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«Information Control Systems and Technologies»
(ICST- ODESA – 2025)

24th – 26th September, 2025

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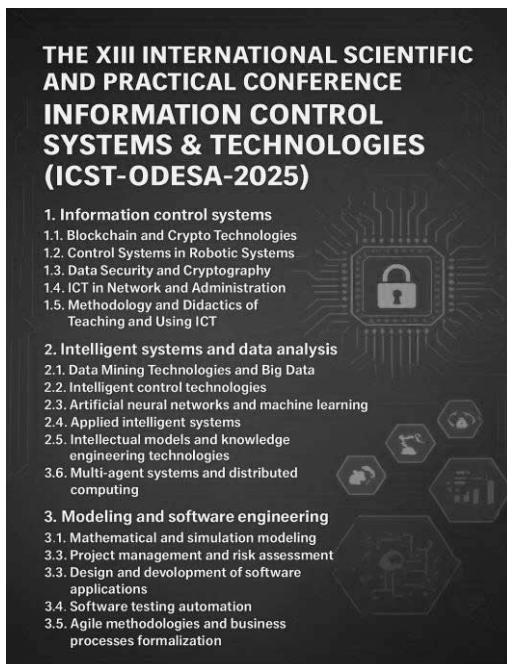
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The collection contains materials accepted by the organizing committee for participation in the International Scientific and Practical Conference "INFORMATION CONTROL SYSTEMS AND TECHNOLOGIES" (ICST-ODESA-2025).

The materials of the conference cover the main directions of development in the field of artificial intelligence, development and analysis of big data, blockchain and crypto technologies, control systems in robotic systems, data security and cryptography, ICT in the network and administration, information systems and technologies in Data Mining, intelligent technologies management, mathematical modeling, methodology and didactics of teaching and using ICT, application development, project management, system analysis, software development.

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Conclusions. The proposed model reconciles deterministic mass-transport equations with a probabilistic description of the incoming flow, providing engineering criteria for selecting belt speeds and route configurations to prevent spillage and reduce energy consumption. Practically, it enables the design of adaptive speed-control strategies based on online estimates of input statistics and exceedance forecasts.

References

1. Pihnastyi, O. M., Ivanovska, O. V., & Sobol, M. O. (2022). Synthesis of the algorithm for the flow parameters optimal control of the reversible conveyor. *Radio Electronics, Computer Science, Control*, 2, P.210-221. <https://doi.org/10.15588/1607-3274-2022-2-20>
2. Pihnastyi, O., & Sobol, M. (2022). The input material flow model of the transport conveyor. Paper presented at the Proceedings of the 2022 IEEE 4th International Conference on Modern Electrical and Energy System, MEES 2022, doi:10.1109/MEES58014.2022.10005769
3. Oleh Pihnastyi, Maksym Sobol, Method for Determining Statistical Characteristics of Input Material Flows of Transport Conveyor. CEUR Workshop Proceedings, Volume 3513, 2023. ISSN 1613-0073, Pages 409-419. Proceedings of the 11-th International Conference "Information Control Systems & Technologies", Odesa, Ukraine, September 21–23, 2023. <https://ceur-ws.org/Vol-3513/paper34.pdf>
4. Oleh Pihnastyi, Maksym Sobol, Anna Burduk Predictive analysis of the interval material flow rates in transport conveyors based on experimental data CEUR Workshop Proceedings, Volume 3790, 2024. ISSN 1613-0073, Pages 494-505. Proceedings of the 12-th International Conference "Information Control Systems & Technologies", Odesa, Ukraine, September 23–25, 2024. <https://ceur-ws.org/Vol-3790/paper43.pdf>
5. Oleh Pihnastyi, Maksym Sobol (2022). Stress analysis in a conveyor belt for the maxwell model of elastic element. *Bulletin of the National Technical University «KhPI» Series: Dynamics and Strength of Machines*, 1, P.81-93. <http://jdsm.khpi.edu.ua/article/view/265430>, <http://jdsm.khpi.edu.ua/indexing>

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**РОЗПІЗНАВАННЯ КЛАВІАТУРНОГО ПОЧЕРКУ ЗА
ДОПОМОГОЮ ВОСЬМИВИМІРНОГО ЕЛІПСОЇДА
ПРОГНОЗУВАННЯ ДЛЯ НОРМАЛІЗОВАНИХ ДАНИХ**
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KEYSTROKE DYNAMICS RECOGNITION USING AN EIGHT-VARIATE PREDICTION ELLIPSOID FOR NORMALIZED DATA

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Анотація. Розпізнавання клавіатурного почерку забезпечує безперервну, ненав'язливу автентифікацію користувача, але його точність часто знижується, оскільки розподіл реальних даних відхиляється від багатовимірного нормального. В роботі досліджується застосування восьмивимірного еліпсоїда прогнозування для нормалізованих даних, що поєднують час утримання клавіші та міжклавішні затримки. Результати показують, що застосування еліпсоїда прогнозування для нормалізованих даних значно покращує точність та ймовірність розпізнавання, досягаючи найкращих результатів з використанням багатовимірного перетворення Бокса-Кокса.

Ключові слова: розпізнавання клавіатурного почерку, багатовимірний нормальний розподіл, нормалізуюче перетворення

Abstract. Keystroke dynamics recognition provides continuous, non-intrusive user authentication, but its accuracy often suffers because real-world data violate the assumption of multivariate normality. This study investigates the application of an eight-variate prediction ellipsoid for normalized data, combining key hold times and inter-key latencies. Results show that normalization significantly improves recognition accuracy and probability, achieving the best results using the multivariate Box-Cox transformation.

Keywords: keystroke dynamics recognition, multivariate normal distribution, normalizing transformation

Розпізнавання клавіатурного почерку є біометричною технологією, що ідентифікує користувачів за унікальними шаблонами введення тексту та забезпечує ненав'язливу й безперервну автентифікацію. Оскільки такі системи здебільшого використовуються для автентифікації, їх часто моделюють як задачі одно-класової класифікації [1], де модель навчається лише на даних цільового користувача та виявляє відхилення, що можуть вказувати на несанкціонований доступ.

Багато існуючих моделей для розпізнавання образів передбачають багатовимірний нормальний розподіл даних. Проте на практиці це припущення часто порушується через природну варіативність у наборі

тексту, наявність шумів і зовнішніх факторів [2]. Як наслідок, точність та ймовірність розпізнавання можуть суттєво знижуватися при застосуванні таких моделей до реальних даних. З огляду на широке використання розпізнавання клавіатурного почерку існує очевидна потреба у вдосконаленні методів розпізнавання для забезпечення вищої точності та ймовірності розпізнавання.

У цьому дослідженні використовується CMU Keystroke Dynamics Benchmark Dataset, загальнодоступний і широко застосовуваний набір даних, розроблений для досліджень у сфері автентифікації.

У випадках, коли багатовимірний розподіл вихідних даних відхиляється від нормального, попередньо застосовуються нормалізуючі перетворення, які поділяються на одновимірні та багатовимірні [3].

Одновимірні перетворення, такі як логарифмічне (LOG) та перетворення Бокса–Кокса (UBCT), застосовуються до кожної ознаки незалежно, натомість багатовимірне перетворення Бокса–Кокса (MBCT) дозволяє враховувати кореляцію між ознаками. Після цього будуватиметься восьмивимірний еліпсоїд прогнозування для нормалізованих даних:

$$(\mathbf{Z} - \bar{\mathbf{Z}})^T \mathbf{S}_Z^{-1} (\mathbf{Z} - \bar{\mathbf{Z}}) = \chi_{m,\alpha}^2, \quad (1)$$

де $\mathbf{Z}$ – гауссівський вектор; $\bar{\mathbf{Z}}$ – вектор вибірових середніх;

$$\mathbf{S}_Z = \frac{1}{N} \sum_{i=1}^N (\mathbf{Z}_i - \bar{\mathbf{Z}})(\mathbf{Z}_i - \bar{\mathbf{Z}})^T; \quad \chi_{m,\alpha}^2 - \text{квантиль розподілу хі-квадрат}$$

з m ступенями свободи та рівнем значущості α .

Для оцінки побудованих моделей застосовуються кілька широко використовуваних метрик: accuracy, specificity та recall. Таблиця 1 містить порівняння результатів використання еліпсоїдів прогнозування для негаусівських даних (Raw data) та нормалізованих даних (1) за визначеними метриками.

Table 1.

Порівняння побудованих еліпсоїдів прогнозування

Model	Specificity	Recall	Accuracy
Raw data	0,9625	0,9588	0,9613
LOG	0,9750	0,9639	0,9714
UBCT	0,9900	0,9845	0,9882
MBCT	0,9900	0,9897	0,9899

Результати показують, що застосування еліпсоїдів прогнозування для нормалізованих даних дозволяє підвищити точність та ймовірність розпізнавання. Хоча одновимірні перетворення забезпечують помітні покращення, найкращі результати досягаються за допомогою багатовимірних перетворень, оскільки вони враховують взаємозв'язки між ознаками.

Література

1. Roy, S., Pradhan, J., Kumar, A., Adhikary, D., Roy, U., Sinha, D., & Pal, R. (2022). A systematic literature review on latest keystroke dynamics based models. *IEEE Access*, 10, 92192–92236. <https://doi.org/10.1109/ACCESS.2022.3197756>
2. Oyebola, O. (2023). Examining the distribution of keystroke dynamics features on computer, tablet and mobile phone platforms. In *Proceedings of the Mobile Computing and Sustainable Informatics (ICMCSI 2023)* (pp. 613–620). Springer. https://doi.org/10.1007/978-981-99-0835-6_43
3. Prykhodko, S., & Trukhov, A. (2024). Application of a nine-variate prediction ellipsoid for normalized data and machine learning algorithms for keystroke dynamics recognition. In *Proceedings of the Information Technology and Implementation (IT&I) Workshop: Intelligent Systems and Security (IT&I-WS 2024: ISS), CEUR Workshop Proceedings* (Vol. 3933, pp. 51–64). CEUR-WS. https://ceur-ws.org/Vol-3933/Paper_5.pdf