

INNOVATION SCIENCE AND TECHNOLOGY

ISSUE 9, PART I / SEPTEMBER 2026

 Acceptance of papers



**Acceptance of
papers**

Published monthly



Topics

economics,
technology, social
sciences



EDITOR-IN-CHIEF:

Mirzaliyev Sanjar Makhmatjon ugli

DEPUTY EDITOR-IN-CHIEF:

Makhmudov Nosir Makhmudovich
DSc., Prof., Academician

DEPUTY EDITOR-IN-CHIEF:

Ochilov Bobur Bakhtiyor ugli – Senior
lecturer at TSUI

THE SCIENTIFIC-POPULAR ELECTRONIC
JOURNAL **"INNOVATION SCIENCE AND
TECHNOLOGY"** HAS BEEN REGISTERED
UNDER THE NUMBER **C-5669633** BY THE
AGENCY FOR INFORMATION AND MASS
COMMUNICATIONS (AOKA) OF THE
REPUBLIC OF UZBEKISTAN, EFFECTIVE
FROM OCTOBER 9, 2024.

CONTACTS

Phone: **+998 50 737 87 88**

Website: <https://ist-journal.uz>

Email: innovationist2025@gmail.com

The scientific electronic journal "Innovation Science and Technology" has been included in the list of scientific publications recommended for the publication of main scientific results of dissertations for the award of PhD and DSc degrees in economics and technical sciences, in accordance with the Resolution No. 370 of the Presidium of the Higher Attestation Commission of the Republic of Uzbekistan, dated May 8, 2025.

Editorial board:



Sharipov Kongiratbay Avezimbetovich,
Doctor of Technical Sciences (DSc), Professor



Abdurakhmanova Gulnora Kalandarovna, Doctor of
Economic Sciences (DSc), Professor



Cham Tat Huei,
Doctor of Philosophy (PhD), Professor (Malaysia)



Muhammad Imran Sadiq
Doctor of Philosophy in Economics (PhD), Professor,
Malaysia



Ahmed Aziz Ismail
Doctor of Technical Sciences (DSc),
Professor (Egypt)



Lee Chin
Doctor of Philosophy in Economics (PhD), (Malaysia)



Asongu Simplice
Doctor of Philosophy in Economics (PhD), Cameroon



Rui Dang
Doctor of Chemistry (DSc), Professor, China



Zahoor Ahmed
Doctor of Philosophy in Economics (PhD), Turkey



Shujaat Abbas
Doctor of Philosophy in Economics (PhD), Russia



Tina A Coffelt
Doctor of Philosophy in Educational Sciences (PhD),
USA



Abdikarimova Dinara Rustamxanovna
Doctor of Economic Sciences (DSc), Professor

Kurbonbekova Mohichehra Turobjonovna
Doctor of Economic Sciences (DSc), Professor

Alimardonov Ilkhom Muzrabshokovich
Doctor of Economic Sciences (DSc), Professor



Razakova Barno Sayfieva
Doctor of Philosophy in Economics (PhD)



Khasanov Sarvar Ulugbek ugli
Doctor of Philosophy in Economics (PhD)



Kholikova Rukhsora Sanjarovna
Associate Professor (PhD)

CONTENTS

ECONOMIC ESSENCE AND CLASSIFICATION OF FINANCIAL ERRORS AND IRREGULARITIES IN BUDGET ORGANIZATIONS AND CRITERIA FOR THEIR INTERNAL AUDIT ASSESSMENT.....	8
Mulayev Farxod Alisherovich	
THE IMPACT OF FISCAL DISCIPLINE AND PUBLIC DEBT ON NATIONAL CURRENCY STABILITY: THEORETICAL APPROACHES AND MODELING	14
G'afurov Olimjon G'olib o'g'li	
THE ROLE OF REMOTE BANKING SERVICES IN ENHANCING FINANCIAL INCLUSION IN UZBEKISTAN	20
Sharipov Tohir Mirakhimovich	
THE IMPORTANCE OF STANDARDIZATION REQUIREMENTS IN THE ACCREDITATION OF NON-DESTRUCTIVE TESTING LABORATORIES.....	26
Ahmedov G'ayratjon Mahmudjonovich	
THEORETICAL ASPECTS OF ASSESSING THE IMPACT OF CORPORATE GOVERNANCE ON ECONOMIC EFFICIENCY IN CONSTRUCTION ENTERPRISES.....	32
Giyosov Ilkhom Karimovich	
FOREIGN EXPERIENCE IN STATE REGULATION OF SUSTAINABLE TOURISM DEVELOPMENT AND THE POSSIBILITIES OF ITS APPLICATION IN UZBEKISTAN.....	39
O'sarov Abdulla Davronqulovich	
THE CURRENT STATE AND DEVELOPMENT TRENDS OF THE SMALL BUSINESS SECTOR IN THE REPUBLIC AND ITS IMPACT ON HUMAN CAPITAL.....	46
Ulugmuradova Nodira Berdimuradovna	
INCREASING ECONOMIC EFFICIENCY BASED ON DIGITAL PLATFORMS IN THE IMPLEMENTATION OF ALTERNATIVE ENERGY TECHNOLOGIES (THE CASE OF RURAL AREAS).....	53
Ashurov Azizbek Ergash ugli	
WAYS TO IMPROVE THE QUALITY OF ASSETS AND STABILITY OF THE CREDIT PORTFOLIO IN COMMERCIAL BANKS	58
Baymuratova Zina Aqilbekovna	
MEASURING GREEN EFFICIENCY IN THE MINING INDUSTRY THROUGH AN INTEGRATED INDICATOR-BASED APPROACH FROM NAVOI MINING AND METALLURGICAL COMPANY.....	63
Kurbanova Mehriniso, Ergashev Hamidulla	
CORRELATION BETWEEN MACROECONOMIC INDICATORS AND TAX REVENUES.....	69
Khakimov Ulugbek Abdullaevich	
ENHANCING ECONOMIC EFFICIENCY AND FORECAST INDICATORS OF SCALING BIG DATA SOLUTIONS IN THE TOURISM INDUSTRY	74
E. I. Temirov	
IMPROVING THE EFFICIENCY OF STATE FINANCIAL SUPPORT FOR FARMS: A RESULTS- AND RISK-ORIENTED APPROACH.....	81
Rashidov Baxadir Yusupovich	
THE ROLE OF REMOTE BANKING SERVICES IN ENHANCING FINANCIAL INCLUSION IN UZBEKISTAN	86
Sharipov Tohir Mirakhimovich	
ORGANIZATIONAL AND LEGAL FOUNDATIONS FOR ESTABLISHING A PERSONNEL RESERVE FOR LOCAL GOVERNMENT AUTHORITIES IN UZBEKISTAN.....	92
G'aniyev Elyor Sobirjonovich	
METAEXTRACT: A HYBRID METADATA EXTRACTION SYSTEM COMBINING RULE-BASED AND STATISTICAL APPROACHES	100
Rashid Muhtorovich Turgunbaev	
DIRECTIONS FOR USING FINANCIAL ANALYSIS RESULTS IN THE DEVELOPMENT OF E-COMMERCE PLATFORMS IN UZBEKISTAN.....	105
Amankulova Mukhlisa Narsafar kizi	

IMPROVING THE ORGANISATIONAL-ECONOMIC MECHANISMS FOR ENHANCING THE PROFITABILITY OF ENTREPRENEURIAL ACTIVITY	111
Inobatov Abror Boshlarovich	
THE CURRENT STATE AND DYNAMICS OF FINANCING ENTREPRENEURIAL ACTIVITIES THROUGH BANK LOANS.....	117
Ergashev Otamurod Tashtemirovich	
IMPROVING THE METHODOLOGY FOR ASSESSING THE EFFICIENCY OF LAND TAX ADMINISTRATION FOR INDIVIDUALS	123
Ramazonov Shamil Ulugbek ogli	
IMPROVING THE EFFICIENCY OF STRATEGIC RESOURCE ALLOCATION IN BANKING ACTIVITIES THROUGH ARTIFICIAL INTELLIGENCE.....	130
Shukhrat Komilovich Roziboyev	
STRATEGIC DIRECTIONS FOR ENHANCING THE COMPETITIVE POTENTIAL OF ENTERPRISES THROUGH INNOVATION-DRIVEN DEVELOPMENT	138
Karima Samatovna Tashmukhamedova	
FUNCTIONAL FEATURES OF SEMANTIC PHENOMENA IN ENGLISH AND UZBEK METALLURGICAL TERMINOLOGY	143
O'tkirova Shahlo Asqar qizi	
DECENTRALIZED TECHNOLOGIES AND ARTIFICIAL INTELLIGENCE AS DRIVERS OF CROWDFUNDING EVOLUTION	151
Karimova Aziza A'zamiddin qizi	
THEORETICAL FOUNDATIONS FOR USING ARTIFICIAL INTELLIGENCE IN ASSESSING CORPORATE FINANCIAL STABILITY	159
Jokhongir Hasanovich Dagarov	
A MODEL FOR ASSESSING THE ECONOMIC EFFICIENCY OF INTRODUCING DIGITAL PLATFORMS	163
Nabiev Zafar Irkinovich	
CHARGING OF SYNTHETIC FIBERS AND IMPROVEMENT OF EMULSION.....	169
Arabov Jamoliddin Sadriddinovich	
ECONOMETRIC ANALYSIS OF FACTORS AFFECTING THE FINANCING OF INNOVATIVE ACTIVITIES OF TOURIST ENTERPRISES IN THE SAMARKAND REGION	177
Ruzibaeva Nargiza Khakimovna	
IMPLEMENTATION OF QUALIFIED PERSONNEL TRAINING CLUSTERS IN THE TOURISM SECTOR OF THE REGIONAL ECONOMY	181
Raxmatov Adxam Itolmasovich	
ASSESSING THE DIGITAL MATURITY OF ENTERPRISES AND IMPROVING THE MECHANISMS FOR STRENGTHENING THEIR COMPETITIVENESS: AN INDEX-BASED FRAMEWORK FOR UZBEK INDUSTRIAL AND SERVICE FIRMS	189
Kungratov Ilmurod Kuzibay ugli	
DIRECTIONS FOR DEVELOPING EMPLOYEE COMPETENCIES IN THE DIGITAL ECONOMY	197
Musaev Ozodjon Shavkat Ogli	
SPEAKER DIARIZATION OF KARAKALPAK SPEECH USING A PRETRAINED SORTFORMER MODEL UNDER LOW-RESOURCE CONDITIONS.....	202
Kudaybergenov Tangirbergen Kadirbergenovich	
ANALYSIS OF THERMAL AND ELECTRICAL PARAMETERS OF A PHOTOVOLTAIC-THERMAL ELECTROBIOMEMBRANE REACTOR IN WASTEWATER TREATMENT FOR MICROPOLLUTANT REMOVAL	208
Sevara U. Mirzayorova	
MODELING MAGNETOELASTIC VIBRATIONS OF COMPLEX-SHAPED TRANSVERSELY ISOTROPIC PLATES USING THE R-FUNCTION METHOD.....	212
Faxriddin Nuraliyev, Nuriddin Tojiyev, Bobir Adilov	

OPTIMAL CONDITIONS FOR EXTRACTION OF VALUABLE COMPONENTS FROM RICE HUSK.....	221
Umarov Faxriddin, Rahimov Baxodir, Blsmanov Ne'matullo, Ataxo'jayev Abdubositxo'ja	
IMPROVING THE ORGANIZATIONAL AND ECONOMIC MECHANISM FOR THE DEVELOPMENT OF THE SERVICES SECTOR: PROBLEMS AND PROSPECTIVE DIRECTIONS	227
Yo'ldoshev Shuxratmirza Tursunboy o'g'li	
INVESTIGATION OF THE KINETICS AND OPTIMAL CONDITIONS FOR THE PRODUCTION OF $FeCl_3$ COAGULANT FROM TEBINBULOQ ORES.....	235
Nurmurodov To'likin, Oljayev Dilshod, Mansurova Shabnam	
ENVIRONMENTAL PROTECTION THROUGH RESOURCE-EFFICIENT WASTE UTILIZATION.....	241
Toirova Nuriya, Urinova Xulkar	
TECHNOLOGICAL AND DIGITAL DIVERSIFICATION IN INDUSTRIAL ENTERPRISES: DIRECTIONS FOR ADAPTING FOREIGN EXPERIENCES TO THE CONDITIONS OF UZBEKISTAN	245
Asadov Elyorbek Kandiyarovich	
A PROCESS-AWARE DATA PREPROCESSING AND TIME-DELAY IDENTIFICATION FRAMEWORK FOR CEMENT CLINKER ENERGY MONITORING	250
Abror Turakulov, Maksadkhon Yakubov, Zafar Turakulov	
DEVELOPMENT OF KPIS TO MEASURE THE SUCCESS OF INNOVATIVE ENVIRONMENTAL PROJECTS WITHIN THE COMPANY.....	260
Musadjanova Nargiza Abduvoxid qizi	
ANALYSIS OF THE EFFICIENT USE OF FINANCIAL RESOURCES IN ENSURING EFFECTIVE ENTREPRENEURIAL ACTIVITY IN THE REGION (ANALYSIS OF THE STATE OF ENTREPRENEURSHIP DEVELOPMENT IN FERGANA REGION).....	266
Bozorov Ilyos Isomiddinovich	
TIJORAT BANKLARIDA ICHKI AUDIT AMALLARINI BAJARISH.....	271
Yuldashev Xurshidbek Mamirjonovich	
THE ROLE OF FASHION ELEMENTS IN THE FORMATION OF A NATION BRAND: A CONCEPTUAL FRAMEWORK AND RESEARCH METHODOLOGY	277
Yusupova Mokhinur Farkhod qizi	
THE ORGANISATIONAL AND ECONOMIC MECHANISM FOR EVALUATING THE EFFECTIVENESS OF MARKETING PROMOTION OF EDUCATIONAL SERVICES.....	287
Umarov Shuhrat Bahodir o'g'li	
COMPUTER VISION TECHNOLOGIES TO IMPROVE THE IMAGE QUALITY OF THE IRIS	297
Makhmudova Shakhzoda, Sharopova Barno, Saydazimov Javlonbek	

COMPUTER VISION TECHNOLOGIES TO IMPROVE THE IMAGE QUALITY OF THE IRIS

Makhmudova Shakhzoda Yorkinovna

PhD Student, Tashkent University of Information Technologies named after Muhammad al-Khwarizmi

E-mail: shaha080599@gmail.com

Sharopova Barno Abdunabiyevna

Lecturer, Karshi State Technical University

E-mail: sharopovabarno5@gmail.com

Saydazimov Javlonbek Karimovich

PhD Student, Tashkent University of Information Technologies named after Muhammad al-Khwarizmi

E-mail: Javlonbek2020@gmail.com

Abstract. The article addresses the problem of improving the quality of eye region images in computer vision systems for biometric identification. A multi-stage image processing algorithm is proposed that includes face detection, localization of the eye region, extraction of the pupil and iris, segmentation of biometrically significant areas, and image quality enhancement by filtering, normalization and contrast enhancement. The main attention is paid to increasing the information content of the textural features of the iris and the periocular region in images obtained from conventional surveillance cameras under low light, noise, blur and limited resolution. The novelty of the work lies in combining glare removal, local contrast enhancement and neural network super-resolution in a single preprocessing pipeline for ordinary RGB cameras. Experimental results show that the proposed approach improves the quality of visual data and the extraction of biometric features and increases the effectiveness of subsequent identification.

Keywords: computer vision, biometric identification, iris, periocular region, image processing, segmentation, image quality improvement, video surveillance, feature extraction, multimodal biometrics.

Аннотация. В статье рассматривается проблема повышения качества изображений области глаза в системах компьютерного зрения для биометрической идентификации. Предложен многоэтапный алгоритм обработки изображений, включающий обнаружение лица, локализацию области глаза, выделение зрачка и радужной оболочки, сегментацию биометрически значимых областей, а также повышение качества изображения с помощью фильтрации, нормализации и усиления контраста. Основное внимание уделяется повышению информативности текстурных признаков радужной оболочки и периокулярной области на изображениях, полученных с помощью обычных камер видеонаблюдения в условиях недостаточной освещенности, шума, размытия и ограниченного разрешения. Новизна работы заключается в объединении методов удаления бликов, локального усиления контраста и нейросетевого сверхразрешения в единую систему предварительной обработки изображений, получаемых с обычных RGB-камер. Экспериментальные результаты показывают, что предложенный подход повышает качество визуальных данных, улучшает выделение биометрических признаков и способствует повышению эффективности последующей идентификации.

Ключевые слова: компьютерное зрение, биометрическая идентификация, радужная оболочка, периокулярная область, обработка изображений, сегментация, повышение качества изображения, видеонаблюдение, выделение признаков, мультимодальная биометрия.

INTRODUCTION

Iris recognition is one of the most reliable areas of computer vision in biometric identification owing to the unique textural structure of each person's iris [1]. Modern computer vision systems can automatically detect a face, localize the eye region, identify biometrically significant elements and recognize a user on the basis of visual features.

However, the effectiveness of computer vision algorithms depends directly on the quality of the input images. Under real video surveillance conditions, eye images are often characterized by low resolution, noise, blur, uneven lighting and partial occlusion of biometric areas [2]. These factors lead to the loss of textural information of the iris and reduce the accuracy of subsequent recognition.

To solve this problem, computer vision systems apply image preprocessing methods aimed at improving

the quality of visual data before the feature extraction stage. Multi-stage processing, which includes face detection, localization of the eye region, pupil and iris segmentation, image normalization, noise reduction and enhancement of textural characteristics, is of particular relevance.

The object of the study is the image of the eye region obtained by conventional RGB cameras, and the subject is the set of methods for preprocessing and enhancing such images. The purpose of this work is to develop a computer vision algorithm for preprocessing eye region images that improves the visualization of the iris and the extraction of biometric features for subsequent identification. The objectives are: 1) to analyse existing approaches to iris segmentation and enhancement; 2) to develop a multi-stage processing framework; 3) to evaluate the effect of the proposed framework on images of different quality.

LITERATURE REVIEW

The classical approach to iris recognition was established by J. Daugman, who proposed localizing the iris with integro-differential operators, normalizing it into a fixed rectangular representation and encoding its texture with Gabor filters [1]. Bowyer, Hollingsworth and Flynn summarized the subsequent development of this approach and showed that image acquisition and segmentation errors remain the main factors contributing to recognition errors [3]. Proença and Alexandre introduced the UBIRIS database of noisy iris images captured under visible light and less constrained conditions, which drew attention to the problem of low-quality input data [2].

With the development of deep learning, the focus of research has shifted towards data-driven methods. Nguyen, Fookes, Ross and Sridharan demonstrated that features extracted by off-the-shelf convolutional neural networks can achieve high iris recognition accuracy [4]. Zhao and Kumar proposed a fully convolutional network that learns spatially corresponding iris features and improves matching accuracy [5]. Comprehensive surveys by Nguyen, Proença and Alonso-Fernandez [6] and by Yin and co-authors [7] show that deep learning is now widely used in segmentation, recognition and presentation attack detection, while image enhancement has received comparatively less research attention. Tapia, Gonzalez and Busch addressed the reliability of iris systems against spoofing by means of a cascade of dedicated deep networks [8].

Research on the periocular region, initiated by Park, Ross and Jain, showed that the area around the eye carries discriminative information in the visible spectrum when the iris itself is of insufficient quality [9]. For the preprocessing stage, the literature offers well-established tools: the Viola and Jones cascade for fast face detection [10], the MediaPipe framework for landmark-based localization [11], contrast-limited adaptive histogram equalization (CLAHE) for local contrast enhancement [12], and generative super-resolution models ESRGAN [13] and Real-ESRGAN [14] for restoring fine details. General machine learning foundations for such pipelines are reviewed by Alzubi, Nayyar and Kumar [15].

Unlike the cited works, which mainly concentrate either on near-infrared acquisition or on the recognition stage, the present study focuses on a combined preprocessing framework for ordinary RGB cameras, in which glare removal, local contrast enhancement and super-resolution are applied sequentially before feature extraction.

RESEARCH METHODOLOGY

The proposed method consists of several successive stages of image processing, implemented with the OpenCV library [16].

Image acquisition. At the first stage, a photograph is taken with a digital camera or webcam. The image may contain a person's face in whole or in part.

Face detection. Object detection methods based on Haar cascade algorithms [10] or modern neural network models such as YOLO and MediaPipe Face Detection [11] are used to localize the face region. The result of this stage is a bounding box of the face.

Extraction of the eye region. After the face is detected, the eyes are located using facial landmarks. The eye coordinates make it possible to select separate regions of interest (ROI) containing the left and right eyes.

Segmentation of the pupil and iris. To determine the central region of the eye, the pupil is located by binarization and the Hough transform for circles. After the pupil boundary is determined, the iris region lying between the inner and outer radii is calculated [1]. The resulting region is normalized and cropped for further processing.

Image quality improvement. Modern image processing methods are used to improve the quality of the iris texture: median filtering to remove noise; CLAHE for local contrast enhancement [12]; sharpening by unsharp masking; super-resolution based on the ESRGAN or Real-ESRGAN neural network models [13; 14]; suppression of blur by deblurring methods; and adaptive enhancement of textural features.

After processing, the iris image contains more pronounced textural patterns suitable for extracting biometric features.

ANALYSIS AND RESULTS

To evaluate the effectiveness of the method, eye images of various quality were processed. After the algorithm was applied, the following effects were observed: improved contrast of the iris, reduced noise, greater clarity of texture lines and better visual separation of the pupil and iris.

In low-resolution images, the use of super-resolution made it possible to restore fine details of the iris structure. The use of CLAHE significantly improved local contrast without excessive amplification of noise. The results demonstrate that comprehensive preprocessing contributes to better extraction of biometric features.

After preprocessing, the iris is localized and segmented. Contrast and sharpness enhancement techniques, including CLAHE and image filtering, are then applied to the selected region. As a result, the textural features and individual patterns of the iris used in biometric recognition are enhanced (Figure 1).

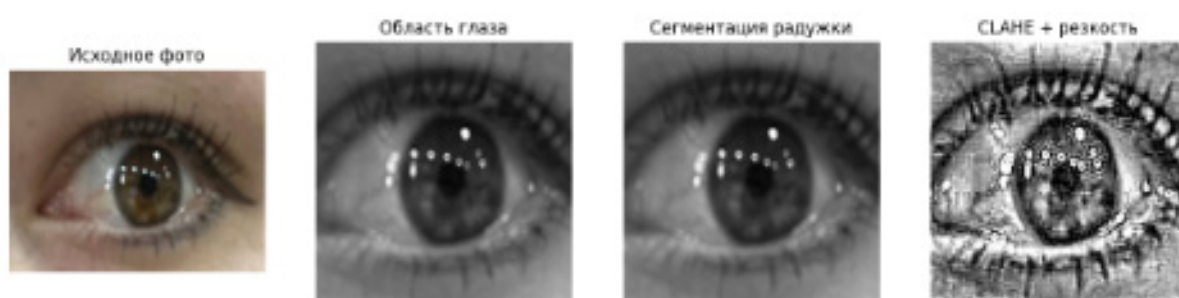


Figure 1. Segmentation and enhancement of the iris texture (input eye image, specular reflection removal, iris localization and segmentation, enhanced iris feature extraction)¹

At the first stage of processing, the initial image of the eye is obtained. Next, the specular reflection removal method is used to reduce the effect of reflections from light sources on the surface of the eye. This improves image quality and the visibility of the iris for subsequent segmentation (Figure 2).

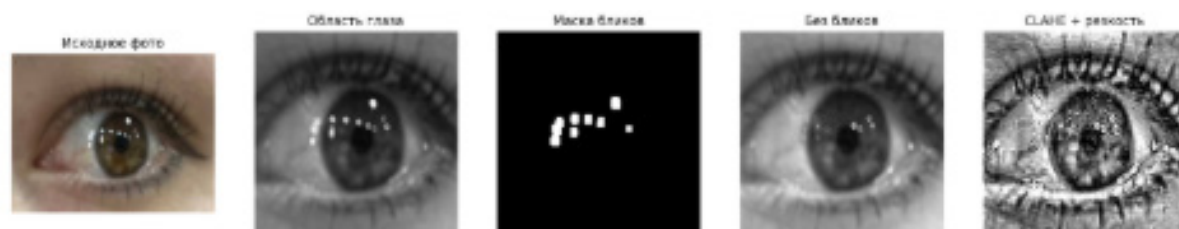


Figure 2. Original eye image and removal of light glare (original eye image, glare removal, specular reflection mask, iris segmentation, enhanced iris texture)²

The proposed approach improves the image quality of the iris when conventional RGB cameras are used without specialized infrared equipment, which makes the system more accessible for mobile and embedded biometric applications. This result is consistent with the observations of Park, Ross and Jain on the usefulness of visible-spectrum ocular data [9]. Despite the positive results, segmentation quality may deteriorate in the presence of glare, eyelid closure or a strong head tilt.

CONCLUSIONS AND SUGGESTIONS

The paper presents a multi-stage method for improving the quality of iris images for biometric recognition tasks. The algorithm includes face detection, eye localization, pupil and iris segmentation and the use of modern image quality enhancement techniques. The results show that the proposed approach improves the visibility of iris texture patterns and increases the information content of images for subsequent recognition.

On the basis of the results, the following is suggested: 1) to use the method in biometric authentication systems, security systems and mobile computer vision applications; 2) to apply deep convolutional neural

¹ Source: developed by the authors based on the research results.

² Source: developed by the authors based on the research results.

networks for more accurate detection of iris boundaries and restoration of textures [6]; 3) to use generative models for intelligent enhancement of low-quality source images [14]; 4) to supplement the proposed processing framework with presentation attack detection in order to increase system reliability [8].

REFERENCES

1. Daugman J. How iris recognition works // *IEEE Transactions on Circuits and Systems for Video Technology*. – 2004. – Vol. 14, No. 1. – P. 21–30. – DOI: 10.1109/TCSVT.2003.818350.
2. Proença H., Alexandre L. A. UBIRIS: A noisy iris image database // *Image Analysis and Processing – ICIAP 2005*. Lecture Notes in Computer Science. – Berlin; Heidelberg: Springer, 2005. – Vol. 3617. – P. 970–977. – DOI: 10.1007/11553595_119.
3. Bowyer K. W., Hollingsworth K., Flynn P. J. Image understanding for iris biometrics: A survey // *Computer Vision and Image Understanding*. – 2008. – Vol. 110, No. 2. – P. 281–307. – DOI: 10.1016/j.cviu.2007.08.005.
4. Nguyen K., Fookes C., Ross A., Sridharan S. Iris recognition with off-the-shelf CNN features: A deep learning perspective // *IEEE Access*. – 2018. – Vol. 6. – P. 18848–18855. – DOI: 10.1109/ACCESS.2017.2784352.
5. Zhao Z., Kumar A. Towards more accurate iris recognition using deeply learned spatially corresponding features // *Proceedings of the IEEE International Conference on Computer Vision (ICCV)*. – 2017. – P. 3829–3838. – DOI: 10.1109/ICCV.2017.411.
6. Nguyen K., Proença H., Alonso-Fernandez F. Deep learning for iris recognition: A survey // *ACM Computing Surveys*. – 2024. – Vol. 56, No. 9. – Art. 223. – P. 1–35. – DOI: 10.1145/3651306.
7. Yin Y., He S., Zhang R., Chang H., Zhang J. Deep learning for iris recognition: A review // *Neural Computing and Applications*. – 2025. – Vol. 37, No. 17. – P. 11125–11173. – DOI: 10.1007/s00521-025-11109-5.
8. Tapia J. E., Gonzalez S., Busch C. Iris liveness detection using a cascade of dedicated deep learning networks // *IEEE Transactions on Information Forensics and Security*. – 2022. – Vol. 17. – P. 42–52. – DOI: 10.1109/TIFS.2021.3132582.
9. Park U., Ross A., Jain A. K. Periocular biometrics in the visible spectrum: A feasibility study // *2009 IEEE 3rd International Conference on Biometrics: Theory, Applications, and Systems (BTAS)*. – 2009. – P. 1–6. – DOI: 10.1109/BTAS.2009.5339068.
10. Viola P., Jones M. Rapid object detection using a boosted cascade of simple features // *Proceedings of the 2001 IEEE Computer Society Conference on Computer Vision and Pattern Recognition (CVPR)*. – 2001. – Vol. 1. – P. I-511–I-518. – DOI: 10.1109/CVPR.2001.990517.
11. Lugaresi C., Tang J., Nash H., McClanahan C., Uboweja E., Hays M., Zhang F., Chang C.-L., Yong M. G., Lee J., Chang W.-T., Hua W., Georg M., Grundmann M. MediaPipe: A framework for building perception pipelines [Electronic resource]. – 2019. – arXiv:1906.08172. – URL: <https://arxiv.org/abs/1906.08172> (accessed: 17.09.2026).
12. Zuiderveld K. Contrast limited adaptive histogram equalization // *Graphics Gems IV* / ed. by P. S. Heckbert. – San Diego: Academic Press, 1994. – P. 474–485. – DOI: 10.1016/B978-0-12-336156-1.50061-6.
13. Wang X., Yu K., Wu S., Gu J., Liu Y., Dong C., Qiao Y., Loy C. C. ESRGAN: Enhanced super-resolution generative adversarial networks // *Computer Vision – ECCV 2018 Workshops*. Lecture Notes in Computer Science. – Cham: Springer, 2019. – Vol. 11133. – P. 63–79. – DOI: 10.1007/978-3-030-11021-5_5.
14. Wang X., Xie L., Dong C., Shan Y. Real-ESRGAN: Training real-world blind super-resolution with pure synthetic data // *Proceedings of the IEEE/CVF International Conference on Computer Vision Workshops (ICCVW)*. – 2021. – P. 1905–1914. – DOI: 10.1109/ICCVW54120.2021.00217.
15. Alzubi J., Nayyar A., Kumar A. Machine learning from theory to algorithms: An overview // *Journal of Physics: Conference Series*. – 2018. – Vol. 1142. – Art. 012012. – DOI: 10.1088/1742-6596/1142/1/012012.
16. OpenCV Documentation. Open Source Computer Vision Library [Electronic resource]. – URL: <https://docs.opencv.org/4.x/> (accessed: 17.09.2026).

Proofreader: Zokir ALIBEKOV

Layout and Designer: Oloviddin Sobir ugli

2026. № 9

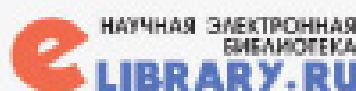
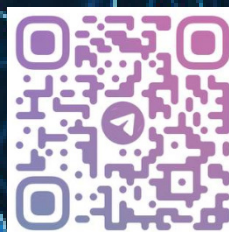
© When materials are reproduced, the INNOVATION SCIENCE AND TECHNOLOGY journal must be cited as the source. Authors are responsible for the accuracy of the information in materials and advertisements published in the journal. Editorial opinions may not always align with those of the authors. Submitted materials will not be returned to the editorial office.

To publish articles in this journal, you may submit articles, advertisements, stories, and other creative materials through the following links. Materials and advertisements are published on a paid basis.

You may subscribe to the journal at any time using the following details. Once subscribed, please send a screenshot or photo of your payment confirmation to our Telegram page @iqtisodiyot_77. Based on this, we will send the latest issue of the journal to your address each month.

“The journal “INNOVATION SCIENCE AND TECHNOLOGY” has been registered by the Agency for Information and Mass Communications under the Administration of the President of the Republic of Uzbekistan from 09.10.2024 under the registration number №390637. License number: C-5669633. PNFL: 30407832680027

Our address: Tashkent city, Yunusobod district, 19th block,
House 17.



Acceptance of articles

Published every
monthly



Directions

Social, economic, political,
technological, scientific



Scopus || Scientific electronic journal specializing in Scopus

CERTIFICATE NUMBER: №390637

**ORDER NUMBER ACCORDING TO
THE LICENSE REGISTER: C-5669633**

CONTACT:



Contact us
+998 50 737 87 88



Telegram channel
t.me/scopus_IST2100



Journal official website
<https://ist-journal.uz/index.php/IST>