

ANNOTATION

of dissertation work on the theme “**Methods and algorithms for estimating the information content of biometric images**” presented for the degree of PhD on speciality 6D070400 - Computer Science and Software Engineering
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Research actuality. Rapid informatization of modern society leads to the emergence of new problems and new approaches to their solution. One of the most important new problems is the need to improve the efficiency of the system for protecting information resources from unauthorized access. This is due to the increase in the flow of confidential information, which is proven by the fundamental drawbacks of classical user authentication systems, as well as objective requirements to ensure the privacy and remote operation of access control systems in various areas of its use.

Analysis of the development dynamics of modern access control systems indicates a clear movement towards biometric systems, which is due to their convenience and reliability in terms of compliance analysis of the control biometric key to a specific user. As such a key are used the pattern of the fingers skin or user's palms, the geometric parameters of the hands, face or ears, the "keyboard handwriting", the drawing of the blood vessels on the hands or the surface of the fundus, the voice and geometric parameters of the handwritten symbols. The advantages include the ability to implement on a universal computer technology, the complexity of compromising with the help of fake models, the ability to perform authentication not only when requesting to enter the information system, but also during its operation.

The prospect of biometric user authentication systems on the basis of geometric parameters' analysis is confirmed both by the fairly wide spread of authentication [3, 9] and by a large number of relevant theoretical and practical studies, the analysis of which was carried out in [1, 2, 12]. At the same time, the spectrum of their application is substantially limited by the relatively low recognition accuracy, a significant development time, insufficient adaptation to many features of modern IS, which predetermines the relevance of research in this direction.

At the same time practical experience and research of scientists Bodyanskiy E. B., Gusev M.M., Reznik O.M., Rudenko O.G., Hinton D. indicate that a perspective way to increase the efficiency of biometric authentication is the usage of artificial neural networks. Furthermore, theoretical developments and experiences in creating information security systems by scientists such as Akhmetov B.S., Karpinsky N.P., Korchenko A.G., Seilova N.A., Tereykovsky I.A., Tinimbaev C.N. point to the need and the possibility of improving neural network authentication tools by increasing the effectiveness of assessing the informativeness of the biometric images characterized by geometric parameters.

Research purpose is the development of neural network methods and means for assessing the informativeness of biometric images characterized by geometric

parameters, which are due to the theoretically grounded choice of characteristics, make it possible to realize an effective evaluation of the informativeness of biometric images.

In accordance with the purpose, the following **research objectives** are defined:

- to investigate the current state of development of the theoretical and practical basis of biometric authentication technologies, based on the recognition of geometric characteristics;
- to formalize the processes of biometric authentication, based on the geometric parameters of the individual;
- to develop neural network models and methods for assessing the informativeness of biometric images;
- to develop a neural network system for assessing the informativeness of biometric images and conduct experimental studies aimed at verifying the proposed solutions.

Research object is the process of evaluating the informativeness of biometric images.

Research subject is the neural network models and methods for estimating the informativeness of biometric images.

Research methods - methods of the theory of digital signal processing, neural networks, computer modeling, mathematical statistics and optimization.

The scientific novelty of the results is that theoretical and practical studies have allowed the development and scientific substantiation of the principles, models and methods of neural network assessment of the informativeness of biometric images.

First:

- a method for adapting the structural parameters of a convolutional neural network to the conditions of the problem of estimating the informativity of biometric images, which through the use of the developed neural network model, the proposed principles of adaptation and the developed criterion for assessing information, allows the realization of an effective evaluation of information;

- the principles of the structural parameters adaptation of the convolutional neural network to the conditions of the problem of assessing the informativeness of biometric images, which provide the possibility of developing an effective method for assessing the informativeness, are grounded. Unlike the known, these principles realize the approach in biometric authentication systems, the process of neural network recognition of a two-dimensional image of a biometric user image should be as close as possible to its biological prototype.

Have received the further development:

- a conceptual model of providing an effective neural network assessment of the informativeness of biometric images characterized by geometric parameters, which due to the formalization of the conditions for creating the means, ensured the possibility of creating effective neural network models and methods of recognition;

- neural network model for assessing the informativity of biometric images, which due to the theoretically substantiated choice of the neural network type,

provides the possibility of an effective evaluation of information, determined on the basis of the accuracy of recognition of test cases.

Practical importance of research. The proposed neural network model and method allowed to develop the architecture of the neural network system, which adapting to the creation conditions, provides sufficiently high recognition accuracy with a minimum of computing costs associated with training, and can also be used to create tools.

Practical significance:

- based on the created models, methods and algorithms, developed laboratory works and lecture materials which are used in educational process of training specialists in the field of knowledge 1701 - "Information Security". The practical use of the dissertation research results is confirmed by the implementation acts into the educational process of the National Aviation University (Ukraine, Kiev) from 17.02.2017 and in the educational process of International Kazakh-Turkish University named after Kozha Ahmet Yassau for first year "Computer Engineering" specialty masters.

- with the use of the proposed method for adapting a convolutional neural network, a computer program has been developed that allows one to estimate the informativeness of biometric images characterized by geometric parameters with the minimum amount of computing resources spent on building a network with an accuracy of 0.99. This made it possible to improve the degree of protection of the information system and optimize the performance indicators of the network protection system, which is confirmed by the implementation act in the activities of LLC "Cipher BIS" from 03.02.2017 and in the activities of LLC «QUARES», Republic of Kazakhstan.

Approbation of work. The main results of the dissertation work were reported and discussed at the seminars in the Department "Computer and Software Engineering" of the KazNRTU named after K.I.Satpaev; at scientific seminars of the National Aviation University of Ukraine; international scientific and practical conference "Information and telecommunication technologies: education, science, practice" (Almaty, 2015); in the proceedings of «Conference" Computational and Informational Technologies in Science, Engineering and Education "(CITech-2015)», Joint issue Computing technologies VOLUME 20 and Bulletin of the Kazakh National University named after Al-Farabi "series mathematics, mechanics and computer science №3" Almaty-Novosibirsk, (Almaty, 2015); 15th International Conference on Control, Automation and Systems (ICCAS 2015) (Korea, 2015); in the reports of the National Academy of Sciences of the Republic of Kazakhstan (Almaty, 2015 and 2017); in the works of the International Satpaev Readings "Competitiveness of Engineering Science and Education" (Almaty, 2016); in the works, section "Information Protection and Cyber Security", Ukraine, (Kiev, 2017); in the works Academy of Technical and Humanistic Service (Bielsko-Biala 2017).

Publications. The main provisions of the thesis are published in 14 scientific papers, 2 of which are published in publications indexed in the Scopus database; 7 articles are published in the publications recommended by the "Committee of Control

in the Sphere of Education and Science” of the Ministry of Education and Science of the Republic of Kazakhstan; 5 articles are published in the materials of international conferences.

The structure and scope of dissertation. Dissertation work consists of an introduction, four chapters, general conclusions, applications, a list of used sources and has 100 pages of body text, 46 figures, 10 tables, 15 pages of applications. The list of literature contains 77 titles and occupies 6 pages. Total workload is 123 pages.

The content of the work

In the introduction, the relevance of the dissertation research topic is disclosed, the problems associated with the topic under study are specified. The paper describes the idea of the work, the purpose and tasks of the research, the scientific novelty and practical value of the work are formulated, the object, subject and methods of research are determined.

The first chapter analyzes normative and technical documentation, scientific and practical works devoted to the development and operation of biometric authentication systems based on the geometric characteristics of biometric objects. It is shown that one of the most representative classes of modern systems of biometric authentication is based on recognition of the user by a set of geometric characteristics determined by: papillary lines of the skin pads of the fingers and palms; a tree of the blood vessels of the finger and palm; contour lines of the palm; a drawing of the irises of the eyes and blood vessels of the fundus: contour lines of the face; contour lines of the auricles; feature of displaying handwritten characters. It is established that in order to increase the efficiency of these systems, it is necessary to improve the accuracy of estimating the informativeness of biometric objects.

At the same time, determined that the actual task is the introduction of means of assessing information on the basis of modern types of neural network models. An important feature of these models should be the adaptation to the expected operating conditions in the recognition circuit of the biometric authentication system and ensuring high accuracy of recognition of biometric images characterized by geometric parameters. Moreover, it was also found that for evaluation of informativeness, it is expedient to use criteria that take into account the accuracy of neural network recognition of training sample examples, as well as the accuracy of recognition by the neural network of examples of the test sample.

As a result, there is a need to improve the methodological base of neural network recognition of biometric objects that are characterized by geometric parameters and the development on this basis of method for adapting the neural network model and the method of creating appropriate neural network facilities.

For the approbation of the proposed solutions, it is expedient to develop an appropriate neural network system and analyze its effectiveness.

The second chapter is devoted to solving the scientific task of formalizing the processes of biometric authentication based on the geometric parameters of the personality.

In the process of solution, a model of highly reliable biometric authentication tools was developed, which made it possible to determine the characteristics of the

main types of attacks on these means. It is also determined that it is possible to evaluate the informativeness of biometric images on the basis of the stability indicators of the neural network authentication system to one of such attacks, which are mainly determined by the error of the means of authentication.

The conceptual model of providing an effective neural network estimation of informativity of biometric images allowing to take into account:

- conditions for the functioning of biometric authentication systems;
- the need to implement the effective use of neural networks for the recognition of biometric images and the main directions for improving their functioning;
- the ability to manage neural networks and the definition of custom variables.

The usage of the obtained models ensured the possibility of clearly defining research directions related to the development of effective neural network models and tools for the effective evaluation of the informativeness of biometric images.

In the third chapter was solved the scientific task of developing neural network models and methods for estimating the informativeness of biometric images characterized by geometric parameters. The main results of the chapter are as follows:

- the neural network model for evaluating the informativeness of biometric images was further developed, which due to the theoretically substantiated choice of the neural network type provides the possibility of an effective estimation of the informativity, determined on the basis of recognition accuracy;

- the principles of adapting the structural parameters of a convolutional neural network to the conditions of the task estimating the informativeness of biometric images, providing the possibility of developing an effective method for assessing information content, were proposed for the first time. Unlike the known, these principles realize the approach in biometric authentication systems, the process of neural network recognition of a two-dimensional image of a biometric user image should be as close as possible to its biological prototype;

- firstly developed method for adapting the structural parameters of convolutional neural network to the conditions for the task of estimating the informativeness of biometric images. It is possible to realize an effective estimation of informativity, using this developed neural network model.

The fourth chapter is devoted to solving the scientific and practical problem of developing a neural network system for assessing the informativeness of biometric images based on the accuracy of their recognition in biometric authentication systems. Also in this section was solved the problem of conducting experimental studies aimed at confirming the reliability of the main results of dissertation work. The main results of the section are as follows:

- architectural solutions for assessing systems have been further developed on the basis of analysis of their geometry which in contrast to known ones, imply the use of subsystems for determining the conditions for creating neural network facilities and developing neural network models, which provides sufficient recognition accuracy and adaptation to the conditions of development and application;

- an experimental setup has been developed that provides the possibility of carrying out experiments aimed at verifying the reliability of the main results of the thesis.

- the conducted researches allow to assert that the usage of the proposed method provides an opportunity to build a neural network system with a minimal amount of computing resources and provides an accuracy of estimating the informativeness of biometric images in the range of 0.95-0.99.

In conclusion, the main results and conclusions of the dissertation work are reflected.

On the basis of the dissertation work 14 publications have been published:

1. Berik Akhmetov, Alexander Ivanov, Alexander Malygin, Zhibek Alibiyeva, Kaiyrkhan Mukapil, Guljanat Beketova and Nazym Zhumangalieva. Prospects for multiple reductions in test samples with a multivariate, multicriteria, the neural network statistical analysis of biometric data. Research journal of applied sciences 10 (12): p.956-967, 2015, ISSN:1815-932X. ©Medwell Journals, 2015

2. Akhmetov B.S., Alibiyeva Zh.M., Beketova G.S. Biometrics, biometric identifiers and technologies. Bulletin of the National Academy of Sciences of the Republic of Kazakhstan. № 6, 2014 p.3-6. Almaty city

3. Akhmetov B.S., Alibiyeva Zh.M., Beketova G.S. Methods and algorithms for estimating biometric images. Bulletin of Kazakh-British Technical University. № 3, 2014, p.38-41. Almaty city

4. Akhmetov B.S., Ivanov A.I., Perfilov K.A., Funtikova Yu.V., Alibiyeva Zh.M. The effect of parallel statistical analysis of biometric data by two Pearson criteria. Reports of the National Academy of Sciences of the Republic of Kazakhstan. №2, 2015, p.18-25. Almaty city

5. Akhmetov B. B., Korchenko A.G., Tereykovsky I.A., Alibiyeva Zh., Bapiyev I.M. Parameters of efficiency estimation of neural networks of cyber attacks recognition on network resources of information systems. Reports of the National Academy of Sciences of the Republic of Kazakhstan. №2, 2017, p. 19-27. Almaty city

6. Akhmetov B.B., Korchenko A.G., Tereykovsky I.A. , Alibiyeva Zh. M., Bapiyev I.M. Parameters for assessing the effectiveness of neural network information systems for the detection of cyber attacks on network resources. Reports of the National Academy of Sciences of the Republic of Kazakhstan. №2, 2017, p.27-38. Almaty city

7. Akhmetov B.B., Tereykovsky I.A., Alibiyeva Zh.M. Determination of the input parameters of a neural network model designed to recognize phonemes in systems of voice biometric authentication. Bulletin of KazNRTU named after K.I.Satpayev, September, №5, 2017. p.261-267. Almaty city

8. Akhmetov B.S., Gorbachenko V.I., Kuznetsova O.Yu., Alibiyeva Zh.M. Neuro-fuzzy decision support system for diagnosing the syndrome of endogenous intoxication. Bulletin of KazNRTU named after K.I.Satpaev, January, №1, 2017. p.100-109. Almaty city

9. Bakhytzhan Akhmetov, Alexander Ivanov, Alexander Malygin, Zhibek Alibiyeva, Kaiyrkhan Mukapil. Perspectives of Multiple Reduction of Biometrical Test Selection Scopes While Increasing Network Dimension of Pearson's Private Criteria. 2015 15th International Conference on Control, Automation and Systems (ICCAS 2015) Oct. 13-16, 2015 in BEXCO, Busan, Korea, p.1333-1336

10. Akhmetov B.B., Ivanov A.I., Funtikova Yu.V., Alibiyeva Zh.M. Multicriteria statistic analysis of test biometric data. Proceedings «Conference "Computational and Informational Technologies in Science, Engineering and Education" (CITech-2015)», Part I, Joint Issue Computing Technologies VOLUME 20 and Bulletin of the Kazakh National University named after Al-Farabi "Mathematics, Mechanics and Informatics Series №3", Almaty-Novosibirsk, 2015. p. 83-89

11. Gorbachenko V.I., Alibiyeva Zh.M., Mukapil K., Togzhanova K.O. Neural network methods for solving partial differential equations. Proceedings of the II International Scientific and Practical Conference "Information and Telecommunication Technologies: Education, Science, Practice". - Almaty: KazNRTU named after K.I.Satpayeva, 2015. - Volume I. - p. 116-119

12. Alibiyeva Zhibek, Balakhan Gauhar. Bankruptcy prediction based on knowledge of the neural network system. Proceedings of international Satpaev readings "The role and place of young scientists in the implementation of the new economic policy of Kazakhstan", II-volume, Almaty 2016, p.230-234.

13. Tereykovsky I.A., Tereykovskaya L.A., Korchenko A.O., Akhmetov B.B., Alibiyeva Zh.M. Neural network recognition of hand-written characters in the system of biometric authentication. Collection of works, Section "Information Security and Cybernetic Safety" release-2, Ukraine, Kiev 2017 of page 29-44

14. Tereykovsky I.A., Alibiyeva Zh.M., Tashimova A. Voice signals noise reduction in the biometric authentication systems. The collection of works, Academy of technical and humanistic service in Bielsko-Biala 2017, volume 2, page 27-34.