PHMSA Quarterly Report – Public Page

Date of Report: *3rd Quarterly Report-June 20th, 2024*

Contract Number: *693JK323RA0001*

Prepared for: *PHMSA, Government Agency: DOT*

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

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For quarterly period ending: *June 20th, 2024*

1. Items Completed During this Quarterly Period:

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

1.1.1 The assembly of the CAV.v.1 fabrication with the accessories

The fabrication of CAV.v.1, using aluminum was completed. The device (Figure 1) comprises of two parts including the cover and the cylindrical body. The cover weighs 0.669 pounds, while the cylindrical body weighs 1.04 pounds.

Figure 1 The first iterative attachment fabrication with light, camera and tempered glass attached

The accessories procured, some of which were already described in Report #2 were thereafter assembled with the device in order to create a watertight component which was then attached to the PIG.

1.1.2 The set-up for the static water test facility

The preliminary testing of the assembly (Figure 2) was carried out so as to start gathering preliminary images and also come up with ways of improving and optimizing the device. The facility for the test was set up in our laboratory. The set-up includes an 8 in carbon steel pipe, connected to a tank with the use of epoxy to prevent leakage.

Figure 2 Preliminary lab test set-up

1.1.3 The procedure design for the static water test under various conditions

The test was carried out to check the capacity of the camera to gather images of various defects in different pipe conditions and light orientations and also the enable us to see how water tight the device is. The details of the defects, pipe condition and light orientation tested and to be tested are shown in the Figures 3-5, respectively.

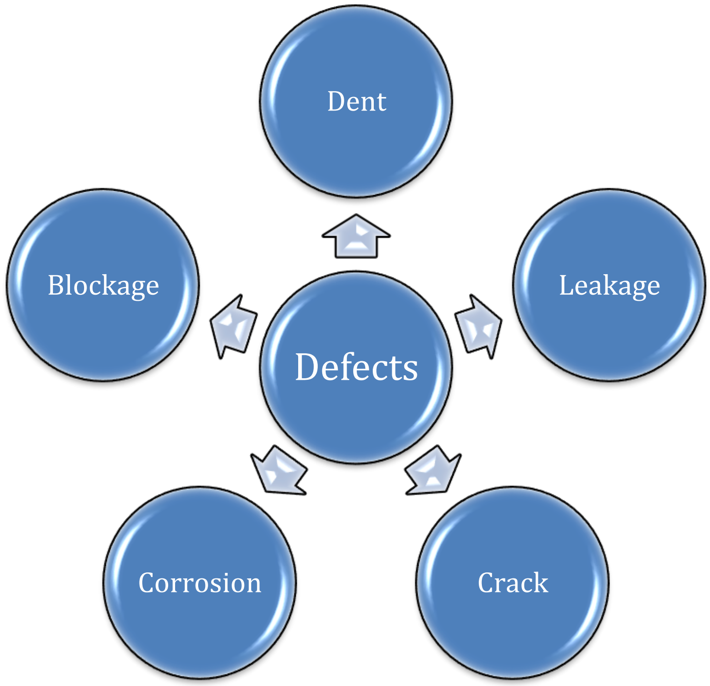

Figure 3 the various types of defects to be simulated

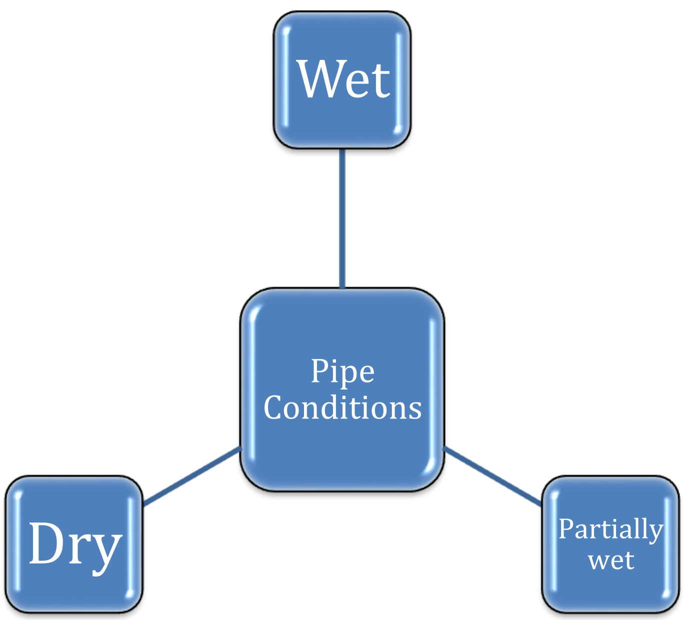

Figure 4 various pipe conditions to be simulated

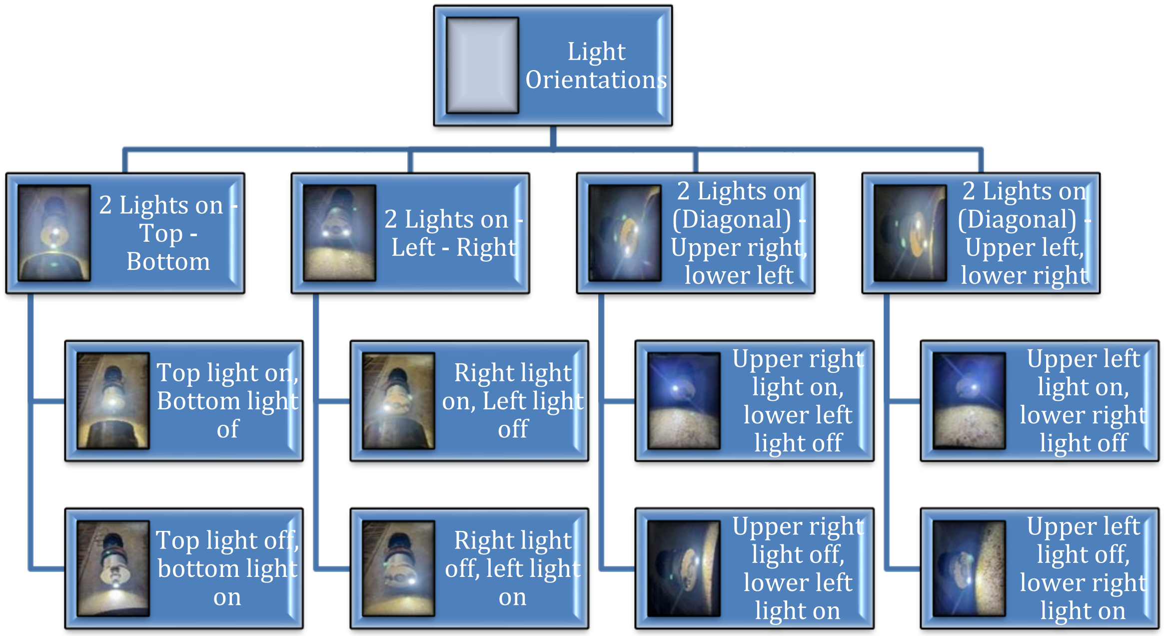

Figure 5 various lights orientations that were considered

1.1.4 The new design (Version 2, CAV.v.2) and the accessories

We continued to improve the design of the attachment to CAV.v.2 to reduce the flow resistance from the pipeline to have a dome shape for the attachment as shown in Figure 6.

(a) (b)

Figure 6 Trial design 3D model print for version 2 (a) separated (b) overall sketch

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

Deep learning algorithms are going to be utilized for the purpose of identifying possible defects in the pipelines. Therefore, it is necessary to have a thorough dataset to feed these algorithms. To accomplish this goal, the group has begun gathering images to construct a trustworthy database. In the initial part of the process, a total of 162 videos were compiled from a variety of various sources. All the videos that were gathered had durations that ranged from less than one minute to more than forty-five minutes. After the videos were collected, frame-by-frame images were taken from each video. Following the completion of this stage, the total number of photos contained roughly 12,000 photographs. However, the quality of some of the photographs was quite poor due to several variables, including the presence of low light, the motion of the camera, and the fact that the camera was submerged in liquids. Figure 7. shows some of the instances of the collected images.

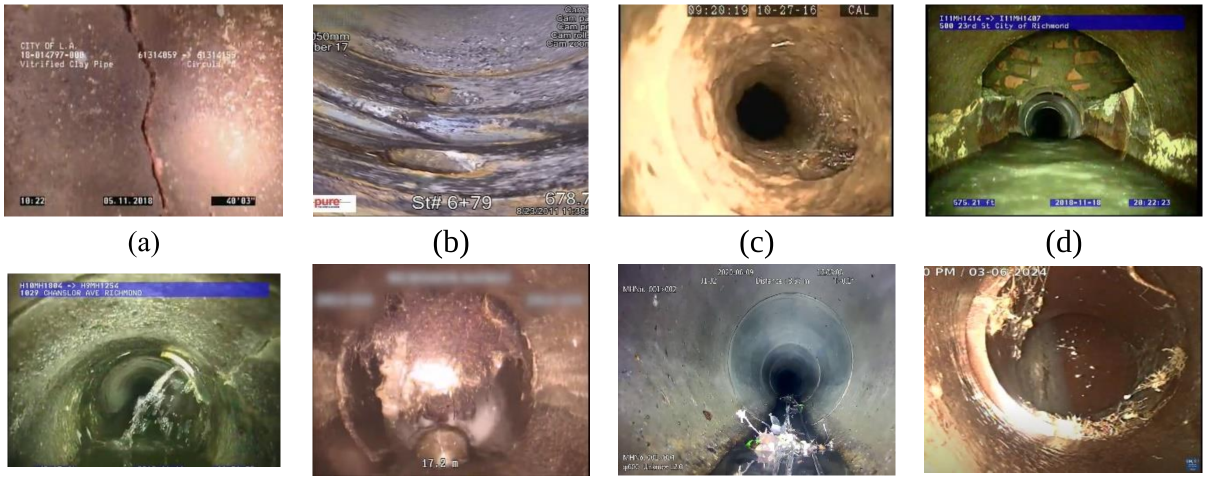

Figure 7 Representative pipeline anomalies: (a) crack [1] ,(b) dent [2], (c) corrosion [3], (d) broken pipe [4], (e) leakage [5], (f) blockage [6], (g) settled deposit [7], (h) root intrusion [8].

The total number of images that were acquired were greater than 5000 in total, after the images that were deemed to be of no use were removed. Leaks, settled deposits, cracks, corrosion, dents (less than 10 instances), broken pipe, root insertion, and blockage are the seven categories of defects that were observed in the pipes that were gathered. Additionally, there were over two thousand images of the pipelines in their normal conditions that were also included in the collection. Following the completion of the data cleaning process, the following is a list of the final number of photos for each defect in Figure 8.

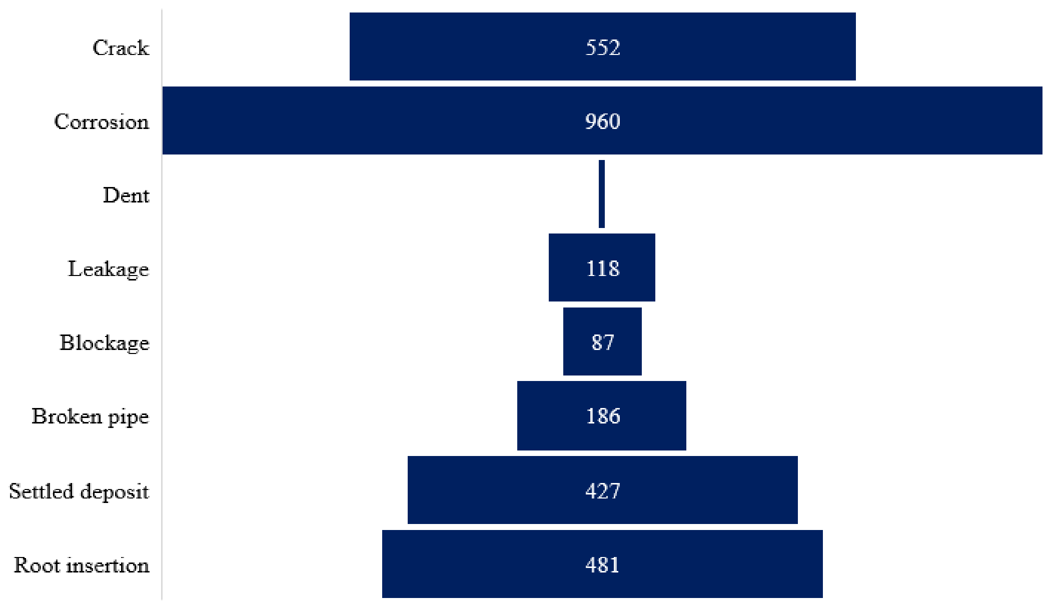

Figure 8 Number of collected images

2. **Items Not-Completed During this Quarterly Period:**

The research team has reviewed the tasks for this quarter, and we confirm that the project is on time and aligns with our scheduled milestones and objectives.

References:

[1] Johnson E. Sewer pipe inspection CCTV. https://www.youtube.com/watch?v=PVxfo5yacTE&t=1736s; 2018.

[2] Technologies P. 42" Sewer force main inspection - robotics. https://www.youtube.com/watch?v=FurZqtd-K9w; 2011.

[3] Plumbers K. Cracked cast iron pipe video inspection. https://www.youtube.com/watch?app=desktop&v=9OnFayHzfHo; 2017.

[4] 360 P. 360 pipes sanitary sewer pipe inspection. https://www.youtube.com/watch?v=AlqL6R-W_E4&t=24s; 2018.

[5] 360 P. CCTV sewer pipe inspection. https://www.youtube.com/watch?v=76Ftzl9YaWM&t=685s; 2018.

[6] U. K. Closed circuit television (CCTV) sewer inspection. https://www.youtube.com/watch?v=L-XciKTweFg; 2018.

[7] Pei W. Pipe periscope inspection video. https://www.youtube.com/watch?v=evpS3zxAtpE; 2020.

[8] Rooter B. Job \#55613180. https://www.youtube.com/watch?v=05XJwDtwtRU; 2024.