ΛΌΓΟΣ

www.logos-science.com

COLLECTION DE PAPIERS SCIENTIFIQUES SUR LES MATÉRIAUX DE LA

VI CONFÉRENCE SCIENTIFIQUE ET PRATIQUE INTERNATIONALE

«Débats scientifiques et orientations prospectives du développement scientifique»

Paris
République française

1er Mars
2024

SCI SORBONNE &
Plateforme scientifique européenne

DOI 10.36074/logos-01.03.2024

ISBN (en ligne) 978-2-37467-148-2
ISBN (imprimer) 978-617-8312-01-5

SCI SORBONNE | European Scientific Platform

ΛΌΓΟΣ

COLLECTION DE PAPIERS SCIENTIFIQUES

SUR LES MATÉRIAUX DE LA
VI CONFÉRENCE SCIENTIFIQUE ET PRATIQUE INTERNATIONALE

«DÉBATS SCIENTIFIQUES ET ORIENTATIONS PROSPECTIVES DU DÉVELOPPEMENT SCIENTIFIQUE»

Paris,
République française

1er Mars,
2024

République française
«La Fedeltà»

Ukraine
«UKRLOGOS Group»

2024

UDC 082:001
D 29

Président du comité d'organisation: Goldenblat M.[1]
Vice-président du comité d'organisation: Blandin G.[2]

L'organisation au nom de laquelle le livre est publié:
[1] PO Plateforme scientifique européenne, Ukraine
[2] SCI SORBONNE, République française

Responsable de la mise en page: Bilous T.
Responsable de la conception: Bondarenko I.

D 29 **Débats scientifiques et orientations prospectives du développement scientifique**: c avec des matériaux de la VI conférence scientifique et pratique internationale, Paris, 1er Mars 2024. Paris-Vinnytsia: La Fedeltà & UKRLOGOS Group LLC, 2024.

ISBN 978-617-8312-01-5 UKRLOGOS Group LLC, Ukraine
ISBN 978-2-37467-148-2 (PDF) «La Fedeltà», République française
DOI 10.36074/logos-01.03.2024

Les résumés et articles des participants à la VI conférence multidisciplinaire scientifique et pratique internationale «Débats scientifiques et orientations prospectives du développement scientifique», qui s'est tenue à Paris le 1er Mars 2024, sont présentés.

The conference is certified by Euro Science Certification Group (**Certificate № 22512 dated January 7, 2024**);

The conference is also included in the catalog of International Scientific Conferences by ResearchBib; and registered by State Scientific Institution «Ukrainian institute of scientific and technical expertise and information» in the database «Scientific and technical events of Ukraine» (**Certificate № 66 dated 5 January 2024**).

Bibliographic descriptions of the conference proceedings are indexed by Google Scholar, CrossRef, OpenAIRE, OUCI, Scilit, Semantic Scholar, Mendeley, WarldCat and ORCID.

UDC 082:001

ISBN 978-617-8312-01-5
ISBN 978-2-37467-148-2 (PDF)

Débats scientifiques et orientations prospectives
du développement scientifique

SECTION 15.
AUTOMATISATION ET INSTRUMENTATION

DOI 10.36074/logos-01.03.2024.041

RESEARCH ON THE APPLICATION OF DYNAMIC PROGRAMMING ALGORITHM FOR LOAD BALANCING ON CONVEYOR LINES IN THE PHARMACEUTICAL INDUSTRY

Oleksandr Klymenko[1]

1. PhD student department of Computer-Integrated Technologies,
Automation and Robotics (CITAR)
Kharkiv National University of Radio Electronics, UKRAINE

The use of robotic sorters in the pharmaceutical industry requires the development of effective balancing algorithms that can take into account the variety of products, their characteristics and processing speed requirements [1-3]. Research in this area will allow to develop optimal load management strategies, increasing production efficiency and minimizing the errors probability. The use of balancing algorithms in the pharmaceutical industry also helps to reduce costs, optimize production times and ensure compliance with quality standards. Due to the constant changes in market demands and technological developments, research in this area provides an opportunity for continuous improvement and optimization of production processes in the pharmaceutical field [4].

Dynamic Programming (DP) algorithm is a method for solving optimization problems based on breaking a complex problem into simpler subproblems and storing the results of their solution for later use. To balance the load on conveyor lines with sorting robots in the pharmaceutical field, the mathematical principle of the DP algorithm can be presented as follows [5-7] .

Let T_{ij} - robot j task i completion time; M_j - number of tasks performed by the robot j; S_i - sorting speed for the task i; D - extra time to move to the next task. We carry out initialization, that is, we set the initial values of the variables, in this case M_j =0 for all the robots.

We define a recurrent equation that describes the optimal time to complete each task for each robot

$$T_{ij} = T_{ij} + \frac{W_i + D}{S_i} \quad (1)$$

where: W_i *- task* i *sorting time excluding travel time.*

For each robot, select a task that minimizes the total execution time:

$$M_j = \arg\min_i T_{ij} \quad (2)$$

The next step is to update the values of the variables, taking into account the choice of the optimal task:

$$M_j = M_j + 1 \quad (3)$$

We repeat the process for the next task until all tasks are completed. The final result is the optimal distribution of tasks between robots and the minimum total execution time

This equation and process is repeated for each task and robot to determine the optimal distribution of tasks and execution times on an assembly line with sorting robots.

The advantages and disadvantages of the Dynamic Programming (DP) algorithm in load balancing on conveyor lines with sorting robots are presented in Table 1 [8-10] .

Table 1

Analysis of the advantages and disadvantages of the Dynamic Programming (DP) algorithm in load balancing on pharmaceutical conveyor lines

Aspect	Advantages	Disadvantages
Efficiency	Provides an optimal solution to the load balancing problem	Computational complexity can be high with large amounts of data
Optimality	Solving the optimization problem at the level of the entire system	Not always applicable in real time due to time costs
Time costs	Using saved results from previous subtasks	Requires significant computing resources to implement
Computational complexity	Effective for relatively small amounts of data	Not always applicable in real time with large volumes of data

– **Conclusions.** Dynamic programming algorithms ensure optimal distribution of tasks between sorting robots, as a result of which the processing time of performed operations is minimized. To increase the efficiency of dynamic programming algorithms, it is necessary to take into account the complexity of calculations with large volumes of data.

REFERENCES:

[1] Borys, S., Kaczmarek, W., & Laskowski, D. (2020). Selection and optimization of the parameters of the robotized packaging process of one type of product. *Sensors*, *20*(18), 5378.

[2] Hao, Nini, Xinming Sun, Mengchao Zhang, Yuan Zhang, Xingyu Wang, and Xiaoting Yi. 2023. "Vibration and Noise Analysis and Experimental Study of Rail Conveyor" *Sensors 23*, no. 10: 4867. https://doi.org/10.3390/s23104867

[3] Nevliudov, I. S., Yevsieiev, V. V., Maksymova, S. S., Omarov, A. O. M., & Klymenko, O. M. (2023). Conveyor Belt Object Identification: Mathematical, Algorithmic, and Software Support. *Appl. Math. Inf. Sci., 17*(6). - P. 1073-1088.

[4] Khalid, M. S., Yevsieiev, V., Nevliudov, I. S., Lyashenko, V., & Wahid, R. (2022). HMI Development Automation with GUI Elements for Object-Oriented Programming Languages Implementation. *International Journal of Engineering Trends and Technology*, 70.1, 139-145.

[5] Nevliudov, I., & et al.. (2021). Development of a cyber design modeling declarative Language for cyber physical production systems, *J. Math. Comput. Sci.*, 11(1), 520-542.

[6] Attar, H., & et al.. (2022). Zoomorphic Mobile Robot Development for Vertical Movement Based on the Geometrical Family Caterpillar. *Computational Intelligence and Neuroscience*, 2022, Article ID 3046116, https://doi.org/10.1155/2022/3046116.

[7] Nevliudov, I., Yevsieiev, V., Maksymova, S., Demska, N., Kolesnyk, K., & Miliutina, O. (2022, September). Object Recognition for a Humanoid Robot Based on a Microcontroller. *In 2022 IEEE XVIII International Conference on the Perspective Technologies and Methods in MEMS Design (MEMSTECH)* PP. 61-64. DOI: 10.1109/MEMSTECH55132.2022.10002906

[8] Nevliudov Igor, Maksymova Svitlana, Yevsieiev Vladyslav, & Klymenko Oleksandr. (2023). Using Mecanum Wheels for Radio Shuttle. *Multidisciplinary Journal of Science and Technology*, 3(3), 182–187.

[9] Yevsieiev, V.., & Gurin, D. (2023). COMPARATIVE ANALYSIS OF THE BASIC METHODS USED IN INDUSTRY 4.0 AND INDUSTRY 5.0. *Collection of Scientific Papers «ΛΌГOΣ»*, (September 29, 2023; Bologna, Italy), 113–115. https://doi.org/10.36074/logos-29.09.2023.31

[10] Моделі та методи кіберфізичних виробничих систем в концепції Industry 4.0 : монографія / І. Ш. Невлюдов, В. В. Євсєєв, А. О. Андрусевич, С. С. Максимова ; – Oktan Print – Prague. 2023. – 321 с.