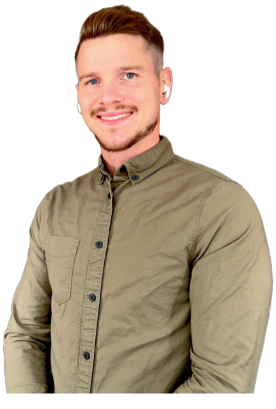

Automated Tactile Sensing for Quality Control of Locks Using Machine Learning

Tim Andersson

Licentiate Thesis Defence

ASSA ABLOY
The global leader in door opening solutions.

Time: 7 June 2024. 09:15 (CET)

Location: Mäladalen University (Eskilstuna Campus) Room: C3-003

Automated Tactile Sensing for Quality Control of Locks Using Machine Learning

Tim Andersson

Licentiate Thesis

Biography

Tim's journey began with 4 years studying airplane and train maintenance, followed by 8 years working as a maintenance technician. This hands-on experience fueled his ambition to become an engineer.

In 2015, he pursued a Master's in robotics, honing skills in programming, mechanical, and electrical work which later enabled him to start his company TIMectronic where he utilize his expertise. Now an industrial doctoral candidate at ASSA ABLOY.

Tim's research focuses on identifying mechanical anomalies in cylinder locks using torque measurements and machine learning with the end goal of replacing the human tactile sense in quality control. His trajectory showcases a passion for research, innovation and problem-solving in engineering.

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Abstract

This thesis delves into the use of Artificial Intelligence (AI) for quality control in manufacturing systems, with a particular focus on anomaly detection through the analysis of torque measurements in rotating mechanical systems.

The research specifically examines the effectiveness of torque measurements in quality control of locks, challenging the traditional method that relies on human tactile sense for detecting mechanical anomalies. This conventional approach, while widely used, has been found to yield inconsistent results and poses physical strain on operators.

A key aspect of this study involves conducting experiments on locks using torque measurements to identify mechanical anomalies. This method represents a shift from the subjective and physically demanding practice of manually testing each lock. The research aims to demonstrate that an automated, AI-driven approach can offer more consistent and reliable results, thereby improving overall product quality.

The development of a machine learning model for this purpose starts with the collection of training data, a process that can be costly and disruptive to normal workflow. Therefore, this thesis also investigates strategies for predicting and minimizing the sample size used for training. Additionally, it addresses the critical need of trustworthiness in AI systems used for final quality control.

The research explores how to utilize machine learning models that are not only effective in detecting anomalies but also offers a level of interpretability, avoiding the pitfalls of black box AI models. Overall, this thesis contributes to advancing automated quality control by exploring the state-of-the-art machine learning algorithms for mechanical fault detection, focusing on sample size prediction and minimization and also model interpretability. To the best of the author's knowledge, it is the first study that evaluates an AI-driven solution for quality control of mechanical locks, marking an innovation in the field.

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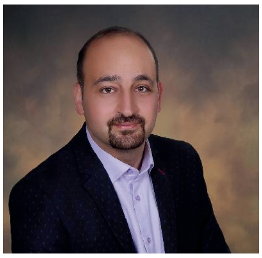

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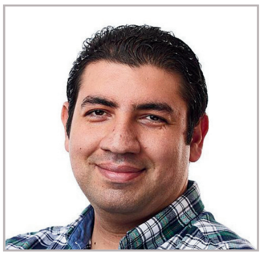

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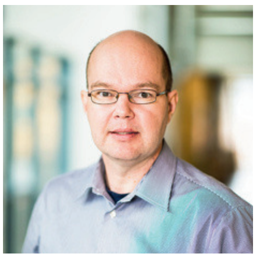

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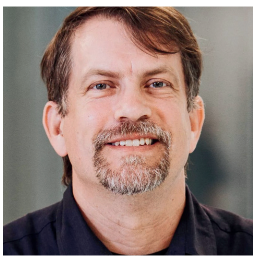

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List of publications in the thesis

Paper I
Title: Comparison of Machine Learning's- and Humans'- Ability to Consistently Classify Anomalies in Cylinder Locks
Authors: Tim Andersson, Markus Bohlin, Tomas Olsson, Mats Ahlskog
Published in: Advances in Production Management Systems. Smart Manufacturing and Logistics Systems: Turning Ideas into Action, 2022, pp. 27–34. doi: 10.1007/978-3-031-16407-1_4.

Paper II
Title: Sample size prediction for anomaly detection in locks
Authors: Tim Andersson, Markus Bohlin, Tomas Olsson, Mats Ahlskog
Published in: Procedia CIRP, vol. 120, pp. 870–874, 2023, doi: 10.1016/j.procir.2023.09.090

Paper III
Title: Interpretable machine learning model for quality control of locks using counterfactual explanations
Authors: Tim Andersson, Markus Bohlin, Tomas Olsson, Mats Ahlskog
Published in: (In press) 8th International Conference on Artificial Intelligence, Automation and Control Technologies (AIACT 2024), Phuket: Journal of Computational and Cognitive Engineering, 2024.

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