

**A Summary of the 5th Quarterly Report
for the Technical Activities Council**

**Bridge Condition Assessment Using Remote
Sensors**

Michigan Technological University

Cooperative Agreement No. DTOS59-10-H-00001

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EXECUTIVE SUMMARY

This quarterly report documents progress for “*Bridge Condition Assessment Using Remote Sensors*” during the fifth quarter for the period of January 1, 2011 – March 31, 2011. Our Michigan Tech research team is investigating the use of remote sensing technologies to assess the structural health of bridges and provide additional inputs to bridge asset management systems. The project will explore correlations between commonly used inspection techniques and remote sensing systems, and develop a decision support system to combine various inputs to create a unique bridge signature that can be tracked over time.

The primary goals of this project are to:

1. Establish remotely sensed bridge health indicators.
2. Develop a baseline bridge performance metric, the “signature,” for benchmarking overall bridge condition.
3. Provide a system that enhances the ability of state and local bridge engineers to prioritize critical repair and maintenance needs for the nation’s bridges.

The project schedule is shown below with Quarter 5 activities bounded by dashed lines:

ID	Task Name	2010												2011											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Administration	[Task 1: Administration - spans all months from Jan 2010 to Jan 2011]																							
2	Bridge Condition Characterization	[Task 2: Bridge Condition Characterization - spans from Feb 2010 to Oct 2010]																							
3	Commercial Sensor Evaluation	[Task 3: Commercial Sensor Evaluation - spans from Apr 2010 to Sep 2010]																							
4	Decision Support System	[Task 4: Decision Support System - spans from Jul 2010 to Mar 2011]																							
5	Field Demonstration	[Task 5: Field Demonstration - spans from Jan 2011 to Oct 2011]																							
6	Assessment	[Task 6: Assessment - spans from Dec 2011 to Jan 2012]																							

Accomplishments for this quarter are discussed below and include progress on all tasks, and a follow-up to previous quarter concerns highlighted by the program manager, Caesar Singh (Appendix C). As part of the administrative task (Task 1), meetings were held with our Michigan DOT technical partners and the project Technical Advisory Council. In addition, to these project meetings, key project members participated in a dialogue at the TRB Annual Meeting with the University of North Carolina Charlotte project team (*Integrated Remote Sensing and Visualization (IRSV) System for Transportation Infrastructure Operations and Management*), regarding project synergies and collaboration.

Also, according to the Revised Cost Proposal submitted June 26, 2009, and included as Attachment 2 of that cost proposal, the following deliverables were cited for Quarter 5. All technical memos are located on our website http://www.mtri.org/bridgecondition/Tasks_and_Deliverables.html and are discussed in the relevant tasks below.

- ✓ Technical Memorandum No. 15 – update of laboratory investigation, structural modeling, and preliminary sensor response correlation (Task 2.2 and 2.3).
- ✓ Technical Memorandum No. 16 – progress update on integration of bridge health indicators into DSS and development of bridge condition signature (Task 4.5)
- ✓ Technical Memorandum No. 17 – DSS beta version evaluation and summary of DSS capabilities for integrated bridge assessment (Task 4.6 and 4.7).
- ✓ Technical Memorandum No. 18 – update on site selection for field demonstration and preliminary instrumentation plan (Task 5.1).

TECHNICAL STATUS

Progress of each of the six tasks is documented below with references to the Technical Memos which are located at the end of this document.

Task 1: Administration

Several sub-tasks within the administration have been initiated and completed.

The project website continues to be updated: www.mtti.mtu.edu/bridgecondition . This website includes an overview of the project, information related to the project schedule, tasks and deliverables, the decision support system, project team partners, and key links for the project. All presentations, papers and reports are downloadable from our website under the “Tasks & Deliverables” link.

The following presentations were documented for this quarter:

- “Remote Sensing: A New Approach to Assessing the Condition of Our Bridges”, *Roads and Bridges Magazine* (publication pending)
- Updated partner MDOT on “*Bridge Condition Assessment Using Remote Sensors*” at meeting on February 24,2011
- Reported progress of “*Bridge Condition Assessment Using Remote Sensors*” project to Technical Advisory Council on March 3, 2011
- Colin Brooks (MTRI) presented “*Bridge Condition Assessment Using Remote Sensors*” to Michigan Bridge Conference on March 23, 2011 in Big Rapids, MI.
- A project synopsis “*Bridge Condition Assessment Using Remote Sensing Technologies*” was presented to NSBE National Convention Technical Research Exhibition on March 25, 2011 by Renee Oats (MTTI).

The annual project meeting with the program liaisons, Caesar Singh and Vasanth Ganesan, was held on January 21, 2011 at the U.S. DOT office. The meeting included an update on project progress, discussions on budget matters and a discussion of future

activities related to the current project, and additional discussions on future outreach and implementation plans, which were beyond the scope of the current project.

In addition to the annual project meeting, an informal meeting with the University of North Carolina Charlotte project team (*Integrated Remote Sensing and Visualization (IRSV) System for Transportation Infrastructure Operations and Management*) was held to open dialogue related to project synergies and collaboration. The meeting allowed for overviews of both projects and informal discussion of progress and challenges for implementation. The result of the discussions was an offer of information sharing between the two projects and an invitation by the UNCC team for the MTU team to visit and participate in the IRSV National Advisory Committee meeting in Charlotte. Colin Brooks and Devin Harris are slated to attend in May 25-26, 2011.

A meeting was held February 24, 2011 in Ann Arbor, MI with the USDOT RITA research team and partner MDOT for updates and technical feedback on progress to date. The agenda and supporting documents are included as Appendix A.

The second project Technical Advisory Council meeting was also held in Ann Arbor, MI on March 3, 2011. An updated progress report was presented to the members with positive feedback assessed. Supporting documents for the meeting are included in Appendix B.

Task 2: Bridge Condition Characterization

This task consists of several sub-tasks including feasibility studies (through laboratory and small scale field investigation and demonstration) and structural modeling. Progress has been completed on these sub-tasks through several activities.

Previous quarter activities related to Task 2 focused primarily on narrowing down the suite of sensors to be evaluated and performing preliminary assessment of their capabilities. The efforts of Q5 have included a more refined evaluation of these sensor technologies with an emphasis on field application for bridge condition assessment. The sensors/technologies selected for final assessment include:

- Thermal IR
- 3-dimensional optics (including photogrammetry)
- Digital Image Correlation
- Radar –
 - GPR (Ground Penetrating Radar)
 - SAR (Synthetic Aperture Radar)
 - InSAR (Interferometric Synthetic Aperture Radar)
- Electro-optical airborne and satellite remote sensing
- StreetView-style high-resolution digital photography

In addition to the refined sensor assessment, additional focus has been given to how these sensors/technologies will be integrated into the Decision Support System (DSS).

Technical Memorandum No. 15 describes in more detail the laboratory progress, structural modeling and preliminary response correlation with remote sensors as required in tasks 2.2 and 2.3. In addition, **Technical Memorandum No. 16** includes a discussion of how the sensor/technology outputs will be integrated into the DSS.

Task 3: Commercial Sensor Evaluation

The commercial sensor evaluation was completed during Quarter 3 and is documented in the report *An Evaluation of Commercially Available Remote Sensors for Assessing Highway Bridge Condition*. The report can be downloaded from www.mtti.mtu.edu/bridgecondition by clicking on “Tasks and Deliverables” and “Deliverable 3-A”. It continues to inform our study and has served a steady reference during project work.

Task 4: Decision Support System

The development of the Decision Support System has made significant progress in Q5 including the development of a graphical interface and preliminary skeletal framework for data integration and decision making. This preliminary system was presented to both the MDOT project partners and the TAC during their respective meetings for feedback. Following the presentation, a formal discussion was initiated regarding the broader vision of the system and desired features from the end-user. In this discussion participants provided valuable input and prompted the creation of an ad-hoc DSS Focus group tasked with refining the requirements of the system. The first meeting of the DSS Focus group is scheduled for April 18, 2011 in Lansing at the MDOT Construction and Technology Office. Additional details on the progress of the DSS development are presented in **Technical Memorandum No. 16** and **Technical Memorandum No. 17**.

Technical Memorandum No. 16 discusses the integration of bridge health indicators into the decision support system (DSS) and the development of the bridge condition signature per task 4.5.

Technical Memorandum No. 17 explains the DSS beta version evaluation by the Technical Advisory Council through a secure web portal and summarizes the capabilities of the DSS for integrated bridge assessment as required in tasks 4.6 and 4.7.

Task 5: Field Demonstration

Planning for the field demonstration of the remote sensing technologies was initiated in Q5. As part of the planning process, the project team developed preliminary criteria for the two test bridges to be evaluated. This criteria was further refined during the MDOT partner meeting and the TAC meeting. In general, the selection criteria focused on bridges that were representative of the largest population of bridge types that also provided the greatest potential for successful demonstration of the technologies (bridges with the challenges of interest and potential observable with the selected technologies). In addition, the criteria included aspects of safety, economy and scheduling.

Technical Memorandum No. 18 summarizes the site identification for the field demonstration and preliminary field instrumentation plan (task 5.1).

Task 6: Assessment

A preliminary discussion on the assessment task of the project was initiated at the MDOT partner meeting and the TAC meeting. The discussion focused primarily on the challenges associated with the assessment and the inputs required from project partners to allow for a realistic assessment.

PROBLEMS ENCOUNTERED

No technical problems were encountered during this quarter. We will continue to make any problems encountered a focus of the study, including rapid communication with the project sponsor.

FUTURE PLANS

Quarter 6 activities will continue to follow the general schedule outlined within the technical project proposal. Task 1 administrative activities are progressing well. From a technical perspective, the primary focus of the activities in Quarter 6 will continue on with laboratory and modeling of bridge models (Task 2) and continue with field instrumentation installation and field demonstration planning.

Anticipated Activities and Deliverables for Quarter 6 include:

- Further laboratory and modeling progress (full bridge models) and remote sensor correlations (Tasks 2.2, 2.3).
- Field instrumentation installation and calibration, and outlining the field deployment (Task 5.2).

ADVISORY/STEERING COMMITTEE MEETING

Members of the Technical Advisory Committee include:

Steve Cook – Michigan Department of Transportation
C. Douglas Couto – Transportation Research Board
Charles Ishee – Florida Department of Transportation
Michael Johnson – CALTRANS
Dan Johnston – Independent Materials Consultant
Dennis Kolar – The Road Commission for Oakland County
Duane Otter – Transportation Technology Center, Inc.
Keith Ramsey – Texas Department of Transportation
Roger Surdahl – Federal Highway Administration
Peter Sweatman – University of Michigan Transportation Research Institute
Vacant – Federal Highway Administration (FHWA)
Carin Roberts-Wollmann – Virginia Tech
Amy Trahey – Great Lakes Engineering Group

TAC members will be provided with a summary of Quarter 5 activities.

ATTACHMENT Listing – Quarter 5

- Technical Memorandum No. 15 – update of laboratory investigation, structural modeling, and preliminary sensor response correlation
- Technical Memorandum No. 16 – progress update on integration of bridge health indicators into DSS and development of bridge condition signature
- Technical Memorandum No. 17 – DSS beta version evaluation and summary of DSS capabilities for integrated bridge assessment
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- Appendix A – Meeting notes and supporting documentation for MDOT team meeting held on February 24, 2011
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- Appendix C – Memo addressing concerns from 4th Quarter Report and Invoice Review