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Pipe Inspection Robot

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ABSTRACT- 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 the robots appears to be one of the most attractive solutions. The robots with a flexible structure may boast adaptability to the environment, especially to the pipe diameter, with enhanced dexterity, manoeuvrability, capability to operate under hostile conditions. The wheeled robots are the simplest, most energy efficient, and have the best potential for long range. Loading the wheels with springs, robots also offer some advantages in manoeuvrability with the ability to adapt to in-pipe unevenness, move vertically in pipes, and stay stable without slipping in pipes. These types of robots also have the advantage of easier miniaturization. As we are observed that in industry, home, power plant etc. there are several problems occurs inside the pipe like Corrosion, Cracking, Dent Mark, Metal Losses etc. so, we are inspecting the pipe with the help of "PIPE INSPECTION ROBOT".

KEYWORDS: - Inspection, Pipe, Robots, Miniaturisation

I. INTRODUCTION

The young and dynamic growing field of cooperative robotics has become a diverse research area that often seems to go in several directions at once. Areas of interest range from high level human interactive robots to biologically inspired autonomous gnat like agents in the past fifteen years many different areas have emerged, each generating significant amount of progress however the field is so new that no topic area within cooperative robotics can be considered mature.

Robotic manipulators are widely used to help in dangerous, monotonous, and tedious jobs. This high stiffness is achieved by using heavy material and a bulky design. Hence, the existing heavy rigid manipulators are shown to be inefficient in terms of power consumption or speed with respect to the operating payload. Also, the operation of high precision robots is severely limited by their dynamic deflection, which persists for a period of time after a move is completed.

A. Electromagnetic Acoustic Transducers (EMAT) – milled steel

A transducer uses the direct beam method to discover anomalies in a pipe wall; the pink arrows represent the ultrasonic waves. Electromagnetic acoustic transducers (EMAT) induce ultrasonic waves into uniformly-milled metal inspection objects (e.g., pipe walls, tank floors). Technicians can assess metal condition and detect anomalies based on the reflections of these waves – when the transducer passes over an anomaly, a new reflection appears between the initial pulse and the normal reflection.[1]

Direct beam EMAT, where the tool induces ultrasonic waves into the metal at a 0° angle (or perpendicular to the metal surface), is the most common inspection method. Direct beam inspections determine metal thickness as well as detect and measure the following defects:

- Metal loss on the internal surface (e.g., pitting corrosion, general metal loss)
- Metal loss on the external surface (e.g., pitting corrosion, gouges), including a residual thickness measurement in defect areas
- Mid-wall pipe mill anomalies (e.g., laminations, non-metal inclusions), including depth measurement

B. Magnetic Flux Leakage (MFL)

Magnetic flux leakage (MFL) tools use a sensor sandwiched between multiple powerful magnets to create and measure the flow of magnetic flux in the pipe wall. Structurally-sound steel has a uniform structure that allows regular flow of the magnetic flux, while anomalies and features interrupt the flow of flux in identifiable patterns; the sensor registers these flow interruptions and records them for later analysis. The following figure illustrates the principle of a typical MFL inspection tool; the left side of the diagram shows how an MFL tool works in structurally sound pipe, while the right side shows how the tool detects and measures a metal loss defect

A. Laser profilometry

Laser profilometry assessment of the pipe wall corrosion pit shown in the previous image. Laser profilometers project a shape onto the object surface. Technicians configure the laser (both angle of incidence and distance from the object) to ensure the shape is uniform on normal metal. Superficial anomalies (e.g., pitting corrosion, dents) distort the shape, allowing the inspection technicians to measure the anomalies using proprietary software programs. Photographs of these laser distortions provide visual evidence that improves the data analysis process and contributes to structural integrity efforts.

II. LITREATURE REVIEW

A. According to Professor CHAU-PEI-LU

A pipe inspection robot with GUI control panel, called NTU-Navigator, is developed in this paper. The NTU-Navigator is light-weight, modular, easy to manipulate and easy to repair. The robot can be easily controlled by using the GUI on PC. The modular design concept is also used in designing this robot. It can be divided into four modules and each module has its independent control circuit. The steering method of the robot inside the U-shapes pipe is developed on the basis of fuzzy set theory. Different parameters are used as the input variables and the steering angle is the output variable. The inference engine consists of three modes. Under various modes, the deflection of the robot inside the pipe can be examined from the simulation program.

B. According to HANG PANG HUANG

Pipeline systems are widely used in such industries as the chemical industry and nuclear power plants. The applications of pipeline systems include carbon dioxide transportation, gas transmission and distribution, oil transmission, cable encapsulation, and water transmission. The fluid in the pipelines is often subject to high pressure, high temperature, and condition change. Therefore, in-pipe inspection is important for the pipelines' operation under safe conditions. We can detect the conditions inside the pipelines through sensing devices, such as cameras, infrared sensors, and ultrasonic sensors. However, the pipes are not always located above the ground or in safe places. Sometimes they are even located at places that cannot be easily accessed. In addition, the geometry of the pipe may vary and hence make inspection difficult. Considering the requirements and limitations, a properly designed pipe inspection robot should possess the following properties-

- lightweight
- Modular structure
- A mechanism with reusability and expandability
- A quality camera for image viewing and recording
- Variable lights to illuminate the interiors of pipes
- A reliable method for moving and steering in the pipes
- An ability to operate in geometrically changing pipes
- A fail-safe method of manual retrieval
- Stable communications and power supply
- A user-friendly control console for the operators

CONCLUSION

Using robotics for infrastructure inspections can save the Department of Transportation millions in lane closures and heavy equipment rentals. By updating the 50year old methods currently in place for infrastructure inspections, the Department of Transportation will get better results, allowing them to better allocate resources.

Post-tension tendons that hold up large concrete structures worldwide (e.g., bridges) are still mostly inspected manually. Robotic inspection devices can peer through concrete and steel and take the guesswork out of post-tension tendon inspections.

Lightweight, portable without lane closures or heavy equipment can save money and prevent traffic interruptions and deadly accidents.

Replacing the manual subjective inspection with robotics within the same budget is the key to fixing and maintaining a strong infrastructure. The information provided by robotic inspections will help extend the service life of valuable infrastructure assets, keep the public safe and save billions in untimely replacements.

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