Structural Health Monitoring of Rail Mounted Gantry Cranes

Daniel Hendrickson

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Advisor: Mark Hinders, Professor of Applied Science

Abstract

The Port of Virginia utilizes rail-mounted Auto Stacking Cranes at their Virginia International Gateway and Norfolk International Terminal facilities. The tracks and cranes are under high load and stresses due to cargo and system weight, leading to frequent failures. Equipment failures are expensive to repair and disrupt operations. Building on an existing body of research in rail nondestructive evaluation, ultrasonic testing, and signal processing, we utilize modern instrumentation to detect flaws in the cranes and rails as early as possible. With current methods, the maintenance team cannot identify flaws until equipment fails. Our methodology involves ultrasonic evaluation of the rails with laser vibrometry with a combination of wavelet fingerprinting and neural networks to signal problems before a failure. Results are validated against simulation based on the Elastodynamic Finite Integration Technique. Next low-power accelerometers are installed on the cranes to collect movement data. The readings are compared against detailed surveys of the tracks, and an algorithm for identifying rail flaws from the accelerometers is developed. Finally, the accelerometer data is analyzed with a new three-dimensional wavelet fingerprint, allowing machine learning anomaly detection algorithms to highlight sections of the crane recordings that are potentially problems.