SEQUENCING NON-INTERSECTING BALLPOINT PEN LINES AND LASER PRINTER WRITINGS BY COUNTING TONER PARTICLES

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Introduction

Laser printers have been widely used by most officials because of producing high-quality text rapidly in places to prepare legal requirements, and printed documents, including contracts, agreements, and testaments. (McGarry, 2011; Morawska, 2009).

Laser printers allow the toner powders in their cartridges to adhere to the paper surface at high temperatures. The electrostatic force between the paper and the toner particles is responsible for the adhesion of the toner to the surface. The electrostatic force is inversely proportional to the square of the distance. Since the line groove region is further away from the toner particles than the normal surface of the paper, the effect of the electrostatic force decreases in these regions. Therefore, it is expected that the normal surface, where the force is large, is more likely to attract and adhere toner particles, and therefore, the number of toners sticking to the writing area will be negligible (Konarowska, 2014; Wang, 2015; Esmaeili, 2019).

Printing additional text on papers with genuine signatures or on papers with printed text and signatures is a widespread forgery type. It is not uncommon for spouses, close friends, and business partners to sign on a blank piece of paper to be used as needed, based on mutual trust (Koppenhaver, 2007; Albrecht, 2018). A large number of cases come to our forensic handwriting and questioned document examination laboratory, where it is claimed that the upper parts of these documents, which were signed on blank paper, were filled without the consent of the signer.

So far, numerous studies have been published to determine the sequence between intersecting ballpoint pens and laser printed writings. However, the methods and measurements of these studies require that crossing lines exist between toner and ink to produce results. On the other hand, only a few studies have been reported for sequencing non-intersecting ballpoint pen lines and laser printer writing.

This study aimed to determine whether counting the printer toner particles on the ballpoint pen lines and the adjacent blank area was a useful method for determining the order of non-intersecting ballpoint pen and laser-printed writings formed on soft and hard substrates.

This study is based on the hypothesis that the toner particles will selectively adhere to a groove of lines than the adjacent area of the paper.

Material and Method

Samples were formed by writing letters and numbers as a pattern by using a common brand (PenSan), blue, 1.0 mm tip ballpoint pen on papers which are placed on five papers as a soft surface or a substrate as a hard surface. Half of the patterns were made on papers on which paragraphs were already written, and the other half on blank papers. In each sample, there are patterns formed on both hard substrate and soft substrate. The same paragraph was written on blank paper containing the patterns and printed out. Printouts were taken from five different printers.

Each sample was examined under infrared light using Video Spectral Comparator (VSC 8000, Foster+Freeman, UK). Two forensic document examiners evaluated the existence of the particles on the groove of sample lines using a double-blind method. The amount of the particles on the groove of line strokes determined whether the letters and numbers on the document were formed before or after the document text was printed. Two examiners were evaluated independently.

Results

When the patterns which formed on a soft substrate were examined both examiners correctly determined 8 out of 10 samples, whether the patterns were written on paper in which paragraphs were already written or not. It was determined that 2 samples that could not be evaluated correctly belonged to fairly new and slightly used printers and that the toner particles scattered on the paper surface were very few.

When the patterns which formed on the hard substrate were examined; the toner particles seemed similar to the results of the soft substrate examination. It is also determined that the usage frequency of printers affected the toner particle spread on the paper. For this reason, differentiation of the sequence of pen lines and toner particles is quite challenging when the samples are prepared with brand new printers which have left rarely toner particles on the paper surface.

Discussion and Conclusion

It has been concluded that the toner particles in the ballpoint pen lines of a signatory who has seen and approved the written paragraph are more or less equal to those in the other areas of the paper. Whereas, if signed on blank paper, fewer particles will be encountered in the pen lines of the signature due to selective physical avoidance.

The most important difference of this study from other studies is that while the studies in the literature include the methods that only the counting toner particles which were formed by different printers, on the pen lines prepared by different people, this study determines if the writing surface hardness affects the differentiation sequence between toner particles and pen lines (*see*. Konarowska, 2014; Lunakova, 2016; Wang, 2015; Esmaeili, 2019).

This is a preliminary study and the results are promising for more comprehensive studies.

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