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Comprehensive Analysis of Indian Bank Cheques for their Security Features and Forensic Authentication

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Abstract: ***Background: Security features play a pivotal role in authenticating various security documents, particularly financial instruments like cheques. In addition to safeguarding the identity of the holder, it is of utmost importance to shield these documents from forgery attempts. To achieve this goal effectively, the implementation of security measures such as watermarks, unique printing techniques, ultraviolet-visible features, VOID-Pantograph, Micro-Printing, and other relevant methods becomes imperative. CTS-2010 lays down some really important guidelines with respect to the use of security features in Indian cheques with an attempt to standardize it with the ever-changing technology along with the Modus-Operandi of the Criminal.***

Results: The current research paper conducts a comparative analysis of the security features being currently utilized in cheques across nine different banks in India, with the help of the VSC-8000 H/S system. Cheques adhering to the CTS-2010 standards share common dimensions. In terms of security, all reviewed cheques have watermarks with the bank's name and logo, often accompanied by "CTS-INDIA" along with UV Fluorescence Ink is used for bank logos and various elements like amount in words, emitting distinct colors under UV light. Unique micro lettering is present under the pay column, rupees column, and amount box. Notably, SBI, HDFC, and Union Bank cheques exhibit the highest number of security features, enhancing their security value.

Conclusions: By meticulously identifying and scrutinizing the presence or absence of covert features in these cheques, the study emphasizes the significance of incorporating as many of these measures as possible to enhance the overall security value of cheques on a universal scale. These findings are crucial for banks and financial institutions, guiding them in fraud prevention and customer safeguarding. Through strong security measures and ongoing advancements in design, printing, and technology, banks can effectively reduce risks linked to counterfeit cheques and unauthorized modifications.

Keywords: Cheques, Security Features, Watermarks, Counterfeiting, Negotiable Instruments Act, Indian Banking, Fraud Prevention, Security Documents.

I. INTRODUCTION

A cheque is a document used to authorize a bank to pay a specific amount of money from the account of the holder to the designated person or entity named on the cheque. Because of its high susceptibility to counterfeiting, cheques are equipped with various security features to prevent fraudulent activities. Cheques are widely recognized as important banking documents, which possess characteristics that ensure their authenticity and integrity. According to Section 13 of the Negotiable Instruments Act, of 1881, a negotiable instrument refers to a promissory note, bill of exchange, or cheque payable to the specified payee or bearer. Furthermore, Section 6 of the same Act specifically defines a cheque as a bill of exchange drawn on a particular bank and payable on demand. Cheques serve as substitutes for cash, facilitating financial transactions even in the absence of physical currency [1].To protect from counterfeiting, cheques are manufactured and printed with security features that are embedded within the paper. The security features are also found in other important documents like passports, PAN cards, voter IDs, Aadhar cards, currency, and cheques themselves. The size, shape, and other distinct characteristics within the cheque are crucial to ensure its security.

The security features vary across countries and banks but generally include visible elements that can be easily identified under normal lighting conditions. These features aid individuals in distinguishing between genuine and fraudulent cheques, safeguarding against potential scams or unauthorized alterations [2]. It is important to note that the specific type and quantity of security features used may differ among countries and financial institutions ([3],[4]). Cheques commonly incorporate various security features to deter counterfeiting and ensure their authenticity. These features include:

Cheque Truncation System (CTS):CTS came into effect in 2010, which is an Indian Standard which provides for the Mandatory Features that any cheque leaf should contain. These include:

Paper Material- The paper mechanized cheque processing uses cotton material along with Magnetic Ink Character Recognition (MICR) technology as per guidelines provided in CTS -2010. As per the specifications given in CTS-2010, the paper should be image-friendly and offer protection against changes by being chemically sensitive delivering a noticeable outcome after any obliteration, erasures, additions, etc. Also, according to CTS-2010 standard paper used as cheques shouldn't glow under the Ultraviolet light. This will guarantee that checks feel the same way across banks. [3]

Length-Breadth and Diagonal Measurements (Overall cheque leaf and Amount Box): CTS-2010 also states for the standard measurements of the cheque leaf viz. its length, breadth, and diagonal measurements, as well as for the other elements of the leaf such as amount box, MICR code length, and breadth, etc. serving as a security feature. [3]

Cheque Design: Each bank incorporates their own unique design, logos, and background printing on cheques. These design elements typically consist of the bank's name, branch address, holograms, and bank logo. A well-designed cheque makes it difficult for an ordinary person to distinguish between a genuine cheque and a fraudulent one. Therefore, it is crucial to implement effective design elements that are not easily replicable. [3]

Uniform Dimensions: Standard cheques have consistent dimensions to ensure their security. For example, in Indian cheques, the length is typically 202 mm, and the width is 92 mm. Adhering to standardized dimensions helps in identifying irregular or suspicious cheques ([3],[4]).

Paper Quality: Securing the cheque paper is a primary concern in cheque security. The paper used for manufacturing Indian cheques is carbon-free and UV-free, meaning it does not fluoresce when observed under UV light. Instead, UV-visible features are placed on the paper to enhance security. ([1],[3])

Watermarks: Watermarks are considered one of the most effective security features as they are challenging to counterfeit. Different banks use various combinations of watermarks, which can be observed under Transmitted Light (TL) conditions. In Indian cheques, watermarks generally are the bank's logo or their name [4].

Unique Printing Ink: Cheque printing methods, inks and dyes vary in different countries. In Indian cheques, the use of fugitive ink causes bleeding when exposed to water. This bleeding effect serves as an important security measure [5].

Ultraviolet-Visible Features: Cheques include UV-visible features that fluoresce when exposed to UV light. These features differ from bank to bank and may include fluorescent bank logos, names, the rupee column, micro-lettering at the back, as well as the areas assigned for the writing of amount in words, Figures, signatures, and beneficiary names. Genuine cheques display specific fluorescent features under UV light, distinguishing them from fraudulent ones where the entire paper may turn uniformly fluorescent. ([5-7])

Microscopic Features: Since, the CTS 2010 Indian cheques are required to incorporate microscopic features throughout the paper or in specific sections such as date columns, pay columns, amount boxes, and rupee columns. These features can be examined using microscopes or magnifying glasses. When cheques are photocopied or scanned, these micro letters become illegible, aiding in the detection of counterfeit cheques [7].

Void Pantograph: A unique feature exclusive to Indian cheques is a rectangular box, positioned below the account number column. This box employs steganography, utilizing a distinctive arrangement of lines. When a genuine cheque is photocopied, the box will display the words "VOID" or "COPIED" instead of appearing as a blank space for filling in the amount ([3],[7]).

Bleeding Effect: The bleeding of the ink in cheques is an interesting property as a security feature to authenticate. Bleeding effect will be observed if a few drops of water are placed over the cheque leaf leaving the ink to get dissolved in water and bleed.([5-8])

Infrared Features: To study the usage of infrared specific ink features, as long as the light illuminates and propagate towards the cheque leaf one or more features like logo, IFSC number, Bank name etc. may appear or disappear from the cheque and the same can be observed on the instruments main screen. The appearance and the disappearance of the features due to the illumination of the IR light depends on the specific affinity of the ink and reaction of the ink and light to give such effect. Such effects can be fluorescence, Glow, excitation of the ink particles etc.

Fig.1 shows all the above-mentioned security features present in the standard Indian bank cheques.

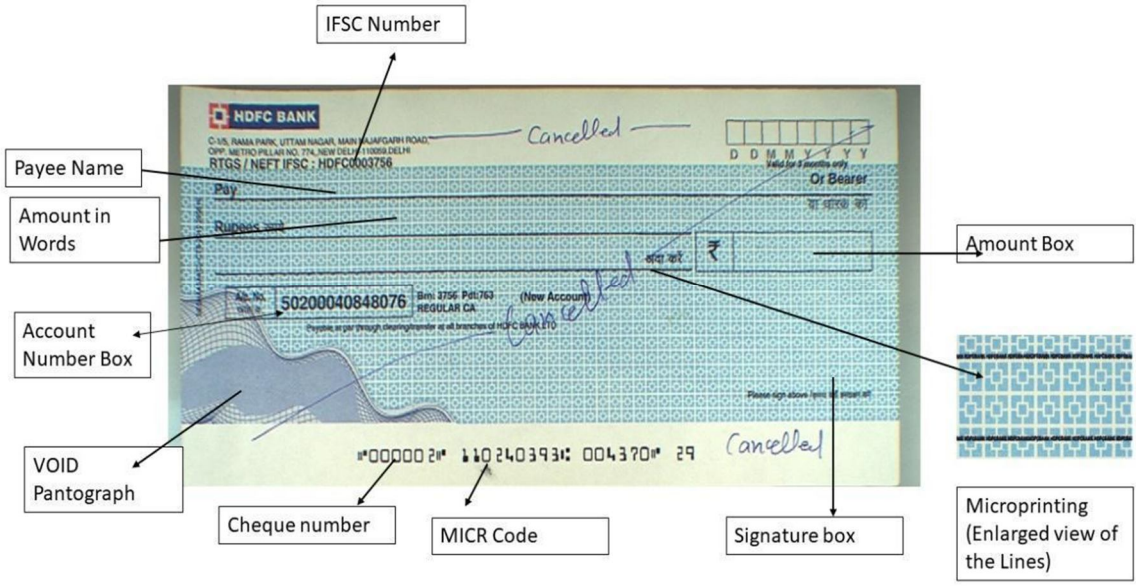

Fig.1 Security Features of a Standard Indian Bank Cheques are being shown here

II. METHODS

Cheques from nine different Indian banks were collected and examined using VSC®-8000/HS (foster+freeman). VSC is an advanced non-destructive spectral analytical system designed to capture absorption, reflectance, fluorescence, and transmitted spectra for various documents, including Cheques. In this research, we examined the covert security features present in the Cheques. Each sample was placed into the live-camera unit/primary unit where an image was captured using the high-precision 12-megapixel camera of the Super Resolution Imaging (SRI) system [8]. The cheques were photographed under white light illumination. Subsequently, exposure to different illumination settings such as Side Light (SL), Oblique Light (OL), Transmitted Light (TL), UV light (365 nm), and Infrared Light (780 nm). Various security features one by one, including Microprinting, Micro texting, Guilloche Pattern, Optically Variable Ink (OVI) (if any), Watermarks, and more were also studied.

III. OBSERVATIONS

A. United Commercial Bank (UCO Bank)

For analyzing the security features of UCO bank cheque white light was used showing clear and definite security features such as Pantographic Image, Dimensions as per CTS, color system, format and design of the cheque as per the CTS System (Fig. 2), Under Spot light watermarks were distinctly observed such as UCO Bank Logo, CTS logo, Printing paper company logo etc. were found in the form of circles at various locations (Fig. 3). To study further latent features UV light was used to view the cheque for glowing UV Security ink printing, strategic placement of UCO Bank logo, these features otherwise would not be seen with naked eyes (Fig. 4). Under TL the placement of the UCO Banks logo was studied in the form of watermark, fluorescent ink, etc. Similarly, no Infrared feature was observed (Fig. 6-7), Micro lettering with Bank's name and Pantographic image with "VOID" written (Fig.8) were seen.

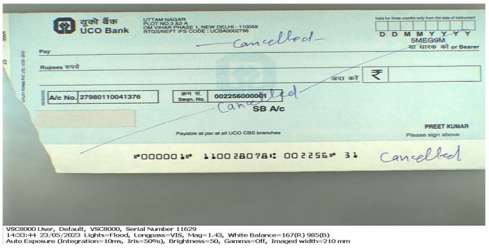

Fig.2 Under White Light

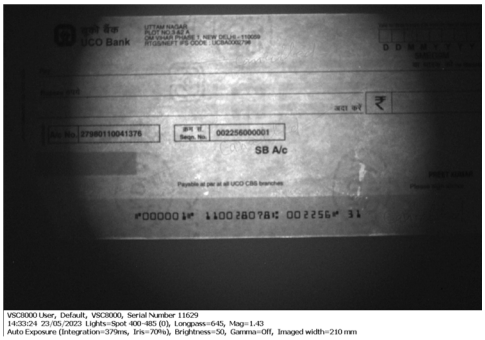

Fig 3: Under Spot Light

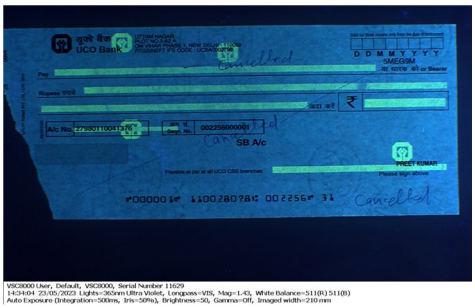

Fig 4: Under UV Light

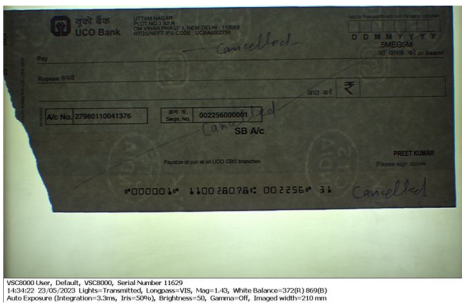

Fig 5: Under TL

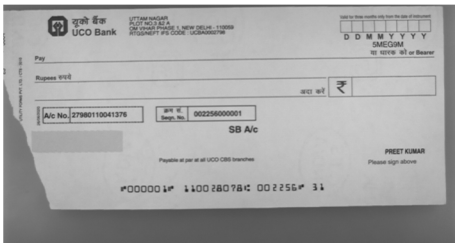

Fig 6: Under IR

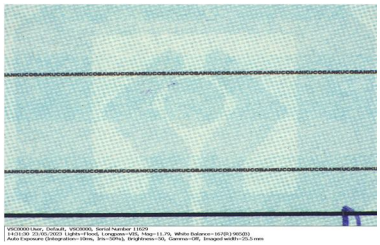

Fig 7: Micro Printing

Fig 8: Void Pantograph

B. Industrial Credit and Investment Corporation of India (ICICI Bank)

To analyze the security attributes of ICICI Bank cheques white light was illuminated, the cheque unveiled distinct security features like Pantographic Image, dimensions in accordance with CTS specifications, the prescribed color scheme, and adherence to the CTS System's layout and design (Fig. 9). Under spotlight illumination, watermarks of ICICI bank logo, CTS logo, and the logo of the printing paper company were readily visible, taking the form of circles positioned at various strategically placed locations (Fig. 10).When exposed to UV light, the cheque exhibited luminescent UV Security ink printing, and UV sensitive ICICI Bank logo (Fig. 11). In the transmitted light setting, the positioning of the ICICI Bank's logo was scrutinized through watermarks and fluorescent ink, among other notable elements (Fig. 12). No Infrared characteristics were observed, while Micro lettering featuring the bank's name and the Pantographic image with the inscription "VOID" were distinctly visible (Fig. 13, 14, and 15 respectively).

Fig 9: Under White Light

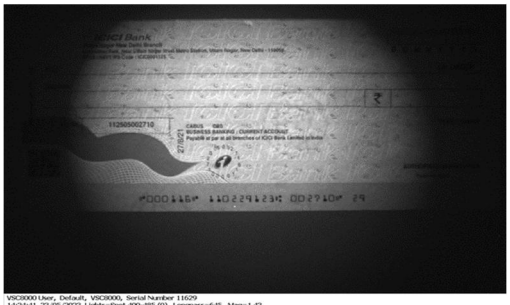
Fig 10: Under Spot Light

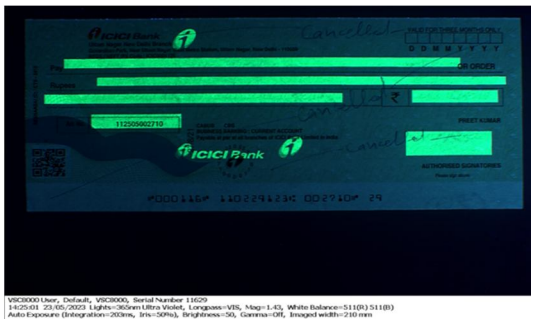

Fig 11: Under UV Light

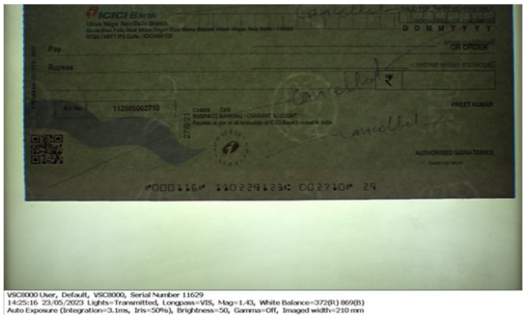

Fig 12: Under TL

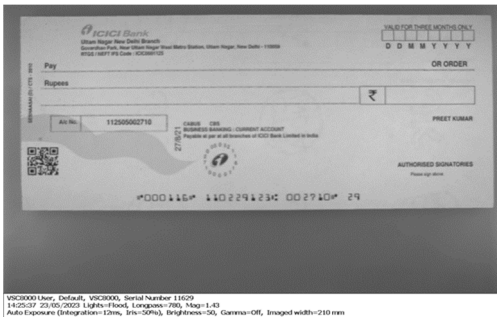

Fig 13: Under IR Light

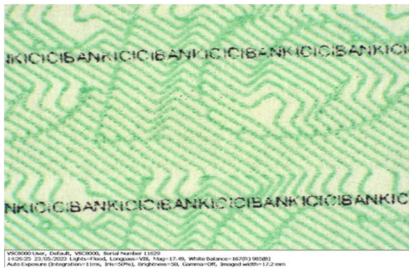

Fig 14: Micro Printing

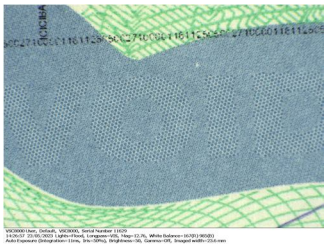

Fig 15: VOID Pantograph

C. State Bank of India (SBI Bank)

SBI Bank cheque was observed under the white light for the overall view of the security features namely serial numbers, dimensions, cheque format and design as per the CTS-2010 Standards (Fig. 16). Spotlight to study latent features like watermarks of bank logo, CTS standard circular in shape outlined in black ink, and other fluorescence features (Fig. 17). UV light for the observation of UV-Specific ink, glowing logo of SBI Bank at the top of the cheque leaf (Fig. 18). Transmitted light to look for the watermarks seen as encircled logos of SBI all over the surface of the leaflet etc. (Fig. 19). When studied under IR light SBI cheque showed contrasting black bold ink used for the areas related to address, Serial number, Account number, etc. to make it strong against fraudulent activities (Fig. 20). VOID Pantograph, Micro Printing and Micro-Texting was also readily observed in the SBI Bank Cheque (Fig. 21.

Fig 16: Under White Light

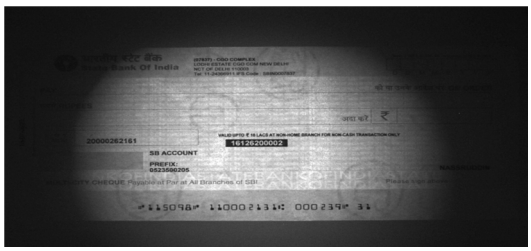

Fig 17: Under Spot Light

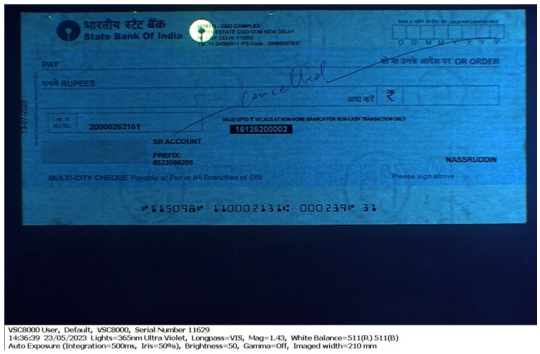

Fig 18: Under UV Light

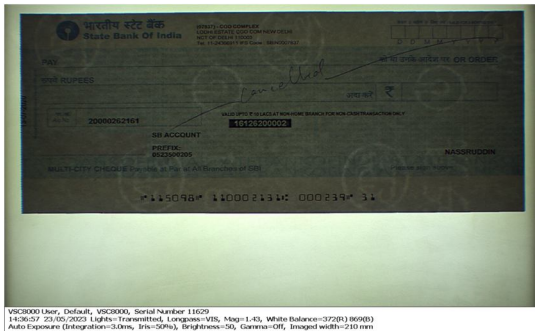

Fig 19: Under TL

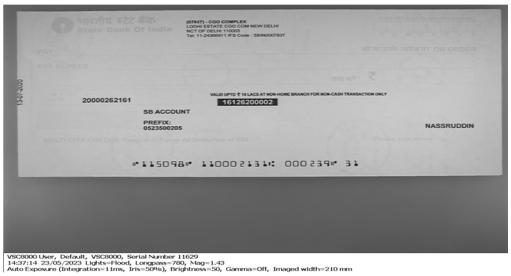

Fig 20: Under IR Light

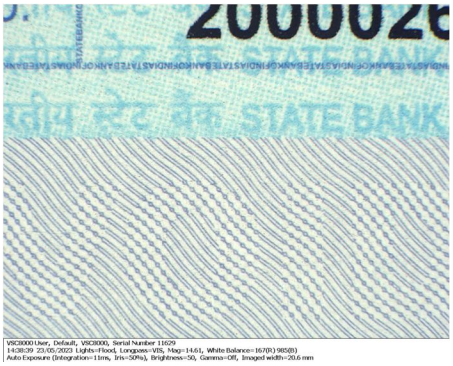

Fig 21: VOID Pantograph

D. Kotak Mahindra Bank

Kotak Mahindra Bank cheque was studied under white light to ensure compliance with the CTS-2010 Standards, encompassing features such as serial numbers, dimensions, cheque format, and design (Fig. 22). A focused spotlight was employed to scrutinize latent characteristics such as watermarks of the bank's logo, the circular CTS Standard outlined in black ink, and fluorescence features (Fig. 23). The utilization of UV light revealed distinct UV-Specific ink attributes, including the radiant Kotak Mahindra Bank logo situated at the top of the cheque leaf (Fig. 24). Transmitted light was employed to detect watermarks in the form of encircled Kotak Mahindra Bank logos distributed across the surface of the leaflet (Fig. 25). IR features were not very much evident in Kotak Mahindra Bank cheque (Fig. 26). Prominent security features, including VOID Pantograph, Micro Printing, and Micro-Texting, were studied distinctly observed on the Kotak Mahindra Bank cheque (Fig. 27, 28).

Fig 22: Under White Light

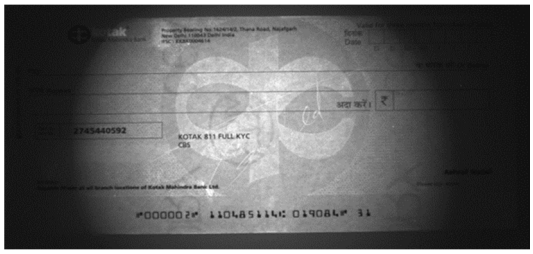

Fig 23: Under Spot Light

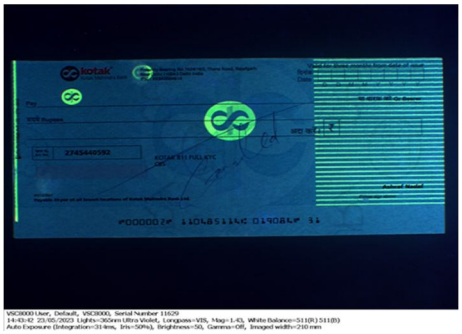

Fig 24: Under UV Light

Fig 25: Under TL

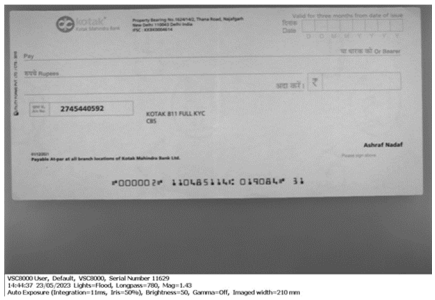

Fig 26: Under IR Light

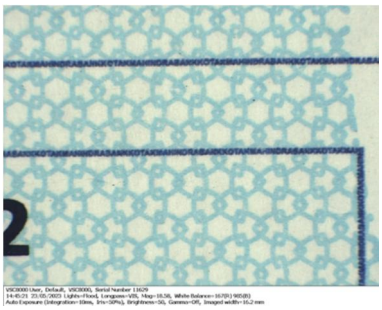

Fig 27: Micro texting

Fig 28: VOID Pantograph

E. Punjab National Bank (PNB)

PNB cheque was seen under white light to examine the CTS-2010 Standard features, like serial numbers, dimensions, cheque format, and design (Fig. 29). Spotlight examination was performed to examine covert features such as watermarks of the bank's logo, CTS water mark, fluorescence features (Fig. 30). The UV light used to examine UV-Specific ink usage, Bank logo (Fig. 31).

Transmitted light was performed to observe the presence of watermarks encircled and embedded across the surface of the leaflet (Fig. 32).IR features were not present on the cheque (Fig. 33). Other security features observed like VOID Pantograph, Micro Printing, and Micro-Texting, were also available on the cheque (Fig. 34).

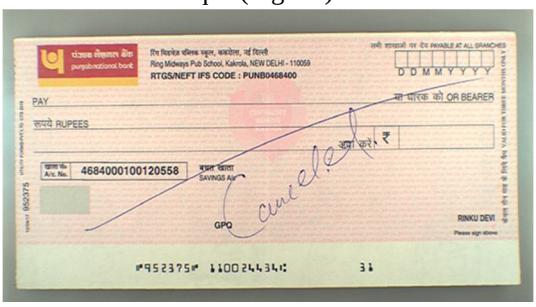

Fig 29: Under White Light

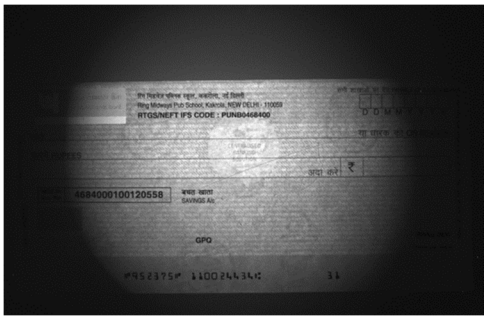

Fig 30: Under Spot Light

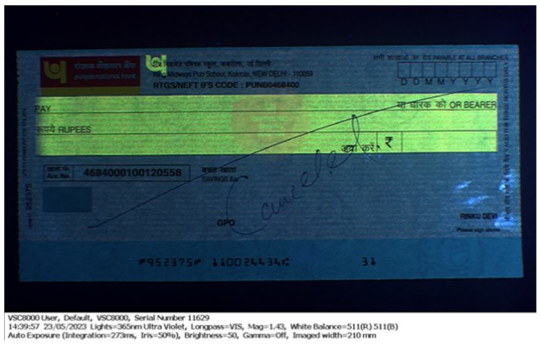

Fig 31: Under UV Light

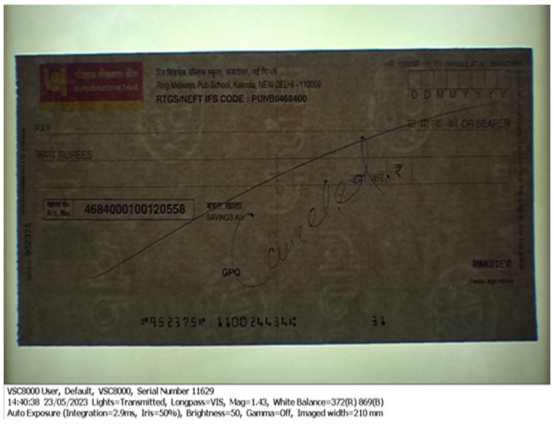

Fig 32: Under TL

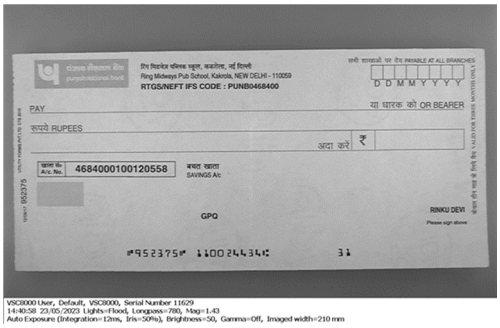

Fig 33: Under IR Light

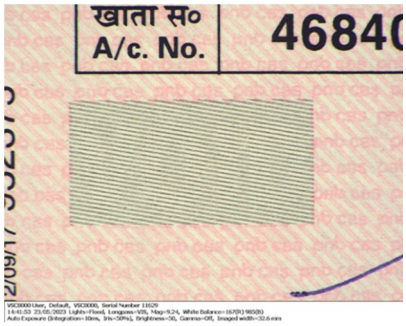

Fig 34: VOID Pantograph

F. Corporation Bank

The examination of Corporation Bank cheque was conducted under white light to study CTS-2010 Standard specifications, encompassing elements such as serial numbers, dimensions, cheque format, and overall design (Fig. 35). A focused spotlight analysis was undertaken to uncover covert attributes, including watermark patterns featuring the bank's logo, the distinctive CTS watermark, and use of the fluorescence characteristics, (Fig. 36). UV light was employed to study for the utilization of UV-Specific ink and the positioning of the bank's logo (Fig. 37). Utilizing transmitted light techniques, the presence of encircled watermarks distributed across the cheque's surface (Fig. 38). IR features were notably absent on this particular cheque (Fig. 39). Security features like that of VOID Pantograph, Micro Printing, and Micro-Texting were also observed (Fig. 40 and 41).

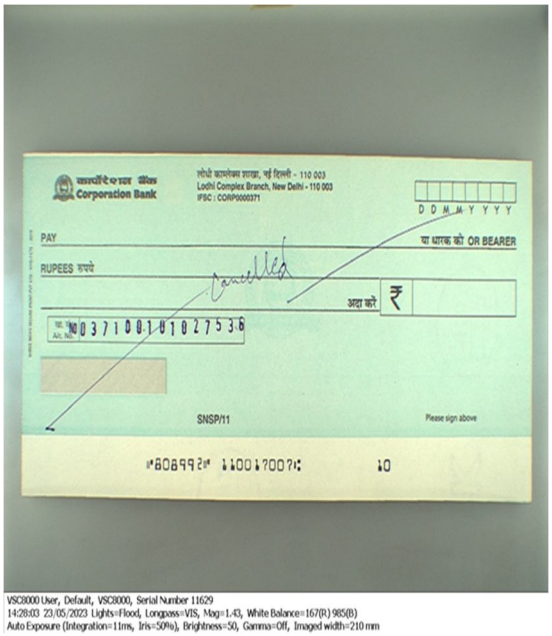

Fig 35: Under White Light

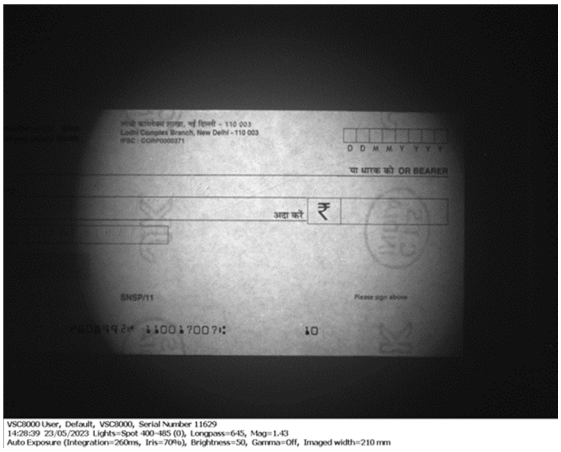

Fig 36: Under Spot Light

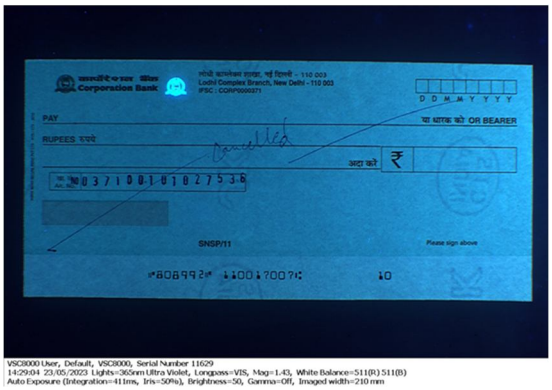

Fig 37: Under UV Light

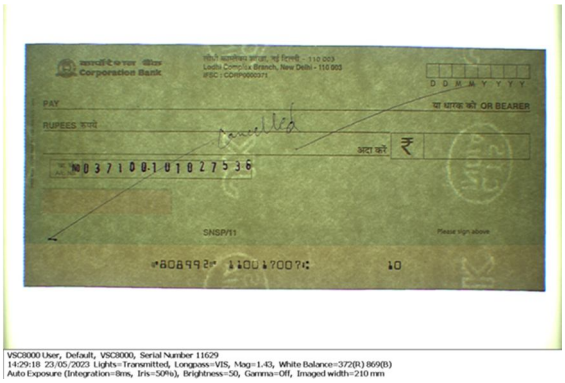

Fig 38: Under TL

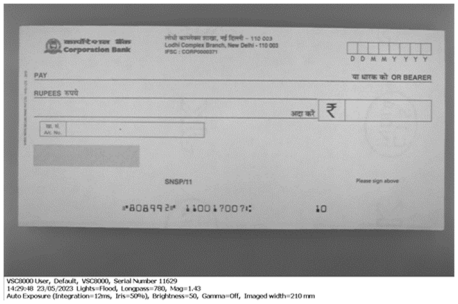

Fig 39: Under IR Light

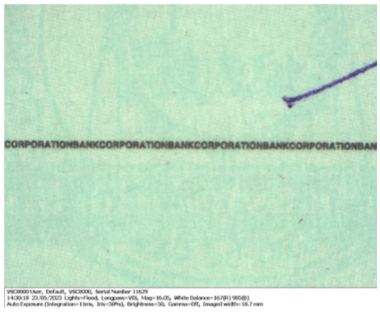

Fig 40: Micro Printing

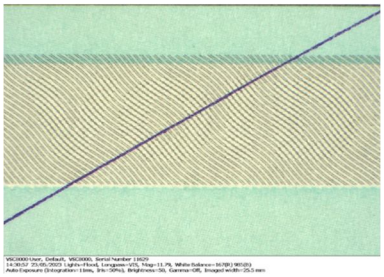

Fig 41: VOID Pantograph

G. Housing Development Finance Corporation Bank (HDFC Bank)

HDFC Bank cheque studied using white light to assess its compliance with the CTS-2010 Standard specifications, encompassing factors such as serial numbers, dimensions, cheque format, and overall design (Fig. 42). A focused examination was conducted using SL for watermark patterns showcasing the bank's logo, the distinctive CTS watermark, and fluorescence characteristics of cheque (Fig. 43). UV light was employed to study UV-Specific ink and the placement of the bank's logo (Fig. 44). Employing techniques involving transmitted light, the presence of encircled watermarks distributed across the cheque's surface was observed (Fig. 45). IR features were absent on this specific cheque (Fig. 46). Inclusion of VOID Pantograph, Micro Printing, and Micro-Texting were also studied in detail (Fig. 47 and 48).

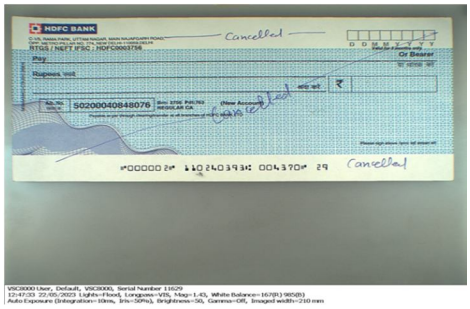

Fig 42: Under White light

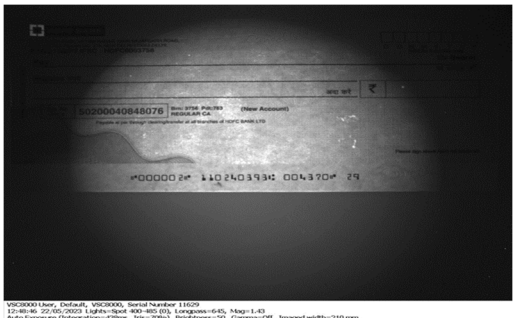

Fig 43: Under Spot Light

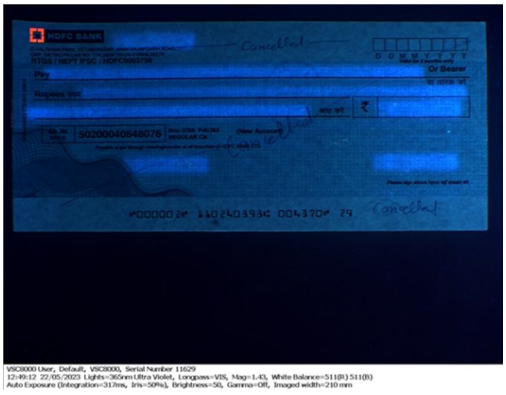

Fig 44: Under UV Light

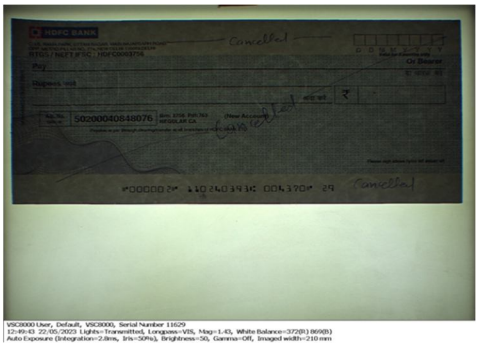

Fig 45: Under TL

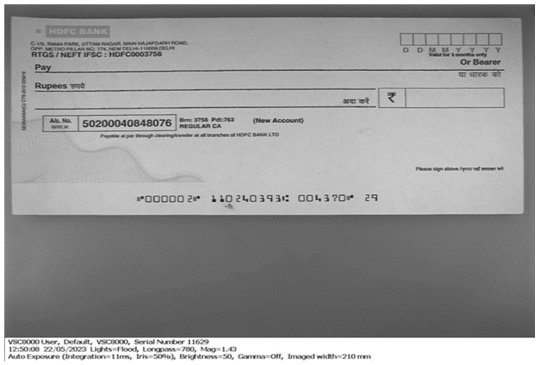

Fig 46: Under IR Light

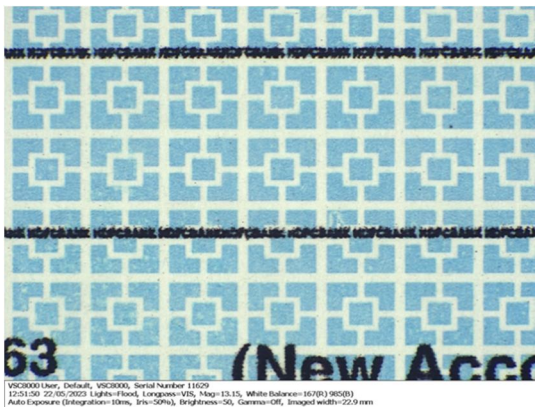

Fig 47: Micro Printing

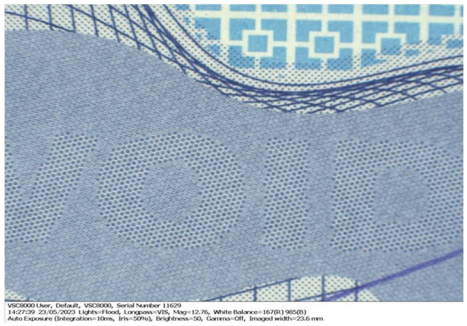

Fig 48: VOID Pantograph

H. Union Bank

Study conducted on Union Bank cheque using white light to assess its conformity to the CTS-2010 Standard specifications. Important aspects like serial numbers, dimensions, cheque format, and the overall design, as visually represented (Fig. 49). Using spotlight features including watermark patterns that highlight the bank's logo, the distinctive CTS watermark were studied (Fig. 50). For specific investigation of latent features, UV light was utilized to explore the implementation of UV-Specific ink and the precise positioning of the latent bank logo (Fig. 51). Transmitted light to study the presence of watermarks distributed across the cheque's surface was observed (Fig. 52). With respect to the IR features Union Bank cheque did not manifest any such notable characteristic (Fig. 53). Nonetheless, features like VOID Pantograph, Micro Printing, and Micro-Texting were present (Fig. 54 and 55).

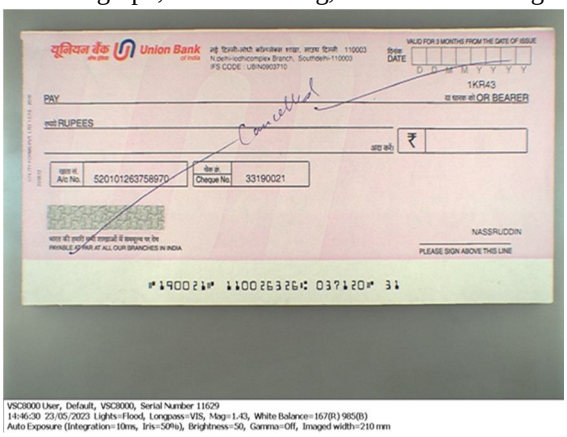

Fig 49: Under White Light

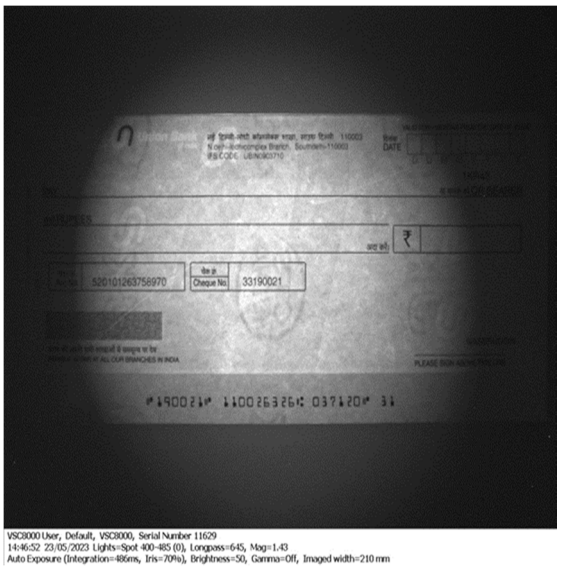

Fig 50: Under Spot Light

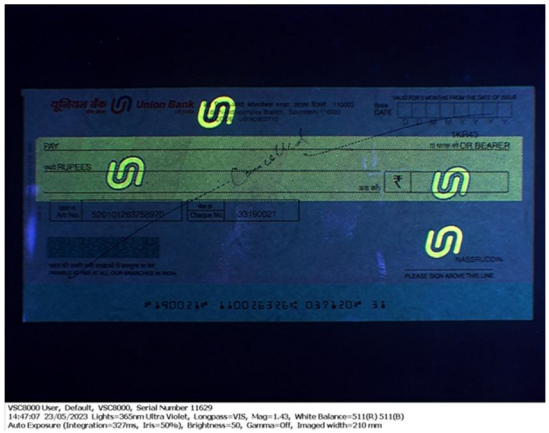

Fig 51: Under UV Light

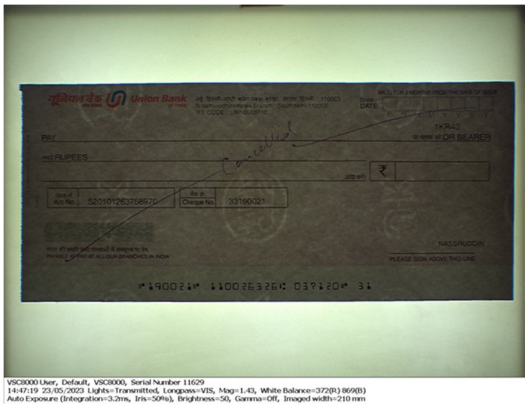

Fig 52: Under TL

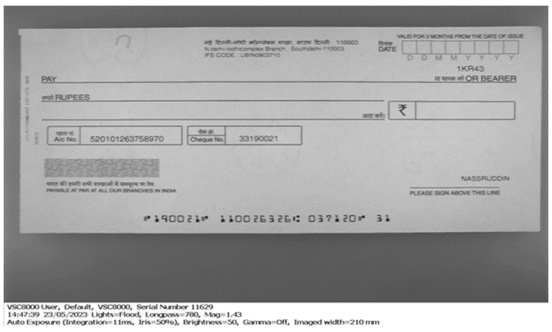

Fig 53: Under IR Light

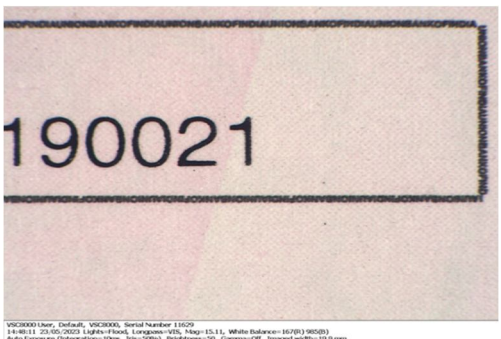

Fig 54: Micro Printing

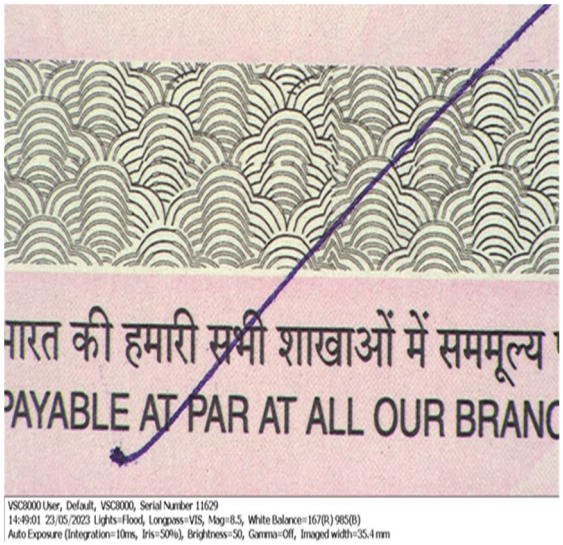

Fig 55: VOID Pantograph

I. Bleeding Effect

Bleeding effect or running down of ink, was checked among all the cheques as seen in (Fig. 56 and 57). This is employed as a security feature in bank cheques to enhance their protection against counterfeit and fraudulent activities. This technique involves the intentional use of printing methods and inks that result in the ink spreading slightly beyond the intended lines or edges of the printed characters or patterns ([10-12]). This subtle bleeding effect is difficult to reproduce accurately through standard copying or scanning processes, making it challenging for counterfeiters to replicate. The unique irregularities caused by the bleeding effect are hard to replicate through standard reproduction methods, such as photocopiers or scanners. As a result, the authenticity of the cheque can be verified more easily by comparing the original with a potentially counterfeit copy.

Fig 56: Bleeding Effect in UCO Bank Cheque

Fig 57: Bleeding Effect in HDFC Bank Cheque

TABLE I
RESULTS OBTAINED DURING THE EXAMINATION UNDER VSC®-8000/HS:

Security Features	Bank Cheques							
	UCO	ICICI	SBI	Kotak Mahindra	PNB	Corporation Bank	HDFC	Union Bank
Dimension (overall Length-Breadth, and Amount box)	✔□	✔□	✔□	✔□	✔□	✔□	✔□	✔□
Watermark	✔□	✔□	✔□	✔□	✔□	✔□	✔□	✔□
Spot Light	✔□	✔□	✔□	✕	✔□	✔□	✕	✔□
UV-Feature	✔□	✔□	✔□	✔□	✔□	✔□	✔□	✔□
Micro Printing	✔□	✔□	✔□	✔□	✔□	✔□	✔□	✔□
Complex Patterns	✕	✔□	✕	✕	✕	✕	✔□	✕
Paper Material	✔□	✔□	✔□	✔□	✔□	✔□	✔□	✔□
VOID-Pantograph	✔□	✔□	✔□	✔□	✔□	✔□	✔□	✔□
IR-Feature	✕	✕	✔□	✕	✕	✕	✕	✔□
Micro-Texting	✔□	✔□	✔□	✔□	✔□	✔□	✔□	✔□
Transmitted Light	✔□	✔□	✔□	✔□	✔□	✔□	✔□	✔□
Account Holder's Details	✔□	✔□	✔□	✔□	✔□	✔□	✔□	✔□
Bleeding Effect	✔	✔	✔	✔	✔	✔	✔	✔

IV. RESULTS

All the cheques were examined and the observations have been shown as images and marked in Table-1. On the basis of the given table, it has been found that the most common character i.e. the dimension of the cheques viz. It's Length-20.3cm, Breadth-9.2cm, and Diagonal-22.4 cm which conforms to the standards of CTS-2010. Similarly, the dimensions of the amount box are measured as Length-4.9 cm, Breadth-0.8cm. The most unique features IR was observed in the cheques of Union and SBI Bank whereas the complex patterns were present in the cheques of ICICI and HDFC Bank. All the cheques viewed under Transmitted Light (TL) exhibited the presence of watermarks consisting of the bank's name and its logo. The watermarks were visible, accompanied by the text "CTS-INDIA" at different positions and varied in number across different bank cheques. The shape of the watermark is mostly oval, with a diameter ranging from 2.6 to 3.0 cm [8]. All the cheques were incorporated with UV Fluorescence Ink at various locations in the form of bank logos, places like amounts in words, etc. glowing with characteristic color. Each bank cheque displayed distinct micro lettering, which was observed beneath the pay column, rupees column, and amount box. Hence, based on the analysis this can be deduced that SBI, HDFC, and Union Bank were found to contain maximum security features providing secure value to the cheque.

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V. DISCUSSION

Security features are integral elements embedded in cheques during manufacturing and printing to safeguard against counterfeiting. These features are analogous to those found in documents like passports, PAN cards, voter IDs, Aadhar cards, currency, and more. Thus, meticulous attention is necessary while incorporating security features in cheques, including considerations of size, shape, and characteristics. Cheques contain several visible security features that help individuals differentiate genuine ones from fraudulent ones, even under normal lighting. These features can vary across countries and banks. Notably, Indian cheques possess a pantograph image beneath the account number column. When photocopied using regular machines, the word "VOID" or "COPIED" appears in the pantograph box, although this effect is not replicated by laser printers or scanners. This situation underscores the need for more advanced security features, a responsibility that the Indian government should take up for enhancing secure transactions.

Proposed security enhancements include holograms, microprinting, un-photocopiable patterns on the back of cheques, security threads, guidelines for security features on the back of cheques, innovative watermark patterns (including negative/positive watermarks), and size reduction of cheques. Additionally, a suggestion is made to categorize cheque books based on transaction amounts, issuing separate books for substantial transactions and those under 1 lakh. Future research will delve into implementing these proposed security features to ensure authentic, intact, and secure transactions. Additional features can also be integrated by banks for personal customization or to make their cheques more secure which might not have been recommended by the RBI [3]. These include the embedded fluorescent fibers, secondary fluorescent ink, toner fusing, check-sum, structural magnetics, a security thread, and hot stamped holograms on multi-city cheques among others as an extra layer of security ([3],[4],[6],[8]).

VI. CONCLUSIONS

As per the Guidelines laid down under the CTS-2010, the formulated dimensions of the cheques issued by any Indian Bank were proposed. These dimension measurements form the basis for the authentication of cheques and it requires a lot of time, precision but with the use of advanced technologies like VSC-8000 and other portable instruments, authentication has become easier, more scientific, and universally standardized. ([9],[10]).

The present study emphasizes the necessity of incorporating robust security measures to protect from counterfeiting and fraudulent activities, ensuring the integrity of the financial systems by showcasing the effectiveness of various security features present, such as watermarks, microprinting, UV-visible features, void pantograph, etc. These features not only differentiate genuine cheques from counterfeit ones but also act as a deterrent against potential fraudsters.

Video Spectral Comparator (VSC-8000/HS) provides valuable insights into the unique security aspects of different bank cheques. The examination of each cheque allowed for a better understanding of their strengths and vulnerabilities, aiding in the continuous improvement of security features.

The findings of this research will have significant implications for banks and financial institutions in their pursuit of fraud prevention and customer protection. By implementing robust security measures and continuous innovation in cheque design, printing, and technology, banks can mitigate the risks associated with counterfeit cheques and unauthorized alterations.

List of Abbreviations:

CTS- Cheque Truncation System
HDFC- Housing Development Finance Corporation
ICICI- Industrial Credit and Investment Corporation of India
IR- Infrared
MICR- Magnetic Ink Character Recognition
PNB-Punjab National Bank
RBI- Reserve Bank of India
SBI- State Bank of India
SL- Spot Light
TL- Transmitted Light
UCO Bank- United Commercial Bank
UV- Ultra-Violet
VSC- Video Spectral Comparator

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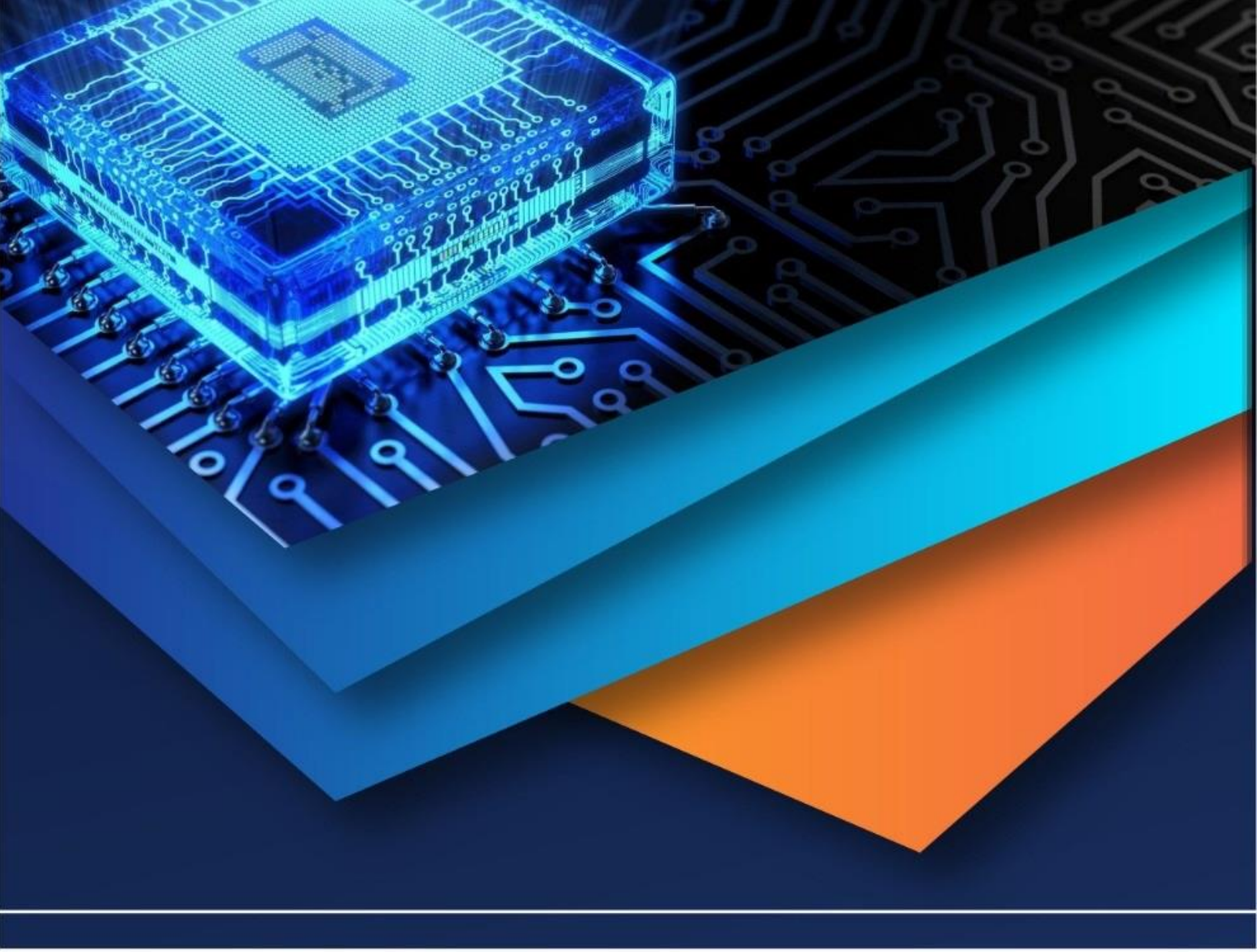

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