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PIPE INSPECTION SYSTEM: A REVIEW

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Abstract *- Pipe inspection is necessary to locate defects due to corrosion and wear while the pipe is transporting fluids. Because pipelines are typically buried underground, they are in contact with the soil and subject to corrosion, where the steel pipe wall oxidizes, and effectively reducing wall thickness. Recently many plants' pipes and drains became old and many robots to inspect these pipes were developed in the past. Inspection robots are used in many fields of industry. One application of pipe inspection system is monitoring the inside of the pipes and channels, recognizing and solving problems through the interior of pipes or channels. This paper gives a review of various methods of pipe inspection considering the advantages and disadvantages of existing systems.*

Keywords- Autonomous mobile robot, In-pipe inspection.

I. INTRODUCTION

The inspection of pipes may be relevant for improving security and efficiency in industrial plants. These specific operations as inspection, maintenance, cleaning etc. are expensive, thus the application of the robots appears to be one of the most attractive solutions. The pipelines are the major tools for the transportation of drinkable water, effluent water, fuel oils and gas. A lot of troubles caused by piping networks aging, corrosion, cracks, and mechanical damages are possible. So, continuous activities for inspection, maintenance and repair are strongly demanded.

Recently many plants became old, so steel pipes, ceramic pipes, concrete pipes and plastic pipes used for transportation of water and gas also became old. And, these pipes become cracked because of deterioration and corrosion. Thus inspection of pipes is important for improving security and efficiency in industrial plants. It include inspection, maintenance, cleaning etc. which are expensive, thus the application of the robots appears to be one of the most attractive solutions. Pipelines which are tools for transporting oils, gases and other fluids such as chemicals, have been employed as major utilities in a number of countries for long time. Many robots to inspect these pipes were developed in the past, but they had a heavy power supply and a signal wire. The moving ability is probably the greatest problem to deal with.

[1] Kentarou. Nishijima, Yixiang.Sun, RupeshKumar Srivastava, Harutoshi Ogai1and Bishakh. Bhattacharya.

In this paper, a rotating probe in vinyl chloride pipe was tested, and a new inspection robot system for drain pipe was developed. They developed a drain pipe inspection robot that can be controlled by wireless radio communication in the inside pipe and can also transmit image information of the inside of the pipe in real time. They used a 19m cleaned ceramic pipe with a diameter of 25cm and 30cm is shown in Fig.1.

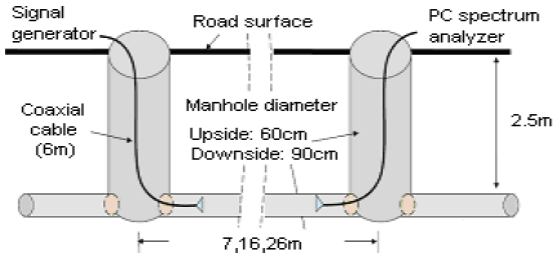

Fig.1. Wireless communication property measurement in the ceramic pipe

This experiment inspected transmission loss in ceramic pipes using previously tested robot and also inspected transmission loss in ground and space. And we clarified the relational equation between a pipe's diameter and the possible radio transmission distance in an earthenware pipe, as shown in Fig.2.

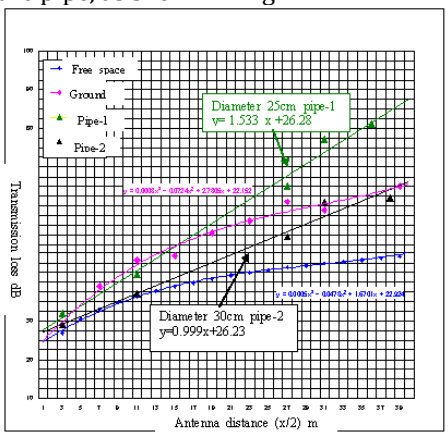

Fig.2. Transmission property

From these results, they developed a drain pipe inspection robot equipped with practical wireless radio

communication system. The robot was developed based on drain pipe inspection robot 'Mogurinko250'.

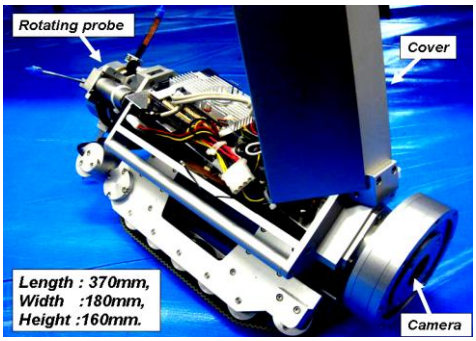

Fig.3. Inspection robot

This experiment used a resting robot with a rotating probe in a clean vinyl chloride pipe with a 25cm diameter. Voltage change was measured in free rotation, and when the probe touched defects with heights and width of 5mm, 3mm and 1mm. In this result, a probe could measure the defect of 5mm, 3mm and 1mm in the vinyl pipe. When a probe touched the defect, voltage showed a substantial decline.

[2] E Navin Prasad, M Kannan, Azarudeen and N Karuppasamy.

A very important design goal of the robotic systems is the adaptability to the inner diameters of the pipes. So, a new design is proposed for inspecting pipelines. The major advantage is that it could be used in case of pipe diameter variation with the simple mechanism. We developed a pipe inspection robot that can be applied to 140- 180mm pipeline. The kinematics of mechanism and actuator sizing of this robot have been investigated. A real prototype was developed to test the feasibility of this robot for inspection of in-house pipelines. In the proposed mechanism the problem is solved by a spring actuation and increasing the flexibility of the mechanism. The propulsion of the robot has been successfully conducted using only three motors, a radical simplification over existing efforts. The robot was designed to be able to traverse horizontal and vertical pipes.

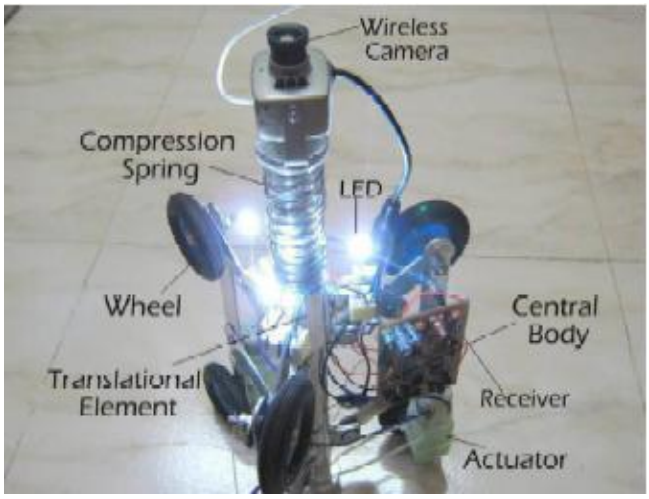

Fig 4: Pipe Inspection Robot

The mechanism used is a four bar mechanism consisting of three revolute joints and one prismatic joint.

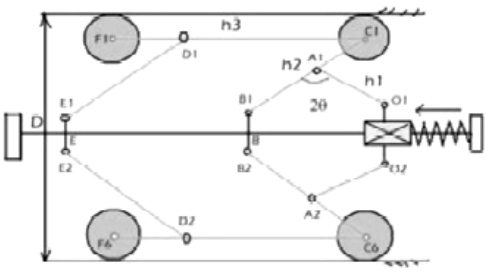

Fig 5: Mechanism of Pipe Inspection Robot

[3] Atul Gargade, Dhanraj Tambuskar, Gajanan Thokal.

In this paper an in-pipe inspection robot has designed that can deal with many kinds of pipes with various diameters (140mm-200mm.) such as plastic pipes or metallic pipes which are in horizontal or vertical manner only for 750 mm distance.

The pipe inspection robot is composed of body, fore leg system, rear leg system and springs. Three legs of each leg system are arranged at an angle of 120 degrees to each other to move inside various pipe diameters. By using spring it is able to move freely inside pipes of different diameters. A CCD camera is installed on front part of the fore leg system to do visual inspection of pipe.

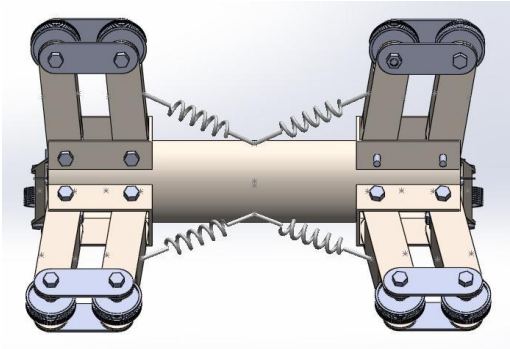

Fig 6. Pipe inspection robot

Static stress analysis of robot assembly is done in Ansys and analysis results are shown in following figure.

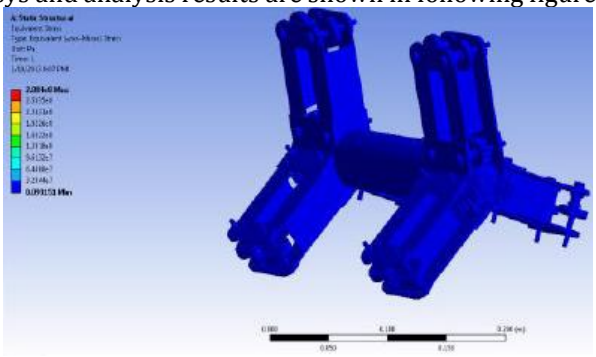

Fig7. Stress analysis of robot assembly

[4] Dana Al-Matter,

In this project, Dana Al-Matter has designed a robot that can repair leakages in the pipe network. Such a robot can avoid risk while repairing leakages in pipes. The swinging nozzle feature makes it possible to cover the entire area of the leak. Moreover, the robot has an advanced mobility feature where it can move in any type of pipe network and also the robot itself can be improved to be smaller in size to tackle small pipe diameters.

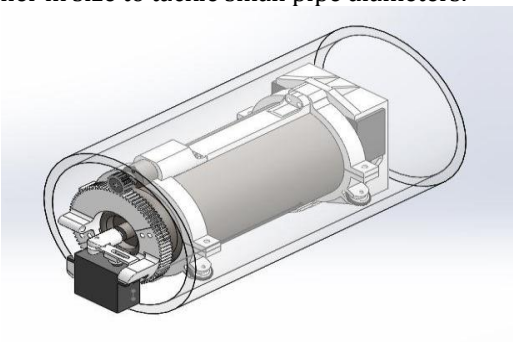

Fig 8: Pipe Leakage Repairing Robot

This robot goes inside the pipe and detect leakage area and then nozzle is rotated to the correct circumferential position and then the servo will spray the adhesive on the affected area. The nozzle is able to swing so that the spray can cover the hole of the detected leakage and its surrounding area. This robot carries instant leak sealer which can repair a small leakage hole within 3 minutes.

[5] O. Tătar, D. Mândru, I. Ardelean,

In this paper two wheeled-type in-pipe minirobots are proposed. Thus, the studied minirobots are characterized by an adaptable structure, based on linkage mechanisms. The prototypes were designed for inspection of pipes with variable diameters within 140 and 200 mm.

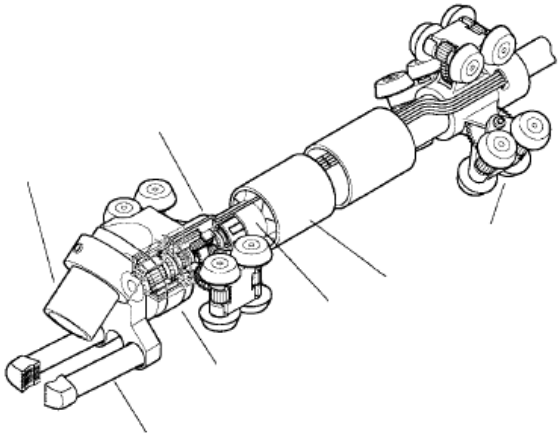

Fig. 9 In-pipe inspection robots with adaptable structure.

Main advantage of this type of robot is adaptable structure. The minirobot is powered through wires and it is controlled with the aid of a microcontroller *ATMEL Atmega8535*. A very important design advantage is the adaptability of the in-pipe robots to the inner diameters of the pipes.

In order to determine the strength of the actuators required to hold the robot against the pipe wall, a simulation was run to estimate the magnitude of the forces exerted on the robot due to the fluid flow inside a pipe.

SUMMARY AND CONCLUSION

A review of pipe inspection robots showed that all the robots were designed for operation in empty pipes and so did not have to deal with restrictions to their shape and area inside the pipe. Only one robot was designed to operate in live pipes, but was not designed to operate in vertical pipes. It was clear from the review that research for various machines operating in pipes is an important and innovative solutions are needed.

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