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MULTIPARAMETER BIOMETRIC PERSONALITY IDENTIFICATION

M.S. Aliaskar[1,2], A.T. Mazakova[1,2], Т.Ж. Мазаков [1,2], G.S. Bayrbekova[2], M.T. Orynbay [2]
[1]Institute of information and computational technologies of the SC MES RK, Almaty, Kazakhstan,
[2]Al-Farabi Kazakh National University, Almaty, Kazakhstan
ORCID: 0000-0002-3013-6617
87071160626@mail.ru

Abstract The article is devoted to the development of a system for biometric identification of a person by face, fingerprints and voice. As informative signs of biometric identification of a person by face, two-dimensional and three-dimensional characteristics of a person's face were used, taking into account the area and volume. A sophisticated identification algorithm has been developed to take into account such phenomena as portrait shift, different photo scales and the tilt of the identified person.

For biometric identification of a person by fingerprints, an FPM10A scanner and an Arduino microcontroller were used. Identification signs are based on the analysis of the structure of papillary patterns on the finger: type and type of papillary pattern; direction and steepness of streams of papillary lines; the structure of the central pattern of the pattern; delta structure; the number of papillary lines between the center and the delta and many other signs.

Each print can contain up to 70 or more minutes. For biometric identification of a person by voice, the MFCC and PLP algorithms are used for digital processing and analysis of audio recordings. Various algorithms are used for acoustic analysis of speech: hidden Markov models, a model of a mixture of Gaussian distributions. The result of determining the tone of speech and the content of speech for the purposes of identification by voice is obtained. The “Multiparameter automated system of biometric identification of a person” has been developed on the Visual FoxPro DBMS.

Keywords: information security, two-dimensional and three-dimensional image, identification, papillary patterns, voice characteristics, human speech, acoustic modeling.

Introduction

The problem of information protection and information security is one of the most important aspects of the development of modern society. Currently, the solution to this problem in the field of development and operation of information systems for various purposes is associated with the development of various requirements to ensure their security and the creation of software and hardware against unauthorized access [1-3].

Automatic human recognition for identification has many applications in various fields. Problems of public security, the need for remote authentication, the development of human-machine interfaces arouse increased interest in this technology [4-5].

Biometric identification methods are increasingly being used in access control systems for workplaces, mobile devices, local and global information resources. Since the implementation of the systems does not require specialized equipment, and the biometric feature cannot be lost, forgotten, or transferred, the most promising are systems whose principle of operation is based on human face recognition [6].

Authentication methods based on the measurement of a person's biometric parameters provide 100% identification. Now, the following biometric characteristics are successfully used in biometric systems for user authentication: iris, fingerprint, palm print, vascular patterns, facial geometry, voice imprint, signature, DNA comparison [7-8].

Currently, there are no biometric parameters that combine all these properties at the same time, especially if acceptability is considered. Therefore, the use of multiparametric biometric authentication becomes relevant.

Materials and methods

As mentioned above, the task of biometric identification of a person by face, fingerprints and voice belong to one of the tasks solved using data processing algorithms.

Discussion. Visual FoxPro DBMS was selected for the software implementation of the AS "Biometric Information Security System".

The interface part is implemented based on the Visual FoxPro 9 DBMS, which includes the following modes: 1) biological characteristics, 2) parameters of characteristics, 3) source databases, 4) database setup, 5) simple identification, 6) complex identification, 7) classification.

Now, the "video image of the face", "fingerprint" and "voice" are included as biological characteristics.

The mode is "source databases". Portraits in the following graphic formats can be used as source data for images: bmp, gif, jpeg, tiff and png. For the "face video image" mode, the main information is a three-dimensional 3d model presented as a regular height matrix.

In the IsxDan.dbf table, the fields have the following assignments:

Kodxar – code of biometric characteristics;

koddan–the code of the original face image;

namdan–the name of the file containing the face image;

kla – the number of the class to which the image belongs (calculated in the "classification" mode)

The following types are introduced for the parameters of the characteristics:

1 - the coordinate of the point; 2 - distance (number); 3 - area; 4 - volume.

"Video image of a face"

To characterize the "video image of a face", several parameters have been defined, which are:

1) point - the coordinates of the pupils of the eyes, the bridge of the nose, the tip of the nose,

2) distance – between the eyes, between the bridge of the nose and the tip of the nose, the base of the nose,

3) perimeter - triangle (pupils of the eyes and the tip of the nose), triangle (bridge of the nose and the base of the nose),

4) area – eye socket isolines, nose isolines,

5) volume – eye sockets, nose.

A three-dimensional 3d model presented as a regular height matrix is used as the initial data for the "face video image" [9-10].

The algorithm for constructing the height matrix is based on the method of interpolation of surfaces. In it, unevenly distributed points in three-dimensional space are interpolated by a continuous function of two independent variables. To build a regular height matrix, the following steps are performed: the formation of reference nodes, the calculation of the matrix of nearest points and the distance matrix, the interpolation of nodes, the correction of the height matrix.

"Fingerprint"

Systems based on fingerprinting compare the received memory fingerprint with other fingerprints that are stored in the system databases or with the fingerprint of a specific person, the method of comparison also depends on the scope of this technology [11-12].

The FPM10A module with the Adafruit Arduino library was used to create a block of a biometric fingerprint identification system [13].

The unit for taking a snapshot and identifying fingerprints is implemented based on the Arduino UNO controller.

The optical fingerprint scanner is a module that can be used in conjunction with Arduino and other microcontrollers. It can store fingerprints (1000 fingerprints) in memory with their further identification.

There are two main steps when using a fingerprint sensor. First, data is recorded in the sensor memory, that is, a unique ID is assigned to each fingerprint, which will be used for

comparison in the future. After recording the data, you can proceed to the "search", comparing the current image of the fingerprint with those recorded in the sensor memory.

Using the SFGDemo and ArduinoIDE program, new fingerprints are loaded, assigning each of them a new ID #. All uploaded fingerprint images are encrypted.

Several types of descriptors were used in this study: SIFT, SURF and ORB [14]. Based on the results of the analysis of the effectiveness and speed of methods and algorithms for biometric identification of persons, the following conclusions can be drawn.

Using the approach based on the allocation of key points in the image for biometric identification by fingerprints, allows you to create a software system based on it for rapid fingerprint recognition and subsequent search.

SURF/SIFT algorithms have the best classifying abilities when solving everyday search problems on textured images. Both algorithms are more demanding on the hardware and are more suitable for other computer vision tasks, also both algorithms are patented and have a ban on commercial use, without the consent of the copyright holder. For fingerprint identification tasks, they have "excess capacity".

The ORB algorithm has a higher speed of operation in comparison with the above algorithms by SIFT/SURF techniques and is more suitable for the tasks of biometric identification by fingerprints. The descriptors of the ORB algorithm are binary descriptors and a match check for such descriptors, this is the sum of the Hamming distances for each byte of the descriptor. The use of this algorithm is more suitable for the tasks of searching for an incomplete fingerprint.

"The Voice"

One of the parameters of biometric identification of a person is the voice, but a person's voice may vary depending on age, emotional state, health, or other factors, which makes the identification process more difficult to implement. Voice identification technology is used in various fields of information security, access control systems, criminology, and other fields.

Since the human voice is the sum of many individual frequencies created by the vocal cords, it is possible to identify several features that can be observed and analyzed in the speech of each person:

• Vocality of speech (volume, tempo, stability – physical components);
• Tonality of speech (intonation – psychological components);
• The content of speech (vocabulary of a particular person).

Loudness is a subjective measure of sensation associated with the impact of sound vibrations on the hearing organs and depends on the amplitude and frequency of these vibrations.

The pace of speech is a subjective measure related to the speed of pronunciation of certain segments of speech in time. The tempo may be related to the content, usually the most important words are pronounced slower. The volume and tempo of speech are individual for each person.

The difference in the timbres of different voices is described by different frequency spectra. The mathematical apparatus for analyzing the frequency spectrum is the Fourier transform, to describe a complex sound wave with a spectrogram.

I consider the peculiarities of human hearing, namely its nonlinear nature in relation to the perception of sound frequencies. For this task, the conversion from the Hertz scale to the mel scale is used (mel is a psychophysical unit of pitch) below is the formula for the transition between frequency (Hz) and pitch in mel

$$m = 1127 * ln(1 + f/700) \quad (1)$$

a set of M mel scale filters is superimposed on the calculated spectrum, usually M = 20 or M=24, usually the more filters, the higher the accuracy, while the filters are shifted to those frequencies in which there is most in the audio recording:

$$x_i = \sum_{k=0}^{N-1} |X_k| * H_i(f_k), i = 1..M \quad (2)$$

A variety of algorithms are also used for acoustic speech analysis, the most common are hidden Markov models (SMM or HMM in the English version), as well as a model of a mixture of Gaussian distributions (SGR or GMM in the English version), neural networks have been actively used in recent years [15].

The mode is "identification". In this mode, for the input data about a person (an image of a face, a finger, or an audio file) that needs to be identified, the degree of its correspondence with each of the data entered in the IsxDan.dbf table is calculated.

Conclusion

ARM "Biometric information security System" has been developed. The structures of the database tables and their relationship are defined.

For the first time, the human recognition algorithm considers such parameters as the volume of the nose, the volume of the eye socket, and other three-dimensional characteristics. To speed up identification, all data in the source database is pre-classified.

A complex identification algorithm has been developed to consider such phenomena as portrait shifting, different photo scales and the tilt of the identified person. Numerical studies carried out on the model problem have shown the effectiveness of human recognition when zooming in on a photo.

Based on the Arduino microcontroller and the FPM10A scanner, a recognition system has been developed for storing data, further processing it, identifying, and displaying fingerprint images. The structure of the structure of papillary patterns on the fingers was chosen as identification features. The result of matching fingerprints with different rotation through the scanner was obtained. A promising area is the search for an incomplete fingerprint, since often in practice there is only a part of the fingerprint to search for matches.

The system has worked out three algorithms for analyzing audio recordings to solve the problem of biometric identification by voice.

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ТҰЛҒАНЫ КӨП ПАРАМЕТРЛІ БИОМЕТРИЯЛЫҚ СӘЙКЕСТЕНДІРУ

М.С. Әлиасқар[1,2], А.Т. Мазакова[1,2], Т.Ж. Мазаков[1,2], Г.С. Байрбекова[2], М.Т. Орынбай[2]
[1]ҚР БҒМ ҒК Ақпараттық және есептеуіш технологиялар институты, Алматы, Қазақстан,
[2]Әл-Фараби атындағы Қазақ ұлттық университеті, Алматы, Қазақстан
ORCID: 0000-0002-3013-6617
87071160626@mail.ru

Аңдатпа. Мақала адамның бет-әлпеті, саусақ іздері және дауысы бойынша биометриялық сәйкестендіру жүйесін дамытуға арналған. Адамды тұлға бойынша биометриялық сәйкестендірудің ақпараттық белгілері ретінде ауданы мен көлемін ескеретін адам бетінің екі өлшемді және үш өлшемді сипаттамалары қолданылады. Портреттің ауысуы, фотосуреттердің әртүрлі масштабы және сәйкестендірілетін тұлғаның көлбеуі сияқты құбылыстарды есепке алу үшін күрделі сәйкестендіру алгоритмі жасалды.

Саусақ іздері арқылы адамды биометриялық сәйкестендіру үшін fpm10a сканері және Arduino микроконтроллері қолданылады. Сәйкестендіру белгілері саусақтағы папиллярлық өрнектердің құрылымын талдауға негізделген: папиллярлық өрнектің түрі мен түрі; папиллярлық сызықтар ағындарының бағыты мен көлбеуі; өрнектің орталық үлгісінің құрылымы; Дельта құрылымы; орталық пен Дельта арасындағы папиллярлық сызықтардың саны және басқа да көптеген белгілер.

Адамды дауыспен биометриялық сәйкестендіру үшін аудио жазбаларды сандық өңдеу және талдау үшін MFCC және PLP алгоритмдері қолданылады. Сөйлеуді акустикалық талдау үшін әртүрлі Алгоритмдер қолданылады: жасырын Марков модельдері, Гаусс үлестірімдерінің қоспасы моделі. Дауысты сәйкестендіру мақсатында сөйлеу тоналдылығы мен сөйлеу мазмұнын анықтау нәтижесі алынды. Visual FoxPro ДҚБЖ-де "жеке тұлғаны биометриялық сәйкестендірудің көп параметрлі автоматтандырылған жүйесі" әзірленді.

Кілттік сөздер: ақпаратты қорғау, екі өлшемді және үш өлшемді сурет, сәйкестендіру, папиллярлық өрнектер, дауыс сипаттамасы, адамның сөйлеуі, акустикалық модельдеу.

МНОГОПАРАМЕТРИЧЕСКАЯ БИОМЕТРИЧЕСКАЯ ИДЕНТИФИКАЦИЯ ЛИЧНОСТИ

М.С. Әлиасқар[1,2], А.Т. Мазакова[1,2], Т.Ж. Мазаков[1,2], Г.С. Байрбекова[2], М.Т. Орынбай[2]
[1]Институт информационных и вычислительных технологий КН МОН РК, Алматы, Казахстан,
[2]Казахский национальный университет имени аль-Фараби, Алматы, Казахстан
ORCID: 0000-0002-3013-6617
87071160626@mail.ru.

Аннотация. Статья посвящена разработке системы биометрической идентификации человека по лицу, отпечаткам пальца и голосу. В качестве информативных признаков биометрической идентификации человека по лицу использованы двумерные и трехмерные характеристики лица человека, учитывающие площадь и объем. Для учета таких явлений, как сдвиг портрета, разный масштаб фотографий и наклон идентифицируемого лица, разработан сложный алгоритм идентификации.

Для биометрической идентификации человека по отпечаткам пальцев использован сканер

FPM10A и микроконтроллер Arduino. Идентификационные признаки основаны на анализе строения папиллярных узоров на пальце: тип и вид папиллярного узора; направление и крутизна потоков папиллярных линий; строение центрального рисунка узора; строение дельты; количество папиллярных линий между центром и дельтой и множество других признаков.

Для биометрической идентификации человека по голосу использованы алгоритмы MFCC и PLP для цифровой обработки и анализа аудиозаписей. Для акустического анализа речи применены различные алгоритмы: скрытые марковские модели, модель смеси гауссовских распределений. Получен результат определения тональности речи и содержательности речи для целей идентификации по голосу. На СУБД Visual FoxPro разработана «Многопараметрическая автоматизированная система биометрической идентификации личности».

Ключевые слова: защита информации, двухмерное и трехмерное изображение, идентификация, папиллярные узоры, характеристика голоса, человеческая речь, акустическое моделирование.

Information about authors

Aliaskar Magzhan Sundetuly – doctoral student of Al-Farabi Kazakh National University, 87071160626@mail.ru

Mazakova Aigerim Talgatovna – doctoral student of Al-Farabi Kazakh National University, aigerym97@mail.ru

Mazakov Talgat Zhakupovich – Doctor of Physics and Mathematics, Professor of Al-Farabi KazNU, tmazakov@mail.ru

Bairbekova Gaziza Serikkyzy – PhD, zika_3086@mail.ru

Orynbay Majit Temirbekuly – graduate student of Al-Farabi Kazakh National University, temirbek.majit@gmail.com

Әлиаскар Мағжан Сүндетұлы-Әл-Фараби атындағы Қазақ ұлттық университетінің докторанты, 87071160626@mail.ru

Мазакова Әйгерім Талғатқызы – Әл-Фараби атындағы Қазақ ұлттық университетінің докторанты, aigerym97@mail.ru

Мазақов Талғат Жақыпұлы-физика-математика ғылымдарының докторы, . Әл-Фараби атындағы ҚазҰУ профессоры, tmazakov@mail.ru

Байырбекова Ғазиза Серікқызы- PhD, zika_3086@mail.ru

Орынбай Мәжит Темірбекұлы-Әл-Фараби атындағы Қазақ ұлттық университетінің студенті, temirbek.majit@gmail.com

Алиаскар Магжан Сундетулы – докторант Казахского национального университета имени Аль-Фараби, 87071160626@mail.ru

Мазакова Айгерим Талгатовна – докторант Казахского национального университета имени Аль-Фараби, aigerym97@mail.ru

Мазаков Талгат Жакупович – доктор физико-математических наук, профессор КазНУ им. Аль-Фараби, tmazakov@mail.ru

Баирбекова Газиза Сериккызы – PhD, zika_3086@mail.ru

Орынбай Мажит Темирбекулы – студент Казахского национального университета имени Аль-Фараби, temirbek.majit@gmail.com