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"Pipe Inspection Robot" – Review

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Abstract:* a pipe inspection robot is a device or an instrument use to inspect and clean the pipe either an industrial or non-industrial. This is an innovation that took place in recent year to eliminate the human factor from the work of inspecting and cleaning the pipe which is a risky task. Pipe inspection robots are used in many fields of industry and also in other work such ask cleaning and maintaining the city pipe line. The work of industrial pipe inspection robot is to monitor the inside view of the pipes, to keep the notice on the various changes and recognizing the irrelevant changes, which may cause problem and to take preventive action to prevent the problem. If the problem has been recorded then take initiative action to solve the problem. Though the industrial pipe inspection robot is monitoring the inside view of pipes still it can find out the outer surface problem of pipe such as crack formation and this can be done with the help of ultrasonic sensors, which will be a part of our project. The pipe inspection robot can be use for the cleaning purpose by adding and attachment to it, such as scrapper which will scrap out the unwanted dross from the pipes. Automated inspection of the inner and outer surface of a pipe can be achieved by a mobile robot i.e Radio Frequency controlled robot, which uses relays and microprocessor with RF receiver to transmutes the single. Because pipelines are typically buried underground or they are bolted on walls, they are in contact with the soil, atmospheric air and subject to corrosion. This condition under which pipe lives may cause the reactions due to which it may get subjected to problem such as corrosion and this corrosion can occur on both sides of outer, due to conditions and inner, due to the fluid it carrying. Hence the strength of pipe reduces. If crack goes undetected and becomes severe, the pipe can leak, leads to loss. Pipe inspection is necessary to maintain the plant in best working conditions by detecting the problem and preventing them or making them correct at time.

In this work, we made a pipe inspection robot based on four bar linkage with actuators to give movement and it can travel according to the shape and position of pipes.

Keywords— Inspection robot, Actuators, Night Vision Camera, R F Receiver, R F Transmitter, R F Controller, Frame.

I. INTRODUCTION

A robot (also called a droid) is a machine, especially one programmable by a computer which is capable of carrying out a complex series of actions automatically. Robots can be guided by an external control device or the control may be embedded within. Robots may be constructed to take on human form but most robots are machines designed to perform a task with no regard to how they look. Likewise, Pipe inspection robot is a robot which is use to take care of pipes in terms of maintenance, cleaning and problem solving and preventing, controlled by radio frequency controller and monitor.

Robotics is one of the most innovative field in engineering which can change the complete work process by reducing the human factor in dangerous work and improving the efficiency and performance of the industry. Hence we can see the rising use of robots in various work process including home cleaning. Robot is a combination of mechanical mechanism, electronic sensors and controllers and artificial intelligence, such combination forms a robot which can be used to replace the work place of human to increase the speed the process by increasing overall efficiency of process.

The reason behind the idea of pipe inspection robot is mainly focused on the elimination of direct involvement of human from the work of inspection and cleaning of pipes, which are categories as precarious work. Because pipes are mainly buried underground or they are fitted at heights, which make them difficult to clean and inspect with casualty of danger while digging or climbing. Hence we are trying to create a robot which can shape according to the size of pipe and should be able track down the position of pipe (i.e horizontal and vertical).

In this project, we are four bar linkage to design the frame which has three fixed joints and one moving joint. In addition for the motion, actuator will be installed at various positions considering the traction factor. While radio frequency receiver and controller will use to controlling and receiving action which can be done by using relays. Relays will get mount on the links to receive and transmit the signals. Hence robot can be controlled from distance depending upon the range of receiver. Furthermore, for monitoring purpose, Night vision camera will come to use with this various sensors will also be in use to carry out the inspection purpose such proximity sensor, temperature sensor, Ultrasonic sensor etc. For cleaning, there will be an additional attachment such scrapper, cleaning brushes etc. This arrangement of comprehensive equipment makes the robot very useful in industrial activity of pipe

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inspection and cleaning.

II. LITREATURE REVIEW

In this paper on “Thermal Tracking in Mobile Robots for Leak Inspection Activities” by authors Aitor Ibarguren, Jorge Molina, Loreto Susperregiand and Inaki Maurtua. In this paper th6ey discussed, presents an autonomous robotic system to perform pipeline inspection for early detection and prevention of leakages in thermal power plants, based on the work developed within the MAINBOT (http://www.mainbot.eu) European project. Based on the information provided by a thermo graphic camera, the system is able to detect leak the collectors and pipelines. Beside the leakage directional algorithms, the system includes a particle filter-based tracking algorithm to keep the target in the field of view of the camera and to avoid the irregularities of the terrain while the robot patrols the plant. The information provided by the particle filter is further used to command a robot arm, which handles the camera and ensures that the target is always within the image. The obtained results show the suit ability often proposed approach, adding a tracking algorithm to improve the performance of the leakage detection system.

Fig.1: Robotic platform and thermo graphic camera.

This paper on “Review of Design and Fabrication of in Pipe Inspection Robots” by Prof. Kuber K.H., Praveen Kumar, Ashish Patil, Udayraj Yadav and Jashita Nair. In this review paper, authors have discussed different options to detect cracks, corrosion or third party damages in the pipelines. In-pipe leak detection means a using the unit for detection inside the pipeline. This consists of moving and non-moving methods for detection. These methods rely mainly on the usage of special sensing devices in the detection of gas leaks. Depending on the type of sensors and equipment used for detection. The design can be suitably changed according to the diameter of the pipeline under study. Slight variation inside the pipe will be automatically adjusted by the robot. The design can be used in any kinds of pipelines, let it be plastic, metal or any other kind as there will be pressure difference in all kind of pressurized pipelines.


Fig.2: design nxt-g.

This project report on mechatronics, by professor v. Kapila, giovanni del bufalo, gianluca notaro, alessandro rovardi. During the mechatronics class course at polytechnic university, New York a group of three people built a robot capable of moving inside pipes

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and detecting limestone clogs. In this paper describes in detail how cristonia, the robot, was ideated, designed, built and programmed. Design of the inspection robot depends on two main critical factors: size and shape of the pipeline. It will weigh strongly on the manoeuvrability of robot and its dimensions.

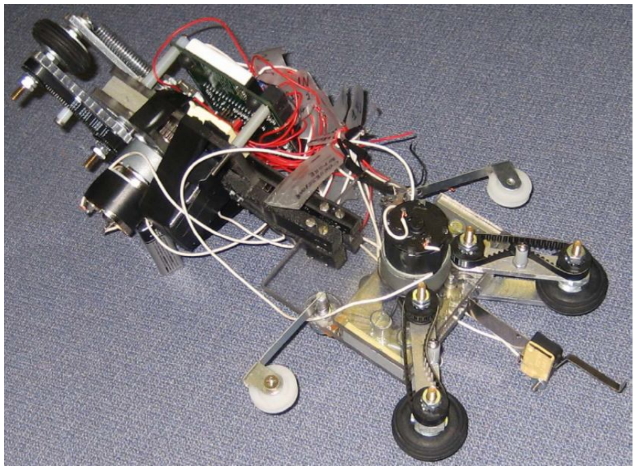

Fig.3: Mechanical design.

From this paper on "a simple architecture for in-pipe inspection robots" by authors mihaita horodinca, ioan doroftei, emmanuel mignon, andré preumont. They have presented 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.

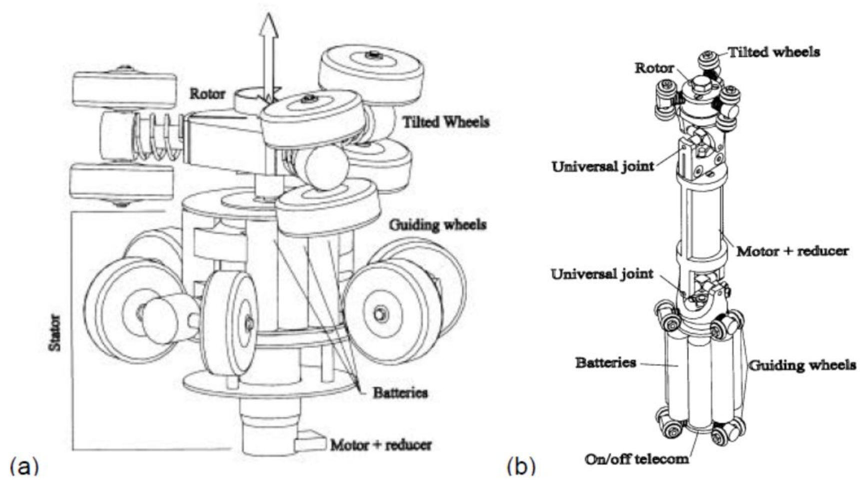

Fig.4: Robot architecture. (a) Two-body architecture for larger diameter (D-170) (b) Three body architecture for small diameter (D-40).

This paper on "In-pipe Robot with Capability of Self Stabilization and Accurate Pipe Surface Cleaning", by Luis A. Mateos and Markus Vincze. During their investigation on this topic there main challenge is to accurate place the robot in the center of the pipe while overcoming the push back forces and vibrations caused in the cleaning process, so that the cleaning tool is able to focus on desired area of the pipe surface. This paper presents the overall design of an in-pipe cleaning robot DeWaLoP, which includes a suspension system to position itself as a rigid structure stably in the center of the pipe, while the H configuration of the robot arm is

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able to stabilize the cleaning tool in the cleaning process, to reduce the vibration and push back forces.

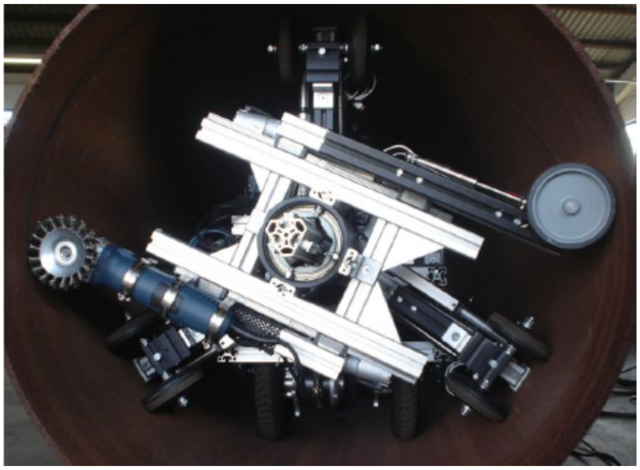

Fig.5: DeWaLoP robot fixed inside the pipe.

In this review paper on "Pipe inspection system," by authors Pramar P. Bakane, Prashant Mujbaile. They discussed, 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. So this paper gives a review of various methods of pipe inspection considering the advantages and disadvantages of existing systems.

In this paper "Defect identification in pipe lines using pipe inspection robot", by E Navin Prasad, M Kannan, A Azarudeen and N Karuppasamy. They analyzed with Pipe Inspection Robot (PIR) with ability to move inside horizontal and vertical pipes has been designed and fabricated. The robot consists of a motor for driving and camera for monitoring. Automated inspection of the inner surface of a pipe can be achieved by a mobile robot. 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. Although it's less common, corrosion also can occur on the inside surface of the pipe and reduces the strength of the pipe. If crack goes undetected and becomes severe, the pipe can leak and, in rare cases, fail catastrophically. Extensive efforts are made to mitigate corrosion. Pipe inspection is necessary to locate defects due to corrosion and wear while the pipe is transporting fluids.

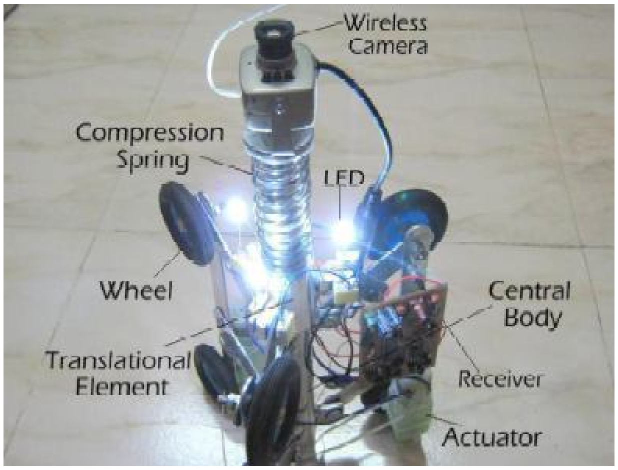

Fig.6: Picture of PIR.

In this paper on "Worm Robot with Dynamic Adaptation to Pipe Diameter for In-Pipe Inspection", Basem F. Yousef and Nabil Bastaki. This paper proposes an in-pipe inspection robot that can adapt to changes in pipe diameter. The sophisticated design and configuration of the robot enables it to travel autonomously through pipes and adapt to diameters changing from 65mm to 220mm. It consists of two clamping modules and one module for steering and locomotion. The clamping modules utilize flexible spring sheets to enable the robot to dynamically adjust its radial dimension and clamping force to attach to pipes of different inner diameters and handle sudden or smooth changes in pipe diameters. A middle module is engineered to enable the robot to not only propel through the pipeline, but also to steer into the desired direction when approaching elbows or junctions. The robot finds its obstacle-free path using a set of sensors mounted on the robot nose.

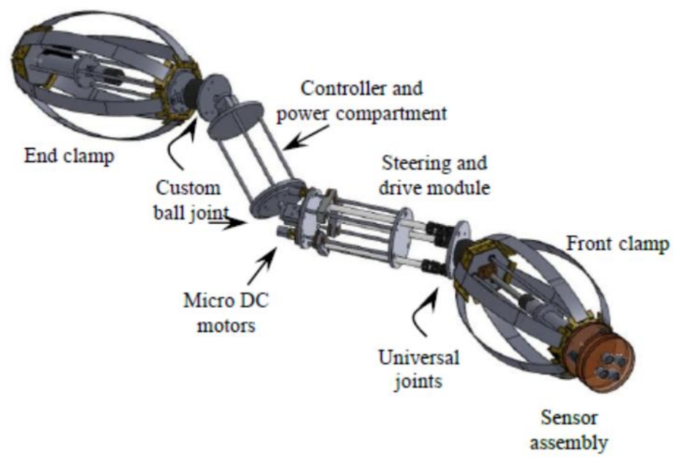

Fig.7: A 3D CAD model of the robot showing the different modules.

his paper on "Design and Control of In-pipe Inspection Robot," by Ngo Cao Cuong , Nguyen Thanh Phuong , Duong Vu Van. This paper proposes an inpipe inspection robot with the wall-pressing force adjustment using DC motor. It is developed for long distance inspection in sea-water pipelines such as horizontal pipelines and slope pipelines with large variable diameters from 600mm to 800mm. Its mechanical design consists of two modules as driving module and control module. The driving module has three pantograph type links spaced in 120° with three caterpillar track wheels. This design makes it possible to realize the adaptation to pipe diameter and the adjustment of wall-pressing force. The control module consists of a micro controller, motor driver and sensor interface. To control the in-pipe inspection robot, firstly, the inpipe inspection robot is considered as a dynamic model of mass-spring-damper system. Secondly, an observer is designed to estimate the unknown wall-pressing force to sustain the robot in pipeline. Thirdly, an algorithm of wall-pressing force generator is presented to find out an appropriate reference value of wall-pressing force. Fourthly, PID fuzzy controller is designed to make the estimated wall-pressing force track the reference values irrelatively to variable diameter of pipeline. Finally, the driving tests results of the developed inpipe inspection robot are shown to prove the effectiveness of the proposed controller and the applicability of the developed inpipe inspection robot.

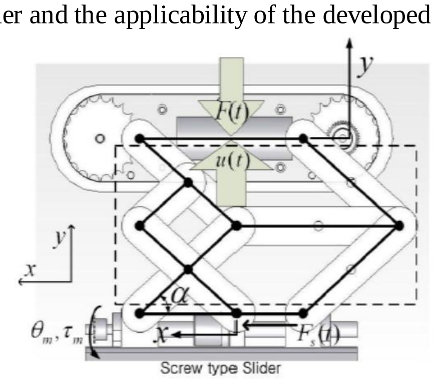

Fig.8: Model of pantograph type link.

In this paper on "advanced pipe inspection robot using rotating probe," by Kentarou Nishijima, Yixiang Sun, Rupesh Kumar Srivastava, Harutoshi Ogai and Bishakh Bhattacharya. In this paper authors discussed for these reasons, we measured the properties of wireless radio signal with steel pipes and ceramic pipes and we developed a practical wireless radio communication system. On the other hand, the Indian Institute of Technology Kanpur has researched a rotating probe using piezo element for inspecting the inside of pipes with a touch sensor system. This time, we developed and tested a new inspection robot that had integrated both the inspection system using wireless radio communication and image transmission developed by Waseda University and the inspection system using the rotating probe developed by the Indian Institute of Technology. In this experiment, we confirmed that we could drive the robot by wireless radio communication system in the inside test pipe and collect the image and some signals from the rotating probe.

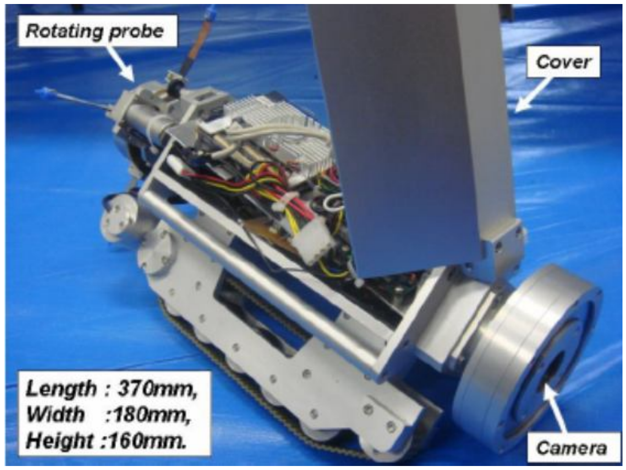

Fig.9: Inspection robot (Mogurinko).

In this paper on "Design and Development of In-Pipe Inspection Robot", by authors Atul A. Gargade and Dr. Shantipal S. Ohol. This paper shows the comparative study of different in-pipe inspection robots. Section VI shows the new developed steering mechanism for improvising working style of in-pipe inspection robot. Still the applications of in-pipe inspection robots are limited according to pipeline material, pipe size and working environment. In-pipe inspection robots are used to inspect varies pipeline elements such as straight pipelines, elbow and branches internally. In-pipe inspection robot inspect the pipes of various size and find the defects and obstacles in the pipes. There are many in-pipe inspection robots which are differ by their power source, steering mechanism and application.

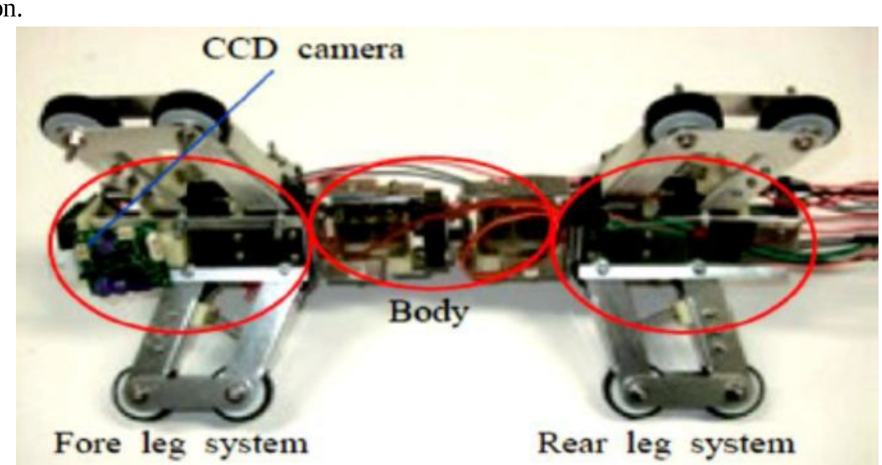

Fig.10: In-pipe inspection robot.

In this paper on "Design of a New In-Pipe Inspection Robot", by authors Ankit Nayak and S. K. Pradhanb. This research work presents investigations into design issues pertaining to development of In-pipe inspection robotics and proposes a new model of an In-pipe inspection robot to overcome some critical design issues. This proposed model is a screw driver type wall press adaptable wheeled In-pipe inspection robot. It is able to move through vertical, horizontal pipes and it can easily pass through elbow of a pipe line. This model comprises of three modules- rotor, stator and control unit. The Rotor module has three wheels mounted on the outer periphery with a helix angle of 15̊. Wheels of rotor follow the helical path on the internal surface of pipe line and move in the longitudinal direction inside the pipe.

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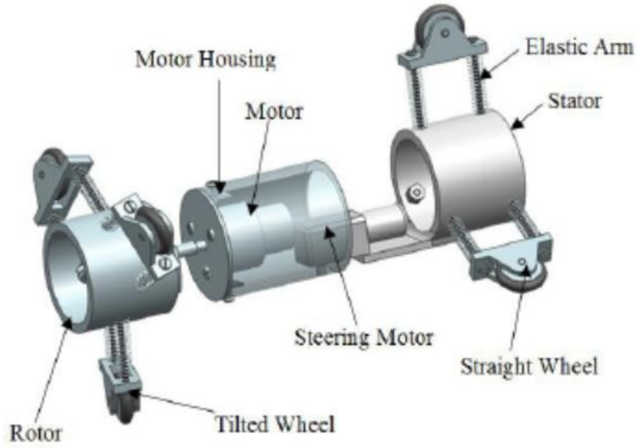

Fig.11: Solid model of new in-pipe inspection robot.

III. CONCLUSIONS

There are some many design configuration has been used for pipe inspection robot as showed in paper, some may have same mechanism or driven action or communication network but they are identically different from each other. As there application focused on only one purpose of inspecting and cleaning with no or less involvement of human. That's the reason we are working on designing the robot which adapt according to size of pipe considering circular pipe. Hence we have chosen the four bar linkage for our robot which is implemented on the frame of robot. Furthermore we have used many sensors and night vision camera for the purpose of inspection with scrapper for cleaning. So we believe with our project we will be able to inspect and clean the pipe effectively and efficiently.

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