



# Evaluating the Use of Unmanned Aerial Systems (UAS) for Transportation Purposes



# **Non-Destructive Evaluation of Bridge Decks at Highway Speeds**

## **2013 Evaluate Deck Surface Deficiencies at Highway Speeds**

Project Included:

- 57 Bridge Decks
  - 49 Evaluated with GPR
  - 12 Evaluated with IR

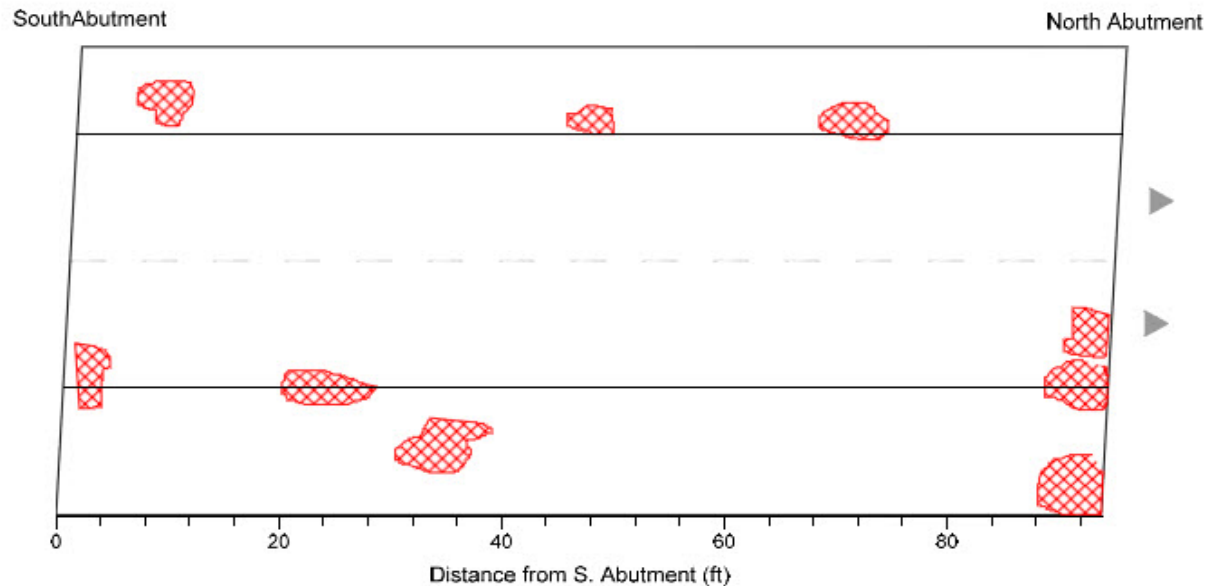
Verification of Data By Hand Soundings:

- 4 Bridge Decks
  - Evaluated with Chain Drag
- Hoping to Sound 4 More, but MoT is Difficult


# NB US-31 over Matthew Road

Infrared Scanning Found 172.8 sft delamination

Chain Drag Soundings Found 0 sft delamination



Deficiencies	Area (ft <sup>2</sup> )	%
GPR	-	-
IR	172.8	3.9
Concrete Patch	-	-

 Delamination / debonding detected by Infrared Thermography



► Direction of traffic

## Bridge Deck Condition Evaluation

Bridge ID: 12750  
US-31 NB over Matthew Road

Analyzed by: AJC  
Checked by: KRM

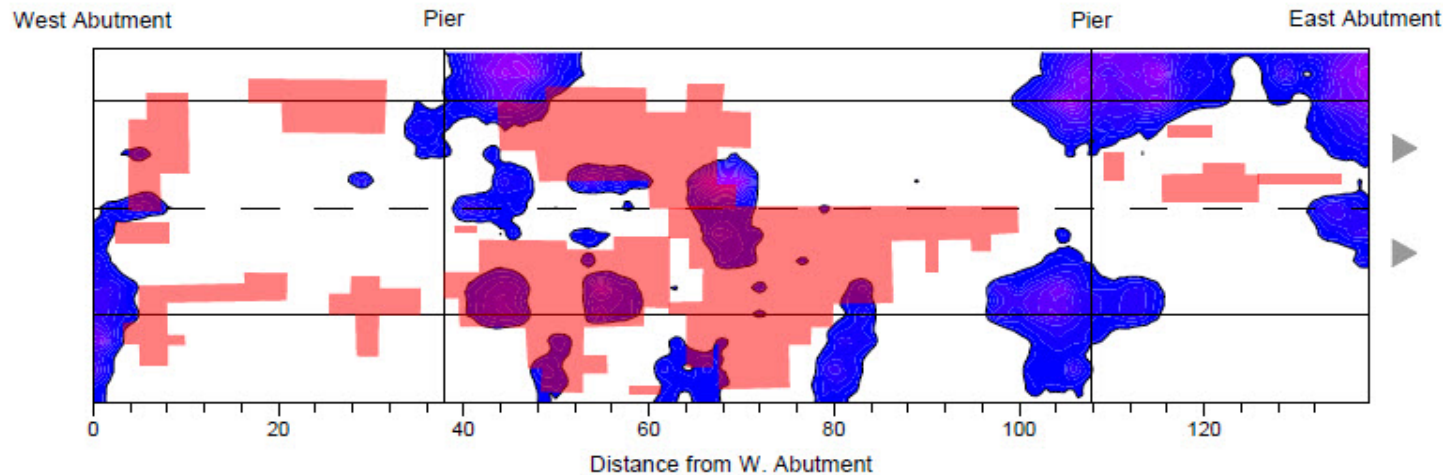
Date: 10/17/13  
Date: 10/18/13

**INFRASENSE, Inc.** 

Sheet: 1 of 1

# SB US-131 BR over Douglas Avenue

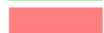
GPR Scanning Found 1,083 sft delamination  
Chain Drag Soundings Found 1,373 sft delamination



Deficiencies	Area (ft <sup>2</sup> )	%
GPR	1083.1	19.7
IR	-	-
Concrete Patch	0.0	0.0
Sounding	1377	24.9



Concrete Patching



Sounding 10/29/14

Deterioration detected with GPR



Increasing severity -->



► Direction of traffic

## Bridge Deck Condition Evaluation

Bridge ID: 4608  
US-131 SB over Douglas Avenue

Analyzed by: AJC  
Checked by: KRM

Date: 10/24/13  
Date: 10/25/13

**INFRASENSE, Inc.**

Sheet: 1 of 1



# **Non-Destructive Evaluation of Bridge Decks at Highway Speeds**

## **Summary**

- Too small of a data set verified to make conclusion
- However, so far data does not seem to correlate well based on quantity and location of deficiencies

# **UAS Benefits for Transportation**

- **Safety:** removes workers (inspectors, etc.) from the roadway that may otherwise expose themselves to traffic
- **Mobility:** reduces congestion and user delay by minimizing the potential of a lane closure needed for conventional human based inspections
- **Efficiency:** quickly assess (within seconds) an asset/operations with potentially higher quality resolution data than achieved by current inspection methods
- **Legacy Liability:** can replace conventional assets along the network needed to support cameras, monitoring devices, etc.
- **Economic Development:** supports state of Michigan companies and universities developing UAS platforms and sensory technologies

# **MDOT Research - Evaluate the Use of UAS for Transportation Purposes**

- Demonstrate how technology can provide aerial inspections for infrastructure assets
  - Roadway Assets
    - Bridges, lighting, signs, guardrail, etc.
  - Confined spaces
    - Pump stations (environmental assessment & physical conditions)
    - Entrances to sewers and culverts
- Demonstrate optical and thermal infrared technologies use to evaluate surface and structural integrity of bridge elements
- Demonstrate how a Light Detection And Ranging (LiDAR) sensor can be used to rapidly assess and inspect transportation infrastructure
- Demonstrate UAV use for monitoring traffic operations

# UAV Platforms

- **Bergen Hexacopter (\$5,400)**
  - payload 12 lbs
  - 20 minute flight time
  - auto-pilot system able to fly programmed waypoints
- **Mid-sized UAV – Phantom (\$800)**
  - 3 lbs payload
  - 25 minute flight time
- **Micro UAV (\$150)**
  - 7-15 minute flight time
  - micro-camera payload
- **Blimp (\$1,000)**
  - 16 ft long blimp 3.5 lbs payload
  - long periods of time in flight



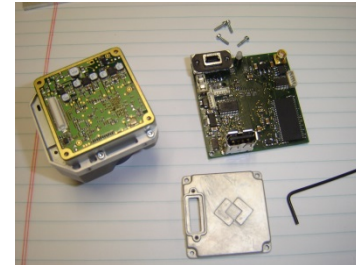


# UAV Sensors

- Optical (\$3,000 w/ \$400 lens - \$3,400)
  - characterize surface defects, generate a photo inventory w/ 3D resolution down to 1cm at 100 ft. - wt: 4 lbs
- Thermal Infrared (\$4,000)
  - detection of subsurface defects such as concrete delaminations on bridges wt: 1 lb
- LiDAR (\$6,300)
  - creates 3D point clouds of surfaces wt: 1 lb



Optical Camera

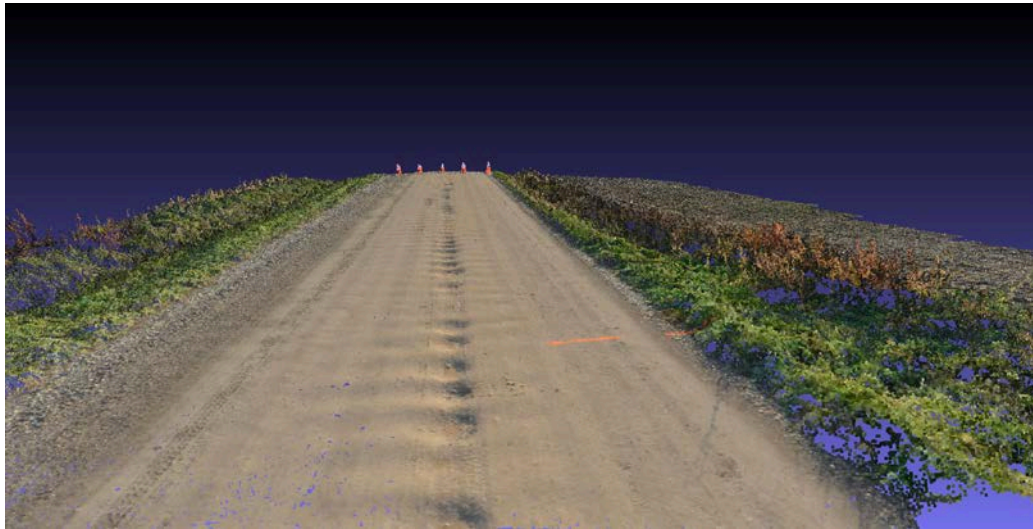


Thermal Infrared Camera



LiDAR Scanner

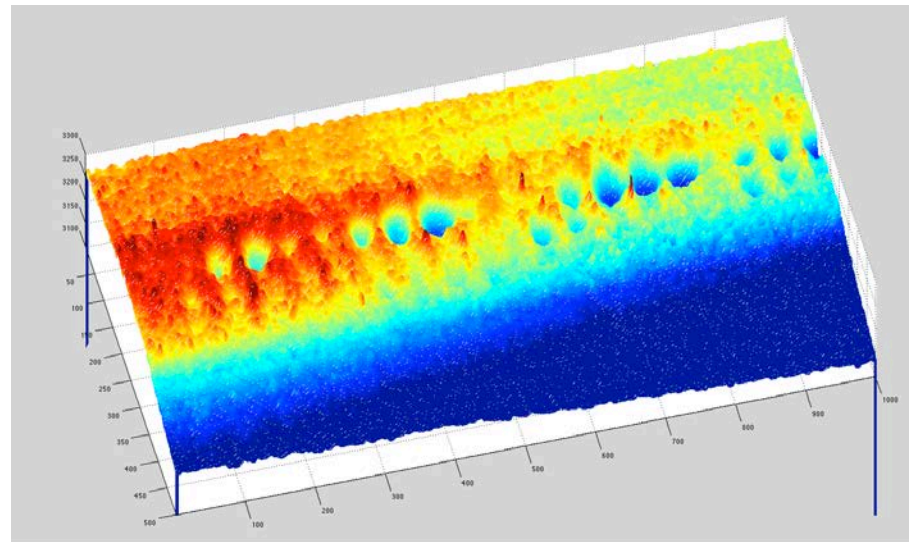
# Mapping Condition State of Unpaved Roads



3D point cloud of an unpaved road generated using image reconstruction



Aerial photo of unpaved road from UAV



3D height field showing potholes on an unpaved road

# Confined Space Inspections

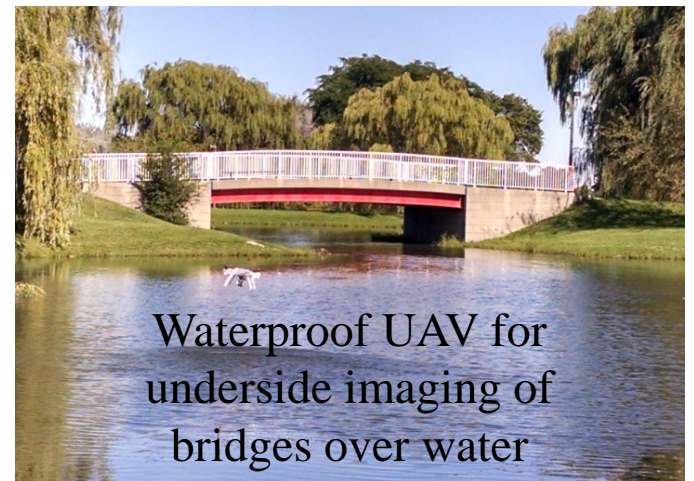
- Capability to fly in confined spaces
  - MDOT Pump Stations
- Is it safe to send a person in?
  - unlit spaces
  - assess environmental condition state (air quality, etc.)
- Successfully tested with live video feed via iPhone





# Traffic Operations

## Construction site imaging





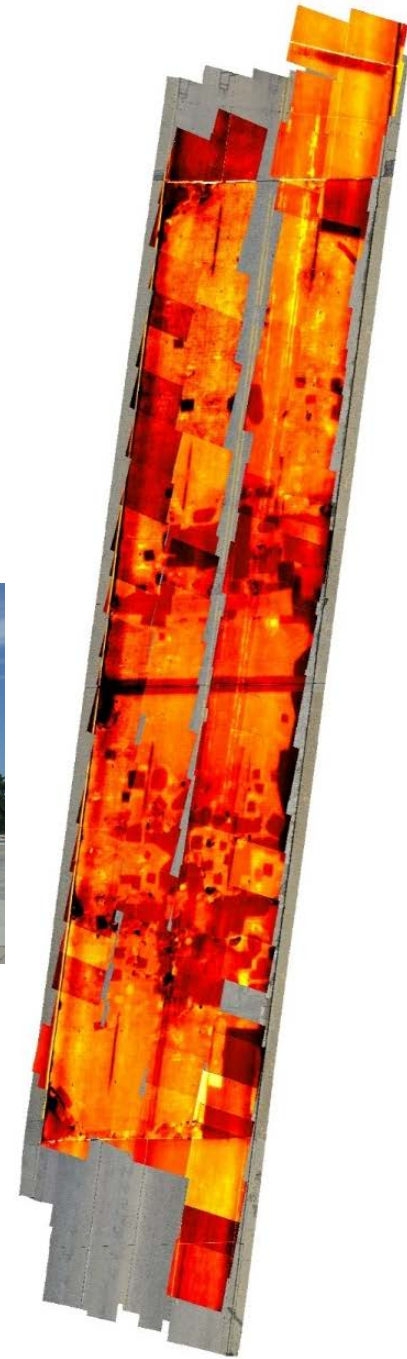
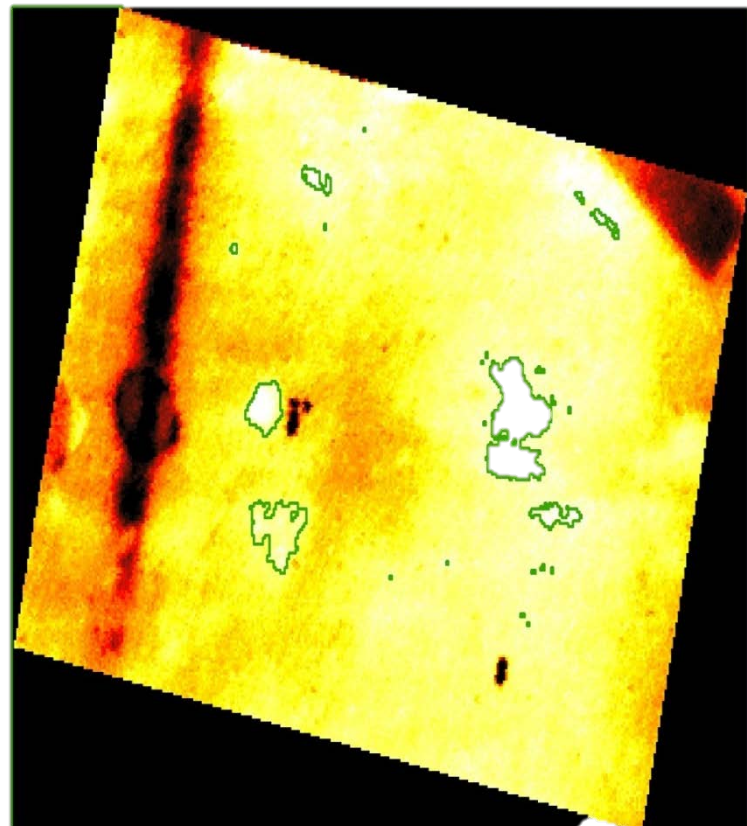
# Non-Destructive Evaluation of Bridge Elements

- Used to detect surface conditions
  - Bridge deck delamination, potholes, cracks, patching, etc.
- Overlapping imagery can be used to generate 3D models to characterized condition state of deck bridge



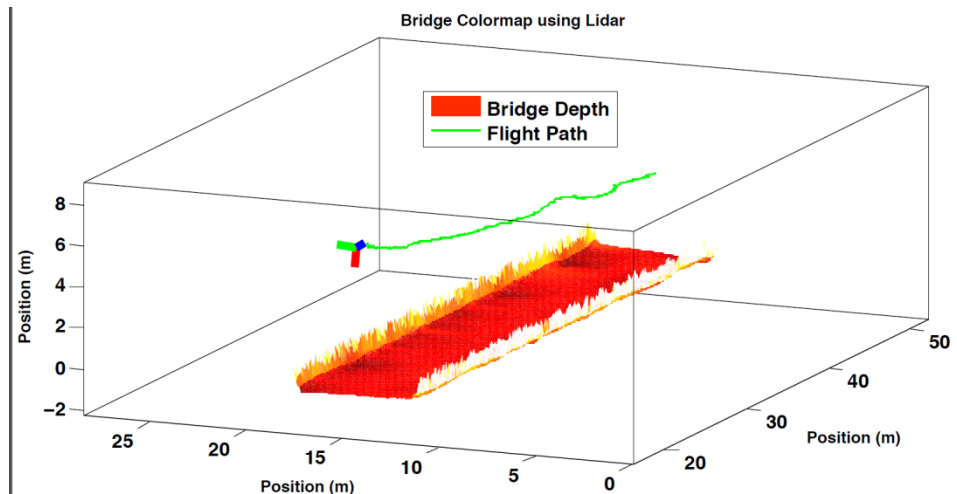
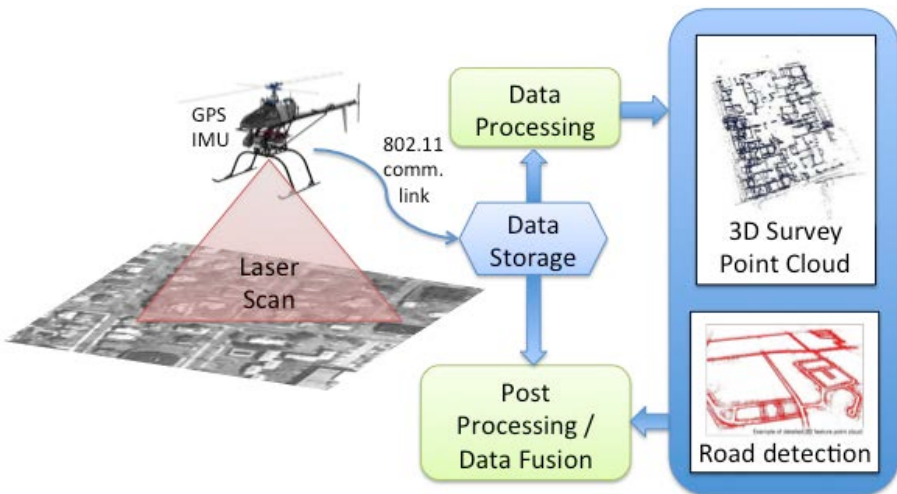
# Aerial Thermal Infrared Scanning

- Detection of subsurface condition
- Infrared imagery automatically detects delamination (left, green polygons)



# LiDAR Scanning for Asset Management

- Goals:
  - Measurement of transportation infrastructure w/ 10cm resolution and 3D models
  - Automated detection of transportation infrastructure (roads, bridges, signs, guardrail, lighting, etc.)





# UAS Demonstration – TIM Crash Reconstruction





# Another Option for Aerial Monitoring of Traffic Operations

## ■ Blimps

- Long flight time – up to several days
- Tethered, lower FAA requirements for flight operations, can operate at night (max 500 ft. line of sight & 5 miles from airports)
- Relatively large open area required for launch and recovery
- Gimbal (gyro) device to stabilize visual display
- Transmit video feed for live viewing

US-23 and Plymouth Road, Ann Arbor,



# **Proposed MDOT UAS Phase II Research (January 2016 to July 2018) Objectives/Deliverables**

1. Develop, deploy, and implement near-time data collection communication backhaul and data storage capabilities proof of concept for the most viable UAV platforms and sensing capabilities
2. Develop, deploy, and implement (via pilot projects) UAV data uses, analysis, and processing systems delivered from on board sensors for two (2) to three (3) specific business functions/activities identified by MDOT
3. Demonstrate, deploy and implement (via pilot projects) data quality protocols to ensure data collected is accurate and within tolerance requirements when compared to current data collection systems at MDOT for the same two (2) to three (3) specific business functions/activities identified by MDOT
4. Provide device/sensory training, deployment/implementation plan, including a user/operation guidance document
5. Determine the return on investment (benefit/cost analysis)
6. Secure an FAA COA



*Thank you!*

