TECHNICAL REPORT

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Information technology — Biometrics — Characterization and measurement of difficulty for fingerprint databases for technology evaluation

Technologies de l'information — Biométrie — Caractérisation et mesure de difficulté pour bases de données d'empreintes digitales pour évaluation de technologie

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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of the joint technical committee is to prepare International Standards. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

In exceptional circumstances, when the joint technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example), it may decide to publish a Technical Report. A Technical Report is entirely informative in nature and shall be subject to review every five years in the same manner as an International Standard.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights.

ISO/IEC TR 29198 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 37, *Biometrics*.

Introduction

Recently, there have been worldwide increasing activities in testing and evaluating the performance of fingerprint recognition systems or algorithms. Testing activities occur in public sector, private sector, and academic entities, typically using datasets exclusive to a given entity. This complicates comparison of test results from different entities. Methodologies for assessing the level of difficulty of test datasets should improve the comparability of performance evaluation results over different fingerprint datasets.

ISO/IEC 19795-1:2006, 5.5.3[11] states:

"In a technology evaluation, testing of all algorithms is carried out on a standardized corpus, ideally collected by a "universal" sensor (i.e. a sensor that collects samples equally suitable for all algorithms tested). Nonetheless, performance against this corpus will depend on both the environment and the population in which it is collected."

Comparison of evaluation results based on testing against different corpora may be misleading. Further, policies for inclusion or removal of low-quality data in a corpus may vary from organization to organization, such that the same algorithm tested against the same corpus may generate different results. There are also certain difficulties when trying to compare multiple evaluation results derived from different corpora. Currently there is no established methodology for characterizing the level of difficulty of datasets used in performance evaluation. The ability to characterize a dataset's level of difficulty should support predictions of operational accuracy when processing data known to be of equivalent difficulty.

The purpose of this Technical Report is to provide guidance on predicting how "challenging" or "stressing" a fingerprint dataset is for recognition, based on factors such as relative sample quality, relative rotation, deformation, and overlap between impressions. The provided guidance can be used for characterizing and measuring the relative difficulty levels of fingerprint datasets used in technology evaluation.

Following the guidance in this Technical Report, users and system evaluators in different organizations will be able to compare and place into context the performance evaluation results of the other organizations according to the level of difficulty of its dataset.

This Technical Report proposes dataset generation methods based on analysis of comparison results or scores from multiple fingerprint recognition algorithms. These dataset generation methods support creation of datasets with specific levels of difficulty and creation of datasets for use in interoperability evaluations.

ISO/IEC TR 29794-4[16] defines methods for expressing the quality score of a *single* fingerprint image. Such quality scores are typically predictive of matching accuracy. This Technical Report, by contrast, is concerned with differences in rotation, deformation, and common area between reference and probe samples.

NOTE Other modalities can be considered in the future as more information becomes available about standardized quality measurements that are suitable for predicting the performance of other biometric systems.

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1 Scope

This Technical Report provides guidance on estimating how "challenging" or "stressing" is an evaluation dataset for fingerprint recognition, based on relative sample quality, relative rotation, deformation, and overlap between impressions. In addition, this Technical Report establishes a method for construction of datasets of different levels of difficulty. This Technical Report defines the relative level of difficulty of a fingerprint dataset used in technology evaluation of fingerprint recognition algorithms. Level of difficulty is based on differences between reference and probe samples in the aforementioned factors. This Technical Report addresses such issues as:

— characterizing level of difficulty attributable to differences between samples acquired from the same finger,

— developing statistical methodologies for representing the level of difficulty of a fingerprint dataset by aggregating influencing factors,

— comparing the level of difficulty of different fingerprint datasets,

— defining procedures for testing and reporting the level of difficulty of fingerprint datasets collected for technology evaluation,

— analysing mated pair data characteristics based on comparison scores,

— describing the archived data selection methodology for building a dataset for evaluation.

This Technical Report provides guidelines for comparing the relative level of difficulty of fingerprint datasets.

Outside the scope of this Technical Report are:

— defining the quality of individual fingerprint images,

— defining the methodologies or explicit measures for evaluating or predicting the performance of fingerprint recognition algorithms.

2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

2.1
raw biometric sample
information obtained from a biometric sensor, either directly or after further processing

2.2
biometric reference
<template, model> one or more stored biometric samples, biometric templates or biometric models attributed to a biometric data subject and used as the object of comparison

EXAMPLE Face image stored digitally on a passport; Fingerprint minutiae template on a National ID card; Gaussian Mixture Model for speaker recognition, in a dataset.