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Study of Discrete Characteristics of Signatures Inks and Photography for Forensic Investigation

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ABSTRACT

His paper describes a method by which laser printers, inkjet printers, and electrostatic copiers, three widely used document production devices, may distinguish documents created. Based on characteristics extracted from the characters in the documents, the proposed approach will differentiate between documents provided by these sources. It can therefore also be used to detect manipulated documents produced by a mixture of these sources. The features associated with laser/inkjet printers and electrostatic copiers are analyzed and the signatures produced by the various physical and technical processes involved in each type of printing are determined. We computed the features of noise energy, contour roughness, and average gradient on the basis of the study of these signatures. This is the first work to differentiate documents created by a laser printer, inkjet printer and copier, to the best of our knowledge, on the basis of features drawn from individual characters in the documents. Experimental findings suggest that this technique has an average precision of 90 percent and works with JPEG compression.

Keywords – *Photography, Forensic, Investigation*

INTRODUCTION

The precedent in forensic science could well be the analysis of contested or challenged handwriting. It is one of the unusual disciplines to have scientific concepts first developed in other disciplines and then harnessed by law enforcement agencies for forensic tasks as an instinctive forensic requirement. About as early as the invention of handwriting, the art of forgery and its associated fraud involving documents emerged. In civil and criminal litigation, the value of documents is largely questioned or questions are posed regarding their authorship, origin and exploitation. Many ways have emerged to assess the veracity and genuineness of documents or signatures on them. The application of a wax seal served to authenticate the document before the origin of the signature, the wax seal bonded the ends of a fabric ribbon that fed through a slit in the paper and was embossed with a personal motif, but later the signature serves the purpose, in addition, the legal procedure tended to involve the signing of witnesses to the signing. These days, not only is document science or the area of forensic document examiner restricted to handwriting, but due to the degree of computer use, it has developed in an

exponential way. Although the preparation of paper output has changed a lot due to different types of electronic printers for which toner is examined instead of ink tests. But one should not forget that the validity of the document is not known unless the document is not signed with a pen. For the document examiners in question, the analysis of ink and its characteristics is very important. The existence of a wide variety of inks and their forms makes it more difficult to deal with the ink database.

OBJECTIVES

1. To develop forensic intervention methods for analysis of specific kind of Inks like disappearing inks and erasable ink.

2. To develop method for admissibility of digital photograph/evidence in court of law.

Examination of Inks

Experts have to answer certain aspects of the document in the forensic analysis of the documents questioned, such as the inspection of paper, the ink used in writing and the writing of the material characteristics. From time to time, both from natural sources and from chemical synthesis, various types of inks have been identified. The form of forgery, addition, and modification or obliteration analysis decides the essence of forgery in various scenarios. In situations where inks with uncommon characteristics are used in execution, the traditionally used methods do not provide the desired results and constrain the examiner from developing novel review strategies in such a case, portraying additional difficulties before record examiners.

Significance of Ink (In Age Determination of Documents).

Because of the wide range of inks on the market, the complexity of chemical processes that inks undergo from the moment they are applied to paper when their ageing process starts, the number of external factors that can impact this ageing process (environmental factors: light, humidity, temperature; in short. storage conditions of the document). Despite the difficulty of this problem, considerable progress has been made with the sole goal of determining how long the ink has been deposited on the paper, which will lead to the date of production of the document being determined.

The modern writing tools, Table 1, which we can now find in any store in any country and, thus, those most commonly used in the documents in question, are divided into two fundamental classes.

1. Ball point pens: containing inks dependent on oil and the colorants of which are dyes.

2. Non-ball point pens: containing inks made of water and whose dyes are dyes as well as pigments (one, the other or both). Roller ball pens are included in this second category of fountain pens, as well as markers and gel ink instruments.

Table 1 Relevant introduction dates into the market in the field of "modern" writing instruments.

YEAR	EVENT
1945	Ball point pen
1950	Glycols as inks solvent
1955	Copper Phthalociayne as a new dye ink
1963	Felt tip pens
1967	Roller ball pens
1970	Highlighters
1984	Gel ink pens

The elements involved and the physical-chemical processes that they undergo after depositing the ink on the paper should also be identified if an investigation of the ink-aging processes is expected. It can be said, in a general and clear way, that the inks of manual writing instruments consist of a dye or a combination of dyes and a carrier or vehicle with one or more solvents and one or more resins. Dyes (soluble in the vehicle and used in viscous and fluid inks) and pigments are subdivided into colorants (dispersed in the vehicle and used, in certain cases, in fluid inks in addition to dyes). A solvent or a combination of both is found in the vehicle (fast drying organic solvents, water). One or more resins that contribute to the characteristics of the ink, such as the viscosity or adhesion of the paper to the ink. In order to alter the rheological properties of inks, other components are often applied to a lower proportion. The manufacturing industry generally holds these additives secret. In addition to this simple composition, the Office of Alcohol, Tobacco and Weapons of the American Treasury Department adopted a chemical marker device that is no longer in operation due to its high cost in the 1970s. Manufacturers included a tag that did not differ over time (chemical indicators as rare earth organ metallic compounds and traces of optical whiteners) and another tag that differed annually. Forensic scientists may be led to define the earliest possible date of the studied document by defining one or both of these markers. This marking scheme, on the other hand, would certainly indicate the need to know which producer used this chemical marker.

A. Visible Ink:

Inks most widely used in India are iron nutgall ink, carbon ink, nigrosine ink, and aniline inks of the following kinds of grades. Iron nutgall inks are chemical solutions of iron salt (ferrous sulphate) and nutgall (gallic acid and tannic acid) inks forming a thick black precipitate undergoing an oxidation process[3]. The forensic significance of this type of ink is that ferrous sulphate undergoes changes due to oxidation over time, and these changes indicate the age of the

written ink. Carbon ink consists of lampblack or soot that is dissolved in water, some portion of gum is added to it for correct viscosity and does not spread on paper, it is a permanent ink, but some portion of ink may be extracted by successful scrubbing. Nigrosine ink is a coal tar substance dissolved in water to create black ink, this ink has an outstanding flowing consistency, but it is not possible to determine the age of writing of this ink. Aniline inks are dyes and can have some of the colours of the rainbow, these inks do not penetrate the paper fibre affected by sun, air and moisture and can be completely dissolved by the application of water, but aniline quickly darkened in air due to oxidation, but its darkening may not have a forensic meaning on ageing as it is not possible to ascertain the age of the document executed in this ink [4] Several different forms of ink, such as ballpoint ink, gel pen inks, are being added to the market over time. However, several substances such as dyes, pigments, cars, surfactants, resins, lubricants, solubilizers, particulate matter, fluorescents, moisturizers, dryers, plasticizers, waxes, greases, soaps and detergents, etc. are also used in modern inks to enhance the characteristics of the ink. The variance in all of these substances listed above directly affects the composition of the ink and consequently the techniques of analysis as well.

B. Erasable ink:

Another type of ink with a unique character created in recent times is erasable ink, although due to chemical erasures, inks can also be erased from the paper surface earlier. In 2006, Pilot pens Inc. introduced the worldwide market of pilot FriXion pens using thermo chromic ink, a composition specifically designed to erase the ink. These erasable inks were mainly composed of solvent, colorant and resin film-forming agent . The ink microcapsule consisted of an organic color donating electron that interacts with the developer compound accepting electron in nature to give the color of the ink. The ink preserved its colored state at temperatures below 65oC because of the reaction between the dye and the creator. The crystalline material was in solid condition during that time. However, heat causes the crystalline material to melt at temperatures above 65oC and thus both dye and developer dissolve, which hinders their contact, leaving the thermo-chromic ink colorless. The ink returns to its visible state at temperatures lower than -10oC as the crystalline material is returned to its solid state.

C. Disappearing ink:

Inks that are visible without the intention of being rendered visible again for a period of time are called disappearing inks. The chemical reaction of thymolphthalein and a simple material such as sodium hydroxide depends on certain disappearing inks. Thymolphthalein, which is typically colorless, turns blue, interacting with the base in the solution. The PH drops below 10.5 as the base interacts with carbon dioxide (always present in the air), and the color disappears . Amazing disappearing ink pens are types of ink-containing pens produced by chemical reaction. The magic pen is similar to an ordinary pen, except the ink varies. In markets, some kinds of porous tip pen inks have appeared; such pens use auto-vanishing fluid inks. The key fundamental structural unit in such inks is acidic in nature, which could be influenced by changes in the environment (humidity, temperature and so on). The problem of missing texts is often faced by forensic record reviewers. There are two approaches in trials to show these missing writings: either non-destructive methods (using hand magnifying lenses, electronic microscopes, various forms of light, infrared illumination) or chemical-based destructive methods. Under UV light, the images can normally not be recovered.

Signature:

Handwriting is an acquired ability and, also referred to as an intramuscular task, is a complex perceptual motor task. Each mature writer's handwriting is personal and individual to him alone. A individual cannot produce exactly what has been written first in a mechanical way. In the writing of the same person, there must be such "natural variations". In the course of life, a person's writing is subject to many changes. In most cases, however, they are very sluggish and do not influence the view. Despite the effect of all external factors such as the design of the writing tool, the writing surface, the writing help, the lighting, the writer's positions, it is a known reality that "brain writing" controls the handwriting by the nervous system's signal.

Admissibility of Photography (Questioned Document) in Court

Any document that is sent to the forensic document laboratory or the Forensic Science Laboratory is challenged. It is an agreed declaration that information submitted for review for potential future use should be registered. After reviewing the questioned document, the Forensic Document analyst must deliver the questioned documents to the valued authority, whether the court, police or any third party. In the event that testimony or cross-examination by the Court is needed, the Forensic Document Examiner should have a record. The best approach has always been to photograph a text. The purpose of document photography is to serve as an archival tool, to record the material submitted for analysis, to assist in viewing the document, where human eyes do not see clearly only in the visible region due to vision impairment, and thus Ultra Violet and Infra-red are used to assist the examiner in examining the document and to assist the document examiner in illustrating the conclusion. There are many kinds of cameras that are available on the market. The processes described by the various organizations are described in stages. The traditional method in which a film (negative) was used to obtain the photograph was substituted by the DSLR for the proof. Therefore, the issue occurs in the admissibility of these documents because the tampering in the picture could be easily found in the film (negative) methods, but the latest fraud approach comes with new technologies that the document examiner does not always know.

The Automated Signature Verification Classical Scheme Figure 1 illustrates a standard ASV scheme. A special instrument (e.g. pen and paper) is used when a person signs into an ASV system, and a sensor Si usually digitizes the sample. To digitize a signature, there are a wide range of potential sensors, such as a printer, a digital tablet, a PDA, a cell phone, and even a specialised pen. Any disruptions typically affect the acquired sample, in addition to collecting the signature. The disturbances are external factors that relate to the

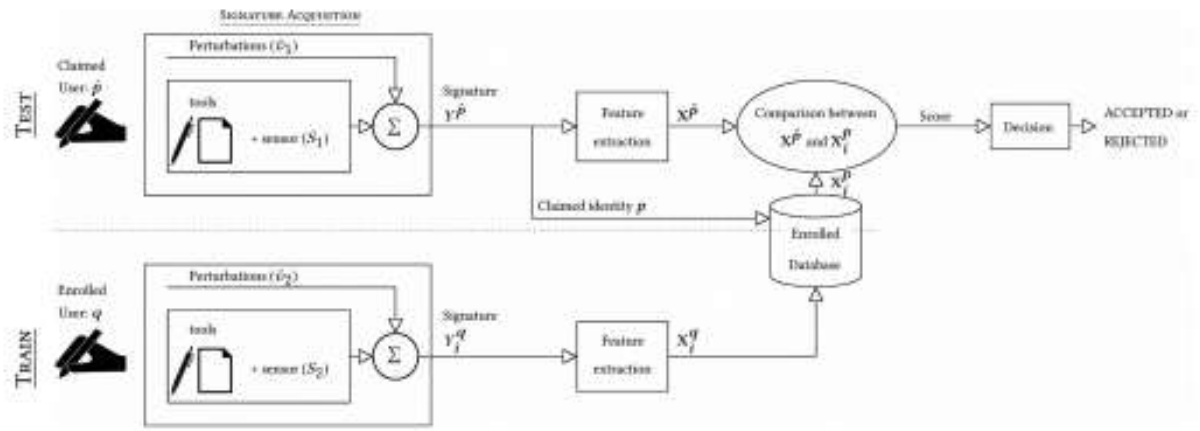

Fig. 1. Typical scheme of an automatic signature verifier (ASV).

Environmental adjustments, such as background noise, or sensor limitations, including resolution or sample rate, to the instrument used for signing, the individual's pose, and the jewellery worn. Intrapersonal variability is another aspect that modifies the signature sample during the repetitions. The dissimilarity between signatures performed by the same writer implies intrapersonal variability. It is an internal factor that can relate to feelings, tension, tiredness, influences of alcohol or narcotics, neuromotor disorders, effects of biological ageing, cognitive-motor disability, and other factors as a result of the mood of the individual, the time available to compose the signature, or the willingness to cooperate.

A calculated signature can therefore be defined as the amount of external and internal disruptions learned through practice over the years during the execution of the signature action plan. Two operating modes occur in an ASV: preparation and checking. A genuine user, let's say q, offers one or more repetitions of his signature, denoted as Yq I in the training mode. These signatures are parameterized and are stored in a database with their parameters, Xq i. In testing mode, the ASV generates a feature matrix (Xp) from the Yp signature of the questioned user p.

A comparison of the signature parameters Xp and the signature parameters Xp I of the enrolled user p is made, as this user claims to be a previously enrolled subject p. A score is received as a consequence. Finally, by supporting or denying the stated hypothesis of p = p, usually based on a decision threshold, the ASV makes a decision. Using this nomenclature, Figure 1 indicates these phases. Beyond the intrapersonal variability, the unpredictable interpersonal variability is the biggest challenge facing ASV systems. This suggests the similarity of signatures executed by various authors. Via three key types of forgeries, interpersonal variability can be minimized by faking the identity of signers: (1) Random Forgeries (RF): This is the situation in which an impostor, without prior awareness of a particular signature, attempts to validate a signer's identity by using his or her own genuine signature. (2) Simple Forgery (SF): This happens when the forger knows the name of the writer but has no access to a signature sample. Its value in the authentication of signatures depends on the country of origin of the signature type. In some countries, many people sign simply by writing their own name and surname, while signers craft unlawful signatures with complicated flourishes or rubrics in other countries. (3) Professional Forgeries (SK): These are created by an impostor who has studied and attempts to replicate the

signature of his or her victim with similar variability within the class. In signature authentication, the test for this form of forgery is the most important. In addition, it should be noted that in signatures there are two modalities: (1) Offline (or static) signatures: the signature information is usually used in a scanned image where the inked signature is deposited on a piece of paper, among others, by using a tool held in the hand like a pen or pencil. (2) Online (or dynamic) signatures: The key feature of these signatures is that they include the temporal and dynamic order in which the signature is executed by the signer.

A tool such as a digitizing tablet is needed to register this kind of signature. While all ASV systems operate according to the general scheme outlined in Figure 1, online and offline systems typically vary in the strategy for extracting the features and generating the final classification. Nevertheless, in both cases, a meaningful statistical signature database is sufficient to evaluate an ASV. The paper is structured as follows: Section 2 addresses aspects of handwritten signature databases that have become a central feature of the report. Best practises in the verification of automated signatures are discussed in Section 3. A summary of the key results of the competition is recorded in Section 4, illustrating the state of the art in the sector. In Section 5, the forensic aspects relevant to signature analysis are discussed. In Section 6, some of the most promising new research directions are discussed. Section 7 ends with a hopeful and constructive note about the future of this technology.

CONCLUSION

As the overwhelming use of erasable pens in recorded forgery cases is growing and causing difficulties before FDE's. An attempt was made in this study to establish an effective non-destructive method for the restoration of erasable ink from the paper surface. The findings obtained are very promising when analyzing simulated samples under VSC. All 275 different light sources were used for analysis, from which spot fluorescence and ultra violet light of varying wavelengths provided the best results for efficient and legible recovery of erased material. Using ED-XRF for elemental analysis, the prepared samples were also examined and it is a non-destructive procedure, but the results obtained are not promising. As far as elemental paper surface analysis is concerned, it provides decent results, but not for ink analysis. The study concludes that the Video spectral comparator's ultra-violet and spot fluorescence light source is the best form of research for restoring erased writing written with erasable pen ink. Though the erased content is overwritten with another pen, this established method could reveal it. In rapid analysis and defining the region of interest, the established technique will be very helpful for FDE's, making the test quicker and easier.

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