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Ultrasonic node synchronized by GPS for rail monitoring

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Rail breaks can be a source of dramatic accidents or service interruptions with huge economic and social impacts. Conventional inspection of rails is generally performed through manual inspection devices or inspection vehicles equipped with ultrasonic or electromagnetic sensors able to check surface and internal defects along the rail in either contact or noncontact manner.

Guided elastic waves are one of the most promising technology for Structural Health Monitoring of elongated structures thanks to their capability to propagate over large distances and their sensitivity to critical defects such as cracks or corrosion. Piezoelectric transducers that are permanently and regularly spaced on the rail can be used to emit and receive such waves. Specific signal processing of the measured signals can detect, locate and characterize a rail damage before it reaches critical size. This type of system is able to send real time alert for safety issue and anticipate maintenance operations minimizing thus service interruptions.

We present here the recent development, in a collaboration between CEA, UGE (formerly IFSTTAR) and Alstom, of guided waves based rail-monitoring system composed of permanent piezoelectric transducers placed every kilometers on the rail and driven by electronic nodes. This system relies on the generic PEGASE motherboard developed by UGE and its GPS-based time synchronization solution that ensures that distant electronic nodes share a common clock with an accuracy below tenths of nanoseconds, sufficient to capture guided waves phenomena.

A specific daughter board able to drive up to 8 ultrasonic transducers in the frequency range of 10 – 200 kHz has been specifically designed for the node. It includes an FPGA that ensures low-level signal processing of measurements. The local diagnosis of each node are then transmitted to a remote server (using wireless protocols such as WiFi or 3G/4G depending on the application) that aggregates the information coming from the different nodes and send an alarm in case of rail damage detection.

The presentation will describe the global SHM system (ultrasonic node and remote server operation) developed for rail monitoring and on-field applications of the solution.