PHMSA Public Quarterly Report

Date of Report: *9th Quarterly Report- December 19th, 2025*

Contract Number: *693JK323RA0001*

Prepared for: *PHMSA, Government Agency: DOT*

Project Title: *Dual Purpose PIG for Cleaning and Internal Integrity Assessment for Hazardous Liquid Pipelines*

Prepared by: *North Dakota State University and Stevens Institute of Technology*

Contact Information: *Ying Huang (ying.huang@ndsu.edu, 701-231-7651)*

For quarterly period ending: *December 20th, 2025*

1.1. Team Project Activity 1: Task 2: Development of the Attachment Set for Transferring the Cleaning Pigs into Dual-purpose Pigs

In this reporting period, additional testing was conducted on Versions 1, 2, and 3, including evaluation of a modified attachment configuration in which the sensor module was relocated from the front of the pig to the rear. The rear-mounted configuration provided a more stable imaging environment and significantly improved the quality of the captured visual data during pig runs. In addition, artificial dent defects were introduced into the pipe and evaluated in the pressurized water loop, thereby generating additional datasets to further refine the machine learning model.

Identification of dent defect in the water pressurized loop test: A dent defect was also machined into a separate pipe segment using a fabricated indenter with a 2-inch diameter head, with the load applied by an MTS testing machine, as shown in Fig. 1. The initial imposed dent depth was approximately 30 mm. After unloading, the elastic rebound of the pipe reduced the permanent dent depth to about 25 mm.

Inspection results for both crack and dent defects across all three housing attachment versions showed that clear images were successfully captured for both defect types.

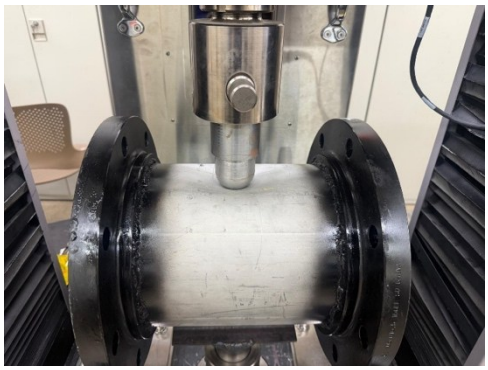

Figure 1. Picture showing the machining of dent in a stainless-steel pipe segment using the MTS machine.

1.2. Team Project Activity 2: Task 3: Machine Learning based Computer Vision Analysis for Pipeline Integrity Assessment of Hazardous Liquid Pipelines

1.2.1. Optimization Machine Learning Models Using Additional Experimental Images (Task 3.2)

During the past quarter, the research group at North Dakota State University conducted additional tests to expand the dataset used for deep learning model training, with particular emphasis on crack and corrosion classes. The tests were performed under varying water levels inside the pipes and with different camera placements on the pig, including front and rear mounted configurations. As the pig traveled through the pipe, video data were collected and subsequently processed to extract additional images for model updating and refinement

1.3.Team Project Activity 3: Task 4: User-friendly Software Development for the Dual-purpose Pig and Economic Analysis

1.3.1. Finalization of Mobile Software Application (Task 4.1 and 4.2)

In the last quarter, development efforts focused on finalizing the mobile application and preparing it for deployment. By the end of the quarter, the Android application reached at final state, with all core capabilities implemented and validated. These capabilities include map interaction with marker clustering, deep linked video playback, segment level analysis, report generation, and integration with external navigation tools. As shown in Fig. 2, the system has been packaged as an installable APK, marking the completion of the mobile development phase and the transition from feature implementation to deployment readiness. With the primary functionality now complete, the next phase will focus on systematic testing, targeted bug fixes, performance optimization under real use conditions, and consolidation of documentation to support long-term maintenance and deployment.

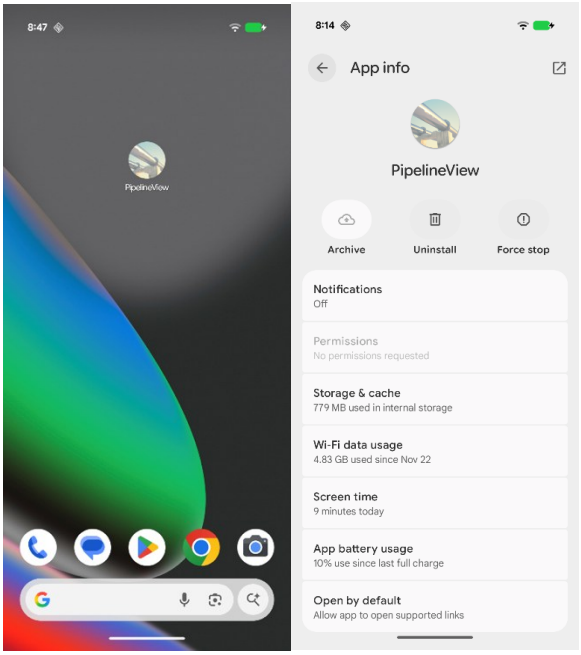

Figure 2. Android application of the developed software

1.3.2. Economic Analysis and Technology Transfer (Task 4.3)

As noted earlier, a provisional patent application was filed and the project team is currently preparing a comprehensive technical summary to strengthen the forthcoming non-provisional patent application. In parallel, the research team has identified and organized key factors to support the planned economic analysis.

1.4.Team Project Activity 4: Task 5 Validating Feasibility through Field Testing and Final Report

1.4.1. Field Testing of the Developed Dual-purpose Pig (Task 5.1)

The research team has continued close coordination with the PRCI Technology Development Center to secure access to the Liquid Test Loop facility for field testing. Based on the most recent communications, the proposed testing plans remain under review and have not yet been scheduled, but

anticipated to come in January to March 2026. The team is preparing all the needed materials and devices needed for the field testing. In parallel, pressurized water testing has continued extensively at the NDSU experimental site to generate field datasets.

2. Project Schedule –

After thorough evaluation of the project progress and careful review of the items listed in section 2 of this report, we confirm that the project is currently on time, aligning with our projected timeline and milestones.