coins which are thought to be among the first western coins. Before the introduction of paper money, the most prevalent method of counterfeiting involved mixing base metals with pure gold or silver. A form of counterfeiting is the production of documents by legitimate printers in response to fraudulent instructions.

Counterfeit money is imitation currency produced without the legal sanction of the state or government. Producing or using this fake money is a form of fraud or forgery. Counterfeiting is as old as money itself, and is sufficiently prevalent throughout history that it has been called "the world's *second* oldest profession. This has led to the increase of corruption in our country hindering country's growth. Common man became a scapegoat for the fake currency circulation, let us suppose that a common man went to a bank to deposit money in bank but only to see that some of the notes are fake, in this case he has to take the blame. Counterfeiting, of whatever kind, may be that has been occurring ever since humans grasped the concept of valuable items, and there has been an

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ongoing race between certifier like (banks, for example) and counterfeiter ever since. Some of the effects that counterfeit money has on society include a reduction in the value of real money; and inflation due to more money getting circulated in the society or economy which in turn dampen our economy and growth - an unauthorized artificial increase in the money supply; a decrease in the acceptability of paper money; and losses. And this some of the methods to detect fake currency are water marking, optically variable ink, security thread, latent image, techniques like counterfeit detection pen and using MATLAB.

II. OVERVIEW

A. Hyperspectral Imaging

With significant advances in printing and production equipment, the production and circulation of inauthentic currency notes have become increasingly sophisticated. Although there are advanced detection and analysis methods for counterfeit currency notes and artifacts, most require expensive laboratory bench-top equipment that require detailed training, and are usually slow to collect and analyze data. Some of these need elaborate sample handling and positioning, and frequently cannot be taken into the field.

This technical note presents a simple fluorescence-based hyperspectral-imaging method of detecting and analyzing the quality or authenticity of currency notes and artifacts using 365 nm Ultraviolet (UV) Bulb. All the image and spectral data are collected by capturing snapshot via camera.

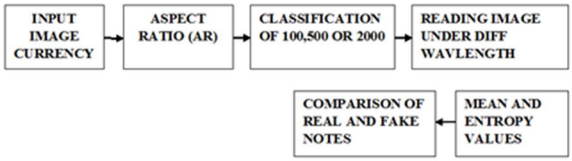


Fig. 1 Block diagrams of the proposed system of hyperspectral imaging.

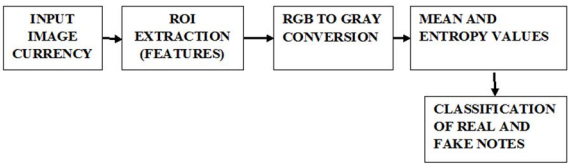


Fig. 2 Block diagram of the proposed system of image processing.

B. Aim and Objective

The main objective of our proposed work is to propose a currency note recognition system under hyperspectral imaging mode with different lights under different wavelengths and the comparison of features by using image processing algorithms.

III. PROPOSED SYSTEM AND ALGORITHM

We propose a system in which the recognition of currency notes can be done automatically based on the combination of enhancement, segmentation and feature extraction method under image processing. First we acquire the images under hardware setup which consists of camera mounted inside the box with the arrangement of UV light, Normal LED light along with multicolor LED's. The hardware setup is interfaced with the PC using USB port of web-camera. Once the power supply on, the images are captured using webcam software by placing the different currency notes inside the box setup. The acquired images are given as the input for the program created in the MATLAB software. Aspect Ratio is calculated initially. Based on the AR, it is classified that the given note is 100, 500 or 2000.

Entropy and Mean act as the main feature extraction technique which is applied for all the images and the values are collected. After running the program, we will get the results such that the graph is plotted between the real note and the fake note under different modes and wavelengths. Therefore we can able to obtain the threshold value which act as the center between real notes and fake notes. The utility of low-resolution images of currency notes acquired from camera is examined to ascertain the performance. The different Features in the note are detected and extracted based on ROI extraction method by setting the width and height of the ROI portion. The extracted features are compared between real note and fake note. Entropy is applied and the entropy value is compared between the two. Through the difference in entropy values, we can classify that the given note is real note or fake note.

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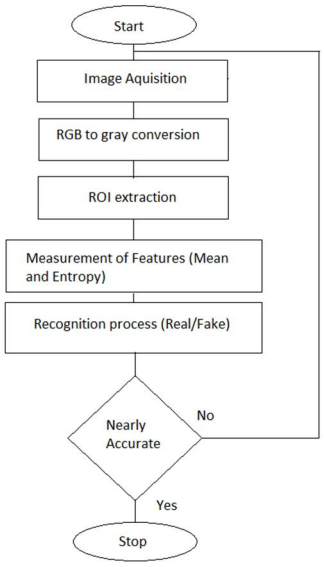


Fig.3 Flowchart of the proposed system

IV. FEATURES OF A REAL NOTE

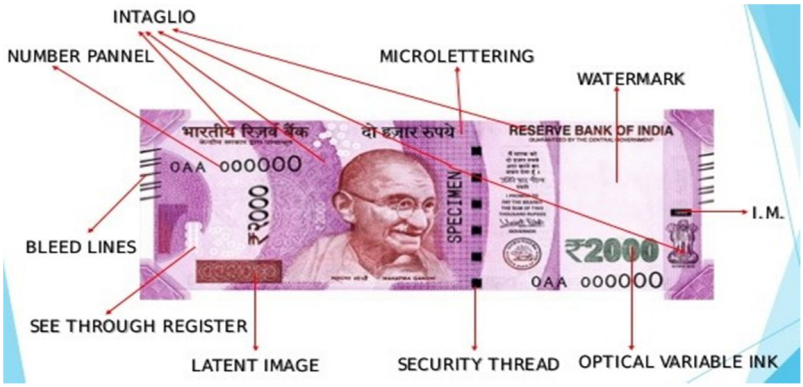


Fig. 4 Security features of the a note

A. The Mahatma Gandhi Series of banknotes contain the Mahatma Gandhi watermark with a light and shade effect and multi-directional lines in the watermark window. Identify applicable funding agency here. If none, delete this text box.

B. This is a new feature included in the Rs.1000 and Rs.500 notes with revised color scheme introduced in November 2000. The numeral 1000 and 500 on the obverse of Rs.1000 and Rs.500 notes respectively is printed in optically variable ink viz., a color-shifting ink. The colour of the numeral 1000/500 appears green when the note is held flat but would change to blue when the note is held at an angle.

C. Number panels of the notes are printed in fluorescent ink. The notes also have optical fibers. Both can be seen when the notes are exposed to ultra-violet lamp.

D. The Rs.500 and Rs.100 notes have a security thread with similar visible features and inscription “Bharat” (in Hindi), and “RBI”. When held against the light, the security thread on Rs.1000, Rs.500 and Rs.100 can be seen as one continuous line. The Rs.5, Rs.10, Rs.20 and Rs.50 notes contain a readable, fully embedded windowed security thread with the inscription “Bharat” (in Hindi), and “RBI”. The security thread appears to the left of the Mahatma's portrait.

E. The portrait of Mahatma Gandhi, the Reserve Bank seal, guarantee and promise clause, Ashoka Pillar Emblem on the left, RBI Governor's signature are printed in intaglio i.e. in raised prints, which can be felt by touch, in Rs.20, Rs.50, Rs.100, Rs.500 and Rs.1000 notes.

F. On the obverse side of Rs.1000, Rs.500, Rs.100, Rs.50 and Rs.20 notes, a vertical band on the right side of the Mahatma Gandhi’s portrait contains a latent image showing the respective denominational value in numeral. The latent image is visible only when the note is held horizontally at eye level.

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G. This feature appears between the vertical band and Mahatma Gandhi portrait. It always contains the word "RBI" in Rs.5 and Rs.10. The notes of Rs.20 and above also contain the denominational value of the notes in micro letters. This feature can be seen well under a magnifying glass.

H. Each note has an unique mark of it. A special feature in intaglio has been introduced on the left of the watermark window. This feature is in different shapes for various denominations (100-Triangle, Rs.500-Circle, and Rs.1000- Diamond) and helps the visually impaired to identify the denomination.

V. METHODOLOGY

A. Image Acquisition

The real-time image of currency is captured using camera is taken as the input. We can use webcam with hardware setup to capture the currency. The acquired image is later converted into the respective RGB histograms.



Fig.5 Acquired image

B. RGB to GRAY conversion

The real-time image of currency is captured using camera is taken as the input. We can use webcam with hardware setup to capture the currency.



(a) (b)

Fig.6 RGB to Gray conversion

C. Feature Measurement

Entropy and Mean act as the main feature extraction technique which is applied for all the images and the values are collected.

D. Classification

We will get the results such that the graph is plotted between the real note and the fake note under different modes and wavelengths. Therefore we can able to obtain the threshold value which act as the centre between real notes and fake notes.

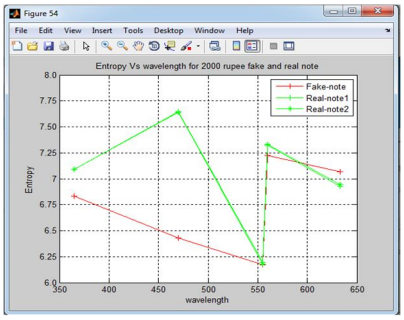


Fig.7 Entropy Vs wavelenght of Real Note and Fake Note 2000 Rupee

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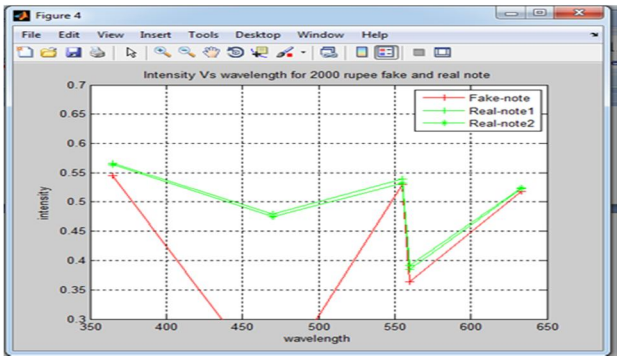


Fig.8 Intensity Vs wavelength of Real Note and Fake Note 2000 Rupee.

VI. IMPLEMENTATION

The execution stage regarding the task is that the complete aim is essentially changed keen on running code. Intend regarding the stage is towards interpreting the aim keen on a finest likely result within an appropriate programmed language. In this section, it covers up the execution phase concerning the task, providing particulars regarding the programmed language as well as improvement background employed. It as well provides a general idea about the important sections regarding the task by means of its bit by bit course.

The execution phase involves the following tasks

1) Cautious scheduling.
2) Examination regarding structure as well as constraints.
3) Aim concerning the techniques towards accomplishing the conversion.
4) Assessment concerning the conversion technique.
5) Accurate judgment about the choosing of the proposal.

A. Software Used

The necessary program regarding private PC that comprises configuration as specified as follows:-

1) Windows 7(64-bit) operating system.
2) MATLAB 7.14 Version R2012a

B. Image Processing Toolbox

Image processing device box permits carrying out image improvement, deblurring of image, characteristic identification, decreasing of noise, image segmentation, arithmetical alteration, as well as registration of image. Image processing device intended for the execution regarding methods proposed are specified below:-

1) Fundamental import as well as export
2) Display

VII. RESULTS

A. Real 2000 Rupees Note.

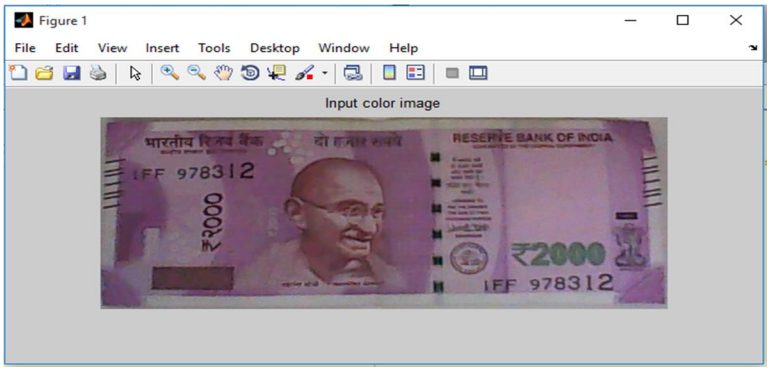


Fig.9 Input of the real 2000 note

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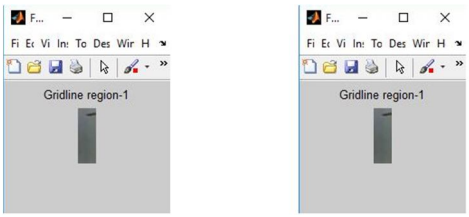


Fig.10 Gridline of note

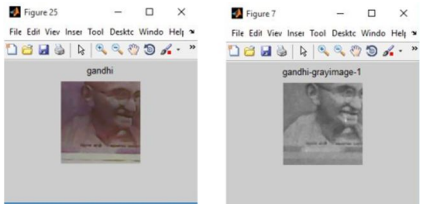


Fig.11 Gandhi security feature of the note

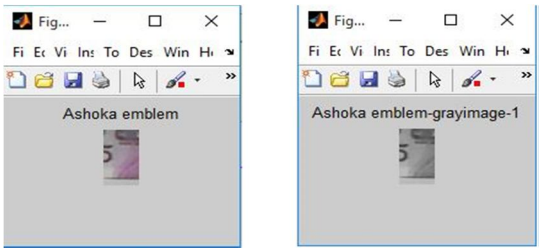


Fig.12 Ashoka emblem feature of the note

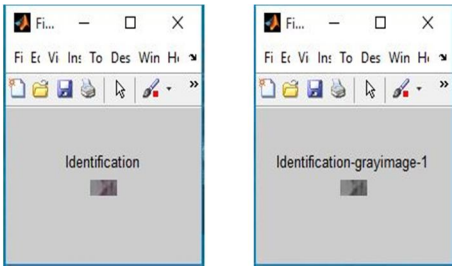


Fig.13 Identification feature of the note

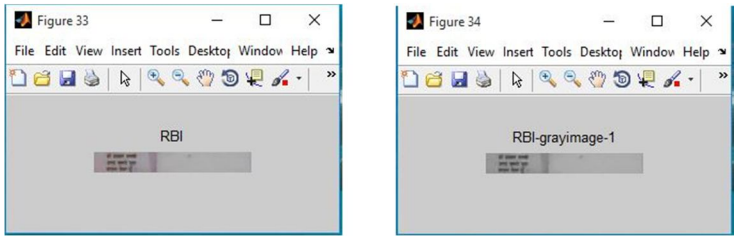


Fig.14 RBI feature of the note

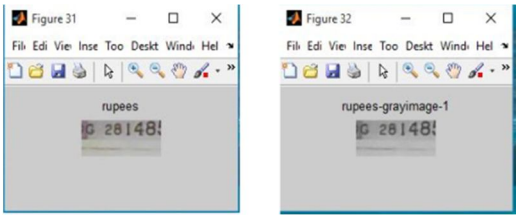


Fig.15 Rupee feature of the note

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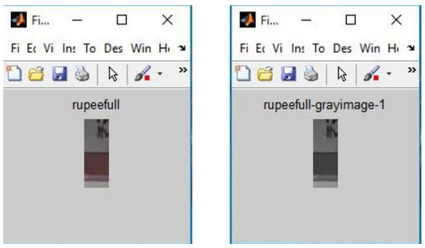


Fig.16 Rupeefull feature of the note

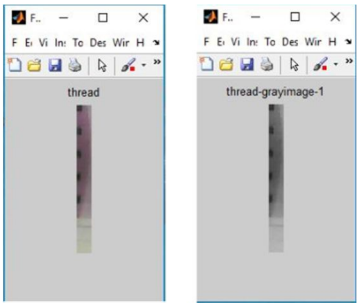


Fig.17 Thread feature of the note

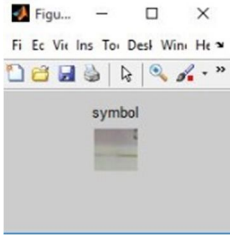


Fig.18 Symbol of the note

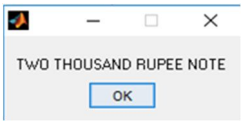


Fig.19 Recognition of the note

B. Fake 2000 Rupees notes.



Fig.20 Input image of a fake 2000 note

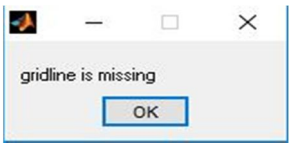


Fig.21 Missing gridline feature

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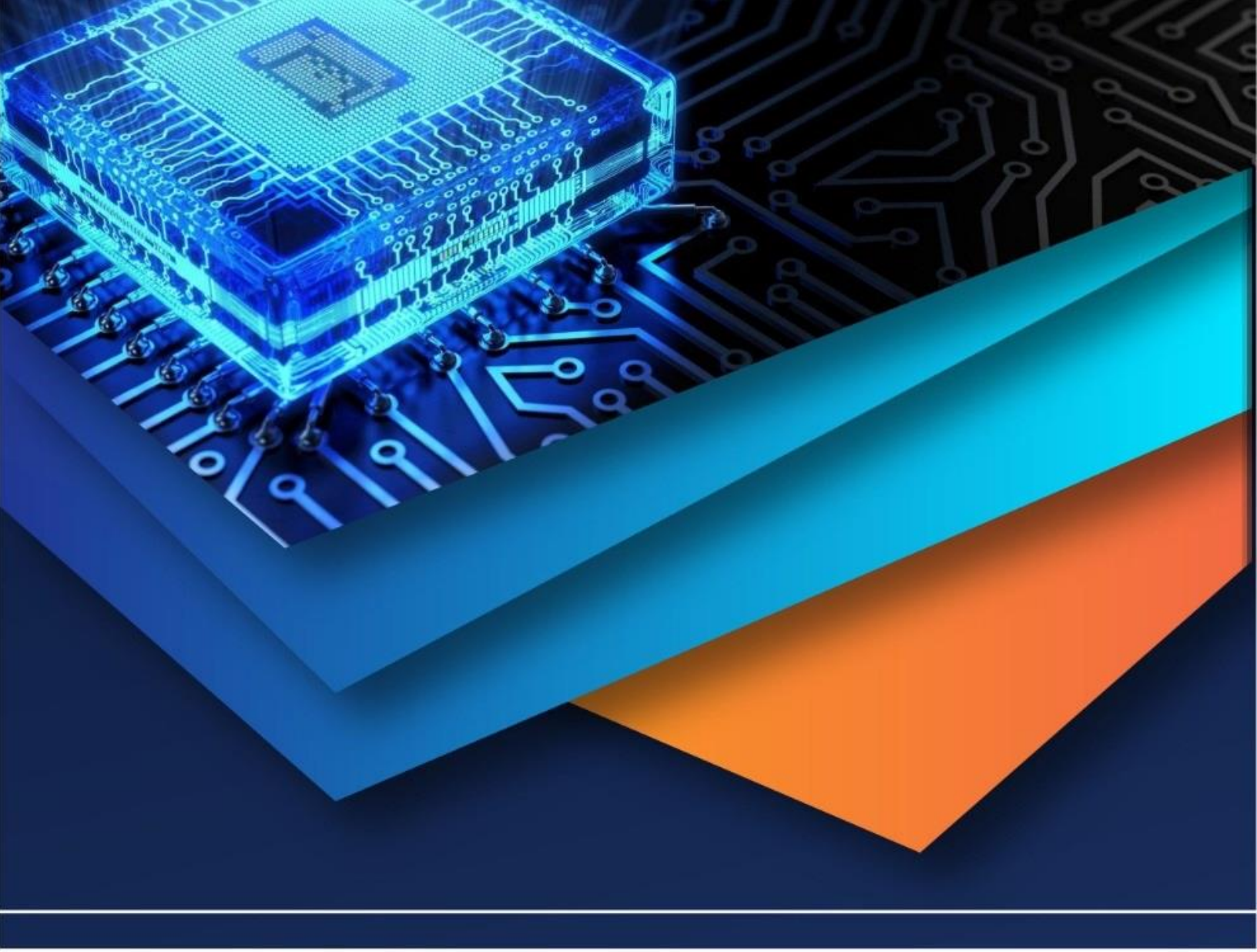
VIII. CONCLUSION

We implemented our proposed idea in two ways: one by using analysis through hyperspectral imaging and the second one is the Extraction of different features in fake and real currency notes and through comparing with each other we can able to differentiate the fake note from the real note. We integrated these two systematic approaches in our proposed work. The different color lights used for hyperspectral imaging are Ultraviolet (UV) light, Normal LED Bulb, Red LED light, Green LED light and Blue LED light with different wavelengths ranging from 360 nm to 800nm respectively. In image processing part, The different features present in the testing input note is identified and compared with the real note and results as the given note is fake or not. Entropy is measured for all the features. The Aspect Ratio is calculated initially for the input notes in order to classify the given note is 100,500 or 2000. This all modules are implemented in MATLAB. We have implemented a fake note detection unit with image processing algorithms. The experimental results indicate that the results achieved are nearly accurate, since the textural background which looks very complex has similar intensity levels.

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