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Effect of Increasing Imitation Skill on Identification of Forged Signatures

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ABSTRACT

Signature is one of the popular hallmarks of person identification. In contrast to its popularity, the signature is often forged by a forger without giving much effort. The present study is aimed to explore the effect of increasing imitation skills on the identification of forged signatures. The signature is forged at three levels of imitation skills defined based on varying times of practicing imitation. The conventional handwriting features are compared at the three forgery levels in comparison to the genuine signature. It has been observed that the slant has the minimum effect on imitation, however, other features are changing significantly.

KEYWORDS: Signature, imitation, forgery, handwriting features

INTRODUCTION

Signature is widely considered one of the most convenient ways of personal identification. It is the way one can prove himself or herself as what he/she claims to be. The signature of an individual can be any kind of combination of letters, numerals, or symbols of any language system. It may comprise all or a few handwriting characteristics or sometimes none of them hence it is as unique as an individual's handwriting. In an immature state of signature individual changes its form, shape, and style many times and finally when an individual feels ease of signing, he/ she follows that pattern style. As time passes with regular use of a particular signature by an individual that signature becomes highly individualized and may consist of some of the inimitable features. Some people are not frequent writers but they sign regularly, in such cases layman is not able to find any similarities between handwriting and signatures produced by them.

The signature can be made in one of three styles, namely, text-based, stylized, and mixed. Text-based signatures are those in which an individual may use letters of a particular language system in upper or lower case and these letters are legible. Stylized signatures are those signatures that comprise embellished letters numerals or symbols. Most often stylized signatures are non-legible because of the decorative appearance of letters. When the signature consists of features of both text-based signatures as well as stylized signatures, then the signature is known as a mixed signature.

Many times, signature shows variations due to particular conditions such as the support surface, writing instrument, the physical condition of an individual, the emotional state of an individual, the influence of drugs or medicines, the progressive age of an individual, etc. but when the variations in genuine signature are seen without above reasons, those are natural variations. Hence no two signatures of an individual are exactly alike.

As signatures are considered a piece of the handwriting of an individual it shows class as well as individual characteristics based on which we can classify and verify it. These characteristics are line quality, word and letter spacing, initial strokes, connecting strokes, terminal strokes, rhythm, tremors, retracing, speed, size consistency, pen pressure, letter formation, shading, pen lifts, slant, alignment, diacritic placements, embellishments, etc. Features of signature are divided into two types such as static and dynamic features in which static features can be observed in already performed signature and dynamic features are observed while performing the signature by using different technologies.

Forgery when concerned with signature can be defined as a falsification of someone else's signature with a kind of deceptive intention of financial or materialistic gain to self or reputational, personal, and financial loss to that person. When a fraudster takes a genuine signature on blank paper and adds content to it without the consent of the signatory is known as forgery over a genuine signature. Generally, forgers try to imitate all the characteristics of model signatures. Here model signature is the signature the forger tries to imitate, but no forgery is considered perfect. Still, as technology is getting developed forgers also finding different ways to imitate genuine signature nearly perfect. Signature forgery can be divided into different types based on the level of skills the forger uses in making forgery. Random forgery is a type of forgery in which the forger is unaware of the original signature of an individual (hence also known as blind forgery). Simulated forgery is a forgery in which the forger tries to imitate the model signature (genuine signature). Traced forgery is when the forger traces or follows the writing movements done in genuine signature by a signatory with the help of tracing paper, transmitted light, or carbon paper. Electronic forgeries are signatures that are pasted on paper electronically.

Forger tries to imitate almost all characteristics of genuine model signature while doing forgery. Skilled forgeries require practicing model signature sufficient times to hide the forger's handwriting features. Such forgeries require careful and scientific examinations by handwriting experts. Such signature forgery verification is performed in two manners that are offline method (static features examination) and the online method (dynamic features examination). Offline signature verification only needs manual examination while online signature verification involves the use of a digitizing tablet device as well as different software such as a movalyzer to measure or observe dynamic features of the signature. This study is meant to go through both the methods offline and online for signature verification purposes. Hence to check the robustness of both verification systems in increasing skill levels of forgers.

LITERATURE REVIEW

Found et. al[1], studied the expertise of forensic document examiners and laymen for forensic signature analysis. Subjects selected for this study were categorized into two groups the first test group of 9 FDEs and the second control group consisted of 12 subjects. Their expertise was correlated by their eye movements which were tracked with the help of the Tobii 1750 binocular eye tracking system.

Linton and Mohammed[2] studied the influence of signing style on the dynamic parameters of signature such as movement duration, size, velocity, jerk, and pen pressure. They collected signature samples of 90 subjects with the help of a Wacom digitizer and a Wacom inking pen.

Fernando et al.[3] studied the robustness of signature verification systems to imitators with increasing skills. They used the biosecurid multimodal database of signatures and analyzed using three different machine experts Hidden Markov Model, Minimum Distance Classifier, and Mahalanobis distance.

Herkt[4] presented a survey performed on a group of 144 police who were chosen as subjects of the survey. He gave an account of the methods of disguise as well as forgery implemented by the subjects of the survey. He came up with the conclusion that the best forgeries were those produced freehand. Many subjects stated that they found the task of disguising their signature difficult and that they tended to flow back to their normal style.

Michel[5] performed a study of fifty subjects by asking for their genuine and disguised signatures. He came up with the finding that people use six tactics to disguise their signatures. Most people only attempt obvious changes in their handwriting, while in many instances many retain attributes of the finer structure of the signature.

Mohammed et al.[6] proposed a study to determine if the dynamic features of signatures differ between genuine and simulated signatures. Dynamic characteristics of the signatures of 60 subjects were collected with a digitizing tablet and analyzed with movalyzer software. They concluded that the dynamic results for genuine and simulated signatures suggest that the forensic document examiner might try to take the writing style of any potential stimulator and the style of the signature into account when conducting an examination.

Zou et.al[7] presented a novel approach to online signature verification using local shape analysis. As well as an algorithm is also proposed for analysis which is the Hidden Markov Model. The Viterbi algorithm is used to obtain the likelihood of signature. The threshold value of likelihood was determined and the signatures having a likelihood value less than that of the threshold value are considered as forged signatures.

Alonso-fernandez et al. [8] investigated experimentally if the knowledge of letters, syllables, or name instances can help in the process of imitating a signature. They used MCYT database of signature to extract the features that are global and local features with the help of two machine experts, the Minimum Distance Classifier and the Hidden Markov Model.

MATERIALS AND METHODS

Genuine signatures of subjects were collected on A4 size white paper using a gel pen with the solid support of a writing pad. Ten signature samples were collected from each subject. Forged signature samples from volunteer imitators were also collected on the paper of the same make and type. These forged signature samples were collected with three different imitation skills as follows:

First skill level: In this level, the forger is allowed to observe the genuine signature for 1 minute and then to imitate the genuine signature.

Second skill level: At this level, the forger is allowed to observe the genuine signature for 5 minutes, practice it for 1 minute, and then imitate the genuine signature.

Third skill level: At this skill level, the forger is allowed to observe the genuine signature for as much time as he/she wants, practice the signature for the required time, and then imitate the signature.

A representative sample has been illustrated in Figure 1 to Figure 4.

Data Analysis: The data of 100 subjects' samples of genuine signatures and Signature forgery samples of each of the 100 genuine signatures at three different imitation skill levels were collected at standard conditions. Then the offline (manual) examination with the help of a pencil, measuring scale, and magnifying lens was done for the following parameters: connections, initial stroke, pen lift, pen pressure, relative size, slant, terminal stroke, rhythm, tremor, retracing, speed, and embellishment. The total count of features of forged signatures that deviated from that of the genuine signatures was noted. A comparison

between features of forged signatures that deviated from genuine signatures of all three skill levels was done and presented in the form of a graph.

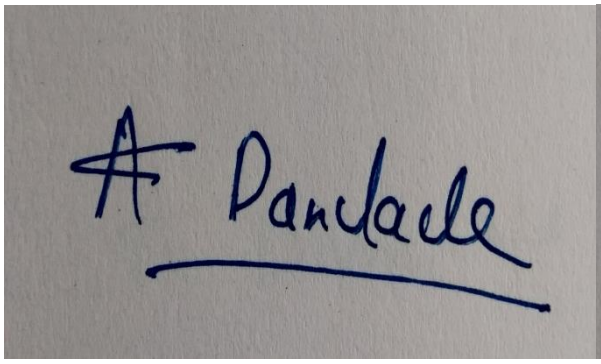

Figure 1: Genuine signature

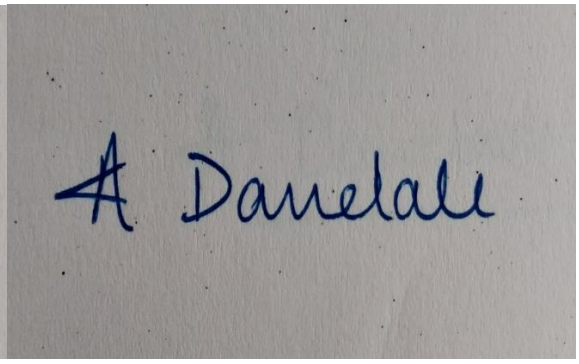

Figure 2: Forged signature at level 1

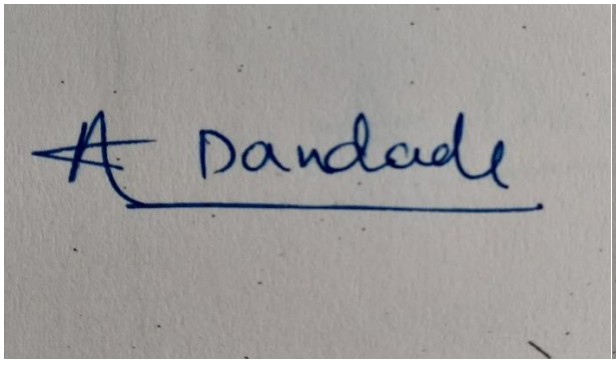

Figure 3: Forged signature at level 2

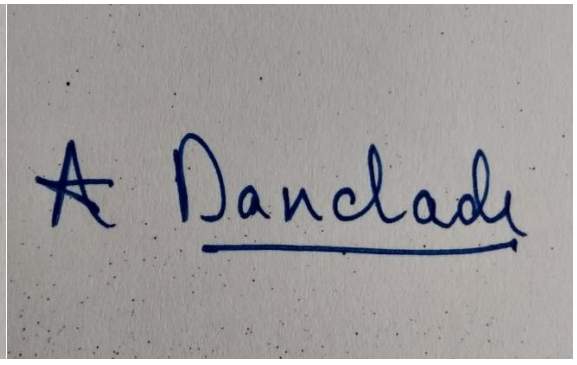

Figure 4: Forged signature at level 3

RESULTS AND DISCUSSION

Figure 5 represents the variations at different levels of imitation in comparison to the genuine one for characteristics of signature. As observed from the figure, variations in signature characteristics in comparison to the genuine one are higher at the very first level of accuracy, which subsequently decreases at the second and third levels of imitation. As observed in the figure, it seems that the forger takes care of the slant, thus less variation throughout the imitations has been observed. Maximum variations have been observed in the case of pen pressure, relative size, tremor, and speed.

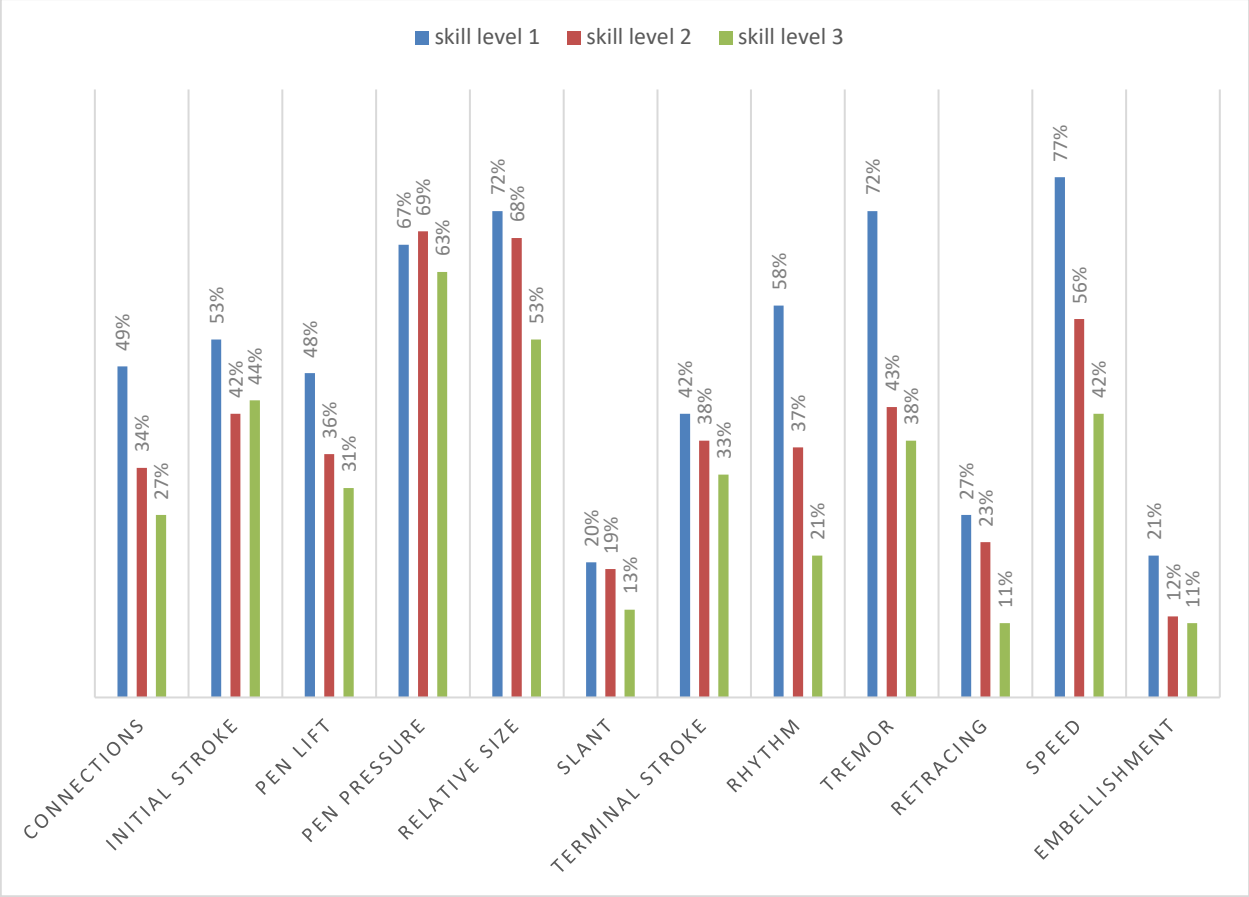

Figure 5: Variations in handwriting features due to various levels of imitation

CONCLUSION

We explored the effect of various levels of imitation on the identification of forger. The experiment on genuine and forged signatures by 100 subjects revealed that increasing the imitation skills of the signature can affect the accuracy of the signature verification task. However, the dynamic feature may further help to understand the concept better.

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