Title: Technical issues in optimizing border checks and the role of biometrics; why EU Border Authorities should accelerate a Multifaceted Biometrics adoption

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Abstract

In the current situation where terrorism has become a dire and global concern, daily border crossings are fluctuating, further checks are being reinforced at border control procedures, biometric data can potentially contribute to a faster, more secure and feasible verification of people's identity; thus tackling any related threats and constraints rising from the aforementioned matters. In light of this, a survey has been conducted within the Horizon 2020 "Intelligent Portable ContROl SyStem - iCROSS" project, in close interaction with various European border authorities which aimed to extract any problems during their daily routines and how the system to be developed could assist them towards a more effective and less risky implementation of their duties.

Introduction

Terrorist attacks and participation in terrorist organizations by EU citizens is on the rise. "Radical organizations have been successful in recruiting worrying numbers of young European citizens, born and raised in Europe, who go on to commit violent acts inside" [1]. To cope with this, the European Union decided in favour of a series of legal changes in the Schengen regime, the most recent and interesting is the systematic control. In effect from 7th of April, Regulation (EU) 2017/458 as regards the reinforcement of checks against relevant databases at external borders, makes checking EU citizens and their travel documents in the databases compulsory; enhanced with biometrics checks, where needed. This means that at the border gates, instead of checking EU citizens randomly, every EU citizen should be checked. So far only third country citizens were under such rule. This will have a very strong impact on the dynamics of cross-border traffic. To consider the numbers for example in Hungary, third country citizens are representing 22% of total border crossings at Hungarian borders, 78% were Hungarian nationals or other EU citizens and persons enjoying the right of free movement. In 2015, this meant that of the 42.2 million persons crossing Hungarian external borders, 9.3 million of them were checked, because they were third country citizens and about 3 million people were checked on a random basis out of all the EU citizens. From the 7th April 2017, all 32.9 million EU citizens will be required to be checked.

The solutions provided by the project, especially the pre-arrival registration and the biometric identification of persons can speed up the process [2], while the wearable intelligent border control equipment will allow extension of the control capacity even where the infrastructure cannot be physically extended (e.g. railway border crossing point) by increasing the headcount of the border control force. Without such innovative technology, a traveller could easily face the same queues and waiting times as in

the 1980s and 1990s [3], resulting in losing the benefits of a dynamic cross-border flow. This is the very core advantage of the Schengen regime, and slowing the border crossing process may result in a direct decrease in the average 2.3% GDP increase effect of Schengen [4]. Solutions like the ones proposed by the project can keep waiting times at low levels, while providing the increased security the EU is looking for, all at the same time. Moreover, the project opens the road for the next generation enhancement of the integrated border management system of the EU [5].

Methodology and Requirements Extraction

Collecting the requirements for the project required an in-depth knowledge and analysis of the border point crossing function from the user perspectives. The requirements methodology utilized multiple techniques with their own specific values, in order to gain a complete picture. These techniques depend on a number of factors, such as the availability and location of stakeholders, as well as the users' knowledge of the development process and methods. For the specific case of the project, and assuming that a representative sample of border guards and border managers could be available for face-to-face interaction, site-surveys, workshops, questionnaires and structured physical interviews have taken place.

More specifically, site surveys and workshops have been considered helpful for gathering information on current processes; this opportunity for observation overcomes the difficulty that some people face to explain what they do and why, especially when having their work routine down to a habit. The opportunity to monitor how the actors are performing their job helps to achieve a better understanding of the entire picture, and to experience the work and the different tasks/ routines of the users. For this reason, a visit to the Tompa-Kelebia border crossing point, organized by the Hungarian Police, constituted a unique opportunity to observe how the procedures are implemented in a real situation and provided a better understanding of how new technologies can fit in these procedures. Moreover, face-to-face contact with users through individual interviewing has been realized as the primary source of requirements and an important way to gather and validate their requirements. For this reason, in-depth, semi-structured interviews and questionnaires were designed and conducted using a representative sample of employees. The aim of the interviews was to identify any problems faced when performing their daily routines and to facilitate how the proposed new system could assist them towards a more effective and less risky implementation of their duties. The interview was designed for two officer classes: Border Guard Managers (Head of Shift or above) and Border Guard Officers (Passport Control Officers, Document/Vehicle Experts) and consisted of two parts, a list of queries (dichotomous and polytomous response format) and several open questions. Each officer was briefed using a participant information sheet and was invited to give informed consent. The interview was anonymous. The categorical answers from the interviews were analysed using elementary data analysis techniques [6].

Market Opportunity: Outcomes of the research

Decisions on whether and how to implement biometric solutions within the research project were driven by the results of the border guard agents interviews. These answers based on their position, experience and working conditions at the border crossing points in Hungary, Greece and Latvia, depicted the end-users requirements which must be taken into account during the implementation procedure of the project.

Hence, *what are the immediate preferences of the respondents in an insider's perspective regarding the use of biometrics in the border control procedure? What are the challenges and new opportunities that the research project should consider?*

The key findings can be summarized to the following:

Palm vein scanner technology was deemed to be a very reliable and easeful way of obtaining unique patterns for identification and was recognized as being far more secure than fingerprints. The data obtained during palm vein scanning is impossible to counterfeit and as a result such scanners provide an optimal environment for fast and secure biometric authentication. However, a remark worth mentioning, raised the susceptibility to dirt (cleanliness of hands) as a potential technical issue. The majority of the answers though, underlined the innovation of the palm vein scanners technology and proposed that the system should support palm vein scanners as the main identification tool of the travellers' identity.

<Insert Figure 1 here>

Figure 1. Palm vein scanner: detection through illumination of blood vessels via IR light (image credit: BIOSEC company)

Most of the respondents strongly stressed the usefulness of face recognition technology. The most commonly repeated argument, was that this technology could support the work of the border guard agent, who is not able to capture all the details of a face in order to identify the traveller sufficiently. Some agents were puzzled regarding the effectiveness of this technology to the intentional or unintentional changes to the image of the traveller's face (i.e. beard, moustache, scars, and glasses) which could lead to a possible distortion and inability to easily identify the traveller's identity. A few responses, indicated also a potential mismatch between face recognition and the facial photo in the passport. These answers rather emphasized that such technology was complementary to any proposed new solution and pointed out the need of connecting face recognition with data stemming from other biometric solutions.

The use of fingerprint technology was confirmed by the majority of the border guard officers as a proven way to check the validity of the travellers' visa. They also indicated the commitment and confidence in this biometric data identification technique. However it was noted that fingerprint systems had complicated procedures and large amounts of data was necessary for processing. Hence, this technology was depicted as only partially suitable and **there were strong recommendations that it should be replaced by either a new generation technology or by palm vein scanner technology**. Also, some respondents revealed that current fingerprint readers faced problems in cold weather due to the change in travellers' skin characteristics.

All respondents agreed that the biometric technologies of palm vein scanning, face recognition and fingerprints could improve the speed of the traveller check at the border. The conclusions and consequently, the end user requirements drawn by this survey are of great importance due to the fact that the survey questioned border guard's officers of different countries, representing people of varying work experience. All of the interviewed persons emphasized the need for new solutions including biometric technologies that enable the improvement of traffic flow at the border crossing. It should be noted that the **majority of the border managers and officers were eager to adopt new biometric technologies** and believed that in this way they could improve their working conditions, achieve better resources allocation and shift management.

The recommendations from border guard officers paved the way for the development of the project, where biometrics play a major role in fulfilling the expectations of the end users. The research project will incorporate biometric technologies both in the pre-registration phase (where the traveller goes through a first check and interview before the arrival at the borders in an automated way) and at the border crossing point. In order to address the above, the architecture of the system is currently being designed, to include palm vein scanners as the main identification tool, face recognition as a complementary tool and fingerprints devices already existing at the border control points in order to be in line with the existing Regulatory Framework.

Yet, the main goal of this project is to promote biometrics as a mainstream method for travellers' identification. In terms of market take-up, the use of new biometric technologies in border crossing checks is likely to be adopted worldwide due to a number of benefits: increased security, reduced checking times of travellers (entry and exit time at the border crossings, clearance time of one traveller), better management of the flow of traffic, increased efficiency and accuracy at the travellers' border checks.

Implementation Overview

The implementation of the aforementioned innovations is a complex process, which includes not only novel biometric solutions but also respective biometric analytics, detection and communication tools. The use of cutting edge biometric solutions is part and parcel of contemporary border management that needs to provide enhanced security as well as facilitated cross border movement as border authorities and officers put premium on these two aspects. Consequently, also based on the outcomes of the end-users requirements collection, biometric research within the project assumes the implementation of the face matching tool, palm vein scanner, fingerprint recognition and an automatic deception detection system.

Face recognition is a relatively well-grounded biometric solution characterized by high public acceptance, which was confirmed in the process of user requirements elicitation. The developed face matching tool will operate at two stages of cross border procedures, i.e. pre-arrival registration procedure and border crossing. The first verification will be done remotely offline. The system will retrieve the image of a traveller captured during the interaction with the automatic deception detection system and will compare it with the uploaded passport photograph. The latter verification, i.e. at the border, relies on capturing a live, high-resolution image of a traveller at a border crossing point and comparing it with the electronic image of the traveller (in case of e-passports) or passport photo page. Subsequently, the system runs the final verification, where the results of pre-arrival phase are compared with the border check results in order to determine whether it is the same person.

The face matching tool designed and implemented within the project is to overcome frequently associated problems with face recognition. For instance, the tool will consider the differences in image quality between scanned and original photograph, which is possible due to the extraction of invariant facial features including shapes, local patterns and biological features. The use of global (shapes, geometrical data) as well as local features (facial characteristics) is believed to further enhance the verification process. What is more, the face verification process will also make allowances for natural variations in lighting, aging, facial marks and expression. Additionally, the tool will be versatile in its application since it will be dedicated for a traveller's device (e.g. laptop, mobile phone etc.), which will be used in the pre-arrival phase and it will cooperate with the body mounted camera at the human agent interview at the border crossing point.

Besides the face matching tool, the project also incorporates biometric solutions such as fingerprint and palm vein recognition into the secure mobile unit of a border officer. This is to equip border guards with state-of-the-art technology giving them tools to perform more robust verification and speed up decision making process. The application of fingerprint recognition for person verification is already a well-known security measure in border procedures as travellers have their fingerprints pattern incorporated on an e-passport's chip. However, the security level of commercially available solutions is relatively low. Therefore, application of a single modality fingerprint sensor might be quite risky, especially one considering available fingerprint spoofing techniques. As a consequence, also based on the aforementioned survey and consultation with border authorities' representatives, the project enhances biometric recognition with a palm vein scanner, which is likely to counter the spoofing attempts and improve the overall security level. The palm vein scanner will perform liveness detection through the illumination of blood vessels via near infrared light source. Additionally, the implementation of palm vein scanner will not hinder the overall transaction time, which in the case of palm vein recognition is calculated to be 1 second.

What is more, a novelty developed within the project that will be tested in real life scenarios will be the automatic deception detection system. This component of the platform is dedicated to non-verbal behaviour analysis of travellers. The tool will be able to provide border officers with the level of deception estimated on the basis of a video recorded during an interview session at the pre-arrival registration phase. The component's architecture is based on the system known as Silent Talker [7], however, it will be re-engineered in order to perform a broader set of functionalities. Deployed in pre-arrival interviews, the component will conduct an observational analysis of a particular individual and generate a traveller's deception score. Furthermore, the component will be boosted by an advanced verbal and non-verbal communication border control agent avatar. The system will be able to perform the analysis of the facial biometrics (micro-expressions) as the interviewee reacts to a randomly asked question about the travel in order to determine whether the person is lying.

<Insert Figure 2 here>

Figure 2. Silent Talker technology: artificial intelligence lie detector via tiny changes in facial expressions (image credit: Manchester Metropolitan University)

Conclusions

The proposed solution aims to enable faster and more thorough border control for third country nationals crossing the land borders of EU Member States incorporating software and hardware technologies in a two-stage procedure. As identified, when interacting with border authorities in different European countries, border control requires the maximum-security level and at the same time limited operational costs and high-speed implementation of checks, procedures and respective processing. Biometrics arise as a solution, combining high security level with minimum impact in time of transit of travellers. The scope of the project is to integrate -among other technologies- biometrics: fingerprint, palm vein readers and face recognition in a user-friendly portable device which will scan and analyse biometric information of travellers in a fast, easy and secure way.

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