

■ REVIEW ARTICLE

Computational Examination of Signatures Using Digimizer

Geo Mariyam Joseph¹, Suneet Kumar²

ABSTRACT

Forensic Document Examination has become more diverse, which require authenticity or validation in determination of genuineness or non genuineness, to reveal forgery, alteration, addition, deletion, and personal identification. Signature identification is a most challenging mission in the field of forensic questioned document examination. Its aim is to determine forged signatures by matching the unknown signature with known signature. Signature is a handwritten depiction of a person that engraves on document as a proof of uniqueness. A person's signature serves as a trademark. It is generally a person's most common writing act and such is largely habitual. Signature of a person may be constituted of only letters, or with letters as well as non-letter patterns, or may be constituted only with non-letter patterns. In this modern computational era, computational approach to handwritten signature is more relevant due to its accuracy, less time consumption. This paper efforts to give computational software used for identification of signature samples. The objective of the study was to identify the natural variation occur to signature with the help of image analyzing software "Digimizer". The efficiency of the proposed method is based on results of 100 writers with 4 signatures of each writer.

KEYWORDS | signature identification, characteristics, digimizer

INTRODUCTION

Document is anything that bears mark, sign, or symbols which have meanings or convey any message to someone. According to Section-3 of Indian Evidence Act, 1872 Document is defined as "any matter expressed or described upon any substance by means of letters, figures, or marks or by more than one of those means, intended to be used or which may be used for the purpose of recording that matter. Section-29 of Indian Penal Code defined Document as "any matter expressed or described upon any

substance by means of letters, figures or marks or by more than one of those means, intended to be used or which may be used as evidence of that matter.

Questioned Document is any document whose authenticity is disputed or questioned; it is also referred as Forensic or Disputed Document. In 1910, Albert S Osborn who is known as the "Father of Questioned Document" authored a classic book "Questioned Document" in which he described the characteristics of handwriting which can be used for the examination.

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Handwriting is that the writing through with an editorial instrument like pen or pencil on any writing surfaces. Majority of people write with their hand; however, some are not able to use their hands in order that, they write with their foot and mouth etc. Handwriting is a neuromuscular activity in which, hand, foot, mouth etc. is merely a device with which instruction send to it by the brain are administrated. Writing includes each printing and running hand styles and is separate from proper calligraphy or typeface. Because to each adult's handwriting is unique and totally dissimilar, it will be want to verify author of document. Writing could be a deliberate action during which making of each letters and words are generally automatic, writer commonly focus on the matter instead of the process of writing.

A signature could be a written illustration of someone that engraves on documents as a symbol of individuality and intent.¹³ A person's signature assists as a trademark. Signature is generally a person's most typical writing act and intrinsically is essentially habitual.¹² As handwriting signature is also a neuromuscular task and they each possess certain intrinsic characteristics that are unique for a person and therefore recognizable. The formation of signature will characterized as - initial in which a signature is created of letters only, second in which a signature is created of certain letters as well as certain non-letter patterns and third in which a signature is created of non-letter patterns only¹⁴

Writing variation in handwriting will be influenced by:

- Health of the author
- Psychological state of the author
- Declining health
- Advanced age, Illness
- Intoxication and drug use
- Writing surface and Writing instrument
- Writing position
- Nervousness

Handwriting identification is that the process of analysis, comparison and evaluation of questioned document with best known writing. Handwriting and signature examination is conducted on the premise of class and individual characteristics of writing.

Characteristics of Genuine Signature

No one ever signs identically constant from one time to another. There is some variation from signature to signature due to temporary effect of either intrinsic or extrinsic character, however, their overall construction remains same. This makes signature highly identifiable. We can identify genuine signature from fraudulent one by examination of some characteristics such as:

- Smoothness, and Fluidity
- Careless execution
- No Pen lifts and Pen Pause
- No tremors unless the writer is ill
- Variations

Class and Individual Characteristics of Handwriting

General or class characteristics of handwriting are those writing features which are common to a group. Class characteristics can be classified as - movement, pen pressure, pen presentation, speed, skill, slant/slope, shading, spacing, alignment, relative size, ratio, line quality.

Movement is that the motion of writing instrument with the action of hand on the writing surface. Author might use finger, wrist, elbow or shoulder and their combinations. Pen pressure is that the weight or pressure involuntarily applied to the writing instrument throughout the act of writing; writing created with a nib pen can clearly show the impact of applying different quantity of pressure; writer can be categorized as light, medium and heavy pen pressure. Pen presentation is the angle of the pen with the writing surface or with the line of writing; the best writing is produced when the angle is 45 degree; this angle can be measured by drawing tangent to the stroke and measuring its angle with baseline. Speed is the time it takes a writer to execute a handwriting; speed can be fast, medium or slow. Skill is the ability or quality learned through repetition till it become habit to do something, the act of writing could be a skill learned through repetition until it become habit; skill can be categorized as poor, medium or good. Slant/slope is that the leaning of axis of letters relative to perpendicular to baseline of writing; slant can be vertical, backward and forward. Shading is that the conscious or voluntary act of applying pressure to the pen whereas competitive sure strokes. Spacing is that

the amount of space between letters, words and line of writing. Alignment is that the arrangement of writing on the imaginary or actual line; some writing stay above the baseline, some stay below the baseline, some stay on the baseline. Relative size is the evaluation of size of letters. Ratio is the relation between height of tall and short letters; if tall letters are many times longer than the small letters the ratio is high, where difference between long and short letters is less the ratio is low. Line quality is defined as the smoothness, evenness, continuity, and directness of strokes.

Individual characteristics are writing features which are individual to each person. It happens once a letter leaves from its normal copybook form. Individual characteristics are deviations from the structure of writing trained and later on are strong identifying characteristics when comparing handwriting samples. Individual characteristics are often considered as:

- Consciously acquired habits
- Subconscious acquisitions

Individual characteristics are classified as: I dot, J dot, loops and circle formation, formation of initial, terminal and medial stroke, formation of connectors, embellishments, arch, bow, cap, crossbar, cusp, eyelet, hiatus, hook, retrace, spur, shoulder, trough, ampersand, bar etc.

For the study of computational analysis of signature of different individuals, samples from various individuals should be available. These samples are collected from 100 individuals both male and female between the age of 18 – 45 years. Efforts were made to obtain a natural way of signature formation from individuals.

Collection of Sample

- After taking consent signature are collected from individuals
- Samples of signature are collected from 100 individuals (both male and female) between the age of 18 – 45 years old
- From each individual 4 signatures were collected

Examination of Sample

- Samples were scanned on a hi-res scanner at 300 dpi
- Examination of signature was carried out using the image analyzing software, “Digimizer”
- Scanned image is then subjected to extract

significant features like: size of letter, slant, area, angle, alignment and cursiveness

- Result is calculated on the basis of observation made during examination

Instrumental Processing

Digimizer is a user-friendly and flexible image analysis software that permit exact manual measurements as well as automatic object detection with measurements of object characteristics. Images may be X-rays, micrographs, etc. Supported file formats are .jpg, .gif, .tiff, .bmp, .png, .wmf, .emf and .dicom files.

Experimental Setup for Examination

Each image of sample was gathered to make a data set of 100 signatures. The figures were transformed into an even format and saved in a single folder. For each signature their x, y coordinates were extracted and each coordinate were calculated to estimate the values for the parameters selected for this study. Formula for corresponding study as shown in Table 1 below:

| Sr. no | Characteristics Observed | Formula for Calculation | Classified as |
|--------|--------------------------|-----------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|
| 1 | Slant | $\theta = \frac{(y1 - y2)}{(x1 - x2)}$ | Right slant if, $\theta > 90$ Left slant if, $\theta < 90$ Vertical slant if, $\theta = 90$ |
| 2 | Size of letters | size $\frac{y\sqrt{(x1-x2)^2+(x1-y2)^2}}{\text{Average vertical distance of letter on x, y plane}}$ | Small Medium Large (based on unit in millimeter) |
| 3 | Alignment | $\theta = \frac{\text{Base}}{\text{Hypotenuse}}$ | Horizontal Uphill/Upward Downhill/Downward |
| 4 | Cursiveness | $\text{Cursive} = \frac{\text{Horizontal Length}}{\text{No. of pen downs}}$ | Low Medium High |
| 5 | Angle of letters | Calculated by software | Acute Obtuse Right |

Table 1 Formulae for Respective Study

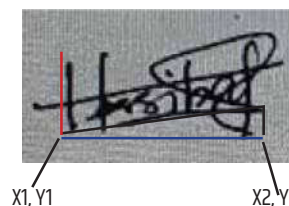


Figure 1: Coordinates of Signature at X and Y Plane

Related Studies

Vaibhav Saran in his study of “Computational Method for Forensic Verification of offline Signatures” analysed signatures through image processing in MatLab. Six characteristics features of signature were obtained to identify the genuineness of individual using pixel values based on coordinate geometry concept for forensic significance. The system could be used for classification of signature based on distance and angle.

Sargur N. Srihari “Computational Methods for Handwritten Questioned Document Examination” discussed about computational approach to handwriting Questioned document examination using algorithms. He analyzed nine characteristics features to access the uniqueness of writing in individuals.

Thameur Dhieb “Towards a novel biometric system for forensic document examination” discussed online handwriting examination through geometric characteristics. Segmented online handwriting into strokes and use uncertain perceptual elements to describe the writing of individuals. The system could be used as an authoritative instrument for online writer verification on Latin and Arabic scripts.

Antonio Parziale in “An Interactive Tool for Forensic Handwriting Examination” proposed a tool for quantitative examination of handwriting features for forensic Questioned documents. Four characteristics features of handwriting were examined through algorithms to recover the sequences of strokes, the tool automatically produces computed features value in both numerical and graphical form.

Ameur Bensafia “Handwritten Document Analysis for Automatic Writer

Recognition” in his study discussed writer identification and writer verification using PSI database and IAM database. He concluded nearly 96% correct verification of handwritten documents and writer verification.

Sargur Srihari Graham Leedham in “A Survey of Computer Methods in Forensic Handwritten Document Examination” proposed his study in the part of forensic handwriting examination with the help of software tools such as CEDAR-FOX system, FISH system, WANDA architecture.

| Characteristics | Observed |
|-----------------|----------------------------------------------------|
| Size of Letter | Small - 6% Medium - 4% Large - 90% |
| Alignment | Uphill - 73% Downhill - 16% Horizontal - 11% |
| Sland | Right - 6% Left - 4% Vertical - 90% |
| Angle | Acute - 6% Obtuse - 4% Right Angled - 90% |
| Cursiveness | Small - 57% Medium - 31% Large - 12% |
| Area | Small - 52% Medium - 46% Large - 2% |

The system developed could be used to verify the degree of match between a questioned and non-document. The system can also be used in examination of white-collar crime such as check fraud by automatic and semiautomatic signature processing.

Raul Sanchez-Reillo “Forensic Validation of Biometrics using Dynamic Handwritten Signatures” studied the examination of signature created during the process of signing are seized via the dynamic signature biometric mode. The application is fully operational which decodes the information stored on the screen with chronological signals, linear and angular measurement can also be attained.

RESULTS

The study on signature analysis conducted between the 100 individuals from both male and female between the age of 18 – 45 years old to determine the class characteristics and natural variation of signature using computational examination.

After analysis of signature, nearly 90% of individuals have large size of letter, 6% of individuals have small size of letter and 4% have medium size of letter. On alignment, 73% of individuals have upward alignment, 16% downhill alignment 11% horizontal alignment. Moving on to slant, 54% had right slant, 41% had left slant and 5% had vertical slant. About angle of writing, 56% of individuals had acute angled signature formation, 43% have obtuse angled signature formation, only 1% of individuals shows right angled signature formation. Talking about the cursiveness of signature, 57% of individuals shows low cursiveness, 31% shows medium cursiveness and 12% shows high cursiveness. While analyzing area of the signature, 52% of individuals shows small area of signature formation, 46% shows medium area and only 2% shows large area of signature formation.

DISCUSSION

The study on signature analysis conducted between the 100 individuals from both male and female between the age of 18 – 45 years old to determine the class characteristics and natural variation of signature using computational examination.

After analysis of signature nearly 95% of individuals have large size of letter, 2% of individuals have small size of letter and 3% have medium size of letter. For alignment 73% of individuals have uphill or upward alignment, 16% downhill or downward alignment 11% horizontal or straight-line alignment.

Moving on to slant 54% of individuals have right or forward slant, 41% have left or backward slant and 5% have vertical or straight-line slant. About angle of writing, 56% of individuals have acute angled signature formation, 43% have obtuse angled signature formation, only 1% shows right angled signature formation.

About the cursiveness of signature, 57% of individuals shows low cursiveness, 31% shows medium cursiveness and 12% shows high cursiveness. While analyzing area of the signature 52% of individuals shows small area of signature, 46% shows medium area and only 2% shows large area of signature formation.

CONCLUSION

The signature samples were examined carefully with the help of Digimizer. Observation is based on the examination done by class characteristics and natural variation of signature by taking x and y coordinates. The class characteristics analyzed for examination are size of letter, slant, angle, alignment, cursiveness and area. The computational method is based on coordinate geometry concept help to verify natural variation in signature.

It concluded that most of the individuals have large size of letter formation, individuals with small and medium size of letter formation are almost similar in ratio. Most individuals form their signature in uphill or upward alignment, individuals with horizontal and downhill or downward alignment shows nearly similar ratio.

Most individuals having forward or right slant and backward or left slant, only few individuals show vertical or straight-line slant formation. Most individuals have acute and obtuse angled formation of signature, least number of individuals shows right angled signature formation.

While examining cursiveness of signature the greatest number of individuals shows low cursiveness, and least number of individuals shows high cursiveness, number of individuals shows high cursiveness lies in between the above two levels. The individuals showing medium and small area of signature is higher than that of individuals showing large area of signature.

In this study, we can say that the class characteristics and natural variation in signature can be examined with the help of coordinate geometry in computational analysis. [IJFMP](#)

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