



Smart-troubleshooting in Industry 4.0 leveraging log files and product information

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Abstract

Connected Internet of Things devices are becoming more powerful, yet the challenge of effectively managing them to prevent failures remains ongoing. In some scenarios, such as with devices produced by a single company, it is possible to use the same fault detection provided by the manufacturer and follow the instructions for resolving the threat. In other cases, such as with devices produced by different companies, the heterogeneity of devices necessitates a more detailed and complex approach to fault detection. Log files, which are records of events or processes generated by a device's software or hardware, are crucial for monitoring device behavior.

It is important to consider the diversity of log files and data to detect threats, identify their root causes, and provide effective solutions. In the realm of troubleshooting interconnected Internet of Things devices, current solutions predominantly address homogeneous device environments, which limit their scalability and adaptability to diverse device types and configurations. Instead, a more flexible approach is needed; one that can accommodate a variety of connected devices while minimizing reliance on specific company instructions. One such method is smart troubleshooting, which involves a 4-step cycle which includes prevention, detection and diagnosis, recovery, and evolution of threats.

Given these premises, the ultimate goal of this research is to define a smart troubleshooting approach based on log files and product information. By leveraging a generalized methodology, this approach seeks to enhance the management of internet of things systems in complex, multi-manufacturer environments.

This thesis focuses on a systematic review of log files and the state of the art in troubleshooting methodologies. During the research, the scarcity of publicly available log files for troubleshooting purposes was identified. Consequently, a method was proposed for generating synthetic log files using generative adversarial networks. The proposed methodology leverages these log files along with product information to enhance smart troubleshooting.

To validate the approach and gather industry feedback, questionnaires and interviews were conducted. Following this, machine learning algorithms will be employed to implement and refine the proposed method. By leveraging a generalized methodology, this approach seeks to improve the management and fault detection of internet of things systems in complex, heterogeneous environments.

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List of publications in the thesis

Paper A

Partovian, S., Bucaioni, A., Flammini, F., & Thornadtsson, J. (2024). Analysis of log files to enable smart-troubleshooting in Industry 4.0: a systematic mapping study, IEEE Access, E-ISSN 2169-3536 (Epub ahead of print)

Paper B

Partovian, S., Flammini, F., & Bucaioni, A. (2024). Leveraging GANs to Generate Synthetic Log Files for Smart Troubleshooting in Industry 4.0, 50th Euromicro Conference Series on Software Engineering and Advanced Applications (SEAA) 2024

Paper C

Partovian, S., Flammini, F., Bucaioni, A., & Thornadtsson, J. (2025). A vision for leveraging product information and log files to enable smart-troubleshooting of heterogeneous interconnected devices, IEEE ICHMS 2025 5th IEEE International Conference on Human-Machine Systems. (Manuscript)

Paper D

Partovian, S., Flammini, F., Bucaioni, A., & Thornadtsson, J. (2025), LogGenST: A Framework for Synthetic Log Generation using LLMs for smart-troubleshooting, Manuscript (preprint)

Biography

Sania Partovian has been exposed to several diverse working environments in industry and academia in the field of artificial intelligence and mechatronics. Being exposed to mechatronics and the basics of mechanical engineering along with electrical engineering has broadened her horizons in developing a solution-oriented mindset with real-world problems. She has also engaged herself in the academic role as a lecturer for more than four years in the field of artificial intelligence.

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