MISTI 73.37.21.

BIOMETRIC IDENTIFICATION AT THE PRE-FLIGHT INSPECTION AT THE AIRPORT

Ozhikenov K.A.[1*], Tuyakbayev A.A.[1], Nurmagambet S.D.[1], Turgenbayev D.N.[2]

[1]*Satpayev University, Almaty, Kazakhstan*
[2]*M. Auezov South Kazakhstan University, Shymkent, Kazakhstan*
[*]**Corresponding author's e-mail:** turgenbaev-63@mail.ru

ABSTRACT

The development and application of biometric technologies is a worldwide trend. The introduction of the first biometric passports made it possible to deploy dozens of national and international programs for automatic identification of a person. The Biometric Recognition Platform allows for expedited check-in, search and boarding without passports and tickets. The platform will reduce queues at the airport, make travel more enjoyable and safer. Biometric Recognition Platform integrates with airport security systems, ticket booking services and airline loyalty programs. Along the way, the platform can recognize the passenger's face, recognize him at the front desk, recognize him at the check-in counter, open passages to the "clean" zone, to the high-comfort waiting room, and provide passage through the turnstiles at the boarding gate. In addition, the system will tell the airline whether a passenger who has checked in on-line has arrived but is late for boarding, and, if necessary, will help to find him at the airport. The platform is based on its own biometric identification algorithms based on neural networks. Some elements of the smart system are already in operation at various airports where identification at the airport entrance is implemented during the initial screening.

Keywords: *biometrics, identification, method, neuron, operator, sign, transformation, function, data, error..*

INTRODUCTION

International airports in many countries have begun to use new biometrics technologies to facilitate faster and smoother passenger interaction at the airport. The busiest airports in the world are implementing the latest technologies to ensure the convenience and comfort of passengers. With a single identification token, a passenger only needs to present a travel document once, after which his face becomes a passport. Today, powerful intellectual technologies, in particular biometric technologies, are used to compare the physical characteristics of passengers with the information contained in the passport chip. Airports are on the way to creating a so-called single identity token - an identity card created by comparing biometric data and passenger passport. The traveler only needs to scan the fingerprints, the iris of the eye. A face scan is used to pass through the various checkpoints. Therefore, travelers save time, and the airport reduces the length of queues and improves the quality of service. Various electronic innovations are being actively tested to optimize processes at airports in order to track baggage through a mobile application, which will contribute to the introduction of new boarding systems at airports

MATERIALS AND METHODS

Theoretical analysis

Biometric identification is a way of identifying a person by individual specific biometric features (identifiers) inherent in a particular person [1].

Biometric identification methods are divided into static and dynamic.

1. Static methods determine the physiological characteristics of a person throughout his life:

fingerprint identification, s_1;

contour and facial expression identification, s_2;

eye iris identification, s_3;

hand geometry identification, s_4;

face thermogram identification, s_5;

DNA identification, s_6;

ear acoustic characteristics identification, s_7;

vein pattern identification, s_8;

identification by other specific static characteristics, s_9.

2. Dynamic methods that determine the characteristics of people associated with the behavior of the subconscious mechanism during repetitive actions:

voice identification, d_1;

handwritten handwriting identification, d_2;

keyboard handwriting identification, d_3;

gait identification, d_4;

identification by other specific dynamic features, d_5.

For this purpose, if we confine ourselves to the above-mentioned criteria, the features can be expressed as the following functions:

$$S = f\left(s_1, s_2, ..., s_i\right) = f\left(s\right) \tag{1}$$

where S – generalized characteristic of static features;

$s_1, s_2, ..., s_i$ – coefficients characterizing static signs;

i – number of static features.

$$D = f\left(d_1, d_2, ..., d_j\right) = f\left(d\right) \tag{2}$$

where D – generalized characteristics of dynamic features;

$d_1, d_2, ..., d_j$ – coefficients characterizing dynamic features;

j – number of dynamic features.

Assuming that they obey the principle of the organization and functioning of biological neural networks, enter a third function:

$$N = f\left(n_1, n_2, ..., n_k\right) = f\left(n\right) \tag{3}$$

where N – generalized characteristics of neural responses to signs;

$n_1, n_2, ..., n_k$ – coefficients characterizing neural responses;

k – number of neural responses to signs.

Human physiology and psychology are constructed in such a way that static and dynamic features and neural responses are interrelated, each being a prerequisite and a consequence of the other

The task is to find a functional relationship between human traits and corresponding neuronal responses.

The following solution is proposed using a vector differential operator whose components are partial derivatives of the coordinates of a three-dimensional space, which is expressed by the following equation:

$$\nabla S = \frac{\partial D}{\partial t} + \frac{\partial N}{\partial t} \tag{4}$$

where ∇ – Hamilton vector differential operator;

S – generalized characteristic of static features;

$\frac{\partial D}{\partial t}$ – rate of change of dynamic characteristics;

$\frac{\partial N}{\partial t}$ – rate of change of neural responses to signs.

The Hamilton vector differential operator of three-dimensional space in a rectangular Cartesian system is defined [2]:

$$\nabla = \frac{\partial}{\partial x}\vec{i} + \frac{\partial}{\partial y}\vec{j} + \frac{\partial}{\partial z}\vec{k} \tag{5}$$

where $\vec{i}$, $\vec{j}$, $\vec{k}$ – unit vectors along the axes x, y, z relatively.

Also uses Hamilton operator recording via components:

$$\nabla = \left\{\frac{\partial}{\partial x}, \frac{\partial}{\partial y}, \frac{\partial}{\partial z}\right\} \tag{6}$$

Equation (4) can be formulated as follows: that changes in dynamic features and neural responses over time lead to clear manifestations of static human features.

For example, if a person has some kind of malicious intent, physiologically, neural reactions occur in the brain, which undoubtedly leads to some changes in dynamic signs in behavior and psychology, which ultimately causes "bright" manifestations of static signs. The manifestations of static signs in this case include, for example, sweating of the palms and fingers (except for those who suffer from clinical hyperhidrosis) caused by a change in pH, which in turn causes changes in face's expression and thermogram, iris' size.

RESULTS AND DISCUSSION

The term «wavelet» in English means a «small wave» and means a generalized name of mathematical functions of a certain form that are local in time and frequency and in which all functions are obtained from one base, changing it (shifting, stretching) [3].

Wavelet transform is an integral transform, which is a convolution of a wavelet function with a signal. The wavelet transform converts the signal from the temporal to the time-frequency representation.

Wavelet transform is a decomposition of the original function into the basis of a wavelet function and is expressed by an integral form's transform [4]:

$$W\left(a,b\right)=\frac{1}{\sqrt{a}\int_{-\infty}^{\infty}x\left(t\right)\psi\cdot\left(\frac{t-b}{a}\right)dt} \quad (7)$$

where $x(t)$ – initial function;

$\psi*(t)$ – parent wavelet function;

b – the shift parameter defining wavelet function's position;

$a > 0$ – a stretch parameter which specifies the «width» of the wavelet function and defines the scale of the transformation.

Consider the Wavelet transform's applied aspects for biometric identification.

1. Wavelet transformation in experimental data processing:

display the most visual and informative picture of the experiment results;

allows to clean source data from noise and random distortions;

to notice "by eye" some features of the data and the direction of their further processing and analysis;

well suited for non-stationary signals' analyzing.

2. Wavelet transformations in image processing. The structure of human vision is designed to focus on the essential details of the image, while eliminating the unnecessary.

Using the Wavelet transform allows:

smoothing or highlighting some details of the image;

increase or decrease in image details;

highlighting important details;

improving the quality of image processing.

3. Wavelet transformations for data compression. Wavelet transforms when compressing data. The feature of orthogonal multiscale analysis is that for sufficiently smooth data, the resulting parts are mostly close to zero. This means that conventional statistical techniques can be used to compress data efficiently. The advantage of wavelet transform is that no additional redundancy is introduced into the original data, and the signal can be fully reconstructed using the same filters. This means that it is possible to apply a very simple implementation of lossy compression, where in order to separate the details from the main signal as a result of the transformation, it is enough to simply discard the details at the scales where they are irrelevant. This allows image compression by 3 ÷ 10 times without significant information loss, and with lossy compression - up to 300 times.

4. Wavelet transformations in neural networks and other data analysis mechanisms. Training neural networks and setting up other data analysis mechanisms are associated with great difficulties, which are manifested by strong noisy data, as well as the presence of so-called "special cases" i.e. random emissions, gaps, nonlinear distortions, etc. The presence of such interferences hides the characteristic features of the data, sometimes posing as them, which ultimately degrades the training results, so the task is to clean the data before proceeding with its analysis. Wavelet transformations have a fast and efficient implementation algorithm, due to which they are one of the most convenient and promising mechanisms for cleaning and preprocessing data for use in artificial intelligence systems, biometric identification, etc.

5. Wavelet-transformations in data transmission systems and digital signal processing. The high efficiency of algorithms and resistance to interference allow wavelet transformation to become a powerful tool in areas where various traditional methods of data analysis are applied, such as the Fourier transformation. The possibility of using it along with the existing methods of processing the conversion results and the presence of characteristic features of the behavior of the wavelet conversion in the time-frequency domain lead to the expansion and appearance of additional capabilities of such systems.

The theory of wavelet transformation has been known for a long time, the mathematical apparatus of wavelet analysis is widely used, and today an important task is to develop applications that use wavelet analysis in biometric identification.

The basis of biometrics is 95% mathematical statistics. The main characteristics of the biometric system:

- FAR (False Acceptance Rate) - false pass rate;
- FRR (False Rejection Rate) - false rejection rate.

FAR characterizes the probability of a false coincidence of biometric data of two people, i.e. the system mistakenly allows access to a user who is not registered in the system [5].

FRR characterizes the denial of access to a valid authorized user of the system. The system is reliable when the FRR value tends to a minimum at the same FAR values.

Figure 1 shows the change's characteristics of FAR and FRR coefficients.

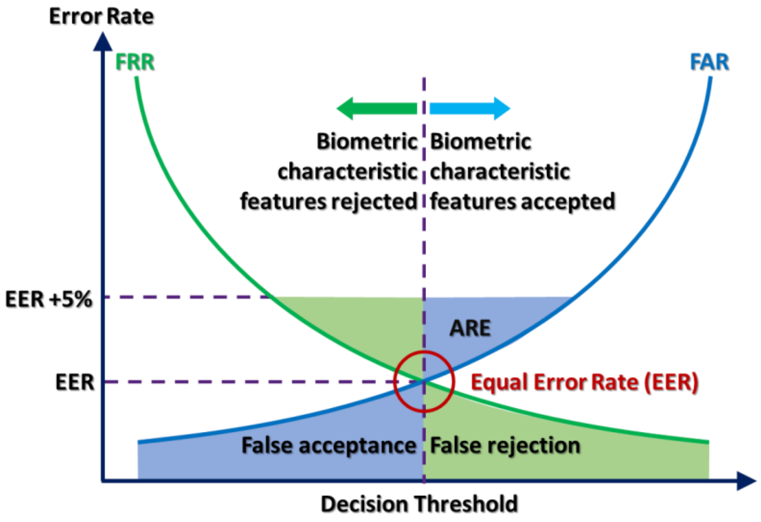

Fig 1. The change's characteristics of FAR and FRR coefficients

The estimation of the FAR and FRR coefficients are probabilistic. If the probability of a false match is denoted as $P_{FAR}(t)$, and the number of fingerprints available in the database is N, then the probability of a false match obtained by a fingerprint scanner can be determined [6]:

$$P_{FAR}(t) = FAR \cdot N \tag{8}$$

If we assume that in a certain period of time N - number of people pass through the checkpoints, then the probability of error

$$P_{FAR}(t) = FAR \cdot N \cdot N = FAR \cdot N^2 \tag{9}$$

If, conditionally, one error is admissible within a certain period of time $P_{FAR}(t) \approx 1$ than:

$$FAR \cdot N^2 \approx 1 \Rightarrow N \approx \sqrt{\frac{1}{FAR}} \tag{10}$$

The EER (Equal Error Rates) (Fig. 1) is the ratio at which the receive error and rejection error are equivalent. The lower the EER, the higher the accuracy of the biometric system, i.e. is an objective parameter [7].

The FAR and FRR parameters must be considered in a complex, only then can we talk about the reliability of biometric identification.

CONCLUSION

The advantages that the application of biometrics provides are obvious: ensuring the safety of passengers and the functioning of airport structures; free movement between the departure area and other departments of the airport; the automation of screening eradicates queues; simplification of service by eliminating passports and boarding passes. Passengers need to scan their documents at special self-check-in kiosks located after the pre-flight security check-in area. Passengers do not need practically anything at all: the personal data entered when issuing a ticket is enough. Then proceed to the boarding gate and, when it is announced, go through special turnstiles with cameras that send data for comparison with the original passport. The information solution for direct comparison of reality with documentary samples in the database is assigned to special structures at the airports.

Wavelet transform allows you to convert a signal from a time representation to a time-frequency representation by means of a mathematical transformation. The method is based on functions that determine what form the analyzed signal will have after conversion. In fact, "wavelet" is a wave function that is superimposed on the existing signal graph, thereby allowing you to determine its properties on a specific part of the signal. The proposed mathematical apparatus of wavelet transformation poses an important task of developing applications using wavelet analysis in biometric identification.

REFERENCES

1 Bryukhomitsky Yu.A. Biometric technologies of personality identification: textbook. Rostov-on-Don, Taganrog: Publishing House of the Southern Federal University, 2017 . 263 p.
2 Vector differential operations of the first order. Hamilton operator. (2021). Available at: https://infopedia.su/14x1060.html (15 May 2021).
3 Foundations of the theory of wavelet transform. (2021). Available at: https://basegroup.ru/community/articles/intro-wavelets (15 May 2021).
4 Wavelet transform - Wavelet transform. (2021). Available at: https://ru.other.wiki/wiki/Wavelet_transform (15 May 2021).
5 Technologies and methods of biometric identification. (2021). Available at: http://www.techportal.ru/security/biometrics/tekhnologii-biometricheskoy-identifikatsii (15 May 2021).
6 Biometric identification. (2021). Available at: http://www.techportal.ru/glossary/biometricheskaya_identifikaciya.html (15 May 2021).
7 Modern biometric identification methods. (2021). Available at: https://habr.com/ru/post/126144 (15 May 2021).