CULLEN COLLEGE OF ENGINEERING UNIVERSITY of HOUSTON

DOCTORAL DISSERTATION DEFENSE ANNOUNCEMENT

AT THE CULLEN COLLEGE OF ENGINEERING

Partially Observable Markov Process Modeling for the Optimal Maintenance of Oil and Gas Pipelines

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Location: E221 Eng Bld 2 (IE Conference Room)
Microsoft Teams: **Join the meeting now**
Meeting ID: 272 282 426 222
Passcode: PFuDK5

Committee Chair:

Gino Lim, Ph.D.

Committee Members:

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Abstract

Partially Observable Markov Decision Process (POMDP) frameworks are employed across various fields such as industry, science, commerce, economics, military, and artificial intelligence due to their adaptability and efficiency in modeling and proficiently solving real-world challenges. This dissertation studies the application of POMDP for maintaining oil and gas pipelines. In the process of its implementation, POMDP solvers play a crucial role in solving the problem and formulating the maintenance problem. Therefore, the first part of the study reviewed the diverse solver approach pursued in the literature. Based on this review, an improved vector pruning algorithm is introduced to enhance the pruning operation and solve POMDP problems. This algorithm inherited the LP optimization as prime and dual with

decomposition from the literature and improved the approach by incorporating bootstrap constraints to expedite the optimization process. Various experiments demonstrated that bootstrapping could speed up the optimization run despite the increase in constraint size.

This study also proposes discrete and continuous modeling approaches for the practical application of POMDP to oil and gas pipeline maintenance. In the discrete framework, the states were identified as the range of deterioration, while the actions represented the maintenance operations. Monte Carlo simulation alongside a pure birth Markov process approach was applied to derive the transition matrix. The inline inspection (ILI) techniques and tool measurement inaccuracies, which can lead to data distortion, are integrated into formulating the observations and observation function. The computation of rewards considers the costs associated with maintenance and failures. In the continuous framework, states were developed using a probability distribution, and ILI readings were included as continuous variables. The models were solved using freely available solvers and the proposed enhanced vector pruning solver. Both approaches have been shown to be effective, with the added benefit of incorporating inaccuracies in measurement and providing recommendations for actions in scenarios involving multiple states. Altogether, the proposed discrete and continuous frameworks are beneficial for the decision-making process in corrosion maintenance operations by more accurately reflecting the stochastic nature of the environment.