COMPARISON OF INKJET PRINTED, LASER PRINTED AND PHOTOCOPIED DOCUMENTS

Gomathi P
Assistant Professor
Department of Forensic Science Technology
School of Allied Health Sciences
Vinayaka Mission's Research Foundation (Deemed to be University)
AVMC & H Campus, Puducherry
pgomathipurushoth@gmail.com

ABSTRACT

In recent years, forensic document technology—which primarily focuses on tracing a document's origin or identifying forgeries—has advanced quickly. Commodity scanners and a computer are used in this technology to carry out the required evaluations. Printer, forgery, and scanner identification have been the main topics of recent document forensics research.

Due to the increasing usage of printers in document generation as opposed to handwritten documents and the counterfeiting of documents generated by various printers, printer examination in questioned document examination has become a need in the modern era.

Inkjet printers, laser printers, and photocopiers—three frequently used document creation devices—were studied under a microscope to determine how they differ from one another. Based on characteristics seen in the characters in the papers, the suggested approach can distinguish between documents created by various sources. Thus, it can also be used to identify documents that have been altered and come from a combination of various sources.

Key words: Questioned documents, printed documents, photocopied documents, comparison of documents, inkjet printed, laser printed

I.INTRODUCTION

The practice of applying scientific ideas and knowledge to legal issues and criminal investigations is known as forensic science. It includes many different scientific disciplines, such as anthropology, chemistry, medicine, physics, engineering, genetics, pathology, psychology, toxicology, etc. Since its start, forensic science has been essential to investigating crimes. It enables the investigators to respond to queries that would not otherwise be possible. The discipline of 'Questioned Document Examination' is one of many sub-branches that forensic science has made known that deals with various parts of an inquiry. Questioned Document Examination, or QDE, is a recognized area of forensics that was developed early in this century as a method of forgery detection or document verification. Any signature, handwriting, typewritten mark, or other mark on a document whose provenance or authenticity is questioned or disputed is considered a questioned document. Letters, cheques, driver's licenses, contracts, wills, voter registration forms, passports, petitions, ominous letters, suicide notes, etc. are some examples. In situations involving forgery, counterfeiting, postal fraud, kidnapping, embezzlement, etc., QDE is used. In recent decades, printing has grown in popularity; today, nearly every workplace and home has a printer that is both accessible and affordable. Some of the most frequently found evidence in QDE is printed material. People are now more knowledgeable about the many methods utilized to solve crimes. People are now aware of how distinctive handwriting is and how it can be quickly identified and matched to the original writer, particularly in the context of QDE. As a result, in order to avoid being identified, criminals try using alternative methods that do not need them to utilize their handwriting, such as using printed documents. To reduce his chances of being detected, a criminal will write and print a letter of threat rather than writing it by hand. Additionally, formal documents like bank statements, cheques, and other legal documents like contracts, wills, and passports are susceptible to forgery because printed text is the most common target. As a result, printed documents are crucial for forensic purposes, and further study is needed in this area.

II.INKJET PRINTERS AND ITS PRINTING PROCESS

An inkjet printer is essentially a print head that moves back and forth as the paper moves through the carriage and essentially sprays ink onto the paper. It sprays liquid ink onto the medium. It is used for oversize printing, for images requiring higher color accuracy (such as HD images), and for printing on special media. An inkjet printer consists of three main components: printhead, transport and advance mechanism. The print head is attached to the ink cartridge and sprays ink onto the paper as the cartridge moves back and forth in the direction of the scan [1].

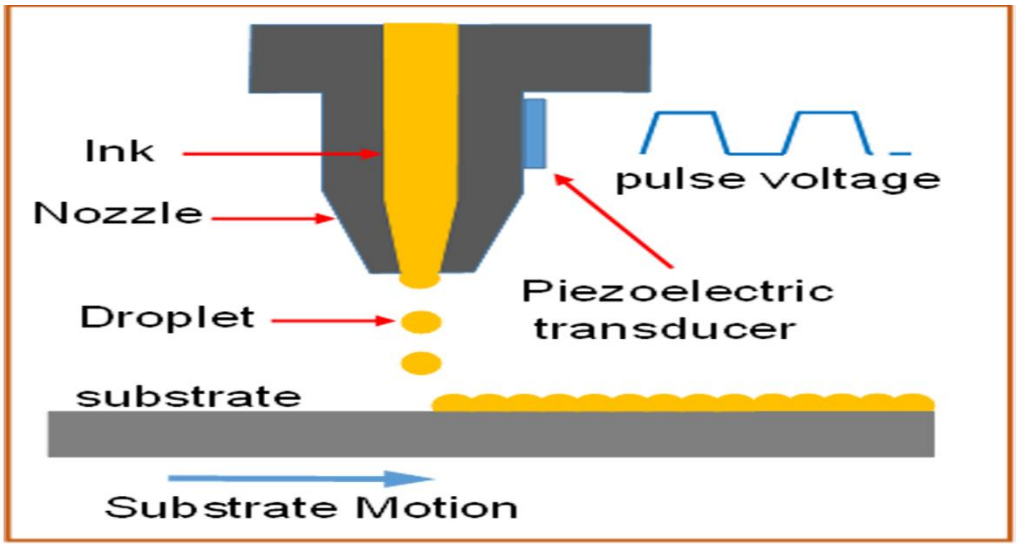

Fig 1. Inkjet printer

III. LASER PRINTERS AND ITS PRINTING PROCESS

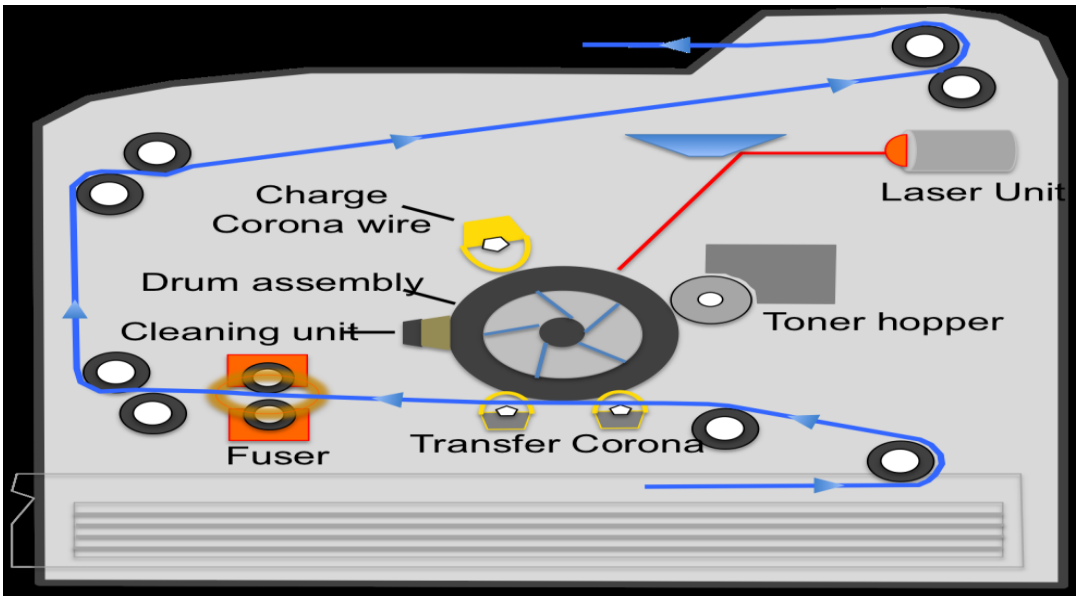

Fig 2. Laser printer

Laser printers using electrostatic digital printing allow the creation of high-quality test photos and graphics as well as medium-quality photos. The process is accomplished by shining a laser beam back and forth

across a negatively charged cylinder known as the "drum", which then picks up and collects the charged toner powder and transfers the image to the paper, which is then heated. to permanently fuse text and/or images. The xerographic printing process is applied by a laser printer. The laser printer adopts the following printing mechanism - The laser scanner first develops the image, then creates a beam from it that shines through the glass window to reproduce the image, below. A mirror in the printer reflects this image and a lens focuses it. The image is transferred to the copier belt, and a unit is in development that converts the image into a printable form. Printable images are transferred to paper. The fuser will permanently seal the image to the page, which will appear in the gallery shelf at the top of the machine. [1]

However, laser printing is different from analog copiers. In laser printers, images are created by scanning media directly through the printer's optical sensor. This allows laser printers to copy images faster than most copiers. Laser printers are preferred in office environments because the cost per copy is much lower than laser printers, they are also faster and quieter.

IV. PHOTOCOPIER

Copiers work on the principles of electricity and photoconductivity. There is a light-sensitive optical sensor inside the machine that first attracts and then transfers ink particles onto plain paper to form a copy of the document.

a. Photocopier working principle

A photocopier works on two basic principles: the fact is that opposite charges attract each other and the tendency of some materials to become more conductive after absorbing electromagnetic radiation, such as ultraviolet, infrared, visible light, etc. (optical conductive). Most modern photocopiers are based on a technology known as xerography, which is essentially a dry copy technique. It involves using charged particles to attract and then place ink particles onto a sheet of paper.

b. Parts of a photocopier

A typical photocopier (also casually known as a ‘xerox machine’) consists of the following components:

A photoreceptor drum (or belt), which is covered by a layer of a semiconductor material, such as selenium, silicon or germanium. This is arguably the most critical part of the machine.

A toner, which is basically just pigmented liquid. Sometimes referred to as ‘dry ink’, a toner is a dry mixture of fine, negatively-charged plastic particles and colouring agents that create the duplicate image on a piece of paper.

Corona wires, which when subjected to a high voltage, transfer a field of positive charge to the surface of the photoreceptor drum and the copy paper.

A light source and a few lenses, which shine a bright beam of light on the original document and focus a copy of the image onto a specific place, respectively.

A fuser can be considered the ‘final’ main component of a photocopier, as a fuser unit melts and presses the toner image onto the copy paper and imparts the final touches to the duplicate image just before it’s ejected from the machine.

c. Working

To begin the copying process, the top cover of the copier is opened and the master copy is placed face down on the glass, where a strong beam of light scans the entire document. The white areas on the paper reflect more light, while the black areas reflect little or no light. A shadow (or image) of the primary copy is formed on the photoconductor.

As the conveyor belt (with photoconductive coating) moves, it also carries the bulb. Negatively charged ink particles stick to the bulb and an ink print of the original is created on the conveyor belt.

A blank sheet of paper is fed into the copier from the other side, which slowly moves towards the photoconductive belt. As it moves on the conveyor belt, a strong positive charge is transferred to it. The strong positive charge of pure paper attracts negatively charged ink particles towards it. Thus, a duplicate image of the primary copy is formed on the blank paper. Finally, just before the paper is released, a fuser (a pair of hot rollers)

provides heat and pressure so that the ink particles are permanently attached/combined to the paper. This is why a newly ejected copy is quite hot to the touch.

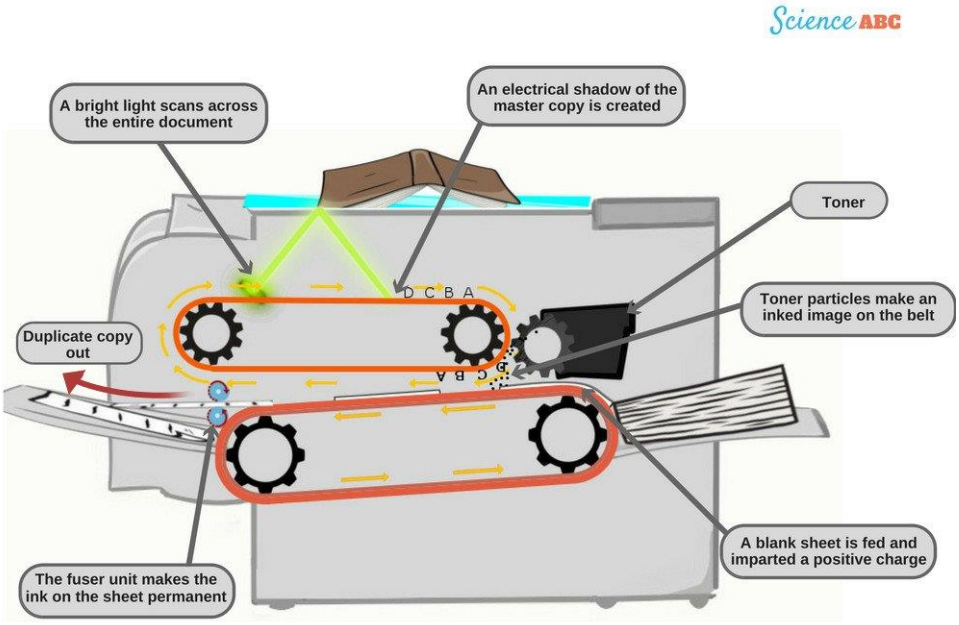

Fig 3. Photocopier

V.COMPARISON OF INKJET PRINTED, LASER PRINTED AND PHOTOCOPIED DOCUMENTS

Table 1. Comparison of inkjet printed, laser printed and photocopied documents

S.NO	CHARACTERS	INKJET	LASER	PHOTOCOPY
1.	Resolution	Low	High	Low
2.	Edge Contrast	Lower contrast and appearance of smudging	High contrast	Better contrast
3.	Edge roughness	Letters are uneven and rough	Letters are sharp and refined	Better edge roughness
4.	Ink flow and uniformity of printed character	Non-uniform	Uniform	Non-uniform
5.	Satellites	Few satellites	Lesser satellites	-------

Inkjet printer document

Resolution: The letters printed from the inkjet printer has a lower resolution and clarity.

Edge contrast: Edges of the letters has a lower contrast and appearance of smudging can be observed at the edges.

Edge roughness: Edges of the letters are uneven and rough, where on higher magnification the edges appeared degraded.

Spur Marks: An inkjet printer works by firing drops of ink onto paper when the print head is moving. As a result, tails or satellites of the ink drop are formed on the document, and the contours of the printed

characters are rough and contain ups and downs. Spur marks were present in the inkjet letters; they differed in pitch and mutual distance.

Ink flow and uniformity of the printed character: Spaying of the ink is evident as there is blotting of the ink on the paper. [4]

There is no uniformity of ink throughout the paper as some places of letters have more ink and some places have lesser ink. Dark spotting was observed in some areas due to uneven inking.

Laser printer document

Resolution: The letters printed from the laser printer has a higher resolution and also the letters are sharper and crisp in appearance.

Edge roughness: Edges of the letters are sharper and refined.

Edge roughness: The edge of the letters has better contrast than that of the inkjet printer and photocopier samples.

Edge contrast: The letters had a better edge contrast than the letters in inkjet samples.

Ink flow and uniformity of the printed character: Ink depositions in the letters are uniform giving it a smooth border, thereby possessing thickness due to more ink spray. [4]

Photocopier Document

Resolution: The letters printed from the photocopier has a lower resolution than that of the laser printer.

Edge roughness: The edge of the letters has better contrast than that of the inkjet samples and lesser than that of the laser printer.

Edge contrast: The letters had a better edge contrast than that of the laser printer and lesser than that of inkjet printer.

Ink flow and uniformity of printed character: Ink deposition in the letters are non-uniform

Their quality is not as good as that of laser printed characters because of the degradation caused by scanning a printed document. [4]

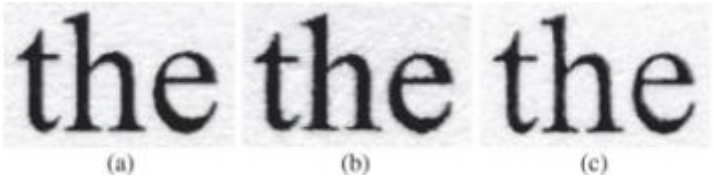

Fig 4. Showing words printed by laser, inkjet and photocopier

CONCLUSION

The basis for printer identification allows law enforcement agencies to trace the origin of fraudulent documents to the suspected printer which will ultimately point to the owner and/or suspect(s). Thus, this can be potentially useful in criminal investigations as corroborative evidence.

Firstly, the study can be applied in secured document analysis to check for forgery as most of the passports and other security documents are printed using Laser printers. If a microscopic examination of the formation of letters is carried out, in addition to the other passport-related examinations, it can aid the investigators to reach a more specific and accurate conclusion. Secondly, Banknotes & Checks, too, adopt a specific printing technique in their text. To check their authenticity, the questioned documents can be compared with the standards microscopically and the formation of letters can closely be examined to establish a match or mismatch of the printing techniques.

This can also be applied to the examination of alterations and additions in disputed printed documents. Official documents are often prone to be forged by making alterations, additions or deletions in the text of the

document. If such a document is in dispute, then the words of the document which are thought to be altered can be compared with the text of the original document, to identify if the printing techniques match. If the printing techniques match, then the individual characteristics of similar letters can be compared. Hence, it can also be used to detect tampered documents produced by a mixture of these sources. Also, this makes it possible to narrow down the search for the type of suspected printer.

REFERENCES

1. Noronha SJ, Basheer SZ, Vijay MN, Alnajjar A, Sharma BK, and Singh N (2017) - A Comparative Study of Different Printed Documents to Estimate the Type of Printer Used. Published date: April 28, 2017
2. Jagjeet Singh Saroa, Komal Saini (2013) - Physical examination of Photocopied documents
3. M. Uma Devi , C. Raghvendra Rao , M. Jayaram (2014) - Statistical Measures for Differentiation of Photocopy from Print technology Forensic perspective
4. Bhoopesh Kumar Sharma, Mandeep Kaur Purba (2021) - A Study of Certain Characteristic Features of Various Printed Documents To Determine The Type Printer Used in Forensic Investigations
5. C.L. Gilmour (1994) - A Comparison of Laser Printed and Photocopied Documents can they be Distinguished?
6. Shize Shang, Nasir Memon and Xiangwei Kong (2014) - Detecting documents forged by printing and copying
7. Jaime H. Bohórquez, Brian P. Canfield, Kenneth J. Courian, Frank Drogo, Corrina A.E. Hall, Clayton L. Holstun, Aneesa R. Scandalis, and Michele E. Shepard (1994) - Laser-Comparable Inkjet Text Printing.
8. Raj Kumar, Avantika Samkaria, Vishal Sharma (2020) - On the spectroscopic cum chemometric approach for differentiation and classification of inkjet, laser and photocopier printed documents
9. Madhusudan Singh, Hanna M. Haverinen, Parul Dhagat, and Ghassan E. Jabbour (2010) - Inkjet Printing—Process and Its Applications