Indian Journal of Science and Technology, *Vol 10(13), DOI: 10.17485/ijst/2017/v10i13/103338, April 2017* *ISSN (Print) : 0974-6846*
ISSN (Online) : 0974-5645

Robotic Ultrasonic Testing

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Abstract

Objectives: This paper describes a system for inspecting the pipelines used under sea water by robotic ultrasonic methods. The invention discusses the use of a series of robots inside the pipeline for the detection of defect using the ultrasonic testing. **Methods/Statistical analysis:** The underwater piping system is the best option for the transportation of oils and natural gases as this pipe ranges a large distance. But there is the possibility of defects such as crack, or corrosion on the wall of pipes. So in order to detect any defect on the interior surface of pipe, non-destructive testing methods are employed. As the pipeline is so long, it is impossible to go and check manually. So robots are deployed inside the pipe line for inspection. In some cases inspection of defects using a single robot is not accurate. Therefore in this present disclosure a series of the robots are deployed in the pipeline which moves to and fro motion to cover certain distance. The series of robots are placed at a specific distant to each other as there will be no collision between them. **Findings:** The deployed series of robots detect the defect by using the ultrasonic non-destructive testing. Ultrasonic inspection is the technology used to test the objects by directing the higher frequency sound waves onto the object to find defects on both surface and internal. This beam travels through the object with some loss, except when it is diverted and reflected by a discontinuity. The detection, location, and evaluation of discontinuities become possible as the velocity of sound into the object being tested is almost constant. **Application/Improvements:** The use of a series of robots in the underwear piping system enables easier and better detection of faults and blockages in the piping system.

Keywords: Camera, Corrosion, Defects, Internet of Things, Main Controller, Non-Destructive, Robots, Ultrasonic, Underwater Pipelines

1. Introduction

The present invention relates to the field of Internet of things (IOT) in inspection of underwater pipelines.

The underwater inspection is formerly performed with remotely operated vehicles and by using an array of Non Destructive Testing (NDT) equipment. This approach to pipeline inspections ensures defects to be identified and repaired. However, these methods are time consuming, involve very high money investment and even sometimes provide inaccurate calculations.

To overcome the current issues related to inspection of pipelines, our team has developed a smart system that deploys robots for the inspection. Robotic ultrasonic testing methods are employed in the place of human intervention (Divers) and other testing equipment.

The method deploys a series of robots moving in a to and fro fashion controlled by a main controller robot that informs the admin/user on the status of the pipelines inside the sea water. The defects are accurately calculated and measured through this method[1,2].

The invention has the following advantages:

- A series of robot are deployed inside the Carbon Steel Pipeline to inspect any defect present in the pipes
- A rotatable camera present on the robots to capture image of the defect
- An ultrasonic transducer placed on the top of the robots which propel the ultrasonic waves to the walls of the pipes to find any detect
- A GSM communication module present on the robot to send the information of the defect along with the image to the user[3]
- User verification switches present on the sub controlled robot for the verification

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2. Description

The present invention includes a series of robots deployed inside the carbon steel pipeline for the inspection of any of the defects present.

The underwater pipeline system is used to transmit oils and natural gases from one place to another which are expensive in nature and small holes or crack on the surface of the pipe can be a great economic loss.

To avoid such loss, crack or defect test of the piping surface is done. Figure 1 illustrates the working of series of robots inside the carbon steel pipe 100 for the inspection of any of the defects. As shown in the Figure 1 a series of robots such as 101,102,103 are deployed inside the carbon steel pipe 100 to inspect any of the defects present on the surface of the pipeline.

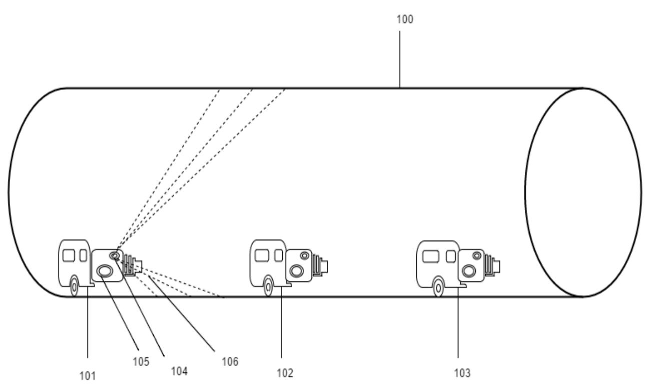

Figure 1. Series of robots.

As the pipeline is so long, it is impossible to go and check manually. So robots are deployed inside the pipe line for inspection. In some cases inspection of defects using a single robot is not accurate. Therefore in this present disclosure a series of the robots are deployed in the pipeline which moves to and fro motion to cover certain distance. The series of robots are placed at a specific distant to each other as there will be no collision between them.

Further the series of robot have a main controller robot and rest are sub controlled robots. The main controller robot controls the action of other sub controlled robots. Once the sub controlled robots detect the defect, they will send information to the main controller robot and the main controller robot will send the data to the user.

The deployed series of robots detect the defect by using the ultrasonic non-destructive testing. Ultrasonic inspection is the technology used to test the objects by directing the higher frequency sound waves onto the object to find defects on both surface and internal. This beam travels through the object with some loss, except when it is diverted and reflected by a discontinuity. The detection, location, and evaluation of discontinuities become possible as the velocity of sound into the object being tested is almost constant.

The robots are having ultrasonic transducer 104 which will send sound waves to the surface of the pipe 100 with certain frequency and based on the pulse-echo technique ultrasonic transducer will detect the defect on the carbon steel pipes 100. Each robot can move certain distance in to and fro motion to cover the specified distance. Every robot is connected with the other. There is a sub controlling unit present in each of the robots which is controlled by the main controller robot. They can communicate with each other and send information to main controller robot. In case of any damage to any of the robots inside the pipe, the nearest robot will trace the problem and send information to the main controller robot. Then the main controller robot will send the information to the user with the help of GSM system.

There is a rotatable camera 106 present on the robot which can be rotate according to the detection of the defect. Whenever the ultrasonic transducer 104 detects the crack on the surface, the rotatable camera will take the snap and send to the user by using the GSM system.

There is also a recording module 105 present nearer to the ultrasonic transducer 104 which will get activated whenever the ultrasonic transducer detects any defect. In addition, a temperature sensor is present in each robot to sense the temperature.

There is also a user verification switch present on each sub controlled robots which can be used by the user whenever he needs to verify the defect in case of any miscommunication or doubts that arises on the mind of the user. The user can contact to the individual sub controlled robot from the control room for verification.

Figure 2 explains the total scenario of defect detection in the underwater carbon steel pipes. As shown in the Figure 2 the scenario starts with the deployment of a series of robots inside the carbon steel pipeline 200. The robots will move in to and fro motion for the detection of defects 201. The ultrasonic transducer present on the robots will send ultrasonic waves to the wall for the inspection 202. If the transducer detects any defect 203 then the micro controller present on the robot will intimate the main controller robot 204 and the main controller robot will send the information to the user using GSM communication module 205.

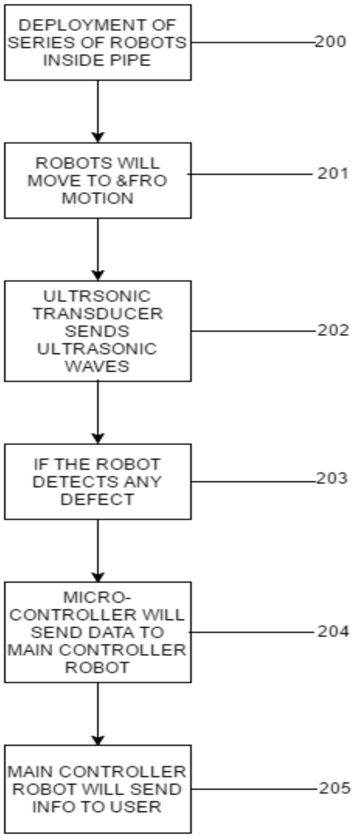

Figure 2. Scenario of defect detections.

3. Implementation

The implementation of the smart robotic system utilizes robots for the inspection of the crack or corrosion in the underwater pipeline.

The current invention has an autonomous robot deployed inside the underwater pipeline system to investigate the defect. Generally, with the age, the pipes in the sea, it gets corroded in the surface which is hard to detect directly by humans.

In this present invention a series of robots are deployed inside the pipeline with in a specific distance inside the carbon steel pipe system in such a way that each robot will move within a specific distance to and fro without colliding with the other robots.

Each robot comprises of ultrasonic transducers, temperature sensors, cameras to trace and find the abnormalities or discontinuity such as cracks, porosity, corrosion and delamination on the surface and interior of the pipelines in of underwater systems.

Further the robot uses ultrasonic testing NDT to inspect the defect inside the long ranged pipeline. Integrating the robotic system to ultrasonic inspection bear several advantages in terms of flexibility of the solution, cost, minimized delivery time and maintenance.

A main controlling robot is present among the series of the robots which controls the other sub controlled robots. Once the series of robots detect any of the defects inside the carbon steel pipe system they will send information to the controller using the GSM control module to intimate about the defects.

4. Conclusion

This present disclosure provides a system that helps in detecting the defects in underwater pipelines autonomously using a series of robots. Also, informs the admin or the main controller for the necessary actions that needs to be taken which would otherwise be very difficult if only humans are involved.

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