

Biometric and Forensic Aspects of Digital Document Processing

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17.1 Introduction

The field of forensic document examination (FDE) is concerned with issues such as whether the writer of a questioned document, say a ransom note, is the same as the known writer of sample documents, whether a signature is genuine or is a forgery, etc. The basis of the use of handwriting as evidence is its individuality, i.e. every person's writing is different, or every person's signature is unique.

More recently, researchers in biometrics have been developing automated means for authenticating a person, i.e. verifying whether a person is indeed who he/she claims to be. The commonly considered modalities for biometrics are fingerprints, iris, hand prints, voice, gait, etc. Since handwriting is a characteristic that is potentially unique to each individual and since it can be captured non-invasively, handwriting and signatures can also be useful as biometrics.

The field of FDE is much broader than the examination of handwriting and signatures. For instance, the examination of inks, typed and printed manuscripts is also in the purview of FDE. The area of commonality between forensics and biometrics is the examination of handwriting and signature by automated methods. It is this area of intersection that is addressed in this chapter.

Forensic examination has been largely based on manual examination by the expert to discern writing habits and other characteristics. Automated methods for handwriting examination are only recently being developed and introduced to the FDE community. Automated signature verification has a longer history although much of the work has been in the on-line case. The use of handwriting and signatures in biometrics is still more recent. Since handwriting is a behavioural characteristic, in contrast to

biological characteristics such as fingerprints, handwriting is possibly useful to biometrics only when used in conjunction with other modalities.

17.1.1 Individuality of Handwriting

Writer identification has a long history perhaps dating to the origins of handwriting itself. Classic forensic handwriting examination is primarily based upon the knowledge and experience of the forensic expert.

The individuality of handwriting has been a contentious issue in the courts. There are several rulings in the United States courts that are concerned with the admissibility of handwriting as evidence. The central ruling on this issue is the supreme court case of *Daubert versus Merrell Dow Pharmaceuticals*, which required that any expert evidence to be admitted has to have a scientific basis. Whether a theory or methodology has a scientific basis has many philosophical implications, e.g. whether it is falsifiable. Four specific criteria to determine whether there exists a scientific basis for an expertise were proposed as follows: (i) experimentation, (ii) error rates, (iii) peer review of the methods and (iv) general acceptance.

Since many types of evidence used by the courts, e.g. fingerprints and handwriting, did not have support in all four measures, research was only recently undertaken to fill the gaps. The individuality of handwriting was studied recently leading to a characterization of the individuality of handwriting when there were sufficient amount of data available [1].

Due to the subjective nature of expert decisions, traditional methods are being supplemented by computerized semi-automatic and interactive systems. Such systems allow for large-scale testing so that error rates can be determined. The choice of the test sets is relevant, e.g. testing on data from twins or other cohort types would pose a more challenging test than when they are collected otherwise.

17.1.2 Organization of Chapter

Section 17.2 describes image pre-processing operations and interactive user interfaces for FDE. Section 17.3 describes discriminating elements, also known as *features* or *characteristics*, that are useful for writer/signature discrimination. Section 17.4 describes a statistical model for writer verification. This model is also applicable to signature verification and other biometric modalities such as voice and fingerprints. Section 17.5 describes an approach to signature verification that includes performance in terms of false acceptance rates and false rejection rates. The concluding remarks in Section 17.6 indicate the future of handwriting in forensics and biometrics.