SHA State Highway Administration
Maryland Department of Transportation

Research Project: SP109B4M
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RESEARCH SUMMARY

LOW COST STRUCTURAL HEALTH MONITORING OF BRIDGES USING WIRELESS SENSORS

Problem

Structural health monitoring is critical to protecting bridges against aging, failures, and potentially collapse. However, instrumentiation techniques suffer from non-scalability due to the high cost of instrumentation devices and installation, and potentially high maintenance costs. While manual inspections of bridges help, they may not provide enough information to prevent catastrophic failures.

Objective

The objective of this project was to develop and test a cost effective and scalable solution for the real time monitoring of bridges for strain, tilt and inclination, temperature, moisture and humity, pressure, and crack activity and growth. The solution developed and studied as a part of this project, is based on Active RF Test (ART) technology which incorporates novel sensing, energy harvesting, and wireless communication technologies into a wireless and batteryless sensor.

Description

As a part of this project, SHA selected a bridge on I-495 over Northwest Branch in Montgomery County, Maryland, to install and test the sensors. The bridge is a large steel truss structure that was built in 1957 and poses difficulties to human inspectors. The sensors have been tested on this bridge to monitor strain and movement of rocker bearings for over a year and have showed a number of interesting results. During rehabilitation work in 2011, there were numerous instances where the system detected sudden shifts or increases in strain readouts. The changes were due to heavy machinery on the bridge, which was determined to be normal. However, under normal conditions when bridge work is not being done, this would have been a warning sign for a potential issue with this structure.

The research team anticipates that each sensor will have a minimum life cycle of 20 years and could last up to 30 years or more. It is also important to note that the sensors are not intended to replace human inspectors rather, they will help track changes in the condition of a structure between inspections.

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Results

The results of this project show that the sensors are able to reliably transmit data and that it is feasible to use them for real time remote monitoring in a cost effective way. The sensors are also lightweight (20-25 g), small (1.3inx3.5inx1.3in), and self adhesive. The average installation time is 1-2 minutes per sensor and the current production cost is about $150-$200 per device. Should the sensors be manufactured in high volumes, the cost is projected to drop below $50 per device.

SHA is interested in testing the sensors on additional structures in the summer of 2012 and in exploring other potential uses for the technology including monitoring scour, chlorides, crack activity, correct operation of rocker bearings, displacement, etc.

Report Information

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