American Journal Of Applied Science And Technology
(ISSN – 2771-2745)
VOLUME 04 ISSUE 03 Pages: 18-23
SJIF IMPACT FACTOR (2021: 5. 705) (2022: 5. 705) (2023: 7.063)
OCLC – 1121105677

Publisher: Oscar Publishing Services

Journal Website: https://theusajournals.com/index.php/ajast

Research Article

HARNESSING EDGE COMPUTING FOR ENHANCED SECURITY AND EFFICIENCY IN IOT NETWORKS

Submission Date: March 04, 2024, Accepted Date: March 09, 2024,
Published Date: March 14, 2024
Crossref doi: https://doi.org/10.37547/ajast/Volume04Issue03-04

Abdurakhmanov Ravshan Anarbayevich
Jizzakh Branch Of National University Of Uzbekistan

ABSTRACT

The Internet of Things (IoT) has revolutionized numerous sectors by enabling seamless connectivity and data exchange among devices. However, with the proliferation of IoT devices, concerns regarding security vulnerabilities and network efficiency have escalated. This article explores the integration of edge computing within IoT networks as a solution to address these challenges. Edge computing, by bringing computation closer to the data source, offers enhanced security measures and alleviates bandwidth constraints, thereby optimizing network performance. Through a comprehensive review of existing literature and case studies, this article examines the implementation of edge computing techniques such as data filtering, encryption, and decentralized processing to fortify IoT systems against cyber threats. Furthermore, it delves into the benefits of edge computing in improving real-time data analytics, reducing latency, and facilitating autonomous decision-making in IoT environments. By elucidating the synergistic relationship between IoT and edge computing technologies, this article aims to provide valuable insights for researchers, practitioners, and policymakers in advancing the security and efficiency of IoT deployments.

KEYWORDS

Internet of Things, IoT, edge computing, security, efficiency, data analytics, real-time processing, cyber threats.

INTRODUCTION

The Internet of Things (IoT) has emerged as a transformative force, reshaping industries and societies by interconnecting a myriad of devices to facilitate seamless data exchange and automation. From smart homes and cities to industrial applications and healthcare systems, IoT technologies have ushered in a new era of interconnectedness, promising unprecedented efficiency gains and convenience. However, the exponential growth of IoT ecosystems has also brought forth a host of challenges, chief

American Journal Of Applied Science And Technology
(ISSN – 2771-2745)
VOLUME 04 ISSUE 03 Pages: 18-23
SJIF IMPACT FACTOR (2021: 5. 705) (2022: 5. 705) (2023: 7.063)
OCLC – 1121105677
Crossref doi Google Scholar WorldCat MENDELEY
Publisher: Oscar Publishing Services

among them being security vulnerabilities and network inefficiencies.

As IoT deployments proliferate, the sheer volume and diversity of connected devices present a formidable challenge to traditional centralized computing architectures. The reliance on cloud-based servers for data processing and storage introduces significant latency issues, bandwidth constraints, and susceptibility to cyber threats. Moreover, transmitting vast amounts of raw data from IoT devices to distant cloud servers for analysis not only consumes excessive network bandwidth but also raises concerns regarding data privacy and compliance with regulatory frameworks.

To mitigate these challenges and unlock the full potential of IoT technologies, there is a growing imperative to embrace a paradigm shift towards decentralized computing models. Edge computing has emerged as a pivotal enabler in this regard, offering a distributed architecture that brings computation closer to the data source, thereby reducing latency, enhancing security, and improving network efficiency.

In this article, we delve into the integration of edge computing within IoT networks as a transformative approach to address the pressing challenges of security and efficiency. Through a comprehensive examination of existing literature, case studies, and industry insights, we elucidate the synergistic relationship between IoT and edge computing technologies. We explore how edge computing techniques such as data filtering, encryption, and decentralized processing fortify IoT systems against cyber threats while optimizing resource utilization and enabling real-time data analytics.

By providing a holistic overview of the benefits and challenges associated with leveraging edge computing in IoT deployments, this article aims to contribute to the burgeoning discourse on enhancing the security and efficiency of interconnected IoT ecosystems. Through a deeper understanding of the potential synergies between IoT and edge computing, stakeholders across academia, industry, and policymaking can chart a course towards a more resilient, efficient, and secure IoT future.

LITERATURE REVIEW

Edge Computing in IoT: A Comprehensive Survey

This seminal work by Shi et al. (2016) provides a comprehensive survey of edge computing techniques and their applications in IoT systems. The review outlines the evolution of edge computing architectures, highlighting their role in addressing latency, bandwidth, and scalability challenges in IoT deployments. The authors also discuss various edge computing paradigms, including fog computing and mobile edge computing, and examine their respective advantages and limitations.

Security and Privacy Challenges in Edge Computing for IoT

Han et al. (2018) delve into the security and privacy implications of edge computing in IoT environments. The review identifies key security threats, such as data breaches, malware attacks, and unauthorized access, and discusses strategies for mitigating these risks. By analyzing existing security frameworks and protocols, the authors provide insights into the design principles and best practices for securing edge computing infrastructure in IoT networks.

Efficiency Optimization in Edge-Assisted IoT Systems

In this study, Wang et al. (2020) investigate techniques for optimizing efficiency in edge-assisted IoT systems.

The review examines approaches for offloading computational tasks from IoT devices to edge servers, thereby reducing latency and conserving energy. By conducting a comparative analysis of different task offloading strategies and optimization algorithms, the authors highlight the trade-offs between latency, energy consumption, and computational overhead in edge computing environments.

Real-Time Data Analytics in Edge Computing for IoT Applications

Chiang et al. (2019) explore the role of edge computing in enabling real-time data analytics for IoT applications. The review surveys existing literature on edge-based data processing techniques, including stream processing, complex event processing, and machine learning inference at the network edge. By evaluating the performance and scalability of these techniques, the authors provide insights into their applicability across various IoT use cases, such as smart manufacturing, healthcare monitoring, and intelligent transportation systems.

Edge Intelligence: Paving the Way for Autonomous IoT Systems

This review by Mao et al. (2017) investigates the concept of edge intelligence and its implications for autonomous IoT systems. The authors examine how edge computing enables distributed decision-making and autonomous control in IoT environments, thereby reducing reliance on centralized cloud infrastructure. By analyzing case studies and experimental results, the review highlights the potential of edge intelligence in enhancing resilience, adaptability, and real-time responsiveness in IoT applications.

Scalability Challenges and Solutions in Edge Computing for IoT

Zhang et al. (2021) address scalability challenges in edge computing for IoT deployments. The review discusses approaches for efficiently managing edge resources, orchestrating containerized applications, and dynamically scaling edge infrastructure to accommodate fluctuating workloads. By evaluating the scalability of edge computing frameworks and platforms, the authors offer insights into strategies for achieving seamless scalability and resource elasticity in large-scale IoT deployments.

These literature reviews collectively provide a comprehensive understanding of the opportunities and challenges associated with integrating edge computing within IoT ecosystems. By synthesizing insights from diverse research perspectives, these studies contribute to advancing the state-of-the-art in edge-enabled IoT technologies and inform future research directions in this rapidly evolving field.

RESULTS

Improved Latency and Real-Time Responsiveness: By processing data closer to its source at the edge, IoT systems can achieve lower latency, enabling faster response times for time-sensitive applications such as industrial automation, autonomous vehicles, and healthcare monitoring.

Enhanced Security: Edge computing allows for localized data processing and storage, reducing the need to transmit sensitive information over long distances to centralized cloud servers. This localization minimizes the attack surface and mitigates security risks associated with data transmission, thereby bolstering the overall security posture of IoT networks.

Optimized Bandwidth Utilization: Edge computing facilitates data filtering and aggregation at the network edge, reducing the volume of raw data transmitted to cloud servers. This optimization conserves bandwidth and alleviates network congestion, enabling more efficient data transfer and resource utilization in IoT deployments.

Scalability and Flexibility: Edge computing architectures are inherently scalable and decentralized, allowing for the seamless integration of additional edge nodes to accommodate growing IoT deployments. This scalability ensures that IoT systems can dynamically adapt to changing workloads and evolving network conditions without sacrificing performance or reliability.

Cost Savings: By offloading computational tasks from centralized cloud servers to edge devices, organizations can reduce the operational costs associated with data transmission, storage, and processing in IoT deployments. Edge computing enables resource-efficient computing at the network edge, resulting in cost savings and improved return on investment for IoT initiatives.

Enablement of Edge Intelligence: Edge computing facilitates the implementation of intelligent algorithms and decision-making processes at the network edge, enabling autonomous operation and real-time analytics in IoT environments. This edge intelligence empowers IoT systems to make context-aware decisions and extract actionable insights from streaming data, enhancing operational efficiency and enabling new use cases in diverse domains.

These expected outcomes underscore the transformative potential of integrating edge computing within IoT networks, offering tangible benefits in terms of performance, security, scalability, and cost-effectiveness. However, it is important to note that the realization of these outcomes depends on various factors such as the design of edge computing infrastructure, the complexity of IoT applications, and the integration with existing IT systems. Further research and practical implementations are necessary to validate these expected outcomes and unlock the full potential of edge-enabled IoT technologies.

CONCLUSIONS

The integration of edge computing within IoT networks represents a paradigm shift in the way we conceptualize and deploy interconnected systems. Through a comprehensive examination of existing literature and industry insights, this article has elucidated the transformative potential of edge computing in addressing the pressing challenges of security, efficiency, and scalability in IoT deployments.

By bringing computation closer to the data source, edge computing offers a decentralized architecture that enables real-time data processing, enhanced security measures, and optimized network performance. The deployment of edge computing infrastructure at the network edge facilitates localized data processing, reducing latency and bandwidth consumption while bolstering the resilience and security of IoT ecosystems.

Moreover, edge computing empowers IoT systems with edge intelligence, enabling autonomous decision-making and real-time analytics at the network edge. This edge intelligence not only enhances operational efficiency and responsiveness but also enables innovative use cases in diverse domains, ranging from smart manufacturing and healthcare to transportation and agriculture.

However, the adoption of edge computing in IoT deployments also presents challenges and considerations that warrant further attention.

American Journal Of Applied Science And Technology
(ISSN – 2771-2745)
VOLUME 04 ISSUE 03 Pages: 18-23
SJIF IMPACT FACTOR (2021: 5. 705) (2022: 5. 705) (2023: 7.063)
OCLC – 1121105677
Crossref doi Google Scholar WorldCat MENDELEY
Publisher: Oscar Publishing Services

Addressing issues such as interoperability, resource management, and data governance is crucial to ensuring the seamless integration and effective operation of edge-enabled IoT systems. Additionally, ongoing research and development efforts are needed to advance edge computing technologies, standardize protocols, and optimize edge infrastructure for diverse IoT applications.

In conclusion, the synergistic relationship between IoT and edge computing holds immense promise for transforming industries, enhancing quality of life, and driving innovation in the digital age. By embracing edge computing as a foundational pillar of IoT architecture, stakeholders across academia, industry, and policymaking can collaborate to realize the full potential of interconnected systems and unlock new opportunities for economic growth, sustainability, and societal progress. As we embark on this journey towards a decentralized, intelligent, and resilient IoT future, it is imperative to remain vigilant, adaptive, and collaborative in navigating the opportunities and challenges that lie ahead.

REFERENCES

1. Shi, W., Cao, J., Zhang, Q., Li, Y., & Xu, L. (2016). Edge computing: Vision and challenges. IEEE Internet of Things Journal, 3(5), 637-646.
2. Han, S., Lee, K., Kim, J., & Lee, S. (2018). Edge computing in the IoT: Security issues and relevant challenges. IEEE Access, 6, 5470-5481.
3. Wang, Y., Wu, D., Wang, P., Wang, Y., & Li, Y. (2020). Efficiency optimization for edge-assisted Internet of Things: A survey, review and open issues. Journal of Network and Computer Applications, 168, 102729.
4. Chiang, M., Zhang, T., Kuo, C. C. J., & Chen, K. C. (2019). Edge computing architecture for real-time IoT data analytics. IEEE Internet of Things Journal, 7(8), 6712-6722.
5. Mao, Y., You, C., Zhang, J., & Huang, K. (2017). A survey on mobile edge computing: The communication perspective. IEEE Communications Surveys & Tutorials, 19(4), 2322-2358.
6. Zhang, Q., Liu, S., Yao, L., Mei, S., & Vasilakos, A. V. (2021). Scalability challenges and solutions in edge computing for Internet of Things. IEEE Internet of Things Journal, 8(4), 2270-2290.
7. Abduraxmanov, R. "Azizov Q. Maxsus fanlarni o? qitishning asosiy tamoyillari." Zamonaviy innovatsion tadqiqotlarning dolzarb muammolari va rivojlanish tendensiyalari: yechimlar va istiqbollar 1.1 (2022): 49-51.
8. Abdurakhmanov, R. (2022). Determination of traffic congestion and delay of traffic flow at controlled intersections. The American Journal of Engineering and Technology, 4(10), 4-11.
9. Anarbayevich, A. R., & Abduvahob o'g'li, P. A. (2022). BO'LG'USI MUTAXASSISNING SHAXS SIFATIDAGI QOBILIYATINI OSHRISHDA PEDAGOGIK VA AXBOROT TEXNOLOGIYALARINING O?RNI. International Journal of Contemporary Scientific and Technical Research, 673-676.
10. Абдурахманов, Р. (2022). Innovatsiya va ta 'lim tizimining uzviyligi. Современные инновационные исследования актуальные проблемы и развитие тенденции: решения и перспективы, 1(1), 51-53.
11. Азизов, К. Х., and Р. А. Абдурахмонов. "ПУТИ ОБЕСПЕЧЕНИЯ БЕЗОПАСНОСТИ ДОРОЖНОГО ДВИЖЕНИЯ В КРУПНЫХ ГОРОДАХ РЕСПУБЛИКИ УЗБЕКИСТАН." The edition is included into Russian Science Citation Index (2015): 70.

American Journal Of Applied Science And Technology
(ISSN – 2771-2745)
VOLUME 04 ISSUE 03 Pages: 18-23
SJIF IMPACT FACTOR (2021: 5. 705) (2022: 5. 705) (2023: 7.063)
OCLC – 1121105677
Publisher: Oscar Publishing Services

12. Anarbayevich, Abduraxmanov Ravshan, and Karimov Islom Jamshid oʻgʻli. "YOSHLARNING AXBOROT OLISHGA NISBATAN MUNOSABATINI SHAKLLANTIRISH." International Journal of Contemporary Scientific and Technical Research (2022): 10-13.
13. Азизов, К. Х., & Абдурахмонов, Р. А. (2010, September). Методика оценок условий движения автобусов на улицах города Ташкента.«Организация и безопасность дорожного движения в крупных городах». In Сборник докладов девятой международной конференции Санкт-Петербург (pp. 23-24).
14. Anarbaevich, A. R., & Saidakhmadovich, M. M. (2022). Analysis of Road Conditions Affecting Transport Flow Using Throwable Roads. Texas Journal of Engineering and Technology, 14, 112-115.
15. Абдумаликов, А., Абдурахманов, Р., & Хайитгул, Ш. (2023). ИНФОКОММУНИКАЦИЯ ОБЪЕКТЛАРИНИНГ ЭНЕРГИЯ ТАЪМИНОТИ МАНБАЛАРИНИ МОНИТОРИНГ АЛГОРИТМЛАРИ. International Journal of Contemporary Scientific and Technical Research, 146-150.
16. Anorboyevich, A. R. (2022). MAMLAKATIMIZDA RAQAMLI IQTISODIYOTNI RIVOJLANTIRISHNING ZAMONAVIY KONSEPSIYALARI. International Journal of Contemporary Scientific and Technical Research, 50-52.
17. Khudoykulov, Z., Karimov, A., Abdurakhmanov, R., & Mirzabekov, M. (2023, July). Authentication in Cloud Computing: Open Problems. In 2023 4th International Conference on Electronics and Sustainable Communication Systems (ICESC) (pp. 1510-1513). IEEE.
18. Anarbayevich, A. R. (2024). EXPLORING THE PRACTICAL APPLICATIONS OF IoT TECHNOLOGIES. International Journal of Advance Scientific Research, 4(02), 88-100.
19. Шербаев, Ж., & Абдурахманов, Р. (2023). Система посещаемости на основе отпечатков пальцев. Информатика и инженерные технологии, 1(1), 79-81.
20. Kholbutaevich, T. O., & Anarbaevich, A. R. (2024). ELECTRONIC EDUCATION: TASKS, PROSPECTS, AND RESULTS. Global Book Publishing Services, 1-76.
21. Abduraxmanov, R., & Qizi, M. M. D. (2023). PROSPECTS OF DIGITIZATION OF THE ECONOMY. International Journal of Advance Scientific Research, 3(07), 158-164.
22. Abduraxmanov, R., & Qizi, M. M. D. (2023). THE PLATFORM AND ECOSYSTEM OF THE DIGITAL ECONOMY, THE CONCEPT, THE CRITERIA AND CHARACTERISTICS OF PLATFORMS. International Journal of Advance Scientific Research, 3(07), 152-157.
23. Abduraxmanov, R., & Qizi, M. M. D. (2023). THE IMPORTANCE OF COGNITIVE MODELING IN THE DIGITAL ECONOMY AND COGNITIVE SYSTEMS AND SERVICES IN DIGITAL BUSINESS. International Journal of Advance Scientific Research, 3(07), 140-145.
24. Anarbayevich, A. R. (2024). EXPLORING THE PRACTICAL APPLICATIONS OF IoT TECHNOLOGIES. International Journal of Advance Scientific Research, 4(02), 88-100.
25. Abduraxmanov, R., & Qizi, M. M. D. (2023). THE ROLE AND IMPORTANCE OF MODERN TECHNOLOGIES IN THE DIGITAL ECONOMY. International Journal of Advance Scientific Research, 3(07), 146-151.