MATEC Web of Conferences **87**, 02029 (2017) DOI: 10.1051/matecconf/20178702029
ENCON 2016

Development of In-Pipe Robot D300: Cornering Mechanism

Ana Sakura Zainal Abidin[a], Sim Chia Chie, Muhammad Hamizan Zaini, Muhammad Farhan Aiman Mohd Pauzi, Mohammad Muaz Sadini, Shahrol Mohamaddan, Annisa Jamali, Rasli Muslimen, Muhd Fadzli Ashari, Mohd Syahmi Jamaludin

Department of Mechanical and Manufacturing Engineering, Universiti Malaysia Sarawak, Sarawak, Malaysia

Abstract. Utilization of robots for in-pipe maintenance considered as one of the most effective ways to improve the pipeline operation. The specific condition and structure of a pipeline system is a challenge for the robots to perform its task. This research aims to assess the characteristic and performance of the in-pipe robot in a 90^0 pipe elbow. Hence, a prototype of in-pipe robot for 300 mm UPVC pipe diameter (IPR-D300) has been built. The conception of the robot is based on wall-pressed caterpillar type which is suitable for not only horizontal pipeline position, but also vertical and elbows pipeline. This robot is equipped with ultrasonic sensors, high performance microcontroller board and powerful geared motor for travelling in the corner of pipeline. The developed IPR-D300 consist of three independent driving modules that are able to alter the speed according to the pipeline characteristic. The hardware and software of the IPR-D300 performance have been tested and successfully perform the cornering task smoothly. The developed IPR-D300 potentially can be applied for in-pipe cleaning operation especially on centralised sewerage system. As standard pipeline size for sewerage system housing in Malaysia is 200 mm, smaller and robust in-pipe robot will be the future target.

1 Introduction

Pipeline system has been employed as the main utilities in most nations for an extensive period of time [1]. This is because shipping with pipeline system has a lower cost per unit and higher capacity which is the most economical way to transport large quantities of flowing products. However, many troubles occurred in pipelines for the long-term erosion of transport materials and environmental effects namely blockage, crack, corrosion and mechanical damage [2]. Thus, regular cleaning and inspection are needed to ensure the safety, integrity and maximum efficiency of the operation of pipeline systems. Nevertheless, it becomes a challenging issue as it is tough to detect the area of crack or clog inside the pipes that are buried underground. Besides that, the maintenance and service to fix the damage manually by labours is very time consuming, less effective and costly.

Currently, the utilization of robots to do the maintenance of the pipeline is considered as one of the most effective ways to solve the problems [3]. Basically, a robot is able to move freely in a pipeline that enable it to perform more accurate checking and perform maintenance task within short period of time with lower operation cost. However, specific condition and structure of a pipeline system had caused the robots to hardly achieve high applicability. Lots of research about the locomotion of in-pipe robot have been studied to solve different condition and structure of pipeline system. Therefore, this research has been conducted with the aim to develop an in-pipe robot that can navigate smoothly during cornering. This research limits to specific scope namely; (1) the cornering angle is 90^0 elbow (2) the diameter of pipeline is 300 mm (3) material of pipeline is UPVC. This paper repots on the development of the in-pipe robot and performance of the developed in-pipe robot during cornering.

In-pipe robots have been around since many years ago. Prior research have shown many mechanisms and designs have been developed by scientists and inventors from all over the world. Basically, the in-pipe robots can be classified into seven categories according to their driving mode and design namely Pig type, Wheel type, Caterpillar type, Wall-press type, Walking type, Inchworm type and Screw type [4]. There are also designed robots, Stickybot and Mini-Whegs that mimic the nature creatures (insects and lizards) that are able to climb [5, 6]. Locomotion of the in-pipe robot is chosen base on their designated job and application. Some robot may implement two or more types of locomotion at once in order to improve its performance and efficiency in certain applications.

As compared to the wheel-based robot, caterpillar tracks is more suitable to drive on unsteady surface. This is because the caterpillar tracks is able to distribute the robot's weight evenly over a larger surface of the track where the wheel-based robot of the same potential would fail to do the job. Meanwhile, larger surface area of

[a] Corresponding author: zaasakura@unimas.my