Human Movement Science 43 (2015) 169–182

Contents lists available at ScienceDirect

Human Movement Science

journal homepage: www.elsevier.com/locate/humov

A feature based comparison of pen and swipe based signature characteristics

Joshua Robertson *, Richard Guest

School of Engineering and Digital Arts, University of Kent, Canterbury CT2 7NT, UK

ARTICLE INFO

Article history:
Available online 18 June 2015

PsycINFO classification:
2330
4010
2221
2260

Keywords:
Biometrics
Signatures
Handwriting
Touch
Tablets
Gesture
Swipe
Security
Finger
Pen

ABSTRACT

Dynamic Signature Verification (DSV) is a biometric modality that identifies anatomical and behavioral characteristics when an individual signs their name. Conventionally signature data has been captured using pen/tablet apparatus. However, the use of other devices such as the touch-screen tablets has expanded in recent years affording the possibility of assessing biometric interaction on this new technology.

To explore the potential of employing DSV techniques when a user signs or swipes with their finger, we report a study to correlate pen and finger generated features. Investigating the stability and correlation between a set of characteristic features recorded in participant's signatures and touch-based swipe gestures, a statistical analysis was conducted to assess consistency between capture scenarios.

The results indicate that there is a range of static and dynamic features such as the rate of jerk, size, duration and the distance the pen traveled that can lead to interoperability between these two systems for input methods for use within a potential biometric context. It can be concluded that this data indicates that a general principle is that the same underlying constructional mechanisms are evident.

* Corresponding author.
E-mail addresses: J.J.Robertson@kent.ac.uk (J. Robertson), R.M.Guest@kent.ac.uk (R. Guest).

http://dx.doi.org/10.1016/j.humov.2015.06.003
0167-9457/

1. Introduction

1.1. Biometric technologies

Biometric technology can be classified as an automated method of verifying or recognizing the identity of a living person based on physiological or behavioral characteristics. The physiological biometrics relies on the physical attributes of an individual such as fingerprints, facial features or even DNA. Research in the area of biometrics technologies highlight advancements to better facilitate these modalities into their associated applications (Beham & Roomi, 2013; Koon, Yang, & Tseng, 2014; Lakshmanan, Selvaperumal, & Mun, 2014). Physiological modalities are commonly implemented into large-scale biometric deployments such as Automated Border Control (ABC) systems (Nuppery, 2014) and access control (Maghiros, Puine, Delaitre, & Lignos, 2005). Behavioral biometrics, on the other hand, rely on the identification of human invariant features found in signatures, voice samples and walking styles (gait). The behavioral-based handwriting analysis of electronic digitally captured signatures is recognized for its acceptability, trustworthiness and low error rates (Shridnar, 2006).

The first automatic signature verification system was developed in 1965 (Mauceri, 1965) and research has continued to focus on various features and applications. Recent technological advancements offering ubiquitous capture possibilities within devices such as Personal Digital Assistants and tablet computers have increased interest in the dynamic capture.

The general movement involved when one signs his or her signature can be observed to mirror the movement of a gesture swipe, where users perform a stroke in a handwriting fashion. Technology that utilizes finger-based motion for interaction with trending devices is yet to be fully explored. Research and development in the field are needed to establish its potential and protect its long-term success as a form of interaction. One possible development that is yet to be made is the possibility of utilizing this technology within a biometric context.

1.2. Signature verification

Decades of research and development support biometric signature verification as a useful tool for verification scenarios. The modality is used to verify a user's handwritten movement to prove their identity. Development has led to a point where commercial systems within application areas such as documents certification, financial and legal domains are prevalent and efficient (Impedovo & Pirlo, 2008).

Verification can be performed at two levels, static (offline) and dynamic (online). At 'static' level – a completed signature image is compared (algorithmically or otherwise) to another signature or 'dynamically' where the constructional and temporal elements of the signature construction can be assessed at feature level. Samples in both scenarios are traditionally captured on a device such as a tablet computer or pressure sensitive pad using a special inkless pen. The device acquires the image in real time and processes it through software that in turn runs various functions to run segmentation and feature extraction to produce both static and dynamic measurements.

Dynamic samples can often be presented in a replay of real-time capture and segmentation can produce features such as pen position, pressure and tilt captured alongside a time offset during the process (Jain, Griess, & Connell, 2002). These devices may or may not provide visual 'ink' feedback to the signer during the process, however most contemporary devices use a write-on screen whereby virtual ink is displayed during the writing process performed using a non-inking pen.

Data captured from a DSV tool is a reliable indicator of a person's identity, when matching samples are obtained and compared. These characteristics are often incredibly difficult to replicate and thus are highly resistant to imposters. Research has demonstrated how off-line signatures can be forged by humans and machines with ease (Lovell & Madsu, 2008). This makes DSV a useful tool for identifying users once subjects are enroled into a database.

No two signatures are ever the same, however. Characteristics obtained through DSV are considered to have high intra-class variability, meaning data may vary from trial to trial due to conditions that are hard to control, such as nerves and hand jerk. This makes recognition sometimes complicated and can lead to higher error rates in the system (Kovari & Charaf, 2010). It is important to note that a