

The Effectiveness of Hand Held Digital Microscope and Stereo Microscope in Determining Sequence of Strokes of Green Pen Ink and Blue Seal- A Comparative Study

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ABSTRACT:

Background: Sequence of strokes is the study to determine the sequence in which writing strokes are made on the paper. Determining sequence of strokes is an important part of forensic document examination. The choice of method depends on the accessibility and availability of the means at that time.

Materials and Methods: In this paper, chronological sequence of intersecting pen strokes with seal ink has been determined using Stereo Microscope and hand held digital microscope. The exemplars were prepared at different time intervals. Intersections of blue seal impression with green colour ball point pen ink were studied. Strokes were examined under both the instruments and results were compared.

Results: Dragging of ink was not seen when seal was over signature whereas when signature was over seal dragging was seen in around 50 % of intersecting points. Continuity of pen was seen in

only 20% of intersecting points whereas continuity of seal was seen in 80% of intersecting points. Spreading of seal was seen in around 80% of intersecting points. Relative gloss of ball pen was seen in about 70% of intersecting points.

Conclusion: Due to the 3- dimensional view property of stereo microscope it was much more effective and results are more reliable. So therefore, it can be concluded that the stereo microscope is more effective in examination of sequence of intersecting lines than hand held digital microscope.

KEY WORDS: Seal impression, Pen inks, Intersections, Digital Microscope, Stereo Microscope, Green ink, Blue seal

Background

To determine the sequence of stroke is part of forensic document examination. There are various

types of ink used in different types of writing instruments; due to which the determining the sequence of stroke can be problematic. With the advancement in technology many techniques have been developed to determine the sequence of strokes depending on the nature of writing instrument, type of ink or type of material. The need for the investigation of sequence of strokes of writing emerges when it is said that part of written material has been added after the signature was done on the document or this examination can be performed to learn which of the handwriting was last written. The determination of sequence is very important to verify the accountability of the questioned document. By examining properties of ink like absorption of ink onto the paper, color of the ink, properties of ink like gloss and luminescence can help in more easier and faster detection of sequence of intersecting lines^{2,3,4}. It is possible to observe how the pen tip, besides releasing the ink, deforms the paper. This is because; the writing pressure leaves more or less deep impressions, according to: Writing pressure (amount of pressure exerted over the paper during act of writing) ;Underlying material (sheet of paper lying on metal surface or on paper block);

Writing material (fountain pen, pencil, gel pen, ballpoint pen interact in different ways with paper); Type of paper used (the production process determines the size and the morphology of the fiber's layers in the paper) (*Max Frei theory revisitation: does really strokes depth changes along time*)*Frei-Sulzer et al. (Based on microscopic analysis)* claimed that strokes are time dependent, due to the (supposed by his observations) 3-years paper elastic release time. According to his theory it is possible to try to date the handwritten document studying depth change over time. Montani (2012), Examination of Heterogeneous Crossing Sequences between Toner and Rollerball Pen Strokes by Digital Microscopy and 3-D Laser Profilometry⁷.Giuseppe Schirripa Spagnolo (2006). Potentiality of 3D laser profilometry to determine the sequence of homogenous crossing lines on questioned documents. In this paper the potentiality of the 3D micro-topography to resolve the writing order of signatures to detect the tampering of manuscripts, to analyze pressure variation, and to identify strokes in handwritten⁴. Andre Braz (2014). A study to visualize and determine the sequencing of intersecting ink lines

examined sequence of strokes using Raman spectroscopy by doing the analysis of inks. Intersections are formed by the writing of ink; they can also be formed by printed text, paper fold, typewriting, indenture, and etc⁸.Ka Young Lee (2014), Sequence discrimination of heterogeneous crossing of seal impression and ink-printed text using adhesive tapes, explained technique to discriminate the sequence of stamped seal impression and ink-printed text in a document to detect falsely signed documents⁹.SC Leung (1997), Systematic study of the lifting technique for determining the writing sequence of intersecting ball pen strokes using Kromekote technique. A theory is proposed to explain the lifting of ball pen ink and its application in the metho¹⁰.

MATERIALS AND METHOD

Sample Size

Total of 120 intersections were prepared with Blue seal ink and ball point green pen ink (writing instrument) on A4 size white sheet.

Sample Preparation

In this the blue colour ink and round seal is used. The content written on the seal- Institute of

Forensic Science, GFSU, Gandhinagar, with University Logo in the center. The sequence of preparing sample was either seal was placed first or pen was written first. The samples were prepared in a batch of 6 i.e. in the different time interval ;In first batch of samples the seal was immediately placed on the signature and vica versa; In second batch of samples the seal was placed on the signature after the time interval of 10 minutes and vica versa; In third batch of samples the seal was placed on the signature after the time interval of 2 hours and vica versa; In fourth batch of samples the seal was placed on the signature after the time interval of 3 days and vica versa; The fifth batch of samples the seal was placed on the signature after the time interval of 10 days and vica versa; The sixth batch of samples the seal was placed on the signature after the time interval of 1 month and vica versa.

Type of Paper

A4 size sheets were used of Xerox Company for the purpose of sample preparation.

Writing Instrument

Ball pen of Flair brand was used.

Instrument Used

The AM4113T Dino-Lite handheld digital microscope is designed with a high quality 1.3 megapixel image sensor that lets you view and capture objects with the greatest of details. It can view objects at various magnifications depending of distance with a max magnification of up to 220x¹³.

Stereo microscope uses light reflected from the surface of an object rather than transmitted through it. The instrument uses two separate optical paths with two objectives and eyepieces to provide slightly different viewing angles to the left and right eyes. This arrangement produces a three-dimensional visualization of the sample being examined¹⁴.

RESULT AND DISCUSSION

When samples were observed, the following observations were made:

No **Dragging** of ink pigments were seen in samples when seal was over signature in both the instruments (as seen in fig. 1 and 3). When observed under **Hand held digital microscope**, samples in which signature was over seal, with no time interval i.e. immediate samples, with 10 minutes time interval and 2 hours interval out of all intersecting points approximately 60 % of them were showing dragging of seal ink pigments (as seen in fig. 3 and 4). In the samples of time

interval 3 days, 10 days and 1 month dragging of ink was not seen when signature was over seal. Whereas when same samples were observed in **Stereo microscope** for Dragging of ink, samples in which signature was over seal, with no time interval i.e. immediate samples, with 10 minutes time interval and 2 hours interval out of all intersecting points approximately 65 % of them were showing dragging of seal ink pigments, also it was seen in samples with time interval of 3days in approximately 50 % of intersecting points. And In the samples of time interval 10 days and 1 month dragging of ink was not seen when signature was over seal (as seen in fig. 1 and 2).

In **both** the instruments, When seal was over signature the **Continuity** of pen stroke was seen instead of seal ink i.e. where pen strokes were present there were no / or relatively very less interaction of seal ink with paper. This was seen in the samples of immediate and 10 minutes interval. In the time interval of 2 hours, 3 days and 10 days the continuity of pen stroke at some intersecting points and at some points the continuity of seal ink were seen. Last in the time interval of 1 month the continuity of only seal ink was seen. When signature was over seal only continuity of seal ink were seen in all the samples (as seen in fig. 1 to 4).

In **both** the instruments, No **Spreading** of ink were seen when seal was over signature in any sample (as seen in fig. 1 and 3). When signature was over seal out of all intersecting lines only samples with no time gap i.e. immediate samples were showing Spreading of seal ink pigments in

approximately 50% intersections (as seen in fig. 2 and 4).

When observed under **Hand held digital microscope, Relative gloss** of the ball point ink is seen in approximately 25% of intersecting points when seal was over signature, and when signature was over seal it was seen in approximately 65 % of intersecting points. Whereas when same samples were observed in **Stereo microscope, Relative gloss** of the ball point ink is seen in approximately 25% of intersecting points when seal was over signature, and when signature was over seal it was seen in approximately 69 % of intersecting point(as seen in figure 3 and 4)

CONCLUSION

Dragging of ink was not seen when seal was over signature whereas when signature was over seal dragging was seen in around 50 % of intersecting point. Continuity of pen was seen in only 20% of intersecting point whereas continuity of seal was seen in 80% of intersecting point. Spreading of seal was seen in around 80% of intersecting points. Relative gloss of ball pen was seen in about 70% of intersecting point. Due to the 3-dimensional view property of stereo microscope it was much more effective and results are more reliable. So therefore, it can be concluded that the stereo microscope is more effective in examination

of sequence of intersecting lines than hand held digital microscope.

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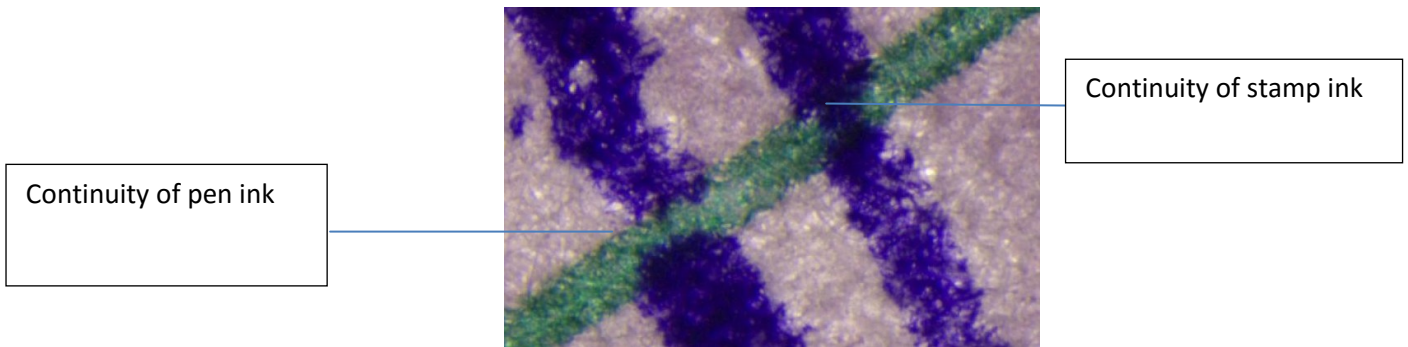


Fig 1 specimen of Stamp was over signature when observed under stereo microscope

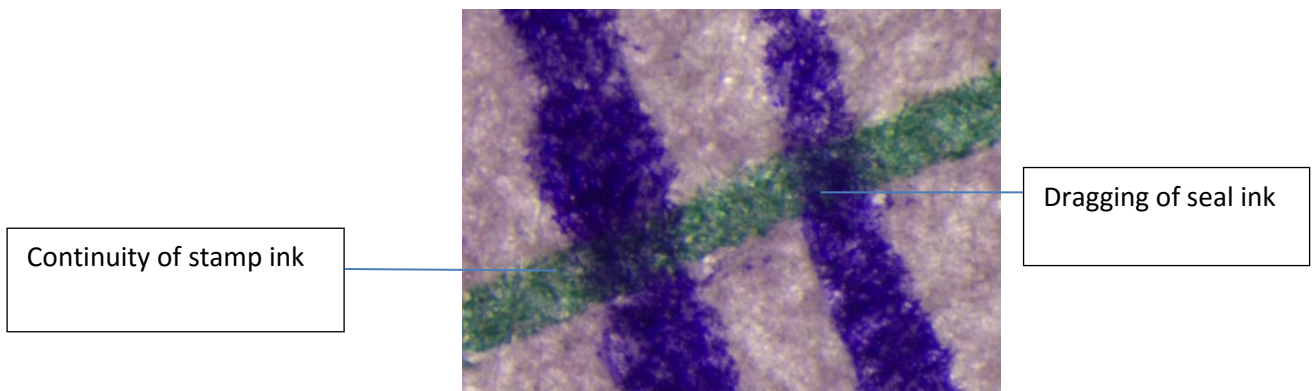


Fig 2 specimen of signature was over stamp when observed under stereo microscope

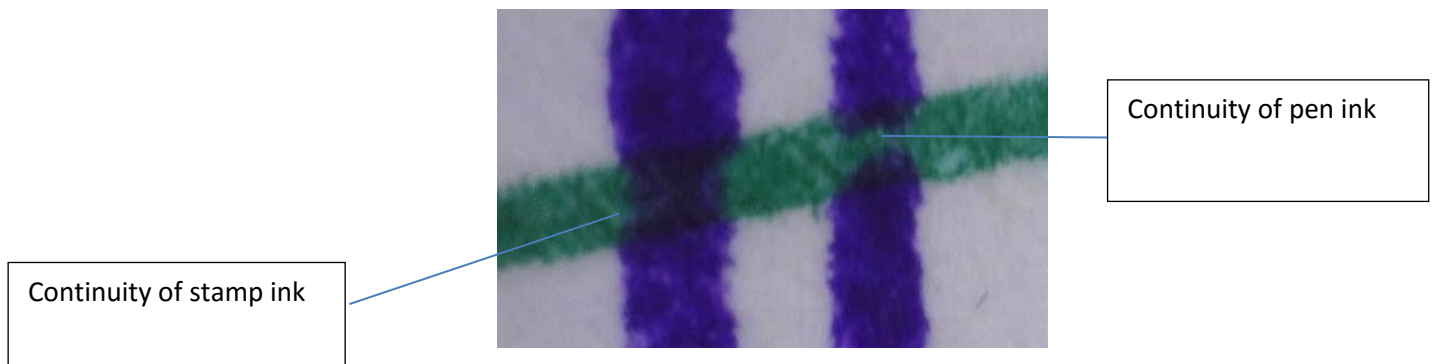


Fig 3 specimen of Stamp was over signature when observed under hand held digital microscope

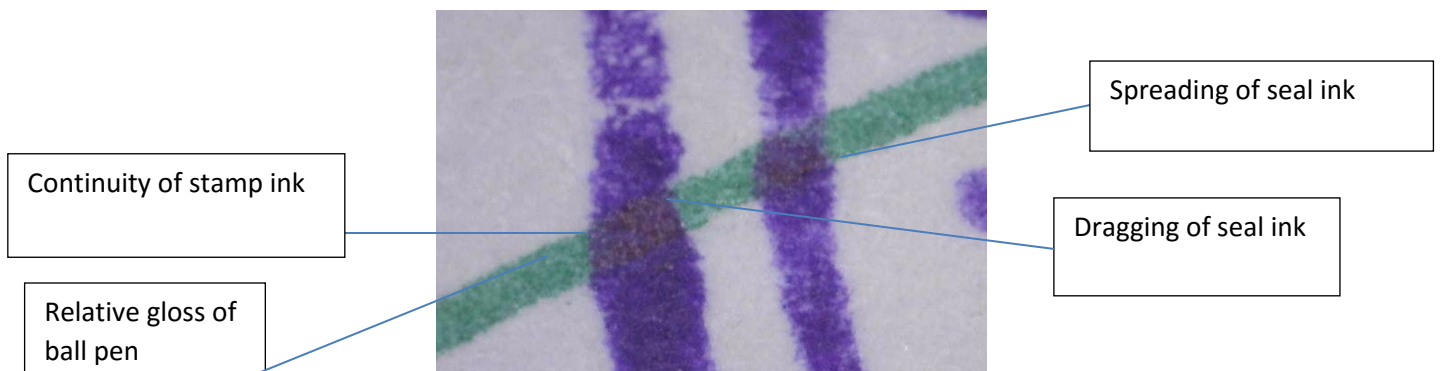


Fig 4 specimen of signature was over stamp when observed under hand held digital microscope

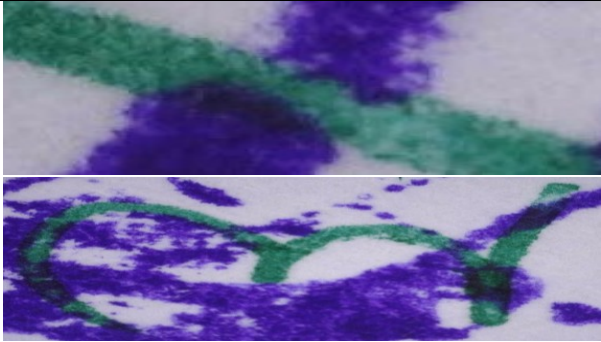
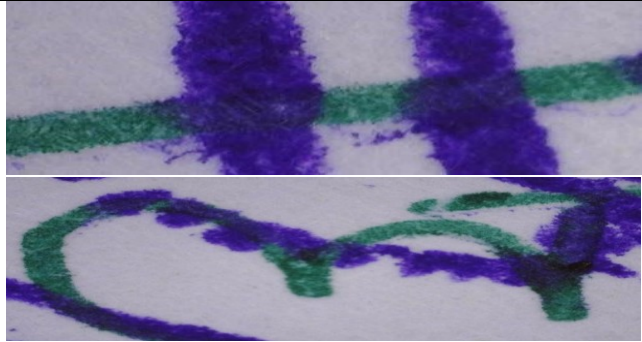
Light source	Time gap	Type of pen used	Stamp was over signature	Signature was over seal		
Visible	Immediate	Ball pen				
Characteristics /Sequence	Type of Pen	Time Gap	Dragging of ink pigment	Continuity of stroke	Spreading of ink	Relative gloss of the ballpoint ink
Seal was over signature	Ball pen	Immediate	Absent	Continuity of pen strokes at some points and Continuity of Seal ink at some points	Spreading of seal ink	Absent
Signature was over seal	Ball pen	Immediate	Present	Continuity of Seal ink	Spreading of seal ink	Present

Table-1 The Results Of Ball Pen Was Over Seal Impression And Vica-Versa When Observed Under Digital Microscope

- No dragging of ink pigments were seen when seal was over signature whereas when signature was over seal out of all intersecting lines about 70% were showing dragging of seal ink pigments.
- When seal was placed over signature after the time interval of immediate the continuity of pen stroke at some intersecting points and at some points the continuity of seal ink were seen whereas when signature was placed over seal after the time interval of 3days only continuity of seal ink were seen.
- Spreading of seal ink was seen in both the groups i.e. when seal was over signature seal and vica-versa.
- Relative gloss of the ball point ink was not seen when seal was over signature whereas when signature was over seal Relative gloss of the ball point ink was seen

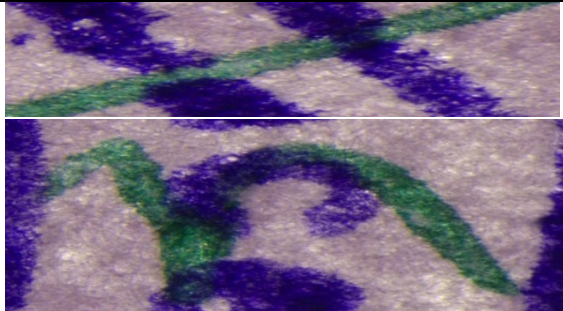
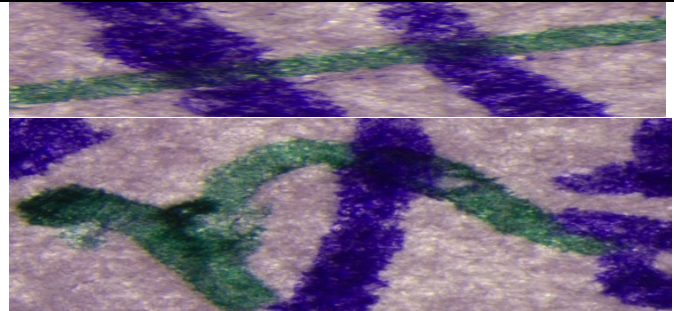
Light source	Time gap	Type of pen used	Stamp was over signature	Signature was over seal		
Visible	Immediate	Ball pen				
Characteristics /Sequence	Type of Pen	Time Gap	Dragging of ink pigment	Continuity of stroke	Spreading of ink	Relative gloss of the ballpoint ink
Seal was over signature	Ball pen	Immediate	Absent	Continuity of pen strokes at some points and Continuity of Seal ink at some points	Spreading of seal ink	Absent
Signature was over seal	Ball pen	Immediate	Present	Continuity of Seal ink	Spreading of seal ink	Present

Table-2 The Results Of Ball Pen Was Over Seal Impression And Vica-Versa When Observed Under Stereo Microscope

- No dragging of ink pigments were seen when seal was over signature whereas when signature was over seal out of all intersecting lines about 70% were showing dragging of seal ink pigments.
- When seal was placed over signature after the time interval of immediate the continuity of pen stroke at some intersecting points and at some points the continuity of seal ink were seen whereas when signature was placed over seal after the time interval of 3days only continuity of seal ink were seen.
- Spreading of seal ink was seen in both the groups i.e. when seal was over signature seal and vica-versa.
- Relative gloss of the ball point ink was not seen when seal was over signature whereas when signature was over seal Relative gloss of the ball point ink was seen.

