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Editorial

Introduction to the Topic of AI and IoT for Promoting Green Operation and Sustainable Environment

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1. Introduction

In the current era, green operation has become a key strategic direction for firm development, with its core being the realization of a win–win situation for economic and environmental benefits through environmentally friendly production processes [1]. From the design stage of products, energy conservation and emission reduction, and pollution prevention and control in the manufacturing process to the greenization of packaging and transportation and the recycling of materials, the green operation runs through the entire life cycle of production [2].

The vigorous development of artificial intelligence (AI) and the Internet of Things (IoT) technologies has provided unprecedented opportunities and strong support for the implementation of green operation strategy [3]. In the complex system of the green operation, the stable operation of production equipment is vitally important. Once equipment malfunctions occur, they not only lead to a sharp increase in system maintenance costs, eroding corporate profits, but also seriously disrupt the production rhythm, reducing production efficiency, and even impose additional burdens on the environment due to material and energy waste [3]. The integrated application of AI and IoT technologies has brought hope to solving these problems. Together, they can conduct real-time monitoring and in-depth analysis of the production process, accurately capture abnormal fluctuations in equipment operation data, and predict potential fault risks in advance and promptly diagnose and repair them [4]. Through customized intelligent systems, they can comprehensively control the "health status" of machines and seamlessly connect with remote maintenance and component control systems to ensure the continuity and stability of the production process, minimize the occurrence of unexpected events, and effectively promote the green operation to new heights, creating the sustainable and ecological environment [5].

2. Contributions of Published Literature

This topic covers a total of 48 articles in five different journals in which researchers closely focused on the practical problems in various industries and strove to provide practical solutions. In terms of technology application and innovation, the authors actively introduced cutting-edge and emerging technologies, such as the IoT, blockchain, and AI, and proposed a variety of innovative algorithms and models, effectively improving the efficiency and accuracy of data processing and analysis. For example, in the article "K-Means++ Clustering Algorithm in Categorization of Glass Cultural Relics" [6], the authors used the K-Means++ clustering algorithm to classify glass cultural relics, providing an important basis for studying the manufacturing techniques and compositions of ancient glass.

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In the field of environmental and sustainable development, a great deal of attention has been paid to resource recycling and utilization. Of particular interest is the quantitative assessment of the environmental impacts of production and treatment processes through life cycle assessment and other methods to provide a basis for the formulation of sustainable development strategies. For example, in the article "Analysis and Simulation of Land Use Changes and Their Impact on Carbon Stocks in the Haihe River Basin by Combining LSTM with the InVEST Model" [7], the authors studied the land use changes and carbon stocks in the Haihe River Basin by integrating the LSTM and InVEST models. They found that the land use changes in this area mainly involve the mutual conversion of cultivated land, forests, and grasslands, as well as the conversion of cultivated land to construction land, resulting in an overall decline in carbon stocks. Through this research method, theoretical support can be provided for watershed land use planning, ecological restoration, and management, contributing to regional sustainable development.

In the aspect of safety monitoring and guarantee, research has been conducted on the wall-climbing robot technology for coal mine shafts to support coal mine safety monitoring. The research methods and technical ideas used also provide useful references for safety monitoring in other fields. For example, in the article "Research on Coupling Adsorption Experiments for Wall–Climbing Robots in Coal Mine Shafts" [8], the authors studied the electromagnetic and negative pressure coupling adsorption technology of the wall-climbing robot in the coal mine shaft and analyzed the adsorption characteristics and motion laws of the robot under different working conditions. They found that the robot provides an effective technical means for the safety monitoring of the coal mine shaft. This research not only solved the problems existing in the safety monitoring of the coal mine shaft but also provided a reference for safety monitoring in other fields. For example, in the safety monitoring of buildings, bridges, and other structures, the research methods and technical ideas can be borrowed to improve the accuracy and reliability of safety monitoring.

In the field of energy management and optimization, the focus is on the efficient utilization and integration of renewable energy, with intelligent algorithms and system models being used to optimize energy distribution and scheduling, reduce energy consumption and carbon emissions, and ensure a stable and sustainable energy supply. For example, in the article "Unveiling Genetic Reinforcement Learning (GRLA) and Hybrid Attention-Enhanced Gated Recurrent Unit with Random Forest (HAGRU-RF) for Energy-Efficient Containerized Data Centers Empowered by Solar Energy and AI" [9], the authors aimed to solve the energy consumption problem of data centers by proposing the GRLA to optimize container placement, and they combined the HAGRU-RF model to predict solar power generation. Experiments showed that GRLA effectively reduces energy consumption in different data center environments, and the HAGRU-RF model is much more accurate in predicting solar energy than traditional methods are, providing an effective strategy for data centers to achieve a sustainable energy supply using solar energy and having important demonstration significance for improving the utilization efficiency of renewable energy in the energy management field through intelligent technology.

In the field of ecosystem protection and restoration, research on key ecological processes and biodiversity of damaged ecosystems is important. Authors have used ecological models and monitoring technologies to assess the health status of ecosystems and formulate scientific restoration plans. In the article "A Review of Eco-Product Value Realization and Eco-Industry with Enlightenment toward Village Ecosystem Service in the Karst Desertification Control" [10], the authors used a literature review to explore the realization of ecological product value and the development of ecological industries. The research progress in ecosystem services, ecological product value accounting, realization mechanisms, and ecological industries is sorted out in the context of karst desertification control.

Here, the existing problems are pointed out, and the solution directions are proposed, such as constructing a unified value accounting system, improving the ecological compensation and marketing mechanisms, and promoting the diversified development of ecological industries, providing comprehensive theoretical support and practical guidance for the coordinated promotion of ecological protection and economic development in ecologically fragile areas, and facilitating ecosystem restoration and sustainable development.

In the field of industrial development and optimization, authors have promoted the transformation of the manufacturing industry to achieve low-carbon development through AI and strengthen green innovation. They have also promoted the sustainable development of agriculture to optimize the breeding structure and improve the breeding mode. For example, in the article "How Does Artificial Intelligence Impact Green Development? Evidence from China" [11], the authors found that the development of AI has a positive impact on urban energy efficiency. Accelerating green technology innovation and digital economy development improves the cities' energy utilization efficiency. At the same time, the authors also discussed the application of AI in the manufacturing industry. For example, low-carbon development is achieved by optimizing the production process and resource allocation. In the article "Analysis of Greenhouse Gas Emissions Characteristics and Emissions Reduction Measures of Animal Husbandry in Inner Mongolia" [12], the authors analyzed the greenhouse gas emission characteristics and emission reduction measures of animal husbandry in Inner Mongolia and proposed measures such as optimizing the breeding structure and promoting clean production to promote the sustainable development of animal husbandry.

3. Conclusions

In summary, the research covered in this topic has made significant progress in their respective fields and focuses on the core theme of green operation, contributing from different perspectives to achieving the goal of green development. Despite the wide range of research areas, all these authors have demonstrated the huge potential of AI and IoT technologies in promoting green operation. These research results provide practical technical paths and decision-making references for firms in the actual production process, helping them better balance economic and environmental benefits. In the future, these achievements are expected to further stimulate cross-field deep integration and innovative applications, encouraging more enterprises to actively engage in green operation practices, accelerating society's progress toward green development, and achieving a virtuous interaction and coordinated development between economic prosperity and environmental protection as well as providing strong support for addressing global climate change and resource shortages and other severe challenges.

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References

1. Yu, W.; Ramanathan, R. An empirical examination of stakeholder pressures, green operations practices and environmental performance. *Int. J. Prod. Res.* **2015**, *53*, 6390–6407. [CrossRef]
2. Dao, V.; Langella, I.; Carbo, J. From green to sustainability: Information Technology and an integrated sustainability framework. *J. Strateg. Inf. Syst.* **2011**, *20*, 63–79. [CrossRef]
3. Liu, W.; Wu, C.-H.; Tsai, S.-B.; Shao, X.; Wacławek, M. Corporate environmental management in the context of digital transformation. *Ecol. Chem. Eng. S* **2023**, *30*, 91–92. [CrossRef]
4. Liu, W.; Xu, Y.; Fan, D.; Li, Y.; Shao, X.-F.; Zheng, J. Alleviating corporate environmental pollution threats toward public health and safety: The role of smart city and artificial intelligence. *Saf. Sci.* **2021**, *143*, 105433. [CrossRef]
5. Fraga-Lamas, P.; Lopes, S.I.; Fernández-Caramés, T.M. Green IoT and edge AI as key technological enablers for a sustainable digital transition towards a smart circular economy: An industry 5.0 use case. *Sensors* **2021**, *21*, 5745. [CrossRef] [PubMed]
6. Meng, J.; Yu, Z.; Cai, Y.; Wang, X. K-Means++ clustering algorithm in categorization of glass cultural relics. *Appl. Sci.* **2023**, *13*, 4736. [CrossRef]
7. Lin, Y.; Chen, L.; Ma, Y.; Yang, T. Analysis and Simulation of Land Use Changes and Their Impact on Carbon Stocks in the Haihe River Basin by Combining LSTM with the InVEST Model. *Sustainability* **2024**, *16*, 2310. [CrossRef]
8. Xu, Y.; Fu, W. Research on Coupling Adsorption Experiments for Wall–Climbing Robots in Coal Mine Shafts. *Processes* **2023**, *11*, 2016. [CrossRef]
9. Bouaouda, A.; Afdel, K.; Abounacer, R. Unveiling Genetic Reinforcement Learning (GRLA) and Hybrid Attention-Enhanced Gated Recurrent Unit with Random Forest (HAGRU-RF) for Energy-Efficient Containerized Data Centers Empowered by Solar Energy and AI. *Sustainability* **2024**, *16*, 4438. [CrossRef]
10. Yang, B.; Zhang, Y.; Xiong, K.; Huang, H.; Yang, Y. A review of eco-product value realization and eco-industry with enlightenment toward the forest ecosystem services in karst ecological restoration. *Forests* **2023**, *14*, 729. [CrossRef]
11. Chen, M.; Wang, S.; Wang, X. How Does Artificial Intelligence Impact Green Development? Evidence from China. *Sustainability* **2024**, *16*, 1260. [CrossRef]
12. Cao, Y.; Yang, X.; Yang, F.; Sun, Y.; Wang, Q.; Ren, F.; Nie, L.; Aodemu; Feng, W. Analysis of Greenhouse Gas Emissions Characteristics and Emissions Reduction Measures of Animal Husbandry in Inner Mongolia. *Processes* **2023**, *11*, 2335. [CrossRef]