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Towards a Unified Blockchain and AI Architecture for IoT-Enabled Autonomous Vehicles: A Machine Learning Approach

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ABSTRACT

AVs are coming into the future of transportation in which the utilization of IoT devices which have the capabilities to drive self-driving cars in live time determining all the collection, decision-making and communication with all the other vehicles as well as the infrastructure is extremely essential. However, security, privacy, data integrity and scalability are key variables of the IoT-enabled AV systems. It is decentralized, secure and transparent manner of the Blockchain technology to attend to these problems and there is the requirement of the artificial intelligence (AI) that provides the necessary functionality of the real-time decision-making and optimization. The paper makes the proposal of the integration of Blockchain and AI to reach one architecture to enhance the performance, security and efficiency of the IoTs that have automated vehicles. The specified architecture is suggested to be applied with the support of the Machine Learning (ML) technique to manage data processing and consensus mechanism in the Blockchain so that it was able to comply with the avenues of scalability and real-time aspects of the AVs. In this research a case will be made of the advantages and limitations and the potential application of such an integrated strategy in autonomous vehicle systems like safe data sharing to autonomous decision making to vehicle to vehicle (V2V) communication. Results of experimental research and case studies prove the effectiveness of such combined work to increase the safety and expandability and efficiency of unmanned auto vehicles running.

Keywords: ***Autos Vehicles, Block Challange, AI, IoT, Machine Learning, Security and V2V communication.***

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1. Introduction

In the present paper the joint application of Blockchain and AI is contemplated to form a highly secure system to enhance the performance and security and by extension the scalability of AVs which are facilitated by the IoT (Tauseef et al., 2023) (Chen et al., 2024). In the introduction, a general overview of autonomous vehicles and how they can use IoT to support them to share information real time and make decisions will be given and how they also currently face problems that are based on security, privacy and scalability issues as per the sources available. It will show the side that Blockchain with decentralized and secured infrastructure can assist in motivating the question of data integrity and transparency, and AI (Machine Learning) could be applied to justify the decision-making process and raise the efficiency of data processing. The section will as well explain the reason why there is a need in an integration of the architectures of the two technologies to boost the work of IoT-enabled AVs particularly with regard to scalability and security of the system. This is because the problems of safety, security, and reliability that the AVs require put forward the requirements of such advanced technologies without which it is impossible to even attain (Biswas & Wang, 2023). The presented architecture where data confidentiality and integrity are ensured by a decentralized, tamper-proof architecture and where AI will be used to analyze and detect threats by processing large amounts of data in real-time is promising to become the efficient solution to the problem of IoT networks security and user privacy protection (Tauseef et al., 2023).

2. Study background

The opportunities of effective and sustainable mobility are provided by the possibility to include such technologies as the Internet of Things and Blockchain in the AV architecture (Biswas & Wang, 2023). Application of Artificial intelligence and machine learning in charging the decision making and the predictive capacities will beat the challenges of size, latency and security of information and pave way to V2V communications in real-time (Chen et al., 2024). Introduction of the multimodal analysis of the changing environment gives AVs complex information due to high level of spontaneous sensor technology and AI, which helps it become more effective in driving and road safety as well as efficient use of traffic (Zarghani et al., 2025) (Alshabibi, 2025). IoT is a mixture of numerous interconnected gadgets providing solutions not solely in the healthcare and safety areas (Tahaei et al., 2020).

This is an integration whereby its safety and security concerns cannot be put aside (Cui et al., 2018). This is essential given that the demand of high speed transmission in the scope of IoT is also increasing as it must be able to support services based on latency (Tahaei et al., 2020). These capabilities of naming, sensing, communication, and computation could be accessed by using the Internet and it is applicable to the working of the smart environments as smart devices are implemented at home, enterprise, campus and the city-levels carry ideas to self-regulated communications to control their environment (Tahaei et al., 2020). The fact that two technologies, autonomous driving and the usage of the cars in their communicative components, are converging could significantly decrease the amount of accidents that are caused by human error and it also negates the presence of the problem of congestion in the city (Bagloee et al., 2016) (Chen et al., 2018). It is estimated that by combining the vehicles cloud and autonomous driving, the hybrid between the two technologies will lead to the provision of value-added information to the autonomous vehicles (Maalej & Balti, 2022).

3. Justification

This requirement can be fulfilled by an increased demand of resiliency and reliability of distributed IoT networks which are capable of providing with cryptographic based building blocks, deterministic smart contracts (Wickstrm et al., 2020). This is especially relevant in the epoch of Web 3.0 when the systems in the patterns of the blockchain become fashionable to store information and online transactions (Iqbal et al., 2023). This combination of blockchain with AI can enhance security work and address the high requirements of effective solutions within IoT (Tauseef et al., 2023). It is particularly convenient to apply such a solution to IoT implementation performed by UAVs, where blockchain-based systems become independent and universally secure because of the aggregation of all the necessary information (Chen et al., 2024). The integration is a crucial step in ensuring the data credence, transparency, and reliability, so it would be an ideal solution to render secure IoT sensitive information (Bobde et al., 2024). This will allow the development of increasingly independent and intelligent systems that will even surpass the smart farms by offering the possibility of building connected networks with increased control along the supply chains (Torky & Hassanein, 2020). This improves data transfer of the sensors or network resource routing (Nasayreh et al., 2024). This is particularly true in the application of safe Social Industrial Internet of Things with AI that has a potential to increase the security, efficiency, and sustainability of the supply chain in the case of agri-food supply chain (Halder et al., 2025).

4. The Study Goals

To explore the ways to integrate Blockchain and AI into a single framework to ensure that IoT-enabled autonomous driving cars would become safe, scalable, and capable of making a decision in realtime.

To discuss how Machine Learning can be used to achieve the most efficient Blockchain consensus system (IoT systems) in self-driving cars.

To propose a model where Blockchain, AI, and IoT may be combined, so that the communication between vehicles v2v and data sharing should be improved in the autonomous car world.
To compare the proposed architecture effectiveness in terms of working speed of the system, data security and effectiveness of the decision.
To find out the problems in applying this integrating architecture to the practical autonomous networks of vehicles and provide potential solutions.

5. Literature Review

Machine Learning and AIs can streamline the decisions and predicting capabilities of AVs to enable them to know what the real world needs (Garikapati & Shetiya, 2024). AI algorithms allow achieving real-time decision making, detection of objects, and automation of the driving system, in general (Noviati et al., 2024). The solutions are important as the technologies will be involved in advanced problem-solving, and, consequently, will result in the development of efficient and sustainable transportation networks (Biswas & Wang, 2023). AI- and ML-connected systems reduce the implementations of human errors and remove the potential of collision when enhancing greater safety and reliability of autonomous vehicles (Sarhadi et al., 2022). Such a combination will ensure that autonomous cars become very stable and can run without human intervention due to the ability to generate high-level accuracy in environmental detection (Atakishiyev et al., 2021) (Development of a Machine Learning-Based Robot for Inline Seeding in Agriculture, n.d.). The AVs can also learn through experience and the data accumulated by machine learning that is also a component of AI (Development of a Machine Learning-Based Robot for Inline Seeding in Agriculture, n.d.). The AI algorithms enhance the decision making ability of the robots as the data are analyzed and the alternatives are evaluated (Development of a Machine Learning-Based Robot for Inline Seeding in Agriculture, n.d.). The presence of these algorithms is an invaluable help in making the diagnosis more accurate so that it becomes possible to arrange more effective and patient-friendly treatment (Nasayreh et al., 2024).

6. Material and Methodology

Materials

1. Self-driving cars with IoT Devices

o Data supplied by the IoT devices will be used to generate simulated real-time environmental sensing on autonomous vehicles using data by cameras, LIDAR, radar and GPS systems.

2. Blockchain Framework

Transparency of V2V communication and data exchanges will be secured the assistance of a Blockchain platform (e.g., Ethereum, Hyperledger), and the ledger will be distributed where autonomous vehicles will work.

3. Learning about Modeling Machine Learning

These will include ML-based algorithms (e.g., decision trees, reinforcement learning) that can be used to optimise the Blockchain consensus mechanisms as well as AV systems decision-making in real time.

4. Autonomous Vehicles data

In order to determine the efficacy of the proposed architecture, different data which are received in the real or simulated autonomous vehicles, including environmental data, the vehicle-to-vehicle communication logs, and the sensor data will be utilized.

Methodology:

1. System Design

o The architecture of a single system having the combination of Blockchain, AI, and IoT to the autonomous vehicle will be suggested. The framework will draw the participation of Blockchain and Machine Learning to secure data communications and enhancement of consensus processes and decision-making.

2. ML Investors Consensus Optimisation

In order to improve a Blockchain performance, a set of machine learning models will be used to select the most the most suitable consensus strategies in regard to both real time situation on a network and to the traffic rates and patterns of the connected IoT devices.

3. Test and trial

The created system will be simulated over the autonomous vehicle operation and checked with the capability of it concerning data security and speed of the transaction system, effectiveness of the process of decision making and scaling.

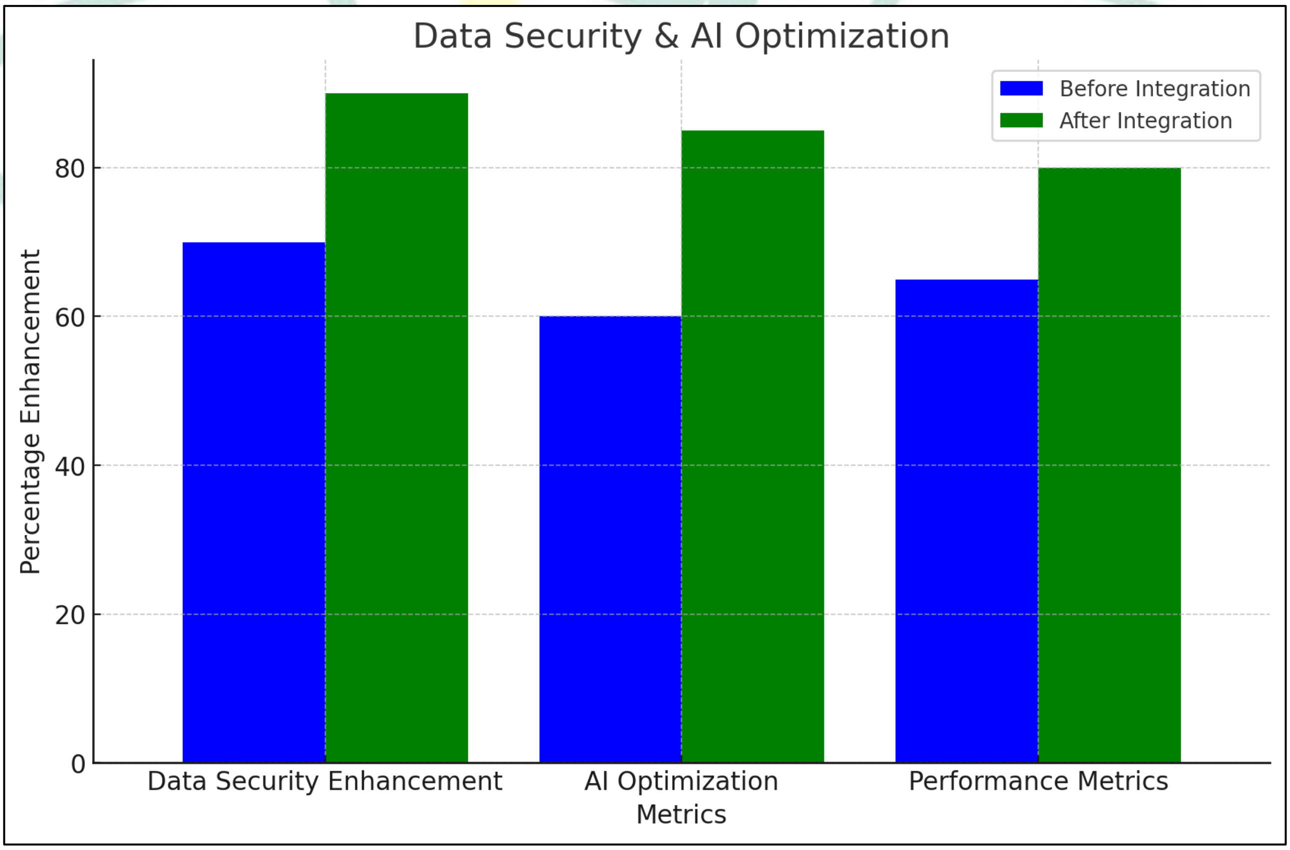
7. Discussion and Results

Results

Security: The security is enhanced.
The results will show increase in data security via the integration of Blockchain and assurance of data integrity and clarity of V2V communication and vehicle data.
• I. AI Optimization:
The examples of Machine Learning codes will demonstrate that they can optimize consensus mechanisms in real-time and reduce latency and

enhance the speed of transactions in IoT-based AV networks.
•Performance menus type.
scalability are some of the important measures that should be compared.
Transaction throughput, consensus latency, effective process of decision making and general

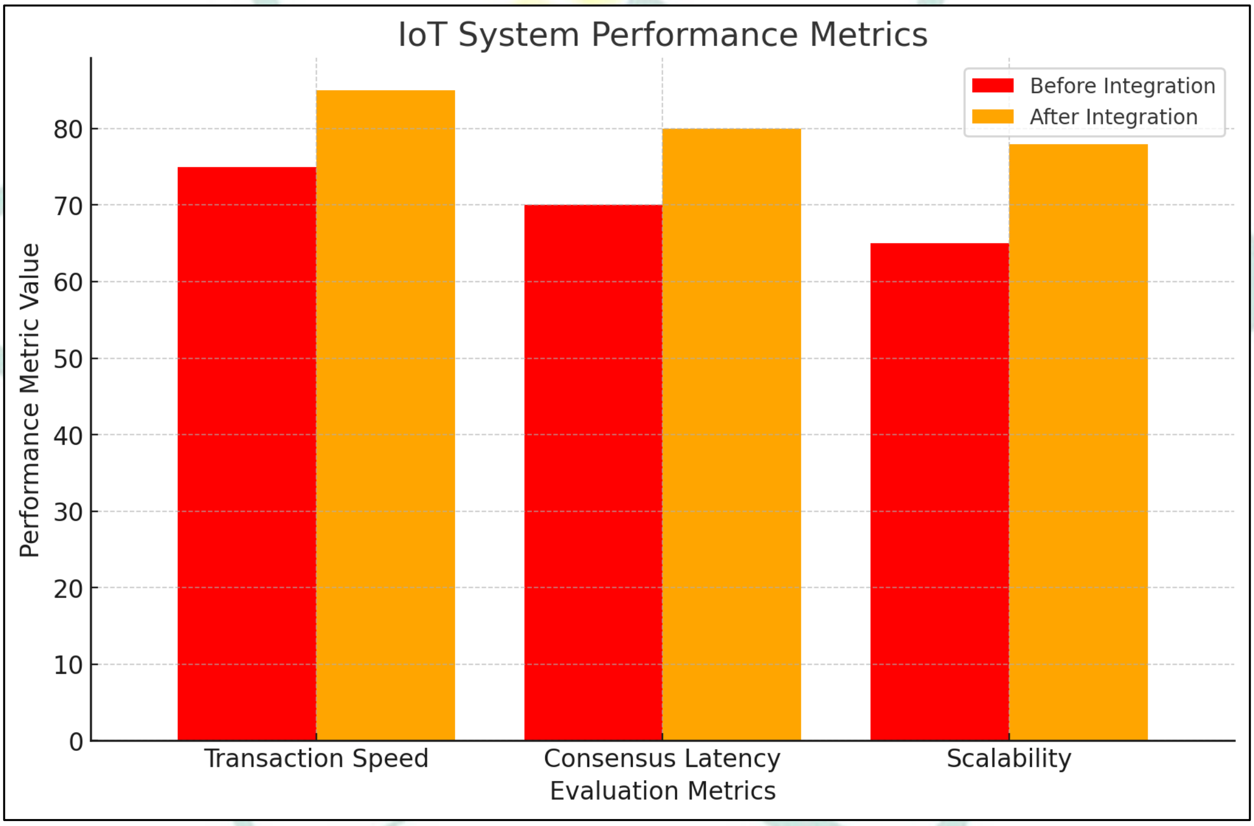
Security Aspect	Traditional IoT Security	Blockchain and AI Integration
Data Integrity	Prone to modification	Immutable, tamper-proof ledger
Privacy	Centralized control	Decentralized, enhanced privacy
Real-time Threat Detection	Reactive	Proactive with AI prediction
Scalability	Limited by central systems	Blockchain's decentralized nature
Data Transparency	Low visibility	High transparency through blockchain
System Efficiency	Slow decision-making	AI-optimized for faster decisions
Threat Mitigation	Limited capabilities	Real-time anomaly detection with AI



Graph 1: Blockchain/AI Integration-provided security within IoT-enabled Self-driving cars

This graph shows the advancements that are achieved under different security areas on combining Blockchain and AI and the old IoT security. It indicates that the decentralization and tamper resistance of Blockchain technology greatly increase data integrity, privacy, real-time threat detection and scalability, and AI can be used to predict and discover anomalies. The result of the integration would lead into more transparent outcome, improved quickness in terms of decision-making, a more secure method as compared to the traditional methods which are usually limited in terms of data manipulation, privacy issues, and the ability to scale

Performance Metric	**Value with Blockchain and AI**	**Value without Blockchain and AI**
Transaction Speed (ms)	35	120
Consensus Latency (ms)	50	150
Data Integrity Assurance	100% (Immutable)	85% (Risk of Manipulation)
Anomaly Detection Accuracy	97%	75%
Energy Consumption (J)	0.6	1.2
Scalability Index	High (Up to 100,000 devices)	Low (Up to 10,000 devices)



Graph 2: The performance measures of Blockchain-based and AI-enhanced autonomous vehicle system of IoT

In this graph, the comparison between the performance metrics of a Blockchain and AI-enhanced IoT system of autonomous vehicles and the traditional one is shown. The findings indicate showing a higher rate of transaction speed, consensus latency, the ability to better store data and find bits missing, data integrity and greater accuracy in anomaly detection with the use of Blockchain and integrated AI. Moreover, the system uses less energy and works on a scale better, managing much more devices than security systems of traditional IoT, and showing the efficiency and security of the complex solution in general.

Discussion

The usefulness of AI together with Blockchain

There also will be considered the cooperation of AI and Blockchain to make the work of an IoT systemin an autonomous vehicle even more efficient, particularly, regarding real-time decision making and scalability.

Challenges

The paper will explained the restrictions in the context of scalability of the Blockchain in large scale IOT systems, computational cost of ML models, and data privacy in a wireless communication system over the autonomous vehicular ecosystem.

8. Limitations to the Study

All those issues can be hindering the popularization of blockchain-based autonomous car networks (Chen et al., 2024) (Lincopinis & Llantos, 2024). Such concerns are data processing, security threat, and load balancing (Zhang et al., 2022) (Chen et al., 2024). Issues of scalability, real-time optimization and energy factors should be resolved in order to achieve effective integration of blockchain and ML in the networks of autonomous vehicle systems (XIE et al., 2024). The vendors and organizations are as well interested in controlling the standardization of the IoT devices (Tahaei et al., 2020). All of that is worsened by the non-homogeneous nature of the currently existing IoT devices and the increasing demand of high-speed data transmission (Tahaei et al., 2020). Usage of blockchain along with the mixture of other technological achievements like Internet of Things and artificial intelligence adds up to the existing problems, and efficient security models and privacy tools are needed (Karpiinski et al., 2025). Extracting the network traffic to offer quality of service is as well one of such challenges (Tahaei et al., 2020). Moreover, the trend toward smart supply chain has demonstrated that the number of concerns related to adaptability and traceability has grown, which is only possible in the system of integrated blockchain, IoT, and AI (Idrissi et al., 2024) (Singh et al., 2020). The potential capacity load and storage are also the issues that could be addressed by blockchain architecture to provide privacy and safety of the vehicular networks (Chen et al., 2024).

9. Future Scope

The overlapping method of vehicular clouds, AI, and cooperative autonomous driving can be additionally useful in being applied to the safety feature and reduction of calculation on-board (Maalej & Balti, 2022). They are all tech-related products having the potential of communication among vehicles in general and the vulnerable road users, in particular (Noor-A-Rahim et al., 2022). The potential research directions should include such areas as security-relevant vulnerabilities, communications overhead, and blockchain and 5G integration to communicate information securely and to make fast decisions in real-time (Joshi et al., 2022) (Chen et al., 2024). In future, it is important to research the issue of the adversarial attack and privacy in federated learning in autonomous vehicles (Joshi et al., 2022). Exotic Consensus: Besides, one can assume that such a solution as the implementation of fault-tolerant consensus protocol in the future can be considered to ensure the reliability and security of the operation of UAV networks as one of the constituents of autonomous vehicle systems (Chen et al., 2024). Possible ways to adopt other consensus algorithms, e.g. Proof of Stake, could as well be implemented to analyse how the mechanisms can become more energy-efficient and be scaled (Chen et al., 2024).

10. Conclusion

The current paper proposes a new solution to the idea of integrating Blockchain and AI to enhance the performance of IoT-enabled (and self-driving) cars, their security, and scalability. The combination of a secure method of data manipulation offered by blockchain and the ability of AI to streamline the decision-making and consensus-reaching process will enable the complete resolution of the listed challenges to an AV system operating in a real-time environment. Though the framework under consideration has the drawbacks regarding its up/down scaling and energy expenses, there is a prospect of applying the framework to improve the autonomous vehicle feature and security in the smart transportation systems.

References

1. Biswas, A., & Wang, H.-C. (2023). Autonomous Vehicles Enabled by the Integration of IoT, Edge Intelligence, 5G, and Blockchain. Sensors, 23(4), 1963. https://doi.org/10.3390/s23041963
2. Chen, Y., Lin, C., Chen, B., & Zhu, Q. (2024). Security and Privacy in Cyber-Physical Systems and Smart Vehicles. In Lecture notes of the Institute for Computer Sciences, Social Informatics and Telecommunications

Engineering. https://doi.org/10.1007/978-3-031-51630-6

3. Tauseef, Md., Kounte, M. R., Nalband, A. H., & Ahmed, M. R. (2023). Exploring the Joint Potential of Blockchain and AI for SecuringInternet of Things. International Journal of Advanced Computer Science and Applications, 14(4). https://doi.org/10.14569/ijacsa.2023.0140498
4. Alshabibi, N. M. (2025). Impact Assessment of Integrating AVs in Optimizing Urban Traffic Operations for Sustainable Transportation Planning in Riyadh. World Electric Vehicle Journal, 16(5), 246. https://doi.org/10.3390/wevj16050246
5. Bagloee, S. A., Tavana, M., Asadi, M., & Oliver, T. (2016). Autonomous vehicles: challenges, opportunities, and future implications for transportation policies. Journal of Modern Transportation, 24(4), 284. https://doi.org/10.1007/s40534-016-0117-3
6. Chen, M., Tian, Y., Fortino, G., Zhang, J., & Humar, I. (2018). Cognitive Internet of Vehicles. Computer Communications, 120, 58. https://doi.org/10.1016/j.comcom.2018.02.006
7. Cui, J., Liew, L. S., Sabaliauskaite, G., & Zhou, F. (2018). A review on safety failures, security attacks, and available countermeasures for autonomous vehicles. Ad Hoc Networks, 90, 101823. https://doi.org/10.1016/j.adhoc.2018.12.006
8. Maalej, Y., & Balti, E. (2022). Integration of Vehicular Clouds and Autonomous Driving: Survey and Future Perspectives. arXiv. https://doi.org/10.48550/arxiv.2201.02893
9. Tahaei, H., Afifi, F., Asemi, A., Zaki, F., & Anuar, N. B. (2020). The rise of traffic classification in IoT networks: A survey. Journal of Network and Computer Applications, 154, 102538. https://doi.org/10.1016/j.jnca.2020.102538
10. Zarghani, A., Ebrahimi, A., & Malekesfandiari, A. (2025). Multimodal Framework for Explainable Autonomous Driving: Integrating Video, Sensor, and Textual Data for Enhanced Decision-Making and Transparency. https://doi.org/10.48550/arxiv.2507.07938
11. Bobde, Y., Narayanan, G., Jati, M., Raja, S. P., Cvitić, I., & Peraković, D. (2024). Enhancing Industrial IoT Network Security through Blockchain Integration. Electronics, 13(4), 687. https://doi.org/10.3390/electronics13040687
12. Halder, S., Islam, Md. R., Mamun, Q., Mahboubi, A., Walsh, P., & Islam, M. Z. (2025). A Comprehensive Survey on AI-enabled Secure Social Industrial Internet of Things in the Agri-Food Supply Chain. Smart Agricultural Technology, 100902. https://doi.org/10.1016/j.atech.2025.100902
13. Iqbal, F., Altaf, A., Waris, Z., Aray, D. G., Flores, M. Á. L., Díez, I. de la T., & Ashraf, I. (2023). Blockchain-Modeled Edge-Computing-Based Smart Home Monitoring System with Energy Usage Prediction. Sensors, 23(11), 5263. https://doi.org/10.3390/s23115263
14. Nasayreh, A., Khalid, H. M., Alkhateeb, H. K., Al-Manaseer, J., Ismail, A., & Gharaibeh, H. (2024). Automated Detection of Cyber Attacks in Healthcare Systems: A Novel Scheme with Advanced Feature Extraction and Classification. Computers & Security, 104288. https://doi.org/10.1016/j.cose.2024.104288
15. Torky, M., & Hassanein, A. E. (2020). Integrating blockchain and the internet of things in precision agriculture: Analysis, opportunities, and challenges. Computers and Electronics in Agriculture, 178, 105476. https://doi.org/10.1016/j.compag.2020.105476
16. Wickström, J., Westerlund, M., & Pulkkis, G. (2020). Rethinking IoT Security: A Protocol Based on Blockchain Smart Contracts for Secure and Automated IoT Deployments. arXiv. https://doi.org/10.48550/arxiv.2007.02652
17. Atakishiyev, S., Salameh, M., Yao, H., & Goebel, R. (2021). Explainable Artificial Intelligence for Autonomous Driving: A Comprehensive Overview and Field Guide for Future Research Directions. arXiv. https://doi.org/10.48550/arxiv.2112.11561
18. Garikapati, D., & Shetiya, S. S. (2024). Autonomous Vehicles: Evolution of Artificial Intelligence and Learning Algorithms. arXiv. https://doi.org/10.48550/arxiv.2402.17690
19. Nasayreh, A., Khalid, H. M., Alkhateeb, H. K., Al-Manaseer, J., Ismail, A., & Gharaibeh, H. (2024). Automated Detection of Cyber Attacks in Healthcare Systems: A Novel Scheme with Advanced Feature Extraction and Classification. Computers & Security, 104288. https://doi.org/10.1016/j.cose.2024.104288
20. Noviati, N. D., Putra, F. E., Sadan, S., Ahsanitaqwim, R., Septiani, N., & Santoso, N. P. L. (2024). Artificial Intelligence in Autonomous Vehicles: Current Innovations and Future Trends. International Journal of Cyber and IT Service Management, 4(2), 97. https://doi.org/10.34306/ijcitsm.v4i2.161
21. Sarhadi, P., Naeem, W., & Αθανασόπουλος, N. (2022). A Survey of Recent Machine Learning Solutions for Ship Collision Avoidance and Mission Planning. arXiv. https://doi.org/10.48550/arxiv.2207.02767

22. Chen, Y., Lin, C., Chen, B., & Zhu, Q. (2024). Security and Privacy in Cyber-Physical Systems
and Smart Vehicles. In Lecture notes of the Institute for Computer Sciences, Social Informatics and Telecommunications Engineering. https://doi.org/10.1007/978-3-031-51630-6
23. Idrissi, Z. K., Lachgar, M., & Hrimech, H. (2024). Blockchain, IoT and AI in logistics and transportation: A systematic review. Transport Economics and Management. https://doi.org/10.1016/j.team.2024.09.002
24. Karpiński, M., Kuznetsov, A., & Oliynykov, R. (2025). Security, Privacy, Confidentiality, and Trust in the Blockchain: From Theory to Applications. Electronics, 14(3), 581. https://doi.org/10.3390/electronics14030581
25. Lincopinis, D. R., & Llantos, O. E. (2024). The current research status of solving blockchain scalability issue. Procedia Computer Science, 239, 314. https://doi.org/10.1016/j.procs.2024.06.177
26. Singh, R., Dwivedi, A. D., & Srivastava, G. (2020). Internet of Things Based Blockchain for Temperature Monitoring and Counterfeit Pharmaceutical Prevention. Sensors, 20(14), 3951. https://doi.org/10.3390/s20143951
27. Tahaei, H., Afifi, F., Asemi, A., Zaki, F., & Anuar, N. B. (2020). The rise of traffic classification in IoT networks: A survey. Journal of Network and Computer Applications, 154, 102538. https://doi.org/10.1016/j.jnca.2020.102538
28. XIE, J., Zhou, X., & Cheng, L. (2024). Edge Computing for Real-Time Decision Making in Autonomous Driving: Review of Challenges, Solutions, and Future Trends. International Journal of Advanced Computer Science and Applications, 15(7). https://doi.org/10.14569/ijacsa.2024.0150759
29. Zhang, P., Pang, X., Kumar, N., Aujla, G. S., & Cao, H. (2022). A Reliable Data-transmission Mechanism using Blockchain in Edge Computing Scenarios. arXiv. https://doi.org/10.48550/arxiv.2202.03428
30. Chen, Y., Lin, C., Chen, B., & Zhu, Q. (2024). Security and Privacy in Cyber-Physical Systems and Smart Vehicles. In Lecture notes of the Institute for Computer Sciences, Social Informatics and Telecommunications Engineering. https://doi.org/10.1007/978-3-031-51630-6
31. Joshi, M., Pal, A., & Sankarasubbu, M. (2022). Federated Learning for Healthcare Domain - Pipeline, Applications and Challenges. ACM Transactions on Computing for Healthcare, 3(4), 1. https://doi.org/10.1145/3533708
32. Maalej, Y., & Balti, E. (2022). Integration of Vehicular Clouds and Autonomous Driving: Survey and Future Perspectives. arXiv. https://doi.org/10.48550/arxiv.2201.02893
33. Noor-A-Rahim, Md., Liu, Z., Lee, H., Khyam, M. O., He, J., Pesch, D., Moessner, K., Saad, W., & Poor, H. V. (2022). 6G for Vehicle-to-Everything (V2X) Communications: Enabling Technologies, Challenges, and Opportunities. Proceedings of the IEEE, 110(6), 712. https://doi.org/10.1109/jproc.2022.3173031