Chapter VI

Seeking Patterns in the Forensic Analysis of Handwriting and Speech

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ABSTRACT

This chapter examines features of handwriting and speech and their effectiveness at determining whether the identity of a writer or speaker can be identified from his or her handwriting or speech. For handwriting, some of the subjective and qualitative features used by document examiners are investigated in a scientific and quantitative manner based on the analysis of three characters ("d," "y," and "f") and the grapheme "th." For speech, several frequently used features are compared for their strengths and weaknesses in distinguishing speakers. The results show that some features do have good discriminative power, while others are less effective. Acceptable performance can be obtained in many situations using these features. However, the effect of handwriting forgery/disguise or conscious speech imitation/alteration on these features is not investigated. New and more powerful features are needed in the future if high accuracy person identification can be achieved in the presence of disguise or forgery.

INTRODUCTION

In forensic analysis, there is often a need to identify a person or persons from evidence obtained at the scene of a crime. For example, evidence is often needed in criminal investigations to determine whether or not a piece of writing or a signature was written by a particular individual. Or it may
be necessary to produce evidence on the identity of the speaker in a recorded voice message left on an answering machine. Alternatively, such analysis may need to be applied to detect the identity of wanted individuals passing through security monitoring and screening operations in such sensitive areas as airport boarding gates and immigration desks.

In all these scenarios, it is necessary to accommodate the natural variations in handwriting and voice caused by environmental factors such as background noise and personal stress/emotional level, which affect both speech and handwriting, and the writing implement or physical position (e.g., sitting, standing, or writing while traveling in a vehicle), which affects the handwriting. In addition, writers or speakers may attempt to disguise their handwriting or voices to avoid detection. Or people may wish to try to pass themselves off as someone else by forging their handwriting so it looks like that of someone else, or they may adjust their voices or accents to imitate someone else.

When there is a need to seek the identity of an unknown speaker or writer, the existing techniques for such forensic analysis are carried out by experts who use their experience and knowledge of handwriting and speech to reach an expert decision. The techniques they use involve detailed examination of the handwriting or speech using various tools such as imaging devices and microscopes for handwriting, and spectral analysis and signal processing tools for speech analysis.

Generally, in forensic analysis, there is a questioned sample of handwriting or speech from an unknown person and other known samples of handwriting or speech from known individuals. These known samples are usually from suspects who may have uttered or written the questioned sample. It is the task of the forensic expert to reach an expert opinion, with supporting evidence, as to whether the unknown sample is the same or different from a known sample.

While forensic examiners use various computer tools to extract features and information from speech and handwriting samples, the final pattern matching or decision-making process to determine whether there is a match between the questioned sample and one of the known handwriting or speech samples is left to human judgment. This is not entirely without justification, as people are extremely capable of matching patterns and seeing similarities between samples, especially when they have become skilled in examining particular types of data. However, the techniques experts use are generally qualitative in nature, and there is little scientific basis on which to base their pattern-matching decision.

In this chapter, we describe the research work we and others have carried out to produce tools that assist forensic examiners in their pattern-matching process. The research seeks to identify and extract important and significant unique features of handwriting and speech and then automatically extract those features and apply automatic pattern-matching techniques to assist the experts in their forensic examination and provide a more scientific basis to support their expert opinion.

**BACKGROUND**

Handwriting and speech are personal biometrics that have long been considered unique to a person and his or her recognition used as evidence in court. However, the methods used to determine the authenticity of speech or handwriting and attributing it to an individual author have been increasingly questioned, as they are heavily reliant on qualitative opinion of expert witnesses and not always supported by quantitative scientific evidence.

For many years there has been considerable research into identifying what a speaker is saying (speech recognition) and, to a lesser extent, who the speaker is (speaker recognition). However, within the forensic context, differences in
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