

Forensic Examination of Original and Scanned Signatures to Study Different Characteristics Using Image Processing Tool.

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Abstract— There has been a simultaneous rise in the employment of image processing software applications in criminal operations to match the recent exponential surge in their use. However, for more effective processing and better storage, the majority of documents these days are created entirely online. The development of computer-based image processing tools and contemporary replication processes has simplified the process of digitally fabricating signatures. The goal of the current study is to identify the various characteristics of scanned (at varying dpi or resolutions) and printed (using inkjet and laser printers) signatures. Many printed signature samples were created from genuine documents, using traditional and digital tools like Adobe Photoshop. Identified traits include alignment errors, irregularities in half-tone patterns, variations in letter spacing, and over-deposition of ink particles. It could be possible to differentiate a scanned signature from the typical signatures of the real person by identifying and analyzing such traits. This study highlights the lack of research on offline scanned documents and makes the case for using the most recent image processing techniques to do forensic analysis on a variety of document types.

Keywords- alignment, inspection, obliterations, authenticity, biometric, dynamic, versatile, sophisticated, fabrication.

I. INTRODUCTION

Documents are media that contain information and track behaviour. Document inspection helps courts determine evidence origin and background. It includes examining ink, paper, and other features. A forensic document examiner (FDE) examines questioned documents, including handwriting, altered papers, erasures, obliterations, indented writing, tracing, inks, and writing implements, to determine authenticity, source, content, or age. Forensic document examiners (FDE) may need to examine documents with multiple printers or generations of copies. Examining staple holes on pages can provide valuable information. Before removing staples, take notes, photos, and save them as proof. This ensures the integrity of the documents and their authenticity.

A forensic document examiner (FDE) can examine documents with multiple generations of copies, focusing on staple holes and handwriting analysis. This method can help identify suspects, verify document veracity, and aid in dispute settlements or crime investigations. Examining handwriting often involves comparing known samples with evidence found

on contested papers. FDEs can advise on the applicability of handwriting analysis to specific cases. Forensic document examiners (FDE) examine documents with multiple generations of copies, examining staple holes and signatures. They use technology to determine the authenticity of handwritten signatures, using photosensitive seals. The examination of signatures is crucial in legal disputes, as it helps identify whether writing ink was used to form the signature. With advancements in technology, signature stamps can be created to reproduce handwritten signatures. The field of signature analysis has seen numerous studies and literature in recent years.

Digitally captured signatures (DCSs), also known as online, electronic, biometric, dynamic, and electronic signatures, are websites that provide information about dynamic systems, while handwritten signatures are considered offline systems.

Adobe Photoshop is a versatile image-editing program developed by Thomas and John Knoll in 1987. It offers a wide range of features for both experts and amateurs, including advanced blends, designs, and basic picture tweaks. It uses

layering for depth and flexibility, and offers pixel-based editing for raster and vector graphics.

II. REVIEW OF LITERATURE

A collection of instruments must be used on the image in order to verify its legitimacy and draw a conclusion that will persuade the court of law. Several researchers have accomplished some commendable work in the connected topic, as the reviews below describe.

Akram et al. (2010) explored digital image processing techniques including pre-processing, feature extraction, and classification, aiming to quickly, accurately, and high-quality document processing. Nigam & Mishra (2011) used Adobe Photoshop Version 7.0 to decode obliteration in graphite pencil handwriting. They used strategies like threshold mode, brightness/contrast, and curves for tonal correction. The non-destructive software supports all image file formats, producing visually striking results for court presentation and interpretation. O'Brien & Farid (2012) introduced a new forensic method that focuses on geometric irregularities caused by artificial reflections in images. The technique is resistant to common image-editing methods and makes use of linear perspective projection and reflective geometry. It uses both visually realistic and professionally made forgeries. Birajdar & Mankar (2013) highlight the ease of manipulating digital photographs due to high-resolution devices, powerful computers, and sophisticated software. They explore blind techniques for forgery detection, establishing a general structure for algorithms, and discussing passive picture authentication. Future studies should focus on the current state of image forgery detection techniques.

Burvin & Esther (2014) studied image splicing, a popular digital alteration, and examined various automatic picture forensic methods for identifying this process. The study by Saini and Kaur (2016) highlights the increasing use of image processing software in criminal operations, including forgery of checks and banknotes, and modification of official records. It highlights the need for document examiners to stay updated on scientific and technological developments in this field. Vikas et al. (2018) aims to identify signs of digitally faked signatures using up to thirty printed samples. Using traditional and electronic tools, they found indications of fabrication such as alignment errors, background traces, and variations in letter regularity and consistency. Similar traits could help differentiate fake signatures from genuine ones. Chourasiya et al. (2023) examines documents altered by computers using free and open-source image editing software, Adobe, FotoForensics, and Forensically beta Photoshop. The findings suggest that these technologies can assist forensic document examiners in

analyzing digitally altered documents to identify changes. The study reveals that transplanted documents have a few minute traits that can be identified by carefully examining soft copies of the documents.

III. MATERIAL AND METHODOLOGY

Handwritten samples were obtained on A4 size sheets of paper and each individual was asked to replicate the signature samples three times with three different pens (blue ball point pen, blue gel pen, and blue pilot pen). Adobe Photoshop was used to analyse the original samples and printed samples of original signatures that had been scanned at 300, 600, and 900 dpi. Every sample was meticulously analyzed and contrasted, both manually and with the aid of the Adobe Photoshop and mainly using brightness, exposure and contrast.

For the examination, a number of handwriting metrics were considered, including a decline in regularity and consistency, an uneven half-tone dot pattern, an excessive amount of ink or toner deposit, and differences in stroke and letter spacing.

The top ten features of Photoshop software are listed below.

1. Layers – Photoshop's layers feature allows for versatile image editing and design elements, allowing for irreversible and permanent changes to the project's backdrop layer. This allows for testing effects without affecting the entire image.
2. Adjustment Layers – Adjustment layers are essential for non-destructive photo editing, allowing for color, brightness, contrast, and other image adjustments without altering underlying pixels. They allow for quick comparison of before and after states, avoiding long-term adjustments.
3. History Panel – The History Panel in Photoshop allows you to track all changes made to an image, allowing you to undo any unwanted actions and restart editing if needed, making it a valuable tool for experimentation and resolving mistakes.
4. Regular Healing Brush – One of the Photoshop tools that is most frequently used is the Regular Healing Brush. It can be used to images to get rid of blemishes, wrinkles, and other flaws. The way the brush functions is by using a sample of pixels from one part of the image to hide flaws in another. This is an excellent tool for photo retouching and enhancing people's appearances. Additionally, it can be used to clean up scanned photos that have flaws or to remove unwanted elements from an image.
5. Crop Tool – The Crop Tool is a crucial tool for cropping images, allowing for adjustments to aspect ratio, deletion of unwanted parts, and straightening out cropped photos, suitable for beginners to significantly influence project appearance.

6. Colour Balance – The Colour Balance option adjusts color casts and temperature in images, giving them a specific look and improving images with less-than-ideal white balance settings.
7. Levels and Curves – Levels and Curves are two functions used to adjust an image's brightness and contrast, enhancing its appearance, improving contrast, and addressing exposure issues, while controlling overall lightness or darkness.
8. Clone Stamp Tool – The clone stamp tool is a crucial tool for photo editing, enabling the copying of pixels from one part of an image to fill another. It effectively removes objects or blemishes, and can duplicate specific elements like the backdrop. It is essential for composite creation and photo retouching.
9. Blending Modes – Blending modes are essential techniques for adjusting the relationship between two layers in an image. Popular options include Multiply, Screen, Overlay, and Soft Light. Experimenting with these modes can significantly alter the image's appearance. This tool is crucial for creative photo editing, composite creation, and retouching.
10. Making a Selection – Photoshop's Marquee, Lasso, and Pen Tools are essential for making selections, editing photos, creating composites, and working with layers. This tool is crucial for creative workers, as it is essential for composite creation and photo retouching, making it a vital skill for photo editing.

IV. RESULTS

Using Adobe Photoshop, the original and scanned signature samples were analysed using brightness, exposure and contrast settings. The original, scanned, and printed samples were analysed to determine the results. It was discovered that the samples scanned at 300 dpi displayed more disruptions in the form of tiny dots on the paper's background surface than the samples scanned at 900 dpi. These observations were done on both kinds of documents, with backgrounds composed of bond paper or A4. For sample evaluation, changes were made in Adobe Photoshop from positive to negative form, and each sample had slightly variable brightness, exposure, and contrast settings. The region with a high concentration of ink or toner deposition usually stands out and dispersion of toner particles (scanned at 300 dpi but extracted from different printers) is highlighted. A sample set of the challenged signatures showed evidence of misalignment in the relative positioning of letters when compared to the reference samples. The misalignment was manually assessed using measuring scale and a magnifying lens with a 10 \times magnification. With the use of imaging tools and a magnifying lens, some of traces that were seen in scanned photos could also be found in the printed page. There were

instances where the loss of constancy caused the letters' rhythm to become jarred. Using Adobe Photoshop, the scanned images of the samples were examined at a magnification of 200 \times . The samples that were scanned at 300 dpi and produced using laser printers showed a greater dispersion of toner particles (scanned at 300 dpi but extracted from different printers) and slight disintegration of the dot-shaped pattern. These overlapping strokes, nevertheless, could be mistaken for pen lift, retouching, or retracing in the printed samples. When comparing the fake signatures to the genuine samples, a slight discrepancy in the stroke/letter spacing was seen. This variance was detected using the measuring scale tool in Adobe Photoshop.

V. DISCUSSION

This study found that analyzing signature samples with image processing software can identify various features linked to digital document manipulations. These include surface irregularities, variations in word size and spacing, dots, and a distinct pattern of dots, in printer-produced samples after scanning at 600 dpi. The findings suggest that improper merging of stroke ends may cause overlapping strokes in printed signatures. Half-tone pattern irregularity was found in printed samples, easily identified in scanned images using brightness, exposure, and contrast settings in imaging software. Extension of the research area

Finding different features in signature samples scanned at different dpi's is the aim of current effort. It would be desirable to broaden the study's scope by including a wide range of signature samples with handwriting from different categories of skilled, semi-skilled, and poor skilled writers, produced under various conditions and circumstances, even though the questioned document examiners would find the information in this article helpful.

VI. CONCLUSION

The study reveals that digital signatures can be identified by identifying traits like letter spacing, uniformity, and alignment flaws. Adobe Photoshop was used for document evaluation, and the scanned image of original samples revealed additional elements like overlapping strokes, dispersion of toner particles (scanned at 300 dpi but extracted from different printers) and over-deposition of ink/toner particles. The study reveals that digitally produced signatures can be detected using characteristics like space variation, uniformity, and alignment defects. Adobe Photoshop was used to examine documents, detecting features associated with image manipulation. Other features like overlapping strokes and over-deposition of ink/toner particles were also observed. The research suggests that document examiners should use prudence and investigate

digital fabrication when handling non-original handwriting or signatures, enhancing their ability to detect such signatures.

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VIII. CONFLICT OF INTEREST

The writers claim to have no conflicting agendas.

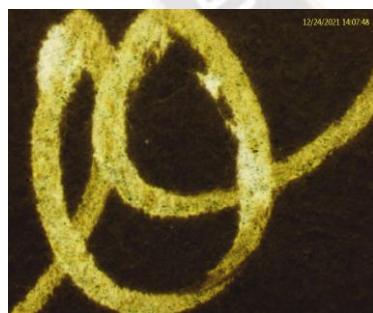
IX. REFERENCES

1. Akram, S., Dar, M.U.D. and Quyoum, A., International Journal of Computer Applications, "Document Image Processing – A review", November 2010, Volume 10, Issue 5, pp. 35-40.
2. Nigam, R. K. And Mishra, P., Malaysian Journal of Forensic Sciences, "Forensic Examination of Obliteration and Alteration in Handwriting using

Digital Image Processing", 2011, Volume 2, Issue 1, pp. 64-66.

3. O'Brien, J. F. and Farid, H., ACM Transactions on Graphics, "Exposing Photo Manipulation with Inconsistent Reflections", January 2012, Volume 31, Issue 1.
4. Birajdar, G. J. and Mankar, V. H., Elsevier –Digital Investigation, "Digital Image Forgery Detection Using Passive Techniques: A Survey", October 2013, Volume 10, Issue 3, pp. 226-245.
5. Burvin, P. S. and Esther, J. M., IOSR Journal of Computer Engineering, "Analyses of Digital Image Splicing Detection", March-April 2014, Volume 16, Issue 2, pp. 10-13.
6. Saini K, Kaur S., Egyptian Journal of Forensic Sciences, Forensic examination of computer-manipulated documents using image processing techniques, 2016 Sep 1;6(3):317-22.
7. Vikas Bhargav, Mohinder Singh, Suryakant Mishra, Problems of Forensic Sciences, "Forensic examination of digitally fabricated signatures in printed documents", January 2018, vol. 112, 111–122. -
8. Chourasiya S., Patel V. and Pandey R., International Journal of Forensic Sciences, "Forensic Document Examination Using Image Processing Tools", March 2023, Volume 8 Issue 1, 8(1): 000292.

Blue ball point pen



Blue gel pen



Blue pilot pen



Figure 1 - Images of original samples (with three different pens – 1. Blue ball point pen, 2. Blue gel pen, 3. Blue pilot pen) with software.

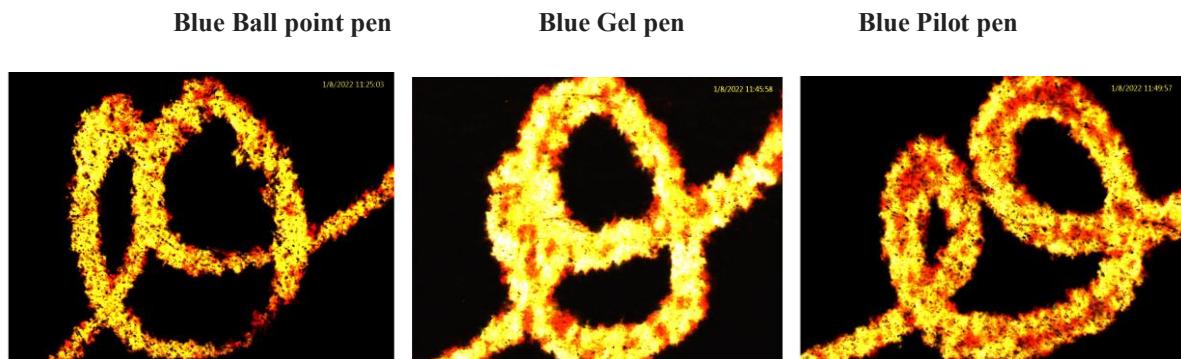


Figure 2 - Difference between sample with ball, gel and pilot pen at same dpi from same printer.

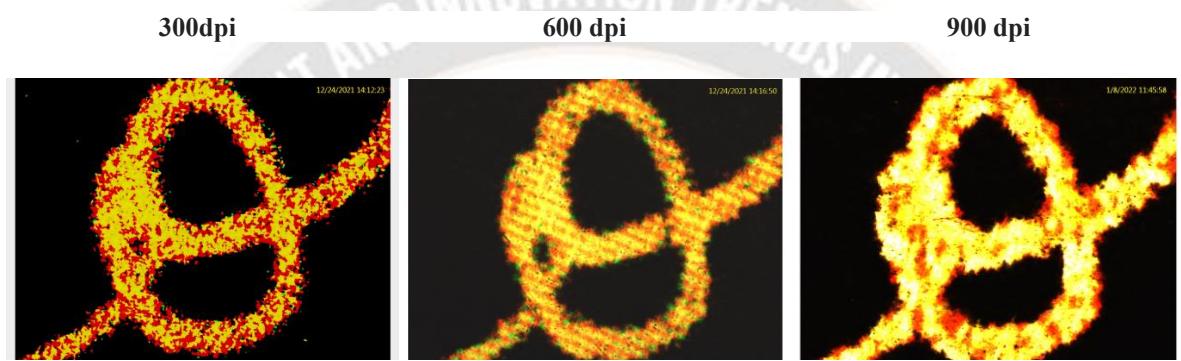
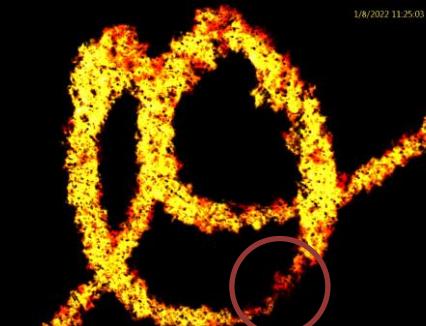
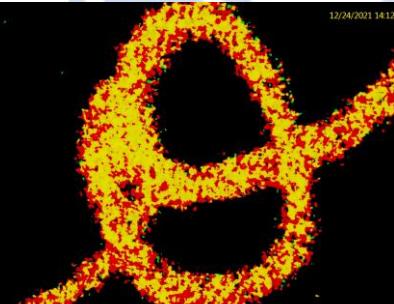
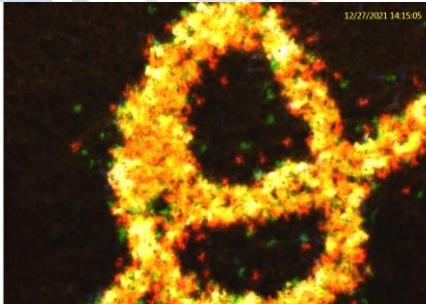
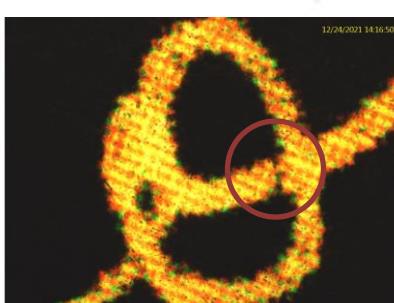
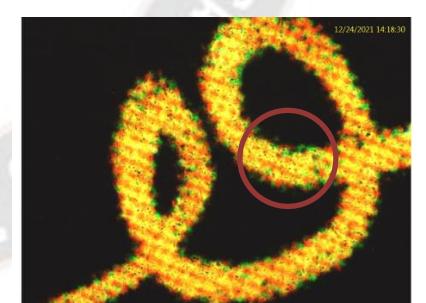


Figure 3 - Images using Software Adobe Photoshop for the samples scanned at 300 dpi, 600dpi and 900dpi.

Table 1 - For comparison of results for both original and scanned signature samples (at different dpi's) extracted from different printers.

Sr.No.	Feature	Results	
1	Variation in size (samples scanned at same dpi but extracted from different printers)		
2	Deposition of ink/toner particles in original and scanned (more with red mark and less with white mark)		

4	Overlapping strokes in original and scanned sample	 <p>12/24/2021 14:08:44</p>	 <p>1/8/2022 11:45:58</p>
5	Change in continuity of stroke in original and scanned sample (mistakenly for pen lift, retouching, or retracing)	 <p>12/24/2021 14:07:44</p>	 <p>1/8/2022 11:25:03</p>
6	Dispersion of toner particles (scanned at 300 dpi but extracted from different printers)	 <p>12/24/2021 14:12:23</p>	 <p>12/27/2021 14:15:05</p>
7	Dot-shaped pattern (appeared as discontinuous and continuous)	 <p>12/24/2021 14:16:50</p>	 <p>12/24/2021 14:18:30</p>