A scientific and applied issue arose regarding the need to reduce the volume of video information provided if it is confidential and reliable. For the cryptocompression coding of images on a differentiated basis while ensuring their confidentiality and key elements as a service component. On the third cascade of processing, it is proposed without loss of information quality. It involves a three-stage technology steps. This paper reports the development of a conceptual method for the source video data in a reduced dynamic range. The generation of a dimension of 16 × 16 elements. The method ensures a decrease in the amount of data for encryption by up to 40 times compared to TIFF and PNG technologies. The devised method does not introduce errors into the data in the coding process and refers to methods without loss of information quality.

**Keywords:** cryptocompression, coding, information protection, floating scheme, differentiated basis, service component.

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DOI: 10.15587/1729-4061.2021.239084

DEVISING AN IMAGE PROCESSING METHOD FOR TRANSPORT INFRASTRUCTURE MONITORING SYSTEMS (p. 18–25)

Oleksandr Volkov
International Research and Training Center for Information Technologies and Systems of the National Academy of Sciences (NAS) of Ukraine and Ministry of Education and Science (MES) of Ukraine. Kyiv, Ukraine
ORCID: https://orcid.org/0000-0002-5418-6723

Mykola Komar
International Research and Training Center for Information Technologies and Systems of the National Academy of Sciences (NAS) of Ukraine and Ministry of Education and Science (MES) of Ukraine. Kyiv, Ukraine
ORCID: https://orcid.org/0000-0001-9194-2850

Dmytro Volosheniuk
International Research and Training Center for Information Technologies and Systems of the National Academy of Sciences (NAS) of Ukraine and Ministry of Education and Science (MES) of Ukraine. Kyiv, Ukraine
ORCID: https://orcid.org/0000-0003-3793-7801

Identifying and categorizing contours in images is important in many areas of computer vision. Examples include such operational tasks solved by using unmanned aerial vehicles as dynamic monitoring of the condition of transport infrastructure, in particular road markings.

This study has established that current methods of image contour analysis do not produce clear and reliable results when solving the task of monitoring the state of road markings. Therefore, it is a relevant scientific and applied task to improve the methods and models of filtration, processing of binary images, and qualitative and meaningful separation of the boundaries of objects of interest.

To solve the task of highlighting road marking contours on images acquired from an unmanned aerial vehicle, a method has been devised that includes an operational tool for image preprocessing – a relevant scientific and applied task to improve the methods and procedures reported here it make possible to successfully solve problems that are largely similar to those that an expert person can face when solving intelligent tasks of processing and filtering information.

The proposed method was verified at an enterprise producing the Ukrainian unmanned aerial vehicle “Spectator” during tests of information technology of dynamic monitoring of the state of transport infrastructure.

The results could be implemented in promising intelligent control systems in the field of modeling human conscious behavior when sorting data required for the perception of environmental features.

Keywords: computer vision, contour detection, filtration, Sobel operator, Hough transform, Laplace operator.

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With the advent of the data age, the continuous improvement and widespread application of medical information systems have led to an exponential growth of biomedical data, such as medical imaging, electronic medical records, biometric tags, and clinical records that have potential and essential research value. However, medical research based on statistical methods is limited by the class and size of the research community, so it cannot effectively perform data mining for large-scale medical information. At the same time, supervised machine learning techniques can effectively solve this problem. Heart attack is one of the most common diseases and one of the leading causes of death, so finding a system that can accurately and reliably predict early diagnosis is an essential and influential step in treating such diseases. Researchers have used various data mining and machine learning techniques to analyze medical data, helping professionals predict heart disease. This paper presents various features related to heart disease, and the model is based on ensemble learning. The proposed system involves preprocessing data, selecting attributes, and then using logistic regression algorithms as meta-classifiers to build the ensemble learning model. Furthermore, using machine learning algorithms (Support Vector Machines, Decision Tree, Random Forest, Extreme Gradient Boosting) for prediction on the Framingham Heart Study dataset and compared with the proposed methodology. The results show that the feasibility and effectiveness of the proposed prediction method based on group learning provide accuracy for medical recommendations and better accuracy than the single traditional machine learning algorithm.

**Keywords**: heart attack prediction, machine learning, ensemble learning, stacking ensemble technique.

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DOI: 10.15387/1729-4061.2021.239288

METHODS AND TOOLS OF FORMATION OF GENERAL INDEXES FOR AUTOMATION OF DEVICES IN REHABILITATIVE MEDICINE FOR POST-STROKE PATIENTS (p. 35–46)

Alexandr Trunov
Petro Mohyla Black Sea National University, Mykolaiv, Ukraine
ORCID: https://orcid.org/0000-0002-8524-7840

Volodymyr Beglytsia
Petro Mohyla Black Sea National University, Mykolaiv, Ukraine
ORCID: https://orcid.org/0000-0002-8994-4600

Gennady Gryshechenko
Petro Mohyla Black Sea National University, Mykolaiv, Ukraine
ORCID: https://orcid.org/0000-0002-5557-2191

Viktor Ziuzin
Petro Mohyla Black Sea National University, Mykolaiv, Ukraine
ORCID: https://orcid.org/0000-0002-3722-613X

Vitalii Koshevoy
Petro Mohyla Black Sea National University, Mykolaiv, Ukraine
ORCID: https://orcid.org/0000-0001-9592-7439

The current processes of recovery of post-infarction and post-stroke patients in the context of the establishment of the institution of family doctors and insurance medicine are considered. It was proposed to introduce modules for automation of recovery devices (MARD) to ensure procedures, quality of life and reduce labor costs during the period of long-term recovery. The forms of presentation of the model of the integral indicator are substantiated, which, in accordance with the requirements of the Ministry of Health, assesses the generalized indicator of the patient’s statement (GIPS), the quality of medical services and increases the efficiency of data compression. A consistent application of two Euclidean norms is proposed, which leads indicators of dissimilar physical nature to a limited metric space. The relationship between the lower and upper bounds of the GIPS, the error, the width of the sliding window, and the values of the derivatives was established on the basis of the Taylor series expansion, geometric inequality and limited space. The relationship between the lower and upper bounds of the GIPS, the error, the width of the sliding window, and the values of the derivatives was established on the basis of the Taylor series expansion, geometric inequality and limited space. The model for evaluating the GIPS as a lower bound and the method for generating information about its properties are substantiated.

A three-level comparator is applied and an vector-indicator (VI) is introduced as an informational addition to the time series. Additional capabilities for intelligent analysis are demonstrated. The
model of GIPS through VI is presented. The examples of IV values are used to demonstrate its applicability to the intelligent analysis of the recovery process. Openness, accessibility, transparency of GIPS and VI as tools of KIT is implemented by the princes of public administration (PA) by reducing it to quantitative control and comparison if there are quantitative and qualitative indicators in the list. VI, sliding windows, as PA and KIT tools in software (SW) for a diagnostic conclusion and correction of the course of procedures, are numerically investigated. It is demonstrated on examples of a numerical experiment with software how the combined application of the method for calculating the GIPS and VI effectively affects the compression ratio, increasing it to 60–75 %.

**Keywords:** automation module, integral indicator, vector-indicator, lossless compression, recovery devices, public administration.

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DEVELOPMENT OF AUDIT AND DATA PROTECTION PRINCIPLES IN ELECTRONIC VOTING SYSTEMS (p. 47–57)

Yuriy Khaponin
Kyiv National University of Construction and Architecture, Kyiv, Ukraine
ORCID: https://orcid.org/0000-0002-9287-0817

Volodymyr Vyshniakov
Kyiv National University of Construction and Architecture, Kyiv, Ukraine
ORCID: https://orcid.org/0000-0003-4608-712X

Viktoria Ternavskaya
Kyiv National University of Construction and Architecture, Kyiv, Ukraine
ORCID: https://orcid.org/0000-0003-2102-619X

Oleksandr Selyukov
Kyiv National University of Construction and Architecture, Kyiv, Ukraine
ORCID: https://orcid.org/0000-0001-7979-3434

Oleg Komarnitskyi
Department of Transport Infrastructure of the Kyiv City State Administration, Kyiv, Ukraine
ORCID: https://orcid.org/0000-0003-4830-919X

It is assumed in standard information protection technologies that there are owners of this information who put forward requirements for protection. In secret voting systems, the information belongs to the community of citizens, and to protect it, vote organizers must create conditions that allow each voter to make sure that the vote secrecy and accuracy of vote counting are preserved. In developed democracies, this issue is resolved through a widely available audit of all procedures that may be mistrusted. Any voter can conduct such an audit. The anxiety of citizens of democratic countries is based on the idea that if electronic voting is introduced, it will be impossible to conduct such an audit. The article proposes principles of auditing, which all those software and hardware tools and processes of the online voting system that can generate voter distrust. This audit is carried out using a dedicated server open to voters and their fiduciaries. This server provides continuous monitoring of actions of the service staff in terms of possible interference in the operation of the voting system. Also, due to this server, auditors receive data on the integrity of the voting system hardware and software including its audit tools and an alarm signal in the event of a threat. It was possible to reduce the average time of processing the voter requests to two seconds. This means that processing a maximum of 2,500 voter requests at a vote station will take no more than two hours. Simultaneous access of 50 voters to the server will not make them wait in the queue for more than 2 minutes. Implementation results were described and links were given for conducting experimental voting on the Internet.

Keywords: audit of online voting system, data protection, exclusion of illegal influence on voters.

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In the course of our research work, the American, Russian and Turkish sign languages were analyzed. The program of recognition of the Kazakh dactylic sign language with the use of machine learning methods is implemented. A dataset of 5000 images was formed for each gesture, gesture recognition algorithms were applied, such as Random Forest, Support Vector Machine, Extreme Gradient Boosting, while two data types were combined into one database, which caused a change in the architecture of the system as a whole. The quality of the algorithms was also evaluated.

The research work was carried out due to the fact that scientific work in the field of developing a system for recognizing the Kazakh language of sign dactyls is currently insufficient for a complete representation of the language. There are specific letters in the Kazakh language, because of the peculiarities of the spelling of the language, problems arise when developing recognition systems for the Kazakh sign language.

The results of the work showed that the Support Vector Machine and Extreme Gradient Boosting algorithms are superior in real-time performance, but the Random Forest algorithm has high recognition accuracy. As a result, the accuracy of the classification algorithms was 98.86% for Random Forest, 98.68% for Support Vector Machine and 98.54% for Extreme Gradient Boosting. Also, the evaluation of the quality of the work of classical algorithms has high indicators.

The practical significance of this work lies in the fact that scientific research in the field of gesture recognition with the updated alphabet of the Kazakh language has not yet been conducted and the results of this work can be used by other researchers to conduct further research related to the recognition of the Kazakh dactyl sign language, as well as by researchers, engaged in the development of the international sign language.

**Keywords:** Gesture recognition, sign language, feature extraction, hand tracking, algorithm evaluation.

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**DOI:** 10.15587/1729-4061.2021.239253

**SIGN LANGUAGE DACTYL RECOGNITION BASED ON MACHINE LEARNING ALGORITHMS (p. 58–72)**

Chingiz Keshimov
Institute of Information and Computational Technologies, Almaty, Republic of Kazakhstan
**ORCID:** https://orcid.org/0000-0002-3923-0958

Zhodas Buribayev
Al-Farabi Kazakh National University, Almaty, Republic of Kazakhstan
**ORCID:** https://orcid.org/0000-0002-3486-227X

Yedilkhan Amirgaliev
Institute of Information and Computational Technologies, Almaty, Republic of Kazakhstan
**ORCID:** https://orcid.org/0000-0002-6528-0619

Aisulyu Ataniyazova
Al-Farabi Kazakh National University, Almaty, Republic of Kazakhstan
**ORCID:** https://orcid.org/0000-0003-1122-6614

Askhat Aitimov
Suleyman Demirel University, Kastelen, Republic of Kazakhstan
**ORCID:** https://orcid.org/0000-0002-9849-1391
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методи інтелектуального аналізу даних і машинного навчання для аналізу медичних даних, які допомагають фахівцям прогнозувати яка може точно і надійно прогнозувати діагноз, є важливим кроком в лікуванні таких захворювань. Дослідники використовували різні

серцевий напад є одним з найбільш поширених захворювань і однією з основних причин смерті, тому знаходження системи, яка містить оперативний інструмент попередньої обробки зображень – комбінований фільтр. Розроблений метод має ряд переваг та усуває недоліки відомих методів при визначенні меж розташування об’єкта інтересу, шляхом виокремлення контурів кластеру точок із застосуванням гістограм.

Ключові слова: криптокомпресія, кодування, захист інформації, плаваюча схема, диференційований базис, службова складова.

В. В. Бараннік, О. Сідченко, С. О. Сідченко, С. С. Шульгін, В. В. Бараннік, А. І. Дацун Поряд з повсякденною використанням цифрових зображень виникає актуальна науково-прикладна проблема щодо необхідності знижен-
сервісу захворювання. У даній статті представлені різні особливості сервісу захворювань, модель заснована на ансамблевому навчанні. Запропонована система включає попередню обробку даних, вибір атрибутів і використання алгоритмів логістичної регресії як мета-класифікаторів для побудови моделі ансамблевого навчання. Крім того, використання алгоритмів машинного навчання (метод опорних векторів, дерево рішення, шкідливий ліс, екстремальний градієнтний бустинг) для прогнозування на основі набору даних. Фрімінгемського дослідження серед і порівняння із запропонованою методологією. Результати показують, що доцільність і ефективність запропонованого методу прогнозування, заснованого на груповому навчанні, забезпечують точність медичних рекомендацій і більш високу точність в порівнянні з едним традиційним алгоритмом машинного навчання.

Ключові слова: прогнозування сервісу на базі, машине навчання, ансамблеве навчання, метод стекованого узагальнення.

DOI:10.15587/1729-4061.2021.239288
ФОРМУВАННЯ МЕТОДІВ ТА ІНСТРУМЕНТІВ УЗАГАЛЬНЕНИЯ ПОКАЗНИКІВ ДЛЯ АУТОМАТИЗАЦІЇ ПРИЛАДІВ ВІДНОВЛЮВАЛЬНОЇ МЕДИЦИНИ ПОСТІНСУЛЬТНИХ ПАЦІЄНТІВ (с. 36–46)
О. М. Трунов, В. П. Беглиця, Г. В. Грищенко, В. О. Сєлюков, В. В. Кошовий

Розглянуто відновлення постінфарктних і постінсультних пацієнтів, що є актуальним у умовах становлення інституту сімейних лікарів та страхової медицини. Запропоновано для забезпечення процедур, якості життя і зменшення трудоднів у період довготривалого відновлення впровадити модули автоматизації приладів відновлення (МАПВ). Обґрунтовано форми представления моделі інтегрального показника, який відповідає до вимог МОЗ оцінює загальні показники стану (ЗПС) пацієнта і якість медичних послуг та приладдя підвищує ефективність стиснення даних. Запропоновано підсумовувати застосування двох Евклідів діалогів, які приводять єдинорідну за своєю фізичною природою показники до обмеженого метричного простору. Встановлено на підставі рівняння у ряд Тейлора, геометричної нерівності та обмеженості простору зв’язок між низькою та високою границями ЗПС, зв’язки їхною відповідності і значеннями похідних. Обґрунтовано модель оцінки ЗПС як нижньої граничної і метод формування інформації про її властивості.

Застосовано тривіттійній комп’ютер та введення вектор-індикатор (ВІ) як інформаційне доповнення часового ряду. Продемонстровано додаткові можливості для інтелектуального аналізу. Представлено модель ЗПС через ВІ. На прикладах значень ВІ продемонстровано його застосовності до інтелектуального аналізу ходу відновлення. Відкритість, доступність, прозорість ЗПС та ВІ, як інструменти КІТ реалізує принципи публічного адміністрування (ПА) щодо збереження даних та поваги до персоналу, які включно з послугами, які надає або надається, а також роботи з інформацією в середовищі ПА.

Ключові слова: модуль автоматизації, інтегральний показник, вектор-індикатор, безвтратне стиснення, приладди відновлення, публічне адміністрування.

DOI:10.15587/1729-4061.2021.238259
РОЗРОБКА ПРИНЦИПІВ АУДИТУ ТА ЗАХИСТУ ДАННЫХ В СИСТЕМАХ ЕЛЕКТРОННОГО ГОЛОСУВАННЯ (с. 47–57)
Ю. І. Хлапонін, В. М. Вишняков, В. М. Тернавська, О. В. Сєлюков, О. О. Комарницький

У стандартних технологіях захисту інформації передбачається, наявність власника, якому належить ця інформація, і він висуває вимоги для інтелектуального аналізу. Представлено модель ЗПС через ВІ. На прикладах значень ВІ продемонстровано його застосовності до інтелектуального аналізу ходу відновлення. Відкритість, доступність, прозорість ЗПС та ВІ, як інструменти КІТ реалізує принципи публічного адміністрування (ПА) щодо збереження даних та поваги до персоналу, які включно з послугами, які надає або надається, а також роботи з інформацією в середовищі ПА.

Ключові слова: модуль автоматизації, інтегральний показник, вектор-індикатор, безвтратне стиснення, приладди відновлення, публічне адміністрування.

DOI:10.15587/1729-4061.2021.239253
РОЗПІЗНАВАННЯ ДАКТІЛЬНОЇ МОВИ ЖЕСТІВ НА ОСНОВІ АЛГОРИТМІВ МАШИННОГО НАВЧАННЯ (с. 58–72)
Chingiz Kenshimov, Zholdas Buribayev, Yedilkhan Amirgaliyev, Aisulyu Ataniyazova, Askhat Aitimov

У процесі дослідницької роботи були проаналізовані американська, російська і турецька мови жестів. Реалізована програма розпізнавання каяхської дактильної мови жестів із застосуванням методів машинного навчання. Сформовано датасет з 5000 зображень для кожного жесту, застосовані алгоритми з розпізнавання жестів, такі як Random Forest, Support Vector Machine,
Extreme Gradient Boosting, при цьому поєднані два типи даних в одну базу, що викликало зміну архітектури системи в цілому. Також була проведена оцінка якості алгоритмів.

Дослідницька робота проведена в зв’язку тим, що наукові роботи в області розробки системи розпізнавання казахської мови жестових дактилів в даній час є недостатніми для повного розуміння мови. У казахській мові є специфічні літери, через особливості правопису виникають проблеми при розробці систем розпізнавання казахської мови жестів.

Результати роботи показали, що алгоритми Support Vector Machine і Extreme Gradient Boosting лідують за продуктивністю в реальному режимі часу, але алгоритм Random Forest має високу точність розпізнавання. В результаті точність алгоритмів класифікації склала 98,86 % для Random Forest, 98,68 % для Support Vector Machine і 98,54 % для Extreme Gradient Boosting. Так само оцінки якості роботи класичних алгоритмів мають високі показники.

Практична значимість полягає в тому, що наукові дослідження в області розпізнавання жестів з оновленим алфавітом казахської мови доці не проводилися і результати цієї роботи можуть бути використані іншими дослідниками для проведення подальших досліджень, пов’язаних з розпізнаванням казахської дактильної мови жестів, а також дослідниками, які займаються розвитком міжнародної мови жестів.

Ключові слова: розпізнавання жестів, мова жестів, витяг ознак, відстеження рук, оцінка алгоритмів.