

A PROPOSAL FOR STRUCTURED ACTIVITIES IN BIOMETRIC IDENTITY AUTHENTICATION

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ABSTRACT

This paper details an expression of interest (EoI) in the area of "biometric identity authentication". This EoI was submitted in response to an invitation made by the EC as part of its preparation of the Sixth Framework Programme. The work in this area is to be supported by a proposed network of excellence (NoE). This will be formed by regrouping the critical mass of expertise required to promote Europe as a leading force in the field. The paper discusses the main objectives of work in this area, and proposes an approach to achieving these. The appropriateness of European-wide activities in the field of biometrics is justified, and a discussion on the availability of the expertise and resources for achieving the objectives is presented. Finally, it is shown that the proposed network of excellence can significantly facilitate progress in the field through an appropriate integration of research activities in Europe.

1. INTRODUCTION

The proliferation of information access terminals coupled with the increasing use of information sensitive applications such as electronic commerce, e-banking and health care have triggered a real need for reliable, user-friendly, and commonly acceptable control mechanisms for accessing private and confidential information. The purpose is to protect the individuals who use such applications as well as the organisations offering them.

In addition to controlling access to personal information and preventing fraud, such mechanisms are also required for the purpose of security in general, i.e. ensuring of the safety of citizens and society at large. The recent worldwide events have indeed confirmed the importance of providing the law enforcement and security agencies with effective means to establish the identities of individuals.

The conventional means of identity verification for access control such as passwords/passports, and personal identification numbers/identification cards can easily be compromised. In view of this, it appears that the required optimal reliability in determining the identities of individuals may only be achieved through the use of biometrics. The main advantage of biometrics is that it bases the authentication on intrinsic aspects of a human being. Although, up until quite recently, the use of biometrics was limited to that in forensic applications, its potential advantages and the great promise it holds have resulted in the technology being considered for a variety of

other applications. Because of this, recent years have witnessed considerable acceleration in research activities in various aspects of biometrics ranging from devices and methods for capturing biometric data to techniques and algorithms for biometrics-based authentication.

2. OBJECTIVES

The main objective is "to investigate biometric identity authentication for the purpose of meeting the trust and security requirements in our progressing digital information society, through effective and dynamic technologies".

In operational terms, the objectives are envisaged to include the following.

- a. To investigate unimodal and multimodal biometric methods for identity authentication.
- b. To facilitate the practical utility and employability of the technology by identifying and addressing technical challenges.
- c. To investigate effective solutions to application specific problems.
- d. To contribute to the introduction of standards and common means of evaluation.
- e. To explore and address social and legal issues (e.g. attitudes of users, security vs. privacy).
- f. To regroup European expertise in the biometrics field in order to achieve the critical mass required.

3. GENERAL APPROACH

The approach proposed consists of several categories as defined below. Although each of these categories will be undertaken by a different sub-net, it is envisaged that there will be an appropriate degree of interaction amongst them.

3.1. Definition of a collaborative program

The study of biometrics has already been undertaken in a number of European projects since 1994. Some of these projects are COST 250, PICASSO, M2VTS, COST 275, VIRSBS and BANCA. The first two projects in this field (i.e. COST 250 and PICASSO) focused only on the use of voice modality. A conclusion of these projects has been

that identity verification based on voiceprint only has not yet reached the level of reliability required for its wide use in practice. In the M2VTS project the emphasis was placed on multimodal verification schemes. The different modalities present were face and voice. One of the major conclusions has been that verification using multiple modalities leads to better results. The next natural step has been that of using more than two modalities. The current investigations in COST 275 are concerned with the use of fused-modalities for identity verification over the Internet. The use of multiple-modalities for identity verification has also been the objective of the BIOMET project in which research is based on the use of up to five different modalities.

The intention of the proposed programme is to investigate unimodal and multimodal biometrics on a far larger scale, and without discarding any type of modality a priori. It is envisaged that this programme, which will be based on structured cooperation, will significantly benefit from the experiences gained in BIOMET and COST 275 as well as those in previous projects.

3.2. Development and evaluation platform

Several databases have been produced in the framework of the previously mentioned projects. One of the first goals of the Network will be to collect all these databases and to take advantage of the experience acquired previously to complete them, particularly, in terms of modality types. These databases will be distributed thanks to the association with ELDA which has already distributed the M2VTS and Biomet databases. The Network goals are, however, more ambitious, and include generating a consistent follow up of the scientific results obtained with the databases previously. This will facilitate the plan for offering the researchers, integrators and end-users a valid framework for the evaluation of different biometrics solutions.

During the **acquisition phase** (construction of the database), the following points should be addressed.

- a. Initial design of the database, including the choice of modalities and the definition of the evaluation protocols;
- b. First acquisition campaign;
- c. Normalisation of the acquisition protocols (including initial evaluations);
- d. Other large-scale acquisition campaigns (on the same site and/or other sites), including time lags to record the human intersession variability.

During the **exploitation phase** we suggest to address the following topics.

- a. Design of a common evaluation protocol;
- b. Organisation of evaluation campaigns where multiple sites will be using the common evaluation protocol;
- c. Detailed study of the results, and the creation of a common "repository" of all the

experiments, together with the results obtained and conclusions. This repository should be updated following each new set of experiments with the database.

The creation of the repository is, in our view, one of the main goals of this part of the project. It will help avoiding the repetition of experiments that have already been carried out by others, and will lead to better exploitation of the database. This repository will lead to a better exploitation of the database.

3.3. European certification centre

Up to now, biometrics (except for fingerprint) has essentially been experimented at a restricted level (employees, members of a specific group) with more or less success, and its introduction in everyone's everyday life raises some non-technical, societal and usage-related questions. Biometrics can be employed in a great variety of applications ranging from PC/network access, physical access, citizen identification, retail and point of sale, e-commerce, surveillance and criminal investigation. Biometric network access and e-commerce identification is expected to grow at a rapid pace in the next few years. PKI and encryption can secure data over the network but they don't necessarily identify who is communicating. Biometrics can be used to identify those at both ends of the transaction. Moreover some modalities necessitate an explicit action from users. Therefore they can lead to a legal verification tool. It is believed that the relationships amongst biometrics, cryptography and network security will have to be revisited and re-established in more depth.

Different types of biometrics modalities have been introduced so far which can be classified as physiological ones: fingerprint, facial-scan, iris-scan, retina-scan, hand-scan and behaviour ones: voiceprint, dynamic signature, keystroke-scan. Physiological modalities are considered as more robust but they are also more intrusive, contrary to the behaviour ones. Some products concentrate on one modality only (for example fingerprint or iris-scan) due to their high discrimination power. However, the suitability of each modality to a given application depends on various factors including the attitudes of users and their personality as well as, the operational environment and conditions.

A common fear is that biometrics data could be stolen or misused. Some American working groups have already proposed certain principles in order to guarantee privacy and to limit identity theft. They advise users to keep strict control in private sector applications and propose the introduction of new laws that carefully regulate the use of biometrics in the public sector. These initial recommendations will have to be studied in more depth in the European context.

It should also be noted that the combination of biometrics with smart cards gives an answer to many questions and concerns about privacy issues, since it eradicates the need for the global storage of biometric data. In addition, these systems can work offline, without connecting to a central

database server, eliminating the questions of network security.

One sub-network will be devoted to the study of these questions, particularly in relation to national organizations, end-users, industry, and legal matters.

The tasks in this sub-network will include:

- a. the definition of scenarios in order to evaluate the potential usefulness of different biometric modalities in different commercial situations,
- b. the description of the real commercial and forensic conditions through specific databases and the evaluation of algorithms in real operational conditions,
- c. the definition of common programming (coding) exchange rules or standards to test and share biometric algorithms in the commercial and forensic applications,
- d. the evaluation of the human acceptance of the different modalities with respect to privacy and security, and
- e. the development of large-scale pilot tests in close collaboration with industry.

3.4. Technology integration

One of the important issues in biometrics is computation and sensing technologies. Technology integration and exploration are strongly related to different usage and application contexts. In this perspective, we will conduct a comprehensive and application-oriented survey and study of the available technologies and their integration, including biometric signature sensors, parallel computation, portable computation platform such as PDA, smart cards, etc.

Integration of multi-modal biometric modalities is strongly based on a thorough understanding of the different sensing technologies and of the associated signal processing. A fully successful multi-modal fusion can only be obtained through this investigation.

The new emerging technologies, especially the sensing technology related to micro machined sensing technologies and integrated smart sensors, are expected to have a strong impact on biometrics. Through their miniaturised size and their particular characteristics, they are expected to provide opportunities for new applications and at the same time to introduce new technological challenges.

3.5. Society awareness

The Network will initiate the development of associations for raising the awareness of the public, opinion makers and policy makers about biometric technologies and their uses. These groups will be mainly composed of manufacturers, integrators and end-users of biometric technology. It is thought that such awareness is fundamental to the acceptability of biometrics and also to the emergence of

new laws, like the «Electronic Signatures Act», for example.

4. NEED AND RELEVANCE

i) Currently, there are a number of commercial identity verification systems developed using various types of biometrics such as fingerprint, human face, hand shape, iris pattern, retina map, voice, and handwriting signature.

However, some critical problems still exist:

- **Performance:** Most of these systems use a single modality (or at best, two modalities) and thus usually lead to poor performance in real conditions (e.g. presence of background noise, variable lighting).

- **User-generated variability:** A biometric signature is strongly related to the physical state of a person, which can be either difficult to capture or even altered during his/her life time (e.g. voice may be altered with illness, a finger may be injured, presence/absence of a beard)

- **User acceptance:** This aspect is very often neglected despite its primary importance to guarantee the success of a biometric application. For example, fingerprint recognition is sometimes perceived as linked with forensic investigation and may therefore be directly rejected by some users. Forensic biometric applications are also sometimes rejected by the citizens, partly because of lack of information and understanding.

- **Sensor/condition variability:** It is also well known that the performance of biometric technology can significantly degrade when a mismatch exists between the training condition and testing environment.

These open questions are indicative of the necessity for a common research program in the forthcoming years in order to evaluate the different biometric modalities, and also to enhance the effectiveness and acceptability of biometrics-based identity verification for different applications and under different operational conditions.

The study of multimodal person authentication will lead to a more flexible integration of the unimodal methods, in regard to the performance of the algorithms and to the user profile. For example the choice of the modalities could be driven by the degree of confidentiality needed for a certain task and/or by the user preferences.

ii) Obtaining a better understanding of the processes for discriminating individuals based on biometric data, is a common aim in several disciplines of forensic science: analytical results from anthropometry, biometry and biochemistry can be used to infer the identity of forensic traces produced by human beings, e.g. marks (finger, ear), behaviours (speech, handwriting), biological material (DNA, hairs, bones, teeth) or still and moving images (face, ear, height, walk).

On the one hand, a consensus exists in most of these forensic disciplines upon a common theoretical framework for the interpretation of the analytical results. On the other hand, the practical application of this theoretical

framework currently poses unsolved problems in most of the forensic disciplines dealing with biometric data.

One sub-network, initiated by the Forensic Speech and Audio Analysis Working Group (FSAAWG) of the European Network of Forensic Science Institutes (ENFSI), will be devoted to significantly improve the understanding and the practical use of the theoretical framework for forensic biometrics, and to develop an interpretation of the analytical results that is consistent and common for all the forensic biometrics. This approach is envisaged to help provide the European judicial systems with relevant forensic information in a way that is understandable and useful for decision-making.

iii) Currently, as far as biometrics is concerned, each European country has its own particularities regarding the usage, legislation, ethic, privacy, etc. These issues will have to be studied and discussed in some specific working groups in order to come up with solutions that are acceptable to all, if possible.

5. EXCELLENCE

Europe has already acquired valuable knowledge and expertise in the field of biometrics through several actions and projects. This Network will regroup the leading universities and research centres in the field, which have been involved in different national and European projects and collaborations both in the past and at present.

GET (Groupe des Ecoles des Télécommunications) is an Education and Research public establishment in the field of Information and Communications Sciences and Technologies. It was created in 1996 to federate the ENST (Ecole Nationale Supérieure des Télécommunications in Paris-Télécom Paris), the ENST Bretagne (Ecole Nationale Supérieure des Télécommunications de Bretagne, in Brest and Rennes), the INT (Institut National des Télécommunications in Evry) as well as 3 other affiliated institutes created through partnerships: ENIC (Ecole Nouvelle des ingénieurs en Communication) with the Université de Lille, Eurecom with the EPFL (Ecole Polytechnique fédérale de Lausanne), IAAI (Institut des Applications Avancées de l'Internet) with the Universités de l'Académie d'Aix-Marseille.

Research is the basis of teaching activities; GET has established numerous links with the professional organisations aiming at economic competitiveness and social concern of the developed technologies; Various institutes within GET take an active role in the national research programmes in the field and participate in numerous European and international contracts. The research activities rely on a large set of competencies spanning from basic technologies, signals and communications, computer and telecommunications networks, to social and economical issues of IT. They are consolidated in a common program gathering 450 faculty members, 300 PhD students in communication systems and networks, multimedia information processing as well as direct applications to the information society (e.g. e-

learning, e-health). GET has a great experience in the field of Biometry. It has initiated the BIOMET (Multimodal Biometric identity Verification) project, with two main objectives: to build a database, from good quality sensors, containing different modalities such as voice, speech, dynamic signature, fingerprints etc...and to study the potential benefits of biometric data fusion. BIOMET's database will serve as a first test platform in Biomet-net.

COST 275 (biometrics-based recognition over the internet) regroups a total of 17 partners covering a broad spectrum of European countries. The main objective of this Action is to investigate effective methods for the recognition of people over the Internet, based primarily on voice and facial characteristics, in order to facilitate, protect and promote financial and other services over this growing telecommunication medium. As implied above, the scope of the work also includes investigations into the usefulness of other types of biometrics and their integration into the proposed technology.

Besides these important academic forces, which will be mainly involved in the technological aspects of the research, the support of industrial partners will be fundamental in order to study integration issues. Some leading industrialists, who are involved in smart-card technology or PDA integration, have already joined the Network. Additionally, there are a number of potential end-users in the proposed Network, who are envisaged to make significant contributions to the usage research.

Partners list:

The following members of COST 275 will participate in this Network: **France:** GET, Université d'Avignon, Institut d'Informatique et Mathématiques Appliquées de Grenoble, IRISA, Rennes, **Spain:** Polytechnical University of Madrid, University of Vigo, University of the Basque Country, University Politecnica de Catalunya, **Greece:** University of Thessaloniki, **Italy:** Fondazione Ugo Bordoni, Università di Sassari, **United Kingdom:** University of Hertfordshire, University of Wales Swansea, University of Surrey, **Switzerland:** Institut Dalle Molle d'intelligence artificielle perceptive (IDIAP), Université de Fribourg, Swiss Federal Institute of Technology Lausanne (EPFL), **Sweden:** Halmstad University, KTH Royal Institute of Technology **Belgium:** Royal Military Academy Belgium, Université catholique de Louvain, **Slovenia:** University of Ljubljana, **Poland:** Wrocław University of Technology, **Croatia:** University of Zagreb.

Belarussia: Belarus Academy of Sciences in Minsk, **Czech Republic:** Czech Technical University, **Turkey:** Bogaziçi University, Koc University, Istanbul, **Bulgaria:** Institute of Information Technologies Sofia, **Germany:** Darmstadt University, University Magdeburg and HTWK Leipzig University of Applied Sciences, **Austria:** Vienna University of Technology, **Spain:** University of Zaragoza, Carlos III University, Madrid, **Italy:** University of Bologna, **United Kingdom:** University of Buckingham.

Forensic laboratories and organisations:

Fondazione Ugo Bordoni, Italy, the forensic Science Service, United Kingdom, "Forensic Speech and Audio Analysis Working Group" (FSAAWG) which is part of the "European Network of Forensic Science Institutes" (ENFSI), Spain Guardia Civil, Basque Police (Ertzaitza, Gobierno Vasco), National Institute of Forensic Expertise ñ Ministry of Justice, Romania, Acoustics Research Institute of the Austrian Academy of Sciences, ATVS-Polytechnical University of Madrid (UPM), Bundeskriminalamt, Section Forensic Speech and Audio, Germany, Forensic Science Centre of Lithuania, The Institute of Forensic Science and Criminology of Ministry of the Interior in Sofia, Institute of Phonetics, Trier University, Germany.

Industrial partners and End-users:

France: ST Microelectronique, France Telecom, Bouygues Telecom, Gemplus, OPSIS, ELRA/ELDA, **Germany:** ORGA Kartensysteme GmbH, ZN Vision, Bochum, **Spain:** Telefonica Moviles, Telefonica I+D, e-Business Innovation Center of IBM, Madrid, Biometric Technologies, BBVA, (Banco Bilbao Vizcaya Argentaria), **Belgium:** Keyware, **Lithuania:** Neurotechnologija Ltd., **United Kingdom:** OmniPerception Ltd, Fulcrum Voice Technologies Ltd. **Italy:** Arakne, Informa, Biometrika.

Non-European partners: Panasonic Speech Technology Laboratory of Panasonic Technologies Company, USA.

6. INTEGRATION AND STRUCTURING EFFECT

Most partners are largely involved in National actions. IDIAP has recently been selected as the "Leading House" of a large National Centre of Competence in Research in multimodal/biometric interaction.

Moreover, a pan European co-operation already exists through different types of projects: COST 275, which has already been mentioned, is concerned mainly with biometrics-based recognition on the Internet. Some IST or ACTS 4th and 5th framework projects have also supported the European research and development in the field of biometrics, in the past ten years. M2VTS (ACTS, 1995-1998) "Multimodal Verification for Telesurveillance and Security Applications", BANCA (IST-1999-n°1159) "Biometric Access Control for Networked and e-Commerce Applications" and VIRSBS (IST 21894) "Visual Intelligent Recognition for Secure Banking Services" research projects, all in biometrics, were co-initiated by the members of this consortium. Some partners are (or were) also involved in other EC projects: MUHCI (RTN, 2000-2003) Multimodal Human Computer Interaction, EAGLES, CAVE, PICASSO, ECVision (IST Project 35454), SAFE: Secure Access Front End (TRIAL Start-Up -2000-2002), MTM (speaker verification), BIOTEST which aimed at developing standard metrics for comparing biometric devices, and establishing testing facilities for such devices.

The AVBPA conference was born by initiative of EU partners. AVBPA97 and AVBPA01 have been organized by

partners in this Network, while AVBPA99 was organized in USA. The ISCA Workshop on speaker identification (Martigny, 1994, Avignon 1998, Crete 2001), COST 250 workshops on speaker recognition (Spain 1996, Greece, 1997 and Turkey, 1998), BKA and OISIN II meetings on forensic speaker recognition (Wiesbaden 1999, 2002), the international workshop on Advances on Facial Image Analysis and Recognition Technology (with the connected special issue of the Image and Vision Computing journal) and the international workshop on Biometric Authentication have also been organized by partners in this Network.

Although considerable experience and expertise have been gained through the projects stated earlier, these activities have been somewhat disjointed and have had limited interaction. These together with the multidisciplinary nature of the field indicate that the way forward in this area should be based on the integration of coordinated activities undertaken by a Network of excellence. It is believed that such an approach would greatly enhance the progress in the field and would facilitate the provision of effective technologies to meet the security and access-control requirements in different applications.

The Network will attempt to complete the existing development material (e.g. databases), and research results in order to provide real, up to date, biometrics solutions.

The Network will facilitate research and introduce evaluation standards through the creation and management of a European database with several modalities and through the development of evaluation platforms.

Some biometric standards are beginning to emerge (BioAPI) in order to help industry easily integrate the full range of biometric devices into any solution. The Network will also be involved in this kind of standardization efforts.

There will also be a structuring effect in Europe by raising the related ethic and societal questions and by working in association with European regulation authorities, to settle common privacy rules, common social habits, etc.

The past experience of the consortium in the dissemination of scientific results will be greatly helpful and used in the organization of workshops, conferences and similar events.

Moreover, the Network will facilitate the transfer of knowledge and expertise across Europe by introducing research degrees programmes as well as Post-doctoral programmes.

Exchanges between the participants will be facilitated by an organization in sub-networks and by the use of e-communications (e.g. emails, e-conferences).

The proposed Network will aim at establishing close links with other "networks of excellence" and "integrated projects" in the security domain. There are already close links with a number of identified integrated projects. These include IRISEP "Identification through iris patterns", coordinated by TRT/France, "Interoperable Multifunction Personal Trusted Devices", coordinated by Gemplus/France, "Personal Trust Device" coordinated by IMEC and Gemplus/France, Telecontract coordinated by

INFORMA/Italy, ICAF "Identity Control with Automatic Face Recognition", coordinated by ZN vision/Germany and Biometrics-based Authentication Infrastructures (BAI) coordinated by Buckingham University/UK. Moreover, some partners are also currently involved in certain aspects of the Connex security including cryptography, watermarking, and multimedia (NoE Semantic-Media coordinated by GET/France).

7. CONCLUSION

An expression of interest in biometric identity authentication has been described in detail. The need for the advancement of the biometrics technology has been discussed and the objectives to be met for this purpose have been set out. As part of the discussions, an analysis of the work required in order to achieve meaningful progress in all aspects of biometrics is also presented. This has been based on the overall objectives, and with reference to the ongoing and completed activities in the field. Using this analysis, a comprehensive plan of work has been presented which covers various facets of biometrics ranging from development tools and technology integration to social and legal issues. Moreover, based on a description of the available expertise and resources, it has been shown that through a network of excellence, the activities can be appropriately structured and the cooperation and progress in the field effectively enhanced.

8. REFERENCES

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