

Methods to make Gurmukhi Handwriting Verification more Authenticated and Convincing to Courts

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Abstract

The objective of this paper is to provide an overview of the current state of Gurmukhi handwriting verification in courts in India, including a review of the methods and techniques used, the challenges and limitations faced, and the future direction of research in this area. This paper also provides recommendations for future research and development in the field of Gurmukhi handwriting verification, with the goal of improving the accuracy and reliability of handwriting verification for this script. The ratios play an important role in the verification and identification of the author. The authors find that the measurement of ratios is a satisfactory tool for ascertaining the handwriting verification. Two methods have been discussed by them, one using Photoshop and other by the measuring the aspect ratio and relativity to compare the handwritings of two documents –admitted and the questioned document. These ratios are very helpful where there is a lack of more standard documents.

Keywords: handwriting verification, Gurmukhi script, forensic document, aspect ratio, relativity.

Introduction

Handwriting verification is a critical aspect of forensic document examination, as it plays a crucial role in authenticating written documents and determining the authorship of handwritten materials (I. Siddiqi & N. Vincent, 2007). In India, the use of Gurmukhi script in legal documents has necessitated the development of methods for handwriting verification in this script. The purpose of this paper is to review the current state of Gurmukhi handwriting verification in courts in India, including the methods and techniques used, the challenges and limitations faced, and the future direction of research in this area. Gurmukhi is an important script used for writing the Punjabi language and is widely used in northern India and Pakistan. It is commonly used in legal documents, including contracts, deeds, and other official records, making it important to have reliable and accurate methods for handwriting verification. In court cases, handwritten documents in Gurmukhi often play a crucial role as evidence. However, the authenticity of such documents is often questioned, leading to the need for a more reliable and convincing verification process. This research paper focuses on recent research efforts towards making Gurmukhi handwritten verification more authenticated and convincing in the courts. However, the development of methods for handwriting verification in Gurmukhi has been limited, and there is a need for further research and development in this area (M. Kumar, G. Z. S. Ptu, & M. Kumar, 2015).

In the courts of India, handwriting verification is often performed by experts in forensic document examination, who use a variety of techniques and methods to determine the authenticity and authorship of written materials. These methods include handwriting analysis, feature extraction, optical character recognition (OCR), biometric authentication, and others (J. Linden, R. Marquis & W. Mazzella, 2017). Each of these methods has its own advantages and disadvantages, and the choice of method depends on the specific requirements of each case.

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One of the challenges in Gurmukhi handwriting verification is the lack of standardization in the methods used. Different experts use different techniques and methods, making it difficult to compare results and establish a clear and consistent standard. Additionally, the availability of experts in Gurmukhi handwriting analysis and verification is limited in India, particularly in remote areas, which results in a lack of access to reliable and qualified experts.

Another challenge is the reliance on subjectivity in handwriting analysis and expert opinion. This method relies on the expertise and judgment of the individual analyst, which results in inconsistent results and the potential for bias, particularly if the analyst is not properly trained or experienced in Gurmukhi handwriting analysis.

The purpose of handwriting verification is to address the court question as to whether the samples are written by the same writer or not. In the process, two documents are compared in this process – admitted document (i.e., the sample) and the questioned document (i.e., document to be verified). Different techniques are developed and implemented for handwriting verification to identify whether the handwriting is forged or disguised or to find the identity of the writer. We come across some satisfying research in English handwriting, (S. Mukherjee and I. De Ghosh, 2020) (A. Priya et.al., 2016) but techniques of English languages cannot be applied because of ‘matras’ in Gurmukhi script, which are missing in English.

Court Requirements

Under Evidence law, the handwriting verification falls in the category of expert evidence which needs to be creditworthy to the court by way of demonstration. This is possible by way of detailed examination procedures and processes adopted by the handwriting experts before the court. Practically, in all cases, as studied by this researcher, the handwriting experts support the version of his client. In such an exercise, in good many cases, there appear experts from both the parties – one arguing that the questioned document was written by the author and another supporting his viewpoint that it was not so. From this exercise of contradictions amongst the experts using the same instruments and methods and bringing about divergent opinions make such pieces of evidence unconvincing, non-scientific, and named as based on conjectures. Therefore, a need arises that handwriting verification must be based on more sound and scientific technique processes and methods where such kind of divergences have only a little scope. Furthermore, it is also required that the use of processes and comparisons of documents made must be demonstrable in the court. All this requires the use of computer techniques and methods.

Existing Practices and Methods

A variety of existing practices and methods are widely used in a variety of applications, including forensics, document authentication, and signature verification (E. N. Zois, L. Alewijnse & G. Economou, 2016). However, each method has its own limitations and challenges, and researchers continue to explore new and more advanced methods to improve handwriting verification (M. Kumar et.al., 2018).

As per the reports of handwriting experts, they examine and compare the disputed and standard documents with the help of microscopic lenses of various powers, falmer magnifiers, illuminous magnifier, colored filters and other necessary instruments like protractor, scale, etc. The digital close-up photographs of disputed and standard documents have been prepared for comparison and demonstration purposes. The photographs prepared

are free from any kind of retouching. In the first instance, the experts examine and compare the disputed documents with regard to the general as well as individual handwriting characteristics to check whether it is written by one and the same person by checking the consistency in the writing characteristics. According to them, natural variations are always present between them due to the fact that the human hand cannot act like a printing machine and application of a conscious mind to forge documents also adds to complications of a foolproof verification.

In India, the methods of handwriting verification that are accepted in courts include:

- *Handwriting Analysis and Expert Opinion:* Handwriting experts and analysts are often called upon to examine handwriting and provide their expert opinion on its authenticity. The opinion of these experts is considered as supplementary evidence in court cases.
- *Document Examination:* This method involves the examination of the physical characteristics of a document, such as paper type, ink type, and watermarks, to determine its authenticity. This method is used to identify and authenticate original documents in court cases.
- *Forensic Document Examination:* This is a specialized form of document examination that involves the use of scientific techniques and methods, such as ink analysis and microscopy, to determine the authenticity of documents. Forensic document examiners are often called upon to provide evidence in court cases.
- *Statistical Analysis:* This method involves the use of statistical techniques, like linear discriminant analysis (LDA) and principal component analysis (PCA) (Ricciardi, Carlo, et al., 2020), to analyze handwriting samples and determine their authenticity. The results of these analyses can be used as evidence in court cases.
- *Biometric Authentication:* This method involves the use of biometric authentication methods, such as fingerprints and iris scans, to determine the authenticity of handwriting. This approach is often used in conjunction with handwriting analysis and expert opinion to increase the authenticity of handwriting verification (Liming Fang et.al., 2020).

These methods are widely accepted in courts in India and are used to determine the authenticity of handwriting in a variety of legal contexts, including civil and criminal cases. However, the accuracy and reliability of handwriting verification methods can vary, and it is up to the court to determine the weight to be given to the evidence presented.

The Shortcomings

The shortcomings of methods of handwriting verification accepted in courts in India for Gurmukhi language include:

- a) *Lack of Standardization:* There is a lack of standardization in the methods used for handwriting verification in India, particularly for the Gurmukhi script. This can lead to inconsistent results and the use of different techniques and methods by different experts, making it difficult to compare results and establish a clear and consistent standard. (A. Sharma, Rajiv K. & Singh, 2008)
- b) *Limited Availability of Expertise:* The availability of experts in Gurmukhi handwriting analysis and verification is limited in India. In the state of Punjab, we come across only 5-6 handwriting experts and claiming expertise of writings in all languages in the State.

This results in a lack of access to reliable and qualified experts, making it difficult to authenticate handwriting in court cases.

- c) *Reliance on Subjectivity*: Handwriting analysis and expert opinion are subjective methods, relying on the expertise and judgment of the individual analyst. This results in inconsistent results and the potential for bias, particularly if the analyst is not properly trained or experienced in Gurmukhi handwriting analysis. (M. K. Mahto, K. Bhatia, & R. K. Sharma, 2015)
- d) *Technical Limitations*: Some of the methods used for handwriting verification, such as OCR and feature extraction, are based on technology that may not be optimized for the Gurmukhi script. This results in errors and limitations in the accuracy and reliability of handwriting verification results (P. Singh & S. Budhiraja).
- e) *Cost*: Some of the methods used for handwriting verification, such as forensic document examination and biometric authentication, are costly and therefore not accessible to individuals or organizations with limited resources (B. Mehta et.al., 2014).

These shortcomings limit the accuracy and reliability of handwriting verification in India for the Gurmukhi script and make it challenging to authenticate handwriting in court cases. To address these issues, it is necessary to develop more standardized, reliable, and cost-effective methods for handwriting verification in India, particularly for the Gurmukhi script.

Need for More Accuracy

We find that by using the Aspect Ratio and Relativity (Vijay Rana, et. al., 2020) even in the traditional methods of verifying the handwriting, result in getting another method of achieving accuracy. But to make it more scientific and to make it convincing to the courts, we have to use scientific and demonstrable methods and techniques (U. S. Mishra, 2021).

Proposed Methods

Photoshop is an efficient tool in the verification of handwritten documents. Through Photoshop, we can clearly show the similarities as well as the differences between the formation of two characters or matras of handwritten documents. Specially in the case of signatures, the differences can be clearly shown with the help of overlapping two signatures (questioned as well as admitted) after normalizing them.

Figure 1. Showing difference of same word written by two different persons by normalising it and measuring it on same scale – difference in terms of height, width of characters and space between characters.

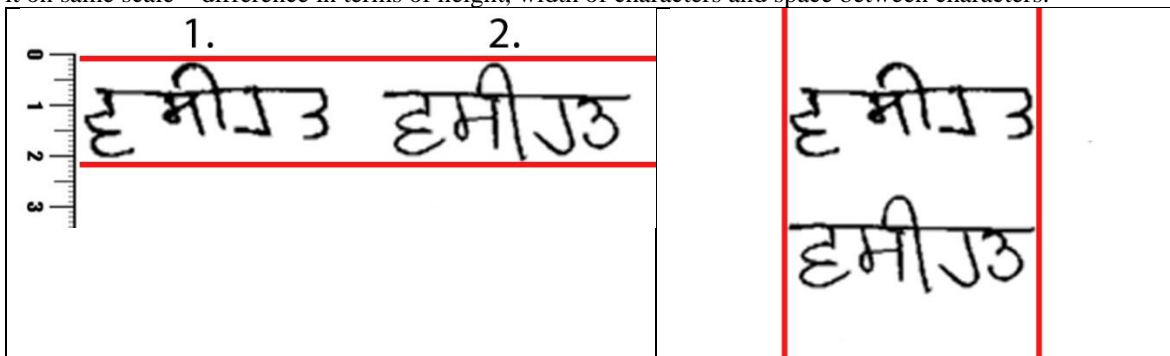


Figure 2. Showing the difference by overlapping characters written by two different authors using multiple layer color mode.

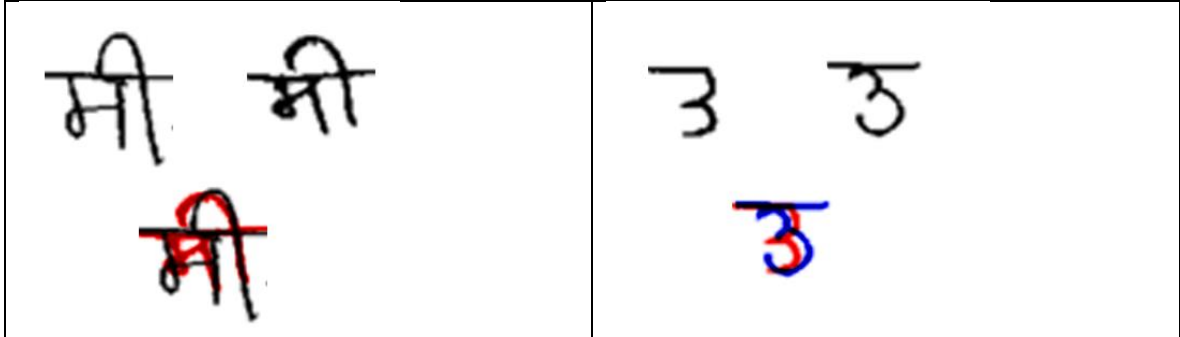


Figure 3. Showing the difference of matras written by two different authors

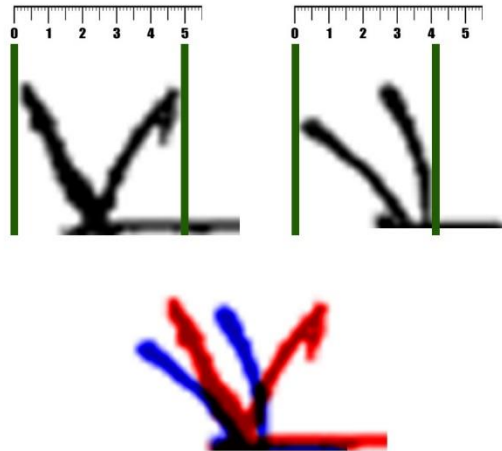
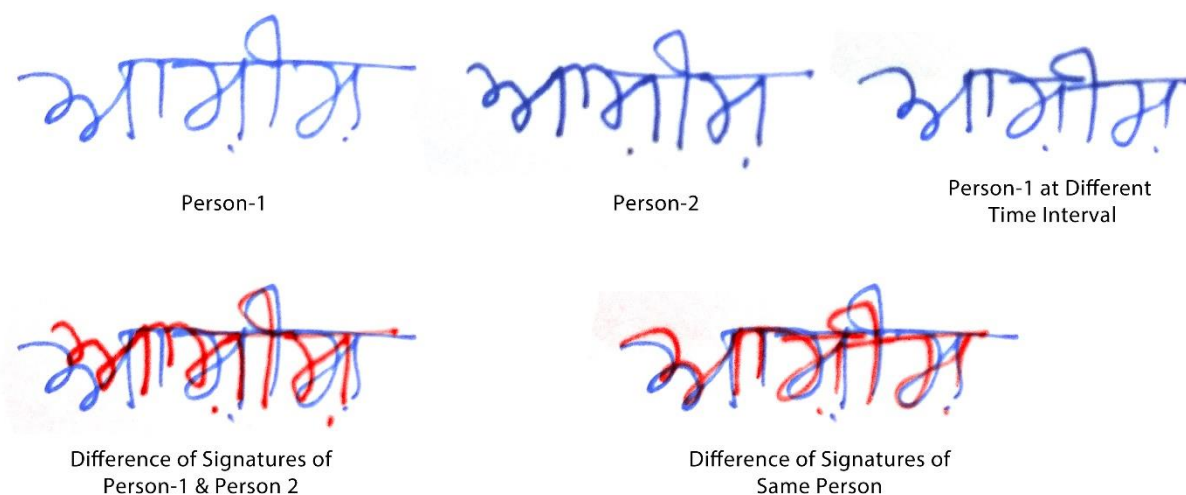


Figure 4. Showing the difference of signatures written by two different authors by overlapping them using multiple layer colormode.



The other technique is to develop software to verify two handwritten documents. For the purpose, we find the ratios of the characters – aspect ratio and relativity of size. The aspect ratio and relativity play very significant role in the verification of the handwritten document. Our handwriting tends to change due to various factors like stress, surface, pen, etc. Sometimes when the person is in danger and wants to write a note but could only find a very small piece of paper, his/her handwriting is effected due to limited space available. But whether the word is written in small space or big space, the aspect ratio and specially relativity of the character remains the same. Thus, comparing the relativities of two same words in two different documents is very helpful in the verification process. The relativity can be measured by size (length and breadth of characters) and by slant of characters. After scanning the document with the most acceptable 300 dpi, the segmentation process of lines and words will be done. Select the particular word for which one wishes to find the ratios. Find the aspect ratio of two characters of same word. The aspect ratio of the character is defined as the ratio of length and breadth of the character. Then, find the relativity of size i.e., aspect ratio of first character divided by the aspect ratio of second character of the same word. The researcher has found that if the difference between relativities of the same word in two different documents is very less i.e. less than 2 then the document is written by same person. If the relativities lie between 2 and 3, then it is a doubtful case and needs further verification. But if the relativity of the words is greater than 3 then it is definitely written by two different authors. The proposed software has been developed by MATLAB and has been experimented with over 100 documents.

Figure 5. Showing aspect ratios (AR) of two different characters and their relativities of same word written by two different authors and the difference of their relativities (ARD).

Values				Values			
Char 1 AR	1.10526	Char 1 Angle	51.2644	Char 1 AR	0.576923	Char 1 Angle	18.4349
Char 2 AR	1.23529	Char 1 Angle	30.9638	Char 2 AR	1.25	Char 2 Angle	14.0362
Relativity	0.894734	Relativity	1.65563	Relativity	0.461538	Relativity	1.31338

Comparison			
ARD	0.433196	ANGD	0.34225

Theoretical Contribution of the Study

Forensic Science is an important area of academic and research importance. The theoretical material available in the paper dealing with handwriting verification is primarily confined to English language and only a passing reference is made to verification of Gurmukhi script handwriting. In this part of handwriting verification, only the traditional tools like using the microscope, magnifying lens, scales, protractor, etc. are used in the name of practical experimentation. Use of computers and its tools is basically a new input that can be added to the available tools of handwriting verification in Gurmukhi script. Therefore, the present research paper will not only add to the existing literature on the subject, but it will also open a new area of experimental research that will help in more accurate and scientific verifications of handwriting in Gurmukhi script.

Limitations of the Study

The present research paper is based on a limited study confined to the use of aspect ratio and relativity as the factors for verification of Gurmukhi handwriting. Although, these two parameters are sufficient to accurately verify the handwriting, but to be more exact and make such verification foolproof, it requires more factors to be involved, therefore, the paper has its limitations of using only two factors which lead to the accuracy of verification to the extent of 80%, leaving a scope of going wrong up to 20%. The sample for this research paper is also limited to 100 samples. To make it more result oriented, the sample could have been increased to 300 or more but at the cost of more time and energy resources required for the purpose.

Conclusions

The use of technology has played a significant role in the development of more accurate and reliable handwriting recognition systems for Gurmukhi handwriting verification. Researchers have attempted to identify and analyze the unique features of Gurmukhi handwriting and evaluate the use of handwriting verification in court cases. These efforts have contributed to the advancement of handwriting verification and have the potential to provide a more reliable and convincing verification process in the courts. The use of technology in handwriting verification is an active area of research, and further advancements are expected in the future. (Sakshi, N. K. Garg & M. Kumar, 2018).

Future Scope

The future research in the field must adopt more characteristics of Gurmukhi script like spacing between the characters, double bar on the top of characters, problem of overlapping etc. (D. Impedovo, G. Pirlò & R. Plamondon, 2012). And combined results of comparison of questioned documents with the standard documents will certainly bring definitely reliable results and pull this branch of Forensics to the level of creditworthy evidence – much higher than the name of conjectures presently given.

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