

# Design and Development of Pipe Traversing Robot

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**Abstract** - In the past twenty years, various in-pipe scrutiny robots (IPIRs) are designed and used. per the propulsion mechanism quantity, these in-pipe scrutiny robots (IPIRs) will be summarized into 2 classes, i.e. single locomotion system and multiple locomotion system.

This paper presents the classic structure options and characters of the 2 classes of IPIRs, and moreover compares their own benefits and limitations, further as performances of every kind IPIR. Ultimately, it's finished that the multiple locomotion kind In-pipe scrutiny golem has become more and more current developing trend.

**Key Words:** Robot, Pipes defects, Electronics control systems, Digital video.

## 1. INTRODUCTION

Robotics is one of the fastest growing engineering fields of today. Robots are designed to remove the human factor from labour intensive or dangerous work and also to act in inaccessible environment. The inspection of pipes may be relevant for improving security and efficiency in industrial plants. These specific operations as inspection, maintenance, cleaning etc. are expensive, thus the application of robots is appearing to be one of the most attractive solutions. The pipelines are the major tools for transporting of drinking water, effluent water, fuel oils and the gas. A lot of trouble is caused by piping networks aging, corrosion, cracks, and mechanical damages are possible. So, continuously inspecting, maintaining and repairing are strongly demanded. With a considerable history behind the development in robotics, in-pipe robots can be classified into seven different sub categories, based on their applications. These are named as pig type robot, wheel type robot, caterpillar type robot, wall-press robot, walking type robot, inchworm type robot and screw type robot

Recently, the using of in-pipe inspection robot has grown increasingly popular in engineering fields including nuclear power plant industry, sewage system, and petroleum industry etc. With carrying various sensors, these in-pipe inspection robots (IPIRs), walking along the pipeline inside, are applied to inspect defects, cracks and erosion caused by strain ageing, creep deformation, water erosion, etc. During the latest 20 years, numerous in-pipe inspection robots (IPIRs) have been designed and fabricated based on several elementary forms according to the locomotion patterns.

### 1.1 Objectives

- Study existing model of Pipe Traversing Robot.
- To analyze different types of robots and their different positions for optimized results suitable for the industry.
- Design and development of Pipe Traversing Robot.
- To address the problem of the weight of robot & increasing efficiency of machine at low cost.
- Development of the prototype model using CAD software.

### 1.2 Methodology

- Investigating pre-existing Pipe Traversing Robot with the help of research paper and manufacturers CatLog.
- Studying and selecting the optimum combination of parts for In-pipe inspection robot.
- Designing pipe traversing robot by performing various mathematical calculations to reach out maximum output from the machine and carry out static structural analysis to support the mathematical calculations.
- Selecting parts from the manufacturers CatLog that are best optimized according to the calculations and the factor of safety.

- Modelling the design in CAD software for the best possible depiction of the actual machine.

1. Camera

A battery is an electrochemical device that may be charged and discharged as needed with an electric current. Small electric devices such as cell phones, remote controls, and flash lights are typically powered by batteries. In the past, the term "battery" was used to refer to the combination of two or more electrochemical cells. We have used 12V, 12Ah battery in our project to carry out the operations such as to power the Arduino Uno, the DC motors etc.



**Fig -1:** Camera

2. DC Motor:

A DC motor, conjointly referred to as an on the spot current motor, is AN electrical machine that converts power into energy by making an on the spot current force field. supported following calculations the motors area unit being designated.

Technical specification



**Fig -2:** DC Motor

The 12V DC Geared Motor can be used in variety of robotics applications and is available with wide range of RPM and Torque.

- Length: 80mm
- Torque: 1.5 kg.cm
- Weight: 130.00g m
- Speed : 10 RPM

3. Arduino UNO:

The Arduino board contains variety of controllers and microprocessors. The Arduino Uno could be a microcontroller board that uses the ATmega328P microcontroller. There square measure fourteen digital input/output pins, 6 analogue inputs, a 16 megahertz ceramic resonator, a USB instrumentality, an influence jack, associate degree ICSP header, and a push on this board. The hardware could be a programmable board and therefore the software system we have a tendency to use is named the "Arduino Integrated Development Environment".



Fig -3: Arduino Uno

4. Distance Motor



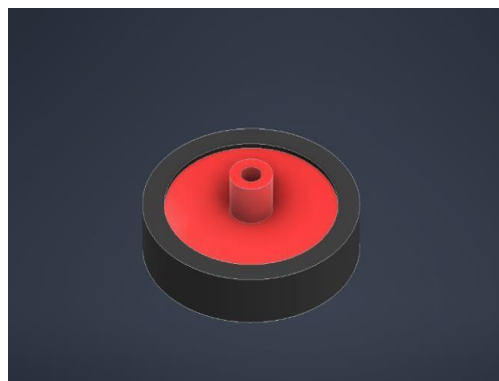
Fig -4 Distance Meter

Advanced digit counter, which have five digit counters. These are especially made for low cost hand winding machines. Our Digital Counters are equipped with left/right lever reset & both side drive shaft extension. Along with this, these are equipped with top going or top coming drive direction. Further specifications are as the following:

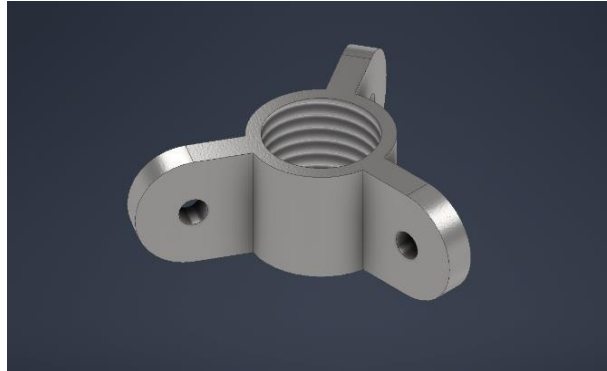
- Overall size (mm) : L-166, W-66, H-70
- Mounting holes: 4 hole, 5mm X-98.5 mm, Y-16.5 mm.

5. Wheels

Diameter - 72 mm

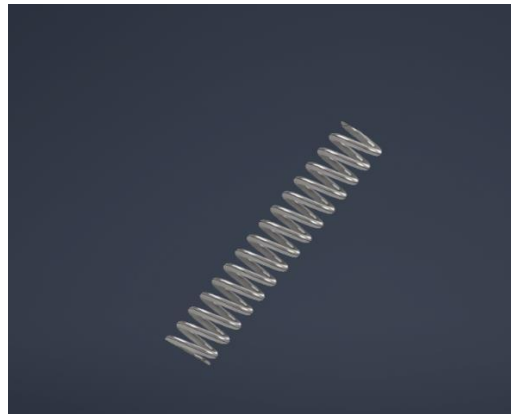


6. Translational Element



Inner diameter – 18 mm Length of the element – 25 mm Material – Mild steel

7. Helical Spring



Inner diameter – 18 mm Outer diameter – 20 mm Pitch – 5 mm

Length of the spring – 60 mm Material – Stainless steel

8. Extreme Links



Distance between the extreme links

Drilled Holes

Link 1 – 30 mm

Link2 – 85 mm

Link3 – 105 mm

Thickness – 3 mm

Drilled holes – 12 and 6 mm

Material – Acrylic

## 2. BLOCK DIAGRAM:

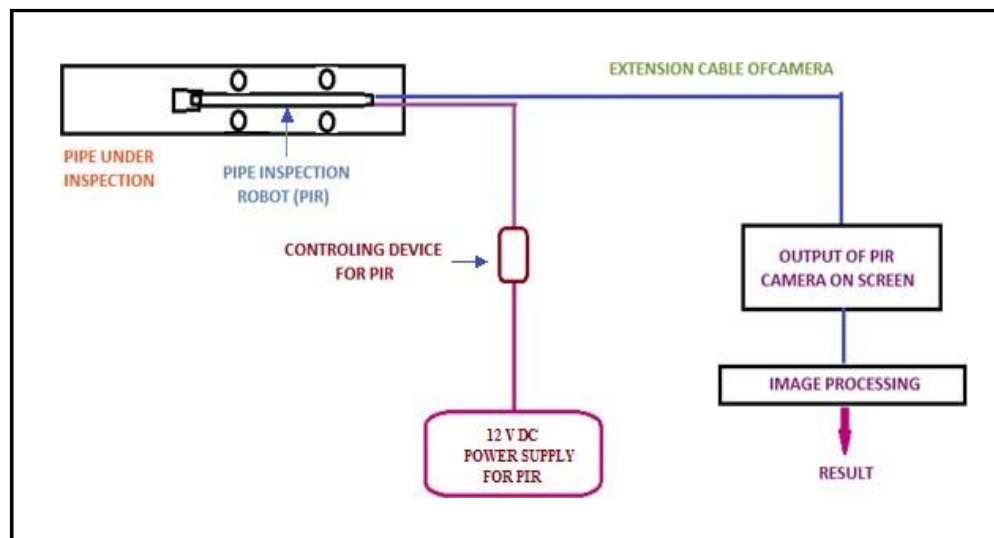


Fig 5:- Block Diagram showing working of Pipe Inspection Robot

## 3. WORKING OF IN-PIPE INSPECTION ROBOT

Working of PIR starts from its insertion in pipe. The front 3 arms are compressed by hand and so inserted within the pipe and so back 3 arms are inserted by pushing the PIR. The motors driven are the primary six arms mentioned here, they pull the whole setup. PIR is regarding a hundred seventy five cm long and to maneuver it freely within the bend pipes, a two degree of freedom connection is provided at the center in order that it will flip simply. As switch is on and current is flowing through wires, wheels start moving and forces PIR to propel forward. Exploiting the friction between wheels and pipe, the motion of wheels becomes attainable.

PIR may have quite 3 arms for higher judgment and perfection however it'd increase the load and price of producing and thus we'd like to try to trade-off between cash involvement and perfection. PIR wheel motion is given ten revolutions per minute, twelve V DC motors thus its speed are often maintained between -10 to ten revolutions per minute. The ability provided to motors is from single 12V dc adapter thus load on every motor are going to be minimum that expected.

As we tend to mention earlier that PIR are going to be able to move within any diameter travel between 203mm to 254mm, we tend to have to produce an automobile adjusting mechanism which will expand and get in touch with as PIR moves within the pipe. A spring of appropriate stiffness is mounted aboard rod, as seen in figure, in order that as arms get contracted thanks to load of compression against pipe, spring gets compressed and has a tendency to expand outward attempting to push arms back to their traditional position however as pipe prohibits them, they can't move.

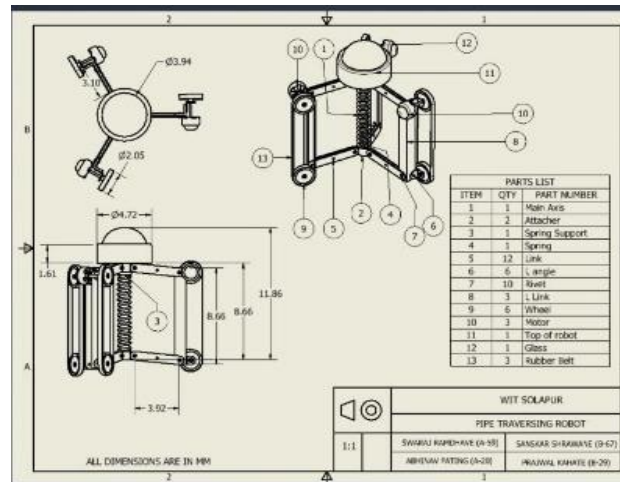


Fig -6 Draft Model

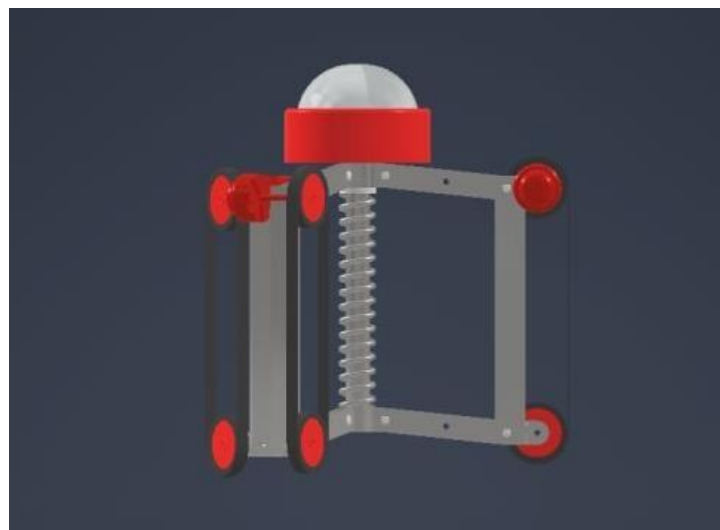


Fig -7 Final 3D Model

#### 4. CALCULATIONS

##### TORQUE CALCULATION FOR WHEEL MOTOR

Rating of the Battery: 12 Volt, 12 Ah Power produced:  $12 \times 12 = 144$  Wh Speed of the motor: 45 rpm Torque of motor:

$$P = [2\pi NT] / 60$$

$$144 = [(2\pi) \times 45 \times T] / 60T = 30.557 \text{ Nm}$$

For 3 wheels,  $T = 15.2788$  Nm

Hence the efficient torque is produced than the rated torque of the motor.

##### PROPOSED WORK

Pipe Traversing automaton is to make associate autonomous automaton used for in-pipe scrutiny. once some amount, each pipeline needs scrutiny and maintenance to confirm their safety and integrity.

The system uses 12V battery to power the vehicle movement motors.

Pipe scrutiny robots are accustomed to examine various pipeline components like straight pipelines, elbow, and branches internally.

The automaton is intended to handle diameter of one hundred twenty five millimetre to a hundred and eighty millimetre. The overall length of the automaton is three hundred millimetre, and therefore the weight is 840 grams.

The vehicle motors are interfaced to Arduino Uno through motor driver that controls the operating of the motors.

The fore and rear legs are connected so as to be parallel to every different in their mutual positions. On the opposite hand, the gap and shutting angles of the legs is unbroken at an equivalent price. Moreover, this automaton contains a giant folding vary because of that automaton will move freely within pipes of various diameters. A CCD camera is put in at the front a part of the forelimb system to observe and value the defects of the pipe

## **ADVANTAGES**

- The pipe inspection robot inspects situation inside the pipe which will be recorded and display on the monitor screen, it also facilitates working personnel for effective observation, detection, quick analysis and diagnosis.
- Save comprehensive investment, improve work efficiency, more accurate detection.
- Reduce the frequency of entering into the testing environment.
- Operating cost related to other method and model is low.
- Higher cake solid concentrations when compared to a belt filter press.
- Cost of manufacturing of this robot is relatively low.

## **5. CONCLUSIONS**

- Robots play a vital role in within pipe-network maintenance and their repairing. a number of them were designed to comprehend specific tasks for pipes with constant diameters, and alternative could adapt the structure operate of the variation of the inspected pipe.
- In this project within pipe standard robotic system area unit planned. a vital style goal of those robotic systems is that the ability to the inner diameters of the pipes. The given model permits the usage of a mini-cam for visual image of the in-pipe review or alternative devices required for failure detection that seem within the inner a part of pipe (measuring systems with optical maser, device etc).
- The major advantage is that it may be utilized in case of pipe diameter variation with the easy mechanism. we tend to developed a pipe review automaton which will be applied to 203mm – 254mm pipeline. a true model was developed to check the feasibility of this automaton for review of in-house pipeline.
- The varieties of review tasks area unit terribly completely different. A standard style was thought-about for simply custom-made to new environments with little changes. Presence of obstacles inside the pipeline could be a troublesome issue. within the planned mechanism the matter is solved by a spring effort and increasing the flexibility of the mechanism.

## **Future Scope**

- Flocculation tank can be installed for maximum efficiency of the machine which can control the water concentration of the feed sludge.
- Automated pressure plate can be implemented for adjusting the clearance at the discharge end to control the dewatering rate but this might come as the cost of increased price.
- Moving filter plates can be installed instead of mesh for maximum dewatering of the sludge.
- Considering variable feed sludge water concentration, a computerized system can be generated that can control the

clearance between the pressure plate and the screw for maximum dewatering depending upon the type of sludge input.

- Modular designs can be used for easy repair and maintenance.

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