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Denysenko Andrii
PhD student of the Department of Intelligent Information Systems,
https://orcid.org/0009-0001-0816-462X
Petro Mohyla Black Sea National University, Mykolaiv, Ukraine
Kozlov Oleksiy
DSc, Professor of the Department of Intelligent Information Systems,
https://orcid.org/0000-0003-2069-5578
Petro Mohyla Black Sea National University, Mykolaiv, Ukraine

ANALYSIS OF TECHNOLOGIES AND ALGORITHMS FOR MANAGEMENT OF COMPUTING RESOURCES IN VIDEO DATA PROCESSING

Abstract. *Managing computational resources in video data processing involves planning, distributing, monitoring, and controlling various types of computational resources such as computing power, network resources, data storage, etc., to ensure their effective use in processing large volumes of video data. This process includes a complex of various tasks for processing, analyzing, and modifying data, which requires significant computational power. Video data are large in size and require a lot of storage space, which can lead to problems such as data transmission delays and data loss. Special hardware and software tools, which can be quite expensive and complex to configure, are usually required for processing video data. This paper provides a comprehensive analysis of existing methods and means for solving the tasks of distributing and managing computational resources in the modern systems of video data processing. Existing modern algorithms and technologies, including those based on artificial intelligence, are examined in detail, identifying their main advantages and disadvantages.*

Keywords: video data processing; management of computing resources task scheduling; resource allocation; load balancing; intelligent algorithms

Introduction

The rapid growth of video content across various industries, including entertainment, security, healthcare, and education, has led to an unprecedented demand for advanced video data processing capabilities [1]. As digital transformation accelerates, video data has become a crucial element in applications ranging from real-time surveillance and video streaming to complex video analytics and artificial intelligence-driven insights. However, the processing of video data is computationally intensive, requiring significant computing power, storage capacity, and network bandwidth [2]. This surge in video data has made the efficient management of computational resources not just a technical necessity but also a critical factor for operational efficiency and cost-effectiveness.

The challenge of managing computational resources in video data processing involves a series of complex tasks, including task scheduling, resource allocation, and load balancing [1-3]. These tasks are crucial to ensuring that computing resources are utilized effectively to meet the high processing demands of large volumes of video data. Inefficient resource management can lead to bottlenecks, increased latency, and high operational costs, negatively impacting the performance of video processing systems. Current resource management techniques, while effective to some extent, often struggle to keep pace with the dynamic and growing demands of video data processing, especially in environments where resource availability and processing loads fluctuate unpredictably [4; 5].

Addressing these challenges requires innovative approaches that go beyond traditional methods. This paper aims to explore how intelligent methods, such as neural networks, reinforcement learning, and evolutionary algorithms, can optimize the management of computational resources in video data processing. By leveraging these advanced algorithms, it is possible to achieve more adaptive, efficient, and automated resource management, reducing the need for manual intervention and improving overall system performance.

The main purpose of this paper is to analyze existing algorithms and information technologies for managing computational resources in video data processing within computer systems. By examining the strengths and limitations of current approaches, this study seeks to identify opportunities for the development of highly efficient intelligent information technologies. Specifically, the paper aims to: a) investigate the challenges associated with managing computational resources in processing large volumes of video data; b) evaluate existing algorithms and approaches for resource management, including task scheduling, resource allocation, and load balancing; c) discuss emerging intelligent algorithms such as neural networks, reinforcement learning, and evolutionary algorithms, and their potential applications in optimizing resource management processes; d) provide insights into the future direction of research and development in the field of video data processing, with a focus on enhancing resource utilization, productivity, and cost-effectiveness.

Features of resource management and distribution in video data processing systems

Managing computational resources in video data processing involves planning, distributing, monitoring, and controlling various types of computational resources such as computing power, network resources, data storage, etc., to ensure their effective use in processing large volumes of video data. This process includes a complex of various tasks for processing, analyzing, and modifying data, which requires significant computational power. Video data are large in size and require a lot of storage space, which can lead to problems such as data transmission delays and data loss. Special hardware and software tools, which can be quite expensive and complex to configure, are usually required for processing video data. To develop highly effective algorithms and information technologies for managing computational resources in video data processing, a comprehensive analysis of existing methods and means of solving these tasks must first be conducted, identifying their advantages and disadvantages.

Algorithms and Techniques for Managing Computational Resources

Existing algorithms for managing computational resources in various computer systems can be divided into several subgroups: algorithms of task scheduling [6], resource allocation [7], load balancing [8], access control, monitoring [9], backup, migration [10], automatic scaling [11], and others. Below, the advantages and disadvantages of the above algorithms are considered in detail.

In turn, the process of computer processing of video data necessitates solving a number of complex tasks: improving video quality, trimming and editing video, compressing and increasing video resolution [12], video image recognition [13], video playback on various devices, video transmission over networks, video data analysis, etc. Effective management of computational resources in solving these tasks is a mandatory condition for processing large volumes of video data, as the requirements for computational power can dynamically increase.

In turn, the task scheduling algorithms are critical in ensuring that computational resources are efficiently utilized. The primary goal is to allocate tasks to resources in a way that minimizes the total processing time or maximizes resource utilization. Common scheduling algorithms include the following.

First-Come, First-Served (FCFS). This is a straightforward scheduling algorithm where tasks are processed in the order they arrive. While simple to implement, it does not consider the priority or size of the tasks, which can lead to inefficiencies.

Round-Robin (RR). This algorithm assigns a fixed time slice to each task and cycles through them [14]. It is fair and ensures that no single task monopolizes the CPU, but can result in high context-switching overhead.

Shortest Job Next (SJN). This algorithm selects the task with the smallest execution time next. It minimizes the average waiting time but can lead to starvation for longer tasks.

Priority Scheduling. Tasks are assigned priorities, and the scheduler selects the highest priority task next. This can lead to starvation of lower-priority tasks if high-priority tasks keep arriving.

Resource allocation algorithms determine how computational resources are assigned to tasks. These algorithms aim to maximize the efficiency of resource use and minimize execution time. Common approaches include the following.

Greedy Algorithms. These algorithms make local optimization decisions, hoping that these decisions will lead to a globally optimal solution. For example, a greedy algorithm for resource allocation might assign the most powerful resource to the most demanding task first.

Dynamic Programming. This approach breaks down a problem into simpler subproblems and solves each subproblem only once, storing the results. It is particularly useful for resource allocation problems where overlapping subproblems exist.

Evolutionary Algorithms. These are search heuristics inspired by natural selection that are used to generate high-quality solutions for optimization problems [15]. They work by evolving a population of solutions over several generations.

Moreover, the load balancing approach [16] aims to distribute tasks across computational resources evenly, ensuring no single resource is overwhelmed while others are underutilized. Common techniques include the following.

Static Load Balancing. This method pre-assigns tasks to resources based on predefined criteria, such as resource capacity or expected task load. It is straightforward but inflexible in adapting to dynamic changes.

Dynamic Load Balancing. In this method, tasks are assigned to resources in real-time based on the current load [17]. This approach is more flexible and can better handle variations in task arrival rates and resource availability.

Least Connections Algorithm. This dynamic load balancing method directs tasks to the resource with the fewest active connections or tasks.

1.1. The algorithms of parallel distribution of computational tasks should be noted separately. This approach involves distributing video processing tasks among different computational devices that can work in parallel. Among them the next technologies can be considered.

MapReduce. This programming model is used for processing and generating large data sets [18]. It consists of two steps: the Map step, which processes and filters data, and the Reduce step, which aggregates the results.

Hadoop. An open-source framework that allows for the distributed processing of large data sets across clusters of computers using simple programming models [19].

Apache Spark. An open-source unified analytics engine for big data processing, with built-in modules for streaming, SQL, machine learning, and graph processing.

In turn, the resource virtualization approach allows creating virtual computational resources from physical servers and ensuring their availability using virtualization systems such as VMware or Hyper-V. This approach abstracts the hardware layer, enabling multiple virtual machines to run on a single physical machine, thus optimizing resource utilization. The key benefits include: (a) flexibility (virtual resources can be easily scaled up or down based on demand); (b) isolation (each virtual machine operates independently, providing a secure environment for applications); (c) cost-effectiveness (virtualization reduces the need for physical hardware, leading to cost savings).

1.2. The cloud computing is also widely used for video data processing. The cloud computing involves using computational resources located in a cloud environment for video data processing. Cloud service providers such as Amazon Web Services (AWS), Microsoft Azure, and Google Cloud offer scalable and flexible resources. The key aspects of cloud computing include: (a) elasticity (cloud resources can be scaled dynamically to match the workload); (b) "Pay-as-You-Go" approach (users pay only for the resources they consume, leading to cost savings); (c) high availability (cloud providers offer redundancy and failover mechanisms to ensure high availability).

Among the widely used technologies, it is also worth mentioning the GPU acceleration [20]. This approach involves using a graphics processor (GPU) for video processing. GPUs have greater power and a large number of cores, allowing them to process large amounts of data in parallel. GPU acceleration is particularly effective for tasks such as video encoding/decoding, image processing, and deep learning. The main advantages of using the GPU acceleration are as follows: (a) parallelism (GPUs can handle thousands of threads simultaneously, providing significant speedup for parallelizable tasks) and (b) bandwidth (high memory bandwidth and computational power make GPUs ideal for data-intensive applications.

The technologies and algorithms discussed above cope in a certain way with the solution of resource allocation problems when processing video data. However, the complexity of such tasks in modern systems is constantly increasing, which requires the development of innovative methods. Advanced research shows that various methods and approaches of artificial intelligence allow us to effectively solve non-trivial problems and significantly increase the efficiency of complex science-intensive processes [21; 23].

Intelligent Algorithms for Managing Computational Resources

To ensure accurate, reliable, and efficient implementation of the approaches mentioned for video data processing, a variety of algorithms for distributing and managing computational resources are continually being developed and refined. As the tasks of computer processing of video data become increasingly complex, and the volumes of information and the necessary computational power grow, the application of intelligent algorithms and approaches is advisable [24]. Specifically, neural networks, fuzzy logic systems, evolutionary and multi-agent algorithms, and other machine learning methods open new possibilities and prospects for automating resource management processes and reducing the costs of video data processing [24, 25]. Next, we will consider in more detail the above intelligent technologies and the features of their application.

Neural networks, particularly deep learning models, have emerged as powerful tools in managing computational resources [26]. Their ability to learn patterns from large datasets enables them to predict resource demands and optimize system performance proactively. By using neural networks, the following efficient technologies for managing computational resources in video data processing can be implemented.

Predictive Resource Allocation. By analyzing historical data, neural networks can predict future CPU, memory, and bandwidth usage. This allows systems to allocate resources in advance, preventing bottlenecks and ensuring smooth operation even during peak loads.

Dynamic Load Balancing. Neural networks can be trained to recognize patterns in workload distribution across different nodes or servers. This enables real-time adjustments to load balancing, ensuring that no single resource is overburdened while others remain underutilized.

Task Scheduling Optimization. Neural networks can also be integrated into task scheduling algorithms, where they predict the execution time and resource requirements of tasks. This predictive capability allows for more efficient scheduling, reducing waiting times and improving overall system throughput.

Neural networks are particularly effective in environments where resource demands are highly variable and influenced by multiple factors, such as user behavior, network conditions, and the complexity level of video processing tasks. Their adaptability and learning capabilities make them ideal for managing resources in large-scale, dynamic systems.

Reinforcement learning (RL) represents a significant advancement in intelligent resource management [27]. Unlike traditional algorithms that follow predefined rules, RL involves an agent that learns to make optimal decisions through trial and error, guided by rewards and penalties. By using this approach, the following techniques for distributing computational resources in video data processing can be implemented.

Real-Time Resource Allocation. In resource management, RL can dynamically adjust resource allocation based on the current state of the system. For example, an RL agent can learn to allocate more CPU power to tasks that are predicted to have a higher impact on system performance, while reducing resources for less critical tasks.

Adaptive Task Scheduling. RL can also be applied to task scheduling, where the agent learns to prioritize tasks based on their urgency, complexity, and resource requirements. This results in more efficient scheduling, especially in environments with fluctuating workloads.

Load Balancing and Scaling. RL agents can manage load balancing by learning from past experiences to distribute workloads more evenly across available resources. They can also trigger automatic scaling of resources when the system detects an increase in demand, ensuring that performance remains consistent [28].

Reinforcement learning is particularly useful in scenarios where the environment is constantly changing, and decisions need to be made quickly. Its ability to learn from experience and adapt to new situations makes it a valuable tool for managing computational resources in video data processing.

Another very powerful approach is to use evolutionary computation to solve resource allocation and optimization problems [29]. Evolutionary algorithms are optimization techniques inspired by the principles of natural evolution. They are particularly effective in solving complex resource management problems where multiple variables and constraints need to be considered simultaneously. Among these methods, genetic algorithms (GAs) are most frequently used to solve the following tasks.

Optimization of Resource Allocation. GAs work by evolving a population of potential solutions over several generations. Each solution is evaluated based on its fitness, which is determined by how well it meets the system's resource management goals (e.g., minimizing execution time, reducing energy consumption). The best solutions are selected and combined to create new solutions, which are then further optimized.

Task Scheduling and Load Balancing. GAs can be applied to task scheduling and load balancing by searching for the most efficient way to distribute tasks across available resources. They consider factors such as task dependencies, resource availability, and execution time, leading to optimized schedules that maximize system efficiency.

Robustness and Flexibility increasing. One of the key advantages of GAs is their robustness. They are less likely to get stuck in local optima compared to traditional optimization methods, making them well-suited for complex, multidimensional problems in resource management.

Genetic algorithms are particularly effective in environments where the resource management problem is too complex to solve using deterministic methods. Their ability to explore a wide solution space and converge on optimal or near-optimal solutions makes them a powerful tool for managing computational resources in video data processing.

1.1. Moreover, systems based on fuzzy logic can be effectively used for solving the considered challenges [30]. Fuzzy logic systems are designed to handle the uncertainty and imprecision inherent in many resource management scenarios. Unlike traditional logic systems that operate on binary true/false values, fuzzy logic works with degrees of truth, making it well-suited for modeling complex, real-world problems. The use of the mathematical apparatus of fuzzy logic in video data processing control systems allows them to be endowed with the following very useful properties.

Handling Uncertainty in Resource Demands. In video data processing, resource demands can vary widely depending on factors such as video quality, resolution, and processing complexity. Fuzzy logic systems can model these variations using fuzzy sets and rules, enabling more accurate predictions and better resource allocation.

Adaptive Resource Allocation. Fuzzy logic systems can adjust resource allocation in real-time based on fuzzy inputs like "high load," "medium load," or "low load." This allows for more flexible and adaptive resource management, as the system can make nuanced decisions rather than relying on rigid thresholds.

Complex Decision-Making. Fuzzy logic systems excel in situations where multiple conflicting objectives need to be balanced [30]. For example, a fuzzy logic system can simultaneously consider factors such as processing speed, energy efficiency, and cost when allocating resources, leading to more balanced and effective management strategies.

Fuzzy logic systems are particularly valuable in scenarios where resource demands are difficult to predict or quantify. Their ability to handle uncertainty and imprecision makes them a powerful tool for managing computational resources in complex and dynamic environments.

1.2. Finally, the approach of multi-agent systems' (MAS) implementation is enough perspective. In turn, MAS represent a decentralized approach to resource management, where multiple autonomous agents work together to achieve common goals. Each agent in the system is responsible for managing a specific subset of resources or tasks, and they communicate and collaborate to optimize overall system performance. Multi-agent systems allow the implementation of the following several approaches in the process of distributing video processing resources.

Decentralized Resource Management. In a MAS, each agent operates independently, making decisions based on local information and objectives [31]. This decentralized approach reduces the risk of bottlenecks and single points of failure, making the system more resilient and scalable.

Collaborative Task Scheduling. Agents in a MAS can collaborate to schedule tasks more efficiently [32]. For example, agents managing different computational nodes can negotiate to balance the load across the network, ensuring that resources are used optimally.

Scalability and Flexibility. MAS are inherently scalable, as new agents can be added to the system without disrupting existing operations. This makes them well-suited for large-scale video data processing environments, where resource demands can vary widely and unpredictably.

Multi-agent systems are particularly effective in distributed computing environments, where resources are spread across multiple locations or devices. Their decentralized and collaborative nature makes them a powerful tool for managing computational resources in complex and dynamic systems.

Thus, having analyzed the above approaches, we can conclude that modern automatic control and resource allocation systems should be implemented using advanced intelligent methods and algorithms to effectively solve the entire complex of complex video data processing tasks. Also, for the greatest implementation of the entire potential, a combination of several different intelligent methods can be applied. Intelligent algorithms are already playing a crucial role in managing computational resources for video data processing, offering solutions to several complex challenges.

Neural networks can predict the necessary computational resources by analyzing historical data patterns and current workload. For example, during a surge in video data, the system can automatically allocate additional resources [32] to handle the load, ensuring smooth operation without manual intervention. This dynamic scaling helps prevent both resource underutilization and over-provisioning, optimizing costs while maintaining performance.

Reinforcement learning algorithms are particularly effective in optimizing task distribution. These algorithms learn from the environment by trial and error, improving decision-making over time. In video data processing, this means that tasks such as encoding, filtering, and analysis can be dynamically assigned to the most suitable computational resources, balancing the load and reducing processing time. This continuous learning and adaptation lead to a more efficient use of resources and enhanced system responsiveness.

Anomaly detection [33] is vital in preventing system failures and ensuring data integrity. Machine learning algorithms can monitor resource usage patterns and detect deviations that may indicate potential issues, such as hardware malfunctions or inefficient processes. Early detection allows for preemptive action, such as reallocating resources or adjusting parameters, to avoid disruptions and maintain consistent video processing quality.

Genetic algorithms are well-suited for optimizing complex video processing parameters. These algorithms simulate the process of natural evolution, iterating through generations of potential solutions to find the most effective configuration. For example, in video compression, genetic algorithms can be used to fine-tune the balance between file size and quality, leading to the best possible output. This evolutionary approach is particularly valuable when dealing with large-scale video data, where manual optimization would be impractical and time-consuming.

Conclusion

This paper has provided a comprehensive analysis of existing algorithms and information technologies for managing computational resources in video data processing. The examination of current methodologies has highlighted the importance of efficient resource utilization in handling the increasing volumes of video data. The emergence of intelligent algorithms presents exciting opportunities for optimizing resource management processes, improving productivity, and reducing costs. By leveraging techniques such as neural networks, reinforcement learning, and evolutionary algorithms, information technologies can enhance their capabilities in processing large datasets, particularly video data. Moving forward, continued research and development in intelligent resource management algorithms are essential to meet the evolving demands of video data processing and unlock new levels of efficiency and effectiveness.

In further research, simulation models of video data processing processes in various information systems will be developed to study the effectiveness of various intelligent algorithms for distributing computing resources. These models will also be subsequently used to develop new highly effective computing resource management systems based on intelligent technologies.

References

1. Sciamanna, F., Zanella, M., Massari, G. and Fornaciari, W. (2021). Managing the Resource Continuum in a Real Video Surveillance Scenario. *2021 24th Euromicro Conference on Digital System Design (DSD),* Palermo, Italy, 2021, pp. 58–61, doi: 10.1109/DSD53832.2021.00018.
2. Zhang, S., Liang, Y., Ge, J., Xiao, M. and Wu, J. (2020). Provably Efficient Resource Allocation for Edge Service Entities Using Hermes. *IEEE/ACM Transactions on Networking*, 28, 4, 1684–1697. Aug. 2020, doi: 10.1109/TNET.2020.2989307.
3. Zhang, Y., Barusso, F., Collins, D., Ruffini, M. & DaSilva, L. A. (2018). Dynamic Allocation of Processing Resources in Cloud-RAN for a Virtualised 5G Mobile Network. *26th European Signal Processing Conference (EUSIPCO),* Rome, Italy, 2018, pp. 782–786, doi: 10.23919/EUSIPCO.2018.8552959.
4. Hossain, M. S., Hassan, M. M., Qurishi, M. A. & Alghamdi, A. (2012). Resource Allocation for Service Composition in Cloud-based Video Surveillance Platform. *2012 IEEE International Conference on Multimedia and Expo Workshops, Melbourne,* VIC, Australia, pp. 408–412, doi: 10.1109/ICMEW.2012.77.
5. Xu, Z., Mei, L., Liu, Y. & Hu, C. (2013). Video Structural Description: A Semantic Based Model for Representing and Organizing Video Surveillance Big Data. *2013 IEEE 16th International Conference on Computational Science and Engineering,* Sydney, NSW, Australia, 2013, pp. 802–809, doi: 10.1109/CSE.2013.122.
6. Minghao, Xia; Haibin, Liu; Jian, Li; Mingfei, Li. (2021). Research on Task Scheduling Algorithm Based on Multi-Time Period Merging. *2021 4th World Conference on Mechanical Engineering and Intelligent Manufacturing* (WCMEIM). doi: 10.1109/WCMEIM54377.2021.00085
7. Praveen, Kumar, Aditya, Tharad, Ulugbek, Mukhammadjonov, Seema, Rawat. (2021). Analysis on Resource Allocation for parallel processing and Scheduling in Cloud Computing. *2021 5th International Conference on Information Systems and Computer Networks (ISCON)*. doi: 10.1109/ISCON52037.2021.9702325
8. Shalu, Rani, Dharminder, Kumar, Sakshi, Dhingra. (2022). A review on dynamic load balancing algorithms. 2022 International Conference on Computing, Communication, and Intelligent Systems (ICCCIS). doi: 10.1109/ICCCIS56430.2022.10037671
9. Zhou, Lin, Li, Zhen, Chen, Yingmei, Tan, Yuqin. (2014). The Video Monitoring System Based on Big Data Processing. 2014 7th International Conference on Intelligent Computation Technology and Automation. doi: 10.1109/ICICTA.2014.207
10. Haiyang, Zou, Mingdong, Li, Zhenhua, Li, Jianqing, Gao. (2018). Design of multi-intelligent data migration strategy based on SDN secondary mode. 2018 International Conference on Artificial Intelligence and Big Data (ICAIBD). doi: 10.1109/ICAIBD.2018.8396170
11. Tao, Li, Jingyu, Wang; Wei, Li, Tong, Xu, Qi, Qi. (2016). Load Prediction-Based Automatic Scaling Cloud Computing. 2016 International Conference on Networking and Network Applications (NaNA). doi: 10.1109/NaNA.2016.49
12. Manri, Cheon, Jong-Seok, Lee. (2018). Subjective and Objective Quality Assessment of Compressed 4K UHD Videos for Immersive Experience. *IEEE Transactions on Circuits and Systems for Video Technology*, 28, 7. doi: 10.1109/TCSVT.2017.2683504
13. Baofeng, Hui, Yuanliang, Ma. (2022). Image Recognition Technology of Monitoring Intelligent Alarm System Based on Deep Learning. 2022 11th International Conference of Information and Communication Technology (ICTech)). doi: 10.1109/ICTech55460.2022.00043
14. Manpreet, Singh Sehgal, Nandini, Bansal, Saloni, Dhingra, Ashish, Bansal, Pransh, Rastogi, Twinkle, Sehgal. (2022). Optimizing Round Robin Algorithm in Operating System. 2022 International Conference on Smart and Sustainable Technologies in Energy and Power Sectors (SSTEPS). doi: 10.1109/SSTEPS57475.2022.00051.

15. Yang, Zhang, Xing, Yang, Yuan, Xu, Yanlin, He, Mingqing, Zhang, Qunxiong, Zhu. (2024) Streaming Media Load Balancing with Improved Genetic Algorithm. 2024 36th Chinese Control and Decision Conference (CCDC). doi: 10.1109/CCDC62350.2024.10588365

16. Shoja, H., Nahid, H. & Azizi, R. (2014). A comparative survey on load balancing algorithms in cloud computing. Fifth International Conference on Computing, Communications and Networking Technologies (ICCCNT). doi:10.1109/icccnt.2014.6963138

17. Yang, Zhang, Xing, Yang, Yuan, Xu, Yanlin, He, Mingqing, Zhang, Qunxiong, Zhu. (2024). Streaming Media Load Balancing with Improved Genetic Algorithm. 2024 36th Chinese Control and Decision Conference (CCDC). doi: 10.1109/CCDC62350.2024.10588365

18. Bichitra, Mandal, Srinivas, Sethi, Ramesh, Kumar Sahoo. (2015). Architecture of efficient word processing using Hadoop MapReduce for big data applications. 2015 International Conference on Man and Machine Interfacing (MAMI). doi: 10.1109/MAMI.2015.7456612

19. Qiaojin, Guo, Jie Hu, Zhongyan, Liang. (2024). A Scalable Target Indexing and Retrieval System for Massive Video Data Processing based on Elasticsearch and Hadoop. 2024 IEEE 7th Advanced Information Technology, Electronic and Automation Control Conference (IAEAC). doi: 10.1109/IAEAC59436.2024.10503896

20. Ivancsics, M., Brosch, N. & Gelautz, M. (2014). Efficient depth propagation in videos with GPU-acceleration. 2014 IEEE Visual Communications and Image Processing Conference. doi:10.1109/vcip.2014.7051557

21. Aggarwal, C. C. (2021). Artificial Intelligence. Springer International Publishing, 490. DOI 10.1007/978-3-030-72357-6.

22. Knight, K., Zhang, C., Holmes, G., Zhang, M.-L. (Eds.). Artificial Intelligence. Second CCF International Conference, ICAI 2019, Xuzhou, China, August 22-23, 2019, Proceedings, Springer Singapore, 2019, 298 p. DOI 10.1007/978-981-32-9298-7.

23. Zadeh, L. A., Abbasov, A. M., Yager, R. R., Shahbazova, S. N., Reformat, M. Z. (2014). Recent developments and new directions in soft computing, 466. DOI 10.1007/978-3-319-06323-2

24. Khochare, A., Sheshadri, K. R., Shriram, R. & Simmhan, Y. (2019). Dynamic Scaling of Video Analytics for Wide-Area Tracking in Urban Spaces. 2019 19th IEEE/ACM International Symposium on Cluster, Cloud and Grid Computing (CCGRID), Larnaca, Cyprus, 2019, pp. 76-81, doi: 10.1109/CCGRID.2019.00018.

25. Lee, H., Kim, Y. -S., Kim, M. & Lee, Y. (2021). Low-Cost Network Scheduling of 3D-CNN Processing for Embedded Action Recognition. *IEEE Access*, 9, 83901-83912. doi: 10.1109/ACCESS.2021.3087509.

26. Armin, Kappeler, Seunghwan, Yoo, Qiqin, Dai & Aggelos, K Katsaggelos. (2016). Video super-resolution with convolutional neural networks. IEEE Transactions on Computational Imaging, 2016.

27. Xu, Y., Zhang, H., Li, X., Yu, F. R., Leung, V. C. M. and Ji, H. (2023). Trusted Collaboration for MEC-Enabled VR Video Streaming: A Multi-Agent Reinforcement Learning Approach. *IEEE Transactions on Vehicular Technology*, 72, 9, 12167–12180. doi: 10.1109/TVT.2023.3267181.

28. Li, T., Wang, J., Li, W., Xu, T. & Qi, Q. (2016). Load Prediction-Based Automatic Scaling Cloud Computing. 2016 International Conference on Networking and Network Applications (NaNA). doi:10.1109/nana.2016.49

29. Mosayebi, A. & Pozveh, A. J. (2020). Heuristic Based Algorithm for SFC Allocation in 5G Experience Applications. *2020 6th Iranian Conference on Signal Processing and Intelligent Systems* (ICSPIS), Mashhad, Iran, 2020, pp. 1–6, doi: 10.1109/ICSPIS51611.2020.9349535.

30. Luong, Thi Hong Lan, Tran, Manh Tuan, Tran, Thi Ngan, Le, Hoang Son, Nguyen, Long Giang, Vo, Truong Nhu Ngoc, Pham, Van Hai. (2020). A New Complex Fuzzy Inference System With Fuzzy Knowledge Graph and Extensions in Decision Making. *IEEE Access*, 8. doi: 10.1109/ACCESS.2020.3021097

31. Seungkyun, Lee, SuKyoung, Lee, Seung-Seob, Lee. (2021). Deadline-Aware Task Scheduling for IoT Applications in Collaborative Edge Computing. *IEEE Wireless Communications Letters*, 10, 10. doi: 10.1109/LWC.2021.3095496

32. Lin, C.-C., Wu, J.-J., Lin, J.-A., Song, L.-C. & Liu, P. (2012). Automatic Resource Scaling Based on Application Service Requirements. 2012 IEEE Fifth International Conference on Cloud Computing, doi: 10.1109/cloud.2012.32.

33. Farshchi, M., Schneider, J.-G., Weber, I. & Grundy, J. (2015). Experience report: Anomaly detection of cloud application operations using log and cloud metric correlation analysis. 2015 IEEE 26th International Symposium on Software Reliability Engineering (ISSRE).

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Денисенко Андрій Васильович
Аспірант кафедри інтелектуальних інформаційних систем,
https://orcid.org/0009-0001-0816-462X
Чорноморський національний університет імені Петра Могили, Миколаїв
Козлов Олексій Валерійович
Доктор технічних наук, професор кафедри інтелектуальних інформаційних систем,
https://orcid.org/0000-0003-2069-5578
Чорноморський національний університет імені Петра Могили, Миколаїв

АНАЛІЗ ТЕХНОЛОГІЙ ТА АЛГОРИТМІВ УПРАВЛІННЯ ОБЧИСЛЮВАЛЬНИМИ РЕСУРСАМИ ПРИ ОБРОБЦІ ВІДЕОДАНИХ

Анотація. *Управління обчислювальними ресурсами при обробці відеоданих передбачає планування, розподіл, моніторинг і контроль різних типів обчислювальних ресурсів, таких як обчислювальна потужність, мережеві ресурси, зберігання даних тощо, щоб забезпечити їх ефективне використання при обробці великих обсягів відеоданих. Цей процес включає комплекс різноманітних завдань з обробки, аналізу та модифікації даних, що вимагає значної обчислювальної потужності. Відеодані мають великий розмір і потребують багато місця для зберігання, що може призвести до таких проблем, як затримки передавання і втрата даних. Для обробки відеоданих зазвичай потрібні спеціальні апаратні та програмні засоби, які можуть бути доволі дорогими та складними для налаштування. У пропонованій статті проведено комплексний аналіз наявних методів і засобів вирішення завдань розподілу й управління обчислювальними ресурсами в сучасних системах обробки відеоданих. Детально розглянуто сучасні алгоритми і технології, в т. ч. на основі штучного інтелекту, з визначенням їхніх основних переваг і недоліків.*

Ключові слова: обробка відеоданих; управління обчислювальними ресурсами; планування завдань; розподіл ресурсів; балансування навантаження; інтелектуальні алгоритми

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