

Design & Development Of Pipe Inspection Robot

Dr. H.K. Mishra, Date Vedant Shivaji¹, Gadakh Prabal Prakash², Wadekar Chaitanya, Wagh Atharva Ganpat⁴

^{1,2,3,4} Bachelor Student, Department of Mechanical Engineering Rajashri Shahu Maharaj Polytechnic, Nashik

ABSTRACT

The inspection of pipelines is crucial for maintaining infrastructure integrity in industries such as oil and gas, water supply, and sewage systems. Traditional methods are labor-intensive and often inefficient, leading to the need for robotic inspection systems. This research presents the design and development of a pipe inspection robot capable of navigating through pipes of various diameters while capturing real-time data. The study explores the mechanical and electrical design, material selection, sensor integration, and control mechanisms. Finite Element Analysis (FEA) and experimental validation ensure performance optimization, making the proposed solution a reliable alternative to conventional inspection techniques.

Keyword : Pipe Inspection Robot Robotics in Pipeline Inspection Automated Pipe Inspection Systems Robotic Systems for Pipe Monitoring

1. Introduction.

Pipelines are essential for the transportation of fluids, gases, and other materials across industries. However, their maintenance poses significant challenges due to inaccessibility and hazardous environments. Robotic systems have emerged as a viable solution for pipeline inspection, offering automation, efficiency, and accuracy. This paper discusses the development of a pipe inspection robot, focusing on its design, components, advantages, and applications.

1.1 Problem Statement

Pipeline failures due to corrosion, blockages, and structural defects can lead to severe economic and environmental consequences. Existing inspection methods, such as manual inspection and fixed sensor networks, have limitations in accessibility and efficiency. A robotic system is needed to provide continuous monitoring and precise defect detection in pipelines.

2. Components.

- High-resolution camera
- Ultrasonic sensors
- Infrared detectors
- Microcontroller unit (Arduino/Raspberry Pi)
- Wireless communication module

- Rechargeable battery
- Adjustable wheeled mechanism

2.1 Design and Development Of Pipe Inspection Robot

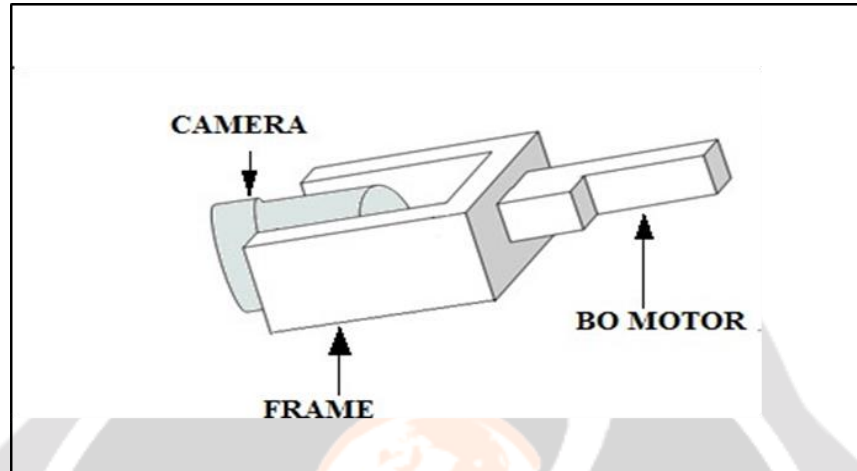


Fig – 1 Pipe Inspection Robot

3. Robot.

The camera & lights are mounted in a swiveling head are attached to the cylindrical body. The swiveling head are integrated to the lighting device a typically used in LED. The LED is used to illuminate inside the pipe line. The camera is pan & tilt by remotely. The motor wiring as shown in fig. are supply with 12v dc power supply through adaptor. The 3v dc power is supplied to the BO motor of camera. Operate the motor wheel the robot remote is connected.

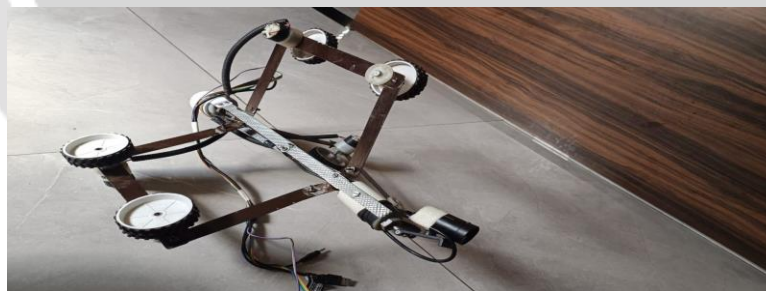


Fig – Robot

4. Advantages.

- Enhanced accuracy in defect detection.
- Real-time monitoring with remote accessibility.
- Adaptability to different pipeline diameters.
- Cost-effective alternative to manual inspections.
- Reduced maintenance downtime.

5 Application

- Oil and gas pipeline inspection
- Water supply and sewage pipeline monitoring
- Industrial pipeline maintenance
- Chemical and hazardous material transportation pipelines

6 Result and Discussion.

In this section, we present the findings obtained from the design and development of the pipe inspection robot. The results include data from various testing phases, performance evaluations, and comparisons of the robot's functionality in real-world conditions.

The results demonstrate that the pipe inspection robot is efficient, accurate, and cost-effective. Performance in various pipe sizes and materials indicates that further improvements can be made in navigation stability and sensor accuracy. Future work will focus on enhancing the robot's mobility in extreme conditions and refining the data processing algorithms for more precise anomaly detection.

7. Conclusion.

The proposed pipe inspection robot presents a significant advancement in automated pipeline monitoring. With its adaptability, real-time defect detection, and remote accessibility, it offers a cost-effective and efficient solution for industries reliant on pipeline infrastructure. Future work will focus on enhancing AI-based defect analysis and autonomous navigation capabilities.

8. Future Work.

The development of pipe inspection robots has shown great promise in improving the efficiency, accuracy, and safety of pipeline inspections. However, several aspects of the robot's design and functionality can be further optimized to enhance its capabilities. Below are key areas where future improvements and research could focus:

Enhanced Navigation and Mobility

One of the primary challenges for pipe inspection robots is navigating through complex and highly irregular pipe networks. Future work could focus on:

- **Improved Mobility in Highly Curved or Narrow Pipes:** Developing more advanced actuators and locomotion mechanisms (e.g., magnetic or flexible crawling systems) to allow for better movement in pipes with extreme curvature or tight spaces.
- **Autonomous Decision-Making:** Incorporating AI algorithms that can help the robot autonomously navigate through complex junctions and avoid obstacles without human intervention.

9. Reference.

Books

- Theory of Machine -Prof. R. S. Khurmi & Prof. J. K. Gupta.
- Automation production systems, and Computer-Integrated Manufacturing - Prof. M. P. Groover

Links:

- <http://www.ulcrobotics.com/products>
- [http://www.piacr.tk/Introduction to Pipe Inspection and Cleaning Robot](http://www.piacr.tk/Introduction%20to%20Pipe%20Inspection%20and%20Cleaning%20Robot)
- <http://www.sciencedirect.com/science/article/pii/S0094114X06002254>
- <http://capitalpipeliners.com/cctv-pipe-inspection-method-applicability>
- <http://www.google.co.in/patents?hl=en&lr=&vid=USPAT5084764&id=tisLA AAAEBAJ&oi=fnd&dq=+of+pipe+inspection&printsec=abstract#v=onepage&q=of%20pipe%20inspection&f=false>
- <http://ieeexplore.ieee.org/xpl/mostRecentIssue.jsp?punumber=3951>
- [http://www.faadooengineers.com/tube/2012/06/11/mechanical-engineering- project-pipe-inspection-robot/](http://www.faadooengineers.com/tube/2012/06/11/mechanical-engineering-project-pipe-inspection-robot/)
- [En.wikipedia.org/wiki/Pipeline_vedio_inspection](http://en.wikipedia.org/wiki/Pipeline_inspection)