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Energy Sustainability and Robotic Integration: A Bibliometric Analysis

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The fourth industrial revolution, driven by advancements in cyber-physical system, artificial intelligence, big data, and the internet of things, necessitates new methodologies to assess the impacts of these technologies on society and industry (Jazdi, 2014; Boas et al., 2005; Warner and Wäger, 2019). Industry 4.0 incorporates highly adaptable robotic systems and energy-efficient solutions to enhance sustainability in manufacturing and construction, consequently contributing to environmental protection (Wang et al., 2017).

Wang et al. (2017) discuss energy-efficient robotic configurations in cloud environments that significantly reduce energy consumption, demonstrating sustainable manufacturing approaches. Haghighi et al. (2021) introduce a framework for multi-robotic additive manufacturing that optimizes energy use in large-scale construction, showing how systematic energy efficiency can be achieved. Additionally, Carabin et al. (2017) provide a comprehensive review of energy-saving methods for robotic and mechatronic systems, highlighting innovations that can significantly improve industrial energy performance. These studies illustrate the potential of advanced robotic systems to contribute to environmental sustainability within the framework of modern industrial advancements; however, the question still remains about what these systems have in-common what categories they can be differentiated into.

Our study proposes an integrative framework to evaluate the effects and role of energy-efficient solutions and highly adaptable robotic systems on environmental sustainability. A dataset consisting of metadata and full texts from thousands of open-source research articles was created on the topic Greentech, particularly in regards to robotic systems and whether or not those articles were related to increasing energy efficiency.

In conjunction with our technological analysis, we employ several bibliometric methods to identify thematic linkages within the field, as bibliometric methods can enhance the identification of subtopics and the overall understanding of data (Nikolenko et al., 2017; Donthu et al., 2021). Text mining of keywords allows us to detect similarities between studies and map out the network of scholarly communication, providing insights into the collaborative nature of technological innovation studies. Subsequent topic mining using a pre-trained open-source AI models in a Python-based data processing pipeline was done, which was later compared to the results of traditional algorithms such as keyword frequency and cluster analysis.

The expected results are that keyword analysis will reveal dominant research themes, aiding in the construction of a semantic field map that identifies and tracks the evolution of core topics within the realm of sustainable development and robotic integration. Our comprehensive approach, supported by advanced bibliometric techniques, aims to offer a holistic view of the implications of emerging technologies, guiding future research and implementation strategies in a manner that prioritizes sustainability and societal well-being.

Keywords: Sustainability, Energy efficiency, Greentech technology, Robotic systems, Bibliometric analysis

References

Boas, T., Dunning, T. and Bussel, J. 2005. 'Will the digital revolution revolutionize development? Drawing together the debate'. Studies in Comparative International Development, 40, 95–110.

Carabin, G, Wehrle, E. and Vidoni, R. 2017. "A Review on Energy-Saving Optimization Methods for Robotic and Automatic Systems." Robotics, 6: 39. https://doi.org/10.3390/robotics6040039.

Donthu, N., Kumar, S., Mukherjee, D., Pandey, N. and Lim, W.M. 2021. "How to conduct a bibliometric analysis: An overview and guidelines." Journal of Business Research, 133: 285-296. https://doi.org/10.1016/j.jbusres.2021.04.070

Haghighi, A., Mohammed, A. and Wang, L. 2021. "Energy Efficient Multi-Robotic 3D Printing for Large-Scale Construction – Framework, Challenges, and a Systematic Approach." Volume 2: Manufacturing Processes; Manufacturing Systems; Nano/Micro/Meso Manufacturing; Quality and Reliability. https://doi.org/10.1115/msec2021-63787.

Jazdi, N. (2014). Cyber physical systems in the context of Industry 4.0. 2014 IEEE International Conference on Automation, Quality and Testing, Robotics, 1-4. https://doi.org/10.1109/AQTR.2014.6857843.

Lihui Wang, Abdullah Mohammed, X. Wang and B. Schmidt. "Energy-efficient robot applications towards sustainable manufacturing." International Journal of Computer Integrated Manufacturing, 31 (2017): 692 - 700. https://doi.org/10.1080/0951192X.2017.1379099.

Nikolenko, S., Koltcov, S. and Koltsova, A. 2017. "Topic modelling for qualitative studies." Journal of Information Science, 43: 102 - 88. https://doi.org/10.1177/0165551515617393.

Warner, K. and Wäger, M. 2019. 'Building dynamic capabilities for digital transformation: An ongoing process of strategic renewal'. Long Range Planning, 52, 326–49. https://doi.org/10.1016/j.lrp.2018.12.001