"DELINEATE AND REFORMATION OF PIPE INSPECTION MACHINE"

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ABSTRACT

A pipe inspection machine is device that is inserted into pipes to check for obstruction or damage. These machines are traditionally manufactured offshore, are extremely expensive, and are often not adequately supported in the event or malfunction. This had resulted in associated environmental services limited. A Newzealand utilize of this equipment, facing significant periods of down time as they wait for their machines to be the repaired. Recently, they were informing that several machines were no longer supported.

This project was conceived to redesign the electronics control systems one of these PIM, utilizing the existing mechanical platform. Requirements for the machine were that it must operate reliably in confined, dark and wet environments and provides a human wears with a digital video feed of the internal status of the pipes. There machine should as much as possible incorporate off the shaft components, cheap, and potentially onsite repair. This project details the redesign and constructions of such machines. It employees there electronic boards integrated with mechanical components and provides video feedback via custom graphical interface although at the prototypes state the electronics has been successful with cost of less than a length of the original machine purchase prize.

Keyword: *machine , pipes defects , electronic control system , digital inspection system*

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1. INTRODUCTION:

Many accidents have happened owing to the crack and the corrosion of pipelines. We will have severe damages if fluid leaks from the pipeline and explodes. It is very difficult to inspect the pipelines because they are buried under the ground. Therefore, we are hoping a method of inspection method with a simple four bar mechanism from the inside of the pipelines without digging the ground. So we proposed a new design in inspecting pipelines.

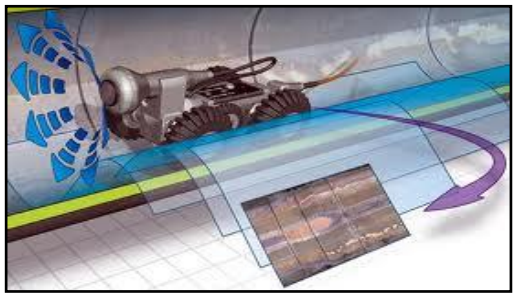

Figure-1: Pipe inspection Machine

1.1 Problem Statement:-

- Now a days many of industries used different diameter pipes for different applications like to carry chemicals, high pressure steam and gasess hence there may be chances of problems like corrosion , leakages.
- It is not possible to avoid all these problems manually.
- The mud inside the pipe can reduce the efficiency of the water/fluid flow.
- The conventional method is very difficult and tiring.

1.2 Objectives:-

- To traverse a machine inside a pipe with forward and backward motion and should also do vertical climbing in pipe.
- It should be able to move in various diameters of pipe.
- To build a fully autonomous pipeline cleaning machine.
- To design a machine that can move horizontally and vertically inside the pipe.
- To construct a machine that can minimize the mud and scale inside the pipe.

1.3 Application:-

- Allow inspection of inaccessible work areas.
- Provide on-line inspection/maintenance without loss of equipment.
- Remove humans from potentially hazardous work situations.
- Reduce equipment/plant downtime.
- Improve maintenance and inspection procedure thorough better coverage and documentation.
- Allows to get fast and much accurate results.

1.4 Advantages:-

- The pipe inspection machine inspects situation inside the pipe which will be recorded and displayed 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 is low.
- Cost of manufacturing of this machine is relatively low.

1.5 Disadvantages:-

- Pipe inspection machines have such limitations as their ability to turn in a T-shaped pipe or move in a plug valve.

- Another drawback of earlier machines is that the friction between the pipe and the cables for communication and power supply makes it difficult to move a long distance. A fiber optic communication system can reduce the friction.
- This machine does not work in water.
- This machine works only in empty pipe.

2. DESIGN OF PIPE INSPECTION MACHINE:

2.1 Selection of Materials:-

The materials used for this machine are light and rigid. Different materials can be used for different parts of the machine. For optimum use of power the materials used should be light and strong. Wood is light but it is subjected to wear if used for this machine. Metals are the ideal materials for the machine as most if the plastics cannot be as strong as metals. Material should be ductile, less brittleness, malleable, and high magnetic susceptibility. Among the metals, aluminum is the material chosen for the linkages and the common rod, which is made as hollow for reduction in weight. However, other materials are chosen for the motor.

The materials chosen for the motor should have high magnetic susceptibility and should be good conductor of electricity. The materials are copper and so on. But aluminum is chosen as the materials for the linkages and central body because of its much-desired Properties. Aluminum has lightweight and strength; it can be used in a variety of applications. Aluminum alloys with a wide range of properties are used in engineering structures .The strength and durability of aluminum alloys vary widely, not only because of the Components of the specific alloy, but also because of heat treatments and manufacturing Processes. Another important property of aluminum alloys is their sensitivity to heat.

Work shop procedures involving heating are complicated by the fact that aluminum, unlike steel, will melt without first glowing red. Aluminum alloys, like all structural alloys, are also subject to internal stresses following heating operations such as welding and casting. The problem with aluminum alloys in this regard is their low melting point, which make them more susceptible to distortions from thermally induced stress relief.

2.2 Effect of Temperature:-

Another important property of aluminum alloys is their sensitivity to heat. Work shop procedures involving heating are complicated by the fact that aluminum, unlike steel, will melt without first glowing red. Aluminum alloys, like all structural alloys, are also subject to internal stresses following heating operations such as welding and casting. The problem with aluminum alloys in this regard is their low melting point, which make them more susceptible to distortions from thermally induced stress relief.

The toughness, as measured by crack propagation energy, decreases as yield stress increases.

At the same yield stress, the under aged structure has greater toughness than the over aged structure.

2.3 Mechanism:-

The mechanism involved here is a four bar mechanism consisting of three revolute joints and one prismatic joint as depicted.

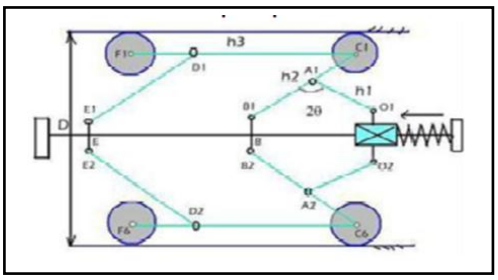

Fig 2.1: Mechanism of PIR

Fig 2.2: Mechanism of PIR

$H = 2r + 2d + 2h2 \times \cos\theta$,

Where,

h1 = 30 mm, h2 = 85 mm, h3 = 105 mm (h1 =OA, h2 = BC = D, h3 = CF)

$H=2\times36+2\times28+2\times85\times\cos 45$

H=248.20mm

Where D - Diameter of the pipe in mm, d - Distance between EE' in mm.h1, h2, h3 are the length of the links in mm. r-Radius of the wheel, H=Height of robot outside the pipe.

For uniform Diameter,

Assume $D = 2r+2d+2h2\cos\theta$

$D=2\times36+2\times28+2\times85\times\cos 50$

D=237.27mm

2.4 Components:-

- Helical Spring
- Translational Element
- Wheel
- Links

- Central Element
- Cap

3. METHODOLOGY:

- Design and development of pipe inspection machine using CAD software.
- Fabrication of CAD models by means of manufacturing equipments.
- Assembling all the fabricated parts.
- Fixing a camera, motors, LEDs and mounting the circuit board onto the crawler.
- Making it to crawl inside a pipe by means of a remote to capture the video image in a monitor.

4. EXPERIMENTATION:

- To design a machine with constrained motion in CAD modeling.
- To determine the torque required for the motor to make the crawler move.
- To determine the actual weight of the machine with the available actuator.
- To determine the supply voltage for the motor.

4.1 To design a machine with constrained motion in CAD modeling:-

This experiment plays a vital role to make the translational element sliding along the central frame without stoppage in between. When the translational element slides, the machine diameter should be varied in order to attain the purpose of fabricating it. Certain considerations should be made if the crawler tends to get locked because of the linkages. These considerations could be given as an input in CAD modeling. In this way, I found the reason to use a compression spring for the return motion and also for the proper traction between the wheels and the pipe.

4.2 To determine the torque required for the motor to make the crawler move.:

The total weight of the crawler should be defined. It might help us in determining the torque required by the motors.

The total weight *W* of the machine is the sum of the six traction forces exerted on the wheel. Thus, each traction force F_{rx} is one six of the whole weight of the machine structure. Thus, the size of the actuator enclosed in the wheel is calculated by,

$$t = F_s * R/6$$

Where F_s is the spring force in N

R is the radius of the wheel,

t is the torque required /wheel

Since only three motors could be used at the rear end, we can double the value of the torque per wheel.

4.3 To determine the actual weight of the machine with the available actuator:

The supply required for the 3 individual motors will be 12V. This 280:1 gear motor spins at 60RPM at 12V, drawing 70mA at stall generating 43 in.oz(0.3036 Nm) torque (free running at 57.6mA).

*Torque= Force * Radius*

Force= Torque/Radius= 0.3036/0.0225= 13.49N= 1.375kg

From the calculation, it is clearly known that an individual motor will drive the machine having 1.375 kg. Perhaps 3 motors could be used for the crawling, so that total weight of the machine should be restricted to 4.13 kg or below.

4.4 To determine the supply voltage for the motor:

The supply required for an actuator is 12V, 70mA. Three actuators will be used for the machine to creep inside a pipe. Since the voltage required is 12V, we need to ensure that the connection should be in parallel where the voltage remains the same and the current will be sum of all the current values in each individual.

Required voltage will be 12V (Parallel connection)

Required current I= I1+I2+I3

= 70+70+70 = 210mA

The motors draw 210mA from the battery. If we use 2100mAh battery, it will last for 10 hours for a single charge. 18650 Lithium batteries are available in the market with 3.7V, 2100mAh.

Hence it is concluded that three 18650 Lithium batteries with 3.7V, 2100mAh should be used for the actuators to rotate in order to make the crawler to move inside the pipe.

4.4 Degree of Freedom:

This mechanism has got 3 revolute pairs and a prismatic pair, so the mechanism involved here is a four bar mechanism.

Number of links, n- 4

Number of joints, j- 4

Number of higher pair, h- 0

$$F = 3(n-1) - 2j - h.$$

Therefore, $F= 3(4-1) - 2*4 - 0$

$F= 3*3 - 2*4= 9 - 8$

$F= 1$

If $F = 1$, the mechanism has fully constrained motion and this represents a working mechanism which has practical utility. All the working mechanisms have single degree of freedom.

5. CONCLUSIONS:

Machines play an important role in inside pipe-network maintenance and their repairing. Some of them were designed to realize specific tasks for pipes with constant diameters, and other may adapt the structure function of the variation of the inspected pipe.

In this project inside pipe modular machine system are proposed. An important design goal of these machine systems is the adaptability to the inner diameters of the pipes. The given prototype permits the usage of a mini-cam for visualization of the in-pipe inspection or other devices needed for failure detection that appear in the inner part of pipes (measuring systems with laser, sensors etc).

The major advantage is that it could be used in case of pipe diameter variation with the simple mechanism. We developed a pipe inspection machine that can be applied to 203mm- 254mm pipeline. A real prototype was developed to test the feasibility of this machine for inspection of in-house pipelines.

The types of inspection tasks are very different. A modular design was considered for easily adapted to new environments with small changes. Presence of obstacles within the pipelines is a difficult issue. In the proposed mechanism the problem is solved by a spring actuation and increasing the flexibility of the mechanism. The machine is designed to be able to traverse horizontal and vertical pipes. Several types of modules for pipe inspection mini machine have been presented. Many of the design goals of the Pipe inspection machine have been completely fulfilled.

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