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Determination of Sequence of Strokes Using Docubox Dragon

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Abstract

Sequence of strokes is the sequence in which writing strokes are placed on the paper. To analyze whether the documents such as wills, letters, contracts, etc. are genuine or not, determination of sequence of strokes becomes necessary. In the present study Stereomicroscope and Docubox Dragon were used for observation and examination of the exemplars. The sequences of strokes in the exemplars were primarily observed using Stereomicroscope and the forged exemplars were further examined using Docubox Dragon. It was observed that stereomicroscope was used for preliminary examination whereas through Docubox Dragon detailed and evident results were obtained using various light sources and filters.

Keywords: Sequence of strokes; Docubox dragon; Stereomicroscope; Density of ink

Introduction

Determination of sequence of strokes in handwriting as well as in blank paper signature cases (whether the signature was done first and then the paragraph or sentence is printed or vice versa) is a kind of examination in the field of Forensic Questioned Document. The examination of sequence of strokes is very important task to fix the accountability of the person who had forged the document [1]. Destructive as well as non-destructive examinations are available to determine the sequence of strokes. Destructive techniques like SEM (Scanning Electron Microscope) and non-destructive examinations like microscopic examination (stereomicroscope), Video Spectral Comparator (VSC), Electrostatic Detection Apparatus (ESDA), digital imaging system; Docubox Dragon, etc. are used. Usually non-destructive examinations are preferred because they are easy to carry out, produces adequate amount of information and the evidence can be used for further analysis using other techniques.

Liquid ink sequencing

A complete absorption of fluid inks on a normal paper creates difficulty in determining the evident presence of top layer. Effect of one line on another strongly corroborates the sequence of intersecting strokes. In earlier times, iron based inks were used in which capillary action the first ink lines was affected so that it would absorb the ink of second line and drag some of it along the crossing. Sequence of ink line can be indicated by observing the darker appearance to the line for a distance of about one mm on both side of crossing [2].

Ball point pen ink sequencing

Ball point pen inks do not flow onto the paper because they have non-aqueous inks. When two ball point pen strokes bisect the grooved line originated by pressure on the ball is vital in determining the order of writing [3]. Heavier pressure is applied while writing with ball point pens as compared to liquid ink pens. Sequence of lines can be determined by utilizing the impression of grooves formed because of this pressure. These grooves influence a pen crossing to a certain limits and make it detectable. Distortion of the grooves at the crossing can be seen due to heavy pressure of the pen. If large amount of pressure is applied the surface of the paper flattens and no difference in the level of surface at intersection can be determined.

The consistency of a line will be disturbed, if a lightly written stroke bisects an indenture. A larger amount of ink will be settled on the further or upward side of the groove there'll be loss on the side where surface of paper falls into the indenture. Deep impression made on one side of paper while writing will affect the surface of other side. A line written on other side of page may be influenced by embossments caused by deep impressions. Deposition of ink on the rising side and on the falling side of the page depends upon the pressure exerted by the pen while making the line. If the pressure exerted by the pen is not much to flatten the ridge larger amount of the ink will be deposited on the rising side and lesser amount on the falling side. Such effects can be observed at the intersection of the lines on the both side of the paper. These facts and observation prove to be of great importance if the order of the writing on the both side of the page is under question. Effect of impression of ball point pen affects the sequence of strokes made with liquid inks but vice-versa is rarely observed. No depression can be observed in the case of liquid ink pen since the surface of the paper remains unchanged [2].

Pencil line sequencing

Due to deposition of "lead" on a paper by a pencil creates difficulty in sequencing the intersections of two pencil lines or liquid or ball point pen lines with the pencil lines [2]. If a good intensity ink line/ stroke is made over a pencil stroke such that it appears to be made at last is a result of order of strokes are affected to a great extent due to width and weight of the strokes. Indentation made on the paper because of the substantial pressure made by the two pencil strokes help in determination of sequence of these strokes. These types of indentation can be observed on stereomicroscope irrespective of intensity of strokes. While examining the intersection of a pencil stroke and ink line at 90 degree angle will show a continuous undimmed metallic lusture

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which is broken or dull. This is observed when the ink lines are made last. For all examination of intersection of strokes either by pencil or ink, stereomicroscope is preferred [1].

Printed sequencing

Ball point pen inks do not get soaked through the toner and remain on the top of the fused toner. This effect can be clearly observed by their specular reflectance under weak magnification. In case of fluid ink from fountain pen, fiber tip pen or roller ball pen soaking of inks through the toner takes place and this effect is not visible. Sequence of ball point pen inks and typed material can be determined even if no crossing takes place. This is possible because fuse toner particle present in laser printed document are spread on complete surface of paper [2]. Due to bisection of written and printed text various conditions are observed such as repulsion of water based ink by oil and waxes present in typewritten ink/ toner image leads to small gaps, beading of ink and slendering of fluid ink line when fluid ink crosses fresh type written or toner ink. This condition can also be observed with ball point pen line. The properties of inkjet images will be similar to fluid ink writing and repugnance will not be observed after considerable time gap between fluid ink /inkjet ink and oil material in typewriting, since the oily material have completely dried. This non-repugnance may indicate that the typewriting was made first. According to the studies the absorption of the ink into the fiber of the toner line may be observed when the fluid ink line intersects the toner line [3].

Earlier many experiments were executed to determine sequence of strokes. Andre Braz et al. (2013) examined sequence of strokes using Raman spectroscopy by doing analysis of inks. Intersections are formed by writing of ink, they can also be formed by printed text, paper fold, typewriting, indenture, etc. the basic principle followed in Raman spectroscopy is that intersection of two ink lines will show different Raman spectra. Point of intersection of two lines of different ink form a disparate layer on top of each other. According to Raman spectroscopy, ink present on the top will be more highlighted and explained by Raman spectrum at surface and the features of ink present underneath will be shown more clearly by the Raman spectrum at a deeper layer [4]. A.K. Singla et al. (1994) suggested a technique for determination of sequence of strokes (carbon ribbon strokes and ball point pen lines) which is totally non-destructive. The basic phenomenon if the technique is the difference in the brightness of carbon ribbon strokes and ball point pen lines. Carbon ribbon strokes appear as compact black layers under magnification and on the other hand ball point lines appear to be glossy with pasty texture. Ball point pen lines shows continuity of line at the intersection with relative brightness over carbon ribbon strokes, on the other hand carbon ribbon strokes appear to be compact black layers which conceal the ball point pen lines and disturbs the continuity at the intersection [5]. Sahni et al. examined the chronological sequence of inkjet strokes of different colors with ball point pen ink or gel pen under stereomicroscope. He examined on the basis of physical characteristic such as specular reflection, relative brightness of ball point ink and spreading of ink [6].

Apart from these examination a quite simple method can also be used in case of intersection between writing instrument (pen, pencil, etc)-

High speed of writing instruments (pen, pencil, etc.)=Low density of ink deposited

Low speed of writing instruments (pen, pencil, etc.)=High density of ink deposited

In the present study, sequence of strokes is determined by analyzing the density of ink at the intersecting strokes using stereomicroscope and Docubox Dragon Projectina.

Materials and Methods

Sample preparation

Seven different types of samples were collected which includes standard sample consisting of intersecting lines of pencil and pen on a normal A4 size paper. The exemplars were prepared using different kinds of writing instruments i.e. liquid ink pen, ball point ink pen, gel based ink pen, toner ink and pencil. All the exemplars were prepared on A4 size paper. Different types of exemplars were prepared such as blank paper signatures, two altered cheque, and four different applications letters out of which two were printed and two were handwritten.

Instruments used

Stereomicroscope: Stereomicroscope is an optical microscope which offers three dimensional study of the samples. It is better than two dimensional study. The samples are illuminated using spot light lamps. The examination is started from low magnification to high magnification. The examination is carried out at the specific and relevant area. It uses two different optical path along with two objectives and eyepieces. Stereomicroscope uses reflected light instead of transmitted light.

Docubox dragon projectina: Docubox dragon have very wide range of applications in field of biology, chemistry, fingerprints, handwriting and printed documents, verification of validity of passports, detection of counterfeit currency, secret writing, etc. It is a compact box which is connected to a computerized system. It consists of 14 different light sources with 20X zoom and a CCD IR sensitive color camera. It works on PIA-5, 6 software. There are 2 types of filters also present- exciting filter and barrier filter [7]. It uses various light source for various purposes, UV illumination (365 nm) for detection of security markers and threads, overwriting, fluorescent fibre etc., UV illumination (254 nm) – for detection of security marks in short UV range, UV illumination (313 nm) for detection of security marks in mid UV range, IR luminescence used for differentiating different kind of inks, different kind of erasures, etc., Side lights for detection of mechanical erasures, intaglio printing, inkless stamps, etc., Transmitted light- for detection of watermarks, security threads, etc. and Retro light for reflective security elements [8]. The document to be analyzed in Docubox dragon, is kept in chamber then depending upon the requirement of the Forensic Document Expert (FDE) various lights are used. And the image of the document can be seen on the computerized system attached to it.

Result and Discussion

After examination of the samples using stereomicroscope, the specific areas where sequence of strokes were observed and further analysed in details using Docubox Dragon. Sample 1 was analyzed under Docubox Dragon using white light at 4.5X zoom at the intersection (A_1) and (B_1) and it was found that at intersection (A_1) the black ball point pen stroke is above the pencil stroke and at intersection (B_1) the pencil stroke is above the black ball point stroke as shown in Figure 1. Sample 2 was analyzed using DIA 100 at 11X zoom at intersection (A_2) and (B_2). The upper surface of digit zero at second place and digit nine at point (A_2) and (B_2) show clear and uniform density of ink but the lower stroke of signature shows lesser density of ink in intersection of the digit nine. Hence it can be concluded that nine was written after the signature was

made as shown in Figure 2. Sample 3 was examined using DIA 100 at 11 X zoom, the upper surface of the digit zero at the second place and digit zero at third place at point (A_3) and (B_3) shows clear and uniform density of ink whereas upper stroke of signature shows more density of ink on intersection of digit zero. Hence it can be concluded that signature was done after digit zero at second and third place was made as shown in Figure 3. Sample 4 was examined using DIA 100 at 11 X zoom, the upper surface of the alphabet 't' and 'm' at point (A_4) and (B_4) shows shows clear and uniform density of ink whereas upper stroke of signature shows more density of ink on intersection. Hence it can be concluded that the alphabet 't' and 'm' were written before the signature was made as shown in Figure 4. Sample 5 was examined using white light at 11 X zoom. The upper surface of the letter 's' and 'f' at point (A_5) and (B_5) shows clear and uniform density of ink but the lower stroke of signature shows less density of ink at intersection, therefore it can be concluded that signature was made before the letter 's' and 'f' as shown in Figure 5. Sample 6 was examined using retro light at 8.2 X zoom, the upper surface of the letter 'd' at point (A_6) and (B_6) shows clear and uniform density of toner ink and ball point ink remain on the top of used toner, therefore the signature was done after printing of the document as shown in Figure 6. Sample 7 was examined using white light at 11 X zoom, the upper surface of the word 's' and 'h' at point (A_7) and (B_7) shows clear and uniform density of toner ink and ball point ink does not remain on the top of the fused toner. Hence the signature was done before printing of the document as shown in Figure 7. The results are compiled in Table 1.

Conclusion

From the present study it has been concluded that Docubox dragon is a successful instrument to determine sequence of strokes. The intersections of different writing instruments (pen, pencil, etc.) as well as the intersections of various writing instruments and printed text can be analyzed by studying the density of ink using this instrument. Further studies regarding sequence of strokes can be made using various other advanced instruments and techniques. Other parameters instead of density of ink can be considered for examination of strokes which can ease the work of forensic document examiner and provides efficient, quick and reliable result.

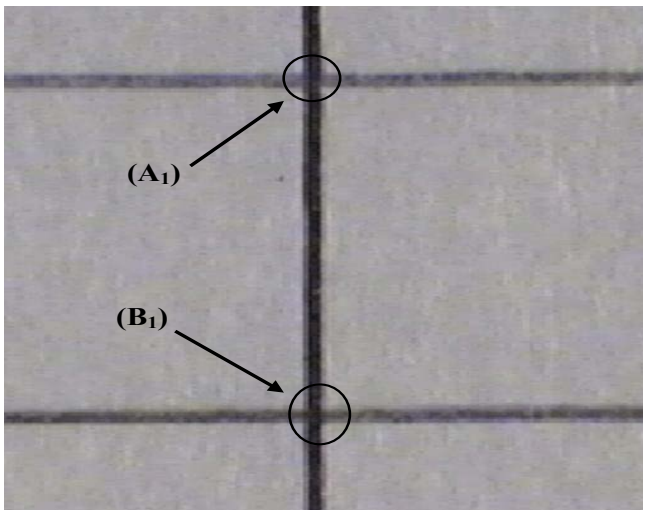


Figure 1: Examination of the sample 1 using stereomicroscope.

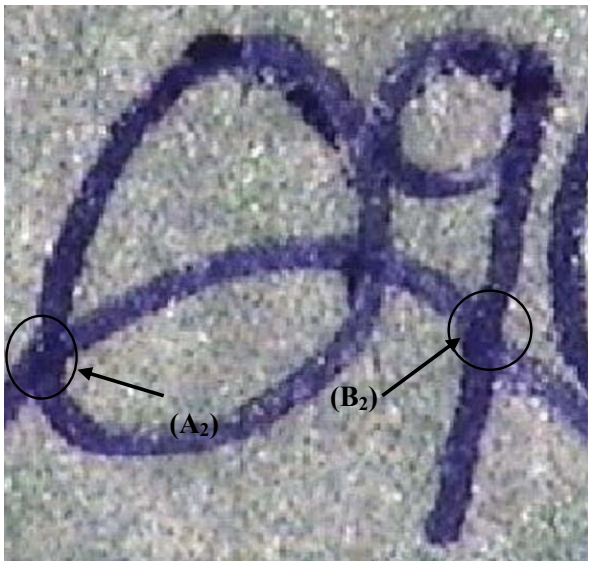


Figure 2: Examination of the Sample 2 using stereomicroscope.

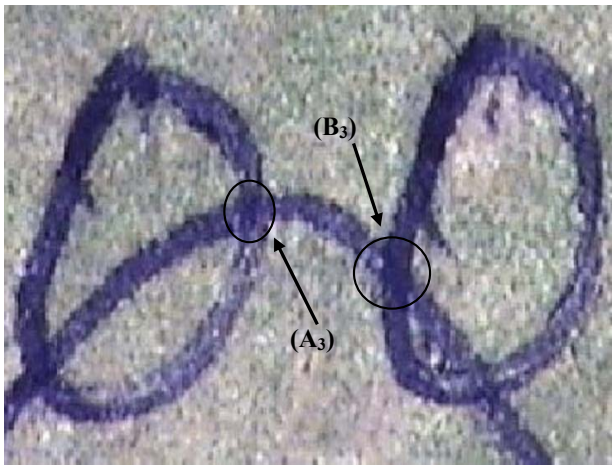


Figure 3: Examination of the sample 3 using stereomicroscope.

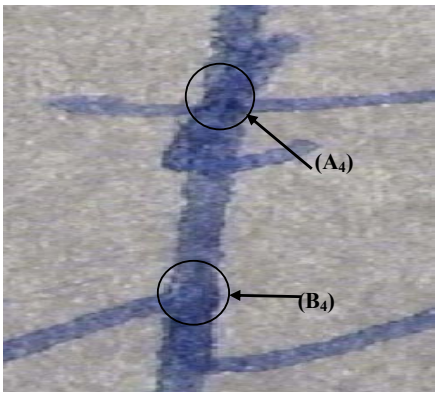


Figure 4: Examination of the Sample 4 using stereomicroscope.

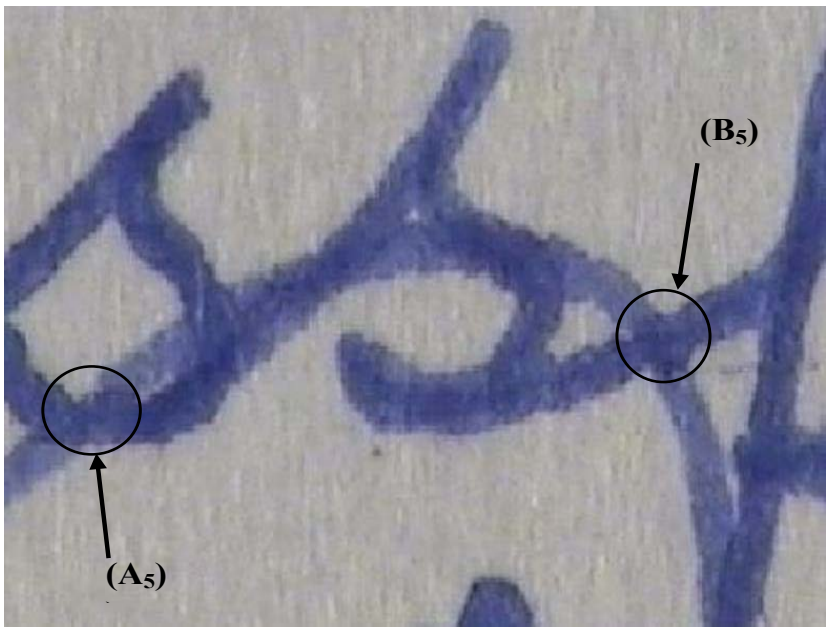


Figure 5: Examination of the sample 5 using stereomicroscope.

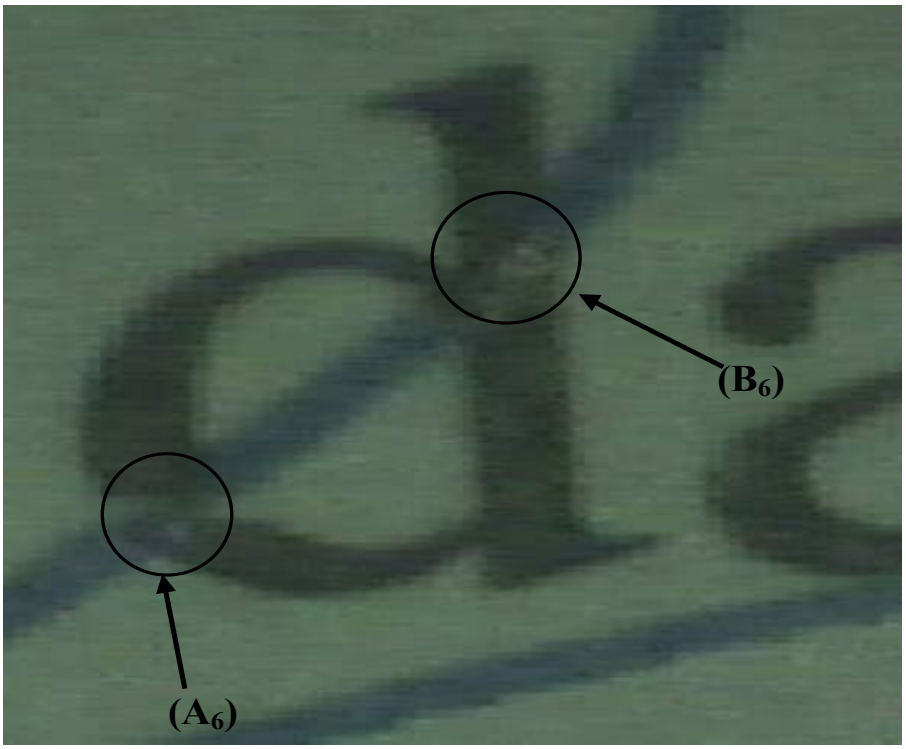


Figure 6: Examination of the Sample 6 using stereomicroscope.

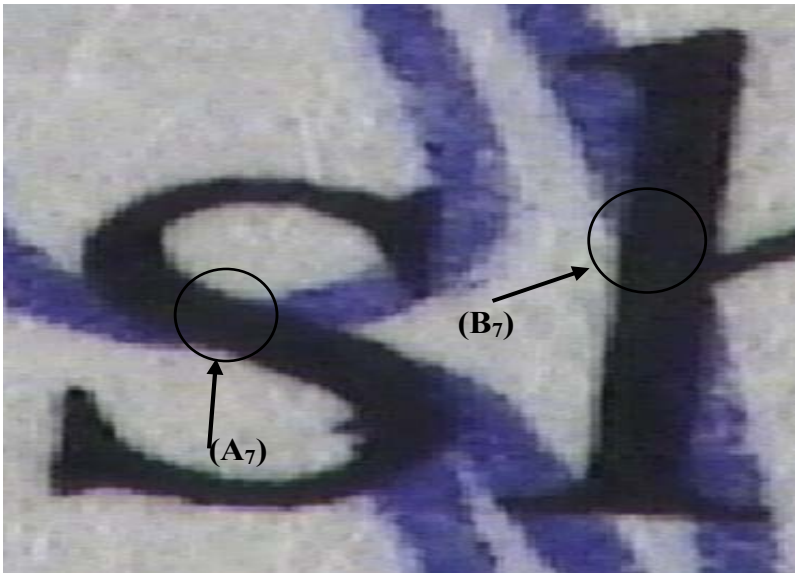
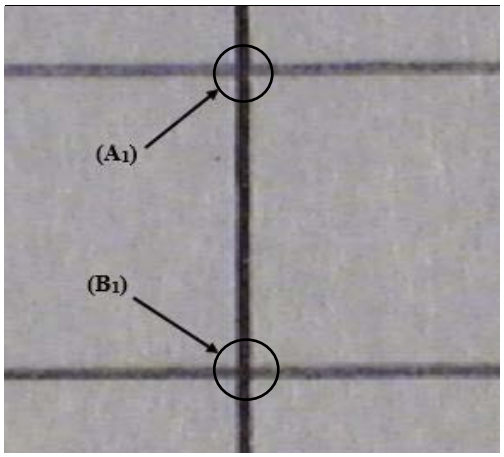
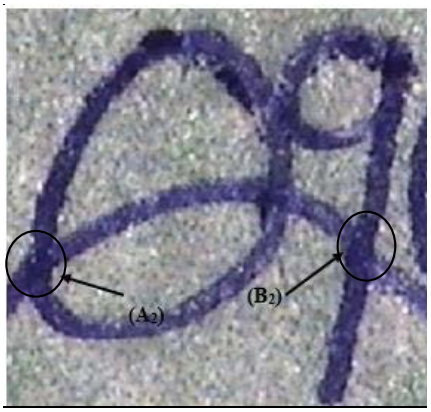
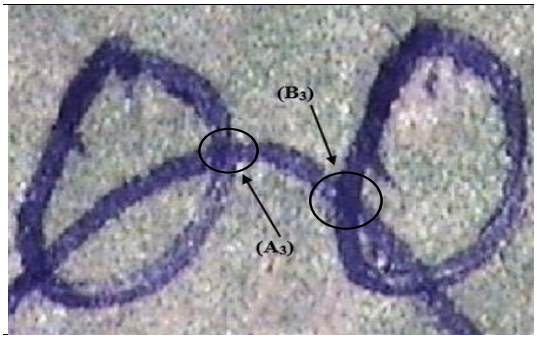
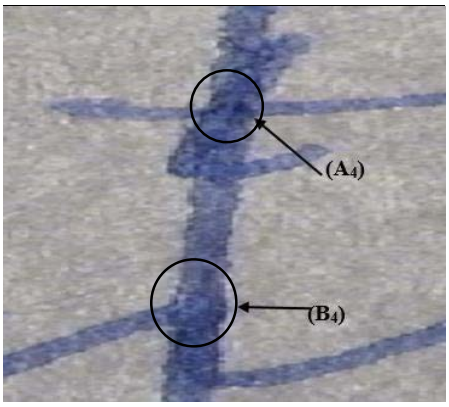
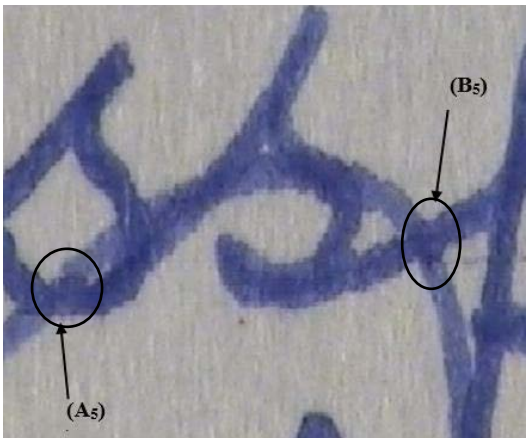


Figure 7: Examination of the sample 7 using stereomicroscope.

S No.	Samples	Type of Light and Zoom	Juxtapose	Result
1.	Sample 1	White light, 4.5 X zoom		(A_1)- Black ball point pen stroke is above the pencil stroke. (B_1)- The pencil stroke is above the black ball point stroke.
2.	Sample 2	DIA 100 light, 11 X zoom		(A_2) and (B_2) - digit 9 was written after the signature was made.

3.	Sample 3	DIA 100 light, 11 X zoom		(A_3) and (B_3) - signature was done after digit 0 (second and third) was made.
4.	Sample 4	DIA 100 light, 11 X zoom		(A_4) and (B_4) - Word “t” and “m” was written first then signature was made.
5.	Sample 5	White light, 11 X zoom		(A_5) and (B_5) - Signature was done first and then word “S” and “f” was made last.

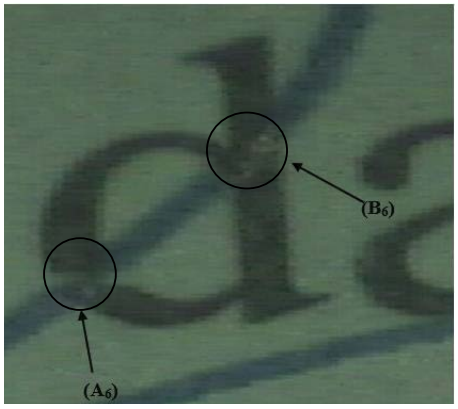
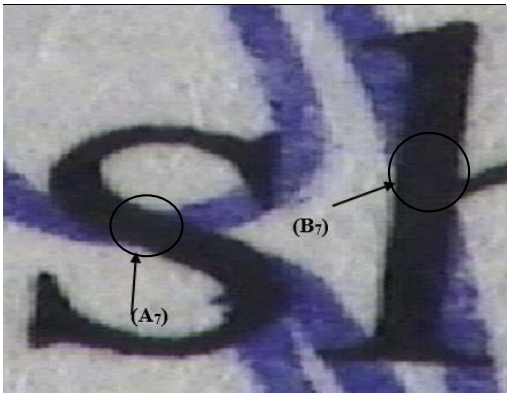
6.	Sample 6	Retro Light, 8.2 X zoom		(A_6) and (B_6) - Signature was done after the printing
7.	Sample 7	White light, 11 X zoom		(A_7) and (B_7) - Signature was done before printing

Table 1: Determination of sequence of strokes.

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