

Project Outcomes Report

# Development of an Autonomous Robotic System for the Inspection of Pipelines

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Leakage is a major factor for unaccounted losses in every pipe network around the world (oil, gas, water). In most cases the deleterious effects associated with the occurrence of leaks may present serious economical and health problems. Therefore, leaks must be detected quickly, localized and repaired. Nevertheless, most state of the art leak detection techniques have limited applicability and are neither reliable nor robust; while other techniques depend on the experience of the operator. This project focused on the development of an autonomous system to inspect pipe network and identify leaks.

The major outcome of this project includes theoretical results, novel hardware design and prototype. Two major novel hardware subsystems were developed in this project. The first is a propulsion module. The propulsion module allowed an ellipsoidal swimming robot to maneuver inside pipe networks. The second is a flexible sensor module allowing the sensor to operate inside pipes with significant irregularities inside. The swimming robot made navigation through complex pipe network possible. It did, however, require new models in order to characterize the robot and for control system design. The new models provide a description of the under-actuated swimming robot dynamics. In addition, a control algorithm was developed during the collaboration for this robot.

We hope that the findings from this collaboration can lead to future projects. As previously indicated, the collaboration led to the development of a novel compliant sensor concept and mathematical models of the novel swimming robot inside a pipe. Additional technical developments are necessary to make the robot completely autonomous. Such developments would include integration of different components/subsystems and testing the overall system at an industrially certified experimental setup. The collaboration with utility companies such as gas, oil and water delivery companies would bring the project to the next phase. We hope that in the future, there are new opportunities for the Kuwait and MIT research teams to collaborate further with appropriate stakeholders in Kuwait.