Global Shipping Container Monitoring Using Machine Learning with Multi-Sensor Hubs and Catadioptric Imaging

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Abstract

We describe a framework for global shipping container monitoring using machine learning with multi-sensor hubs and infrared catadioptric imaging. A wireless mesh radio satellite tag architecture provides connectivity anywhere in the world which is a significant improvement to legacy methods. We discuss the design and testing of a low-cost long-wave infrared catadioptric imaging device and multi-sensor hub combination as an intelligent edge computing system that, when equipped with physics-based machine learning algorithms, can interpret the scene inside a shipping container to make efficient use of expensive communications bandwidth. The histogram of oriented gradients and T-channel (HOG+) feature as introduced for human detection on low-resolution infrared catadioptric images is shown to be effective for various mirror shapes designed to give wide volume coverage with controlled distortion. Initial results for through-metal communication with ultrasonic guided waves show promise using the Dynamic Wavelet Fingerprint Technique (DWFT) to identify Lamb waves in a complicated ultrasonic signal.