RELIABILITY OF FACE READERS IN DIFFICULT CONDITIONS

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Abstract

This article is focused on the evaluation of biometric readers that identify a person based on facial features. Biometric user identification is a highly topical theme these days. The most widespread areas are identification of a person on the basis of fingerprints and identification on the basis of facial features. For testing, systems were selected that identify a person based on facial features. Testing showed errors in these readers under both standard and difficult conditions. Testing was focused on reliability of acceptance authorized user. Testing was performed on the 2 biometric systems. Wrong of user acceptance was based on unfavorable conditions. Unfavorable conditions were: pollution with dark oil, pollution with soil, pollution with makeup, pollution with soot, pollution with black coal, pollution with paints. The results of the measurements showed that the measured reliability values do not correspond to those of the manufacturers. It is necessary to adapt and perfect these biometric identification systems for use in industrial areas, as they are often used in these areas as access or attendance systems.

Key words: face, biometric, reader, reliability, difficult conditions.

INTRODUCTION

Modern biometric technologies offer an automated method of establishing or verifying the identity of living or dead persons on the basis of measurable and in commutable biometric characteristics. These characteristics are demonstrable, precise and unique for each individual and no confusion is possible. The initial use of these systems was very successful, but only until methods of sabotaging them were discovered. Since then, the focus is on developing safe technologies and when introducing them, measures must be taken to minimise the possibility of sabotaging biometric sensors (ABATE, 2005; DI MARTINO, 2016).

Biometric recognition systems are currently used mainly for identifying persons entering facilities (e.g. nuclear power stations, airports, research institutes, banks, state buildings).

Other common use is for recognition of persons (e.g. when searching for specific individuals from wanted persons databases) (DI MARTINO, 2016; STROICA, 2012).

One of the frequently-used methods of biometric recognition is identification on the basis of facial features. Systems working on this principle are already available at prices acceptable for the general public and now we can find them both in commercial and state institutions. These systems can be monocriterial or more. In this article we will be measured multicriterial systems. The reliability of this readers which identifying based on facial features should be investigated (NÍDLOVÁ, 2015).

The most commonly used readers, besides fingerprint readers are readers based on facial recognition. These systems are financially acceptable and therefore are used in many industries. They find their using in industrial areas. Therefore, it is necessary to test the readers in difficult conditions that may occur in industrial areas (NÍDLOVÁ, 2015). Therefore the aim of this study is to evaluate biometric readers that identify a person based on facial features.

MATERIALS AND METHODS

Each measurement comprised twenty repeats. 80 persons were measured (16 women and 64 men) with an age range of 21 – 62 years of age. It was essential to observe laboratory conditions when performing the 3D face scan, especially with respect to lighting (lighting required by the manufacturer is 0 – 800 lx). Measurements were performed on D-Station and IFace 800. All of these devices have optic sensors. These readers were chosen because manufacturers are recommended in difficult conditions. Both use a combination of recognition on the basis of codes, finger prints and sample facial features. Measurements took place under both normal and impaired conditions. The number of false acceptances or failure to capture the user was measured. In addition, the degree of confusion between persons was scrutinised, which to a large extent is expressed in the FAR values (JAIN, 2009; RAK, 2008).

Errors in the form of false rejection of the user do not occur with these readers; there just is the possibility that the user is not identified. The time limit for recognition was set at 5 minutes. If the reader does not manage to identify the user within this time limit, the situation is regarded as a false rejection.

The term standard recognition means recognition under laboratory conditions. Values for establishing the functionality and reliability of biometric recognition systems that work on the basis of 3D face scans were collated over the course of 27 months. The two most important values were the time span during which users were admitted to the facility and the related number of accepted/not accepted (identified, not identified).

Measurement under impaired conditions was intended to simulate situations in dusty operations where smears on faces are common, and also work with lubricants and other substances can lead to dirty faces. In everyday life too, smears can appear on people's faces, for instance smeared make-up in the rain.

Measurement occurred with a selected group of 20 subjects with five repeat measurements. Black coal, earth, soot, make-up, paint and dark oils were used as soiling (RAK, 2008; SVOZIL, 2009).

A hypothesis was set: Pollution of face significantly reduces the reliability of biometric systems identification of based on facial features.

For evaluation of the hypothesis a one-sample test of relative frequencies for the parameter π (SVATOŠOVÁ, 2012).

1. H0: $\pi 1 = \pi 2$
2. Ha: $\pi 1 \neq \pi 2$
3. The level of significance was determined $\alpha = 0{,}05$
4. Testing criterion (1):

$$u = \frac{\frac{m}{n} - \pi_0}{\sqrt{\frac{\pi_0 . (1 - \pi_0)}{n}}} \quad (1)$$

where: m – the value of a successful acceptance of user under standard conditions, percent;

n – number of measurements;

π_0 – average values of reliability under adverse conditions, percent

5. Determination of the uα (from statistical tables according to the level of significance) $u\alpha = 1{,}96$
6. Critical field – K: ($|u| > u\alpha$)

RESULTS AND DISCUSSION

Fig. 1 show the percentual representation of recognitions in separate time intervals. The penultimate column of the graph shows user false rejection rate – FRR, which is stipulated to occur upon exceeding 5 minutes per attempt at recognition. The last specified value in the graphs represents user false recognition (false acceptance rate – FAR). This value appears on the graph to give the results more relevance and is taken from the total number of attempts at recognition. Fig. 1 shows measurements taken on the D-Station reader. 63 % of users were successfully enrolled into the system and were let into the facility. Also the value for both readers of just over 28 % successful recognitions within 5 minutes is very inconvenient for the user. Fig. 1 also shows measurements taken on the IFace 800 reader, and they are even less acceptable than those on the previous reader. Only 59 % of users were successfully enrolled into the system and were let into the facility. Also the value for both readers of just over 30 % successful recognitions within 5 minutes is very inconvenient for the user.

The calculations and the graphic expression thereof tell us that the percentage of false user rejections exceeds the percentage of false user acceptances by about 10 %. However, these values are extremely worrying and the question should be asked as to whether these systems are suitable for entrance security at important facilities. The results of our readings clearly demonstrate that with recognition systems based on facial features there is still considerable room for improvement.

Subjects with prominent facial features were no problem to identify. However, in contrast to standard recognition, the false rejection rate rose with the remaining subjects, see Tab. 1.

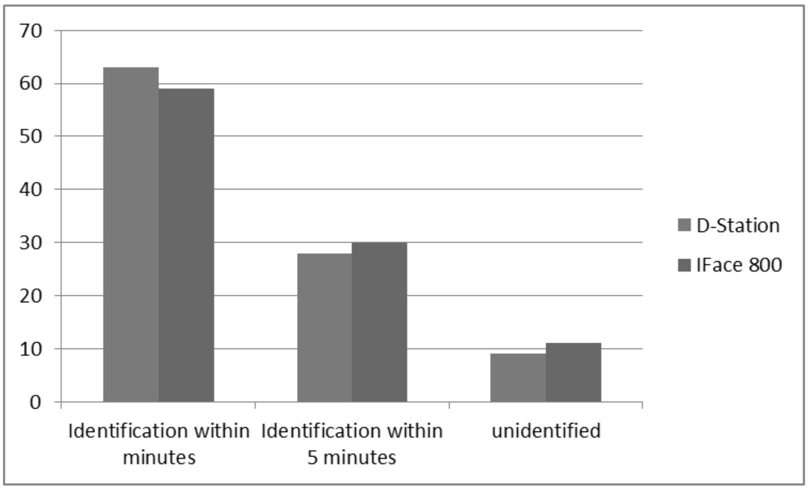

Fig. 1. – Recognition Capability of IFace 800 and D-Station Biometric Device

Tab. 1. – Percentual user acceptance with SD face readers with dirty faces

	IFace 800 – testing [%]	D-Station – testing [%]
Standard identification	84	89
Pollution with dark oil	73	82
Pollution with soil	77	79
Pollution with makeup	63	76
Pollution with soot	58	62
Pollution with black coal	48	58
Pollution with wall paint	40	51

Hypothesis: Pollution of face significantly reduces the reliability of biometric systems identification of based on facial features

Statistical calculation for IFace 800 biometric system

H0: $\pi 1 = \pi 2$

Ha: $\pi 1 \neq \pi 2$

A significance level has been set at: $\alpha = 0{,}05$

Testing criterion (1): u=4,93

Setting uα (from statistical tables, according to significance level): uα = 1,96

Critical field: K: (| u | > uα)

K: (| 4,93 | > 1,96)

H0 is rejected → pollution of face significantly reduces the reliability of biometric systems identification of based on facial features.

Statistical calculation for D-Station biometric system

H0: $\pi 1 = \pi 2$

Ha: $\pi 1 \neq \pi 2$

A significance level has been set at: $\alpha = 0{,}05$

Testing criterion: u=4,50

Setting uα (from statistical tables, according to significance level): uα = 1,96

Critical field: K: (| u | > uα)

K: (| 4,50 | > 1,96)

H0 is rejected → pollution of face significantly reduces the reliability of biometric systems identification of based on facial features.

In view of the results of the one-sample relative frequency test performed with IFace 800 a D-Station readers, the Hypothesis is rejected.

The matter of reliability of biometric systems that identify on the basis of face recognition is also being addressed by Di Martino, Luis D. et al. in their article "Face matching with an a contrario false detection control", where they pointed out the existence of two identical templates. Thanks to this, the reliability of the systems should increase distinctly. Also, in their article "Beard tolerant face recognition based on 3D geometry and color texture", authors Abate, Andrea F. et al. talk of the technology for recognition on the basis of facial features, where color texture was used in combination with 3D geometry as an innovation for increasing reliability. Constant innovation of these systems is important for increasing reliability which, as can be seen in the results of scans, is not user friendly (ABATE, 2005; DI MARTINO, 2016).

CONCLUSIONS

The measurements showed that reliability of the tested facial recognition systems differs from the values cited by the manufacturers. With such readers there are many aspects that can influence their reliability. One of these are light conditions, another is make-up in women or a moustache or beard in men; they are also very sensitive to face soiling and other circumstances. These readers can recognize a person both by fingerprints and by facial features. The question is whether or not the manufacturers concentrated more on the fingerprint option than on facial recognition capabilities. The results clearly show that the existing systems need more testing and improvement to make it possible to rely fully on the technology and to avoid unwanted confusion of persons that can lead to admission of unauthorized persons into restricted areas. It should also be borne in mind that companies will want to use these systems in industrial environments where soiling and dust nuisance is common. The results indicated that readers cannot deal with this type of problem and perform false recognitions or else recognition does not come about at all.

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