



## Technical Note

## Sequencing the intersections of printed strokes with writing instrument strokes using DocuCentre expert (PIA 6000-EDF)

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## ABSTRACT

Introduction of the digital techniques in document examination has encouraged the Forensic Document Examiners to work with better accuracy in non-destructive ways. In this study, the examination of sequence of intersecting strokes of printers (inkjet printer, laser printer, dot-matrix printer) and typewriters with writing instruments (gel ink pen, ballpoint pen and fountain pen) of different colors was carried out by using Docucenter Expert via PIA-6000 software utilizing extended depth of focus. The continuity of the stroke is the only characteristic which has been observed at the point of intersection.

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## 1. Introduction

It is a great challenge for the Forensic Document Examiners (FDE's) to establish the sequence of intersecting strokes. Various techniques were applied and developed on the basis of different nature of intersecting inks by different authors [1–4]. Now-a-days, image enhancement systems are also employed for the examination of different types of sequence of crossing strokes [5].

Present endeavor has been made to determine the sequence of two intersecting strokes by using the Docucenter expert. In this, the sequence has been established by transforming the two dimensional profile of the captured image into three dimensional profiles via PIA-6000 software utilizing extended depth of focus. The surface under examination remains unaffected due to the non destructive nature of the technique and can be preserved for the future.

The PIA-6000 software has a module that allows the repeated scanning of two dimensional images along with z-axis that stack them together giving a resultant focused image with a greater depth of field (DOF). The module sequentially transforms the apparently focused two dimensional image into three dimensional reconstructed model image. It is assumed that the transformation of a 2D image into 3D reconstructed model image might provide some information at the point of intersection of two crossing strokes that can be used for the determination of their sequence in a better way.

## 2. Materials and methods

Two brands of printers and typewriters with writing instruments were used to produce the heterogeneous intersecting lines (Table 1). The intersections include:

- Laser printer strokes (black, blue, red and green colors) with ballpoint pens', gel ink pens' and fountain pens' strokes of all colors (black, blue, red and green) and vice-versa;
- Inkjet printer strokes (black, blue, red and green colors) with strokes of ballpoint pens, gel ink pens and fountain pens (black, blue, red and green) and vice-versa and
- Dot-matrix printer and typewriter strokes of black color with ballpoint pens, gel ink pens and fountain pen strokes of different colors (black, blue, red and green colors) and vice-versa.

The exemplars (intersections) were prepared on white, smooth and non-coated paper (Power-Bilt multipurpose 215×345 mm, 5.6 g/m<sup>2</sup>). Each type of intersection was prepared on three separate white sheets to get repetitive exemplars. The blind samples for the above said exemplars were also prepared. The key for these unknown exemplars was kept with one of the authors.

The examination of all the intersecting strokes was carried out by using Docucenter expert. It has a digital camera of 5 mega pixels and an inbuilt PIA-6000 software. The document was placed on the chamber platform of Docucenter expert and zoomed, so, only selected portion of document carrying intersecting strokes was displayed on the monitor. The fine focusing was adjusted by clicking 'Auto Focus'

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**Table 1**  
List of printing instrument and writing instrument used for the study.

S.No	Make and model of printing instruments	Colors of text from printer
1.	HP Laserjet PCL 6	Black, blue, red, green
2.	HP Color Laserjet 4500	Black, blue, red, green
3.	HP Officejet 9100 PCL6	Black, blue, red, green
4.	HP Officejet pro L7580	Black, blue, red, green
5.	355-Dot-matrix MSP Classic TVS	Black
6.	Dot-matrix/Wipro LQ 1050	Black
7.	Remington R-621171	Black
8.	Facit license no. 676588	Black
9.	Montex Hy-speed gel pen	Black, red, blue and green
10.	Add gel sorento pen	Black, red, blue and green
11.	Cello fine grip ballpoint pen	Black, red, blue and green
12.	Pentek Euro Tip ballpoint pen	Black, red, blue and green
13.	Fountain Chelpark ink	Black, red, blue and green
14.	Fountain Camlin ink	Black, red, blue and green

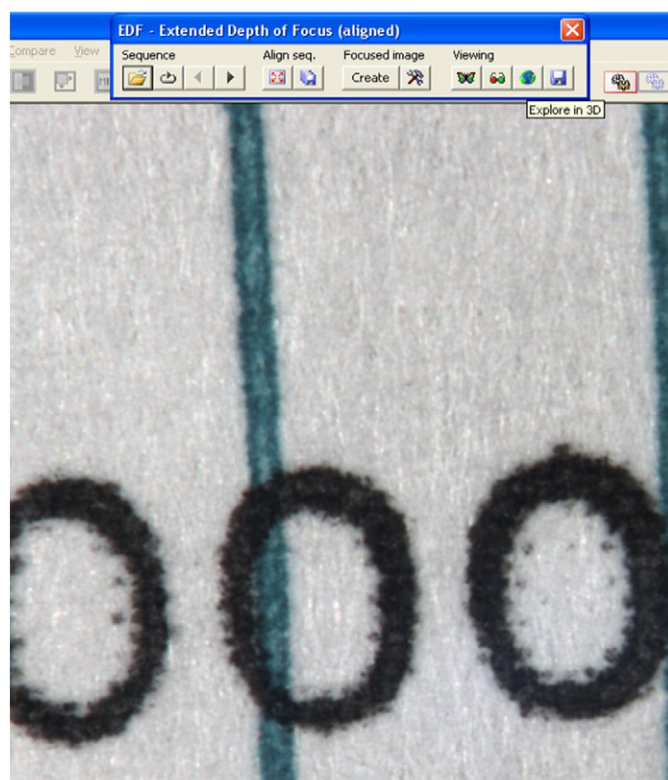
knob on the control panel. The following steps were used to convert 2D image into 3D reconstructed model:

Step 1:- The 'PIA-6000' option was opened from the 'Windows' and the image was displayed on the screen.

Step 2:- The 'EDF Window' option was selected and opened in 'PIA-6000'.

Step 3:- The 'File' option was selected and 'Save Next' was opened in 'EDF Window'. An image saving format appeared on the screen that was completed before saving and scanning each image from different focal planes. Each image was specified with a 'Main' name, a 'prefix' and 'N' (number of images). Then 'OK' knob was pressed and the scanning of image was started in a few seconds.

Step 4:- The same image was scanned from different planes by the camera for several times (12 times) and each scanned



**Fig. 1.** Showing focused image of black typewriter stroke intersected by green gel pen.



**Fig. 2.** Showing transformed 2D image of black typewriter stroke intersected by green gel pen stroke into 3D image.

sectional image was saved sequentially with the same 'main' name but with different 'prefix' and 'N's in the same directory.

Step 5:- The 'Align seq.' knob was pressed that started stacking the scanned images one by one in the order of their acquisition and the image was displayed on the screen.

Step 6:- The 'Create focused image' knob was pressed and in a few seconds a resultant well focused image with greater depth of field was generated on the monitor (Fig. 1).

Step 7:- 'Explore in 3D' knob was pressed in the viewing option that transformed the fully focused 2D image into 3D reconstructed image and was displayed on the screen (Fig. 2).



**Fig. 3.** Showing reverse side of 3D image.

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