USING BIOMETRICS FOR FACIAL RECOGNITION AT AIRPORTS

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Abstract. Nowadays, biometric technologies make it possible to perform this identification or verification practically anywhere and at any time. In information technology, biometrics refers to a system of automatic recognition of persons based on their behavioural and physiological characteristics. The development and progress of this technology have been rapid in recent years. Implementing biometric facial identification by the aerospace industry will influence the next generation of biometrics. The result of this paper offers an analysis of the development of biometric technologies and a comparison of technical and biometric matching and finding out the rate of erroneous photo matching.

Keywords: biometrics; biometrics technology; automatic recognition; facial identification; technological and biometric matching

1. INTRODUCTION

Like all biometric solutions, facial recognition technology measures and compares unique facial features for identification or authentication. Facial recognition software often uses a digital or connected camera and can recognize faces in images, quantify their features, and then compare them to stored templates in a database. Biometric face sensing technology is incredibly versatile, and this is reflected in its wide range of potential applications. Facial biometrics has the potential to be integrated wherever you find a modern camera [10].

Figure 1. Facial biometrics [1]

Facial biometrics uses aspects of the face to verify or identify an individual. There are a wide variety of techniques that are used to capture facial characteristics in a way that is not significantly

affected by age, expression, lighting, or many other variables. Such techniques can include machine learning algorithms such as convolutional neural networks (CNNs) that have been trained on huge sets of facial images. It does not directly involve measuring the distance between characters. Current face algorithms describe the shape and appearance of facial features such as eyes, nose or mouth using image processing specially trained to capture discriminative and stable data combined in a numerical representation known as a face template. The same techniques can also be used to extract information about characteristics such as age or gender [10].

2. BIOMETRICS FACIAL RECOGNITION

Face recognition uses computer-generated filters to transform facial images into numerical expressions that can be compared, and their similarity determined. These filters are typically generated using deep learning, which uses artificial intelligence to process the data.

Face recognition methods vary slightly depending on the application and manufacturer, but generally involve a series of steps to capture, process, analyze, and match the captured face to a database of recorded images. These basic steps are: [2]

2.1. Detection

First, the camera detects a human face, which may be in a crowd or alone. It is easiest to recognize when the person is looking directly into the camera. However, modern technological advances allow facial recognition software to work even if the person's face is slightly tilted [2].

2.2. Facial analysis

Once detected and recognized, a photo of the face is captured and then analyzed. Most facial recognition technologies use 2D images instead of 3D. This is because 2D photos are easier to correlate with public photos or images in a database (these are usually 2D as well). During analysis, the face is divided into distinguishable landmarks - we can call them nodal points. A human face has eight nodal points. Facial recognition technology will analyze each of these points - for example, the distance between the eyebrows, the distance between the eyes, the thickness of the lips, the distance between the chin and the forehead, and many more based on the analysis [2].

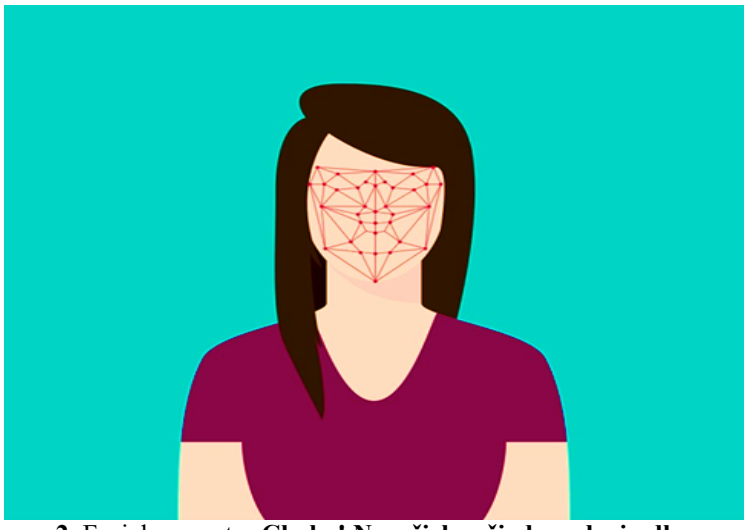

Figure 2. Facial geometry **Chyba! Nenašiel sa žiaden zdroj odkazov.**

2.3. Image-to-data conversion

After parsing, each node point becomes a number in the application database. The entire numeric code is referred to as the face fingerprint. Just as each person has a unique thumbprint, each person has a unique faceprint. This encoding facilitates easier computational comparison of newly acquired facial data with stored databases of previously recorded facial data [2].

2.4. Match

The last step of the process is finding a partner. Your face print is compared against a database of other face codes. The number of matched faces depends on the database and how many databases the software has access to. The facial recognition technology then identifies a match of exact facial features - returning the match found and other relevant information such as address and name to the user.

Several methods have been developed to facilitate and refine face identification. One of them is the gradient method - basically, it replaces the captured image with a version that emphasizes the details most important for face recognition. In this case, each pixel is replaced by a relative illumination representation, which means it shows how the brightness of the pixel compares to surrounding pixels. [10] This relative measurement makes it easier to identify the same face under multiple forms of illumination.

Another approach is projection. In this, a 2D photograph is projected onto a 3D model - for example, a cylinder. When the face is stretched around the 3D model, distinctive features that would be harder to find in a static and flat image are revealed. The projection makes it possible to overcome the difficulties associated with 2D face recognition. With this technology, you don't need an image taken under ideal conditions to achieve great accuracy [3] [10] [8].

Although facial recognition has helped many industries to improve safety, the technology is a major concern for many people. Along with the fact that the surveillance market is growing exponentially and that facial recognition systems can be found in almost every aspect of life, there are a significant amount of people who are against this kind of technology. Some of the major concerns regarding facial recognition software are described below.

Over the years, the capabilities and accuracy of facial recognition technologies have increased significantly. However, there are still limitations - especially when people apply the tips mentioned above. Under ideal conditions, a facial recognition system can have 99.97% accuracy. In the real world, however, ideal photos are rarely achieved. Lighting and positioning must allow the subject's facial features to be unobscured and clear. Aging can also increase the error rate. As a subject's face ages over time, the system is less likely to match it against a photograph of the subject from the database. Another problem is the large differences in accuracy between manufacturers. Some vendors have developed algorithms that provide very accurate results.

3. THE USE OF BIOMETRICS TODAY

3.1. Applications of biometrics

Over the next ten years, facial recognition is likely to transform airports more than any other technology. Airports in Panama, Dubai, Australia, the US, and other countries have already started with facial recognition. It is only a matter of time before virtually every international airport adopts the technology. Facial recognition offers a wide range of security benefits that can improve various aspects of air travel. Facial recognition can also be used to protect passengers and make air travel safer than ever before [8].

3.2. Facial biometrics in the world

The improvements brought about by air travel through facial recognition are significant. They offer passengers a seamless travel experience and significantly increase overall customer satisfaction. At airport security checkpoints, for example, passengers' identities can be quickly and accurately verified, significantly reducing the stress of travelling and allowing more time to dine, shop and relax before boarding. Similarly, customers can be identified and granted access to airport lounges while having a more personalized experience due to the airlines' ability to monitor individual customer preferences. Finally, passengers can experience an easy and expedited boarding process that will get them to their seats faster, which will also help reduce the number of delayed flights. Ultimately, facial recognition brings a myriad of different benefits to passengers, airports, and airlines alike. Three of the most significant benefits are in the areas of increased security, speed, and ease of travel. British Airways, for example, is now able to check in 240 customers in just 10 minutes and without causing mass queuing on the plane - a major problem with air travel [10] [3] [6] [8].

4. FACIAL RECOGNITION APPLICATION TESTING

This article is based on the experience of implementing biometrics at Dublin Airport, Ireland and at selected airports within the USA. Observations of facial recognition technology were made within the airport entry and exit process through electronic gates. Many of the challenges faced by facial recognition included inconsistent match rates, low match rates during pilot trials, network availability issues, circumvention of facial recognition, and the need for staff involvement.

4.1. Pilot testing of biometrics in the USA

Biometric recognition at entry and exit included only passengers aged between 14 and 79. For passengers outside the age range, including children, the elderly and some with reduced mobility, a standard form of identification and screening was used. Testing found an inability to compare images for specific age groups. This was one of the main factors in the low rates of biometric identity confirmation. Testing also showed that passengers under the age of 29 and over the age of 70 had lower match rates [8] [11].

Those under the age of 29 accounted for 18 percent of passengers, but 36 percent of all passengers whose photos led to a false rejection. Passengers over 70 years of age accounted for 4 percent of all travellers, but 10 percent of all travellers whose photos led to a false denial. Many of these rejections were due to the time and age difference between when the photo was taken and stored in the gallery and the age at which the live photo was captured on the day of travel. This time difference could be several years, during which time the facial features of the person may have changed [8].

The lower biometric confirmation rate was influenced by the quality of the photographs. The lighting at the airport was found to have a large effect on the quality of the photographs taken. To increase the effectiveness of facial biometrics, it is essential to ensure that passengers' faces are well lit. It is believed that variations in lighting can cause dramatic changes in facial appearance. Another factor that negatively affected identification using biometrics was photographs from a few years ago; photographs in which faces were obscured by hats, glasses, or scarves and distance contributed to affecting biometric matching rates. Such factors have also been confirmed in previous face recognition studies [12].

Table 1 summarizes the outcomes from tests of biometric systems conducted between 2013 and 2021 in the USA. The table shows that the competent authorities involved in the biometric testing of the selected sample of travellers preferred the use of biometric facial recognition technology over the standard identification method [12].

Table 1. Testing biometric technologies 2013 – 2021 in USA [10]

Test	Biometric mode	Year	Place	Result
Southwest boarder USA	Facial and iris scanning	2013 - 2016	Port of entry Otay Mesa (San Diego, CA)	Travelers preferred facial recognition to iris scanning. Limited iris records were available for matching.
Biometric mobile test on exit	Mobile fingerprint reader	2018 - 2020	10 International airports	The manual fingerprint reading process was inefficient with extensive output processing.
Face comparison 1 – 1	Facial recognition technology	2017 - 2020	Internation al airport Dulles	Facial recognition technology had minimal impact on the processing of visitor and passenger input.
Departures Information System	Facial recognition technology	2018 - 2021	International airport Atlanta Hartsfield-Jackson	Facial recognition technology had minimal impact on the boarding process and passengers.

4.2. Compliance rate during the pilot testing phase

During initial pilot testing of biometrics at Customs and Border Protection (CBP) entry and exit, approximately 15 percent of all passengers were unable to be identified. Figure 3 shows a comparison between technical and biometric match rates. The technical match rate refers to the ability of the Traveller Verification Services (TVS) algorithm to match captured photographs to photographs in the gallery, while the biometric match rate is the percentage of passenger identity confirmations by comparing the actual facial image captured to the photograph stored in the database [12].

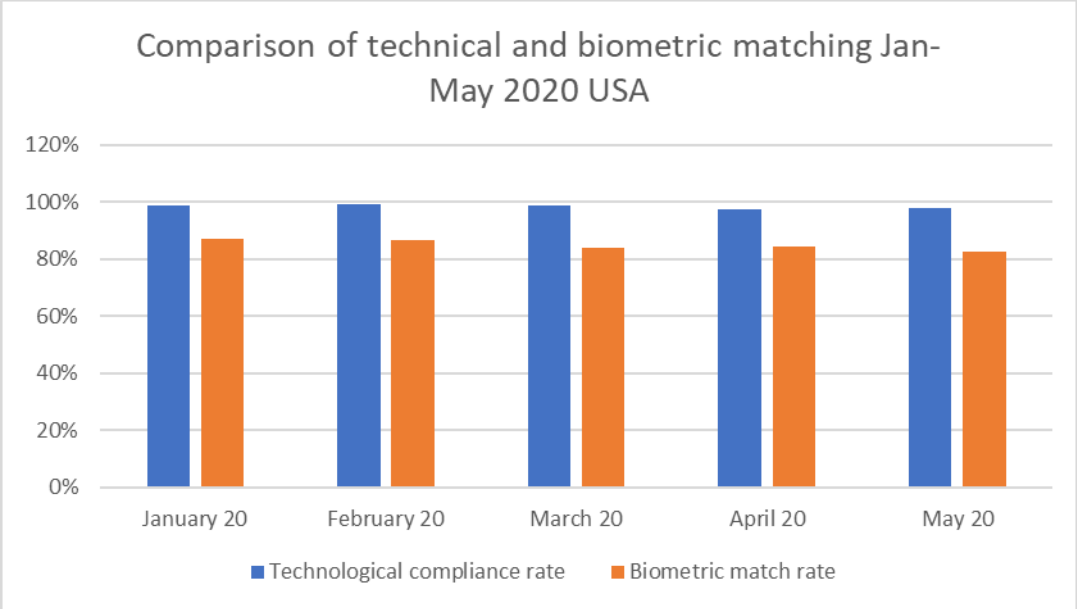

Figure 3. Comparison of technical and biometric matching Jan-May 2020 USA [10]

Figure 9 shows that during the pilot testing phase, approximately 15 percent of passengers at all nine airports failed to be paired with photos, indicating a large room for improvement. Within these results from the pilot, the following became apparent:

- Approximately 0.03 percent of the photos were "false positives," meaning that the passenger's photo was incorrectly paired with an image of another person.
- Approximately 0.5 percent were "false rejects," meaning a failure to match a passenger's photo to another image of the same individual [12].

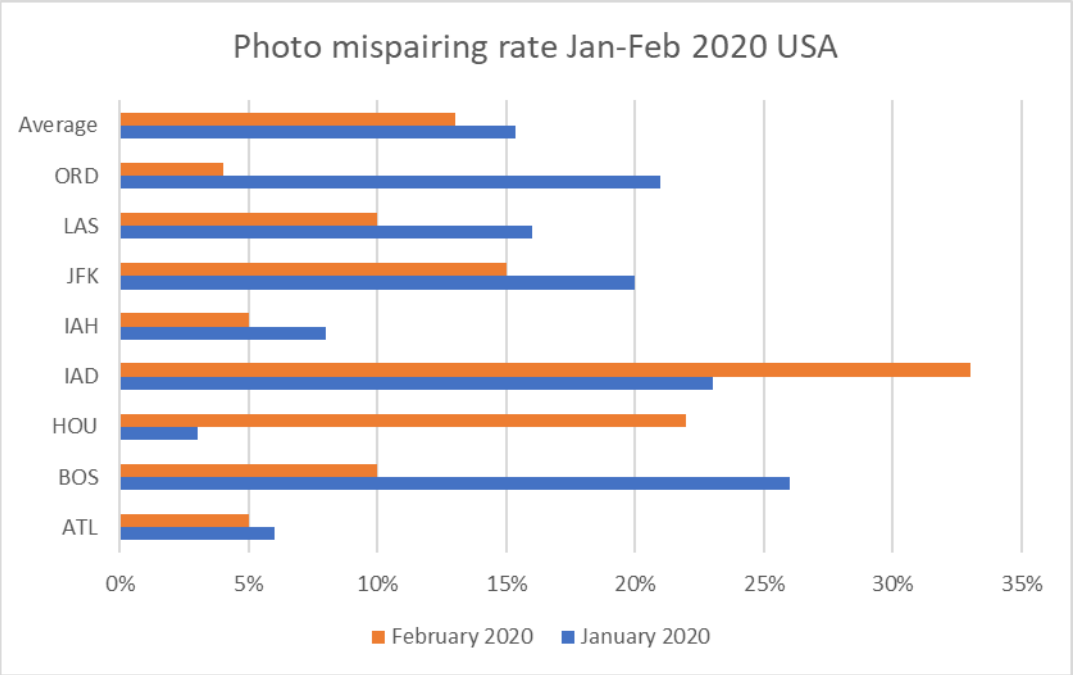

Figure 4. Photo mispairing rate Jan-Feb 2020 USA [10]

False positives results may pose a higher security risk. Matching one passenger's photo with another passenger's photo may result in incorrect identification. In addition, it is essential to increase accuracy and reduce false rejections to increase the efficiency of facial recognition. Several factors may have contributed to the deterioration of the quality of the biometric sample.

On the other hand, it should be noted that the latest software solutions show significantly higher positive pairing values, reaching up to 99.97% matching under ideal conditions. Therefore, it is very important to thoroughly evaluate the parameters and outputs of individual systems when implementing facial biometrics. Choosing the right software solution is critical to the overall effectiveness of the system [12].

5. CONCLUSION

This article provides an introduction to biometric information security systems and discusses the principle of operation, methods, and application in practice. A biometric method of information verification is appropriate in every circumstance. As a result of the development of technology, cameras and video cameras can capture data from a variety of biometric methods, and the implementation of biometric methods would be exceptionally helpful. There is a higher safety risk associated with false positive results. Matching one passenger's photo to another passenger's photo may result in incorrect identity verification. Moreover, reducing false rejections can improve face recognition effectiveness.

Biometric identification is increasingly permeating the daily lives of aviation companies and their employees. This technology is particularly popular due to its undeniable advantages, as evidenced by current trends. Facial biometrics are now commonly used in real life, but in many cases, people don't even realise it. A good example would be airports, where you can enter the country without going through customs thanks to this technology, as self-service entries scan your passport, take a picture of

your face via a camera, and then verify your identity. facial biometrics is now commonly used at Bratislava airport and is also planned to be introduced at Kosice International Airport.

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Received 12, 2022, accepted 12, 2022