Touchscreen Biometrics: Desktop Signature goes Mobile

Prof. Julian Fierrez

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Signature Biometrics: From Lab to Market

Research at UAM 2002...

On-line Writer/Signature Verification

Feature-based (Global Features)
- Distance-based classifiers
  - Mahalanobis
  - Euclidean [Nelson et al., 1994]
- Statistical/other classifiers
  - Gaussian Mixture Models (GMM)
  - Parzen Windows

Function-based (Local Features)
- Time-Sequence matching techniques
  - Hidden Markov Models (HMM) [Dolfing et al., 1998]
  - Gaussian Mixture Models (GMM) [Richiardi et al., 2005]
  - Dynamic Time Warping (DTW) [Sato and Kogure, 1982]

Feature Extraction: Global Features Example

Similarity Computation

- **Dynamic Time Warping (DTW)**
- **Hidden Markov Models (HMM)**

Statistical modeling of signature regions

Point-to-point correspondence


Resources: Multimodal Databases w Signature

- **MCYT Database** (Spanish Project 2000-2003)
  - Fingerprint (with human-labeled quality) and on-line Signature of 330 donors

- **BiosecurID Database** (Spanish Project 2003-2006)
  - 8 Modalities: speech, iris, face, Signature and handwriting (on-line and off-line), fingerprints, hand and keystroking of 400 donors in 4 acquisition sessions

- **Biosecure Database** (EU Project 2004-2007)
  - 3 Datasets: Web scenario, Office scenario, Mobile scenario
  - 667 donors

See: [https://atvs.ii.uam.es/atvs/databases.jsp](https://atvs.ii.uam.es/atvs/databases.jsp)

Benchmarks: SVC 2004

SVC-04 skilled forgeries

SVC-04 random (zero-effort, casual) impostors


BioSec Signature Evaluation Campaign, BSEC 2009

- DTW, HMM and Global Systems
- Score normalization
- Fusion of systems

Signature Biometrics: From Lab to Market

UAM → CECABANK

Research at UAM
2002...

1st Tech. Transfer
2014-2015

• Development and Transfer of signature biometric technology:
  – Cecabank is a Spanish wholesale bank that provides support services to banking business processes (~45% of the Spanish Banking Sector)

Get rid of paper!

9,000 tons of paper = 200,000 trees

➢ Total savings per year:
   Paper elimination
   1,5M euros
   Operative efficiency
   2M euros
   45K hours

Cecabank’s Associates generate 1 billion documents/year
• Development and Transfer of signature biometric technology:
  – Office-like scenarios (Wacom devices)
  – Small number of signatures per user
  – Signature Verification System
    • Main core: Dynamic Time Warping (DTW)

• R&D: device interoperability scenarios
  – e-BioSign database (Wacom and Samsung general purpose devices)
    – Publically available to the research community
      • In use +25 research groups (USA, China, India, Italy, etc.)
      Available at: https://atvs.ii.uam.es/atvs/eBioSign-DS1.html


Julian Fierrez – Biometrics Congress, London, UK, Oct. 17, 2018
Signature Biometrics: From Lab to Market

UAM → CECABANK

Research at UAM
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1st Tech. Transfer
2014-2015

R&D
2015-2016

2nd Tech. Transfer
2016-2017

• R&D: template and system configuration update strategies
  – ATVS Signature Long-Term Extended database (Publically available*)
  – Large number of enrolment signatures per user (46 samples/user)
  – Signature Verification Systems
    • Hidden Markov Models (HMM), Gaussian Mixture Models (GMMs)
    • Dynamic Time Warping (DTW)


Signature Biometrics: From Lab to Market

UAM → CECABANK

1st Tech. Transfer
2014-2015

R&D
2015-2016

2nd Tech. Transfer
2016-2017

• 2nd Technology Transfer: signature biometrics technology
  – ATVS Signature Long-Term Extended database

<table>
<thead>
<tr>
<th>EER (%)</th>
<th>4 signatures</th>
<th>16 signatures</th>
<th>31 signatures</th>
<th>41 signatures</th>
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</thead>
<tbody>
<tr>
<td>Random Forgery</td>
<td>2.8</td>
<td>0.7</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Skilled Forgery</td>
<td>11.7</td>
<td>6.9</td>
<td>4.1</td>
<td>0.7</td>
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</table>
• **R&D:** improving traditional signature verification approaches
  
  – Recurrent Neural Networks (RNNs) deep learning techniques
    
    • LSTM, GRU, Siamese architectures, Bidirectional approaches, etc
  
  

  
  • Deployment by Cescabank: marketed as *BIOTRACE100* technology

  **BIOTRACE100** technology:
  
  - > 18K branches
  - > 46K sensors
  - > 500K transactions/year
**Desktop Signature > Mobile: Touchscreen Biometrics Motivation**

- Users spend more than 2x time on mobile scenarios compared to desktop scenarios

*Source: “Mobile Global Report 2018”, May 2018*

- “In March 2018, 48% of digital consumers were accessing banking services through smartphones or tablets almost exclusively”

*Source: “Online Banking in Europe Report”, June 2018*
**Desktop Signature > Mobile: Touchscreen Biometrics**

**Motivation**

- User authentication difficult to accomplish using **only** traditional approaches

![Personal Identification Number (PIN)](image1) ![One-Time Password (OTP)](image2)

- **Personal Identification Number (PIN)**
- **One-Time Password (OTP)**

> Related to personal details, typical words or sequential numbers

- Security threats [Bonneau et al., 2012]
Desktop Signature > Mobile: Touchscreen Biometrics

Motivation

• User authentication difficult to accomplish using only traditional approaches

Personal Identification Number (PIN)  One-Time Password (OTP)

• Security threats [Bonneau et al., 2012]

Shoulder surfing (visual access to passwords)

Smudge attack (finger grease traces on screen)
**Desktop Signature > Mobile: Touchscreen Biometrics**

- Password-Based Mobile Authentication Incorporating Handwritten Touch Biometrics

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**Example Application**

- **Two-factor authentication** approach:
  1. Check the password
  2. Check the biometric information

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**Password**

```
5 7 6 1 8
```

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• **R&D:** touchscreen biometrics


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**Signature Biometrics: From Lab to Market**

**UAM → CECABANK**

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**Deployment by CECABANK**

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**e-BioDigit Database**

- **Acquisition:** one handwritten digit at a time. Only X and Y time information is considered

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*Available at: [https://atvs.ii.uam.es/atvs/e-BioDigit.html](https://atvs.ii.uam.es/atvs/e-BioDigit.html)
**e-BioDigit Database**

- **# Users:** 93
- **Session 1:** 3 weeks
- **Session 2:**

  - 10 numerical digits (0,1,...,9)
  - 4 samples/numerical digit

*Available at: [https://atvs.li.uam.es/atvs/e-BioDigit.html](https://atvs.li.uam.es/atvs/e-BioDigit.html)*


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**System Architecture**

- **Two-factor authentication scheme:** OTP system

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Comparison with Related Works

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<td>75</td>
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<td>Martinez-Diaz et al. (2016)</td>
<td>Graphical Passwords</td>
<td>3.4% 22.1%</td>
<td>100</td>
</tr>
<tr>
<td>Sae and Memon (2014)</td>
<td>Handwritten Signatures</td>
<td>5.04%</td>
<td>180</td>
</tr>
<tr>
<td>Tolosana et al. (2017)</td>
<td>Handwritten Signatures</td>
<td>0.5% 17.9%</td>
<td>65</td>
</tr>
<tr>
<td>Kutzner et al. (2015)</td>
<td>Handwritten Characters</td>
<td>FAR = 10.42% FRR = unknown</td>
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- Proposed approach **outperforms** other touch biometric approaches for **skilled forgeries**
  - User-friendly interface
  - Small number of enrolment samples

The Future of Touchscreen Biometrics


Julián Fierrez – Biometrics Congress, London, UK, Oct. 17, 2018

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Based on PhD material from Dr. Ruben Tolosana