CAAP Quarterly Report

Date of Report: December 31, 2015

Contract Number: DTPH5614-H-CAP06

Prepared for: Department of Transportation

Project Title: Robust Anomaly Matching for ICIPs: Reducing Pipeline Assessment Uncertainty Through 4-Dimensional Anomaly Detection and Characterization

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For quarter period ending: December 31, 2015

Business and Activity Section

Generated Commitments –

- none

Status Update of Past Quarter Activities –

- Had extensive conversations with Steve Banks of I2I Pipelines concerning his foam-bodied ICIP. Trying to formulate a way to work together on a project. The intent of this effort is to identify the intersection of ICIP (Inline Cleaning and Inspection Pigs) with the work we are doing on Anomaly Matching. This is based on the recognition that Anomaly Matching will become most important when data is being gathered from more frequent (e.g., routine pipeline cleaning) and thus affording us the opportunity to provide denser time series data for anomaly monitoring.
- Completed several iterations of our velocity-insensitive SLAM algorithm.
    - Frame velocity distortion component appears to be working
    - Trajectory selection across multiple velocities seems to be working
    - Tests with simple bitmaps using a simple “global-best match” selection criteria (no trajectory through the difference matrix) yielded a 95% successful match rate.
    - Tests with simple bitmaps using a “local-best match” criteria (by plotting a short trajectory through the difference matrix) matched only 50% of frames correctly, 75% if close matches are considered. This reveals that there is a mistake in our code somewhere.
    - Note: The “local-best match” criteria is necessary for eliminating aliasing across widely separated regions of the inspection. The results from a global-best match criteria will be very prone to false matches.
- Began a comparison of our algorithm against Open SequenceSLAM using our synthetic dataset to try to identify the source of the local-best matching problem.
    - As expected, our initial results were poor but through meticulous analysis we have uncovered two mistakes in our algorithm.
    - We are well into making these repairs. When fixed, we expect a significant improvement on our results using a local-best match criteria.

Description of any Problems/Challenges –

- We still have no data in hand. Pushing forward with what we have. To bypass our data challenges we will be building a pull-cart which we can outfit with a laser scanner. The goal would be to pull this rig through a well-characterized section of test pipe at the PRCI test facility in Houston. This laser data would be similar enough to MFL data that we can continue a majority of the work of this project with it. The only restriction would be the final pattern matching step, where it would be advantageous to have real sensor data. Note, two different sources indicated they could help us with real data, however, IP issues and other corporate proprietary concerns have prevented our obtaining data so far.
- There are some unresolved issues concerning transitioning between velocity planes in the difference matrix. This has to do with the fact that the number of reference frames in each velocity plane changes with velocity. At transition points, the algorithm should match two velocities. We do not have this functionality implemented. Implementing this will take some careful consideration and possibly some experimentation.
- With the variable velocity algorithm configured to behave like SeqSLAM we are seeing some differences between our intermediate results and those produced by SeqSLAM. As noted above, we think we have identified the source of these differences and as we write this report we believe we will have these issues cleared up shortly.

Planned Activities for the Next Quarter –

- Build laser test rig for deployment in Houston in early spring. This will involve organizing and managing a Senior Design Team from Mechanical Engineering at Colorado School of Mines. We have been given approval for this project and look forward to introducing several senior undergraduates to the world of pigs and pipeline inspection.
- Continue to debug and refine our algorithm, with identical configurations we should be getting identical results as Open SequenceSLAM.
- Complete a direct comparison of our algorithm with Open SequenceSLAM in a variable velocity mode.
- Tackle the issue of velocity transitions in our algorithm.
- Characterize the behavior of our algorithm in response to its unique parameters.