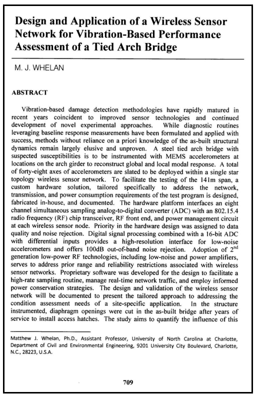

Design and Application of a Wireless Sensor Network for Vibration-Based Performance Assessment of a Tied Arch Bridge

M. J. WHELAN

ABSTRACT

Vibration-based damage detection methodologies have rapidly matured in recent years coincident to improved sensor technologies and continued development of novel experimental approaches. While diagnostic routines leveraging baseline response measurements have been formulated and applied with success, methods without reliance on a priori knowledge of the as-built structural dynamics remain largely elusive and unproven. A steel tied arch bridge with suspected susceptibilities is to be instrumented with MEMS accelerometers at locations on the arch girder to reconstruct global and local modal response. A total of forty-eight axes of accelerometers are slated to be deployed within a single star topology wireless sensor network. To facilitate the testing of the 141m span, a custom hardware solution, tailored specifically to address the network, transmission, and power consumption requirements of the test program is designed, fabricated in-house, and documented. The hardware platform interfaces an eight channel simultaneous sampling analog-to-digital converter (ADC) with an 802.15.4 radio frequency (RF) chip transceiver, RF front end, and power management circuit at each wireless sensor node. Priority in the hardware design was assigned to data quality and noise rejection. Digital signal processing combined with a 16-bit ADC with differential inputs provides a high-resolution interface for low-noise accelerometers and offers 100dB out-of-band noise rejection. Adoption of 2nd generation low-power RF technologies, including low-noise and power amplifiers, serves to address prior range and reliability restrictions associated with wireless sensor networks. Proprietary software was developed for the design to facilitate a high-rate sampling routine, manage real-time network traffic, and employ informed power conservation strategies. The design and validation of the wireless sensor network will be documented to present the tailored approach to addressing the condition assessment needs of a site-specific application. In the structure instrumented, diaphragm openings were cut in the as-built bridge after years of service to install access hatches. The study aims to quantify the influence of this

Matthew J. Whelan, Ph.D., Assistant Professor, University of North Carolina at Charlotte, Department of Civil and Environmental Engineering, 9201 University City Boulevard, Charlotte, N.C., 28223, U.S.A.

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M.J. Whelan

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Ключевые слова:

Содержание.

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