Next-Generation Ultrasonic Testing of Rails using AI

Topias Tyystjärvi[1], Oskari Jessen-Juhler[1], Tuomas Koskinen[1] and Iikka Virkkunen[1]

[1]Trueflaw
Tillinmäentie 3 A 113
Espoo, Finland
(358) 447944316; email topias@trueflaw.com

ABSTRACT

Reliable inspection of rails is paramount to railroad safety. Several non-destructive evaluation methods are commonly used as part of the inspection, including visual testing, eddy current testing and ultrasonic testing. Ultrasonic testing provides high accuracy and reveals internal defects. The downside of ultrasonics is that the inspection data can be difficult to interpret. When multi-probe setups are used at speed, reliable evaluation of the acquired data becomes increasingly difficult to perform. Due to the massive scale of the inspection target, eye fatigue and loss of focus are serious concerns.

To alleviate the concerns related to human factors, automatic analysis methods are of interest. There are two use cases to consider: a) real-time assisted defect recognition during inspection, and b) The annotation of archived data for more efficient off-line viewing. Automatic analysis solutions using traditional signal processing methods like amplitude thresholding fail to take into account commonly occurring geometry like bolt holes and joints, which can give higher amplitude signals than defects. Solutions based on machine learning, however, make it possible to learn and classify these features from data.

In this work, an ultrasonic testing device was designed for the 5-probe (±70/±38/0) unit commonly used in European rail inspections. To make the evaluation from multiple probes easier, an intuitive reconstruction was made, reducing the number of adjacent data views from five per rail to one per rail. Using the view, the inspection can be carried out at speeds up to 3.7 miles per hour. A machine learning model was trained to detect rail defects as well as bolt holes and rail joints. An inspection application with integrated real-time AI annotations was designed, as well as a viewing application for archived data. This represents the next generation of ultrasonic rail inspection, where the very large throughput of data can be leveraged more efficiently.

Keywords: ultrasonic testing, rail inspection, artificial intelligence, machine learning, edge computing