CAAP Quarterly Report

Date of Report: *Dec. 31th, 2018*

Contract Number: *693JK318500010CAAP*

Prepared for: *U.S. DOT Pipeline and Hazardous Materials Safety Administration*

Project Title: Brain-Inspired Learning Framework to Bridging Information, Uncertainty and Human-Machine Decision-Making for Decoding Variance in Pipeline Computational Models

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For quarterly period ending: *Dec. 31, 2018*

Business and Activity Section

(a) Generated Commitments

No changes to the existing agreement

Kick-off teleconference meeting was held on Oct. 29th, 2018.

(b) Status Update of Past Quarter Activities

The research activities in the first quarter consist of the kick-off meeting, the literature review, and some preliminary work prepared for Task 2, as summarized below.

Task 1: Literature review and kick off meeting

Kick-off meeting

The first kick-off teleconference meeting with the USDOT CAAP program director, Dr. Joshua Arnold, was held on Oct. 29th, 2018. The meeting agenda and major activities in the kick-off meeting were shown in Table 1.

Table 1 Kick-off teleconference meeting agenda (Monday, Oct. 29th, 2018)

Items	Major Contents	Note
Objectives	a. Framework of the CAAP Program b. Introduction of the project background and the expected outcomes c. Discussion of detailed contents in the proposed work d. Student training and involvement	Attendees: Joshua Arnold (USDOT PHMSA), Zhibin Lin (NDSU), Zi Zhang and Matthew Pearson (NDSU).
Detailed Activities	a. Introduction o Dr. Arnold addressed the major frame of the CAAP program b. Project Information and Discussion o Dr. Lin stated the background of this project, the motivation of the concepts, and the expected outcomes. o Dr. Lin addressed the potential research challenges in the data mining and data quality. c. Student Training and Involvement o Dr. Lin expressed his appreciation for the major focus of student involvement in the CAAP program. o Dr. Lin confirmed that his group has recruited not only graduate students and undergraduate researchers, but also high school students. o Dr. Lin suggested that the students in the project could be involved and have opportunity to communicate with pipeline industry, if there are more CAAP-hosted forums in future. d. Future Plan o Dr. Lin asked about any plans of Research & Development Forum where the students could provide showcases in near future. e. Other items (e.g., patent and documentation)	

Literature Review

With its inherent nature, the pipeline industry has to face with the great challenges in terms of the high level of variances (e.g., damage type and morphology), noise, and other uncertainty.

The pipeline industry has been collecting substantial quantities of data, while the data fusion could be carried out by physics-based or data-driven methods.

Physics-based methods refer to the solutions using the physical laws, such as first principle of physics. Variances experiences in a pipe could be theoretically solved by the inverse problems through determining parameters existed in the physics-based models or analytical solutions. However, this is particularly a great challenge when the physical models are not clear. For example, the noise interference usually occurs in field measurements collection in sites, which may hinder the effectiveness of physical-based identification methods. Differently, the data-driven approaches could extract sensitive features

from sensor data to assess the structural conditions with less physical inputs. By taking advantage of history sensory data, the data-driven approaches are robust to provide the key information

Although the data-driven approaches offer promising opportunities, the high level of variances as identified above existed in the pipeline industry still post great challenges. This understanding drives us to propose new learning and information fusion framework in this project.

(c) Description of any Problems/Challenges

No problems are experienced during this report period

(d) Planned Activities for the Next Quarter

The planned activities for next quarter are listed below:

- the experimental tests will be conducted, while the data on specified mechanical damage (type and size) will be recorded and analyzed as training features.