International Journal of Scientific & Engineering Research, Volume 8, Issue 2, February-2017
ISSN 2229-5518

Multifunctional Robot for Fault Detection in Pipeline

Omkar Bhogale, Mayank Dedhia, Tanmay Dhuri, Avinash Gupta, Meet Lakhani, Raj Oak

Abstract- The robot is specially constructed so as to travel inside a pipeline to detect cracks and faults. It consists of a cylindrical body with protruding and spring loaded wheels that will facilitate its travelling inside a pipe. The body will also be equipped with various sensors like; ultrasonic sensor, IR sensor, proximity sensor, camera. This project was initiated keeping in mind the fact that these days most of the equipment used for pipe fault detection is used on the outside of the pipe rather than inside.

Index Terms: -Robot, Ultrasonic, IR, R/F, Sensors, Pipelines.

I. INTRODUCTION

In the modern day metropolitan lifestyle, supply of resources via pipeline is of utmost importance. Since it's a manmade structure many times faults occur, that lead to severe accidents. To prevent such calamities many devices have been invented that help detecting such faults. One such device is our multifunctional robot. This bot is capable of moving inside a pipeline unlike most other devices that move over the pipe. This bot is equipped with spring loaded wheels so that it can travel in pipeline of varying diameter. The chassis of the robot has various sensors attached to it for detection of faults. The bot has sensors like ultrasonic sensor, IR sensor, and camera for inspection of structure. The bot will use R/F transmitter to communicate with the user, and also the camera will give a visual feed of the inner conditions of the pipe.

II. DESCRIPTION

Pipelines carry majority of the natural resources over large distances. Since it's a man-made structure there is large number of faults present in them. These faults are unavoidable; but we can always detect them beforehand and prevent any accident from occurring. There have been many incidents in the past where pipelines underneath a city just blew up destroying the infrastructure and also causing grave damage to humankind.

There have been many machines invented which are used to check for defects in a pipeline; but the problem with conventional machines is that they can only work outside of the pipe. Moreover they are obsolete and very difficult to transport & maintain.

We have designed a solution for this very problem. The robot will travel inside the pipe and will constantly keep checking for cracks, leaks and faults on all sides. This bot is equipped with spring loaded wheels that enable locomotion in pipes of varying diameter. The bot will have R/F transmitter that will be used for communication with the user. This bot was designed keeping in mind the above stated problems and will surely help in averting severe accidents which would have caused damage to life and property.

III. HISTORY

In 2003 inventor Fathi Gorbel and James Dabney published a paper on Autonomous robotic crawler for in-pipe inspection to travel through

- *Omkar Bhogale, Mayank Dedhia, Tanmay Dhuri, Avinash Gupta, Meet Lakhani, Raj Oak are currently pursuing bachelors' degree program in . Mechanical Engineering at Thakur College of Engineering, Mumbai, India.*

ducts using a fluid driven screw-drive propulsion system. According to the claim the Wheels located at 120^0 apart around the circumference helps to impart the helical motion. The robot uses complex sensors like penetrant sensor, acoustic sensor, magnetic particle sensor, pressure and flow sensor, thermal sensors and some other sensors along with sample collection tools.

In 2012 Dr Zhiyuan Chen, Maryam Temitayo, Prof. Dino Isa published a paper on Pipe Flaws Detection by using the mind storm robot using a track system for movement similar to an actual tank. The model uses one combined sensor only in front to detect any defects in the pipeline. The bot stops at the place for some time where it detects a crack and then the counter is increased every time the bot stops indicating the distance of successive halts and thus in turn giving the location of cracks from the starting point.

MIT Technologies had published a paper in 2014 on Robotic system for detecting leaks in pipe. According to their claim their technology allows for an unambiguous and reliable sensing of very small leaks that often go undetected for long period. Their robot consists of a set of wheels to propel it through pipes and a drum like membrane that forms a seal across the width of the pipe. When a leak is encountered, the liquid flowing towards it distorts the membrane, pulling it towards the leak site. This distortion is detected by force resistive sensors by a mechanical system and information is sent via wireless communication.

IV. WORKING

The bot has been made keeping in mind many of the hindrances that it will face inside a damaged pipeline. The bot will have three wheels on each end of the chassis that are spring loaded. These wheels will be coupled with a geared motor that will drive the bot inside the channel. Since the job of the bot is that of inspection; thus the speed at which it will travel will be kept low.

This will allow the user to efficiently monitor the condition of the structure being inspected. The chassis of the bot will house all the components and equipment that will detect the faults. The construction will be robust and sturdy for working under difficult situations. Also the material used will be non-reactive so that it can work in pipelines that contain chemical deposits.

The sensors that will be used are basically ultrasonic sensor, IR sensor, proximity sensors and camera. These sensors will communicate data about the pipe directly to the user. The data will be transmitted using a R/F transmitter receiver pair. Different sensors provide data in different formats and values. Thus all the data will be collected by the microcomputer and sent to the user who will see the data on a display and will also be able to store it. All the work will be done in real time and without any delay in transmission.

Initially the bot will provide a visual image of the pipe via the camera allowing user to see if there are any obstacles in the path. The ultrasonic and proximity sensors will start functioning and provide the data about the condition of the pipe. The bot will be using Arduino as a microcomputer which will be processing all the data received during operation. Programming of the Arduino will be done by developing an algorithm first. We will analyze and optimize it to get the desired working of our robot. The program will be written in C or C++ language.

Some source codes needed for our robot will be thoroughly studied by us and later implemented along with our logic.
The final code will be compiled, tested and optimized considering the time and space complexity and also including other factors.

Both the R/F transmitters will be configured, one as a receiver and the other as a transmitter.

Communication will be established between them once the robot starts working. The bot will be in constant connection with the user wirelessly. The user will send instructions and the bot will communicate back by sending sensor readings. The code used will make the whole robot including sensors, motors and other components function the way we require under our control.

Fig (1): Prototype developed by Massachusetts Institute of Technology.

V. INDUSTRIAL APPLICATIONS

There are numerous industrial applications for a robot of this stature. Some of the largest ones are pipeline and petroleum industries which use plethora of pipes for the functioning of their business. Pipes are evidently present in each and every industry; thus their failure may lead to adverse accidents. This bot has a lot of scope for improvement as well. On discussing with industry specialists many new applications will come up.

The future scope of this bot is quite promising as well. The robot could be attached with a cleaning unit that will simultaneously clean the pipe from inside while detecting flaws. The robot could be designed in such a way that it does not require its own power for propulsion, instead it will use the trapped fluid power of fluid that is flowing through the pipe by a vane mechanism.

Most of robots cannot correct the fault on site; our bot could be modified to fill the gap with a filler epoxy substance that will ensure smooth functioning of pipe till the time it could finally be repaired.

The bot could be designed in such a way that it could detect fault even if the fluid is flowing through the pipe and a unique turbine system can be designed to convert some part of flowing fluid into electricity which could be used by on board systems for their power requirement eliminating the limit of use due to low battery storage capacity.

VI. ACRONYMS

Bot: Robot.
R/F: Radio Frequency
IR: Infrared

VII. CONCLUSION

The multifunctional robot will be able to travel inside the underground water and oil &gas pipelines to detect cracks that may have developed on the internal surface.

The camera mounted on the front of the robot would give a live feed of the area in front of the robot thus helping to detect the presence of any fouling or any sludge presence in front of the robot.

The robot would prove to be very helpful in the Oil & Gas industry so as to predetermine any faults that may be present in the underground pipelines. This would help in avoiding the disasters occurring due to bursting of pipelines and would help improve human safety.

If the robot is utilized in water pipelines it would help to exactly locate the leakage points in the pipeline so as to reduce wastage of water during supplies.

Using such a robot would prevent the constant digging up of roads to detect faults in

underground pipelines and would be very helpful in not disturbing the public convenience.

REFERENCES

i. Patent US20030089267-Autonomous robotic crawler for in-pipe inspection Google Patents.

ii. MRL| In pipe Leak Detection mechatronics.mit.edu>in-pipe-detection.

iii. http://www.sciencedirect.com/science/article/pii/0005109887900112

iv. http://www.divaportal.org/smash/get/diva2:348497/FULLTEXT01.pdf

v. http://www.ppsa-online.com/papers/2007-9-Beller.pdf