Pipeline Research Council International, Inc.

PHMSA R&D Forum

PRCI Overview of Projects in Damage Prevention

PRCI Program Manager: Carrie Greaney

Cleveland, OH
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PRCI Membership

- **38 Energy Pipeline Operating Companies**
  - 21 Natural Gas Transmission; 9 Liquid
  - 8 Liquid/Natural Gas

- **3 Pipeline Industry Organization (PIO) Members**
  - Association of Oil Pipe Lines (AOPL)
  - Electric Power Research Institute (EPRI)
  - Operations Technology Development (OTD)

- **37 Associate Members & Technical Program Associate Members**
  - Australia, Canada, China, Europe, Japan, Mexico, U.S.
  - Special Membership – Australian Pipelines & Gas Association (APGA)

- **Worldwide Research Organization**
  - 43 U.S. Companies
  - 35 Non-U.S. (Australia, Brazil, Canada, China, Europe, Japan, Mexico, Saudi Arabia, South Africa)

PRCI — LEADING PIPELINE RESEARCH WORLDWIDE

PRCI Technical Committees

Pipeline TCs

Facilities

| Inspection & Integrity | Surveillance, Operations & Monitoring | Corrosion | Design, Materials & Construction | Compressor & Pump Stations | Measurement | Underground Storage |

ROW-6 On-going Work

ROW-6D/G: DOT OAST-R/RITA Satellite Decision Support System Remote Sensing for Detecting Ground Disturbance

▪ **Objective**: Demonstrate the operations viability of monitoring ground surface movement and third party intrusion along pipeline ROWs from space
  • Creation of online and interactive DSS for
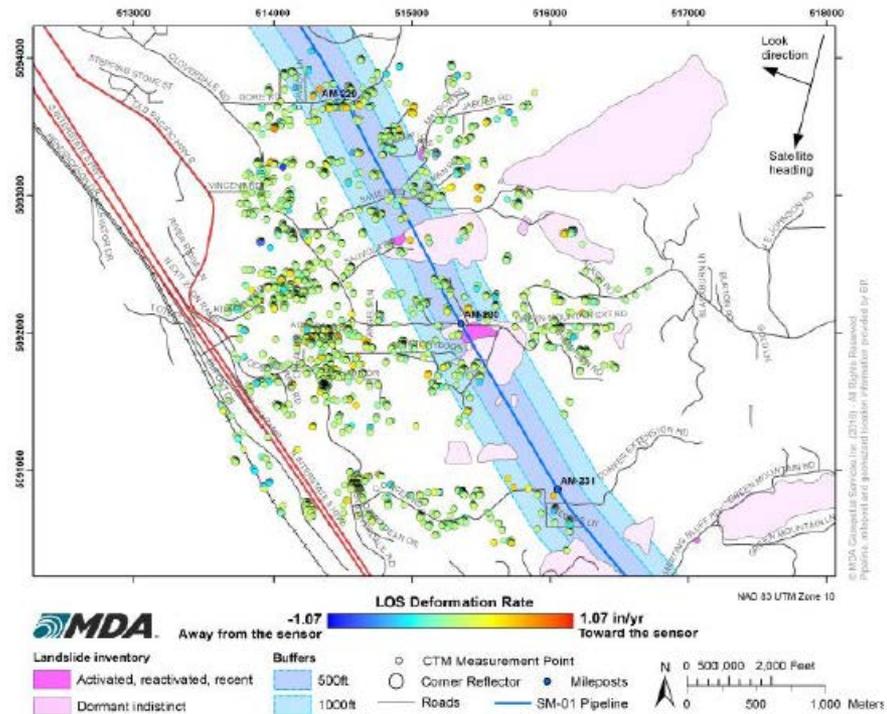 • Collaboration with CalPoly and 2- PRCI projects
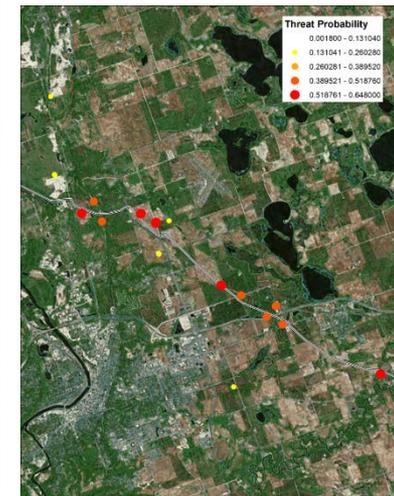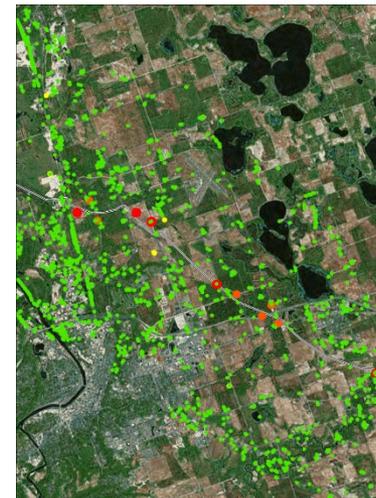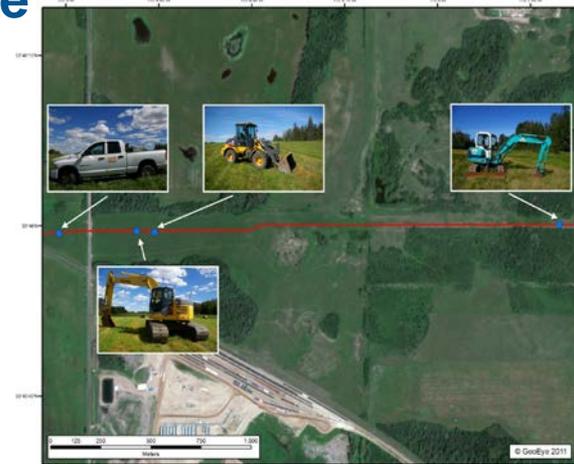
ROW-6 On-going Work

ROW-6D/G: DOT OAST-R/RITA Satellite Decision Support System Remote Sensing for Detecting Ground Disturbance

- **Objective**: Demonstrate Satelitte Remote Sensing for Detecting Ground Disturbance

- *Satellite InSAR and Polarimetric Change Detection Mapping*

- *InSIGHT Online DSS for Geohazard Assessment*

- *Ongoing operational InSAR analysis and deliveries: The CR and point target analyses in both look-directions are updated every 24 days with each RADARSAT-2 image acquisition*

ROW-6 On-going Work

ROW-6D/G: DOT OAST-R/RITA Satellite Decision Support System Remote Sensing for Detecting Ground Disturbance

- **Status**: PRCI portion is complete and awaiting final development of CalPoly DSS system for final data integration. CalPoly is the lead on the project and will be submitting a commercialization/business plan for contingency after completion of the current contract

- **Expected Completion Date** :
- December 2016

ROW-6 On-going Work

ROW-6I : InSAR Detection and Quantification of Pipeline Corridor Movement Induced by Longwall Mining

- **Objective**: Develop methodologies and algorithms to extract ground movement measurements in areas of rapid and substantial movement caused by longwall mining using MDA GSI pioneered Interferometric approaches and Synthetic Aperture RADAR (SAR) data from the RADARSAT-2 satellite program.

- **Status**: Data collection is complete and final
report is being developed for review by the
project team

- **Expected Completion Date** :
December 2016

ROW-3 On-going Work

ROW-3: Right-of-Way Automated Monitoring (RAM) Threat Detection Package

- **Objective**: Development and validation of an integrated hardware/software package to integrate aircraft mounted cameras, sensors, onboard data collection systems, and smart machine vision software
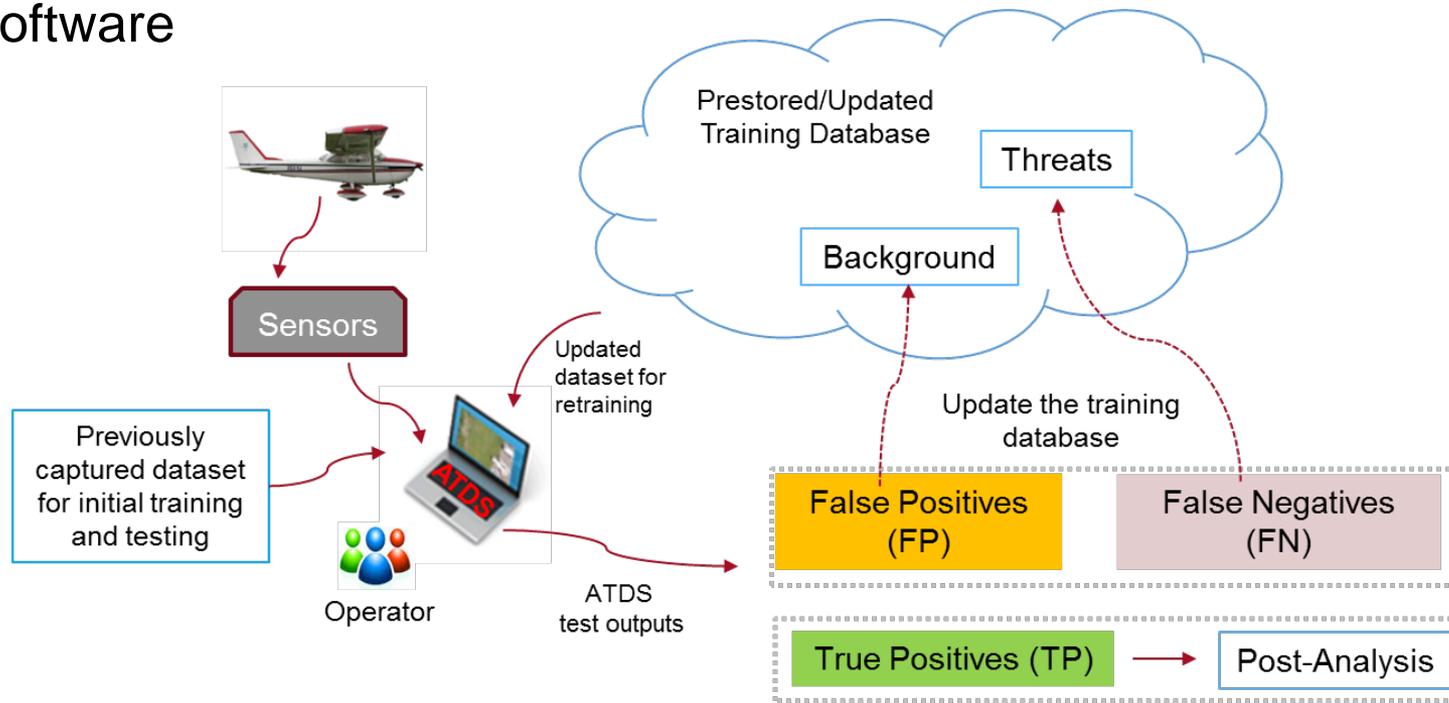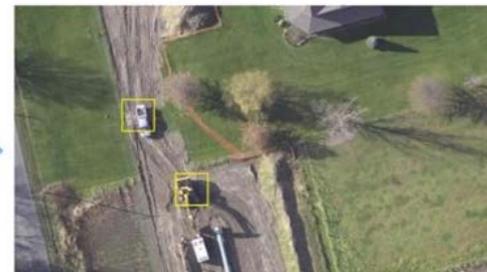
Example Target Detections

Input Raw Image   Detection Output

ATDS Target Detection Accuracy

Statistical Evaluation
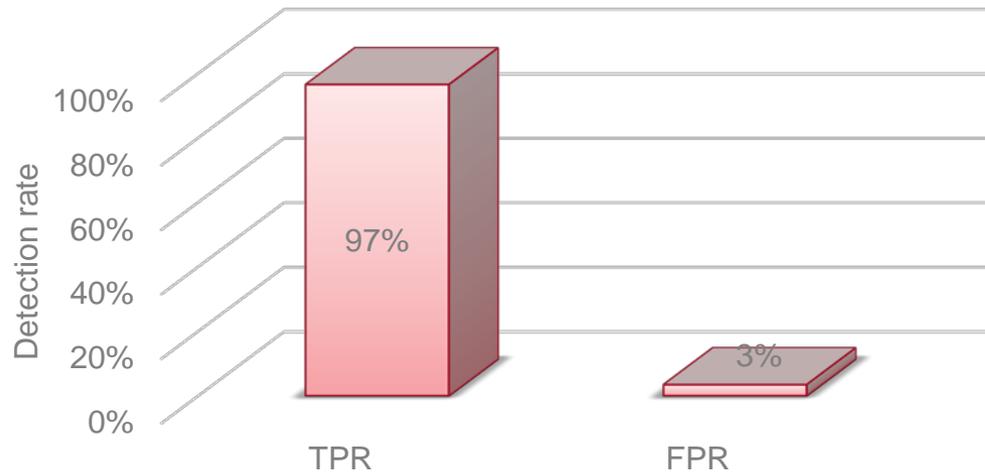
Based on approx. 150 mi. corridor deomonstration

TPR: True Positive Rate (the proportion of actual positives that were correctly classified as positive threat objects in the detected target images).
FPR: False Positive Rate (the proportion of actual negatives that were incorrectly classified as positive threat objects in the total number of detections).

ATDS Technology Package Capabilities

- Threat object detection in aerial imagery.
- Identification of detected objects.
- Automatically generate the geolocations of the detected objects and store in MS Excel.
- Automatic estimation of threat priority.

- Integrated CPU-GPU multi-thread implementation for a near real-time performance.
- Automatically generates a KML file for fast object localization in geographic data in an Earth browser such as Google Earth, Google Maps, etc.

KML file mapping

Detected threats

ATDS Algorithm

Select Shapefile
Start Program
Exit Program
Status
Shapefile selected successfully

Graphical User Interface (GUI)

Threat information in MS Excel File

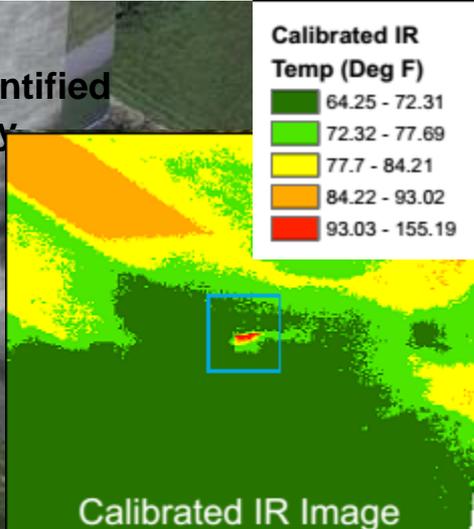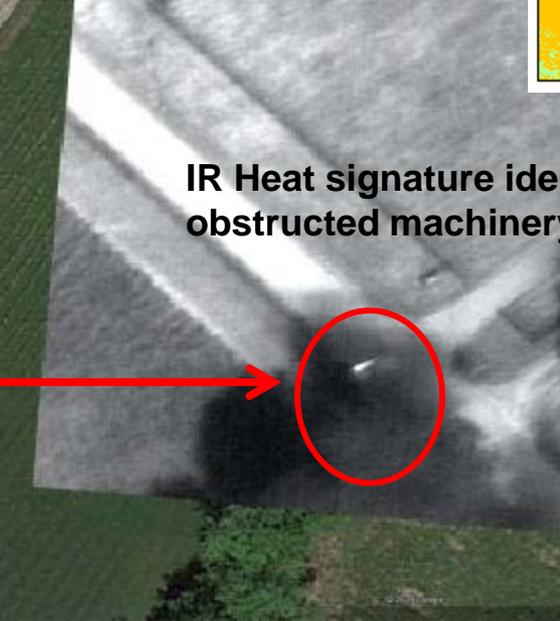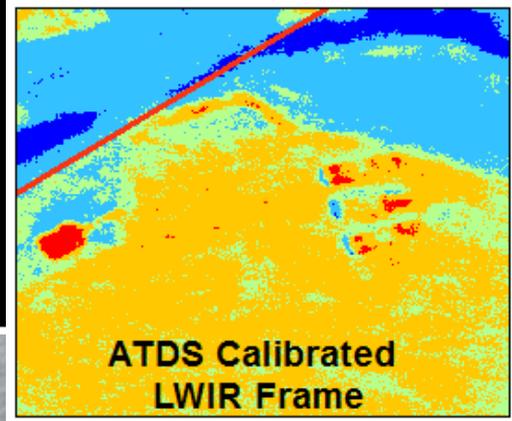| Object_ID for KML (Without Duplicate)	Frame Name (TableName_FolderName_FrameName_SubImage_ThreatPriority)	Latitude (degree)	Longitude (degree)	Distance to Pipeline (feet)	AGL (meters)	Horizontal Pixel Size (inch)	Threat Priority Assessment (1 if the distance is <=50 ft, 2 if: 50< distance <=150 ft, 3 if: distance >150 ft)
1	201409201659_201409201717_1700_1_1	39.6657625	-76.14862371	0	333	2.107	1
2	201409201659_201409201708_1501_2_1	39.66558039	-76.14880742	1.886	333	2.107	1
3	201409201659_201409201703_0501_1_1	39.62040132	-76.29973624	5.771	333	2.107	1
4	201409201659_201409201719_3802_1_1	39.63400127	-76.20810637	7.639	333	2.107	1

ROW-3 On-going Work

ROW-3: Right-of-Way Automated Monitoring (RAM) Threat Detection Package

- **Status**:
  - Completed & Final Report under Review by Project Team
    - ATDS automatically acquires, analyzes, and communicates machinery threats and produces high resolution geo-located visible and calibrated long wave infrared imagery in near real-time
    - ATDS has demonstrated a very high degree of targeting accuracy
    - Plans for several PRCI member operators to take on package and/or algorithm for pilot programs

- **Expected Completion Date** : December 2016

Opportunity for Enhancements/Customization

Original Image

Filtered Detection Output

Rapidly mobilized with multi-sensor package

ATDS Calibrated LWIR Frame

IR Heat signature identified obstructed machinery

Calibrated IR Temp (Deg F)

- 64.25 - 72.31
- 72.32 - 77.69
- 77.7 - 84.21
- 84.22 - 93.02
- 93.03 - 155.19

Calibrated IR Image
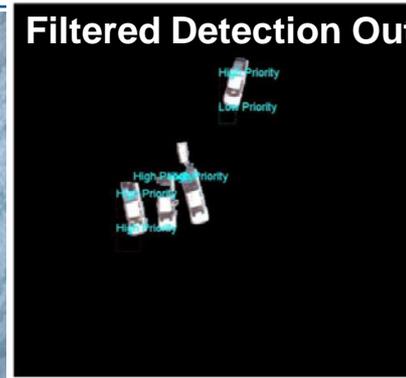
ROW-3 On-going Work

ROW-3K: Demonstration of the Use of Long Endurance Unmanned Aircraft System (UAS) to Conduct Machinery Threat Detection and Oil Spill Detection on a Pipeline Corridor in the National Airspace System

- **Objective**: Demonstrate the operation of long endurance fixed-wing UAS to conduct pipeline patrols. Evaluate the performance differences between manned & unmanned aircraft BVLOS

- **Status**:
  - Flight campaigns completed in partnership with the MAAP VaTech FAA Center of Excellence
  - Final Report being finalized

- **Expected Completion Date** : January 2017

UAS Consortium Primary Objectives

- **Continuation of the RAM Program – Fixed-wing to UAS**
  - Machinery Threat Detection
  - Leak Detection – liquids and gas
  - Encroachment Identification
  - Permanent Record of Conditions

- **Conduct up to 500 miles of linear patrol**
- **Acquire high-res, geo-located multispectral imagery of staged machinery in pipeline & power line corridor**
- **Disseminate imagery & data in near real-time**
- **Evaluate & compare performance of manned & unmanned aircraft**
- **Collaborate with leak detection sensors developed for Fixed-Wind/UAS configurations (i.e. LiDAR)**
- **External Stakeholder Engagement**
- **FAA Rulemaking - BVLOS**

PRCI UAS Consortium 2016-2018

- **Airspace Expansion**
  - Updated COA
  - Liquid transmission lines
  - Liquid distribution lines
  - Gas transmission lines
  - Electric transmission lines
  - Railway

- **Beyond the Horizon Initiative**
  - Includes pipeline, power gen, electric transmission & others with common interest in BLOS UAS

Leveraging a common interest to develop & utilize a calibrated Test Range to accelerate the use unmanned aviation and remote sensing in improving the safety and integrity of our nation's linear infrastructure

Completed Work – Design

CNST-1-3 Pre-Construction Drillability Assessment for HDD in Rock

- **Objective:** Compile an comprehensive summary of all prior DMC research on HDD design. Include an application tool with examples that can be readily applied by operating company engineers.

- **Status:**
  - Research completed and product approved for use Roll-out by "lunch & learn" session hosted by PRCI in December 2015.
  - Available for public since December 2015

2017 Approved Work

ROW-6-2: Evaluation of Current ROW Threat Monitoring, Applications and Analysis Technology

- **Objective:** Determining which ROW monitoring systems are best suited to specific information requirements of the pipeline sector, and determining which systems add value to the existing monitoring approaches. This project should provide an understanding of those information requirements that need to be acquired to drive threat reduction.

- **Status**: New – Kickoff Q1 2017

- **Expected Completion Date**: December 2017

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