ODOT ITS Update- Snowplow Mobile Data Collection Program and Weather Management System

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Motivation

• Snowplow trucks are typically the first responders to snow/ice storm-impacted roadways to improve conditions and enable passenger vehicles to freely travel on cleared roadways.

• Unfortunately, snowplow trucks are poorly equipped to track and report snow/ice cleared roadways, monitor surface road conditions, or amount of sand dispensed per location, etc.

Implementing a mobile data collection using cellular (MDCC) technology aimed at monitoring and reporting road surface conditions, treatments, and improvements to motorists.
MDCC System Components

• Non-contact infrared sensor;
• Mobile Weather station
  – Ambient temp
  – Humidity
  – Barometric Pressure
  – Wind strength/direction
  – Dew point and rainfall;
• Cellphone for real-time communication;
• Cellphone accelerometers/Gyroscopes;
• Truck Extensible Embedded Computing Equipment
  – Sand spreader system
  – Plow pressure;
• Real-time website server for monitoring and communication;
• Database server to received and store collected information.
MDCC System Information

• Cellphone/Tablet:
  Speed/Acceleration  Gyroscope
  Broadband/Bluetooth wireless  location and routes
  Camera images and  incident video recordings

• Mobile RWIS:
  Surface temp  Wind strength/direction
  Ambient temp  Humidity
  Barometric pressure  Dew-point and rainfall

• Truck Extensible Embedded Computing Equip (TEECE):
  Material/Liquid Selection  Plow state (up/Down)
  Auger setting  Plow height above ground (Potential)
  Blast distance  Blast Quantity
  Liquid volume  Spreading distance
MDCC Driver Interface

- Simple Design
- Auto login
- Auto software upgrade
- Minimize Driver interaction
- Local Configuration:
  - Image size
  - Data type
  - Collection frequency
- Connection status update:
  - Online- Connected
  - Offline- No coverage
  - GPS location Acquired
  - Bluetooth connected to TEECE.
- Admin/driver communication messages:
  - Text and audible messages.
  - Video and voice recordings.
- Trip/deployment Type:
  - Construction Vs Snowplow

- System information:
  - Trip time
  - Total Distance
  - Surface Temp
  - Plow position
  - Material Selection
  - Auger setting
  - Sand spread distance
  - Spread rate
MDCC Settings: User Management

- User setup:
  - ID
  - Password
  - Privileges
MDCC Settings: Cellphone/Tablet Management

- Simple cellphone/tablet setup
- Cellphone addition/removal
- Search feature
- Simple tree view
- Cellphone authentication
  - ID
  - Password
  - Unique MAC address
MDCC Settings: Snowplow Truck Management

- Simple truck/cellphone association
- Additional level of potential authentication
MDCC Settings: Data collection

- Remote data settings
- Data collection setting per truck/county/division/all.
- Image size
- Several counters
  - Image
  - Location
  - Sand spreader info
  - Plow position
  - Weather parameters
  - Surface temp
  - Acceleration
  - Gyroscope
Video Processing and Viewing: Event

- Driver communicates back to dispatch via Video recording including voice.
- Recordings are kept in private DB until published by ODOT.
- Search feature per division, county, truck.
Real-Time (RT) Monitoring: Dashboard

- List/search trucks in tree format (All/Divisions/Counties/truck) for ease of accessibility
- Display truck state: Active (green), Inactive (red), and not configured (x).
- Information are updated as it arrives from truck (Pseudo - RT)
- Special display windows: Connection, Communication, and On-Demand.
- Connection shows trucks/cellphone activities.
- Communication allows operator to transmit instructions in text, or request additional information.
- Flexibility of marker display selection.
- Truck status information.
- Automatic map zoom to selected trucks.
RT- Communication: Dashboard

- Unicast (single truck) and broadcast (multiple trucks within a county or division) messages can be transmitted to truck(s).
- On-demand requests can be transmitted for additional information.
RT- Truck Location Monitoring (data/image markers)
RT- Truck Location Monitoring (video marker)
Interactive Data Review & Management

- Rich search features
  - Export data into CSV
  - Map location and routes taken by trucks.
Trip Report

- Interactive database tool
- Data collected per trip.
- Generate a PDF report
Video reviews
Image review
The report includes date, time and GPS location at the moment data are being collected:

- Route location.
- Cellphone gyroscope and acceleration.
- Sand spread information.
- Plow position.
- Weather parameters.
- Surface temperature.
- Distance traveled.
- Truck speed.
Future Software Development

• Incorporate route coloring to indicate past time since last plow or sand application per roadway.
• Improve auto zooming capabilities.
• Incorporate weather status maps into the driver interface.
• Allow search by location, roadway, or highway.
• Implement play back function of historical trips.
Future Big Data and Research Activities

• Develop data mining algorithms to detect hidden patterns.
• Develop truck deployment algorithms to optimize road condition improvements.
• Develop models for dispensing proper (optimal) amount of sand needed to clear and maximize road condition improvement.
• Models to relate road condition improvements (measured by average travel speed increase on a roadway segment) with the amount of dispensed sand, plow trips, materials type, etc.
• Models to relate weather patterns, road surface temperature, materials type, and truck velocity with road condition improvement.
Conclusion

• Transforming snowplow trucks into data collection platforms.
• Improving driving conditions of roadways while enhancing safety of motorists.
• Providing public with RT data and empowering public to make proper driving decisions.
• Reducing materials cost and sand wastefulness.
• Reducing environmental impact of excessive sand application.
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