

Cross Cultural Aspects of Biometrics*

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Abstract

In this paper we summarize our first research results in the field of Cross Culture user authentication. We will investigate intercultural aspects of biometrics, both of technical and legal nature. Besides biometric based user authentication, Human-to-Computer interfaces are an important part of our work.

We present a methodology for intercultural and multimodal data recording and testing of different hypotheses.

1. Motivation

The goal of our work is to analyze multicultural aspects of biometric speech and writing data input. We will analyze data input for either natural human-to-computer interfaces or biometric authentication purposes. As [1] shows, it is possible to estimate some meta-data like script language, origin, gender and age by statistically analyzing human handwriting. By knowing this meta-data, it appears to be possible to adapt the recognition or authentication algorithms in order to enhance their performance/quality (i.e. False-Match/False-Non-Match Rates, FMR/FNMR).

One goal of our research is to show, that speech or handwritten input is of different suitability for biometric authentication and recognition in **different countries and/or in different languages**. It is also interesting to perform the task of user authentication in bilingual or multilingual environment, which may have special relevance to tracking a particular target user under changing situations. Also, using speech input in addition to handwriting opens the potential to build multimodal environments for a more natural and intuitive handling of computer systems.

Another important aspect of our work is the analysis of **user acceptance** of speech and handwriting modalities

for interface or authentication usages. For example handwritten signature verification appears to have some advantages over other biometric modalities in European countries, where it is a traditionally well-established method for manual user authentication. However, the **social or legal perception** of the signature might be different in other cultural or linguistic groups. Our idea is to accomplish an initial survey on the user perception in three different countries (India, Italy and Germany) together with the technical evaluation of speech and handwriting biometrics. In our paper we present our first results with respect to evaluation aspects with focus on privacy and cross cultural issues (section 2). Furthermore we introduce our test methodology and evaluations strategies (section 3). The paper finalizes with a conclusion (section 4).

2. Evaluation Aspects

In this section we briefly discuss privacy issues in the context of collection of biometric and personal data. Other points of discussion are cross cultural issues of user interfaces.

2.1. Privacy Issues

User privacy awareness, i.e. to know, when personal data are taken and for which purpose they are used, is a crucial component for trust in the information society. Without clarity and trust in this area, members of the information society could be scared to be at the mercy of unsearchable surveillance technology. This consideration leads us to improve data control.

To know, that data can move freely and can be a permanent part of scientific progress could also be a crucial component for trust in the information society. If personal data are necessary for scientific progress, they should be explicitly protected.

* This publication has been produced with the assistance of the European Union (project CultureTech, see <http://amsl-smb.cs.uni-magdeburg.de/culturetech/>). The content of this publication is the sole responsibility of the University Magdeburg and their co-authors and can in no way be taken to reflect the views of the European Union.

Since there are concerns about privacy with antagonizing aspects with respect to gaining and processing biometric data, we will have to take care of that issue. We will analyse traffic restrictions, which are designed to cover privacy and we will measure the range of exemptions for scientific purposes as well.

Some countries have established privacy laws to regulate the handling of personal data. Other countries are within an ongoing legislation process to establish data protection rules. In the project, one area of research is to summarize information about that kind of law in the different countries. This information has to be kept in mind while gaining and processing biometric data in our project. We have the goal to use law more for building a bridge over the gap than for widening the gap.

This information is interesting for itself, since it can be of use in other research and commercial projects, which also have implications to processing of personal data.

2.2. Cross Cultural Issues

Additionally to legal issues, there can be varying user perceptions about handling of biometric data. Therefore we will survey, accompanying the technical evaluations, cultural aspects in order to get information about such perceptions. The goal is to develop a mapping of legal and social concerns in the different regions. Is there an interplay of the social, ethical, and existential orientation on the one hand and specific codes of perception on the other hand if biometric data are part of an interaction? An approach to evaluate social and ethnical perception can be based on an online survey and subsequent statistical analysis of the poll data. For the legal issues we analyse the prevailing case law of the three countries.

Also, we want to analyse, if there are differences in power of authentication with multimodal biometric data. For example, we will evaluate the hypothesis, that handwritten scripts or spoken text can lead to different security levels, depending on the language and script.

3. Methodology

In this section we present the technical concept and the metadata, which we will acquire (3.1), present the test plan (3.2) and discuss our evaluation strategy (3.3).

3.1. Technical Concept

Our software system for recording and evaluating speech and handwriting data is based on a generic system design introduced in [2], extended by audio capability and additional metadata models. Fig.1 presents our

design architecture, which consists of the following components:

- **Data Recorder** module: implements the A/D conversion from the audio and handwriting sampling devices. For the sampling, we use tablet PC hardware, equipped with active pen-based (WinTab compatible) digitizer hardware and on-board audio device.
- **Evaluation Database**: stores the complete audio and handwriting signals along with synchronized **metadata**
- **Test Controller** may reproduce user inputs in batch mode process. The operational sequence of batch runs is defined by **Test Profiles**, which feed reproduced signals from the Evaluation Database to plug-in **Algorithms** to be evaluated and protocol their results to the test log.

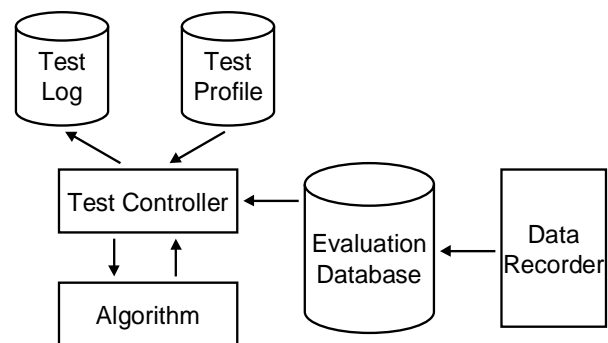


Figure 1 – Model of our evaluation system. The Data recorder collects digitized representations of handwriting signals $x(t)$, $y(t)$ (horizontal and vertical movement signal), $p(t)$ (pen pressure signal), $\theta(t)$ and $\Phi(t)$ (pen incline signal) during the online handwriting process using a tablet digitizer and audio data during a speech session using a microphone. Signals resulting from the sampling processes are stored to the evaluation database. Based on these samples, the Test Controller may execute user verification and other Algorithms, using predefined, stored Test Profiles. Test results are protocolled to the Test Log.

The following metadata categories are requested and stored within the system. For the sake of standardization, we use ISO norms to describe names of countries, languages and scripts.

- **Person related meta data, acquired to the test subjects [1][3]:**
 - Gender (female or male),
 - Age,
 - Handedness (right or left),
 - Ethnicity (white, black, hispanic, asian, ...),
 - Religion,
 - Highest level of education,
 - Place of birth (ISO-3166 [5]),
 - Place of birth of parents (ISO-3166),
 - Place of schooling (ISO-3166)
 - Native language (ISO-639 [6]),

- Known other languages (ISO-639),
- Native script (ISO-15924 [7]),
- Known other scripts (ISO-15924).
- **Process related meta data:**
 - Digitizer device (what kind of handwriting device, microphone, soundcard, other audio hardware, e.g. telephone [4]),
 - Environment (silent audio cabin, noisy laboratory, open air w/o traffic noises),
 - Semantic/type of input (see table 1) and content of input, if not predefined,
 - Used language/script,
 - Block letters or cursive script,
 - Date and time of day.

Input	Style	Sp	Wr
Decimal numbers. (0 – 9)	B	x	x
Latin alphabet	B	x	x
Answer: “What is your good name?”	B/C	x	x
Answer: “Where are you from?”	B/C	x	x
Answer: “How old are you?”	B/C	x	x
Say/write: “Minimum”	B/C	x	x
Say/write: “Maximum”	B/C	x	x
Say/write: “Pay the man first please.”	B/C	x	x
Your signature	C		x
A pseudonym	B/C		x
The PIN number “8710”	B/C	x	x
A free chosen pass phrase	B/C	x	x
A free chosen symbol			x

Table 1 – Example types of inputs for English speech and handwriting modality. *Style* is the writing style: *B* for block letters and *C* for cursive script. *Sp* stands for speech input and *Wr* for handwriting input. Find complete list of input types for all languages (English, German, Italian, Indian dialects) in [8].

3.2 Test Plan

We define a **test module** as a set of recordings (speech or handwritten) of one person at one date in one language. The set of recordings consists of different types of input: a) simple questions to answer, words to say or write and phrases to repeat (see table 1 for some English examples), b) continuous text, as shown in extracts in figure 2. The detailed number of recordings in a test module is given in the test list in [8]; typically, for basic input types such as those shown in table 1, we request ten sample instances and for more extensive texts like in figure 2, we ask for one instance within one module. A **test session** is a set of test modules of one person at one date. In our scenario, a test session of one person consists of at least four test modules; handwritten as well as speech input for the native language(s) and for English language. A **test series** is a sequence of test sessions of one person on five days while a duration not longer than a month.

Rainbow Passage

When the sunlight strikes raindrops in the air, they act as a prism and form a rainbow. The rainbow is a division of white light into many beautiful colors. These take the shape of a long round arch, with its path high above, and its two ends apparently beyond the horizon. There is, according to legend, a boiling pot of gold at one end. People look, but no one ever finds it. [...]

Figure 2 – Excerpt of a test sample text with 330 words overall. The complete sample text can be found in [8].

In each location in Germany, Italy and India, at least ten persons (if possible half of them female) will perform a test series. Each recorded sample of the test modules gets annotated with metadata as described in 3.1.

3.3. Evaluation Concept

A goal of our work is to test different hypotheses, regarding multi cultural aspects of biometric authentication and user interfaces. One hypothesis is that there are differences in speech and handwriting recognition and biometric user authentication results, depending on used language and script, as well as depending on origin of English (as a foreign language for majority of the test subjects) speaking or writing person.

Apart from cultural aspects, we will investigate influence of other person related metadata (see list in 3.1), such as gender or age, on results of authentication and recognition. In [1] Tomai et al state a power of handwritten characters to discriminate persons, belonging to groups of such metadata. For example they correctly recognize a person to be female or male with a probability of 70%. We will try to verify these results and hopefully find other discriminatory features of speech and handwriting. A hypothesis is that it is possible to recognize the origin of an English speaking and/or writing individual on the basis of their manner to speak and/or write.

Beyond this aspect, we will investigate possibilities of fusion of handwriting and speech modalities for estimation of metadata.

4. Conclusions

We have introduced a new approach to include metadata into user authentication systems to evaluate cross cultural impact on biometric authentication processes as well as textual recognition quality.

Creating a database of handwriting and speech test samples from persons with different cultural backgrounds, annotated with valuable metadata, opens the possibility to investigate differences between these dif-

ferent cultures and to fine-tune recognition and authentication algorithms and enhance them, that way.

The novelty of our work is to capture multimodal sample data from persons of different culture groups and to annotate them at the same time with a substantial set of metadata. This opens the possibility for further research activities in the area of inter cultural and multimodal user interfaces and biometric authentication.

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