SUCCESS STORY

DeSSnet

Dependable, secure and time-aware sensor networks

Program: COMET – Competence Centers for Excellent Technologies

Program line: K-Project

Type of project: DeSSnet, Development of Key Enabling Technologies for Time-aware Analytics, 06/2017 – 05/2021, strategisch/multi-firm

Predictive maintenance of large engines with Time-Aware Analytics

Early detection of engine failures is an important aspect for planning maintenance and repairing engine failures as quickly as possible. By using time-aware analytics, it has been possible to detect failures in all operating states of an engine more quickly and, as well as, to detect types of failures that were difficult to detect using a purely rule-based approach. This significantly reduces costs due to consequential damage to the engine and increases the operational guarantee, while at the same time reducing the risk of possible consequential costs due to missed deadlines.

Engine maintenance is an important part of ensuring that engines function safely. However, periodic maintenance can be too late for some failures, which is why predictive maintenance is beneficial. Within the DeSSnet project, a new technology for large engines has been developed in cooperation between AVL and JOANNEUM RESEARCH. These large engines are mainly used in ship or in power plants and those are built as 2- or 4-stroke engines with a varying number of cylinders.

The solutions for predictive maintenance used so far was based on a control system. The aim of this project was to use time-aware machine learning to be able to report motor failures earlier as well as, detect failures that were previously difficult or impossible to detect. The difficulty with motors is that there are a large number of motor states and failures present themselves in different ways. Additionally, the recording rate between the different motors may differ.

The problem arose that a motor delivers different pressure curves at different rotation speeds, and a failure was hard to detect properly.

First, possible sensor errors, such as noise or saturation of the amplifier, were detected and reported. Generally, sensor errors should be corrected as soon as possible, even if they do not

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cause direct consequential damage. Engine failures also have the characteristic of being slow to detect. For example, if the cylinder loses pressure due to wearing off, pressure loss becomes increasingly apparent over time. The sooner such a failure is detected, the sooner it can be repaired. The use of machine learning has led to an improvement in early detection. The trained model compares all the cylinders present at one given time and reports when a cylinder behaves differently from the other cylinders. For each typical failure, a specific region was first defined in the cylinder pressure curve where this failure could be detected. With the existing data, a model was learned for each failure type, with usually 1-2 faulty cylinders in each data set.

The project has shown that it is possible to achieve a faster result using machine learning.

Impact and effects

By detecting sensor failures, but especially by detecting engine failures at an early stage, it is possible to react to them quickly. Ships are usually underway for long periods and are far from repairable locations. In addition, these engines may require special parts. The sooner a problem is identified, the quicker it can be responded to. Necessary spare parts can be transported to specific ports, or a decision can be made as to how long the engine can continue to operate, and necessary steps (e.g., rerouting to an alternate port, ordering of a replacement ship) can be taken.

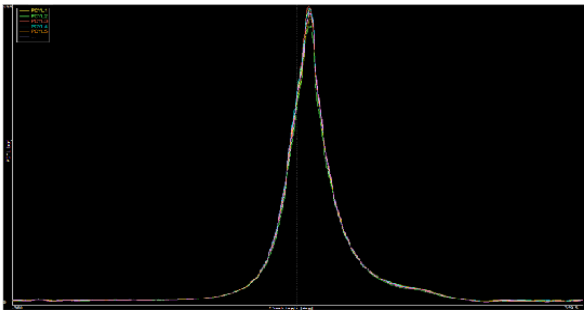

Fig. 1: Cylinder pressure curve of a large engine with a compression loss in cylinder 2. (Copyright: AVL & Joanneum Research)

On the one hand, this ensures the operation of the ship, but also prevents major damage to the engine. Both lead to the reduction of considerable costs caused by failure or non-adherence to a schedule, which can very quickly become very high in both shipping and power plants.

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- AVL, Austria

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