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Handwriting Characteristics Examination Using Special Forensic Doc-Scale

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Abstract:
Numerous types of cases are encountered all over the world in respect to handwriting and signature examination. The cases of forgery, disguise and fraudulent documents are quiet common. Forgery is usually done by person other than the genuine writer, whereas disguise is done by the same individual to conceal one's own identity in commission of fraudulent activities. The forged handwritings varies from the genuine writing in characteristics such as writing slant, writing alignment, proportional size of letters, formation of letters, and introduction of tremrous and hesitation sub-consciously. Previous researches have proved handwriting as 'Brain Writing', indicating handwriting as a personal identification feature of any individual. In handwriting examination these characteristics are identified, examined and compared to prove the authenticity of disputed handwriting or signature. Present research is conducted on the identification and examination of such characteristics on real and prepared forensic cases of disguise and forgery using specifically design "Forensic Doc scale". The outcomes of the study have proven this innovative design as an important tool for forensic document examiner to ascertain such handwriting characteristics and provided conclusive comparison in disputed case of forgery and disguise.

Keywords: Handwriting, Signature, Forgery, Disguise, Characteristics, Forensic Doc-Scale

1. INTRODUCTION

Handwriting is a method of inserting words into a language, consisting of speech that has an enduring effect [1]. Therefore, a handwriting specimen is an expanded set of writers' experimental units that, when sufficient, include the necessary data from a reliable source [2]. A handwriting specimen is referred to as a sample in forensic handwriting analysis, handwriting recognition, and signature verification. Scribbles form as a result of subconscious pattern formation. It is feasible to recognise lettering on documents belonging to a certain individual [3]. Once more, it is unusual that the investigator will be able to identify the handwriting on the document as belonging to the offender they have already looked at. Any written document created or provided to an individual or organisation qualifies as a report, including text, spread sheets, databases, and letters. Samples of handwriting are both requested and recorded. Samples of signatures that help with handwriting comparison are requested [4]. An example of this is when someone asks professionals for help with

script services. Each person's handwriting is composed of three handwriting characteristics: Class or System Characteristics, Individual Characteristics and Idiosyncratic Characteristics [5]. The combination of these characteristics is dependent on the individual.

The features, components, or attributes of writing that place a writer in the context of other writers or provide a written communication a collective identity are known as class or style characteristics. These elements of writing that are somewhat unique to the writer and enable one to distinguish themselves from others in terms of handwriting may be geographical, religious, national, academic, or political boundaries that allow its writing to be related to some recognisable common content [6,1].

The primary objective of the study was to compile information that will be implemented as evidence in court, thereby establishing the guilt or innocence of the accused participant. The expert's capacity to gather information, compile it, and apply it to the research to obtain the evidence needed to conduct a daily action to assess its efficacy [6]. The investigating officer needs to be multi-talented, but above all, he or she must be able to find and gather the data that will be used as evidence.

1.1 *Principles of Forensic Handwriting Identification*:

All handwritings consist of certain attributes which form the basis of handwriting identification and comparison [7]. These attributes or principles are:

1.1.1. Uniqueness: Every individual has his unique way of handwriting until deliberately imitated. Handwriting of two persons is not exactly similar in extended handwriting sample. A person 's handwriting is the output of the sum total of his schooling, training, writing experience, environment and occupation in addition to physical and psychological make-up. Two individuals cannot have the same experiences in life, and therefore, it is possible to distinguish one person 's handwriting from other.

1.1.2. Natural Variations: All handwritings exhibit natural variation or intra-writer variation. It is the negligence with which the writer's routines (distinguishing characteristics) are carried out on a regular basis. There will be some variation between two handwriting samples produced by the same writer. These differences result from the inability of humans to do repetitive tasks with precision similar to that of machines [8]. Being a neuro-muscular task variation in the handwriting style (formation) is expected.

1.1.3. Writing Skill: A writer cannot write at a higher level than they are able to accomplish in a short amount of time while yet seeming genuine. Authors are free to write at or below their proficiency level, but never beyond it [9]. It is not possible for a marginally literate person to execute highly skilled cursive writing who has only learned to produce basic hand-printed letters.

1.2 Instruments Used in Handwriting Examination:

1.2.1 Measuring Rulers and Grids

Among the measuring tools used to ascertain the exact measurement of disputed documents are rulers, gauges, and grids.

(i) Ruler: Standard 6 and 12 inch scales with an opaque paper or metal body and clear plastic or glass on top. Used for estimating the QDs' dimensions. When taking pictures, scales made of opaque paper, metal, and wood are used to record the real size [10].

(ii) Grids: The plastic sheet with grids on it is ideal for tracing the region. Used to examine the graphology of handwriting, signatures, and stamp marks.

(iii) Reticle: A reticle is a flat circular glass with a measuring metre on the bottom that helps with measuring minute details.

1.2.2. DSLR Camera

A premium DSLR with a 35mm or medium format is the best camera to use with QDs [10,11]. These cameras are mostly used in conjunction with a few lenses for telephoto (70–200mm), regular (50mm), close-up, and wide-angle (17–35mm) photography [11]. Close-up photography is the most equipped of all. It reproduces crisp, up-close photos of the contested papers, which are then magnified to reveal the writing characters and provide a more thorough analysis than the actual paper [11].

1.2.3. Replicating Equipment

In addition to a high-definition camera, the detailing is duplicated both digitally and on paper using a photocopier and scanner [12].

Photocopier: They are not limited to making replicas in one-on-one size. A portion of the document is extensively detailed in the larger photocopy. They can also be used to present the evidence in court and, if necessary, in several copies for jurors.

Scanner: Use a specific resolution to capture detail. A minimum of 300 dpi should be captured by any scanner used for forensic analysis. And 600 dpi works well for increased engagement. Documenting exams at a resolution higher than 600 dpi is generally discouraged. Furthermore, enlarged or cropped photographs can be reproduced using inkjet and laser printers in the future.

1.2.4. Light Sources:

Normal visible light, oblique light, transmitted light, infrared light, and long- and short-wave ultraviolet light are examples of light sources. The best light to recognise and examine pen shading, indentation, etc. is oblique light. Simply said, transmitted light comes from a document's back. This is best supplied by a light box with a fluorescent light bulb that has been colour adjusted. When the document is placed on the box, features that would not otherwise be visible can be seen thanks to the light coming from the back of the document [13].

In addition to revealing items that have been destroyed or covered up, UV and infrared lights are utilised to distinguish between inks and papers. These unique lights can be used in conjunction with photography to reveal and capture information through the use of certain films and filters. These strategies are the greatest starting point because they are non-destructive, even though they don't always produce solutions.

1.2.5. Stereoscopic Microscope

A stereoscopic microscope, equipped with both incident and transmitted illumination, offers a low magnification three-dimensional vision that typically spans from 10 to 50 powers [14]. With the use of 3D visualisation, FDE is able to investigate the questioned document sample more thoroughly, looking at things like pressure patterns, written and erased text, the arrangement and sequencing of writing strokes, and more.

1.2.6. Comparison Microscopes

A comparison microscope allows you to examine two samples side by side using just one lens. They fall into two main categories: (1) Full-field comparison approach and (2) Vertical line. The observing field in vertical comparison microscopes is split in half vertically, with one side devoted to each

sample. This eliminates the need to superimpose two areas and allows for a close side-by-side comparison. Used for comparing bullets, cartridges, and fibres [15].
On the other hand, a superposed image view with a steady-flashing light incident source is used for document analysis. Another name for it is a stroboscopic microscope. Different coloured or illuminated incident light can be used for broad-spectrum analysis.
In this case, the rate of strobing was indicated by the following characteristics of the questioned paper:

- A feature that flickers on and off
- A feature that appears to move differently between two documents.

They are out of current because the majority of alternative light analysis is now completed by VSC, and different imaging technologies are used for superimpositions.

1.2.7. Video Spectral Comparator (VSC):

VSC is a non-destructive test that looks at document evidence across a broad spectrum. It has inbuilt IR-sensitive charge-coupled device (CCD) cameras, filters, lenses, a visual display unit, and a wide spectrum light source. Infrared, visible, and ultraviolet radiation are the main radiant energies used with VSC [16].
Moreover, Filtered Light Examination (FLE) and Video Spectral Analysis (VSA) are two types of which VSC is one. In comparison to VSC, the examiner can offer a considerably broader spectrum at a different wavelength with FLE.
However, Foster & Freeman's contemporary models of VSC incorporate samples for investigation in near-infrared radiation (IRR) and infrared luminescence (IRL). This makes it possible to examine ink and restoration capabilities in more depth. Numerous others provide printing capabilities, on-screen displays, and image upgrades [16].
Forensic Applications: VSC for change detection, security features, optical ink characteristics, pencil and ink writing differentiation, restoration, hidden writings, etc.

1.2.8. Electrostatic Detection Apparatus (ESDA)

Using the paper's dielectric characteristics, the Electrostatic Detection Apparatus (ESDA) of the Electrostatic Detection Device (EDD) displays the imprisoned marking over the papered page [17].
The present research and innovation relates to the field of Questioned document examination in Forensic investigation. During the disputed cases of handwriting and signatures, several measurement tools are required to measure the various dimensions of the signatures like angle, slant, spacing, and alignment during comparison with the controlled samples or specimens. For this purpose, the questioned document examiner (QDE) has to perform the difficult task using different measuring devices like ruler, grid, and others. In regards to this, the present innovation i.e. *"Forensic Doc Scale – PROTRACTOR"* was observed as a useful tool during the study for QDE to facilitate all these measurements using this single measuring device.

2. LITERATURE REVIEW

In 1970, Mounted Police, stated that in the all of the evidence may be hidden from view during a forensic investigation if visible light wavelengths from standard lightbulbs are the only ones used. Conventional light may disclose the evidence's presence insufficiently or not at all, depending on the makeup of the evidence and the material it comes into contact with. Evidence that might otherwise be obscured can be uncovered by using what are known as alternate light sources. The Royal Canadians were the first to use alternative light sources in forensic investigations [18].

In 1970, Mehta, M.K., stated that most prevalent scientific handwriting analysis procedures necessitate the use of specialised equipment. When it comes to the craft of a competent and competent questioned document examiner, the greatest focus is placed on the person in question's training and experience. When in an internship, a substantial portion of the training is committed to understanding how to utilise the numerous tools that are so important to the profession [19].

In 1974, Julius., worked over different writing surface in certain instances, and stated that handwriting can also be impacted by the writing surface. The author looked at the writing on quite large copper tubing's harsh metal surfaces. based on some discovered data that suggests the lettering may not have a definitive status but rather be relevant to the original authors. Numerous elements were taken into consideration throughout the assessment, such as how the writing instrument affected the movement of the flesh and the pipe's curvature [20].

A person's writing is rarely extremely valuable when it comes to the writing tool. The writer used several writing instruments, and there was a noticeable difference in the works because of the writer's comfort level and preferred writing tool—an exclusive instrument in and of itself—and the instrument's effect as stated by Brown in 1985 [21].

In 1996, Mayther.J., stated that the appearance of handwriting can be influenced by a variety of elements, including internal and external factors as well as situations and conditions. a long-lasting effect that might affect how handwriting appears in the event that highlights arise. In the event that the person writing the handwriting has the author's mental and physical conditions, the results may manifest as infinity, illness, or handicap. Another element that may have an impact on handwriting's influence is intrinsic component. Furthermore, once that are somewhat related to the circumstances in which the item appears. Likewise, they could be if the necessity for control arises. The author alone is qualified to discuss the many surfaces on which handwritten text is written, such as walls, car roofs, mirrors, skin surfaces like palms, and moving cars, all of which can have a substantial impact on how handwriting appears [22].

In 1999, Huber., stated that each person's handwriting is a distinct neuro-muscular process and a learned ability. The coordination of huge number of muscles and bones is required for the handwriting process which is proven to be 40 and 27 respectively. Natural writing is nothing more than intuitive visual expression. In writing, there are several movements such as movements of finger, and other parts of the upper extremity, and their combinations. These writing movements have an impact on an individual's handwriting features. Line quality, alignment, Size, Spacing, connecting strokes, Pen lifts, Pen pressure, and Slant are some handwriting characteristics. A species may be identified by class traits, but not by an individual. Threat letters on checks, agreements, and contracts are examples of questioned documents. Each incident involving questioned handwriting is different and examined to provide an acceptable solution [23].

Another study was conducted in 2024 by Otsuka, S., & Murai, T to understand the structural linkages between multidimensional literacy skills at the word level—that is, word reading accuracy, semantic understanding, and writing accuracy—as well as the text level—that is, text reading and writing—in Japanese teenagers. The data utilized in this retrospective study came from a sizable database of the most well-liked literacy tests in Japan. Using structural equation modelling (SEM), we tested the hypothesis that accurate word handwriting made an irreplaceable contribution to text literacy proficiency against the backdrop of adolescents' declining literacy skills and the progressive replacement of handwriting with digital writing [25, 26].

3. MATERIALS AND METHODS

The primary objectives of the study were to study certain handwriting characteristics in Prepared and Real Forensic cases of disputed signatures in respect to their selected slant, alignment, spacing,

dimensions, size and proportion and placement, and other by conventional method of analysis and to innovate a specific transparent "Forensic Doc-Scale" for the same purpose.

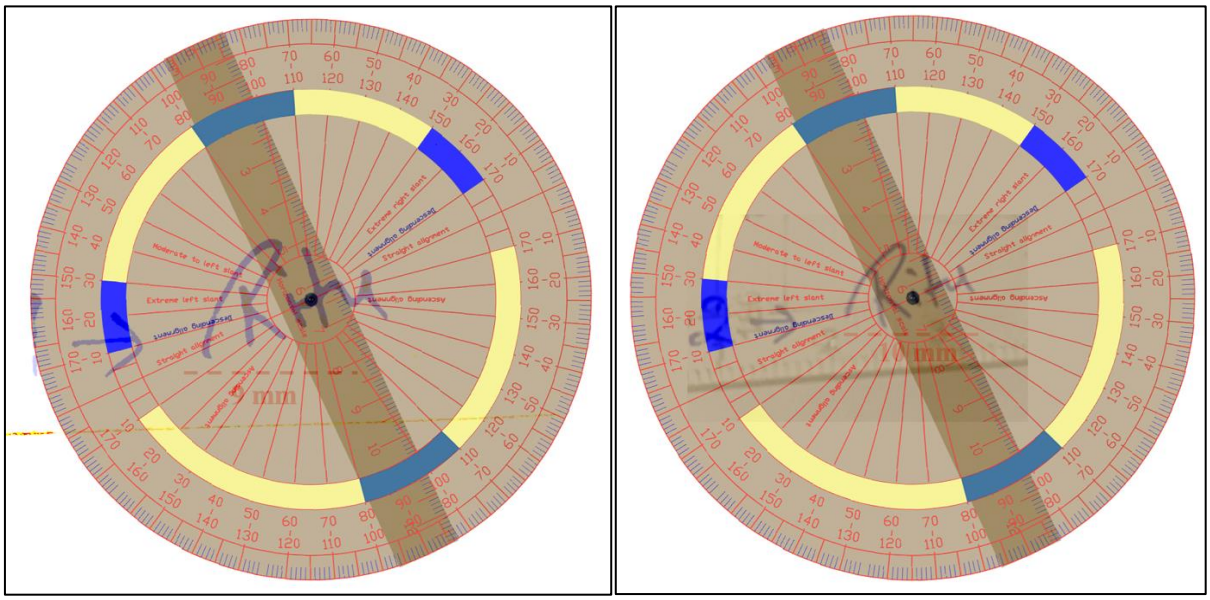
3.1. Sample: Disputed and specimen signatures from the real and prepared cases were collected for the study. 25 real cases were taken for the study from which two disputed and two specimen signatures (25x4=100) were collected. Similarly, 25 prepared cases were taken for the study from which two disputed and two specimen signatures (25x4=100) were collected. A total of 200 samples were analysed using Forensic-Doc Scale.

3.2. Sample Analysis: Firstly, the disputed and the specimen signatures were marked for their specific characteristics i.e. slant, alignment, dimensions, and proportional size for the purpose of examination, identification and comparison. The class and individual characteristics in both the cases (disputed and specimens) were identified for further comparison and analysis by using AACE (Analysis of Known, Analysis of Unknown, Evaluation, and Comparison) method.

The "Forensic Doc-Scale" was kept over the signature samples to measure dimension and characteristics like angle, slant, spacing and alignment. Also, the foldable rulers with millimetre, centimetre and inches demarcations along with the protector were used for all these parameters simultaneously.

4. RESULTS AND DISCUSSIONS

The samples were analysed using the innovative design of Forensic Doc-Scale patented as "PROTRACTOR" (Design Patent No. 408390-001) to study various characteristic features like slant, alignment, angle of writing, proportional size, and aspect ratio etc. Analysis of few of the sample are shown below in Fig. 1 and Fig. 2. Similarly all the 200 samples were analysed using this specially designed Forensic-Doc Scale.



Admitted Signature **Disputed Signature**

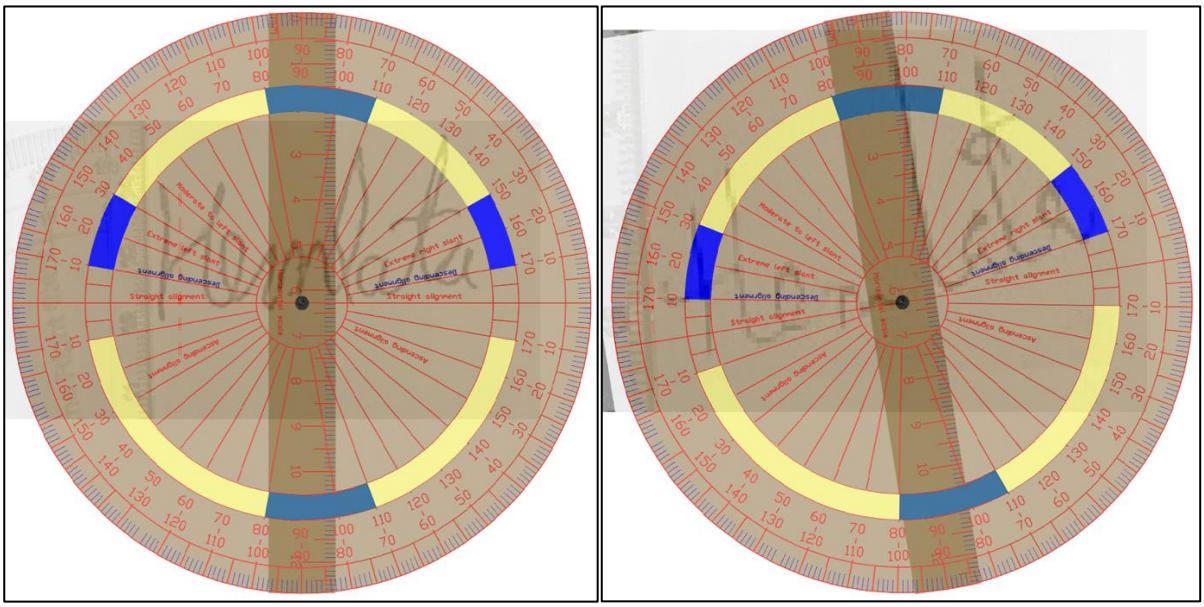
Figure 1: Analysis of handwriting characteristics with the help of "Forensic Doc-Scale" for admitted and disputed signatures in sample no. 1.

Findings in Genuine Case of Writing:

Fig. 1 demonstrated the characteristic features of both the admitted and disputed signatures. that Uphill Alignment in both admitted and disputed sets of the signatures. As visible in the images, the

slant is moderate to leftward slant in both the sets of the signature with slant angle ranging from 95-100 degree approximately. While considering the proportional size i.e. length is to width ratio it was observed that in admitted signatures the ratio is 1.28 cm, whereas in disputed signature it is 1.25 cm. During the analysis of the sample it was observed that, while the alignment and the slant shows similarities among the two samples, however, there is slight variation in angle, proportional size and ratio. The aspect ratio difference is of 0.03 cm which is within the range of natural variations in genuine handwriting as human beings are not computers. Hence, mechanically what has been written first cannot be repeated in exactly similar manner. The results states that both the sets of signatures are made by one single writer.

On the other hand, Fig. 2 demonstrate the examination of handwriting characteristics of the disputed signature, where it found to be forged and not made by the same writer as the writer of admitted signatures. As observed during examination, the class and individual characteristics are different in both admitted and disputed signatures in respect to the slant, alignment, proportional size, and aspect ratio. The natural variations of these signatures are beyond the range of identification of genuine handwriting. The aspect ratio difference of both the signature is more than 0.5 cm which indicates that the signatures belongs to two different writers.



Admitted Signature **Disputed Signature**

Figure 2: Analysis of handwriting characteristics with the help of "Forensic Doc-Scale" for admitted and disputed signatures in sample no. 3

In the present study, the Forensic-Doc Scale provided appreciable measurement and analysis of the class and individual characteristics of the signatures. This invention "PROTRACTOR' is found to be easiest, cumulative and accurate method to examine the handwriting characteristics along with dimensions. Also, moreover it was much easier to identify, measure, and analyse the handwriting characteristics using one single instrument.

5. CONCLUSION

"Forensic Doc-Scale" will be a simple & handy tool for the QDE's that can be used feasibly at any location and on any writing substrate (paper, board, wall etc.) for measuring various dimensions required for the examination and comparison of two sets of signatures or handwriting. The user will simply keep the "Forensic Doc-Scale" on the desire writing substrate bearing the disputed and the

specimen writing / signature to measure dimension like angle, slant, spacing and alignment with the single measurement tool. Also, the foldable rulers with millimetre, centimetre and inches demarcations along with the protector will allow the user to use all these parameters simultaneously. It is necessary to examine the disputed and comparable signatures or handwriting characteristics in respect to slant, alignment and proportional size in almost all forensic cases. As a matter of fact other individual handwriting characteristics such as initial and terminal stroke, connecting stroke and formation of individual letter carries a significant weightage in forensic document examination, however, the characteristics study in this research provides significant parameters to identify authorships. Therefore, the invention "Forensic Doc-Scale" was proven as crucial tool for a forensic document examiner not only to study the class characteristics sophisticatedly but also proven as a significant tool to analysis individual characteristics such as proportional size and dimensions including angle of handwriting. The present innovation will be beneficial for forensic document examiner, bank professionals and forensic science graduates.

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FUTURE SCOPE:

Currently the innovation is not suitable for digital signatures analysis. However in future a digital approach for creating a mobile application with the same measuring features can be created.

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