Rail Structural Health Monitoring using ultrasonic guided waves: system design and deployment

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Railways are a central industrial infrastructure enabling people and goods transportation all across the globe and their use is due to increase in the forthcoming years to reduce the overall carbon footprint of our modern societies. Hence the need to ensure their reliable use, as traffic interruptions or accidents can have dire social, economic and environmental impacts. In particular, rail breaks can produce such incidents and need to be monitored and prevented if possible. Ultrasonic guided waves are a promising physical phenomenon to monitor rails as they can enable the monitoring of long portions with a limited number of sensors. This talk will present a SHM system relying on such waves for rail monitoring which has been deployed for industrial tests on a subway line. The electronics, the sensors and their coupling to the rail were optimized to ensure the measurement of guided waves after a long-range propagation throughout the life of the system. Indeed, specific couplings are needed to enable long-time coupling, and so ultrasound sensitivity of the system, while the rails are bearing high loads or dilating due to temperature changes. An experimental campaign was carried out to evaluate the sensitivity of the system to rail breaks, and to demonstrate its detection under representative, uncontrolled environmental conditions. Particular considerations linked to pulse-echo inspections, inducing a sensitivity to cut-off frequencies and zero-group velocity modes, will be presented.