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

DESIGN OF PIPE INSPECTION ROBOT FOR NON DESTRUCTIVE TESTING

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Abstract - *Pipelines are important means of transportation of gas, water, fuel oils, etc. in various fields. The transportation loss occurs due to aging, corrosion, obstacles, crack and mechanical faults in the pipe line. The lifetime of pipeline can be increased by regular inspections and maintenance and recognizing the cracks, damages and faults. This helps in preventing transportation loss and maintaining profitable gross. Thus, this project aims to propose an autonomous robot used for in-pipe inspection which provides easy way of detecting crack and obstacles inside the pipe by using Non-Destructive Testing. This project is conceived to redesign the electronic as well as mechanical control systems. Requirements for the robot were that it must be able to operate in dark, compact and wet conditions. This is also to do for the redesign and construction of such robot. Its employees the electronic and mechanical components and provides video feedback via a custom graphic interface with the help of Non-Destructive Testing (Dye Penetrant Testing.). this allows the operator to operator to operate the robot remotely.*

Key Words: **Pipe inspection, Robotics, Non-destructive testing, Quality control, Dye penetrant testing**

1. INTRODUCTION

Robotics is one among the fastest growing engineering fields of today. Robots are designed to get rid of the human factor from labor intensive or dangerous work and also to act in inaccessible environment. The use of robots is more common today than ever before and it's not exclusively employed by the heavy production industries.

An in-pipe inspection robot has been designed which will affect many sorts of pipes with various diameters. Dye penetrant inspection is done with the help of the robot and cracks are developed. Liquid penetrant inspection (LPI) is a non-destructive evaluation (NDE) method used for verifying the presence of open discontinuities at the surface of analyzed parts submitted for inspection.

1.1 Early Robotic Inspection Systems

The early deployment of robotic NDT systems centered on visual inspection in inhospitable environments, with the Luna surface and nuclear incident zones prime examples. This section details some early robotic NDT systems and the development through to modern systems.

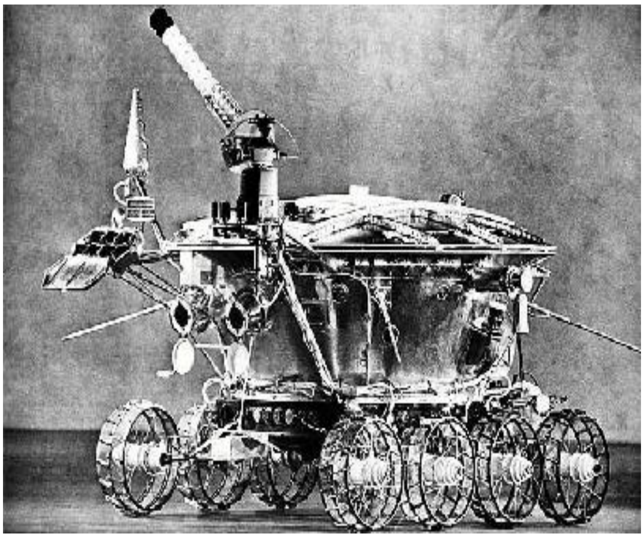


Fig -1: Historic Robotic Inspection Systems

In the late 1960s the Lunokhod 1 Luna rover was developed as part of a planned Soviet manned Luna mission, being launched in 1970. Due to the limited redundancy within the lander, it was designed to go in advance of a manned mission to inspect the lander for damage. Once the manned missions were abandoned it was re-purposed as the first tele-operated extra-terrestrial rover. It was equipped with four corner cameras for panoramic photos, two front facing cameras for operator feedback and an odometer wheel. It also had specialist scientific equipment, including: An X-ray spectrometer and telescope, cosmic ray detector and penetrometer (to measure soil density). Another early example of remote deployment of ultrasonic transducers can be seen in the work of Bridge et al. This work utilized a two-platform pneumatic climbing robot developed by The Institute of Problems in Mechanics, Moscow modified in 1992 to carry a 6-axis PUMA260 robotic arm and Silver wing Ltd dry coupled wheel probe to conduct raster scan inspections to generate C-scan plots on vertical steel plates.

2. DESIGN OF ROBOT

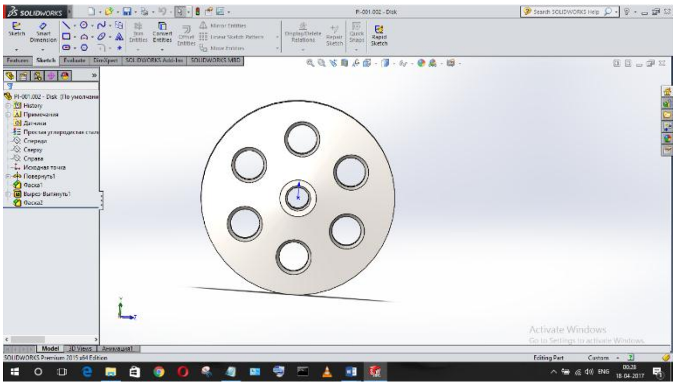


Fig -2: Design of Disk

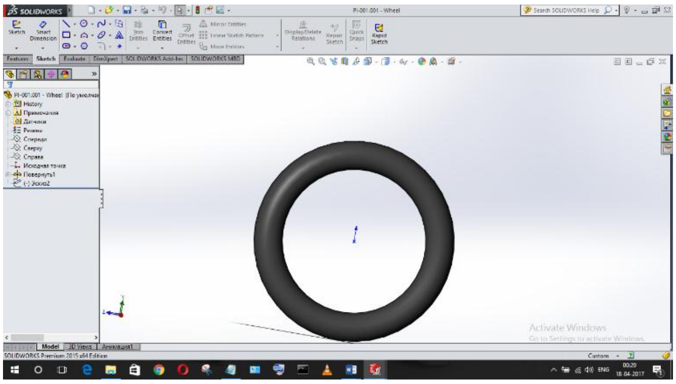


Fig-3: Design of wheel

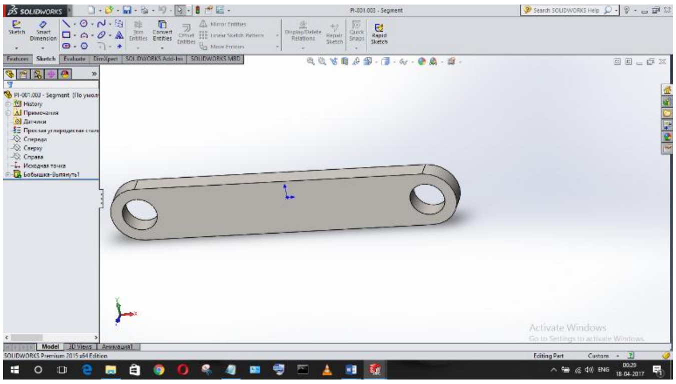


Fig-4: Design of segment

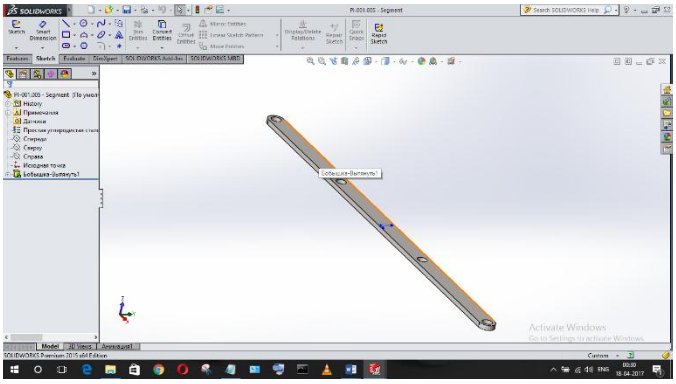


Fig-5: Design of segment

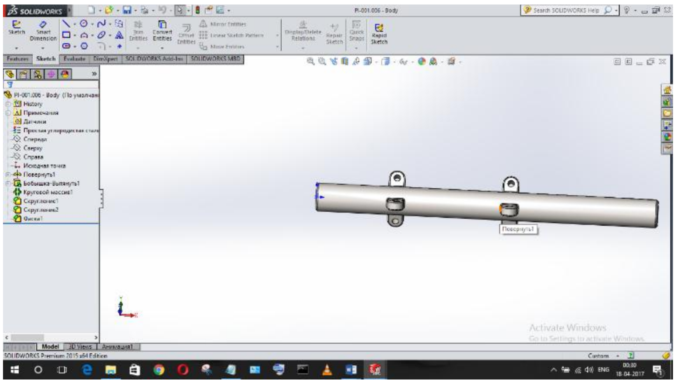


Fig-6: Design of body frame

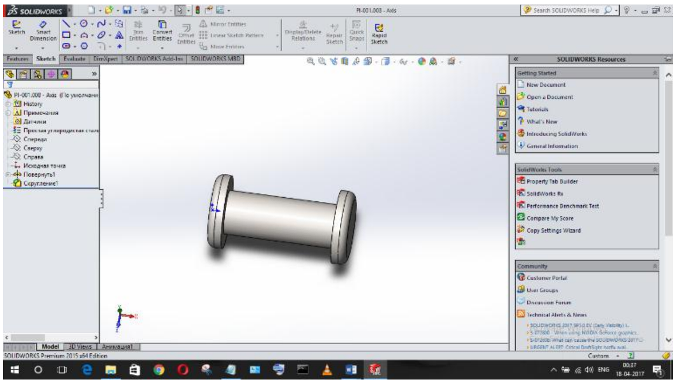


Fig-7: Axis

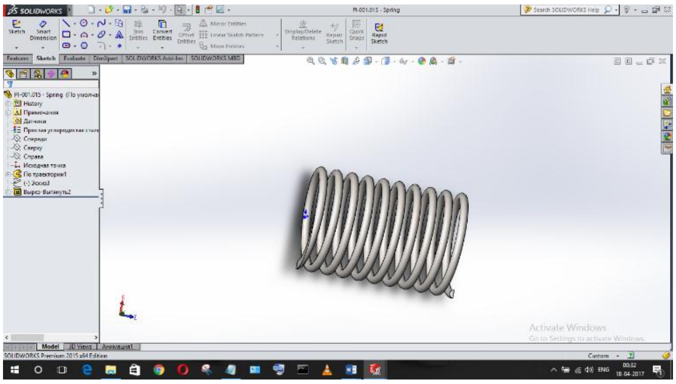


Fig-8: Design of a spring

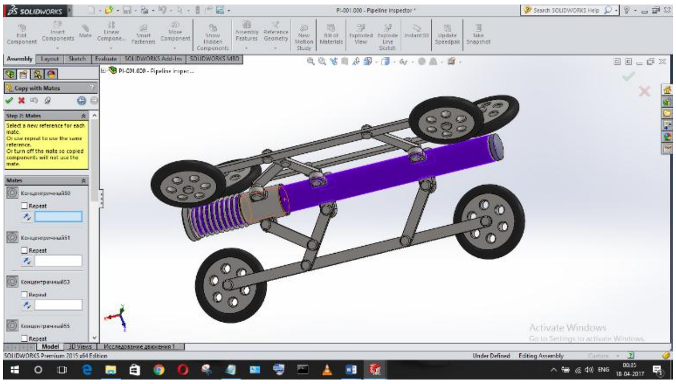


Fig-9: Design pipeline inspection robot

3. FABRICATION AND WORKING

3.1 Radial Arm Drill Machine

The biggest radial arm drill presses are able to drill holes as large as four inches (101.6 mm) in diameter. But for this project only holes of 5 mm and 6 mm were needed. The drilling was done on the aluminum sheets for the required dimensions and then the finished component was filed and reverses drilled using a larger drill bit for a good finish.

3.2 Boring Operation

The boring process can be carried out on a lathe for smaller operations, but for larger production pieces a special boring mill (work piece rotation around a vertical axis) or a horizontal boring machine (rotation around horizontal axis) are used. A tapered hole can also be made by swiveling the head.

3.3 Gas Welding

The most common gas welding process is oxyfuel welding, also known as oxyacetylene welding. It is still widely used for welding pipes and tubes, as well as repair work. Oxy fuel equipment is versatile, lending itself not only to some sorts of iron or steel welding but also to brazing, braze-welding, metal heating (for bending and forming), and also oxyfuel cutting. The equipment is relatively inexpensive and simple, generally employing the combustion of acetylene in oxygen to produce a welding flame temperature of about 3100°C.

3.4 Brazing

Brazing is the joining of metals through the use of heat and a filler metal—one whose melting temperature is above 840 °F (450 °C) but below the melting point of the metals being joined.

It joins them by creating a metallurgical bond between the filler metal and the surfaces of the two metals being joined.

Surface Grinding Operation is used to produce a smooth finish on flat surfaces.

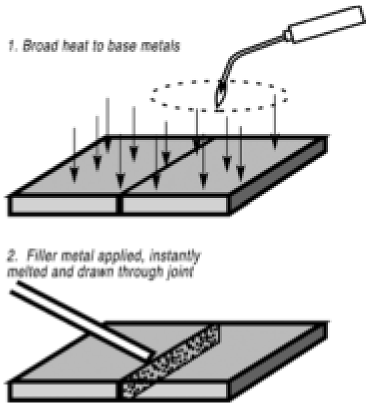


Fig-10: Welded joint

The fabrication phase of the project involves production of the parts designed. It also entails the selection of appropriate electronic circuitry which can be effectively used to achieve and control the robot motion. The various processes used in fabrication of the components are Cutting Drilling Welding Turning.

Fig-11: Holes drilled on link

Fig-12: Assembled robot

As Pipe Inspection Robot is designed mainly for circular bore pipes, it has ability to move inside any bore diameter pipes ranging from 8 inch to 10 inches. The PIR have ability to see inside the dark pipes where no human eyes can see. This made possible by mounting the surveillance camera. The output is sent to outside screen where the digital hi-quality image can be received.

The perfect fitness between the pipe and robot is first conformed after inserting the robot in the pipe. Then the supply of DC 12V dc current from is on for working of robot and the camera is also started. With the help robot control having three buttons, working of robot can be easily control the motions which is forward and reverse by one button and by other two buttons the motion which is swiveling and tilting of the camera head fitted in front of the robot can be control so that we can see the pictures and videos inside the pipe.

Working of PIR is starts from its insertion in pipe. The front three arms are compressed by hand and then inserted in the pipe and then back three arms are inserted by pushing the PIR. The motors driven are the first six arms mentioned here, they pull whole setup. PIR is about 175 cm in length and to move it freely inside Design and fabrication of pipe inspection robot. the bend pipes, a 2 degree of freedom joining is provided at the middle so that it can turn easily. As switch is on and current is flowing through wires, wheels starts moving and forces PIR to propel forward. Using the friction between wheels and pipe, the motion of wheels become possible.

PIR wheel motion is provided with 10 rpm, 12 V DC motors hence its speed can be maintained between - 10 to 10 rpm. The power provided to motors is from single 12V dc adapter hence load on each motor will be minimum that expected.

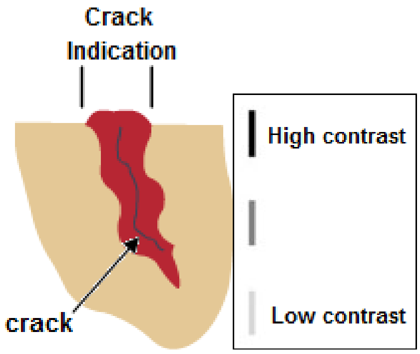
4. DETECTION OF CRACKS BY SPRAYING LIQUID PENENTRANT

The technique is based on the ability of a liquid to be drawn into a "clean" surface discontinuity by capillary action. After a period of time called the "dwell time", excess surface penetrant is removed and a developer applied. This acts as a blotter that draws the penetrant from the discontinuity to reveal its presence.

The advantage that a liquid penetrant inspection offers over an unaided visual inspection is that it makes defects easier to see for the inspector where that is done in two ways:

It produces a flaw indication that is much larger and easier for the eye to detect than the flaw itself. Many flaws are so small or narrow that they are undetectable by the unaided eye (a person with a perfect vision cannot resolve features smaller than 0.08 mm).

It improves the detectability of a flaw due to the high level of contrast between the indication and the background which helps to make the indication more easily seen (such as a red indication on a white background for visible penetrant or a penetrant that glows under ultra-violate.



Operator can control the robot and see the picture of the inside pipe on the output screen and thus if there is any defect such as such as internal material loss, big crack, weld defects dents corrosion erosion or blockage in the pipe. The exact location of the defect is judge by the distance meter provided on the robot it gives distance in centimeters from the starting point from which the robot was inserted inside the pipe. the distance the robot can travel i.e. the length which it can capable to inspect is depends upon the length of the extension cable provided to robot. To ensure the tractive force required pulling the long extension cable and other accessories, robot train can be used which can be made by joining the two or more robots through the universal joints at the end. The inspection can be done on the basis of video and pictures inside the pipe provided by camera. The result can be obtained directly on the basis of these pictures or with the help image processing.

With the help of required setup which consists of a pump, pipe, nozzle which are fitted accordingly at the PIR. The cleaner, penetrant and developer can be sprayed as required by pump-nozzle mechanism.
The Dye penetrant testing process consists of these following steps,
Step 1: Pre-cleaning or Cleaning the Surface

The presence of contaminants on the surface of the part may prevent an effective inspection by either filling a defect, thus preventing the penetrant solution (dye) from penetrating, or contaminating the fluorescent penetrant solution and interfering with the fluorescence process.

Fig-13: Cleaning the surface

Step 2: Penetrant application.

The penetrant dye is applied to the surface of the part for a dwell time which is sufficient to allow the dye to seep into any defects that are present.

Fig-14: Penetrant application

Step 3: Remove penetrant.

This usually involves rinsing part, often using an emulsifier to assist with the removal of the excess penetrant. In some applications the penetrant may be wiped from the inspection area.

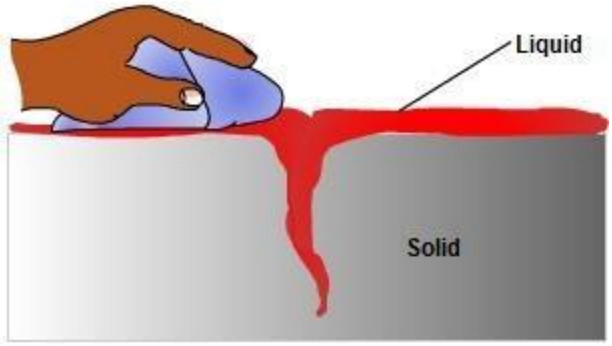


Fig-15: Remove penetrant

Step 4: Apply developer.

A developer is used to draw the trapped penetrant dye out of the defect onto the component surface and also provide a background against which the defect indication will be readily visible. In fluorescent penetrant systems

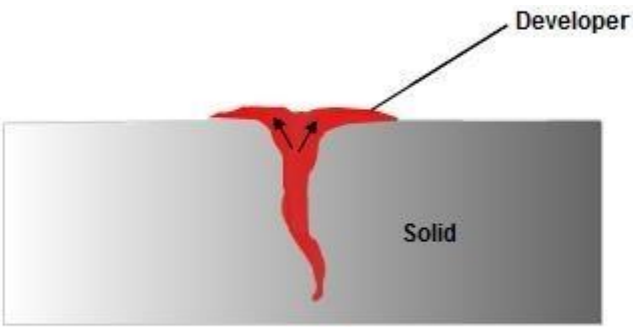


Fig-16: Application of developer

5. CONCLUSIONS

In this paper we have described the investigation into enhanced mobility to improve the accuracy of inspection for pipes through the development and investigation of a wheeled climbing robot. The paper begins propose an in pipe inspection robot which is composed of the adaptable mechanisms, placed at an angle of 120° degrees around the central shaft. Adapting to the interior surface of the pipe, a passive method is used which utilizes two preloaded elastic elements.

By describing the industrial motivation for this research, to investigate the application of robotics in the field of NDT to improve the speed, repeatability and accuracy of inspections focusing on a common industrial need to inspect ferromagnetic pipes for corrosion and weld defects.

ACKNOWLEDGEMENT

The research work for this thesis was carried out at the Mechanical Engineering department of Nawab Shah Alam College of Engineering and Technology during the period 2019-2020. This thesis has been a part of Major project submitted to Jawaharlal Nehru Technological University, Hyderabad in partial fulfillment of the requirements for the award of degree “Bachelor of Technology in Mechanical Engineering”.

The satisfaction and euphoria that accompany the successful completion of the project would be great but incomplete without mentioning people who made it possible with their constant guidance and encouragement. In this context,

We would cordially thank to our internal guide Mr. Md Mansoor Hasan, project coordinator Mr. Mohammed Aqeel Ahmed and head of Mechanical Engineering department Dr. Syed Mujahed Hussaini for all their technical guidance, constant encouragement and moral support in carrying out our project and making it a success.

We are also grateful to our principal, Dr. Syed Abdul Sattar and management of Nawab Shah College of Engineering and Technology under whose supervision the institution runs most successfully.

We would like to express out our heart-felt gratitude to our parents without whom we would not have been privileged to achieve and fulfill our dreams.

We would also like to express our gratitude to all the people behind the screen who helped us to transform an idea into real application.

REFERENCES

[1] Design and Development of Pipe Inspection Robot by Dr. Sharanabasappa C. Sajjan, Naveen Srivatsa H.S, Dinesh Kumar P.

[2] Robotic Pipe Inspection: System Design, Locomotion and Control William by Alexander Blyth.

[3] International Journal for Research in Applied Science & Engineering Technology (IJRASET) Volume 5 Issue VI, June 2017 ISSN: 2321-9653 "Pipe Inspection Robot" – Review by Dnyandeep Mandaokar, Pankaj Runghe Vivek Manne, Nagpur University.

[4] Fully-Automated Liquid Penetrant Inspection Line Simulation Model for Increasing Productivity Article in International Journal of Simulation Modelling • June 2013 by Diana Popescu, C.E Cotet, Darel Anania, Catalin Gheorghe Amza, Polytechnic University of Bucharest.

[5] Fatigue Surface Crack Detection by Using Fluorescent Dye Pentrant Test Technique on Welded Engineering Service Components by G.Kedarnath, KVS Phani, Rajesh Kumar Sahu, B.Kantharaju, Dept of mechanical engineering, KPRIT.

[6] Pipeline Inspection and Child Rescue Robot Bore Well Rescue Robot by N. Sree Nanda, N. Bineeth Patil, V. Sai Lakshmi, A. Vishnu Kumar, M Raju Naik, Jyothi K, MLR Institute of Technology.

[7] Introduction to Non-Destructive Testing Techniques Instructor: Dr. Ala Hijazi.

[8] Development of An In-Pipe Inspection Minirobot by M O Tătar, A Pop,Technical University of Cluj-Napoca.

[9] Pipe Inspection and Declogging Robot, Chandan. R., Wednse.C.A, Vishakh.V. S,Vishal Singh, Dr.Ambedkar Institute of Technology.

[10] Pipe Inspection and Cleaning Robot BY Abdullah Al Deghreer, Mohammed Alyami, Naif Al Mahasheer, Ahmed Al Shalawi.

[11] Non Destructive Method by Penetrant Testing by Shyamji, Dr. Suresh Prasad, Noida International University, Greater Noida. International Journal of Advance Research, Ideas and Innovations in Technology, ISSN: 2454-132X, (Volume3, Issue4).

[12] Machine Design Book by J.K. Gupta and R.S. Khurmi.

[13] A Textbook of Strength of Materials Book by R. K. Bansal.

[14] Manufacturing Technology Vol 2 by P.N. Rao.

[15] Production Technology (Manufacturing Processes) by P.C Sharma.

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