

Design and Development of an In-pipe Inspection Robot

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Abstract

Pipes are widely used engineering structures for transporting almost any fluid, from water to oil and gas. They have been one of the major components in many industries and are essential for life requirements around the world. The integrity of such structures is vulnerable to wear and tear, operational or manufacturing defect, natural disasters, aging, and physical damage from other sources, which can cause leaks, blockages, or damage to the piping. As such, periodic or emergency inspections and maintenance are important operational requirements for those narrow and lengthy pipes. The complexity of this procedure stems from the pipes' diameters, lengths, the mediums inside, the complexity of the pipes' arrangement, etc. Using a tool that can save time and effort in a safe and efficient manner is essential. Therefore, robotic pipe inspection has been introduced. In this study, a design of an inchworm-type in-pipe inspection robot is presented, and the resulting initial prototype is tested. Kinematic analysis was performed to analyze the robot's motion in vertical pipes, determining the optimized robot dimensions. Furthermore, the required minimum motor torque and track friction constant for movement in a vertical pipe were computed. The MATLAB optimization tool is used in optimizing robot parameters. By the end of the project, a proof of concept is reached, and a robot prototype is built and tested in a vertically oriented pipe. The testing of the manufactured inchworm-type in-pipe inspection robot was conducted. The experimental robot performance can be enhanced by employing the optimized robot dimensions. The optimized robot dimensions are tabulated and discussed, and recommendations for improvement are stated.