INTEGRATED REMOTE SENSING AND VISUALIZATION (IRSV) SYSTEM FOR TRANSPORTATION INFRASTRUCTURE OPERATIONS AND MANAGEMENT

Project Description and Year I Achievement Report



PROJECT OVERVIEW

- × Project Goals:
 - + 1) to encourage high-level remote sensing technology application to bridge infrastructure monitoring;
 - + 2) to demonstrate such application to industry-wide audience.
- Research objective: to develop an information management and visualization system (IRSV) that integrates CRS-SI for bridge monitoring and maintenance.
- × Target population: Charlotte and Mecklenburg County.
- × Project sponsored by USDOT-RITA.
- × Project manager: Mr. Caesar Singh.



RESEARCH CHALLENGES

- 1. Remote sensing for bridge routine inspection is a new idea other than seismic areas.
- 2. Remote sensing for bridge routine inspection is not common among DOTs.
- 3. What do remote sensors see on a bridge? Depend on the specific CRS technology.
- 4. Geo-referenced large visualization concept for bridge data presentation remains in the research stage.



SOLUTIONS TO RESEARCH CHALLENGES

- 1. Establish multi-variate data structure upon GIS-based visualization platform.
- 2. Use research team and advisory committee to address system-related issues including data fusion, evaluation algorithms, LiDAR data application and visualization.
- 3. Collaborate with CDOT and NCDOT to address remote sensing data interpretation, advanced image processing and bridge management



IRSV SYSTEM

- IRSV: a high-tech bridge data visualization and management system that can be utilized by bridge engineers to better manage their assets via a total viewpoint about their bridges through the benefits of:
 - + remote sensing
 - + geo-referencing
 - + spatial information display





PROJECT OVERVIEW

- * Project partnerships include North Carolina DOT, Charlotte DOT and ImageCat Inc.
- × Project team is split into four key groups:
 - + Structures and GIS
 - + Image Analysis (ImageCat)
 - + Knowledge Modeling
 - + Visualization



IRSV PARTNERSHIPS



PHASE I TASKS

- 1. Database design and development (partial)
- 2. Domain data collection (partial)
- 3. Infrastructure Characterization (partial)
- 4. Modeling integrate remote sensing, bridge data and GIS data (partial)
- 5. Visualization transitioning AMPISTM into bridge image analysis and large scale visualization (partial)

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- 6. Protocols image data fusion/access control (partial)
- 7. Meetings

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- 8. Final Report and Deliverables
- 9. Formation of advisory committee (additional/partial)
- 10. Demonstration project in California (additional)

Information

11. Bridge scan at other states (additional)

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ImageCat, Inc.™

PROJECT TIMELINE AND PHASE I DELIVERABLES

- **×** Two-phase approach for a duration of four years:
 - + Phase I: System establishment: The research will integrate existing GIS information and bridge structure management with minimal system development and sensing construction to establish an operational visualization platform.
 - × Goal: IRSV concept demonstration using developed prototype (TRL 1-4)
 - + Phase II: System operation/commercialization: Since NCDOT and CDOT will be involved in the early developmental stages – when the IRSV system is established – the system can be operated by each agency for demonstration and subsequent performance enhancement.
 - × Goal: System development and commercialization (TRL 4-8)



ORIGINAL PROJECT TIMELINE



MODIFIED PROJECT TIMELINE



STRUCTURE GROUP OBJECTIVES AND PLAN

- × Data Collection
 - + Remote Sensing data
 - + Bridge Ground Lidar Data
 - + Bridge Data Collection
- × Domain Knowledge Modeling
 - + Establish Domain Knowledge Rationale
- × Remote Sensing Data Analysis
- × LIDAR-based Bridge Defect Analysis (LBDA)
- × Infra-red (thermal) Imaging



IMAGECAT OBJECTIVES AND PLAN

Objectives:

- 1) Refine and adapt AMPIS (Automated Management Pavement Inspection System) to bridge deck surfaces for ground-truth, and
- □ 2) link AMPIS with the UNCC-IRSV system
- Plan: Create a set of test cases that can be used to calibrate and validate AMPIS results to bridge decks and work closely with IRSV team to fully define interface requirements between both systems



KNOWLEDGE MODELING GROUP OBJECTIVES AND PLAN

To support bridge managers with knowledge-based decision making

- + Ontology provides formal description of concepts, properties, and interdependencies.
 - Problem Domain Ontology (PDO) enables complex problem solving where underlying domain concepts provide collective understanding of data based on multidimensional resources
- + PDO provides knowledge models for effective analytical problem solving
- To provide a scalable and adaptable platform support solution for all system components to share common knowledge and understanding
 - + Support interoperability, scalability and adaptability to facilitate heterogeneous data requirements, operational requirements and overlapping functionalities
 - + Compose meaningful set of services that support other system components' needs
 - + Knowledge services can mediate between various system components and processes



VISUALIZATION GROUP OBJECTIVES AND PLAN

- × Create a visualization framework that allows:
 - + Exploration and analysis of bridges of interest.
 - + Connection to the knowledge ontology and incorporate its capabilities in a uniform manner.
- × Design Principles:
 - + Multiple coordinated/Geo-referenced visualizations provide different perspectives to the bridge data.
 - + Highly interactive viewing allow seamless transition from overviews to detailed examination.



VISUALIZATION: CENTER OF INTEGRATION



SUMMARY OF YEAR 1 ACHIEVEMENTS

- + Collect Lidar scan data/develop LBDA (structure) Task 1
- + Collect bridge inspection reports and database for all bridges in Charlotte and Mecklenburg (Garland, Jimmy and structure) Task 2
- + Characterizing bridge management procedures and establish data attribute schema (Garland, Jimmy, knowledge modeling and structure) Task 3
- + Modify AMPIS including map interface enhancement, TIGER street data import, image processing enhancement and user-interface improvements (ImageCat) Task 5
- + Test bridges image capture and study (ImageCat and structure) Task 1
- × Building Knowledge Structure onthology (knowledge modeling) Task 3
- + Software coding using GenOM for functionalities, Web service framework and knowledge processing (knowledge modeling) Task 3
- + Create data profile for bridges using SQL Server 2005 (knowledge modeling) Task 4
- + Establish multi-screen assemblage for large-scale data visualization (visualization) Task 5
- + Establish IRSV visualization system architecture (visualization) Task 5
- + Establish different viewing method for data display and geo-spatial correlations (visualization) Task 5

