Application of Sensor Networks to Intelligent Transportation Systems

by

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Electrical & Computing Engineering Department
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Abstract

The objective of the research performed is the application of wireless sensor networks to intelligent transportation infrastructures, with the aim of increasing their dependability and improving the efficacy of data collection and utilization. Examples include health monitoring of bridges, flood level detection, and other applications of real-time data collection and analysis. This project will enable modeling, prediction, and improvement of trustworthiness for a variety of transportation infrastructures. In collaboration with the Center for Infrastructure Engineering Studies (CIES), a prototype of a base station with data acquisition and long range communication capabilities has been developed. The current application is the measurement of water levels for low-water bridges, and the prototype will be deployed by MoDOT in the immediate future. The research is directly tied to embedded computing (which is the subject of a course previously taught by the principal investigator) and to digital network communications (a new course developed and recently taught by the principal investigator). Three graduate students, one of whom is funded by the UTC, and two undergraduates are involved in the research. Planned future activities include collaboration with service learning activities at Missouri S&T, as well as the National Engineering Projects in Community Service (EPICS) program.
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ABSTRACT

The objective of the research performed is the application of wireless sensor networks to intelligent transportation infrastructures, with the aim of increasing their dependability and improving the efficacy of data collection and utilization. Examples include health monitoring of bridges, flood level detection, and other applications of real-time data collection and analysis. This project will enable modeling, prediction, and improvement of trustworthiness for a variety of transportation infrastructures. In collaboration with the Center for Infrastructure Engineering Studies (CIES), a prototype of a base station with data acquisition and long range communication capabilities has been developed. The current application is the measurement of water levels for low-water bridges, and the prototype will be deployed by MoDOT in the immediate future. The research is directly tied to embedded computing (which is the subject of a course previously taught by the principal investigator) and to digital network communications (a new course developed and recently taught by the principal investigator). Three graduate students, one of whom is funded by the UTC, and two undergraduates are involved in the research. Planned future activities include collaboration with service learning activities at Missouri S&T, as well as the National Engineering Projects in Community Service (EPICS) program.

(1) Teaching – new courses developed; existing courses modified; lecture materials added or updated; labs added or updated and how the additions, modifications, updated, etc related to transportation issues

1. I developed a new course on Network Performance Analysis and Modeling (CpE/CS 401), which I am teaching for the first time in Fall 2009. A number of the examples and case studies presented relate to analysis of transportation networks.

2. I have taught Digital Network Design (CpE 319, distance course) in FS06, SP07, SP08, FS08, and SP09. Examples presented in class include the design of short- and long-range communication infrastructure for structural health monitoring.

3. I have taught Digital Systems Design (CpE 213) in S04, FS05, and FS08. Examples presented in class and homework assigned include the design of an embedded system for structural health monitoring.

4. I taught Introduction to Computer Engineering (CpE 111) in FS07. Examples and assignments included logic design for flood detection systems and traffic signals.
Research – proposals submitted / awarded / pending, including agency and 2-3 line synopsis of work proposed / performed and how it relates to transportation issues; journal articles published / accepted / submitted based on your work under these awards related to transportation issues; conference proceedings published / papers presented and seminars given based on your work as related to transportation issues

Grants awarded:

1. Evaluating and improving the utility of software in the analysis of electromagnetic immunity problems, $120,000, Samsung, 10/2009-9/2010. (Application of research results from the development of an embedded system for structural health monitoring)


Proposals pending:
CAREER: Building a qualitative and quantitative understanding of dependability in cyber-physical systems, $447,205 over 5 years, submitted July 2009, NSF. (Transportation infrastructures are one domain being analyzed)

**Proposals not awarded:**

1. Enhancing problem solving ability using computers for STEM disciplines, $199,375 over 3 years, submitted May 2009, NSF. (Transportation is one of the domains used as an example for problem-solving)

2. Information and system assurance of critical infrastructures, $1,775,447 over 4 years, submitted Dec. 2008, NSF.

3. Interdisciplinary Fellowship Program in Doctoral Education in Large-Scale Pervasive Systems, $846,559 over 3 years, submitted May 2009, Department of Education.

4. IGERT-Collaborative Pre-Proposal: A Doctoral Program in Pervasive Computing and Security for Critical Infrastructure Monitoring, O($1M) over 5 years, submitted Apr. 2008, NSF. (Transportation infrastructure is one domain analyzed)


6. EFRI Pre-proposal: ARACHNID Initiative for Enhanced Resilience and Sustainability of Weakly-coupled Communication and Transportation Infrastructures, $1,990,743 over 4 years, submitted Oct. 2007, NSF.

7. CI-TEAM Implementation Project: Information and System Assurance of Critical Infrastructures, $956,105 over 4 years, submitted August 2007, NSF.


9. Real-Time Monitoring of Bridge Scouring with Distributed Thermal Sensors, $324,379 over 3 years, submitted Feb. 2007, NSF.


**Journal articles:**


Peer-reviewed conference papers:


(3) Service – professional and campus committee memberships, tech transfer activities, etc that are related to transportations issues


2. Organizer and Chair of Special Session on Intelligent Structural Health and Safety Monitoring at the 12th IEEE ITSC, 2009.
