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

<table>
<thead>
<tr>
<th>Deficiencies</th>
<th>Area (ft²)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPR</td>
<td>-</td>
<td>-</td>
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<tr>
<td>IR</td>
<td>172.8</td>
<td>3.9</td>
</tr>
<tr>
<td>Concrete Patch</td>
<td>-</td>
<td>-</td>
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</tbody>
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Delamination / debonding detected by Infrared Thermography

Direction of traffic
SB US-131 BR over Douglas Avenue

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

<table>
<thead>
<tr>
<th>Deficiencies</th>
<th>Area (ft²)</th>
<th>%</th>
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<tbody>
<tr>
<td>GPR</td>
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<td>19.7</td>
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<tr>
<td>IR</td>
<td>-</td>
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<td>Concrete Patch</td>
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<td>Sounding</td>
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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
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

Waterproof UAV for underside imaging of bridges over water
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
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!