Review Paper on Design and Development of Pipe Inspection Machine

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Abstract - For long-distance inspection of main gas pipelines with various diameter series, a pipe inspection robot with active pipe-diameter adaptability and automatic tractive force adjusting has been created. Three sets of parallelogram wheeled leg mechanisms are circumferentially spaced out 120° apart symmetrically in its physical construction.

Key Words: Pipes, Inspection machine, Portable inspection robot, Low-cost fabrication.

INTRODUCTION

There are numerous pipelines that are essential in our lives, such as urban gas, sewage, chemical plants, nuclear power plants, and so on. Furthermore, pipelines are the primary means of transporting fuels and gases, and a lot of countries rely on pipelines as the primary mode of transportation. In our country, metropolitan gas pipelines can be up to 13,000 kilometers long, but because the majority of them were built in the 1980s, there have been several problems caused by ageing, corrosion, cracks, and mechanical damage by third parties. Inspection, maintenance, and repair activities should be undertaken on a continuous basis from now on. However, those activities necessitate massive resources, which may be difficult for gas businesses to manage because they are usually small and medium-sized. In the gas industry, efficient inspection equipment and an integrated maintenance program are essential. This paper introduces an in-pipe inspection robot for the inspection of pipe with pipe diameter flexibility. There have been several models produced for pipe inspection; however, this robot eliminates many of the disadvantages connected with them.

PROBLEM DEFINITION

Many problems might arise as a result of aged pipe networks, corrosion, cracks, and mechanical damage. As a result, continual activities for inspection, maintenance, and repair are highly desired. Robots with a flexible (adaptable) construction may boast environmental flexibility, particularly to pipe diameter, as well as greater dexterity, mobility, and the capacity to function in adverse situations. Pipe inspection robots have long been investigated, and various novel locomotion methods have been presented to address the multiple technological challenges related with changes in pipe diameter, curves, and energy supply. Although a thorough assessment of the literature is impossible due to space constraints, a few major groups can be recognized.

Objective:

In-pipe inspection robot with automatic adaptability to varied pipe diameters and the capacity to detect defects, cracks, corrosion, and blockages, among other things.

To create an adaptive robotic design that can be adjusted based on pipeline factors.

To incorporate a spring mechanism into the robot that can contract and extend in response to pipeline parameters.

To use a remote control to operate the entire system.

LITERATURE REVIEW

[1] Jong-Hoon Kim, Gokarna Sharma, and S. Sitharama Iyengar suggested the design and deployment of FAMPER, a single module completely autonomous mobile pipeline exploration robot that can investigate 150mm pipes. This robot is made up of four wall-press caterpillars, each with two DC motors. Each caterpillar's speed is regulated independently, allowing it to steer through 45-degree elbows, 90-degree elbows, T-branches, and Y branches. The novelty of this paper is that it demonstrates the possibility of using four caterpillar configurations for greater performance in all types of complicated pipeline networks. The robot system has been built and tested in several pipeline configurations.

[2] Atul Gargade1, Dhanraj Tambuskar, and Gajanan Thokal proposed that a robot be made up of three parts: a foreleg system, a rear leg system, and a body. The fore and rear leg systems are built with three worm gear systems set at a 120-degree angle with regard to each other to function inside a pipe of varying widths. The springs are coupled to each leg and the robot body to allow it to work in pipes with diameters ranging from 140mm to 200mm.

[3] Palwinder Kaur1, Ravinder Kaur, and Gurpreet Singh collaborated on a novel concept for handling bore well rescue operations without human intervention and inspecting any form of leakage in the pipe. In order to fit inside the pipe, a wheeled leg mechanism is used in this design. The legs are 120o apart circumferentially and symmetrically. The robot is designed to be adaptable, allowing it to alter its legs based on the dimensions of the pipeline. This structural design allows for pipe diameter adaption as well as changeable attractive force towards pipe walls.

[4] Robotics applications in many industries, particularly pipeline inspection, have been explained by Nur Afiqah Binti Haji Yahya, Negin Ashrafi, and Ali Hussein Humod. This review article was written to fulfil the Automation and Robotics module assessment requirement. The goals of this review paper are to examine several robotics applications in pipeline inspection, to learn about diverse robotics designs in pipeline inspection, and to highlight the difficulties and adaptability improvements in the robotics application that was used. It was determined at the end of this review study that advances were noticed in a few designs of the robot example, such as the Parallelogram Wheel Leg.

[5] Ankit Nayak and S. K. Pradhan built robots to remove human intervention from labor intensive and hazardous work environments. They are also used to explore inaccessible locations that are normally impossible to access by people. Pipe inspection falls into the same category since they transport harmful chemicals and fluids and, in most cases, have small interior diameters or bends that are inaccessible to humans. A screw driver type wall press adaptable wheeled In-pipe inspection robot is proposed in this research. It can go through vertical and horizontal pipelines, and it can easily pass through a pipeline's elbow. This model is made up of three modules: a rotor, a stator, and a control unit. Three wheels are installed on the Rotor module outer perimeter with a helix angle of Rotor wheels travel in the longitudinal direction inside the pipe, following the helical path on the internal surface of the pipeline.

DESIGN METHODOLOGY

Methodology

2.1 The device is powered by three permanent magnets direct current motors. The DC motor that we are utilizing in our project uses 12v and 10-watt power and outputs 10 RPM. The gear box is powered by a DC motor. A nut is placed on the shaft of the DC motor for installing it on the link. The wheel is directly bolted to the motor shaft.

Wheels: The pipe inspection robot's wheels are 75 mm in diameter and 25 mm in width. This wheel is composed of nylon. We used a total of six wheels in this case. The circle of the wheel has a rubber grip so that it does not slumber inside the pipe. Three wheels are idle, while the other three are propelled by a DC gear motor. These wheels grasp, pull, and push the robot inside the pipe.

Spring Arrangement: Springs are flexible machine parts that are used to apply force (or torque) in a regulated manner or to store and release mechanical energy. Flexibility (elastic deformation) is made possible by smartly designed geometry or the use of a flexible material. The springs used in pipe inspection robots are utilised to keep the robot in place inside the pipe. We can compress the robot and place it inside a variety of pipe diameters by applying spring compression. In our project, we employ three springs: two springs for holding the wheels at the front and back of the robot, and a centre spring for making the robot flexible while turning.

Toggle Switch: The toggle switch is used to move the project forward and backward. These switches are installed within the switch box and are wired to the DC motors and batteries. This is a spring-loaded toggle switch; when you release the forward or backward button, it will immediately return to its center position. The electricity used to power devices is controlled by electric toggle switches.

Ms Flat: MS flats are utilised in our project to make the robot arms. MS flats are employed because they are lighter in weight than angle or square pipes and take up less space when constructing mechanisms. The MS flat used in our project has a cross section of 18 x 3 mm. Flats are measured by their width (W) and thickness (T). The weight of a flat bar is simple to determine. Simply multiply the right alloy density by the desired part's length, breadth, and thickness.

Wireless camera: Wireless cameras are wireless transmitters that broadcast a camera signal. Figure 15 depicts the components. The camera is connected to a wireless transmitter, and the signal is transmitted between the camera and the receiver. This functions similarly to radio. A channel is also available for wireless cameras. The visual is obtained after the receiver has tuned in to the appropriate stations. The transmitter sends the wireless camera image to the receiver, which collects it and sends it to a computer or TV monitor, depending on the reception type.

Fasteners (nut and bolt): The nut bolt used to construct the pipe inspection robot is M6 in size. The M6 size was chosen since it is modest in weight and can readily support the load of our mechanism. They are mostly employed in our project for turning the mechanism and tightening the Bush on the shaft.

Battery: The battery is an electrochemical device that converts chemical energy into electrical energy. The battery's primary function is to provide a source of current for the cranking motor and other electrical equipment. It has a voltage of 12 volts and a current of 3 amps.

Pop rivet: In our project, 5 mm rivets are used to construct the robot. The rivet is used to link powder coated sheet to MS flat for the fabrication of exterior pipe. A rivet is a mechanical fastener that is permanent. A rivet consists of a smooth cylindrical shaft with a head on one end before it is attached. The tail refers to the part opposite the head. When the rivet is installed, it is inserted into a punched or drilled hole, and the tail is upset, or bucked (i.e., distorted), such that it expands to about 1.5 times the original shaft diameter, thereby holding the rivet in place. Pounding, in other words, forms a new "head" on the other end by smashing the "tail" material flatter, resulting in a rivet that is flatter.

Shaft: A shaft is a revolving machine element that transmits power from one location to another. However, in a pipe inspection robot, a shaft is utilized to assemble the entire mechanism. The shaft does not convey any tangential power, but rather serves as a chase for the entire project. The material used for the shaft is mild steel c45.

Sheet Metal: Sheet metal is metal that has been produced into thin, flat slabs by an industrial process. Sheet metal is a fundamental kind of metalworking that may be cut and bent into a number of shapes. In this project, sheet metal is utilized to make pipe. The powder coated sheet metal we're utilizing here is 26-gauge, which means it's 0.5 mm thick and weighs 3.9 kg per square meter.

Result

Pipe used for the demonstration is made of a powdered coated sheet plastic with 300 mm in diameter. The footpads are made of rubber grip just for the demonstration, but it may be need to use high friction footpads for real application. Both spring loaded arms are partially expanded at the initial position. The robot is subjected to the speed test. It is done by measuring time while the robot moves along the predetermined distance. It is shown that the average speed ranges 0.6~ 0.79 m/min and fifty percent decrease in speed while taking turn. By using lights and camera clear view of cracks and holes is shown on mobile and holes are visible on pipe from outside.

6.Conclusion

The design and manufacture of a pipe inspection robot has been shown successfully. The camera mounted for inspection purposes functions properly; the camera provides a clear picture of any cracks, obstacles, defects, rust, or holes. For non-insulated pipes, an LED light is put on the pipe inspection robot; if the pipe is cracked or holed in any way, a ray of light shines through the crack, allowing us to readily detect the damaged areas. Three springs are put on the robot, which functions flawlessly. The two springs positioned on the front and back of the robot offer a firm grasp on all six of the robot's arms. This robot can go through pipes ranging in size from 300 mm to 500 mm. Because of the spring, the robot has a very good grip and does not slip inside the pipe, while the middle spring provides flexibility to the robot, allowing it to turn inside the pipe. The robot is controlled by a wired remote, and a wireless camera with a power bank is included. The pipe utilised in the demonstration has a diameter of 300 mm and is made of powdered coated sheet plastic. The footpads are made of rubber grip for demonstration purposes only; high friction footpads may be required for real-world usage. Both spring-loaded arms are half extended at the start. A speed test is performed on the robot. It is performed by measuring time as the robot travels along a predetermined path. The average speed is shown to be between 0.6 and 0.79 m/min, with a 50% decrease in speed when turning. By utilising lighting and a camera, a clear image of cracks and holes is displayed on the mobile device, and holes on the pipe are visible from the outside on the go.

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