Human Monitoring & Authentication using Biodynamic Indicators & Behavioural Analysis

FP6 IST - STREP Project ID 026990
Duration January 2006 – June 2008
Coordinated by CERTH
Project Coordinator: Dr. Dimitrios Tzovaras
EU Funding: 2.5 MEuro
http://www.humabio-eu.org

Next Generation Biometrics
Dimitrios Tzovaras
HIDE Focus Group Meeting
31/10/2008, Maastricht, The Netherlands

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Biometrics - SoTA

Biometric identifier	Universality	Distinctiveness	Permanence	Collectability	Performance	Acceptability	Circumvention
DNA	H	H	H	L	H	L	L
Ear	M	M	H	M	M	H	M
Face	H	L	M	H	L	H	H
Facial thermogram	H	H	L	H	M	H	L
Fingerprint	M	H	H	M	H	M	M
Gait	M	L	L	H	L	H	M
Hand geometry	M	M	M	H	M	M	M
Hand vein	M	M	M	M	M	M	L
Iris	H	H	H	M	H	L	L
Keystroke	L	L	L	M	L	M	M
Odor	H	H	H	L	L	M	L
Palmprint	M	H	H	M	H	M	M
Retina	H	H	M	L	H	L	L
Signature	L	L	L	H	L	H	H
Voice	M	L	L	M	L	H	H

Jain et. al., 2003

Biometrics - SoTA

Biometric	Accuracy	Ease of use	User acceptance	Stability	Cost	Trans-parency[1]	Typical applications	Suitability for	
								1:1	1:N
Finger-scanning	High, possibly Very High	High	Medium Low	High	* to ***	Overt	Traveller clearance, driver's license, welfare	Yes	Yes
Hand geometry	High	High	Medium High	Medium High	***	Overt	Access control, traveller clearance, day care	Yes	No
Facial recognition	Medium High[2]	Medium High	High	Medium Low	***	Covert	Casino, traveller clearance	Yes	Poten tially[3]
Iris scanning	Very High	Medium Low	Medium High	High	*****	Covert	Prisons, access control, traveller clearance	Yes	Yes
Retinal scanning	Very High	Low	Low	High	****	Overt	Access control, traveller clearance	Yes	Yes
Finger geometry	Medium	High	Medium High	Medium High	***	Overt	Access control, amusement park ticket holder	Yes	No
Voice recognition	Medium	High	High	Medium Low	*	Covert	Low security applications, telephone authentication	Yes	No
Signature verification	Medium	High	Medium High	Medium Low	**	Overt	Low security applications, applications with existing 'signature'	Yes	No

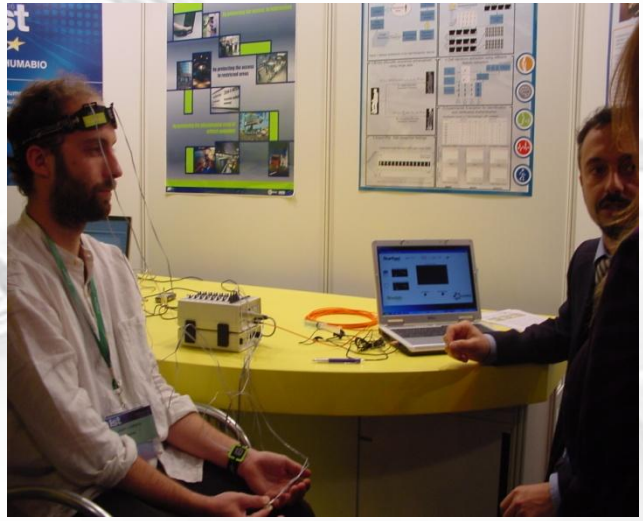
O.E.C.D. (Organisation for Economic Cooperation and Development Report), 2004, 32

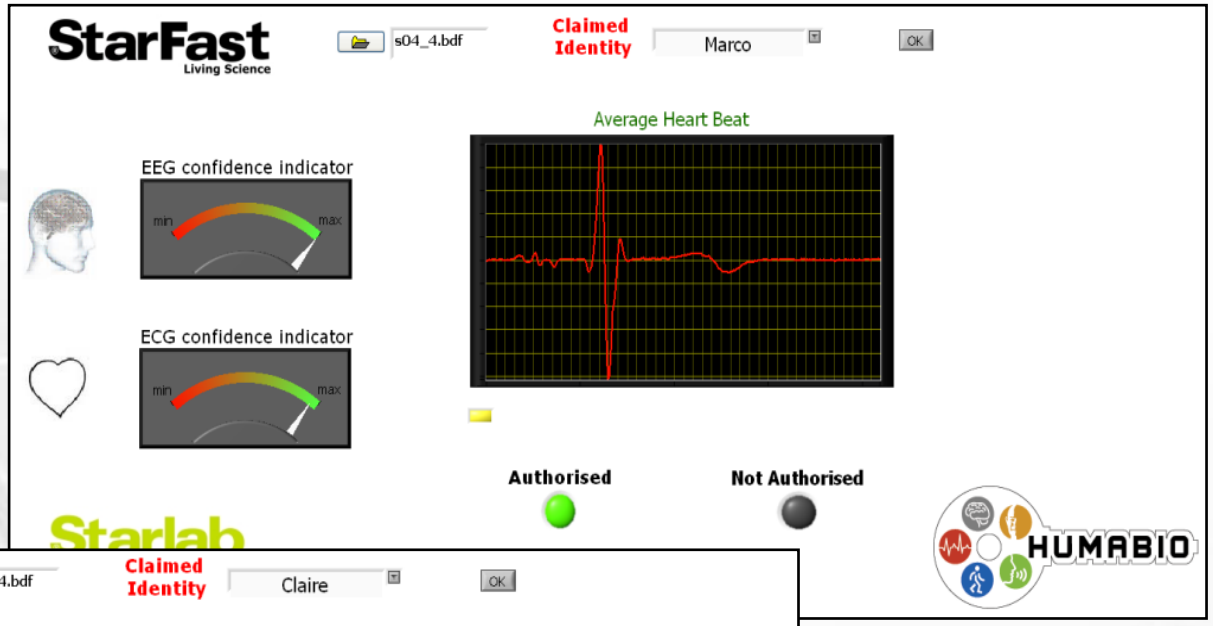
HUMABIO Mission and Objectives

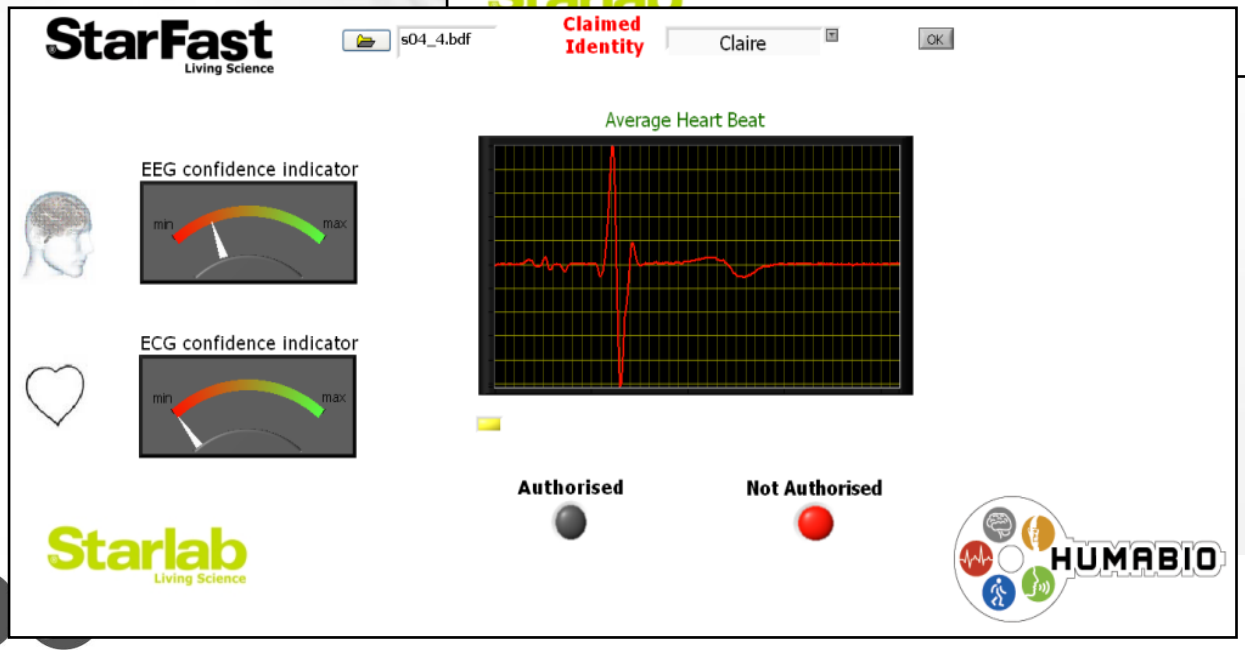
- To address the issues that current biometric solutions face. Namely:
  - Limited use of multiple biometric modalities
  - Increased spoofing possibility
  - Biometric template ageing – Need for repeated enrolments
- To introduce new types of biometrics and implement emerging biometric modalities such as **EEG baseline and ECG**.
- To introduce novel sensors in the biometrics market aiming at the **user's convenience**, **system unobtrusiveness** and the integration of biometrics to Ambient Intelligent solutions.
- To combine the authentication mode, with validation of nominal physiological state and continuous physiological monitoring in order to boost safety levels for critical operations.
- To develop a modular, robust, multimodal biometric authentication and monitoring security system which utilizes a **biodynamic physiological profile**, unique for each individual, and advancements of the state-of-the art in behavioural and other biometrics, such as **facial, speech, gait** recognition and **seat based anthropometrics**.
- To create the necessary enhanced security framework for the integration of the biometric authentication system to a corporate security grid or other controlled and monitored ambient intelligence environments, in order to guarantee trust and privacy concerning the citizen's personal biometric template and data.

HUMABIO Achievements: EEG/ECG Authentication

-**Starfast** (Starlab Fast Authorization bio-Scan Tester)



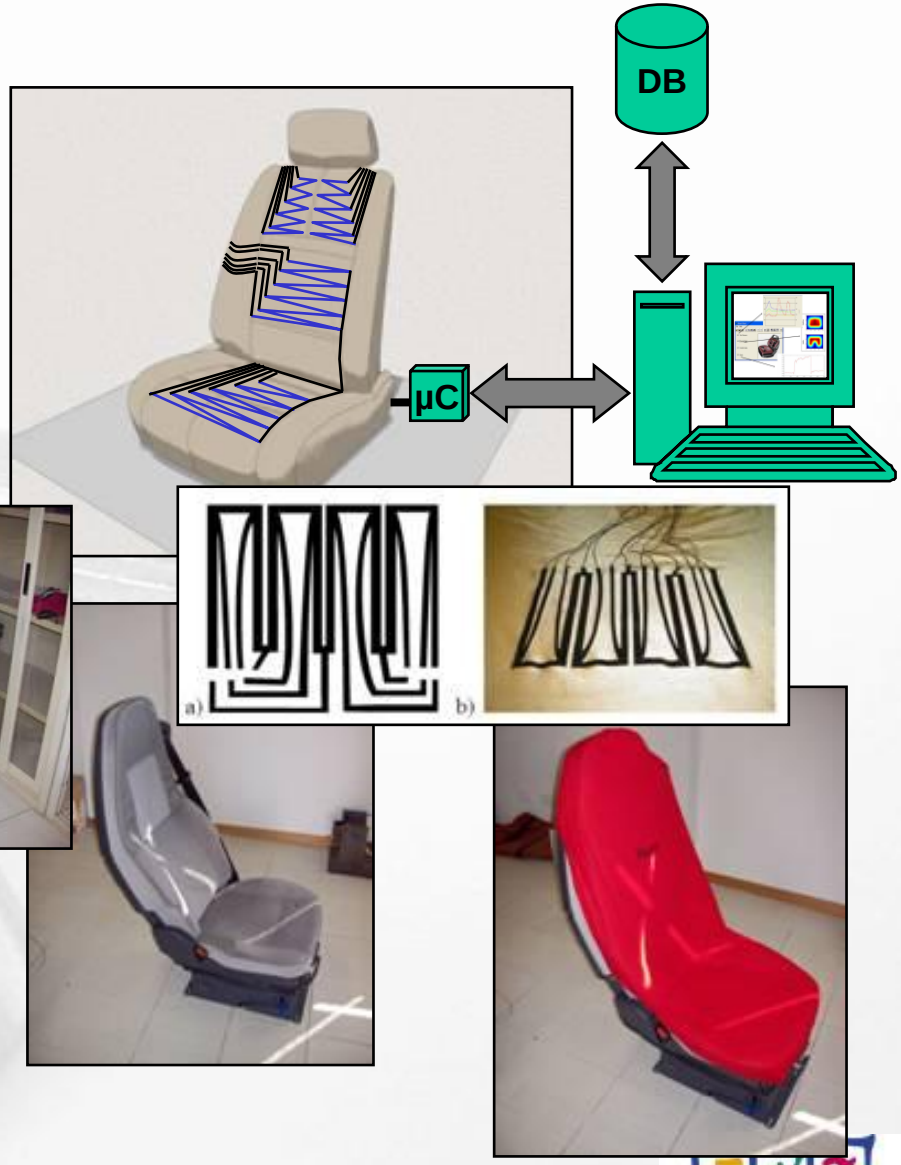




HUMABIO Achievements – Sensing Seat

"Sensing Seat" for the extraction of the person's anthropometric profile

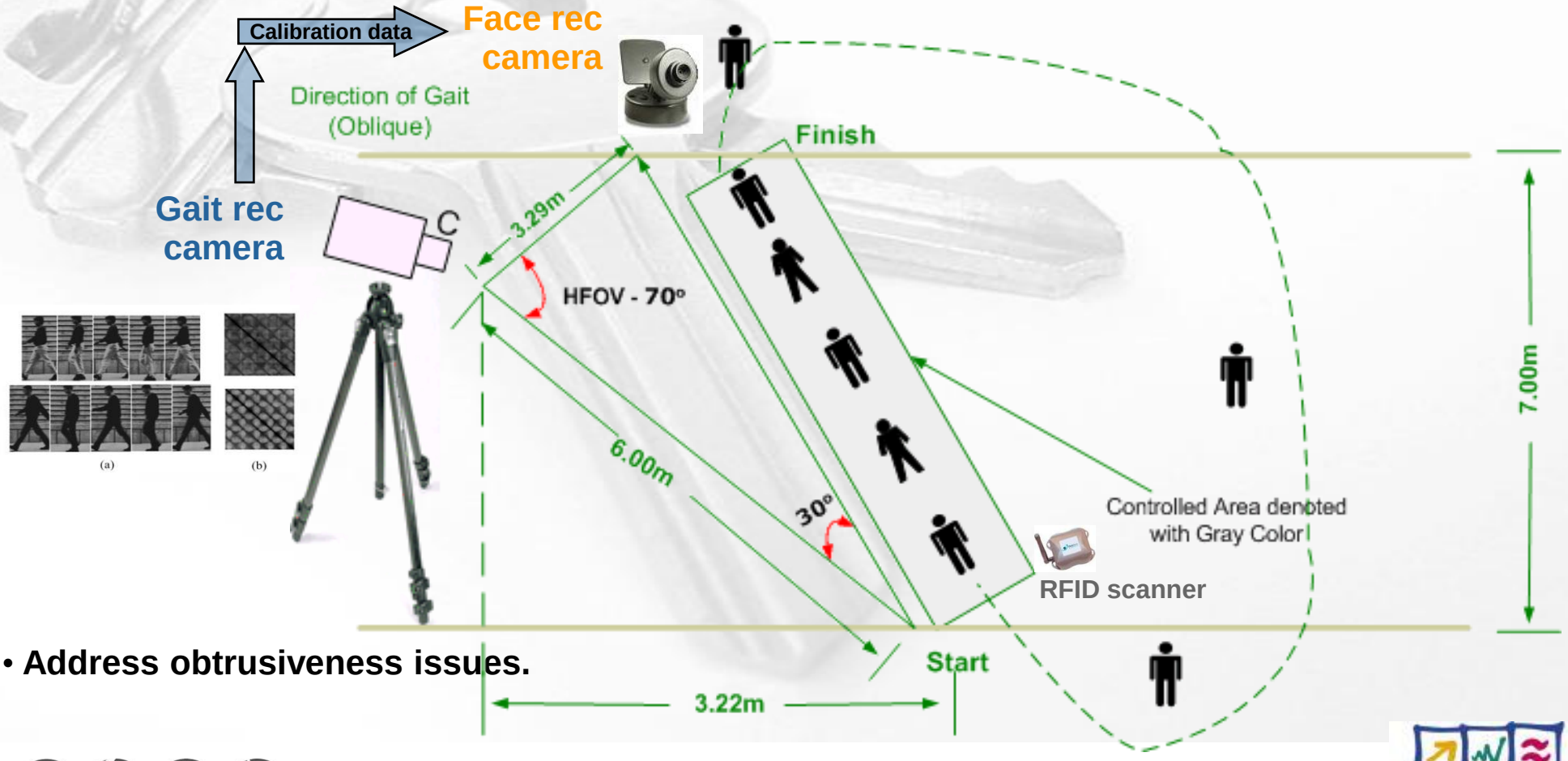
- **Sensor design and developments**
- **Truck seat provided by VOLVO Sensing Cover**
  - 3 sensor arrays (3 x 12 strain sensors)
  - sensors are placed on the back of the cover
- **Data acquisition board**
  - Hi-impedance front-end
  - UNIPI USB-DAQ or NI-DAQ
  - ~20 fps
- **Standard laptop PC**
- **Software interface**
  - real-time monitoring of the sensing seat signals
- **Classifications and processing algorithms**



HUMABIO Achievements - Unobtrusiveness

- **To draft and demonstrate new authentication procedures for transparent to the user collection of biometric data**

Airport pilot, authentication of personnel on-the-move



- **Address obtrusiveness issues.**

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HUMABIO Pilots

- **Three pilot applications to test the multimodality of HUMABIO (March-April 2008)**

- Truck pilot
(Driver authentication, validation and monitoring for hypovigilance, extreme stress)
Lab at Volvo Technology, Gothenburg, SE

F
AP
EEG
ECG

F
V
AP
EEG
ECG

- Office pilot
(Fixed seat operator authentication, validation and monitoring for extreme stress, hypovigilance only in critical ops scenarios)
FhG Lab Innovation Center (LIC), Stuttgart, DE

- Restricted area pilot
(Unobtrusive authentication on the go
EuroAirport Basel, SW

F
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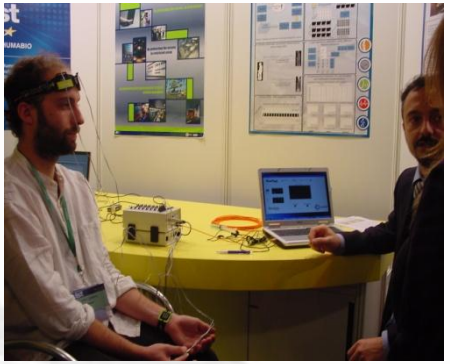
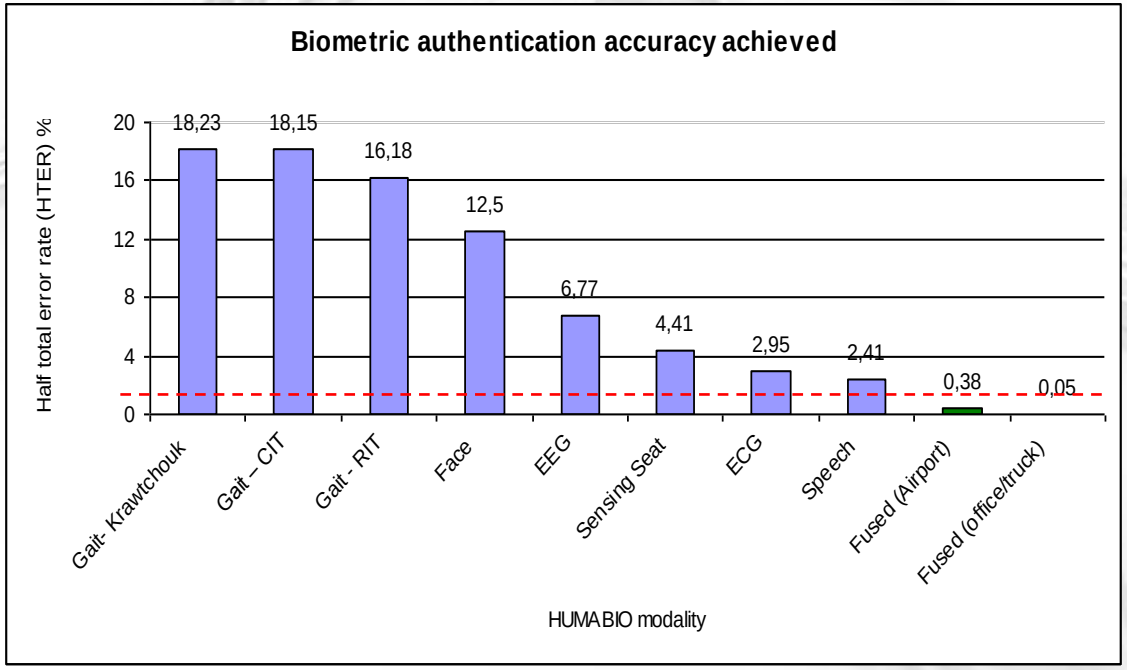
Main project results

- Preliminary working prototypes demonstrated:





- Achieved accuracy surpassed target performance for biometric authentication

- HUMABIO Contributions/Innovations:
  - Standards
  - Trust, Security and Dependability metrics
  - Biosec API
  - Sensors
  - Industry best practices

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Unobtrusive Authentication Using ACTIvity Related and Soft BIOmetrics

7th Framework Programme
2007-ICT-1–1.4, 215372

Starting Date: 1/3/2008

EU Funding: 3.2 MEuro

http://www.actibio.eu

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ACTIBIO: Project Motivation

- To research and develop **multimodal signal (behavioural and physiological) analysis techniques for the detection and understanding of patterns of activities** entangled in important events and unusual patterns of a specific sensor infrastructure installation.
- To address the monitoring of user actions in a specific period time with the use of biometric modalities that have **dynamic nature** and which **change significantly** during activity-related work.
- To introduce the use of emerging modalities which can **discriminate** adequately **various activities** that could be performed by the subjects in **critical** operations.

HOW?

Introducing **for the first time** novel physiological **activity-related** biometrics combining them with unobtrusive behavioural and soft biometrics (Gait, Face, etc.)

Introducing/Using **unobtrusive sensors** for activity-related signals
- Sensing seat
- Wireless Physiological
- Cameras

Designing **new application scenarios** for unobtrusive authentication and monitoring
- Fixed position/seat pilot
- Fixed workplace pilot

Increased performance

Increased unobtrusiveness and security enhancement

ACTIBIO: Project Innovation

Project summary:

Biometric authentication and monitoring using activity-related signals for the enhancement of security and safety in controlled environments

- Novel **physiological** and **behavioural** biometrics
  - Biodynamic features that are based on the response of the person to specific stimuli while performing specific work-related activities.
  - Fully Unobtrusive and fully integrated in an Ambient Intelligence environment
- Novel **activity-related profile creation** and **multimodal fusion**
  - Dynamic behavioural profile of the user (face, gesture, gait, body dynamics-wearable sensors)
  - Physiological profile of the user (analysis of EEG and ECG)
  - Fusion algorithms for the multimodal profile creation
- Novel **biometric databases** based on activity-related events
  - Collection and initial analysis of activity-related event data
- Novel **applications**
  - Continuous authentication and monitoring based on activity-related patterns paves the road for new security standards
- Novel **algorithms**
  - Novel decision making methods for the authentication and monitoring of the individual

ACTIBIO: Project Innovation

- ACTIBIO proposes measuring the reaction of the users to specific stimuli. This approach is pioneering and not yet explored in the literature
- ACTIBIO's approach is expected to create huge new potential to the biometric research
- ACTIBIO proposes new methodology for the use of:
  - ✓ Physiological modalities: EEG, ECG
  - ✓ Behavioural modalities: face and gait dynamics
  - ✓ Wearable sensors and sensors integrated in the infrastructure
  - ✓ Soft biometrics (e.g. height, weight and body structure)
- Continuous unobtrusive authentication and monitoring through the exploitation of the new types of biometrics
- Multimodal biometrics authentication combined with monitoring procedure of activity-related behavioural and physiological patterns are examined and tested within ACTIBIO for the first time in the industry.
- New levels of unobtrusiveness for the subject will be explored via the use of novel sensors as well as the implementation of ACTIBIO prototypes that allow authentication on the move based on activity-related signals.

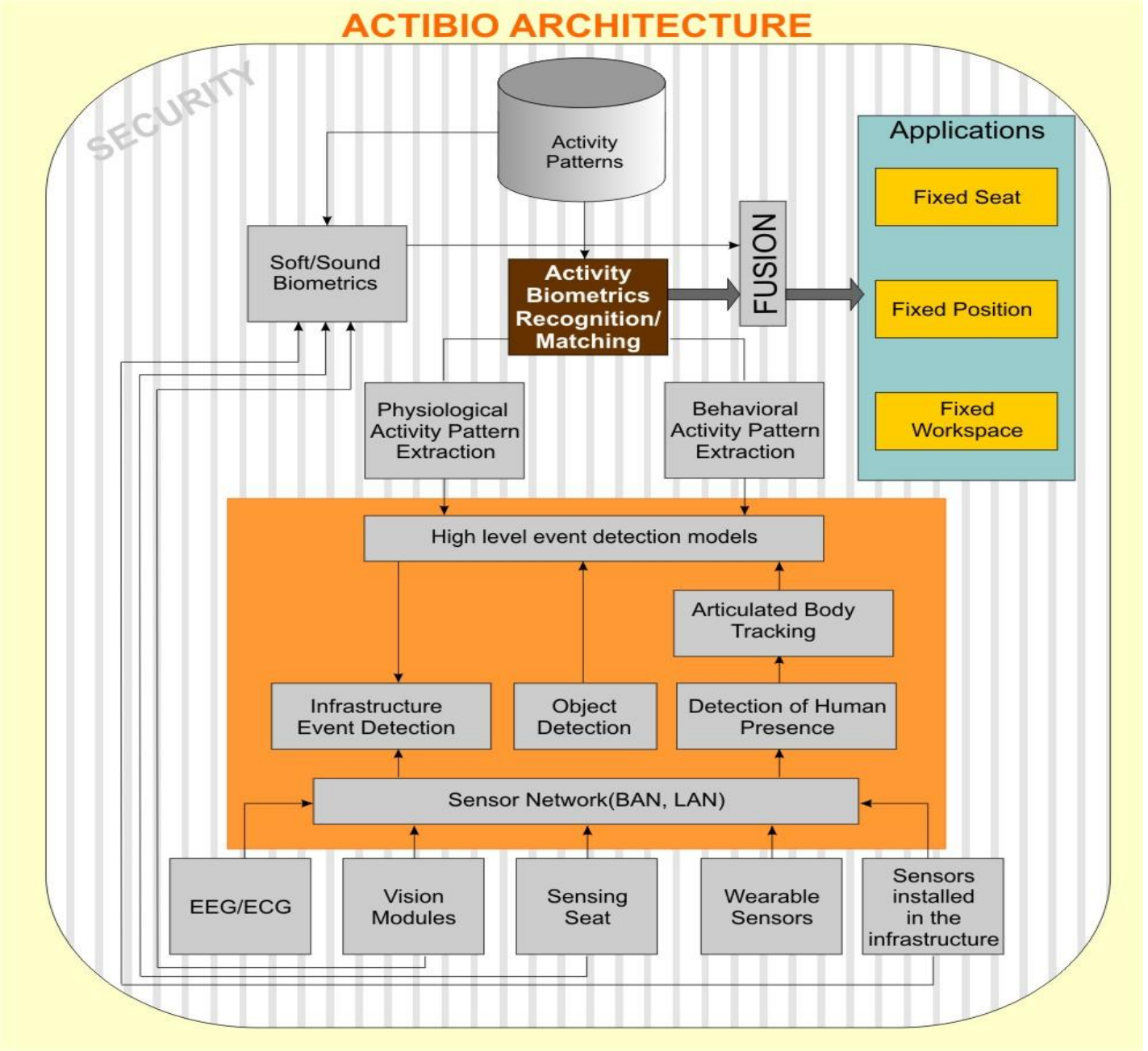
ACTIBIO: Consortium Partners

- Public authorities (1)
  - Baudirektion URI, Gotthard-strassentunnel (Switzerland)
- Industries (1)
  - ALCATEL-LUCENT (Germany)
- Research Institutes (3)
  - CERTH (Greece)
  - EURECOM (France)
  - CSSC (Italy)
- Universities (3)
  - King's college London (UK)
  - University of Pisa, UNIPI (Italy)
  - University of Catalunya, UPC (Spain)
- SMEs (3)
  - STARLAB (Spain)
  - G4S TELEMATIX S.A. (Greece)
  - Teletel (Greece)

Strong consortium

- Scientific expertise: computer vision algorithms, human detection techniques, biometric recognition algorithms, multimodal biometric fusion
- Industrial expertise: software and hardware providers, security software design and development, distributed database design and implementation

ACTIBIO: Architecture



ACTIBIO: Project pilots

- ACTIBIO proposes three innovative pilots targeting the secure and continuously operation of machines and networked infrastructures

  - ✓ Fixed position/seat

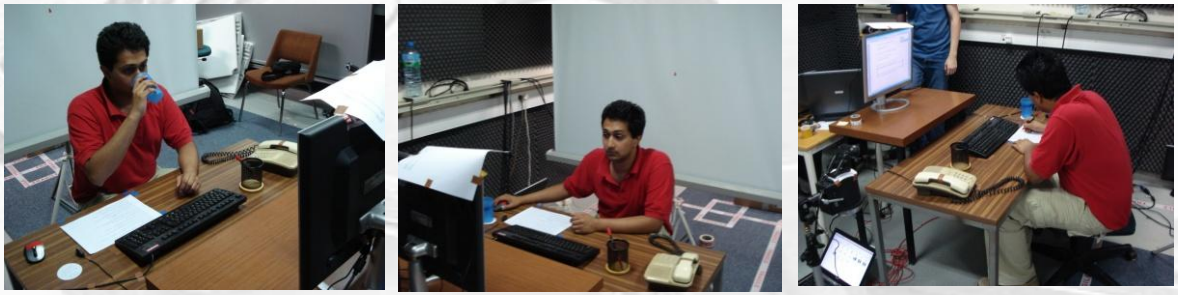
    Office/Laboratory pilot (**G4S**)

  - ✓ Fixed seat position pilot (**CERTH**)
    (Driver authentication + monitoring)

  - ✓ Fixed workspace pilot (***G4S/GST***)
    (unobtrusive authentication)

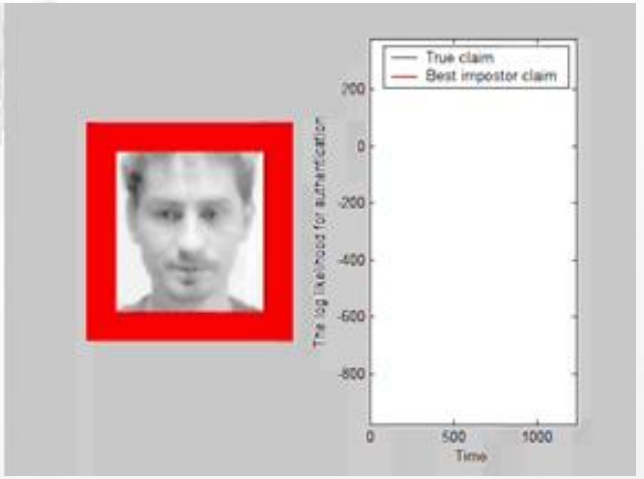
ACTIBIO: Demos (I)

- Fixed Seat/Office



Pilot Setup

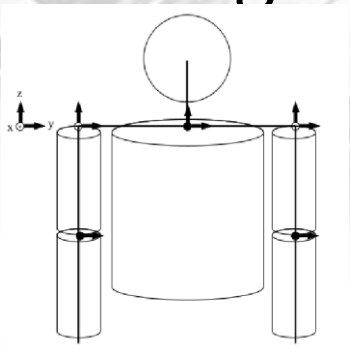
Multi – sensorial Monitoring



Multimodal Authentication & Monitoring

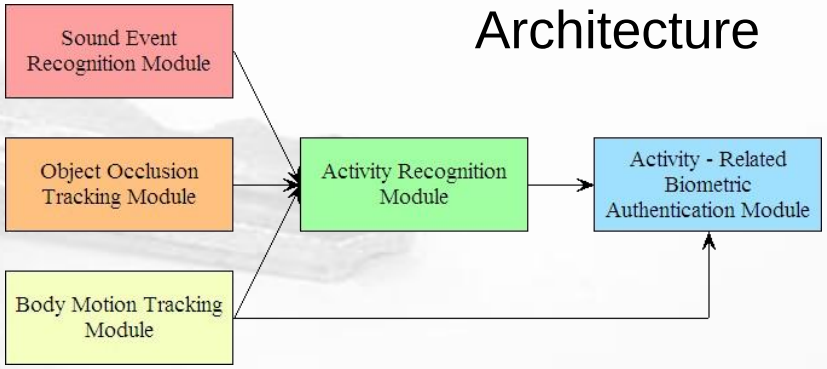
ACTIBIO: Demos (II)

- Representation, Feature Extraction and Algorithm Development

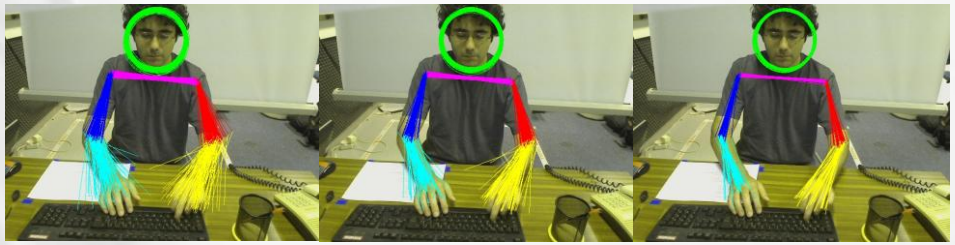


3D Body Model

Activity – related Biometrics Architecture



Feature Extraction

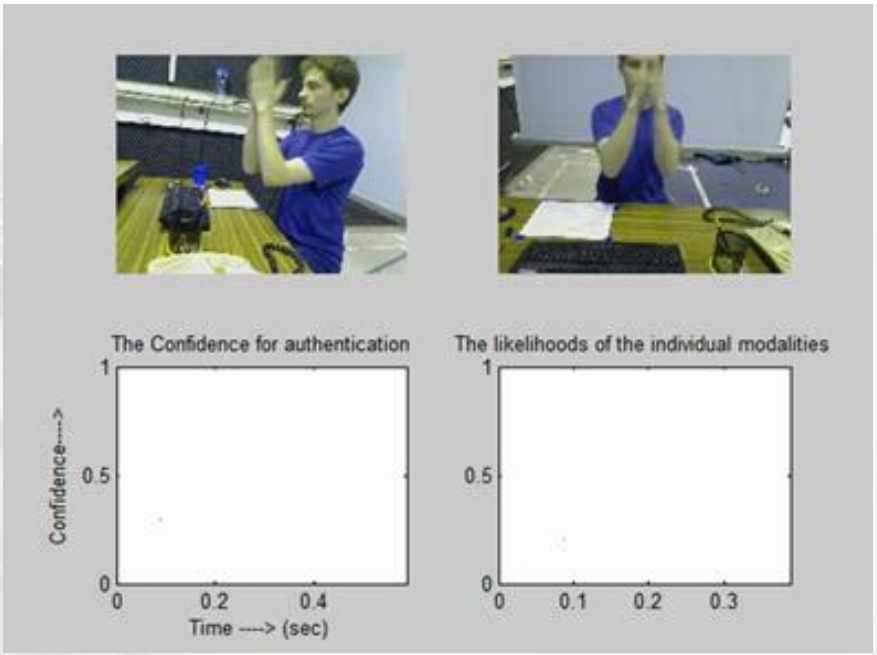


Body Tracking with Annealing Particle Filtering

ACTIBIO: Demos(III)

- Body Tracking & Multimodal Fusion

3D Body Tracking for Fixed Seat/Office Pilot



Fusion of different Modalities for Final Authentication Inference