Spectral analysis of various security features in the Indian currency note of highest denomination using Video Spectral Comparator-40

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Abstract

The question of authenticity of paper currency is usually asked from forensic document examiners since the cases of counterfeit currency notes using sophisticated printers are on the verge. Such type of currency is infused through international borders and when seized are identified on the bases of various security features specified in that note. Indian currency also have various security features which are changed or enhanced time to time by Reserve Bank of India to avoid counterfeiting. Present paper emphasize on studying various security features on the paper currency of highest denomination in India that is ₹1000 with Video Spectral Comparator-40 which works on the principal of interaction of light of various wavelengths with currency notes.

Keywords: Currency notes, counterfeit, authenticity, security features, Video Spectral Comparator

Acknowledgements: The authors gratefully acknowledge the Head of the Department, Department of Criminology and Forensic Science, Dr. Harisingh Gour Central University, Sagar, Madhya Pradesh, India for allowing us to use necessary facilities.

Introduction

Currency is a generally accepted form of money, including coins and paper notes, which is issued by a government and circulated within an economy and used as a medium of exchange for goods and services, currency is the basis for trade [1]. Most countries have assigned the responsibility for issuing national banknotes to a central bank. A banknote (often known as a bill, paper money, or simply a note) is a type of negotiable instrument known as a promissory note, made by a bank, payable to the bearer on demand [3]. The Indian rupee (sign: ₹; code: INR) is the official currency of the Republic of India. The issuance of the currency is controlled by the Reserve Bank of India [2]. As of 2014 banknotes of the denominations of ₹5, ₹10, ₹20, ₹50, ₹100, ₹500 and ₹1000 are in circulation. The Indian 1000-rupee banknote (₹1000) is of highest denomination of Indian currency. It was first introduced by the Reserve Bank of India in 1954, demonetized in January 1978 and reintroduced in 2000. [4] [5]

Counterfeiting of Currency note:

Counterfeit is a parallel term which comes to our mind when we talk about currency which refers to fake or made in imitation like counterfeiting of currency notes that are not produced...
by authorities. Indian economy and an average citizen is badly hit by these fake banknotes, according to a report fake currency amounting to around Rs 90,000 crores is in circulation in Indian economy, which is smuggled into India by Pakistan’s ISI, which is further used for various terrorist activities. Such currency looks so genuine that even disbursed by ATMs, used at petrol pumps, used by local businessmen therefore more and more people are falling prey of such counterfeit currency. Everybody is so suspicious of accepting banknotes of denominations Rs 500 and Rs 1,000 as majority of such notes come out to be fake. An international report suggests that currency counterfeiting is costly for society: law enforcement agencies assign a lot of resources to dissuade, identify and prosecute counterfeiting operations; if someone erroneously accepts counterfeit currency as payment, he has to bear the loss. [6]

Legal Provisions in India for counterfeiting
Sections 489 A, B, C, E of Indian Penal Code (1860) state various penalties for Counterfeiting, in addition to these acts if counterfeit notes are circulated for financing terrorist activities (within state or cross border). The case shall be registered under UAPA Act 2008 revised from amendment of 1967. If found culpable, court may sanction Life Imprisonment. [7]

Significance of Security features:
A banknote carries security features mainly on its paper; design and printing process. Several new security features are added from time to time to make counterfeiting more difficult. RBI has issued a master circular to all the banks for detection and Impounding of Counterfeit Notes before Issuing over Counters, Feeding ATMs. [8]

Testing methods:
Devices like currency detector or currency validator are used by banks to authenticate currency. These devices may also be used at retail outlets, fare collection machines etc. Such machines scan paper currency using optical and magnetic sensors like photocell. The physical attributes like thickness of currency and dimensions also ensures its correctness. Genuine currency notes have a clear polyester thread embedded vertically in the paper. The thread is inscribed with the denomination of the note, and is visible only when held up to light. Each denomination has a unique thread position and will glow a unique color in ultraviolet (UV) light. [9]

Indian Currency:
The Reserve Bank has introduced banknotes in the Mahatma Gandhi Series since 1996 and has so far issued notes in the denominations of Rs.5, Rs.10, Rs.20, Rs.50, Rs.100, Rs.500 and Rs.1000 in this series. These notes contain distinct security features to facilitate the detection of genuine notes. The present work has been done with the aim to analyze these security features in the Indian currency note of highest denomination that is Rs1000 with Video Spectral comparator, which identifies the currency on the basis of spectral analysis. [10]

Materials and Methods
Present study has been undertaken to study spectral examination of various security features in Indian paper currency prescribed by Reserve Bank of India. Currency note of Mahatma Gandhi series of denomination 1000 was selected for present study. The absorption spectral characteristics were examined by video spectral comparator (model 40). Various types of features were examined on paper currency note using different lights ranges (UV-365,312,
254nm, Ultra Violet transmitted 365nm), by using different magnification ranges and spot light, various filters. In these ranges various security features were analyzed.

**Video Spectral Comparator 40 (Foster + Freeman)**

It is an automated machine which uses different light sources to examine documents. It has the option of transmitted light, filters for various wavelengths which facilitate the detection of various alterations. It is most useful forensic tool to check the authenticity of valuable documents. An inbuilt camera helps to view the image on the monitor which could be saved and used for preparation of reports.

![Video Spectral Comparator-40](image.png)

**Figure 1: Video Spectral Comparator-40**

**Procedure:**

- Firstly switch on the power supply of Video Spectral Comparator, set all the settings before working.

- Place the paper currency note on the document platen under the canopy in the chamber of VSC, which contains the video camera, sources of reflected light and optical filters and a video image is displayed on monitor.

- Adjust the position of currency by viewing on the monitor.

- After placing the currency note, select various illumination options in the range of UV (200-400nm), Visible (400-700nm), IR (700-1000nm), illumination geometry, different optical filters and different magnifications to get the required results.

- Once the required result is attained on monitor, the image is saved.
Results and Discussion:

The quality of analysis and opinion drawn in any case depends on more number of scientific methodologies adopted in the process of analysis. In this study the spectral studies have been made to add more conclusive opinion. The result found in the spectral study observed to be...
spectral behavior of Indian paper currency note. Following type of security features on paper currency note were analysed under video spectral comparator-40.

I. **Watermark and electrotype watermark:** The watermark and an electrotype mark in 1000 rupee.

![Image of 1000 rupee note showing watermark and electrotype mark](image-url)

**Figure 3:** Paper currency note of Rs.1000 showing watermark of the Mahatma Gandhi portrait and electrolyte mark in transmitted light.
Figure 4: Paper currency note Rs.1000 showing RBI (secret watermark) besides Gandhi watermark in transmitted.
Figure 5: Paper currency note Rs.1000 showing denomination value (secret watermark) below Gandhi portrait and secret watermark of 1K above denomination value.

II. Security Thread: 1000 denomination banknotes contain security thread whose color changes from green to blue when viewed from different angles. It present fluoresces under ultraviolet light. It also contains the words 'Bharat' in the Devanagari script and 'RBI' appearing alternately.

Figure 6: Paper currency note Rs.1000 showing red color security thread in visible light.
Figure 7: Paper currency note Rs.1000 giving fluorescent by security thread in 365nm UV light.

Figure 8: Paper currency note of Rs.1000 showing micro letters RBI and Bharat in Hindi, give fluorescence in transmitted UV light.

III. **See through register:** On the left side of the note next to the watermark window, half the numeral of each denomination is printed on the frontage and half on the back. The accurate back to back registration makes the numeral appear as one when viewed against light.
Figure 9: Paper currency note Rs.1000 showing see through register denomination number 1000 in transmitted light.

IV. **Latent Image**: In the banknotes of `20 and above, the vertical band next to the (right side) Mahatma Gandhi’s portrait contains a latent image, showing the denominational value 20, 50, 100, 500 or 1000 as the case may be. The value can be seen only when the banknote is held horizontally and light allowed falling on it at 45°; otherwise this feature appears only as a vertical band.
**Figure 10:** Paper currency note Rs.1000 showing latent image in transmitted spot light.

![Paper currency note Rs.1000 showing latent image in transmitted spot light.](image)

**Figure 11:** Paper currency note Rs.1000 showing latent image in 365nm UV light.

![Paper currency note Rs.1000 showing latent image in 365nm UV light.](image)

**Figure 12:** Paper currency note Rs.1000 showing latent image in 365nm transmitted UV light.

![Paper currency note Rs.1000 showing latent image in 365nm transmitted UV light.](image)
V. **Micro printing**: This feature appears between the vertical band and Mahatma Gandhi portrait. It contains the word ‘RBI’ also contain the denominational value of the banknotes. ([rbi.org.in](http://rbi.org.in))

**Figure 13**: Paper currency note Rs.1000 showing latent image.

**Figure 14**: Paper currency note Rs.1000 showing position of micro-printing at the backside.
of the head and ear of Mahatma Gandhi readable as 1000 and RBI with flood light and Magnification 20.91.

VI. **Optical Security fibers**

These are the colored viscous fibers mixed in cotton pulp during the manufacturing process of the paper and can be visible or invisible in day lights but fluoresces under U V lights. In genuine paper currency notes, there are three coloured optical fibers i.e. yellow, blue and green. These tiny fibers can be seen on both the sides of note under ultraviolet light and denomination note 1000 has one extra colour of Red.

*Figure 15: Paper currency note Rs.1000 showing optical security fibers giving Yellow fluorescence under transmitted UV.*
Figure 16: Paper currency note Rs.1000 showing optical security fibers giving Reddish Yellow fluorescence under 365nm UV.

Figure 17: Paper currency note Rs.1000 showing optical security fibers giving red Yellow fluorescence under 254nm UV.
VII. **Optically Variable Ink (OVI):**

The 1000 on the 1000 banknotes are printed in Optically Variable Ink viz., a colour-shifting ink. The color of these numerals appears green when the banknotes are held flat but would change to blue when the banknotes are held at an angle.
Figure 19: Paper currency note Rs.1000 showing OVI (optical variable ink) printing of numerals 1000. The numerals appear Green when note is held flat and turns Blue when the angle of the note is changed or it is tilted.

VIII. Intaglio Printing: The portrait of Mahatma Gandhi, Reserve Bank seal, Guarantee and promise clause, Ashoka Pillar emblem, RBI's Governor's signature and the identification mark for the visually impaired persons are printed in improved intaglio style with a raised printing. This type of printing can be felt by rubbing the obverse side of the note with finger.
Figure 20: Intaglio Printing in Reserve Bank seal, Guarantee and promise clause, Ashoka Pillar emblem, RBI’s Governor's signature and the identification mark for visually impaired persons

IX. **Fluorescence:** The number panels of the banknotes are printed in fluorescent ink. The banknotes also have dual colored optical fibers. Both can be seen when the banknotes are exposed to ultra-violet lamp.
**Figure 21:** Paper currency note Rs.1000 the number panels, optical fibers giving fluorescence under 365nm Ultra Violet.

**Figure 22:** Paper currency note Rs.1000 the number panels, optical fibers giving fluorescence under 312nm ultra violet.
**Figure 23:** Paper currency note Rs.1000 the number panels, optical fibers giving fluorescence under 254nm Ultra Violet.

**Figure 24:** Paper currency note Rs.1000 the number panels, optical fibers giving fluorescence under transmitted Ultra Violet.

X. **Identification mark:** A special feature in intaglio has been introduced on the left of the watermark window on all notes except Rs.10/- note. This feature is in different shapes for various denominations (Rs. 20-Vertical Rectangle, Rs.50-Square, Rs.100-Triangle, Rs.500-Circle, and Rs.1000-Diamond) and helps the visually impaired to identify the denomination.
Conclusion

Present study was carried out to analyze the various genuine features of Indian currency of denomination 1000 using Video Spectral comparator-40 (Freeman-Foster) to study various genuine features as per the guidelines of RBI. Present study can be very helpful in distinguishing between genuine and fake Indian currency notes. The method adopted is quite convenient and authentic which can be more and more adopted by bank officials, security agencies, money exchangers and forensic investigators. The procedure is highly appropriate, quick and user friendly as images displayed on monitor can be easily viewed, area under view can easily be analyzed and saved to be presented in form of report.

References:
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8. http://www.online.citibank.co.in/portal/newgen/seo/banking/RBI-MASTER-CIRCULAR-COUNTERFEIT.PDF

Figure 25: Paper currency note Rs.1000 showing Brown colored diamond identification mark or Braille mark crossing the Brown vertical line.


