Transportation Consortium of South Central States

Development of a Self-Powered Structural Health Monitoring System for Transportation Infrastructure

Key Points

Project Number:
17PTAM03

Start Date:
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End Date:
11/08/2018

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Texas A&M University

Funds Requested to UTC:
$109,000

Funding Source(s):
Tran-SET
Texas A&M University
University of Texas at San Antonio

Total Project Cost:
$218,000

Brief Project Description

Early detection of critical transportation infrastructure needs by monitoring their structural health will enable transportation agencies to opt for low-cost preservation treatments to decrease the life-cycle cost of transportation infrastructure and reduce the financial resources necessary for its rehabilitation and reconstruction. Therefore, the purpose of this project is to develop a self-powered structural health monitoring system to improve durability and to extend the life of transportation infrastructure such as pavements, such that the existing transportation system is preserved.

Problem Statement

Roadways are one of the major civil infrastructures that play an important role in raising the economic impact of societies through connecting commerce and moving people. However, with the economic growth and expanding roadways to support the population expansion, the number of vehicles is sharply increasing. This is expected to cause more congestions and therefore more loss of lives, higher crash rates, and rapid deteriorating of transportation facilities. There is a pressing need to enable smart transportation networks through integrating sensing and monitoring technologies on the transportation infrastructure assets. This technology will enable traffic management units and roadway authorities to be well informed to make safer, coordinated, and smarter decisions for the transportation networks. This study aims to explore, develop, and implement state-of-the-art techniques to scavenge available unused thermal or mechanical energy in roadways and utilize it in innovative new applications to improve sustainability and safety of transportation systems.

Objective

The goal of the project is to develop a self-powered structural health monitoring system to improve durability and to extend the life of transportation infrastructure such as pavements, such that the existing transportation system is preserved. This technology is especially attractive for remote or rural areas where there is no roadside access to the electric power grid (i.e., this encompasses about 70% of the roadway network in Texas, which is heavily used for fossil fuel and agricultural production).

Intended Implementation of Research

Technology Transfer

The dissemination of research results is critical to the success of this project. The objectives of the dissemination plan is to advance state of the art for researchers, professionals, practitioners, end-users and students, train engineers and stakeholders to advance their knowledge and promote study findings for future implementation and commercialization. In addition, the study team will present the research methodology and findings in peer-reviewed top journals in respective fields of study such as; the ASCE Journal of Transportation, Journal of Energy Harvesting, Journal of Intelligent Transportation Systems, IEEE Transactions on Intelligent Transportation Systems and alike.

Education, Workforce Development, and Outreach

The following activities will be planned to support Tran-SET's initiative for education, workforce development, and outreach:

- Offer summer research experiences for undergraduate students at university campuses;
- Support two fully funded graduate students at each institution to assist in the research activities.
- Present study activities in class lectures, graduate presentations classes, and laboratory demonstration sessions.
- Organize training workshops to stakeholders, such as traffic management controllers, road and transport authority, public transit authority, ministry of transport, local governments and general public. The workshop will provide module demonstration, and hands-on training on module operation.
- Present the research findings in international meetings, symposiums and conferences such as the annual meeting of the Transportation Research Board, IEEE, ASCE and ASME sponsored conferences and International Conferences on Roads. The team is actively engaged in conferences organizations and participation in their perspective research field in materials science, and electrical and civil engineering.
- Utilize the current webinars sponsored by ASCE and other UTCs to reach vast majority of researchers around the world, share knowledge on the subject, and solicit input from the research community. Efforts will be made to present the study with TRB webinars, ASCE webinar series and IRF a-learning webinars.
- Present the research findings to the general public via local newspapers, newsletters and TRAN-SET website.

Anticipated Impacts/Benefits of Implementation

Early-detection of critical transportation infrastructure needs by monitoring their structural health will enable transportation agencies to opt for low-cost preservation treatments to decrease the life-cycle cost of transportation infrastructure and reduce the financial resources necessary for its rehabilitation and reconstruction. Developing and implementing this technology will support workforce development in the manufacturing, installation and operation of these sensors in roadways. Furthermore, it will provide training of students involved in the research activities and will educate future engineers in working in multidisciplinary groups to address transportation challenges. Main impacts of the project can be listed as follows:

1. Enhance the structural and surface conditions of rural infrastructure through continuous monitoring and early damage detection.

2. Traffic monitoring in remote areas not served by the electrical grid will enable wide-spread pavement monitoring and improve safety.
3. Develop maintenance-free sensors will result in cost-effective maintenance of these infrastructure in metropolitan and rural areas.
4. Bring together researchers from a multitude of engineering fields including civil, electrical and materials to develop, test and implement these sensors in roadways.

Weblinks:

- Tran-SET's website (http://transet.lsu.edu/completed-research/)
- TRB's Research in Progress (RIP) database (https://rip.trb.org/view/1467481)