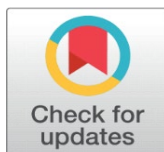
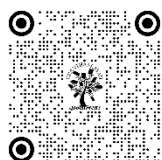


# THE IMPACT OF INK ON THE LINE QUALITY CHARACTERISTICS OF A SIGNATURE IN MULTIPLE GENERATIONS PHOTOCOPIES

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## ABSTRACT

In criminal investigations, photocopied documents represent the most dependable evidence in the absence of the original document. In this research paper, an effort has been made to study the effect of ink colour on line quality features of signature in multigeneration photocopies in ten different subsequent generations. Some of the line-quality features that were looked at were the beginning and ending strokes of letters or words, handwriting features like ink smudging, and writer features like pen lifts and tremors. This study collected various documents featuring original signatures in blue, black, red, and green ink. We obtained the signatures from various official personnel on A4-sized white paper, using both gel and ballpoint pens. The original and photocopied signature samples such as original, generation 1, generation 2, generation 3 and till 10th generation were examined manually with the help of magnifying lens. The handwriting characteristics of original & photocopied signatures were examined under Video Spectral Comparator 6000 HS (Foster & Freeman Co Ltd England) under higher magnification power along with various light sources. This research was carried out to assist Forensic Document Examiners in recognizing the common difficulties found in the line quality features of multi-generation photo-copies of signature samples.

**Keywords:** Multi-Generation Copy, Photocopying Machine, VSC 6000, Line Quality Features

## 1. INTRODUCTION

Historically, Forensic Document Examiners have believed that "Original evidence is the best evidence." However, ideal circumstances don't always exist, so FDEs must work with what they have. [1] The advancement of modern reproduction technologies, such as photocopiers that can scan, copy, and print documents, has led to the acceptance of photocopied documents as evidence [2]. It is common for document examiners to evaluate photocopied documents; when the original documents have been lost, destroyed, or are no longer available. [3]. In order to determine the authorship of writings and signatures, forensic document examiners often use photocopied documents [4]. This photocopied document lacks the handwriting features seen in the original, as photocopies are filtered reproductions of original materials. Handwriting characteristics in photocopied signatures have been studied by forensic document examiners [5] Even though photocopies do not always allow for complete handwriting examinations, there is usually

enough information in them to allow for significant comparison. It is important to consider the characteristics of the line quality when determining the authenticity of a signature.[6] In handwriting, line quality is often used to distinguish between genuine and forged handwriting. This is determined by a number of factors, such as writing skill, speed, rhythm, freedom of movement, shading, and pen position. In order to examine original documents, document examiners prefer photocopies because they conceal finer details of the line quality. A fraudster may be able to reproduce letter designs, but they usually cannot match the level of skill and fluency exhibited by a genuine signature.[7]

The development of different types of ink, such as ballpoint, fountain pen, and printer ink, has paralleled advancements in writing technology. Each type of ink has unique properties that influence writing style, legibility, and longevity.[8] In different cultures, certain ink color may hold specific symbolic meanings. For example, in many Western cultures, black ink is traditional for formal and official documents, while in some Asian cultures, red ink is used for signatures and important seals. Different coloured inks are often used for highlighting or annotating text, such as using a bright color to draw attention to key points or corrections. This helps in organizing and emphasizing information within documents. [9,10]

The current research has been undertaken to study the effect of ink colour on line quality features of signature in multigeneration photocopies which were reproduced on a similar type of paper as the original signature sample printed with Photocopier Machine (KYOCERA, TASKalfa 2200).

## 2. MATERIALS AND METHODS

### 1) Sample Preparation

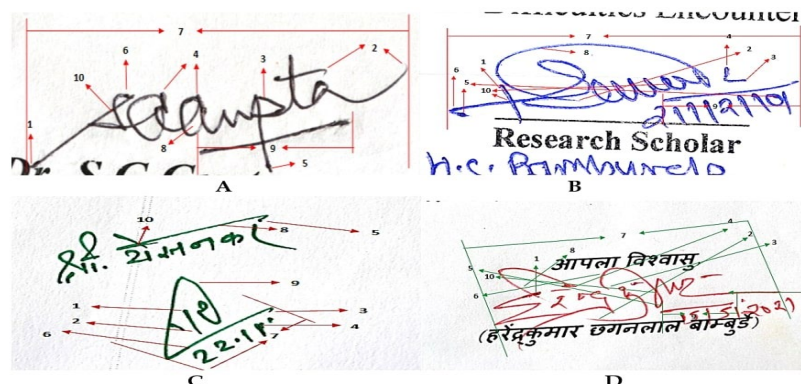
The different type documents containing original signature in different colours such as blue, black, red and green, were collected from different official personnel on A4 size white paper using gel and ball writing ink. The first generation photocopy (Generation 1) was produced directly from original document (O) and then the first generation photocopy (Generation 1) was used to generate the second generation of photocopy (Generation 2), a similar process was used to generate the third, fourth and so on till tenth generation photocopy. All the original samples were photocopied on a similar type of paper as the original samples without any change in their contrast or magnification. Only signature portion of document was selected for this study. Likewise total 44 signature samples using different colour ink such as blue, black, red and green were generated for the analysis of line quality features.

### 2) Sample Analysis

All the original and photocopied signature samples (O, Gen 1, Gen 2, Gen 3, Gen 4, Gen 5 and till Gen 10) were examined manually with the help of magnifying lens. The handwriting characteristics of original & photocopied signatures were examined under Video Spectral Comparator 6000 HS (Foster & Freeman Co Ltd England) under higher magnification power along with various light systems.

## 3. OBSERVATION

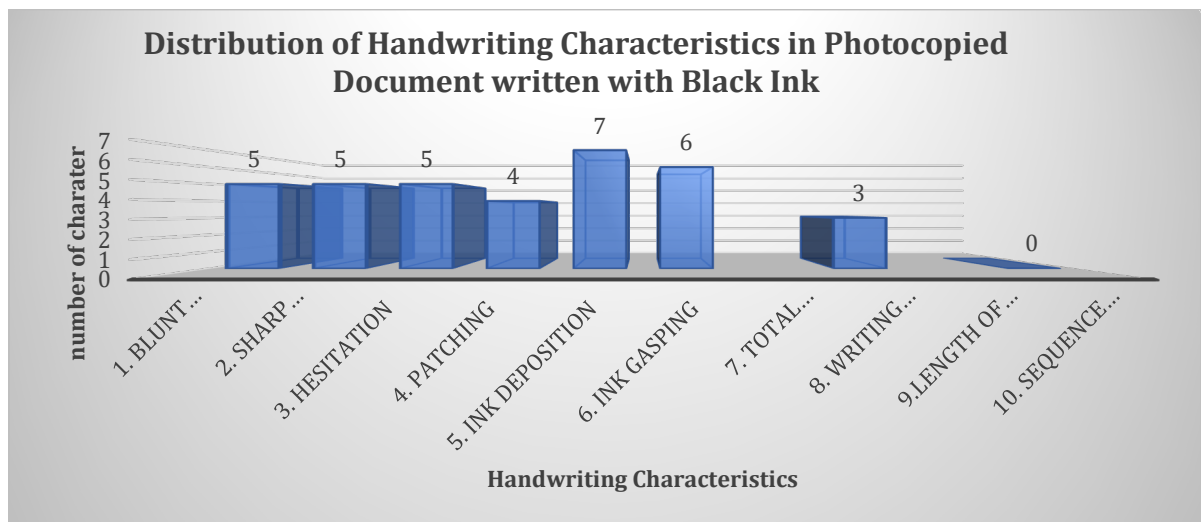
In this study, the original and subsequent generations of signature samples were examined to study the effect of ink colour on line quality features of signature in the form of Initial Stroke, Terminal Stroke, Hesitation, Patching, Ink Deposition, Ink Gassing, total length of the signature, Length of baseline, Sequence of stroke etc.



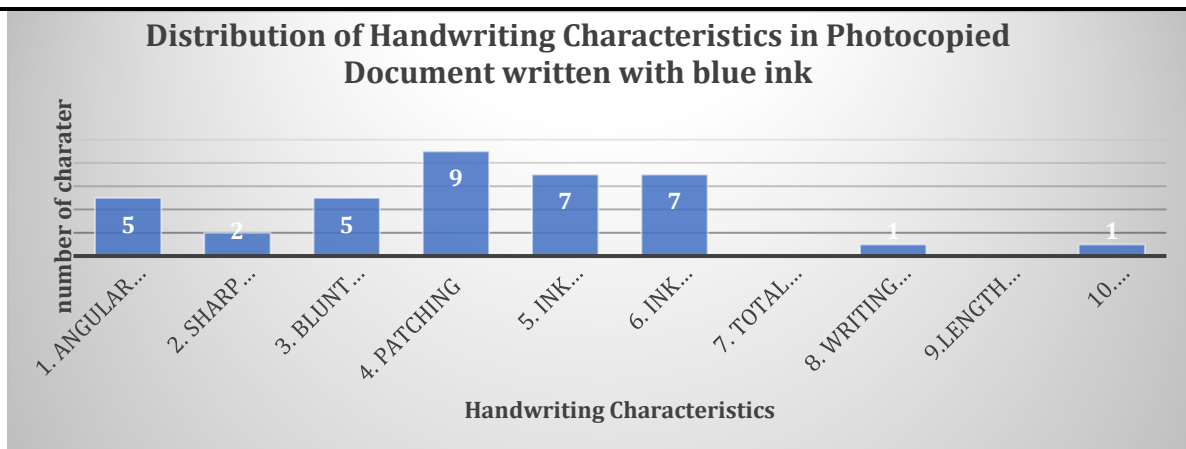
**Figure 1** Handwriting Characteristics of Original Signature signed with A-Black, B-Blue, C-Green and D-Red coloured ink.

 Dr. S. G. Gupta A(G1)	 Research Scholar B(G1)	 22. 22mm C(G1)	 Dr. S. G. Gupta D(G1)
 Dr. S. G. Gupta A(G2)	 Research Scholar B(G2)	 22. 22mm C(G2)	 Dr. S. G. Gupta D(G2)
 Dr. S. G. Gupta A(G3)	 Research Scholar B(G3)	 22. 22mm C(G3)	 Dr. S. G. Gupta D(G3)
 Dr. S. G. Gupta A(G4)	 Research Scholar B(G4)	 22. 22mm C(G4)	 Dr. S. G. Gupta D(G4)
 Dr. S. G. Gupta A(G5)	 Research Scholar B(G5)	 22. 22mm C(G5)	 Dr. S. G. Gupta D(G5)
 Dr. S. G. Gupta A(G6)	 Research Scholar B(G6)	 22. 22mm C(G6)	 Dr. S. G. Gupta D(G6)
 Dr. S. G. Gupta A(G7)	 Research Scholar B(G7)	 22. 22mm C(G7)	 Dr. S. G. Gupta D(G7)
 Dr. S. G. Gupta A(G8)	 Research Scholar B(G8)	 22. 22mm C(G8)	 Dr. S. G. Gupta D(G8)
 Dr. S. G. Gupta A(G9)	 Research Scholar B(G9)	 22. 22mm C(G9)	 Dr. S. G. Gupta D(G9)
 Dr. S. G. Gupta A(G10)	 Research Scholar B(G10)	 22. 22mm C(G10)	 Dr. S. G. Gupta D(G10)

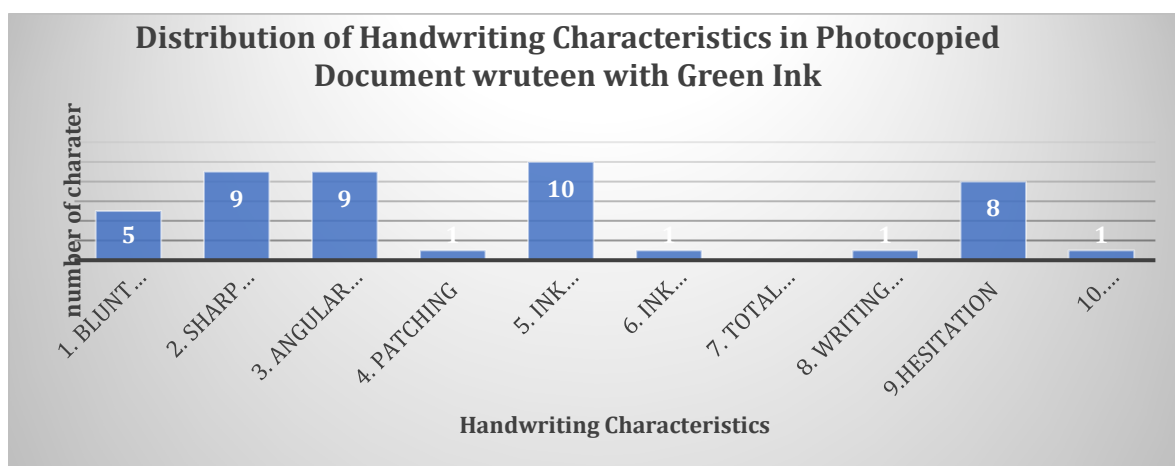
Figure 2 Photocopied signature samples (Gen 1, Gen 2, Gen 3, Gen 4, Gen 5 and till Gen 10) generated from original signature samples.



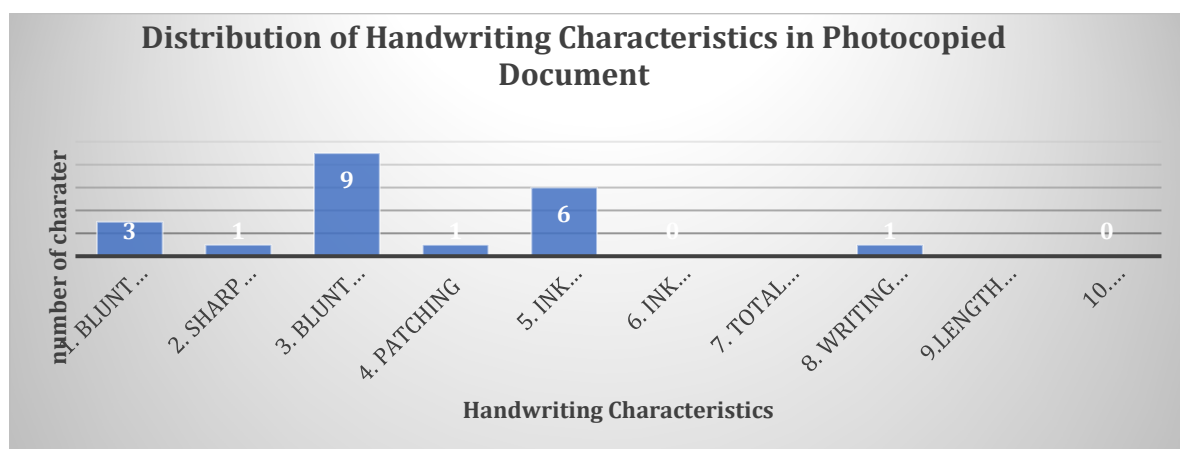
Graph. 1 Distribution of Handwriting Characteristics in Photocopied Document written with Black ink



Graph 2 Distribution of Handwriting Characteristics in Photocopied Document written with blue ink



Graph 3 Distribution of Handwriting Characteristics in Photocopied Document written with green ink



Graph 4 Distribution of Handwriting Characteristics in Photocopied Document written with red ink

## 4. DISCUSSION

The shape and place can be ascertained from the good quality photocopies. Hesitation is defined as a pause or stop in the writing motion in which the writing instrument remains in contact with the writing surface [11]. This is one of the peculiar features of the line quality in case of forgery. In the present study pen pause was observed in 06/10, Ink gooping or blobing is the feature that was observed in the form of extra ink deposits along with the main line stroke in case of

ball point writings. It can be very well detected in original writings/signatures. But in case of photocopies, ink gooping/ blobing was also misinterpreted as hesitation or pen pause. Pen skipping is observed as break in the inked stroke either due to the high speed of writing or because of the fact that ink does not fill in the stroke though groove is very much present. This is a typical nature of ball-point pen strokes.

In case of photocopies, un-inked or break in the ink-lines were observed. It was not possible to ascertain that whether these hiatuses were because of unnatural pen lifts, or because of the nature of writing instrument. Light strokes due to high-speed and less pressure used in original signatures also appeared as pen lifts. In some signatures the concealed pen-lifts were observed like continuous strokes because of the artifacts added due to the process of photocopies. In the present study, it was observed that the pen lifts were present in 5/10 and 5/10 cases in case of photocopies by photocopiers respectively. This is because of the fact that the minute details or the peculiarities, by which these features can be recognized in original writings/signatures, could not be reproduced by photocopying process. Tremors were observed as shaky irregular strokes caused by unnaturally slow pen movements due to conscious attention to letter-forms in deliberate rather than spontaneous writing. This feature was observed in 6/10 cases in original and photocopied samples. In case of good-quality photocopies, they were reproduced in 6/10 samples and in case of photocopies, this feature was reproduced in only 5/10 cases. After 7<sup>th</sup> photocopies, a difference in length was observed in these features.

The most probable reason behind this is because the tremors were less pronounced in original signatures. Moreover, the photocopiers were also not able to reproduce it well as there were breaks in the continuity of strokes due to the non-deposition of toners.

## 5. CONCLUSION

It has been concluded that examination can be done from the photocopies though photocopies do pose problems in ascertaining some of the important handwriting features. Black and Green ink shows maximum characteristics as compared red and blue till 8th Photocopy. Total length of Signature Slightly increased in black, blue and red ink except green gel. Misidentification of Handwriting characteristics could be possible after 5th Photocopy in blue and after 7th in Black, green and red. Some false characteristics such as tremors could recognize till 8th photocopy. The visibility of signature becomes faint in all type of Ink. For comparison purpose up to 4th or 5th photocopy should be considered. The features like pen lifts, pen skipping, pen patching is more commonly misinterpreted. Moreover, the possibility of a fabrication must always be considered when examining a photocopy-to-photocopy document. Higher magnification of VSC-6000 minimizes the possibility of false handwriting character identification during photocopy-to-photocopy examination.

## CONFLICT OF INTERESTS

None.

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## AUTHORS' CONTRIBUTIONS

1st author was responsible for the sample collection, analysis, interpretation of the data, and writing of research paper. 2nd author contributed to the idea of the research, study design, and supervision of the work and approved the version to be published. Both authors conducted the retrieval of the literature and analysis. 2nd author contributed to manuscript writing and revised it critically for important intellectual contents. All the authors have read and approved the final manuscript.



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