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# Design and Manufacturing of Pipe Inspection Robot

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***Abstract:*** *Many kinds of pipes are being utilized to construct important lifelines such as water and gas supply in our contemporary society. Also pipes are widely used in chemical industries and in gulf countries for carrying petrol, diesel, oil etc. But after some years these pipes get damaged and defects are occurring in pipe. If the defects in the pipe are caused by rust and nature calamity, it is difficult to find out the defects and the location of the defects, and also there is great amount of loss of fluids and gases. Thus scheduled inspection must be done. If we decide to do this inspection manually then large amount of time, effort and labour is necessary to grub up the pipes that are buried in the ground. If the robot can inspect inside the pipes, fast and accurate examination will be able to be done at low cost. Size and shape adaptability will be achieved by lead screw mechanism.*

***Keywords:*** *pipe, petrol, diesel, fluids, gases.*

## I. Introduction

Robotics is one of the fastest growing engineering fields, presently they are used for wide variety of works especially in manufacturing industries e.g. spot welding, loading, and unloading of the tool and work piece, painting etc. Primarily robots are designed in such way that they reduce human intervention from labor intensive and hazardous work environment; sometimes it is also used to discover inaccessible workplace which is generally impossible to access by humans. The complex internal geometry and hazard content constraints of pipes require robots for inspection purpose. With these constraints, inspection of the pipe becomes so more necessary that, tolerating it may lead to some serious industrial accidents which contaminate environment and loss of human lives also.

For inspection of such pipes, robot requirement is must especially in order to check corrosion level of pipe, recovery of usable parts from pipe interior, for a sampling of sludge and scale formation on pipe internal surface etc. Designing of a new in-pipe inspection robot is carried out in this research work. It involves kinematic and dynamic analysis of screw drive type robot. Kinematic calculations are performed to find the trajectory of rotor motion and to also to analyse the motion of the robot in the straight and curved pipeline. From the dynamic equation of robot, the effect of frictional force, drag force, and mass of the robot are analysed on the robot to find the required minimum motor torque for moving in horizontal, inclined and vertical pipelines. After performing design steps, the solid model is prepared in CATIA V5 of the proposed robot. Motion simulation and experimental study are performed with the help of this solid model and an initial robot prototype.

Inspection of pipeline is an important task so as to ensure there are no defects that may eventually lead to problems such as leakage, which in the worst case scenario may lead to a fatal hazard such as an explosion. Primarily robots are designed in such way that they reduce human intervention from labor intensive and hazardous work environment; sometimes it is also used to discover inaccessible work place which is generally impossible to access by humans. The complex internal geometry and hazard content constraints of pipes require robots for inspection purpose. With these constraints, inspection of pipe becomes so more necessary that, tolerating it may lead to some serious industrial accidents which contaminate environment and loss of human lives also. For inspection of such pipes, robot requirement is must especially in order to check corrosion level of pipe, recovery of usable parts from pipe interior, for sampling of sludge and scale formation on pipe internal surface etc. On other hand many researchers have a research on pipe inspection robot, in these research they have taken the different criteria or different pipe diameter for the inspection of the pipelines. A Two specific mechanisms in the robot are important for successful locomotion: the Adaptable Quad Arm Mechanism (AQAM) and the Swivel Hand Mechanism (SHM). The second project is robot is design using only two wheel chains and inspection pipe is 80 to 100mm. Used screw drive chain and inspection of pipe is curve. In a robot, using worm gear, the pipe of diameter 180 to 200mm were inspected. Inspection and repair robots for waste water pipes, a challenge to sensory and locomotion and design issues. The works deals with the design and prototyping of an apparatus to traverse piping systems for inspection, cleaning and or examination of the piping systems and using non-destructive technique. All pipe lines become old after several years use e.g. steel pipes in factories, steel pipe carrying water or gas, ceramic pipes, concrete pipes and plastic pipes. In order to inspect

and repair these pipes, a flexible automatic inspection robot is needed. In addition, in order to control the inspection robot and transmit the collected data to the terminal, which is located at the pipe inlet, a wireless communication system for life time Maintenance was developed and its performance was analysed.

## II. Problem & Statement

A pipe inspection robot is a device or an instrument use to inspect the pipe either an industrial or nonindustrial. This is an innovation that took place in recent year to eliminate the human factor from the work of inspecting 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. To design and develop pipe inspecting robot which will travel in the pipe and provide its actual video footage to the operator. To guarantee excellent performance in pipe inspection we implemented chuck jaw mechanism. Mathematical modelling will be done in CATIA V5 and analysis will be done on ANSYS 14.5 rigid body dynamics. To improve the reliability of the product the actual model will be built. This robot model will be used as the base robot model for in pipe inspection robot. It should have size and shape adaptability to go through pipes of diameter ranging from 16 to 20 inches.

## III. Literature Review

**1)Jong-Hoon Kim, Gokarna Sharma, and S. Sitharama Iyengar** have proposed the design and implementation of a single module fully autonomous mobile pipeline exploration robot, called FAMPER that can be used for the inspection of 150mm pipelines. This robot consists of four wall-press caterpillars operated by two DC motors each. The speed of each caterpillar is controlled independently to provide steering capability to go through 45-degree elbows, 90-degree elbows, T-branches, and Y branches. The uniqueness of this paper is to show the opportunity of using 4 caterpillar configuration for superior performance in all types of complex networks of pipelines. The robot system has been developed and experimented in different pipeline layouts.

**2)Atul Gargade1, Dhanraj Tambuskar, Gajanan Thokal** have proposed that Many kinds of pipes are being utilized to construct important lifelines such as water and gas supply in our contemporary society. Also pipes are widely used in chemical industries and in gulf countries for carrying petrol, diesel, oil etc. But after some years these pipes get damaged and defects are occurring in pipe. If the defects in the pipe are caused by rust and nature calamity, it is difficult to find out the defects and the location of the defects, and also there is great amount of loss of fluids and gases. Thus scheduled inspection must be done. If we decide to do this inspection manually then large amount of time, effort and labour is necessary to grub up the pipes that are buried in the ground. If the robot can inspect inside the pipes, fast and accurate examination will be able to be done at low cost. Size and shape adaptability will be achieved by chuck-jaw mechanism.

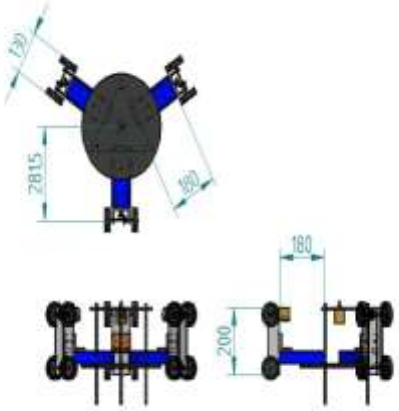
**3)Palwinder Kaur1, Ravinder Kaur, Gurpreet Singh** have worked on innovative concept to handle the bore well rescue operations without human intervention and to inspect any type of leakage in the pipe. Wheeled leg mechanism is employed in this design to go inside the pipe. The legs are circumferentially and symmetrically spaced out 120º apart. The robot is made adaptive so that it can adjust its legs according to the pipeline dimensions. This structural design makes it possible to have the adaptation to the diameter of the pipe and to have adjustable attractive force towards the walls of the pipe.

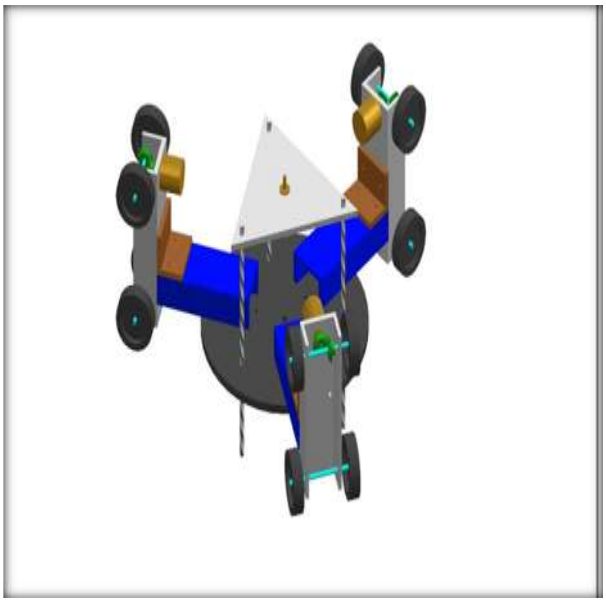
**4)Nur Afiqah Binti Haji Yahya, Negin Ashrafi, Ali Hussein Humod** Robotics application has slowly increasing for the past 13 years. Much increase was seen in 2011. This review paper was written to study the robotics application in various industries mainly in pipeline inspection. This review paper was to fulfil the requirement of Automation and Robotics module assessment. The objectives of this review paper are; to observe different robotics applications in pipelines inspection, to learn the different design of robots in pipeline inspection, to outline the problems and adaptability improvements in the robotics application that was applied. The major problem of in-pipe inspection robots found is the different in diameter of pipes in any plant. And other problem relative to the inspection ways for different types of pipe applications. At the end of this review paper, it was concluded that improvements were seen in few designs of the robot example like the Parallelogram wheel leg.

## IV. Objective

- To make an adaptive robotic design so as to adjust it according to the pipeline parameters.
- To add grip to robot which can contract and expand according to the pipeline parameters.
- To control the whole system with remote.

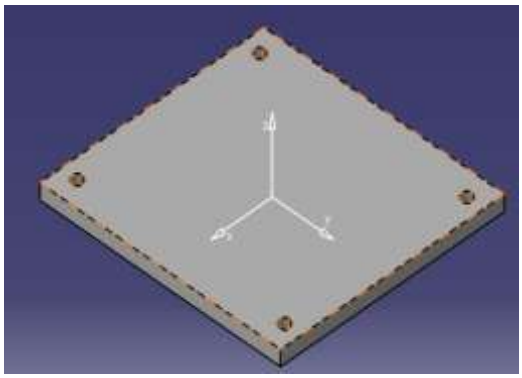
## V. Working Model



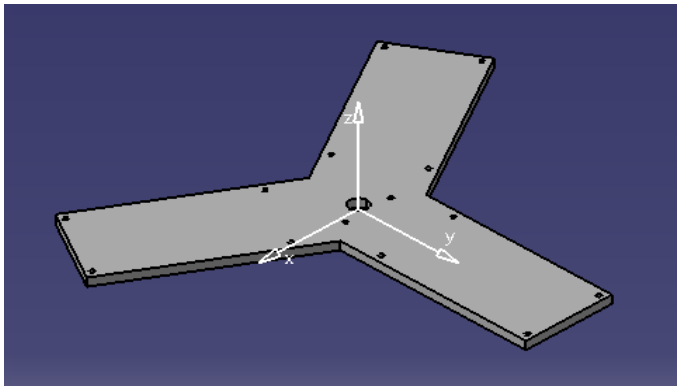



## VI. Catia Model

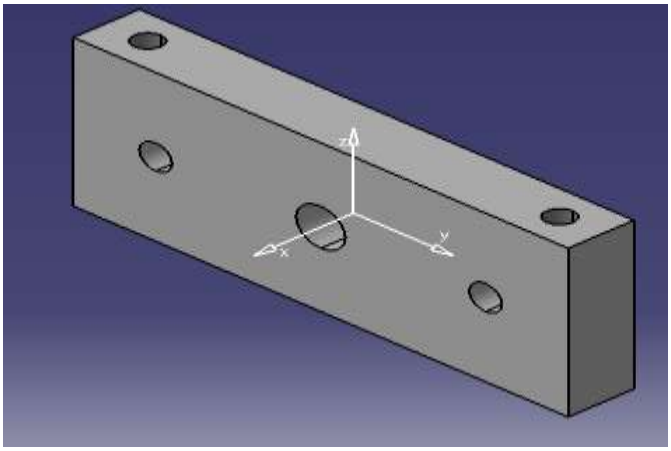
**1)Fixed Plate**



**2)Top Plate**



**3) Moving Plate**



## VII. Conclusions

robot for pipeline exploration that can be used for the inspection of 16 to 20 inches' pipelines. We have also described the chuck jaw mechanism that provides for the excellent size and shape adaptability according to the diameter of the pipe in vertical as well as horizontal pipelines. Our robot is equipped with a chuck jaw mechanism system which makes it extendable for more complicated tasks and provides easily extendable interfaces in the experiments, the robot showed outstanding mobility in 16 to 20-inch pipeline layout. Mechanical design of-of all robot components is safely done. Modeling and assembly of all robot components are done on CATIA V5. Stress analysis of major components of the robot is separately carried out on ANSYS 14.5. Stress analysis results are matching with the analytical result and both values are less than permissible values. It also shows that optimization method is successfully applied to various parameters of robot .by using the chuck jaw mechanism the robot is optimally designed to crawl through the different pipe diameters smoothly which ensures the mobile stability as well as adaptability in various diameter pipes. The stresses on the parts are more when the motion of in vertical pipes and low in the horizontal pipe as it has to sustain its weight against gravity while moving in vertical pipes. This robot will reduce the human interference in the hazardous environment. It can do the pipe inspection beyond human reach.

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