Michigan Tech
Transportation Institute

Bridge Condition Assessment Using Remote Sensing Technologies

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Project Synopsis

Michigan Tech | CAR | Department of MDOT Transportation

Highlights of Presentation

- Introduction
- Overview of Project Concept
- Critical Tasks Involved
- Bridge Condition Challenges
- Evaluation of Technologies
- Application of Technologies
- Scheme of DSS & Bridge Signature
- Concluding Remarks

Introduction

- Bridges are critical in transportation infrastructure
- Endure various loading conditions and environmental effects
- As of 2010, of the near 600,000 US highway bridges, nearly 11.5% were structurally deficient
- There is a need to continuously monitor these structures using non-destructive processes
- A decision supporting system can be incorporated to ensure bridges receive timely maintenance and repair

The Average U.S. Bridge has received a structural grade of…..


Settlement


Delamination w/ patching

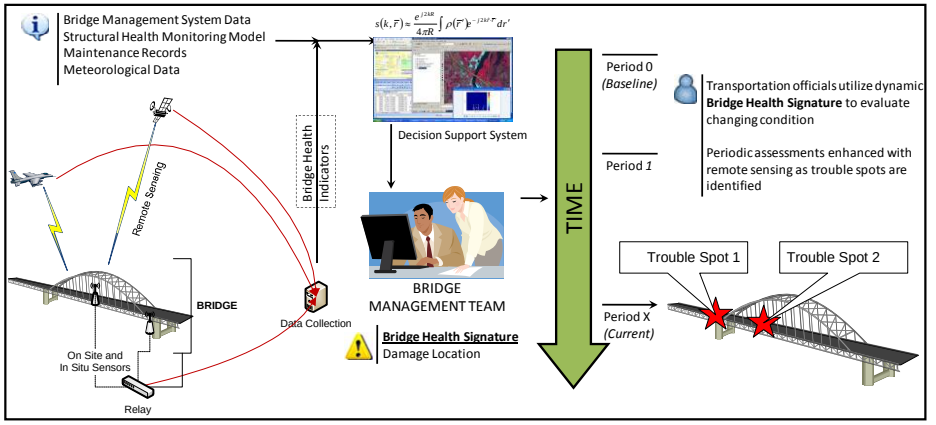

Deck Section Loss


Deteriorated Concrete Element

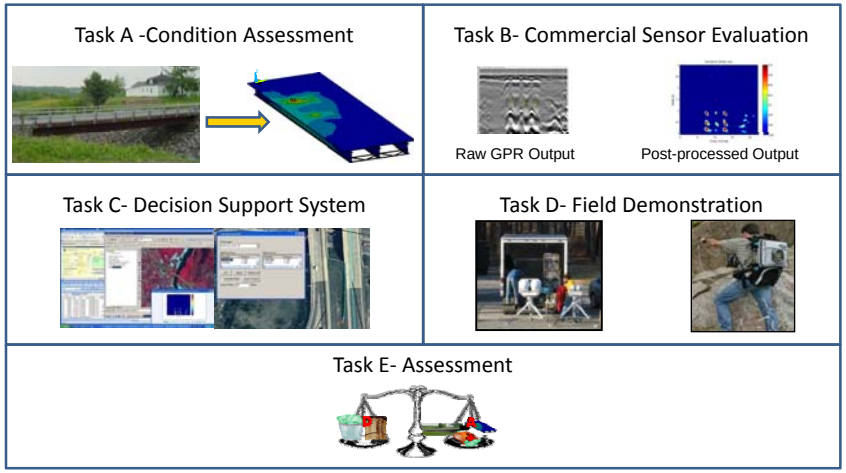
Current Approach for Condition Assessment

- At least every two years, FHWA administers bridge inspections according to National Bridge Inspection Standards
- Visual inspections are a most common practice
- Conventional non-destructive evaluation techniques are implemented; can be costly and require a skilled user
- Address advancing technologies, in particular using commercially available remote sensing techniques in bridge inspections

Project Concept



Critical Tasks



Top Priorities / Challenges

Location	"Top 10" Priorities/Challenges
Deck Surface	Map cracking, Scaling, Spalling, Delaminations (thru surface cracks), Expansion Joint External Issues
Deck Subsurface	Scaling, Spalling, Delaminations , Expansion Joint Internal Issues, Corrosion, Chloride Ingress
Girder Surface	Structural Steel and Structural Concrete Cracking, Paint Condition, Steel or Concrete Section Loss
Girder Subsurface	Structural Concrete Cracking, Concrete Section Loss, Chloride Ingress, Prestress Strand Breakage
Global Metric	Bridge Length, Settlement, Transverse Movement, Vibration, Surface Roughness

Commercial Sensor Evaluation Report

Evaluated twelve RS technologies for Bridge Condition Assessment

Performance criteria:

- ❑Commercial availability
- ❑Sensitivity of measurement: resolution
- ❑Cost: capital, operational
- ❑Ease of pre-collection prep: structure, equip
- ❑Ease of data collection and operation
- ❑Complexity of analysis
- ❑Stand-off distance rating
- ❑Traffic Disruption

Written for consideration of bridge engineers


An Evaluation of Commercially Available Remote Sensors for Assessing Highway Bridge Condition

October 2010

Michigan Tech

CSE Report: Promising Technologies

Further investigated technologies:

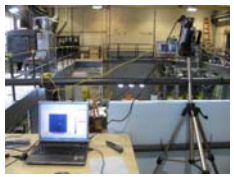
- ➢Radar including SAR and InSAR
- ➢Street-view Style Photography
- ➢3-D Optics including Photogrammetry
- ➢Satellite Imagery and Aerial Photography
- ➢Thermal Infrared (IR) [featured technology]
- ➢Digital Image Correlation [featured technology]

Thermal IR

Definition: Measuring the radiant temperature of the concrete deck by thermal infrared camera (anomalies interrupt the heat transfer through the concrete).

Proposed Application: Locating delaminations and other subsurface defects.

Thermal IR Laboratory Setup

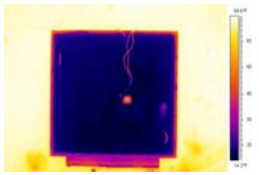


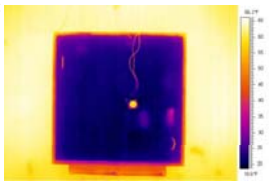
Specimen with simulated defects

10:07

Time-dependent effects

11:27

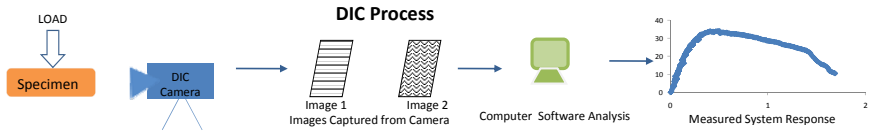


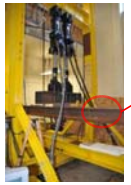


Digital Image Correlation

Definition: Technique consisting of correlating pixels on optical images to determine variations

Proposed Application: Global response (movement, settlement, vibration); 3D models

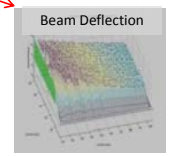


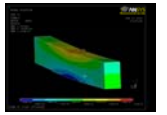


Loaded Steel Beam

Enhanced Tracking Pattern

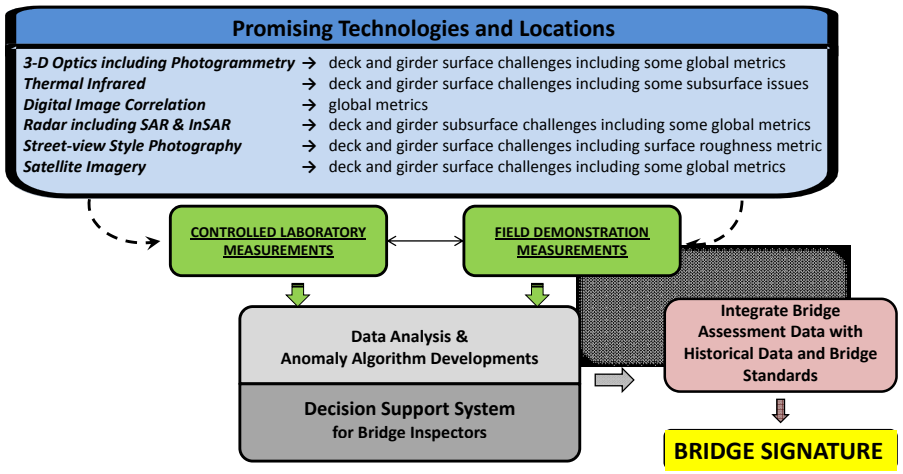
Sample results





Comparisons w/ FEA Models

Scheme of DSS & Bridge Signature



Concluding Remarks

- Further investigated remote sensing technologies shows great feasibility for bridge condition assessment
- Continued laboratory tests and field demonstrations applications for technologies
- An integrated decision support system will be analyze to complement bridge inspection practice
- A comprehensive project review will be completed for total project analysis

Acknowledgements

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  - Michigan Department of Transportation
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Project Team / Disclaimer

- Project Team Members: MTTI + MTRI + CAR

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Thank You!

Questions?…

For more information on this project:
www.mtti.mtu.edu/bridgecondition/