International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 05 | May 2020 www.irjet.net p-ISSN: 2395-0072

INTERNAL INPIPE INSPECTION AND RECTIFICATION BOT

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Abstract - *Pipelines are a very significant tool as they are used by many industries for various applications such as transportation of gas, oil, fuel, etc. These pipeline systems deteriorate progressively due to aging, corrosion and mechanical damage. Ignorance of these problems leads to accidents which incurs huge losses in terms of both economy and lives. Hence these pipeline systems should be inspected regularly. This paper focuses on the design of an autonomous in-pipe inspection robot which detects cracks using image processing, clears blockages and also provides a visual view of the interiors of the pipe. This pipe inspection robot also aims at removing human factor from labor intensive and dangerous work, thereby reducing the number of accidents that happen due to the lack of regular inspection.*

Key Words: **Wall pressed, Haar Cascade, Linear actuator**

1.INTRODUCTION

Pipelines are used for transportation of gases and water in our society. They are also used in chemical industries and by gulf countries for transportation of fuels such as petrol, diesel, oil etc. Over time these pipes get gradually degraded and undergo rusting and corrosion. As the pipes carry toxic chemicals, fluids and have small diameters or bends they are inaccessible by humans for inspection. Also inspection of underground pipes requires a lot of manual work for digging. Hence there is a need to find an alternative approach for inspecting the pipeline systems. There are many techniques that are presently used for pipeline inspection which include radiography, ultrasonic techniques, thermography etc.

Radiographic methods use X-rays or gamma rays to examine the internal structure of pipes. However it is difficult to find cracks and other small defects using radiography. In addition, radiation is harmful to human body and safety measures are to be taken. Ultrasonic testing involves sound waves to detect cracks, holes, welds and other structural defects in the pipe. The limitation of this method is that data acquisition and evaluation depends on the expertise of the technician. This makes it difficult to get results with precision. In thermography if the temperatures are in a very close range the objects become indistinguishable leading to misreading of information. To overcome these challenges we design a robot for pipe inspection.

A robot is a machine, especially one programmable by a computer which is capable of carrying out a complex series of action automatically. An in-pipe inspection robot is designed such that it can fit exactly into the pipe and move horizontally (forward and backward). It consists of motors for driving and camera for monitoring and is used to detect cracks, clear blockages and also rectify the cracks. This robot performs visual inspection which is an inexpensive method for inspection and also removes human intervention.

The rest of the paper is organized as follows. Literature survey, Methodology are explained in section 2 and 3 respectively. Section 4 has Conclusion, Section 5 briefs about Future scope and References are followed in next Section.

2. LITERATURE SURVEY

The research paper of Akshay Ashok [1], provides us a description of the design and fabrication of an in-pipe inspection robot. The robot is a wall press type of robot that consists of 3 wheels in the front and back. Six DC motors are used as actuators for robot movement. A wireless camera is attached in the front which can cover an area of 180°. The output of the camera is given through the receiver connected to LED screen.

In the review paper by Nusrat Alim [2], there is an autonomous robot can operate on both obstacle avoiding mode using ultrasonic sensor and line following mode using infrared sensor and cam detect leakage by navigating through areas. After the detection, it will send a wireless signal of intensity to the receiving module which consists of a LCD display to monitor the intensity of gas leakage in real time.

Mohamed Abdellatif proposes an inspection robot for sewage pipelines which uses image processing techniques for crack detection [3]. Raspberry PI is used as the microcontroller and Raspberry PI camera module is used for capturing videos. These videos are stored in the memory and later retrieved after the inspection to apply image processing algorithms. Encoders are fitted to the robot to track the distance. MATLAB is used as it provides various image processing operations. However a GUI has to be created to

perform offline processing and to show the images of defects.

In review paper by Aruna R [4], the robot is monitored and controlled manually; the operator monitors the inside of the pipes via a wireless camera attached to the robot. The various sensors attached to the robot helps to determine the distance of the blockage from the robot. It consists of fan like structures with sharp blades that penetrate through the blocks by cutting them.

In the review paper Inpipe Inspection Robot [5], the robot has outstanding mobility in horizontal pipes in forward direction; it detects blockage using sensors and clears the path through milling. The robot consists of a motor for driving and camera for monitoring which provides the actual footage to the operator. It is designed in such a way that it reduces human efforts while inspecting these pipelines.

3. METHODOLOGY

The main purpose of this project is to inspect pipes, adopt corrective measures and provide its live streaming video. The robot moves front and back along the axis of the pipe. If there is any blockage, it is detected by using a IR senor and are cleared by flaps attached to the rotatory DC motor [6]. Using Image processing, cracks inside the surface of the pipe are detected and are rectified by using linear actuators.

3.1 BLOCK DIAGRAM

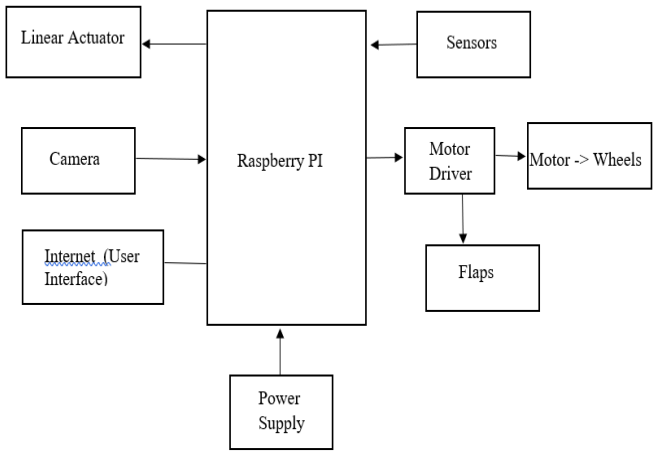

Fig -1: Block diagram of the proposed system

3.2 ROBOT BODY

The robot body is of a wall pressed type mechanism where the three metal strips are placed 120 degrees apart around the main centre rod. On the either side of the three metal ends, are the DC motors which run the wheels and help in the movement of the robot front and back [1]. However, the centre rod and the metal strips are connected firmly with a high strength spring to fit it inside the pipe initially. Other electronic components are made to sit on the metal strips. The camera is fixed at the front end of the prototype [4].

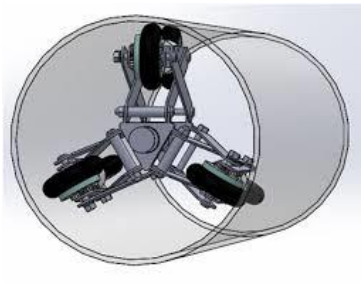

Fig-2: Wall pressed type robot **Fig-3**:Robot inside the pipe

3.3 MICRO CONTROLLER : Raspberry pi

RASPBERRY PI micro controller 3B model is used for the robot main control mechanism. This minicomputer controller board has inbuilt camera facilities hence easier for us to interface it [3]. It supports Open CV and can be easily coded using python.

3.4 LOCOMOTION

For the prototype to move in forward and backward direction, six DC motors are connected to a motor driver and in-turn connected to the raspberry pi as it controls the locomotive action of the robot. The raspberry pi does not supply enough output voltage through its pins for the motor to run. Hence a motor driver L293D is required. As per the programming, the raspberry pi gives control signals to the motor driver (i.e. high or low depending on what action is required) and the driver drives the motor and the robot moves in the required direction.

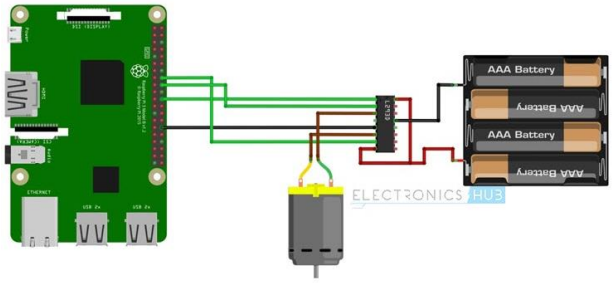

Fig-4: PI with motor driver and motor

3.5 BLOCKAGE DETECTION AND CLEARENCE

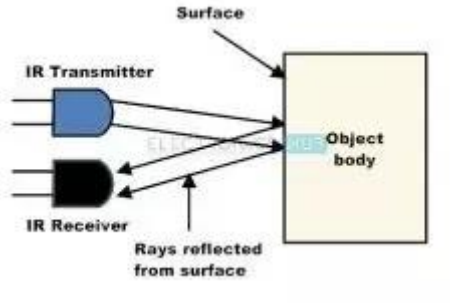

Fig-5: Object Detection

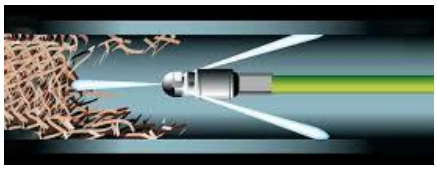

Fig-6: Clearing the block with flaps

An IR sensor is placed in the front portion of the robot and it sends IR waves and if any blockage is present, then the waves reflect back and the IR receiver obtains these reflect waves. This acts as a high signal given to the raspberry pi and that in-turn actuates the motors to which the flaps are connected and these flaps run in a rotatory motion which is perpendicular to the block and hence is cleared [4].

3.6 CRACK DETECTION AND RECTIFICATION

Image processing is used for the detection of cracks as it will be applicable to pipes if present underground also. Haar cascade method of image processing technique is used as it is the simplest of all object detection techniques and each Haar feature is only a "weak classifier" (its detection quality is slightly better than random guessing) a large number of Haar features are necessary to describe an object with sufficient accuracy and are therefore organized into cascade classifiers to form a strong classifier.[8] For better accuracy, a light source will be provided so that the camera properly captures images. Other cameras such as thermal cameras, IV night vision cameras might be used but it is expensive hence any web cam or raspberry pi cam with sufficient light will work.

For rectification of cracks, the robot consists of a tube filled with a semifluid. When the robot detects a crack the semifluid is pushed on to the crack region by using a linear actuator made of servo motor. The linear actuator consists of a gear system that converts the rotatory motion of the servo motor into a linear motion. This linear motion can be used to apply force on the tube to push the semifluid and fill the crack.

Table-1: Comparison between previous papers on in-pipe inspection robot.

Sl No.	Author Name	Title	Technique stated	Betterment in our system
1.	1.Mohamed Abdellatif, 2.Hazem Mohamed 3.Amro Kamal	Mechatronics Design of an Autonomous Pipe Inspection Robot	Using Raspberry pi and pi cam, the video inside the pipe is recorded and later retrieved to apply image processing algorithms using MATLAB. An extra GUI environment needs to be set up for viewing the video.	Using Raspberry pi and pi cam, the video will be captured and the image processing algorithms can be applied instantly using python and open CV methods. Although it takes some processing time i.e., delay is observed.
2.	1. Aruna. R 2. Venkatesh. S 3. Bhavishya. G 4. Ms. D. Jessintha	Intelligent Detection and Elimination of Blockage in Sewage pipes using a Robot	The robot over here is sent inside the pipe and gives a video to the observer. The observer then manually inspects the conditions inside and takes the decision to perform further actions depending on the situation.	The robot itself is trained in few aspects to inspect the pipe. These aspects include crack detection and blockage detection.

3.	1. Pooja G M 2. Niharika S N 3. Kavyashree M S 4.Chandrashekhara GN	Inpipe Inspection Robot	This robot is capable of finding blocks using sensors and clears the path through milling.	The proposed system gives an extension by detecting cracks and rectifying them using linear actuators to plaster the crack by using semifluid.

4. CONCLUSION

Robots can be effectively used as tools to carry out work in labor intensive, hazardous and unreachable work environments. Pipeline systems are one such environment. In this project, a robotic system based on wall pressed mechanism is proposed which aims at providing adaptable structure and autonomy. The objective of this research is to build a robot that can be operated in different modes such as obstacle detection, crack detection and rectification of minor cracks. The robot is designed to be able to travel in forward and backward directions. This given prototype permits the usage of an ip-camera for visualization of in-pipe inspection, obstacles are detected using IR sensors and are cleared by flaps attached to the rotatory DC motor and cracks inside the surface of the pipe are detected and rectified by using image processing.

5. FUTURE SCOPE

The limitations can be overcome by broadening various features and its applications. The developments that can be made are mentioned below.

- The robot can be made adjustable for different dimension of pipe upon the usage of spring
- To make use of tilted and guide wheels for traversing bends in pipes.
- The vertical movement of the robot by using suction pipe.
- Adapting a 360 degree rotating camera.
- Implementation of long range sensors.
- To provide alternate design without links to facilitate better motion.

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