Pipe Inspection Mechanism Robot

Varshil .H Patel[1], Prof. Neel M. Joshi[2], Prof.Swapnil Suresh Kumar Solanki[3], Prof. Jaimin R. Patel[4], Darshil A. Patel[5], Harsh R. Patel[6], Virendrasinh V. Bodana[7], Piyush Chaudhary[8]
[1,2,3,4,5,6,7,8]*LDRP-ITR*

Abstract-The paper presents original robot architecture for in-pipe inspection. The Robot consists of two parts articulated with a universal joint. One part is guided along the pipe by a set of wheels moving parallel to the axis of the pipe, while the other part is forced to follow an helical motion thanks to tilted wheels rotating about the axis of the pipe. A single motor is placed between the two bodies to produce the motion. All the wheels are mounted on a suspension to accommodate for changing tube diameter and curves in the pipe. The robot is autonomous and carries its own batteries and radio link Four different prototypes have been constructed for pipe diameters of 170, 70 and 40 mm, respectively. For smaller diameters, the batteries and the radio receiver may be placed on an additional body attached to the others. The autonomy of the prototypes is about 2 hours. This architecture is very simple and the rotary motion can be exploited to carry out scrubbing or inspection tasks.

The field of robotics applications continues to advance. This dissertation addresses the computational challenges of robotic applications and translations of actions using of sensors. One of the most challenging fields for robotics applications is pipeline-based applications which have become an indispensable part of life. Proactive monitoring and frequent inspections are critical in maintaining pipeline health. However, these tasks are highly expensive using traditional maintenance systems, knowing that pipeline systems can be largely deployed in an inaccessible and hazardous environment

I. INTRODUCTION

Everything from water to crude oil even solid capsule is being transported through millions of miles of pipelines in the United States. The pipelines are vulnerable to losing their functionality by internal and external corrosion, cracking, third party damage and manufacturing flaws. If a small water pipeline bursts a leak, it can be a problem but it usually doesn't harm the environment. However, if a petroleum or chemical pipeline leaks, it can be an environmental and ecological disaster. Thus, for keeping pipelines operating safely, periodic inspections are performed to find cracks and damage before they become cause for serious concern.

When a pipeline is built, many inspection methods can be used to evaluate its quality such as visual, X-ray, magnetic particle, and ultrasonic. These inspections are performed as the pipeline is being constructed so gaining access to the inspection area is not problem. Most pipelines are buried except some pipelines like the Alaskan oil pipeline. Once the pipeline is buried, it is undesirable to dig it up for any reason.

Therefore, many remote visual inspection equipments to assess the condition of the buried pipe have been developed. For inspection and recovery action of damaged pipeline, robotic crawlers of all shapes and sizes have been developed to navigate the pipeline. The video signal is typically fed to a truck where an operator reviews the images and controls the robot.

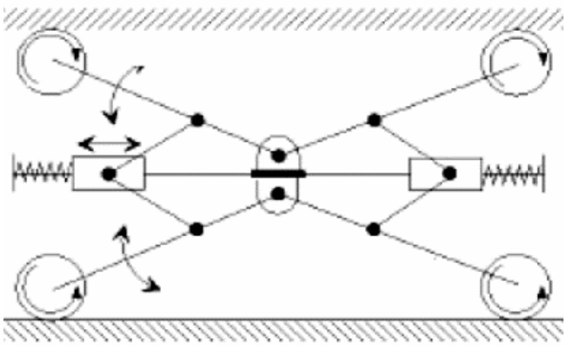
II. OBSTACLE IN PIPELINE

There are many areas where robots can be replaced for human; amongst them pipelines is one of the most challenging areas. Pipelines have been used in major utilities for a long time. Over billions of places, from huge plants to an individual house, robots are employed by people. But many troubles like aging, corrosion, erosion, cracks and physical damages from third parties, have occurred in pipelines. Therefore, maintenance of pipelines is essential in order to keep them functional, and moreover the continuation cost for these activities is being increased. Even with the above-mentioned problems in pipeline, people still prefer them. The reason being pipelines are used in transporting substances through a mere pipe. Most of the time liquid and gases are sent through pipes.

Pneumatic tubes that transport solid capsules using compressed air are also being used. Like gases and liquids, any chemically stable

III. ANALYSIS OF THE LINKAGES IN THE STRUCTURE OF ADAPTABLE IN-PIPE ROBOTS

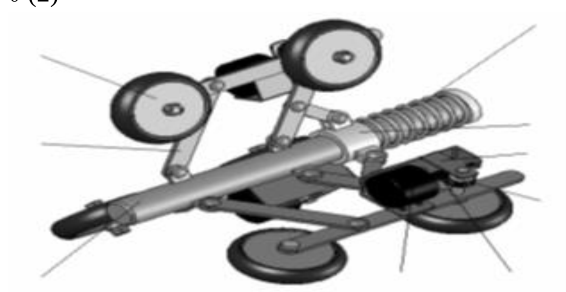
Most of the in-pipe robots take the mechanisms derived from several basic mechanisms or their combinations. For example, the robots are based on the mechanisms given in respectively 3, b the picture and the kinematic scheme of the in-pipe inspection robot called MRINSPECT *Multifunctional Robotic crawler for IN pipe inspection*) [2] is presented. It has six slider-crank mechanisms, arranged at120° one from each other, each of these having a driving wheel.



The wheels are actuated by DC motors, and belt transmission. The robot is designed as the springs to actuate the mechanisms with equal forces. This structure allows the robot to move within pipes with horizontal, vertical, and elbow-typed portions. The force that the mini robot mechanism exercise son the pipe walls is generated with the help of an extensible spring. The helical spring disposed on the central axis Assures the repositioning of the structure, in the case of the pipe diameters' variation.The components of the mini robot are : *1* – helical spring, *2* – translational element,*3* – actuator support, *4* – worm wheel, *5* – worm gear, *6* – actuator, *7* – central axis, *8* – link, *9* – wheel. The wheels at the back are driven by three DCSANKO motors, through reduction transmissions. The weight of the mini robot (the weight of current feeding wires is also considered) is 987 g, and the wheels have the radius r = 25 mm and the length 17 mm; the component elements have the lengths: 1 30 mm h = 2 h =70 mm , 3 h =105 mm .In the present paper, we proposed two wheeled type in-pipe mini robots characterized by an adaptable structure based on linkages mechanisms. Compared with the above-presented robots, our prototypes are characterized by a simple structure and kinematics, small number of actuators, light weight, low power consumption The actuation of the driver wheels is made through two worm gears with 1 2 52 z = , .This mini robot has movement capacities for inspection in 140 -200 mm diameter pipes in horizontal or vertical configuration.

The robot's height can be determined with the relation(h =OA h = BC = DE h = CF 1 2 3 , ,)) 2 H = 2r + 2d + 2h cos θ (1)where r is the radius of the wheels and d is the distanced' (EE'= d = 28 mm).The maximum and minimum height of the robot

can be determined based on the angle θ, (θ ∈ 15°÷ 60°)and on the lengths of the elements h1, h2, with the relation[4]( ) 2 *min/ max* 2 *max/ min H* = *r* + *d* + *h cos* θ (2)



Where *min* θ and *max* θ are the maximum and minimum limits of the angle θ .The mini robot is powered through wires and it is controlled with the aid of a microcontroller *ATMEL Atmega8535*.An interface realized in *Delphi* software was developed. The drive DC motors can be powered with the voltage between 3-12 V. The presented structure allows the usage of a CCD camera for pipe inspection or other devices needed in detecting of a malfunction in the pipes (remote-controlled laser measuring systems, sensors).In the 3D model of the mini robot in a curved pipe is illustrated. For pipes with elbows (tubular network in T or L shape) we propose the usage of mini robot which is made of two modules connected with a spherical joint. The model of this structure, which will be developed in the near future, is presented in.

It is more compact from the constructive viewpoint and uses a single DC motor for actuation, disposed on the main axis of the mini robot . Transmission of motion from the driving motor to the wheels of the mini robot is realized using three transmissions with gears. The DC motors equipped with speed reducer can be powered with the voltage between 4-6 V. The maximum current is 50 mA and maximum torque is220 N cm.

One of the most important issues in the design of the mechanism from the structure of the robot is how to obtain the traction power enough to pull instrumentation and the robot itself. On the condition that the wheels do not slip over pipe surface, the traction force by wheel is proportional to the friction coefficient and pressing force between the wheel and the pipe surface. Since the friction coefficient depends on the wheel material and surface condition of pipe, the link mechanisms that are able to adjust tthe wall pressing force are to be designed note: *1* – worm, *2, 3, 4* – gears, *z*1 =1 one thread, 4 44 *z* = teeth.

Denoting with *n M* the motor rotation frequency and with *n R* motor wheel rotation frequency from the expression of gear ratio For the development of a modular robotic system second module having in its structure the same mechanism) was realized

Using the two modules connected by a universal joint a prototype of a modular robotic system with adaptable structure, as is presented in was developed. The first module generates traction force. The joint disposed by the two modules of the robot offers the capacity of orientation of this one. The second module is necessary for the transportation of the necessary equipment for performing the in pipe inspection. Conclusions In this paper two wheeled-type in-pipe mini robots are proposed. A very important design goal of these robotics' stems is the adaptability to the inner diameters of the pipes. Thus, the studied mini robots are characterized by an adaptable structure, based on linkage mechanisms. The prototypes were designed in order to inspect pipes with variable diameters within 140 and 200 mm. The modular robotic system is still in the phase of development.

IV.LIMITATION

Pipeline inspection robots have such limitations, as
(i) their capability to turn in a T-shaped, curved pipes and move in plug valve.
(ii) Another drawback of earlier pipeline inspection robots is that friction between the pipe and cables for communication and power supply makes it difficult to move long distance. A fiber optic communication system can reduce the friction.
(iii) Some of the pipeline inspection robots does not work in water.

V. ADVANTAGE

- Man can not enter in the small pipes for inspection so this system used there.
- To avoid leakage of crude or water from pipeline.
- Maintenance cost low.
- Easy to operate.
- Inspect borewell pipe lines.

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