Dynamic signature verification using portable devices

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The proliferation of touchscreen-enabled devices represents an emerging and promising environment for automatic biometric validation systems.

Used for validation in legal and commercial transactions for centuries, signature verification is among the most widely accepted biometric procedures. Automatic signature verification using handheld devices is a new, intuitive user-validation approach, replacing passwords that may be forgotten or stolen. It can help reduce costs in corporate environments through workflow streamlining (e.g., for approval processes) and minimizing printing needs. Unfortunately, it is affected by considerable behavioral variability because users sign differently each time. Moreover, unlike other biometric features, signatures can be forged relatively easily.

While offline signature-verification systems often use scanned signatures, online or dynamic systems rely on digitized signals captured from pen movement on a tablet or touchscreen. This provides more information than static images, such as pen speed or pressure. Two main approaches are used in dynamic signature-verification systems for similarity computation or matching (see Figure 1). Local systems use the time series derived from the raw signals and employ techniques such as hidden Markov models or dynamic time warping. Global systems, on the other hand, extract a holistic feature vector from each signature based on factors such as signature duration or average speed, and they perform matching with distance-based classifiers or statistical models.

Research in dynamic signature verification traditionally uses signatures captured on pen tablets in controlled environments, leading to notably low verification rates. However, the quality of the captured data is much lower for touchscreen-enabled portable devices, for which information about pressure or pen orientation is not available. We have identified many challenges associated with the use of touchscreen-enabled portable devices that are not present for pen tablets, such as sampling errors and apparent increased variability.

Signature verification on handheld devices has a wide range of applications, mostly as substitute of passwords or handwritten signatures on printed documents. A key advantage of mobile validation is that touchscreen-enabled devices do not need any additional acquisition hardware, unlike for sensors and cameras for fingerprint and face verification, respectively. Possible applications include remote or wireless payments, legal transactions, e-government, remote user login, and the paperless office, where documents are signed electronically. Digitized dynamic signature information can be embedded in electronic documents, thus enabling automatic validation or protection against repudiation (when an individual denies having signed). It is not necessary to perform verification instantly because it is often only required in case of a reclamation. It can be done either locally by the handheld device or remotely by a server (see Figure 2). While the former can help to develop simpler systems, remote verification allows use of more complex algorithms since more computational resources are available.

We confirmed that signature verification using handheld devices is more challenging than for traditional pen tablets. The latter capture pen movements during ‘pen ups,’ which occur on average during approximately 20% of signature signals. This information is lost for touchscreens. Examples of signatures captured by a touchscreen are shown in Figure 3. Poor ergonomics, an unfamiliar surface and stylus, and user movement may also

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increase variability among signatures from the same user. Our experiments with a database of signatures captured under realistic conditions with pen tablets and personal digital assistants (PDAs) for the same set of users show an increase of approximately 50% in the error rate for PDAs.\(^3\) Signature features related to speed or acceleration seem much more distinctive for pen tablets than for PDAs, thus leading to increased variability in signature dynamics on handheld devices.

Publicly available resources for research into signature verification using handheld devices are limited. In 2007, we acquired the BioSecure multimodal database, which includes signature samples captured with PDAs and pen tablets from more than 600 individuals.\(^4\) At that time, we organized the BioSecure multimodal evaluation campaign to test state-of-the-art biometric systems with data from the new database. Our verification results for PDA-captured signatures showed that there is still room for improvement in this field.

In conclusion, signature verification using handheld devices requires further developments but has many promising applications. The error rates of biometric systems based on signature capture are still notably higher than those for other methods, such as iris scans or fingerprints. Variability-compensation techniques may be helpful to deal with the results for handheld devices. Interoperability is also a problem that has not yet been studied scientifically. Finally, touchscreen-device interfaces are becoming focused on fingertip interaction rather than stylus use. Therefore, solutions for person authentication related to signature verification, such as graphical passwords (traced with the fingerprint on the screen), may become relevant and deserve further attention. In 2009, the BioSecure signature evaluation campaign will compare the performance of verification systems between PDAs and pen tablets. We will also evaluate device interoperability.

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References