IAPR Young Biometrics Investigator Award

IJCB 2017 Keynote Talk

Julian FIERREZ

[https://atvs.ii.uam.es/fierrez]

School of Engineering

UNIVERSIDAD AUTONOMA DE MADRID, SPAIN

Escuela Politécnica Superior

Denver CO, USA, Oct. 3, 2017

UAM UNIVERSIDAD AUTONOMA DE MADRID

Funding Acknowledgements

Public

SIXTH FRAMEWORK PROGRAMME

SEVENTH FRAMEWORK PROGRAMME

TABULA RASA

BIOSEC

BIOSECURE

BEAT

cost 2101

BIOMETRICS FOR IDENTITY DOCUMENTS AND SMART CARDS

COST Action IC1106

MINISTERIO DE EDUCACIÓN Y CIENCIA

MINISTERIO DE DEFENSA

MINISTERIO DEL INTERIOR

GUARDIA CIVIL

La Suma de Todos

Comunidad de Madrid

Private

Telefónica

BBVA

cecabank

SERVICIOS FINANCIEROS

accenture

Outline

1. The biometrics network around me
2. The dynamics around me (advice for young researchers :-)
3. My voice: Adaptation in Multimodal Biometrics
4. Helping others to find their voices:
   - F. Alonso and J. Galbally: Biometric Quality (Fingerprint/Iris/Signature)
   - P. Tome and E. Gonzalez: Unconstrained / Beyond Visible (Face/Soft/Body)
   - M. Martinez (and R. Tolosana): Touch Interaction (Signature/Gestures)
5. A look into the future

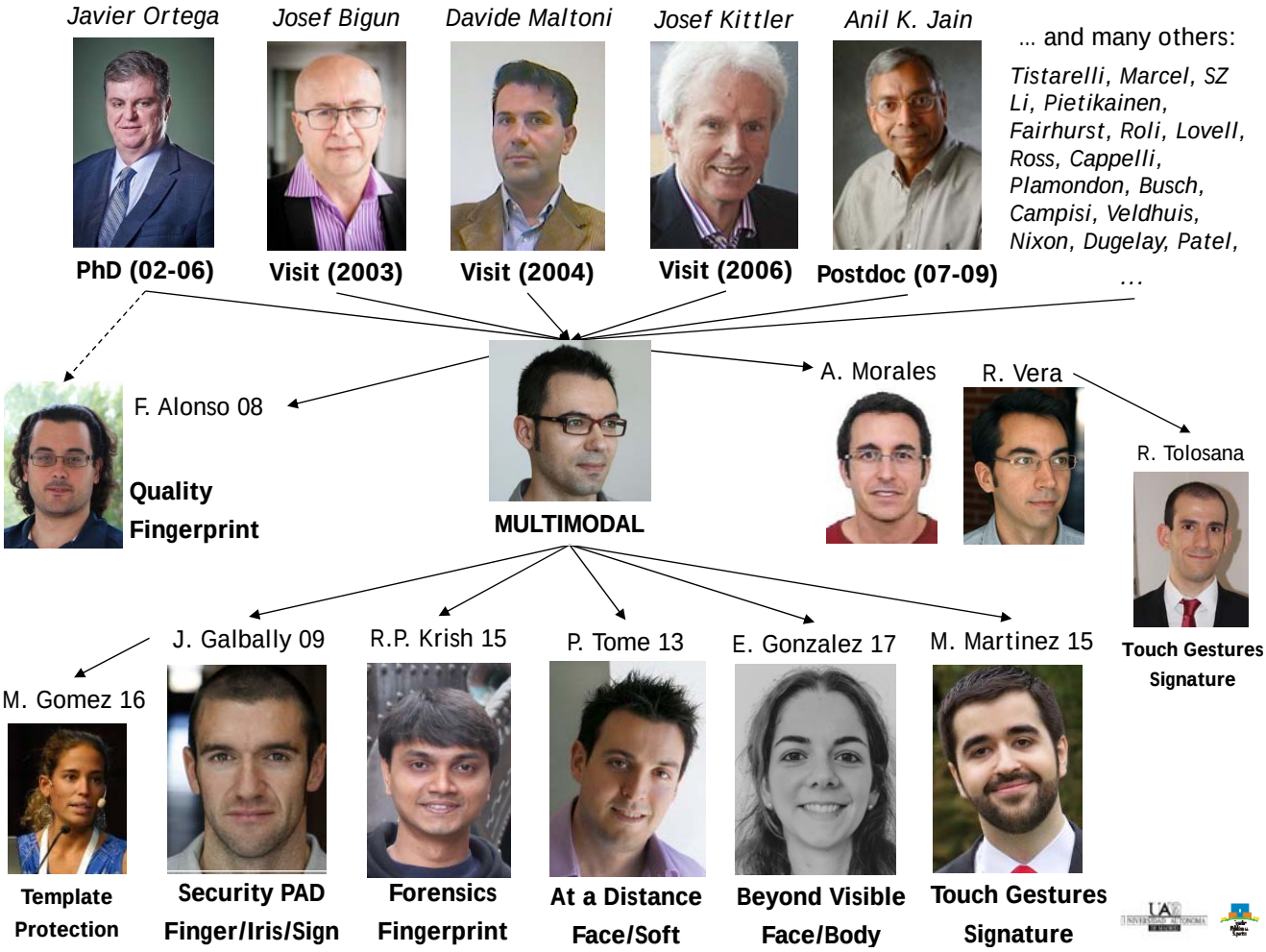
The Biometrics Network around Me

Julian FIERREZ

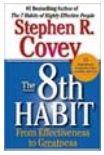
School of Engineering

UNIVERSIDAD AUTONOMA DE MADRID, SPAIN

IJCB, October 3, 2017



The network dynamics around me (recommendations for soon-to-be researchers)



Self-Mastery:

1 – Be Proactive

2 - Begin with the End in Mind

3 – Put First Things First

Interdependence:

4 – Think Win-Win

5 - Seek First to Understand, Then to be Understood

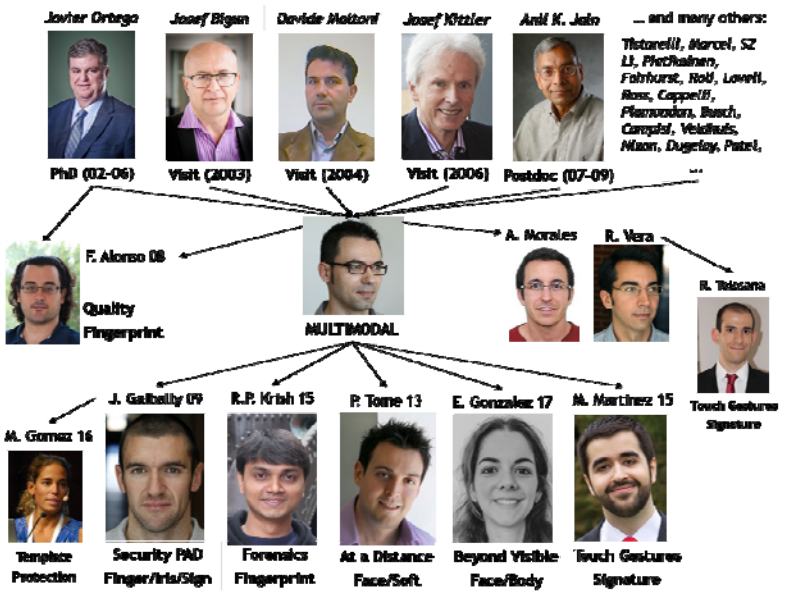
6 - Synergize

Continuous Improvement:

7 - Sharpen the Saw

From Effectiveness to Greatness:

8 - Find your voice and inspire others to find theirs.



My Voice:
Adaptation in Multimodal Biometrics

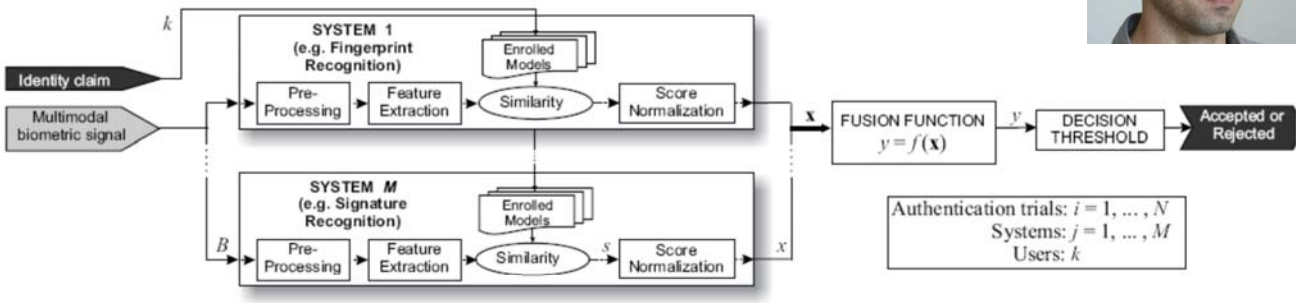
Julian FIERREZ

School of Engineering

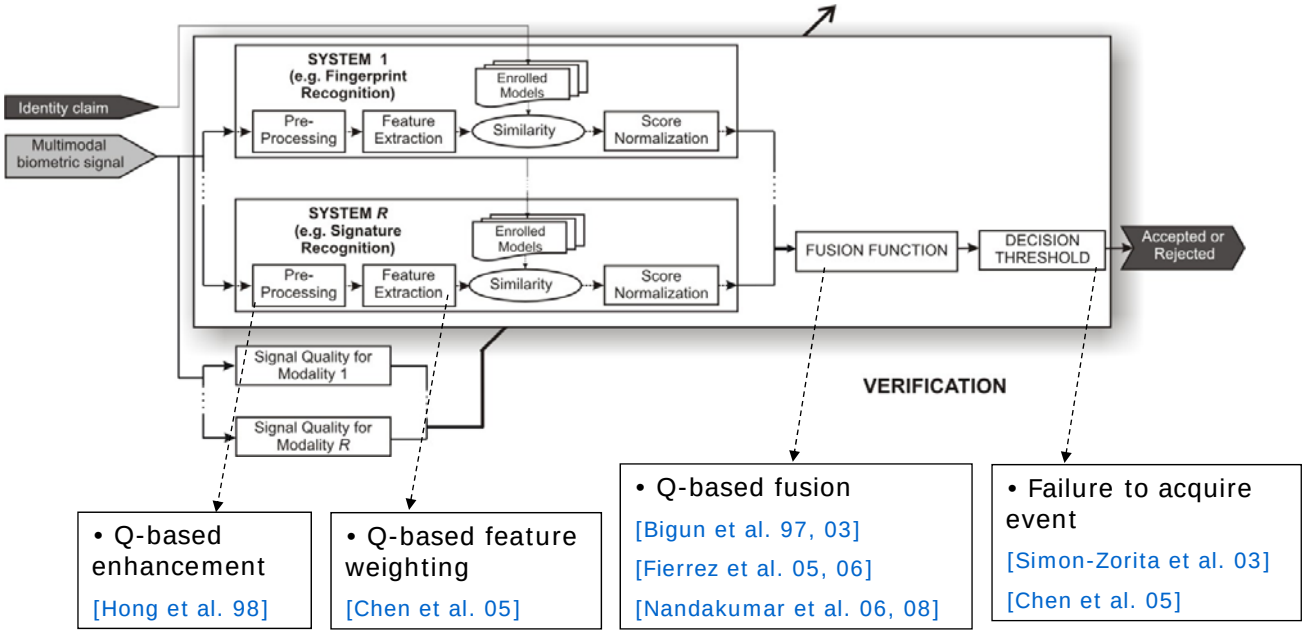
UNIVERSIDAD AUTONOMA DE MADRID, SPAIN

IJCB, October 3, 2017

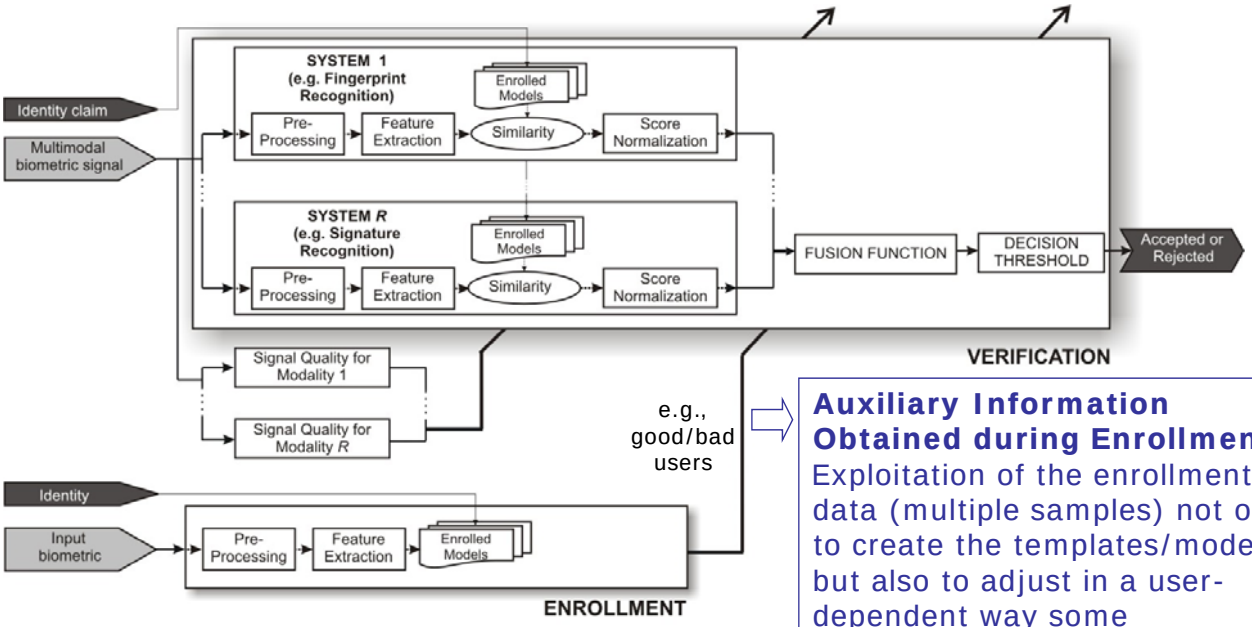
MY VOICE (PhD 2002-2006):
Adaptation in Multimodal Biometrics



Work	Modalities	M	Arch.	Level	Gain
Brunelli and Falavigna [1995]	Speaker, face	5	P	C	ID:17→2 (TE)
Duc *et al.* [1997]	Speaker, face	2	P	C	VER:6.7→0.5 (TE)
Kittler *et al.* [1998]	Speaker, face	3	P	C	VER:1.4→0.7 (EER)
Hong and Jain [1998]	Face, fingerprint	2	S	R/C	ID:6.9→4.5 (FR@0.1%FA)
Jain *et al.* [1999b]	Speaker, face, finger	3	P	C	VER:15→3 (FR@0.1%FA)
Ben-Yacoub *et al.* [1999]	Speaker, face	3	P	C	VER:4→0.5 (EER)
Choudhury *et al.* [1999]	Speaker, face	3	P	C	ID:16.5→6.5 (TE)
Chatzis *et al.* [1999]	Speaker, face	4	P	C	ID:6.7→1.07 (TE)
Verlinde *et al.* [2000]	Speaker, face	3	P	C	VER:3.7→0.1 (TE)
Ross and Jain [2003]	Face, finger, hand	3	P	C	VER:16→2 (FR@0.1%FA)
Kumar and Zhang [2003]	Face, palmprint	2	P	C	VER:3.6→0.8 (EER)
Wang *et al.* [2004]	Speaker, finger	2	P	C	VER:2→0.7 (EER)
Poh and Bengio [2006]	Speaker, face	8	P	C	VER:2.2→0.7 (TE)



J. Fierrez-Aguilar, J. Ortega-Garcia, J. Gonzalez-Rodriguez and J. Bigun, "Discriminative multimodal biometric authentication based on quality measures", *Pattern Recognition*, May 2005.



Auxiliary Information Obtained during Enrollment: Exploitation of the enrollment data (multiple samples) not only to create the templates/models but also to adjust in a user-dependent way some parameters of the system during verification


ANIMAL INSTINCTS

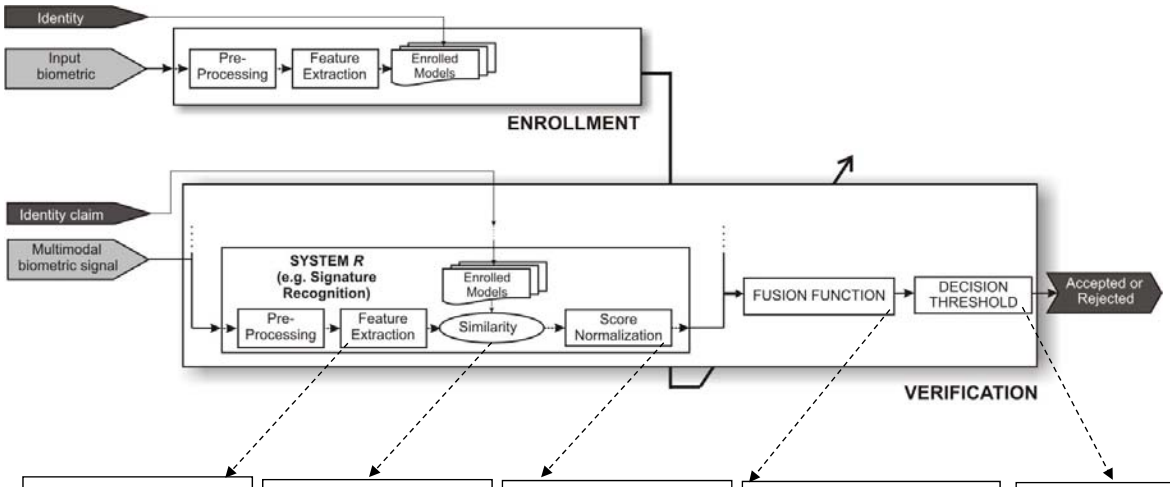
EXTENDING DODDINGTON'S CONCEPT TO FACIAL RECOGNITION SYSTEMS

Wise as an owl, blind as a bat, clever as a fox, boarish, catlike, having horse
often described in relation to animals. It's not surprising that researchers mig
when attempting to categorize specific groups. In fact, in 1998 George R. Dod
that time the senior principal scientist with SRI International and visiting scien
Institute of Standards and Technology, co-authored a paper on performance
recognition systems in which he suggested that all people could be classified
groups in regards to their speech patterns and how well they could be identifie

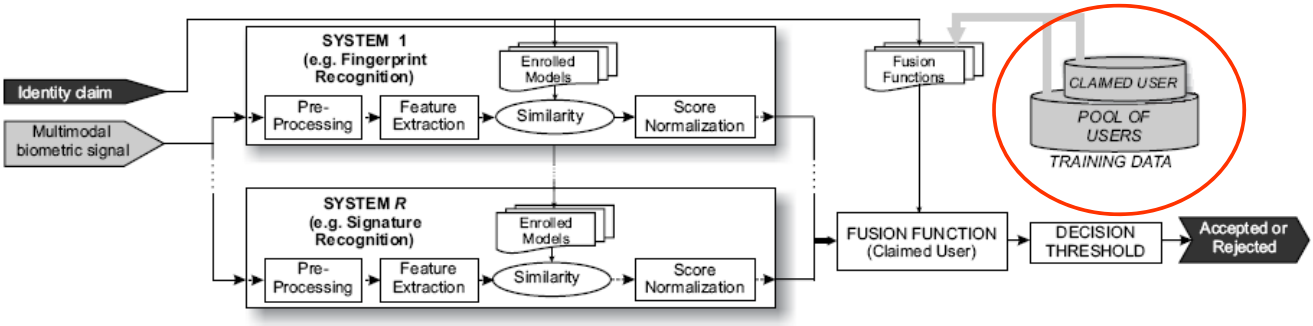
Doddington's mer
sheep, goats, lam
Sheep represente
population. Readi
from another, the
recognition systen
model. Goats were

[Hicklin et al., "The myth of goats: how many people have fingerprints that are hard to match", NISTIR 7271, 2005].

Exploiting the zoo (User-dependent processing)



- UD features [Fairhurst et al., IPRAI 94]
- UD modeling [Martinez et al., ICFHR 08]
- UD score normalization [Fierrez et al., TSMC 05] [Poh et al., MMUA 06, TASLP 08]
- UD fusion [Jain et al., ICIP 02] [Toh et al., TSP 04] [Snelick et al., PAMI 05] [Fierrez et al., PR 05]
- UD decision (e.g., UD tresholds [Jain et al., PR 02], failure to enroll events and exception handling)



GLOBAL: Set of training scores from a pool of users (genuine and impostor)
LOCAL: Set of training scores from the user at hand (genuine and impostor)

→ **Bayesian** and **SVM** user-dependent fusion algorithms

Multilevel score:

$$\mathbf{x} = [x_1, \ldots, x_R]'$$

Fused score:

$$s_T = f(\mathbf{x}_T) = \log p(\mathbf{x}_T|\omega_1) - \log p(\mathbf{x}_T|\omega_0)$$

Fusion training set:

$$X = (\mathbf{x}_i, y_i)_{i=1}^N$$
$$y_i \in \{\omega_0, \omega_1\} = \{\text{Impostor, Client}\}$$

$$p(\mathbf{x}|\omega_0) = N(\mathbf{x}|\mu_0, \sigma_0^2)$$
$$p(\mathbf{x}|\omega_1) = N(\mathbf{x}|\mu_1, \sigma_1^2)$$

Global training set:

$$X_G \xrightarrow{\text{ML}} \{\mu_{G,0}, \sigma^2_{G,0}\}\ \{\mu_{G,1}, \sigma^2_{G,1}\}$$

Local training set:

$$X_{j,l} \xrightarrow{\text{ML}} \{\mu_{j,L,0}, \sigma^2_{j,L,0}\}\ \{\mu_{j,L,1}, \sigma^2_{j,L,1}\}$$

MAP adaptation

$$\mu_{j,A,k} = \alpha_k \mu_{j,L,k} + (1-\alpha_k)\mu_{G,k}$$
$$\sigma^2_{j,A,k} = \alpha_k(\sigma^2_{j,L,k} + \mu^2_{j,L,k}) + (1-\alpha_k)(\sigma^2_{G,k} + \mu^2_{G,k}) - \mu^2_{j,A,k}$$

J. Fierrez-Aguilar, D. Garcia-Romero, J. Ortega-Garcia and J. Gonzalez-Rodriguez, "Bayesian adaptation for user-dependent multimodal biometric authentication", *Pattern Recognition*, August 2005.

Resources: Multimodal Biometric Databases

- **MCYT Database** (Spanish Project 2000-2003)
  - Fingerprint (with human-labeled quality) and on-line signature of 330 donors
- **BioSec Database** (EU Project 2003-2005)
  - Face, fingerprint, speech, iris of 200 donors in 2 acquisition sessions
  - Multiple acquisition sensors in some modalities
- **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

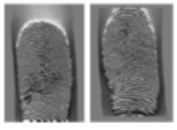
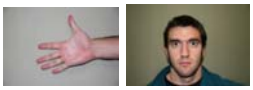
J. Ortega-Garcia, J. Fierrez-Aguilar, et al., "MCYT baseline corpus: A bimodal biometric database", *IEE Proceedings Vision, Image and Signal Processing*, December 2003.

J. Fierrez, J. Ortega-Garcia, D. Torre-Toledano and J. Gonzalez-Rodriguez, "BioSec baseline corpus: A multimodal biometric database", *Pattern Recognition*, Vol. 40, n. 4, pp. 1389-1392, April 2007.

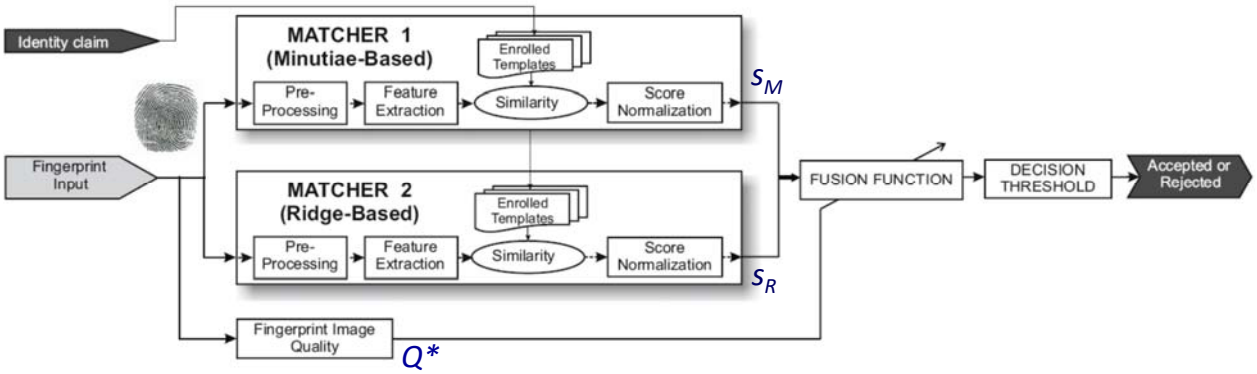
J. Fierrez, J. Galbally, et al., "BiosecurID: A Multimodal Biometric Database", *Pattern Analysis and Applications*, Vol. 13, n. 2, pp. 235-246, May 2010.

J. Ortega, J. Fierrez, et al., "The BioSecure Multimodal Database", *IEEE Trans. PAMI*, June 2010.

BIOSECURE DS2: Voice, face, signature, fingerprint, iris, hand

PHILIPS SPC 900NC + PLANTRONICS Voyager 510		
LG IrisAccess EOU3000		
BIOMETRIKA FX2000		
YUBEE (Atmel FingerChip)		
WACOM Intuos A6 + Inking Pen		
CANON EOS 30D + Ring Flash		

Example: Q-based multi-algorithm fingerprint

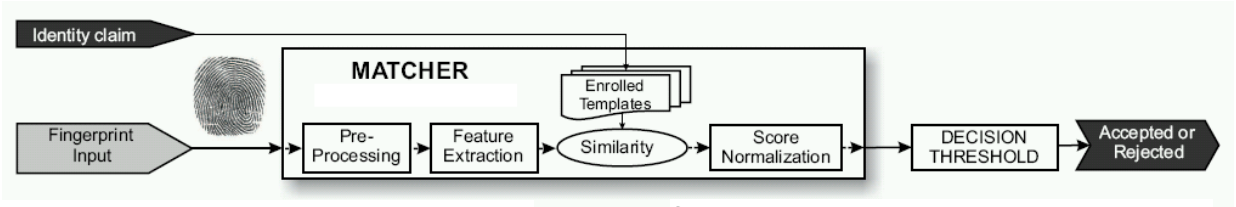


- Matching scores s_M and s_R are already normalized to the range [0,1].
- Performance of one matcher (minutiae) drops significantly as compared to the other one under image quality degradation.

$$\rightarrow s_Q = \frac{Q}{2} s_M + (1 - \frac{Q}{2}) s_R$$

J. Fierrez-Aguilar, Y. Chen, J. Ortega-Garcia and A. K. Jain, "Incorporating image quality in multi-algorithm fingerprint verification", in *Proc. of ICB*, Springer LNCS-3832, 2006.

*Y. Chen, S. Dass, and A. Jain, "Fingerprint Quality Indices for Predicting Authentication Performance", *Proc. AVBPA* 2005.



PREPROCESSING

- Normalization
- Orientation field
- ROI
- Ridge extraction & profiling

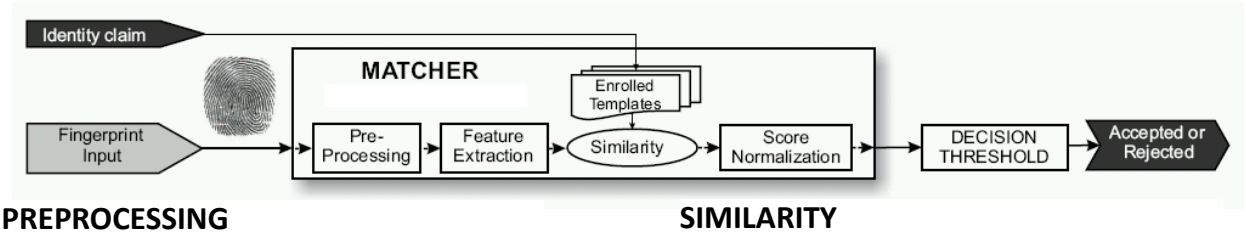
SIMILARITY

- Minutiae alignment
- Pattern matching (edit distance)

FEATURE EXTRACTION

- Thinning
- Imperfection removal
- Minutiae extraction

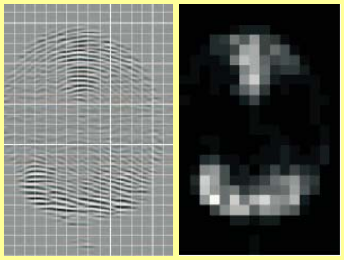
D. Simon-Zorita, J. Ortega-Garcia, J. Fierrez-Aguilar, J. Gonzalez-Rodriguez, "Image quality and position variability assessment in minutiae-based fingerprint verification", *IEE Proc. VISP*, vol. 150, no. 6, pp. 402-408, 2003.



PREPROCESSING

<NONE>

SIMILARITY

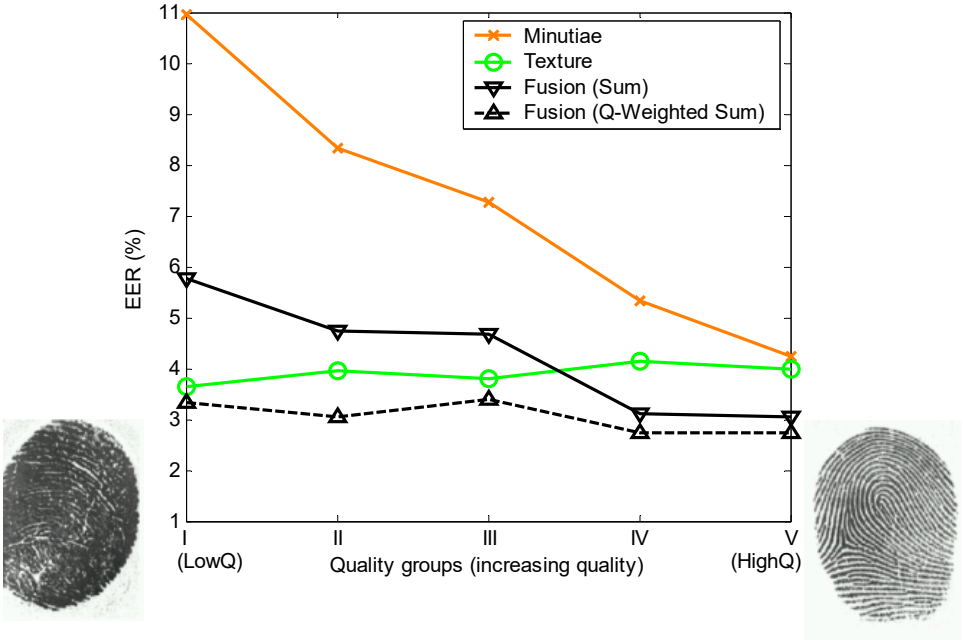


- Correlation-based alignment
- Matching based on Euclidean Distance

FEATURE EXTRACTION

- Energy responses of Gabor filters in different directions
- FingerCode

J. Fierrez-Aguilar, L. M. Muñoz-Serrano, F. Alonso-Fernandez and J. Ortega-Garcia, "On the effects of image quality degradation on minutiae- and ridge-based automatic fingerprint recognition", in *Proc. IEEE ICCST*, October 2005.



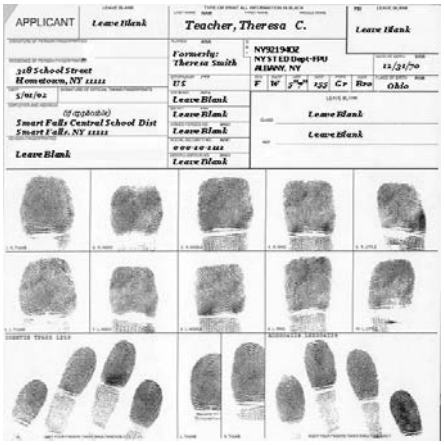
Observations:

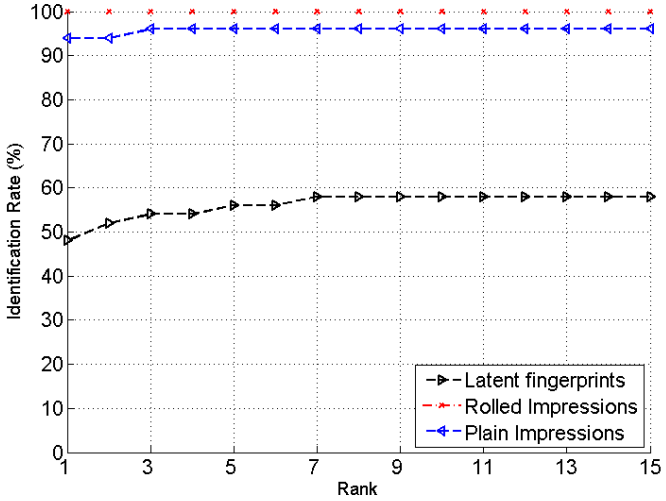
- The performance of the minutia-based matcher drops significantly under degraded image quality.
- The performance of the ridge-based matcher is robust to the global image quality measure considered.
- *Quality-based fusion* outperforms the best system in all cases.

Practical AFIS Evaluation vs Quality

GUARDIA CIVIL

- 50 queries (real cases)
- Background DB:
  2.5 million ten-print cards





M. Puertas, D. Ramos, J. Fierrez, J. Ortega-Garcia and N. Exposito, "Towards a Better Understanding of the Performance of Latent Fingerprint Recognition in Realistic Forensic Conditions", in *Proc. ICPR*, August 2010.

Helping Others to Find Their Voices

Julian FIERREZ

School of Engineering

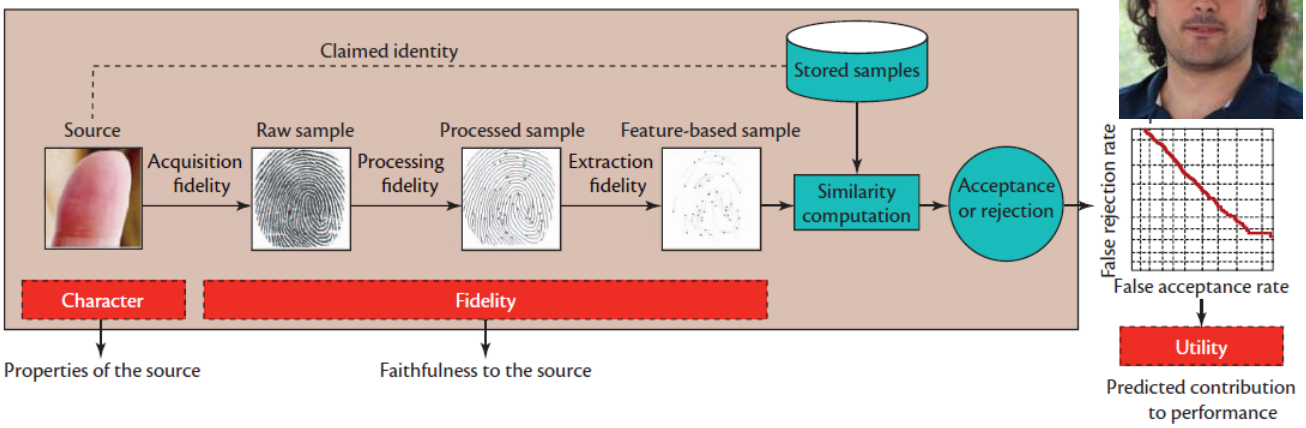
UNIVERSIDAD AUTONOMA DE MADRID, SPAIN

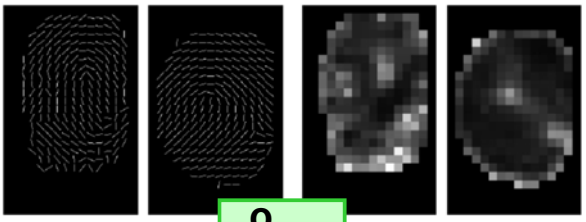
Escuela Politécnica Superior

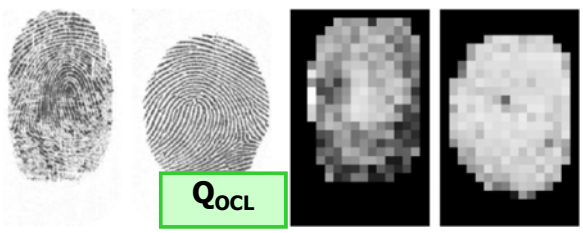
IJCB, October 3, 2017

UAM UNIVERSIDAD AUTONOMA DE MADRID

HELPING FERNANDO ALONSO (PhD 2008)
Biometric Quality – Fingerprint Q Measures







F. Alonso-Fernandez, J. Fierrez and J. Ortega-Garcia, "Quality Measures in Biometric Systems", *IEEE Security & Privacy*, Dec. 2012.

H. Fronthaler, K. Kollreider, J. Bigun, J. Fierrez, F. Alonso-Fernandez, et al., "Fingerprint Image Quality Estimation and its Application to Multi-Algorithm Verification", *IEEE Trans. on Information Forensics and Security*, June 2008.

F. Alonso-Fernandez, J. Fierrez, et al., "A comparative study of fingerprint image-quality estimation methods", *IEEE Trans. on Information Forensics and Security*, Vol. 2, n. 4, pp. 734-743, December 2007.

HELPING JAVIER GALBALLY (PhD 2009):
Assessing Finger Presentation Attacks

(a)

(b)

(c)

TABULA RASA

(e)

(f)

(g)

A. Hadid, N. Evans, S. Marcel and J. Fierrez, "Biometrics systems under spoofing attack: an evaluation methodology and lessons learned", *IEEE Signal Processing Magazine, Special Issue on Biometric Security and Privacy*, September 2015.

J. Galbally, J. Fierrez, F. Alonso-Fernandez, and M. Martinez-Diaz, "Evaluation of Direct Attacks to Fingerprint Verification Systems," *Telecommunication Systems*, 2010.

J. Galbally, R. Cappelli, A. Lumini, G. G. de Rivera, D. Maltoni, J. Fierrez, J. Ortega-Garcia, and D. Maio, "An evaluation of direct and indirect attacks using fake fingers generated from ISO templates," *Pattern Recognition Letters*, 2010.

Assessing Finger Presentation Attacks (2)

Real

Rec. Images

Fake

J. Galbally, J. Fierrez, F. Alonso-Fernandez, and M. Martinez-Diaz, "Evaluation of Direct Attacks to Fingerprint Verification Systems," *Telecommunication Systems*, 2010.

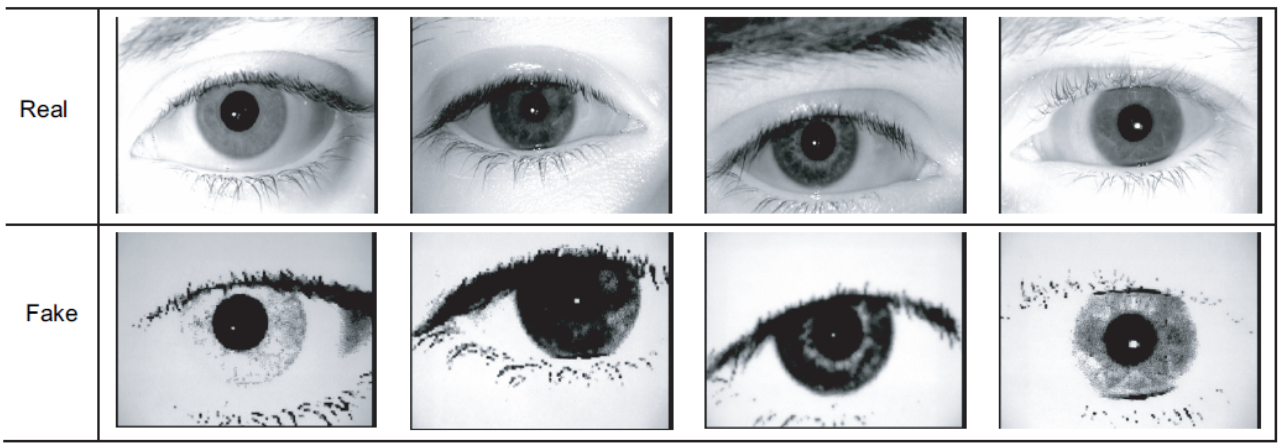
J. Galbally, R. Cappelli, A. Lumini, G. G. de Rivera, D. Maltoni, J. Fierrez, J. Ortega-Garcia, and D. Maio, "An evaluation of direct and indirect attacks using fake fingers generated from ISO templates," *Pattern Recognition Letters*, 2010.

Assessing Fake Iris Attacks

TABULA RASA

Real

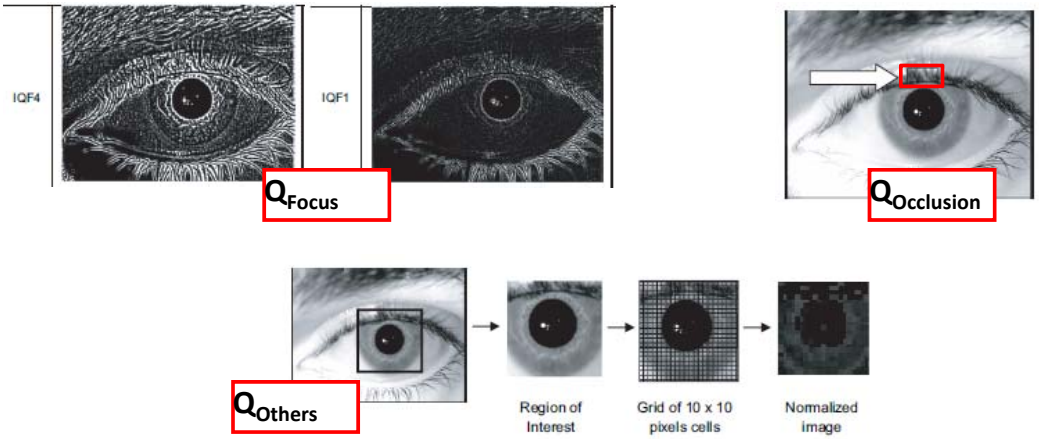
Fake



J. Galbally, J. Ortiz-Lopez, J. Fierrez and J. Ortega-Garcia, "Iris liveness detection based on quality related features", in *Proc. Intl. Conf. on Biometrics, ICB*, New Delhi, India, March 2012.

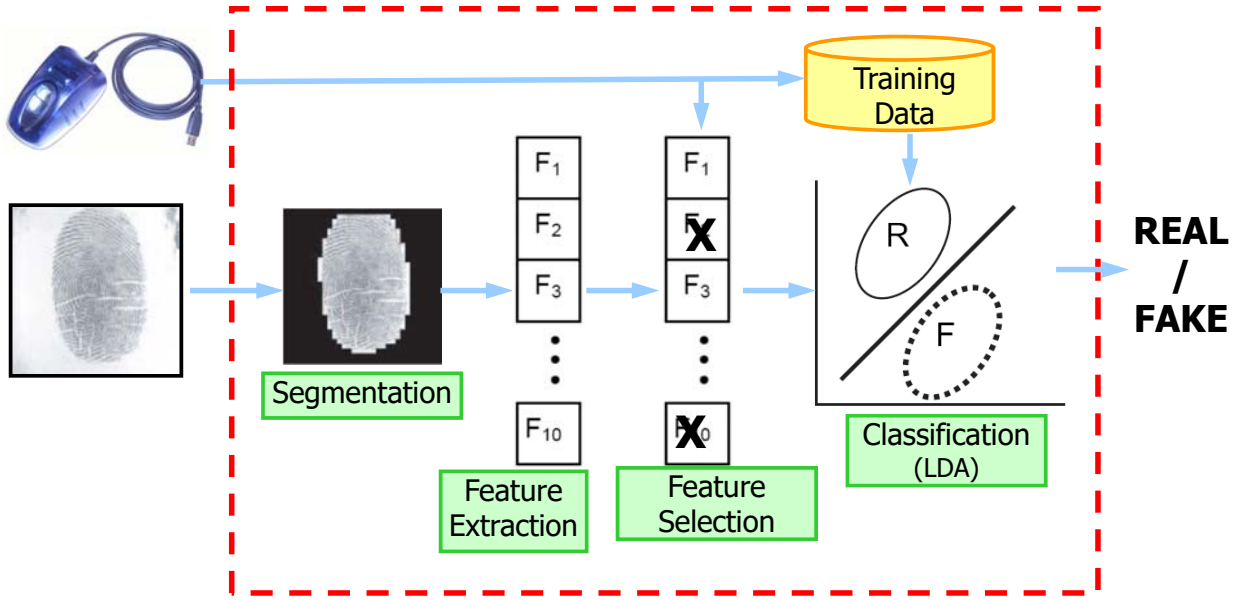
Iris Quality Measures

Class	Features
Focus	*IQF1, IQF4, IQF15, IQF16*
Motion	*IQF2, IQF5, IQF18, IQF20*
Occlusion	*IQF3, IQF6-12, IQF17, IQF19, IQF21*
Others	*IQF13, IQF14, IQF22*



J. Galbally, J. Ortiz-Lopez, J. Fierrez and J. Ortega-Garcia, "Iris liveness detection based on quality related features", in *Proc. Intl. Conf. on Biometrics, ICB*, New Delhi, India, March 2012.

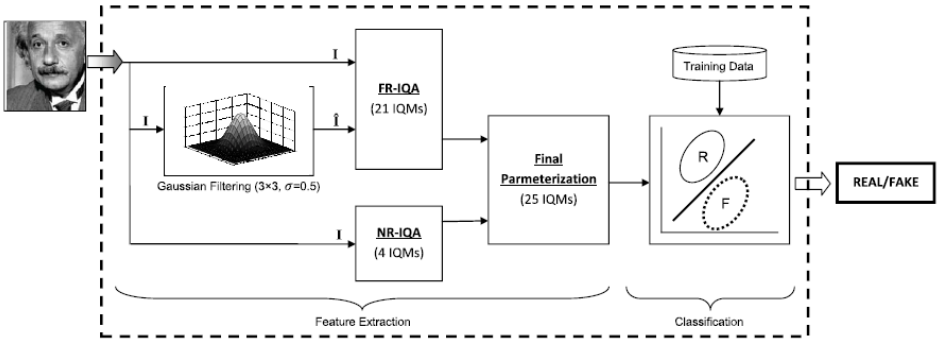
Fingerprint/Iris Presentation Attack Detection

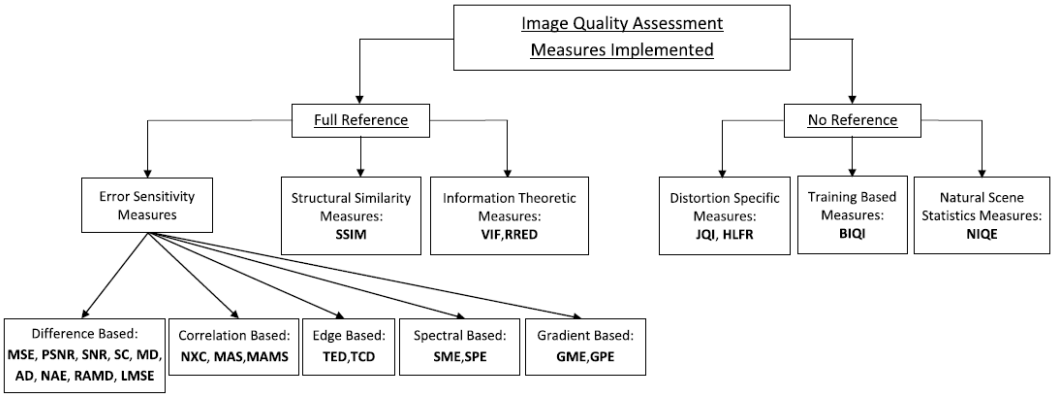


J. Galbally, F. Alonso-Fernandez, J. Fierrez and J. Ortega-Garcia, "A High Performance Fingerprint Liveness Detection Method Based on Quality Related Features", *Future Generation Computer Systems*, January 2012.

J. Galbally, J. Ortiz-Lopez, J. Fierrez and J. Ortega-Garcia, "Iris liveness detection based on quality related features", in *Proc. Intl. Conf. on Biometrics, ICB*, New Delhi, India, March 2012.

General Image Quality Measures for PAD



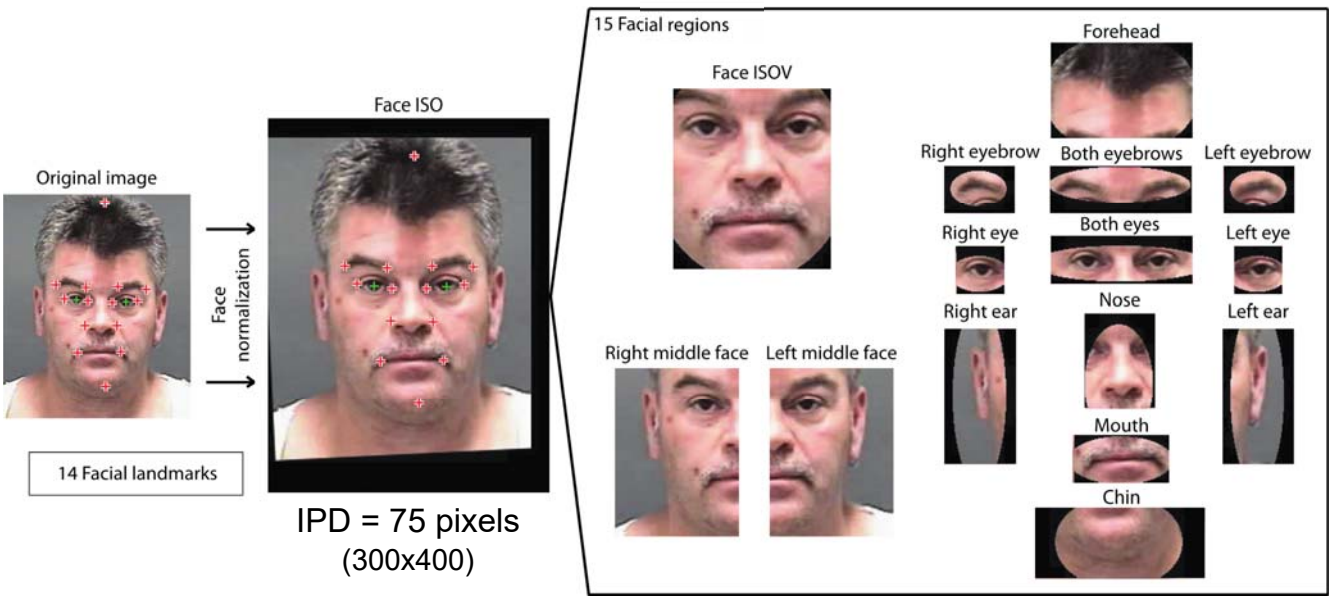


J. Galbally, S. Marcel and J. Fierrez, "Image Quality Assessment for Fake Biometric Detection: Application to Iris, Fingerprint and Face Recognition", *IEEE Trans. on Image Processing*, Feb. 2014.

HELPING PEDRO TOME (PHD 2013)
Region-based Face Recognition

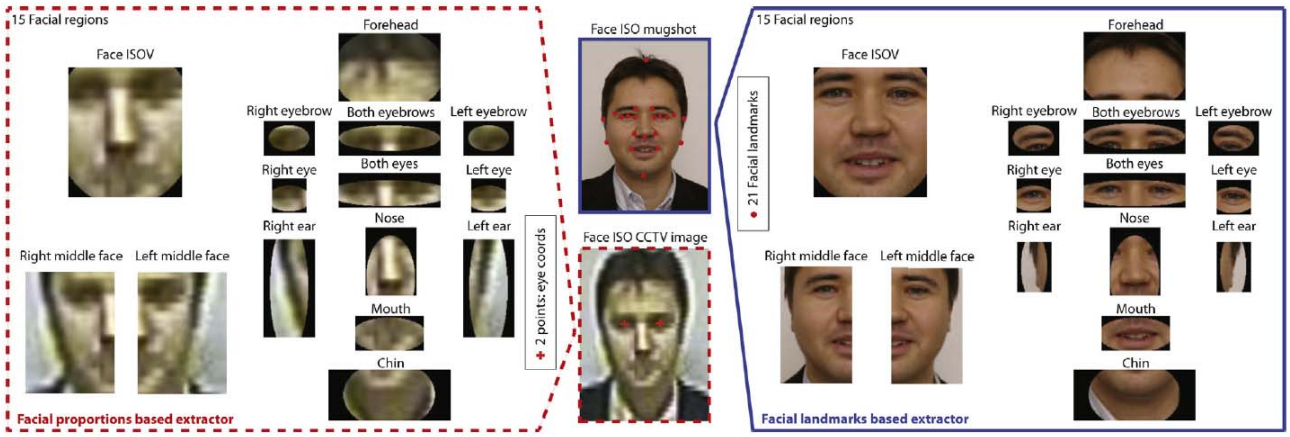
GUARDIA CIVIL

Netherlands Forensic Institute
Ministry of Security and Justice



P. Tome, J. Fierrez, R. Vera-Rodriguez and D. Ramos, "Identification using Face Regions: Application and Assessment in Forensic Scenarios", *Forensic Science International*, 2013.

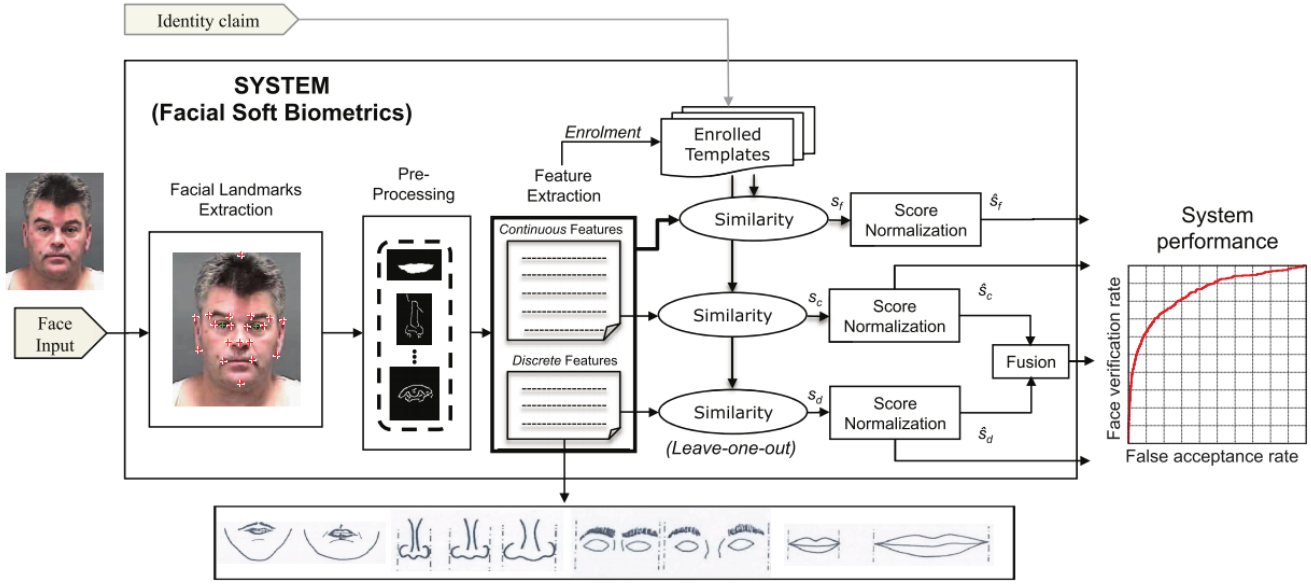
Unconstrained Face: CCTV vs Mugshots



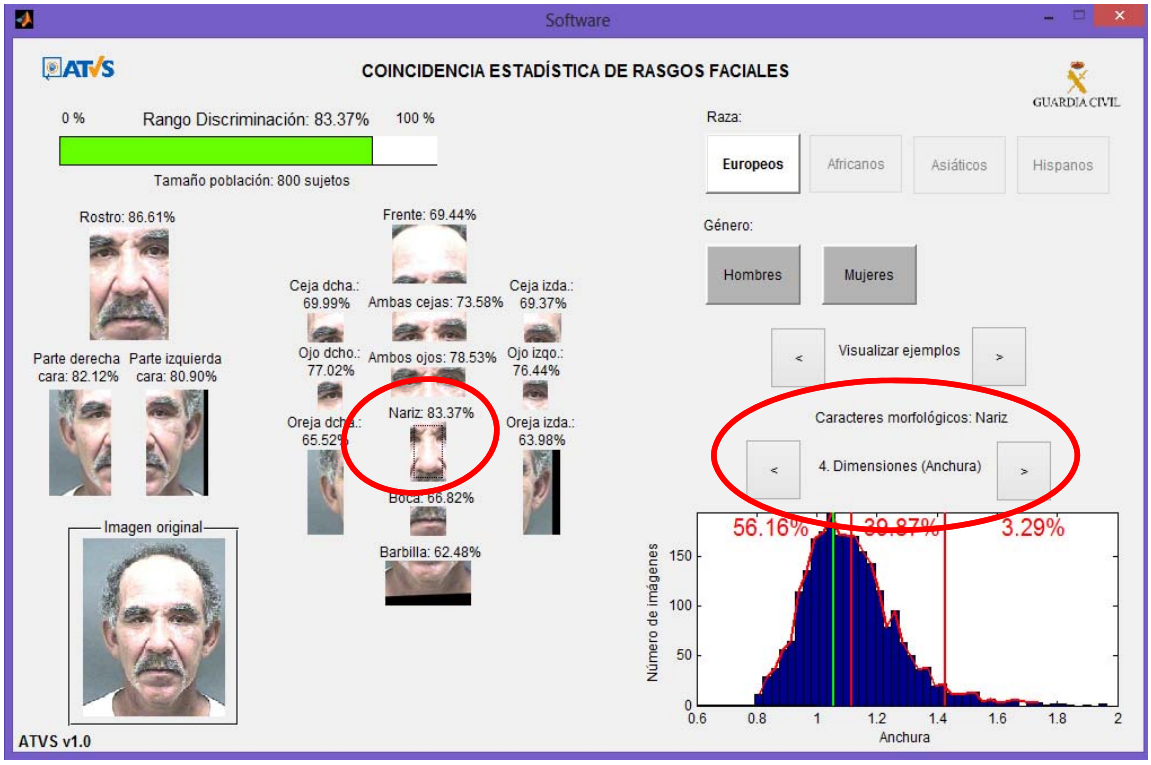
P. Tome, J. Fierrez, R. Vera-Rodriguez and D. Ramos, "Identification using Face Regions: Application and Assessment in Forensic Scenarios", *Forensic Science International*, 2013.

P. Tome, J. Fierrez, R. Vera-Rodriguez and J. Ortega-Garcia, "Combination of Face Regions in Forensic Scenarios", *Journal of Forensic Sciences*, 2015.

Facial Soft Biometrics for Forensics



P. Tome, R. Vera-Rodriguez, J. Fierrez and J. Ortega-Garcia, "Facial Soft Biometric Features for Forensic Face Recognition", *Forensic Science International*, December 2015.



UNDERSTANDING THE DISCRIMINATION POWER OF FACIAL REGIONS IN FORENSIC CASEWORK

Pedro Tome[a], Luis Blázquez[a], Ruben Vera-Rodriguez[a], Julian Fierrez[a], Javier Ortega-Garcia[a], Nicomedes Expósito[b] and Patricio Lestón[b]

[a]Biometric Recognition Group - ATVS, Escuela Politecnica Superior
Universidad Autonoma de Madrid
Avda. Francisco Tomas y Valiente, 11 - Campus de Cantoblanco - 28049 Madrid, Spain
{pedro.tome, luis.blazquez, ruben.vera, julian.fierrez, javier.ortega}@uam.es
[b]Dirección General de la Guardia Civil - DGGC Madrid, Spain

P. Tome, L. Blazquez, R. Vera-Rodriguez, J. Fierrez, J. Ortega-Garcia, N. Exposito and P. Leston, "Understanding the discrimination power of facial regions in forensic casework", in *Proc. Intl. Workshop on Biometrics and Forensics*, 2013.

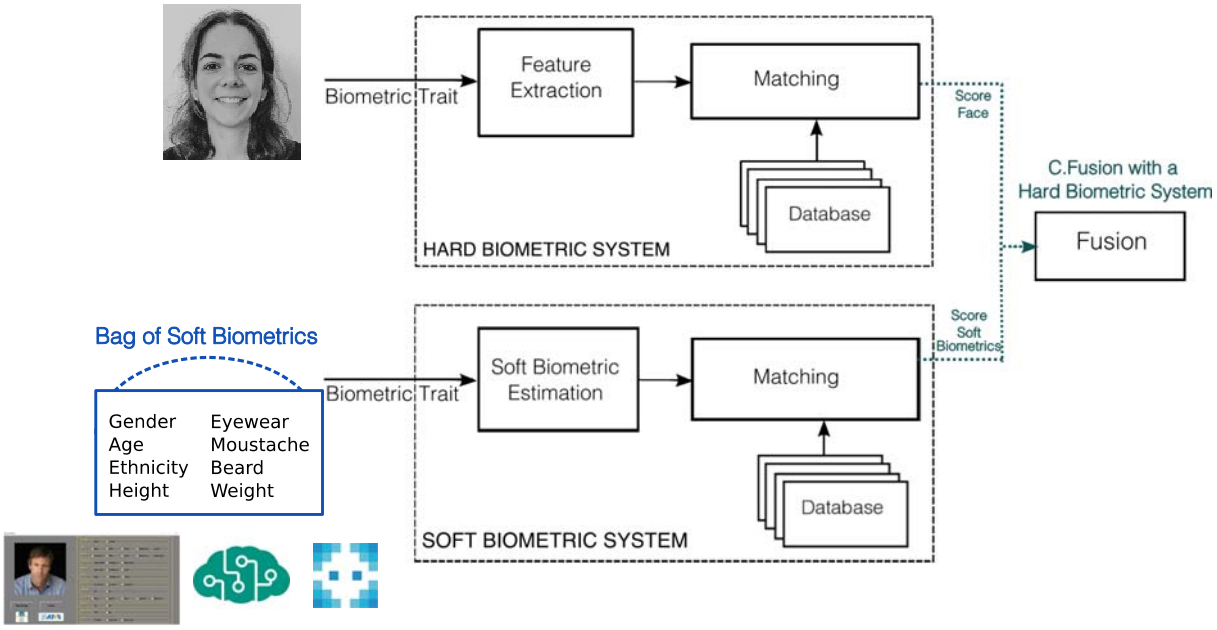
HELPING ESTER GONZALEZ (PHD 2017)

Person Recognition in challenging scenarios can be improved by using **body static information** in the **visible spectrum and beyond**, not commonly used in biometrics, such as **body shape**, **body texture**, and **soft biometrics.**

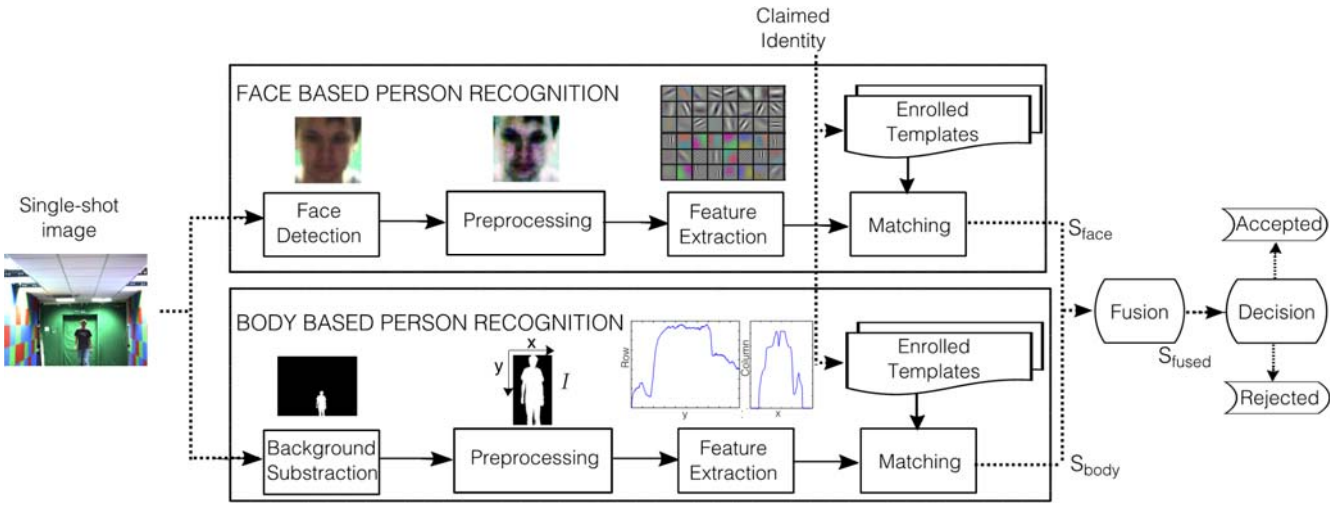
Depending on the scenario, such body information may be the **most useful source of information** for person recognition.

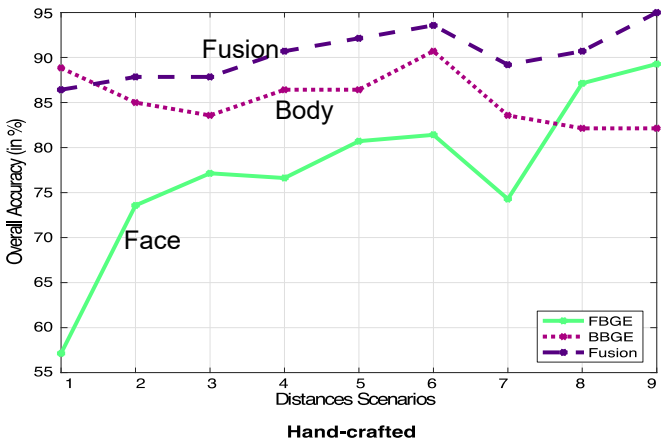
Face + Soft Biometrics

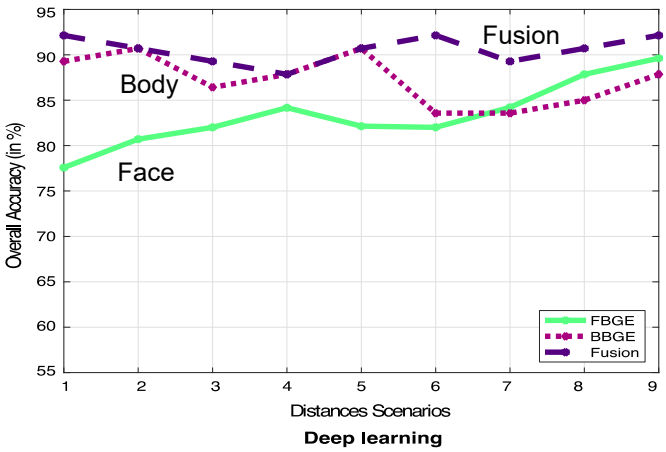
- VGG-face DNN and Face++ COTS



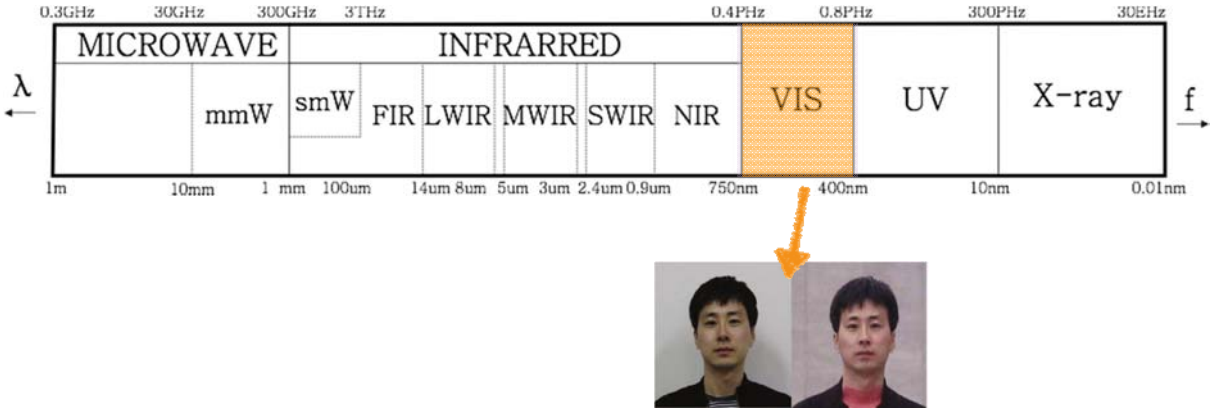
E. Gonzalez-Sosa, J. Fierrez, R. Vera-Rodriguez, and F. Alonso-Fernandez, "Facial Soft Biometrics for Recognition in the Wild: Recent Works, Annotation and COTS Evaluation", *Under Review.*



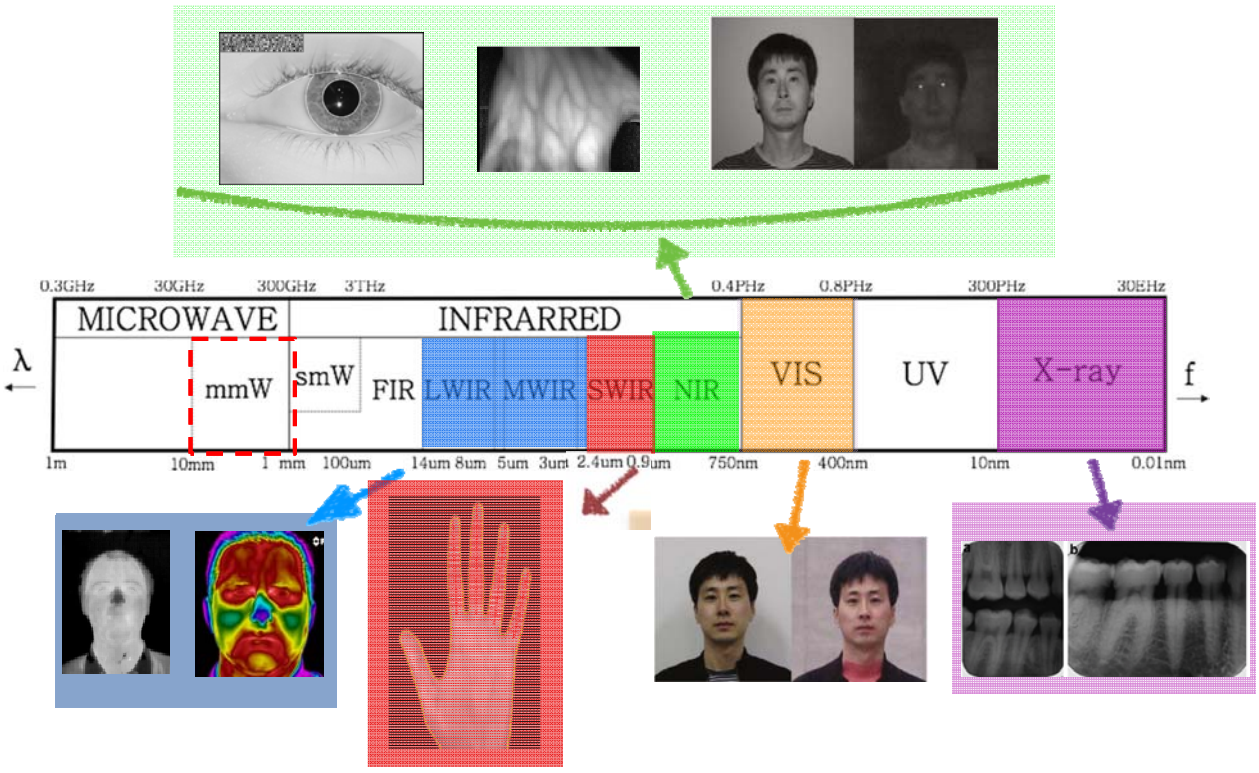




Beyond the Visible Spectrum

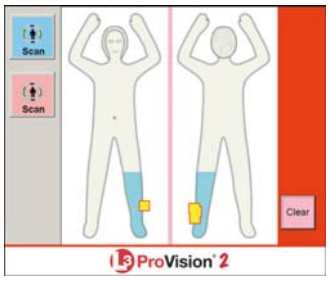


Beyond the Visible Spectrum



millimeter Wave (mmW) Imaging

- 30-300 GHz
- Properties
  - Highly transparent to clothing
  - Inocuos to Health
  - Active and Passive architectures
  - High cost acquisition devices
  - Privacy issues

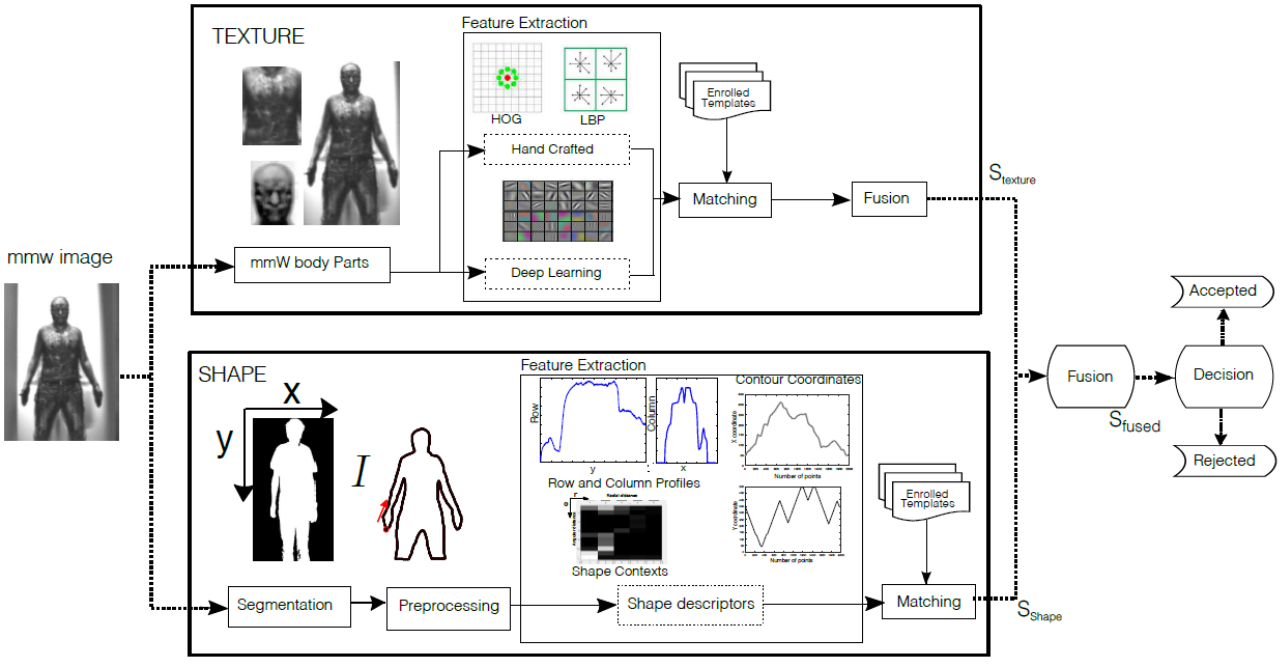


- Why?
  - Already deployed in international airports
  - Acquires the full body signature

- Person Recognition. How?
  - Shape
  - Texture

Alefs et al. “Thorax biometrics from millimetre-waves images”, *Pattern Recognition Letters*, 2010.

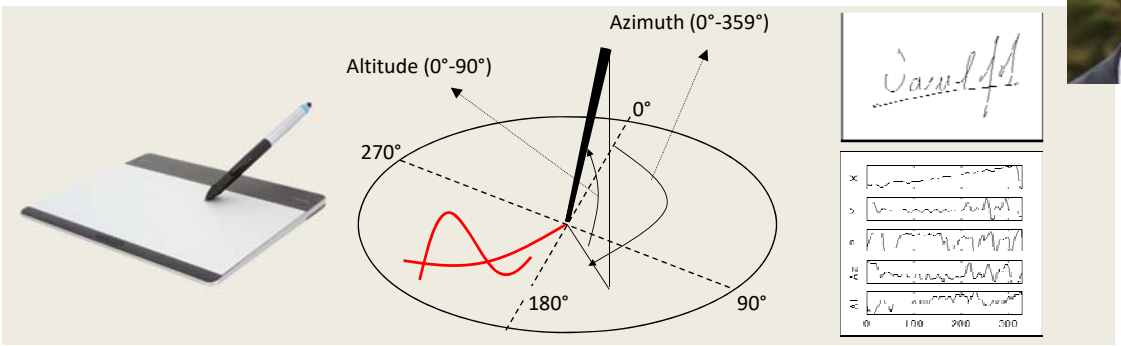
mmW Imaging for Biometrics



E. Gonzalez-Sosa, R. Vera-Rodriguez, J. Fierrez and Vishal M. Patel. “Exploring Body Shape from mmW Images for Person Recognition”, *IEEE Trans. on Information, Forensic and Security*, 2017.

HELPING MARCOS MARTINEZ (PHD 2015): Signature Recognition

On-line / Dynamic

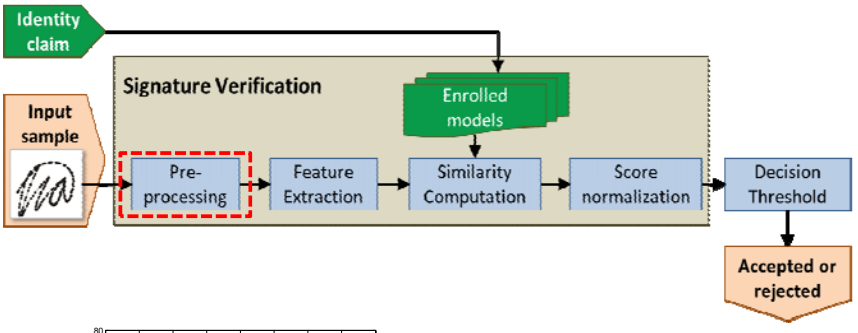


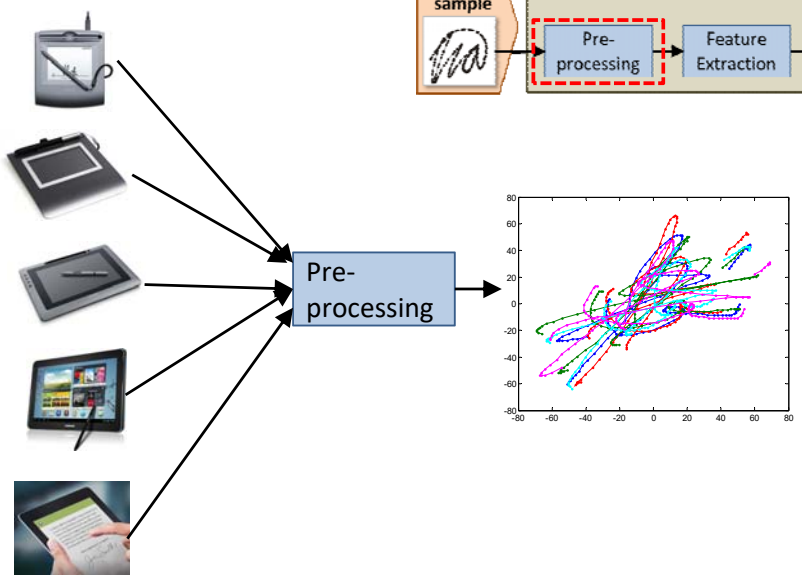
Off-line / Static

J. Fierrez, J. Ortega-Garcia, et al., "HMM-based on-line signature verification: feature extraction and signature modeling", *Pattern Recognition Letters*, Vol. 28, n. 16, Dec. 2007.

J. Fierrez, and J. Ortega-Garcia, "On-Line Signature Verification", Chapter 10 in *Handbook of Biometrics*, A.K. Jain, A. Ross and P. Flynn (eds.), Springer, pp. 189-209, 2008.

Pre-Processing and Feature Extraction

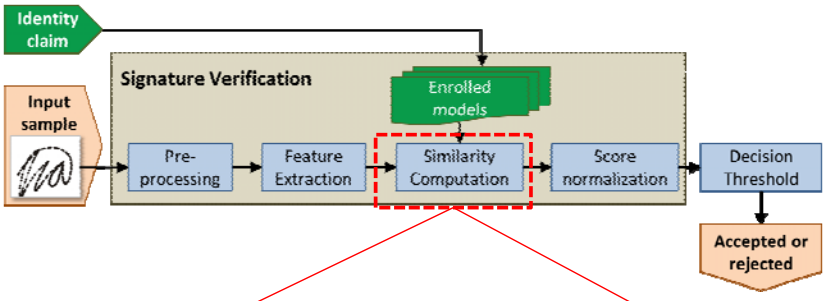


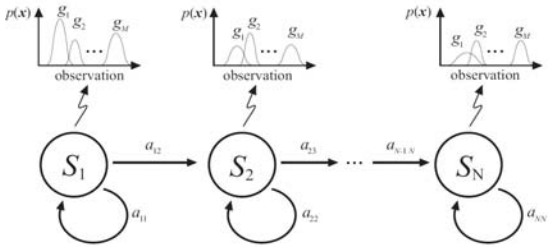


- Size normalization and centering
- Pressure normalization
- Resampling

M. Martinez-Diaz, J. Fierrez and S. Hangai, "Signature Features", Stan Z. Li and Anil K. Jain (Eds.), *Encyclopedia of Biometrics*, Springer, pp. 1375-1382, 2015.

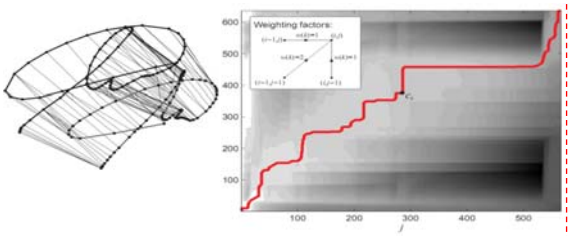
Similarity Computation





Hidden Markov Models (HMM)

Statistical modeling of signature regions

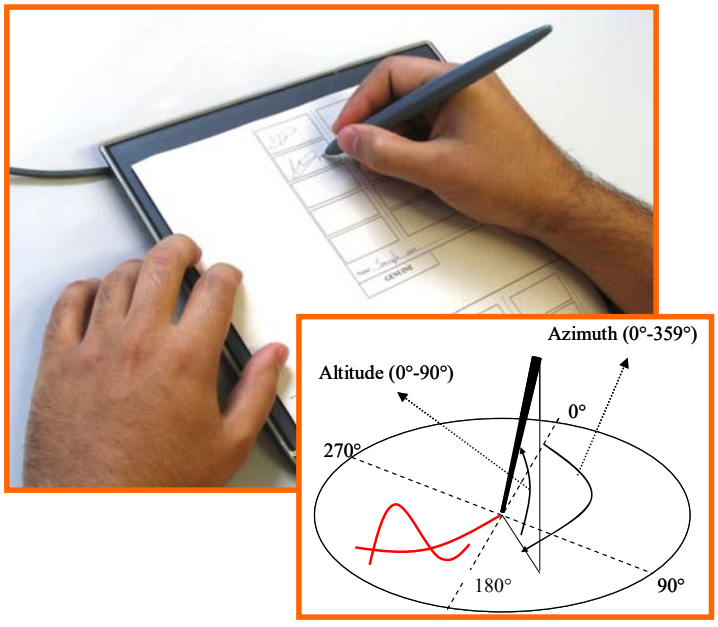


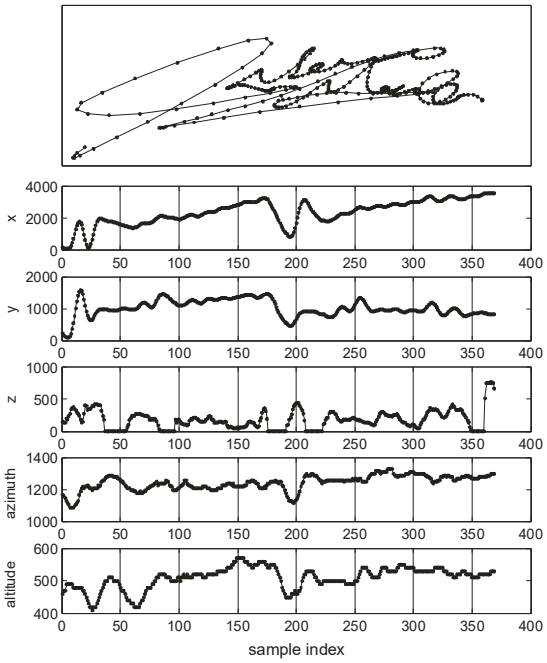
Dynamic Time Warping (DTW)

Point-to-point correspondence

M. Martinez-Diaz, J. Fierrez and S. Hangai, "Signature Matching", Stan Z. Li and Anil K. Jain (Eds.), *Encyclopedia of Biometrics*, Springer, pp. 1382-1387, 2015.

Traditional Acquisition Scenario





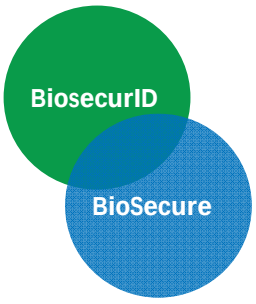
M. Martinez-Diaz and J. Fierrez, "Signature Databases and Evaluation", Stan Z. Li and Anil K. Jain (Eds.), *Encyclopedia of Biometrics*, Springer, pp. 1367-1375, 2015.

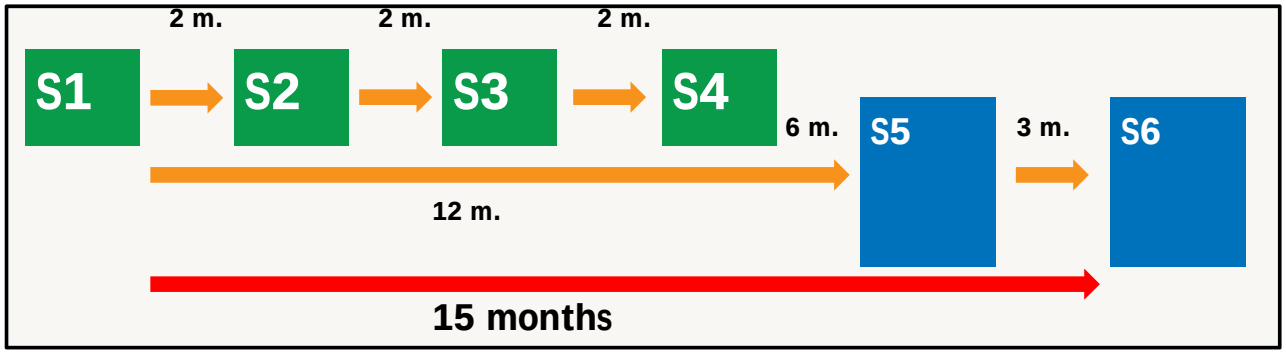
ICDAR 2009 Competition Winner

http://sigcomp09.arsforensica.org/

Template Aging in Signature (SLT)

- 29 common users from BiosecureID and Biosecure.
- **6 sessions with a 15-month time span (inter-session).**
- 46 genuine signatures: 4 + 4 + 4 + 4 + 15 + 15
- 10 skilled forgeries per user





J. Galbally, M. Martinez-Diaz and J. Fierrez, "Aging in Biometrics: An Experimental Analysis on On-line Signature", *PLOS ONE*, vol. 8, no. 7, p. e69897, July 2013.

BIOTRACE100 Performance (2015)*

- Accuracy (SLT Database):

	4 training signatures	16 signatures	31 signatures	41 signatures
Random Forg.	97.2 %	99.3 %	99.9 %	99.9 %
Skilled Forg.	88.3 %	93.1 %	95.9 %	99.3 %

- State of the art performance
- Template and system configuration update strategies in order to minimize the aging effect

R. Tolosana*, R. Vera-Rodriguez, J. Ortega-Garcia and J. Fierrez, "Preprocessing and Feature Selection for Improved Sensor Interoperability in Online Biometric Signature Verification", *IEEE Access*, Vol. 3, pp. 478 - 489, May 2015.

e-BioSign Database (2016-2017)*

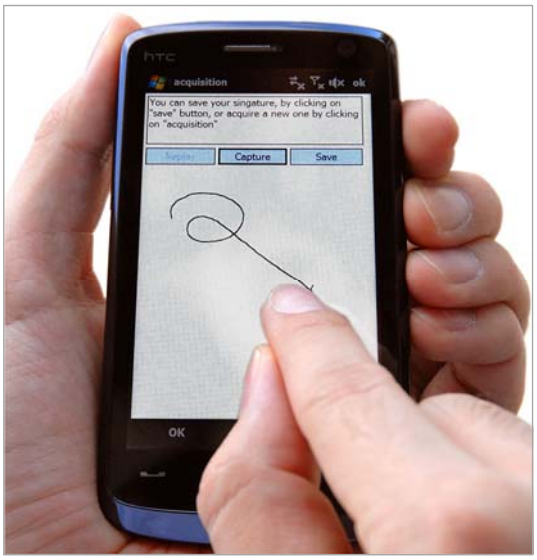
WACOM STU-500 | WACOM STU-530 | WACOM DTU-1031 | SAMSUNG ATIV 7 (WIN8) | SAMSUNG GALAXY NOTE 10.1 (ANDROID)

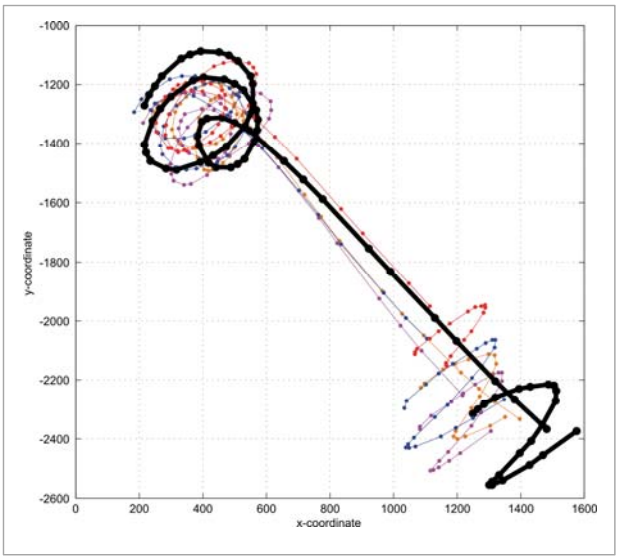
- 70 users, 2 capturing sessions
- 5 devices (3 Wacom, 2 Samsung)
- 8 genuine signatures and 6 skilled forgeries per user and device
- Stylus and finger as writing tools (Samsung)

R. Tolosana*, R. Vera-Rodriguez, J. Fierrez, A. Morales, J. Ortega-Garcia, "Benchmarking Desktop and Mobile Handwriting across COTS Devices: the e-BioSign Biometric Database" *PLOS ONE*, 2017.

From Signature to Touch Gestures

- **Graphical Password-based User Authentication with Free-form Doodles**





M. Martinez-Diaz, J. Fierrez and J. Galbally, "Graphical Password-based User Authentication with Free-Form Doodles", *IEEE Trans. on Human-Machine Systems*, August 2016.

M. Martinez-Diaz, J. Fierrez, and J. Galbally. "The DooDB graphical password database: Data analysis and benchmark results". *IEEE Access*, September 2013.

EAB EU Biometrics Industry Award 2014

CHAIRMAN OF THE AWARD COMMITTEE:

- **Prof. Patrizio Campisi**, University of Roma TRE, Roma, Italy

COMMITTEE MEMBERS:

- **Prof. Josef Bigun**, Halmstad University, Sweden
- **Prof. Christoph Busch**, Gjøvik University College, Norway
- **Prof. Mike Fairhurst**, University of Kent, UK
- **Jean Christophe Fondeur**, Morpho, France
- **Prof. Anil Jain**, Michigan State University, USA
- **Dr. Tom Kevenaar**, GenKey, The Netherlands
- **Dr. Els Kindt**, Katholieke Universiteit Leuven, Belgium
- **Prof. Josef Kittler**, University of Surrey, UK
- **Prof. Ajay Kumar**, The Hong Kong Polytechnic University, Hong Kong
- **Prof. Arun Ross**, Michigan State University, USA
- **Dr. Günter Schumacher**, JRC, European Commission
- **Prof. Massimo Tistarelli**, University of Sassari, Italy
- **Prof. Raymond Veldhuis**, Twente University, The Netherlands
- **Prof. Jim Wayman**, San Jose State University, USA

- The European Biometrics Industry Award is granted to **Marcos Martinez Diaz** from the Universidad Autonoma de Madrid (Spain) for his study *Graphical Password-based User Authentication with Free-form Doodles*.

Winner of the EAB Research Award 2014: Marcos Martinez Diaz

http://www.eab.org/award/reports/report2014.html?ts=1410595407633

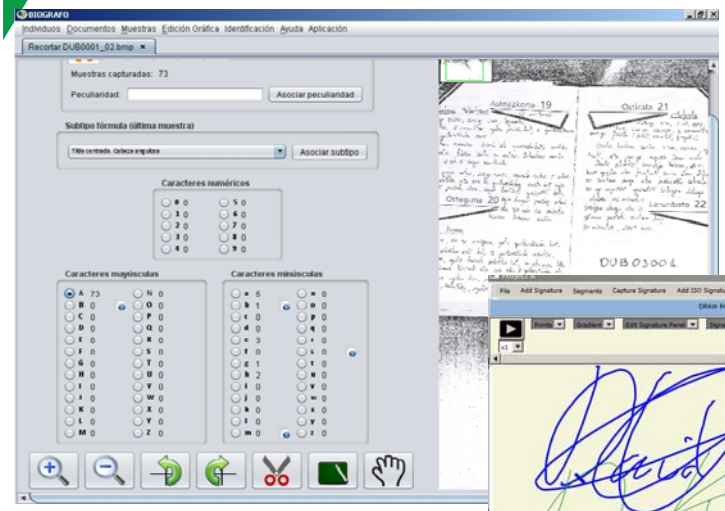
Banking Industry – Tech Transfer to cecabank

SERVICIOS FINANCIEROS

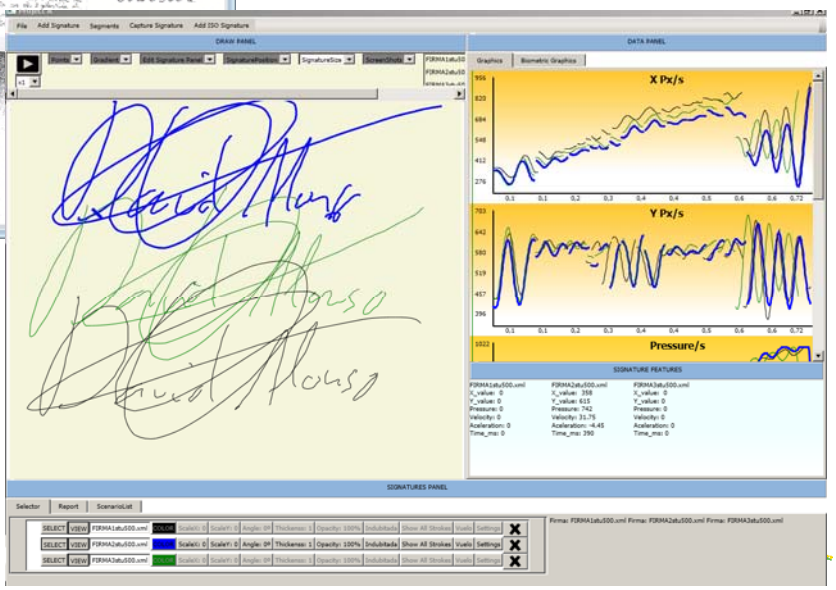
- Stylus and finger-drawn signature recognition
- Off-line fraud detection and on-line verification
- Semi-automatic tools to aid experts in signature comparison (lawsuits)

Dynamic signature acquisition and management solution already in operation
(> 46k sensors, > 500M operations/year)

Handwriting/Sign Tech Transfers to Forensic Labs



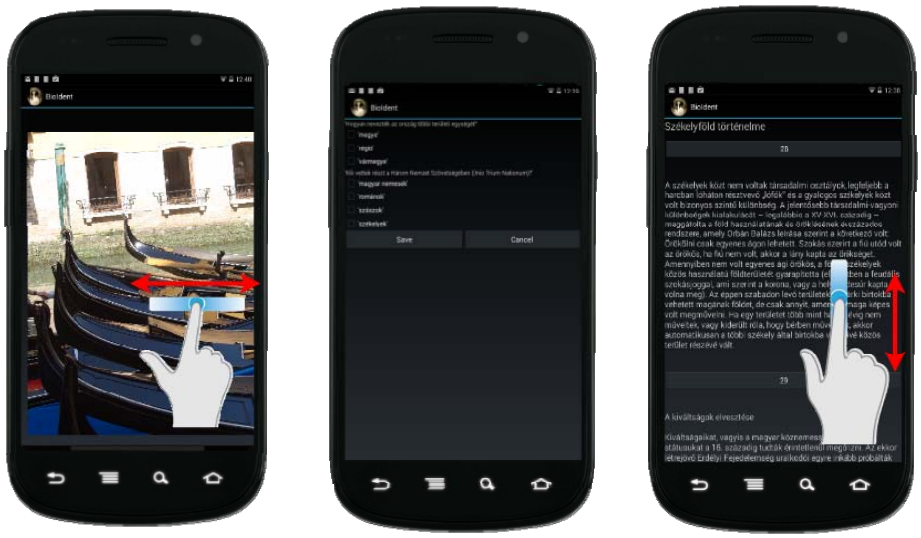
J. Galbally, S. Gonzalez-Dominguez, J. Fierrez and J. Ortega-Garcia, "Biografo: An integrated tool for forensic writer identification", in *Proc. Intl. Workshop on Computational Forensics*, Springer LNCS-8915, November 2015.



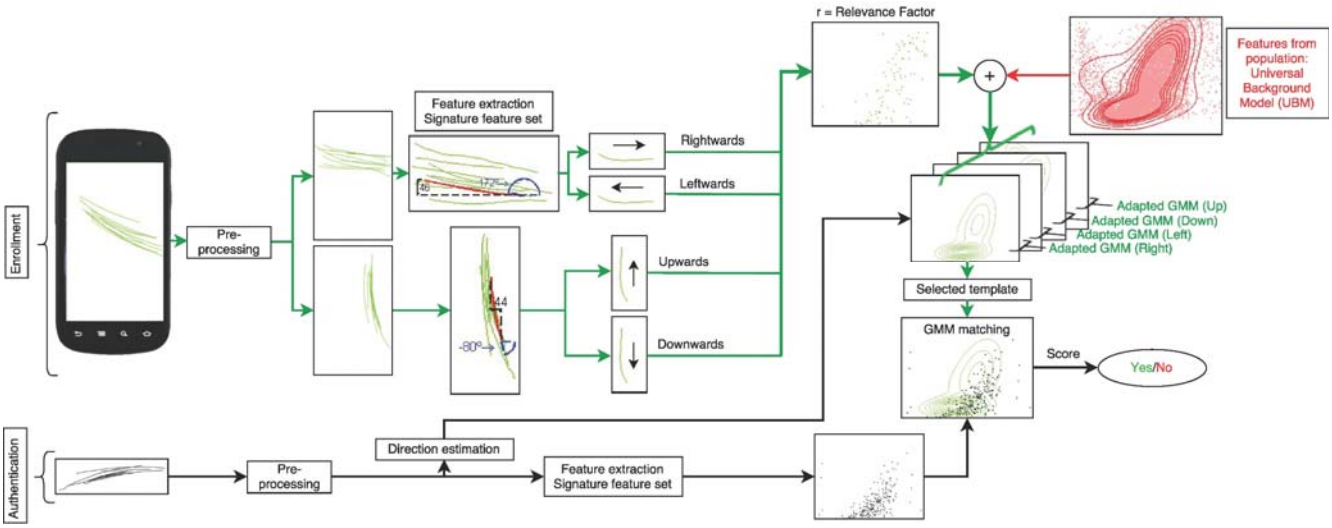
R. Vera-Rodriguez, J. Fierrez and J. Ortega-Garcia, "Dynamic Signatures as Forensic Evidence: A New Expert Tool Including Population Statistics", M. Tistarelli and C.Champod (Eds.), *Handbook of Biometrics for Forensic Science*, Springer, 2017.

Current Work: Swipe Biometrics

- Continuous user authentication through touch biometrics:
  - Security beyond the entry-point
- Situation:
  - Freely interacting with the touchscreen while reading or viewing images



Current Work: Swipe Biometrics



A. Pozo, J. Fierrez, M. Martinez-Diaz, J. Galbally and A. Morales, "Exploring a Statistical Method for Touchscreen Swipe Biometrics", in *Proc. Intl. Carnahan Conference on Security Technology, ICCST 2017*, October 2017.

A Look Into The Future

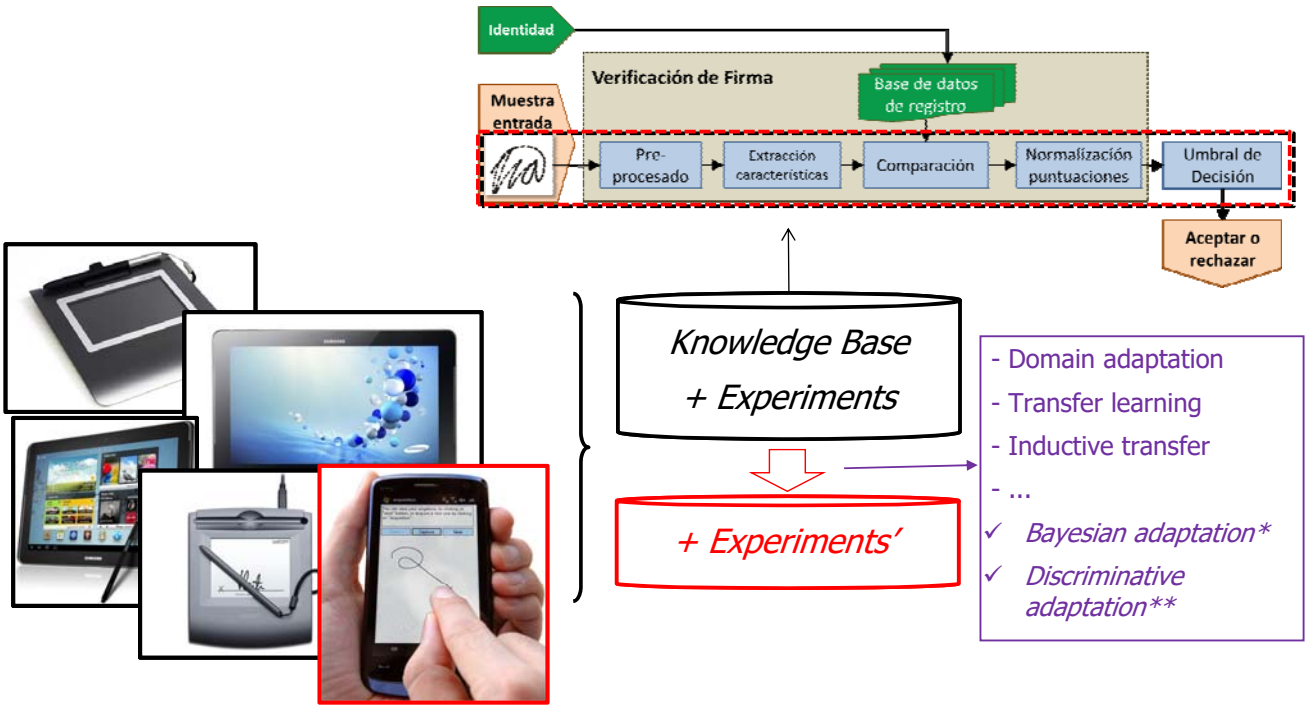
Julian FIERREZ

School of Engineering

UNIVERSIDAD AUTONOMA DE MADRID, SPAIN

IJCB, October 3, 2017

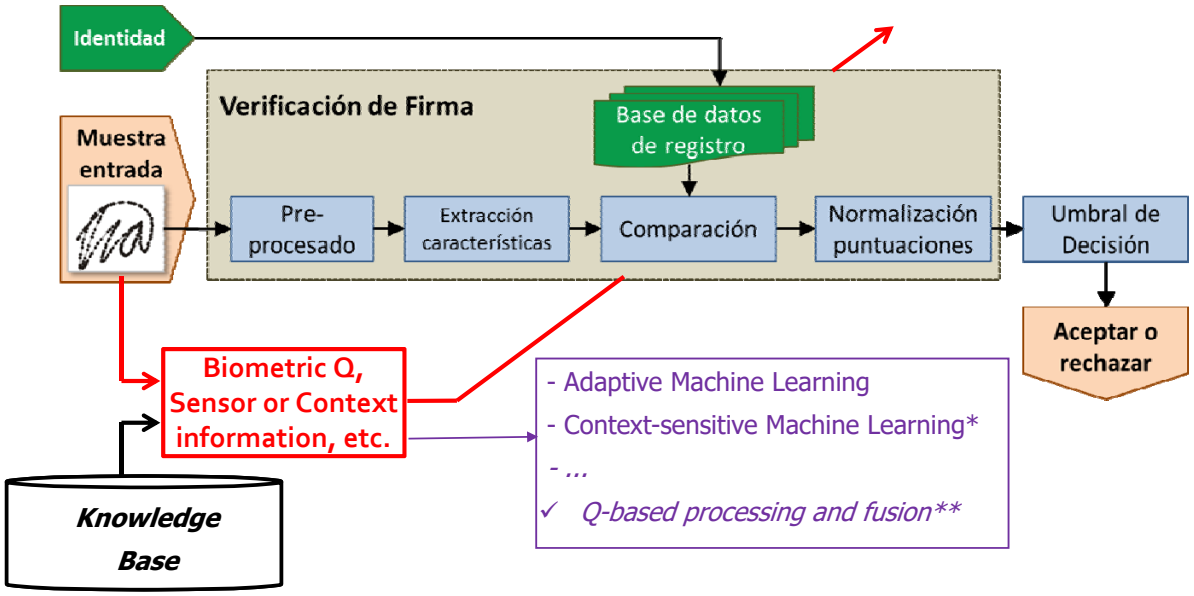
Challenge 1: Adapting to New Application Scenarios



* J. Fierrez-Aguilar, D. Garcia-Romero, J. Ortega-Garcia and J. Gonzalez-Rodriguez, "Bayesian adaptation for user-dependent multimodal biometric authentication", *Pattern Recognition*, August 2005.

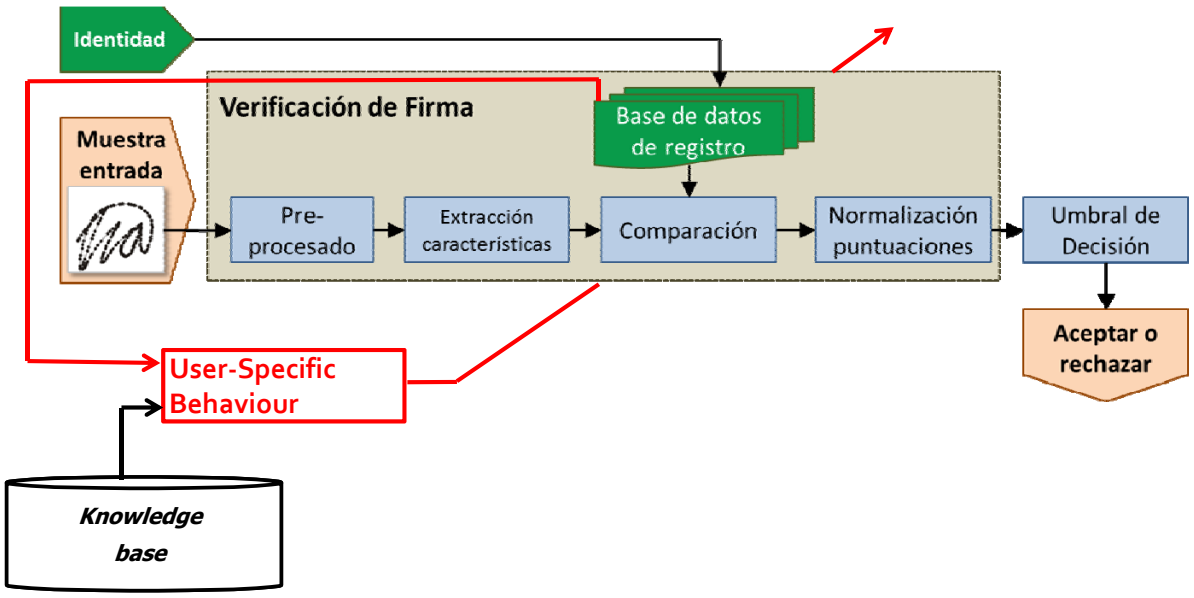
**J. Fierrez-Aguilar, D. Garcia-Romero, J. Ortega-Garcia and J. Gonzalez-Rodriguez, "Adapted user-dependent multimodal biometric authentication exploiting general information", *Pattern Recognition Letters*, December 2005.

Challenge 2: Contextual Information



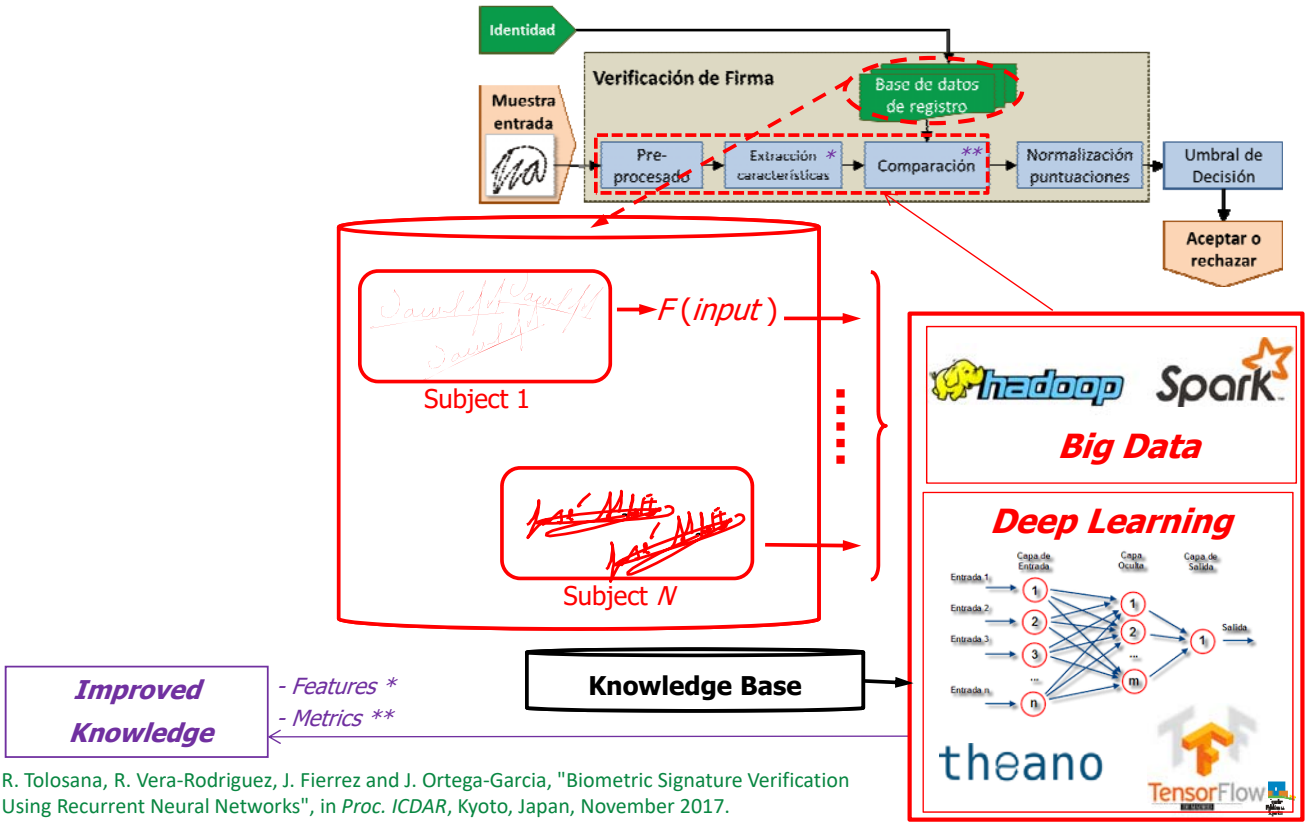
* P. Aleksic, M. Ghodsi, et al. "Bringing Contextual Information to Google Speech Recognition", *Interspeech*, 2015.
** F. Alonso-Fernandez, J. Fierrez, and J. Ortega-Garcia, "Quality Measures in Biometric Systems", *IEEE Security & Privacy*, Dec. 2012.
** F. Alonso-Fernandez, J. Fierrez, *et al.*, "Quality-Based Conditional Processing in Multi-Biometrics: application to Sensor Interoperability", *IEEE Trans. on Systems, Man and Cybernetics A*, Vol. 40, n. 6, pp. 1168-1179, 2010.

Challenge 3: Adapting to User Specificities



J. Fierrez, J. Ortega-Garcia and J. Gonzalez-Rodriguez, "Target Dependent Score Normalization Techniques and their Application to Signature Verification", *IEEE Trans. on Systems, Man and Cybernetics-C*, August 2005.

Challenge 4: Exploiting Big Data



R. Tolosana, R. Vera-Rodriguez, J. Fierrez and J. Ortega-Garcia, "Biometric Signature Verification Using Recurrent Neural Networks", in *Proc. ICDAR*, Kyoto, Japan, November 2017.

IAPR Young Biometrics Investigator Award

IJCB 2017 Keynote Talk

Julian FIERREZ

[https://atvs.ii.uam.es/fierrez]

School of Engineering

UNIVERSIDAD AUTONOMA DE MADRID, SPAIN

Escuela Politécnica Superior

Denver CO, USA, Oct. 3, 2017

UAM UNIVERSIDAD AUTONOMA DE MADRID