JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue

JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)

An International Scholarly Open Access, Peer-reviewed, Refereed Journal

DEVELOPMENT OF ROBOT FOR INSPECTION OF PIPELINE FROM INSIDE

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Abstract: Pipelines are predominantly designed to transport oil, gas, water, and other important resources over long distances or between countries. They are acknowledged as one of the safest ways of energy transportation. However, hazards like metal loss, pitting and cracks might occur inside a pipeline. These could end in personal injury or death, economic losses, and environmental damage. Therefore, increasing attention has been given in the research field to pipeline inspection and monitoring for condition-based maintenance and structural integrity management. Pipelines are found out in several environments and consequently suffer various damage challenges, like environmental electrochemical reaction, welding defects, and external force damage, etc. Defects like metal loss, pitting, and cracks destroy the pipeline's integrity and cause serious questions of safety. This should be prevented before it occurs to make sure the safe operation of the pipeline.

Keywords — pipeline, transport, damage, inspection, safety.

I. INTRODUCTION:

Most of the harmful fluids are transported by pipelines. The pipelines are widely used in large industries, in water distribution to cities. In such System there is Gradual corrosion accelerates and permanent deterioration increases the chances of failure that may cause the cracks on wall of pipe. It will affect human safety, environmental pollution and production loss. Recent pipeline leaks had indicated that the relate cost is more than the downtime and clean-up costs, leading to increased environmental awareness and concerns. Limit routine inspection operations to only the "waste" portion of the pipeline that eventually results in a piping system with questionable integrity. Integrity confidence level will drop below acceptable level. Testing the currently untested parts of the pipeline network becomes a must.

To inspect and to monitor the pipeline, we are implementing a system which has a robot. Some sensors such as Gas sensor, camera, and ultrasonic sensor are mounted on the robot along with LCD screen. The robot will travel through the pipeline and it will detect the crack and corrosive part of pipeline and this information is sent to main computer. With this information we can take necessary preventive action on it so further incidents or accidents can be avoided.

II. EXISTING SYSTEMS:

A. Industrial Ultrasonic Testing:

Crack detection, industrial ultrasonic testing is the oldest and the most propagated. Since the 1940s, the law of physics which governs sound waves` propagation had been widely useful in order to detect cracks, discontinuities, porosity, and other internal defect in materials, such as metals, ceramics, and polymers [1]. Crack detection technique uses the simple theory of sound wave's physical nature i.e. the vibrations traveling through any medium. The medium can be a solid, a liquid, or a gas [1]. The sound wave travels

through the medium with specific velocity and wavelength, as these waves collide with an obstacle, the wave get reflected and transmitted back to the source. The reflected waves can be interpreted following their frequency. As there is more retransmission frequency, the more assurance the tester is of the existence of a crack, because the wave produces different echo patterns which can be recorded and displayed on tools and devices.

B. Microwave Imaging Technique:

The As for steel based materials, the usage of open-ended rectangular waveguide probes was suggested for the detection of cracks since the first 1990s [2]. In fact, this was mainly introduced so as to identify long surface cracks' in metals. Then this technique is used to detect cracks whose length is greater than or equal to the broad dimension of a waveguide [2]. For experimental purposes, various cracks of various widths and lengths were created onto different metal plates, and a computer-controlled stepper was moving the surface over the hole of the open-ended waveguide while observing the standing-wave characteristics inside the waveguide [2].

Consequently, it had been concluded that, when a crack's axis is parallel to the upper dimension of the waveguide and orthogonal to the electric field's vector, the standing wave undergoes a pronounced shift in location. Such a shift is a clear indicator of a change in the reflection coefficient and the metal's properties, and proves its utter dependence on the relative emplacement of the crack also as the probing location on the stationary wave pattern [2].

C. Internal Based leak detection System:

Computerized pipeline inspection is a term that refers to algorithmic inspection tools that are used to improve the abilities of a pipeline to identify abnormalities which may create or forms a leak in pipeline. This Computerized method system uses pipeline operation data to calculate prediction operational parameters under normal mode. The predictions are compared to measured parameters to identify changes that may be indicates a leak. This technique is completely depends on the data collected from the field instruments, which are constantly input into a computer program that mathematically or statistically evaluates the information. Evaluation results are generated in the form of parameter estimates, the estimated parameters are subjected to some judgment criteria to determine if a leak is present. The ways of using this technique can be differentiated by the types of instruments and programs (or algorithms) used [3].

D. Robotic platform for leak detection:

The more part of the pipelines system is accessible by In-Line monitoring Tools but this access is restricted to the section in between the entering and exiting traps only. Unfortunately, corrosion does not have this restriction. The industry looks for means of monitoring these in-accessible pressure holding piping systems, preferably, without disturbing the operations. It is a fact that suitably reliable and accurate monitoring results can only be obtained by direct pipe wall contact/access. If that is not viable from the externally, internal monitoring is necessary. Since modifying pipeline systems for In-Line monitoring is mainly not practical, pipe monitoring robot gives improvement of robotic monitoring services for presently in-accessible pipeline systems. Robotics is one of the fastest rising engineering fields of today. The main issue is in their design and implementation involves in combining the capacity of self-movement with that of self-sustaining and the property of low weight and dimension [4].

III. BLOCK DIAGRAM:

The block diagram of proposed system is shown in figure. This system is implemented with microcontroller, sensors and WiFi. The system is implemented with help of one robot on which ultrasonic sensor, gas sensor and wireless camera are mounted. The robot is inserted in the pipeline and the sensors on the robot are collects the information of pipeline and sends it to external computer for processing.

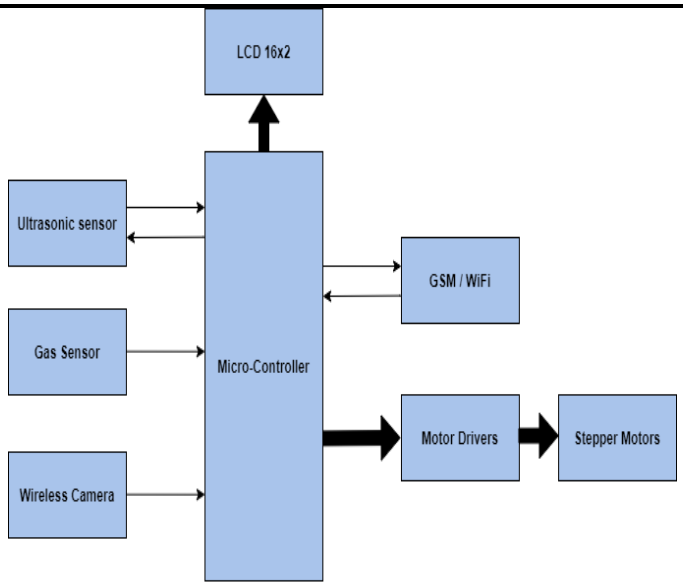

Fig 1: Block Diagram of system

A. Ultrasonic Sensor:

An ultrasonic sensor is used to measure the distance of an object, it emits ultrasonic sound waves, and this reflected waves from the obstacle are converted into an electrical signal. Ultrasonic waves travel with higher speed than the speed of the sound that humans can hear. Ultrasonic sensors have two main components: the transmitter which emits the sound wave and the receiver which collects the waves reflected from an obstacle. We have used this technology to detect the obstacle in the path of robot when it is inside the pipeline.

B.Gas Sensors:

A gas sensor senses the concentration of gases or atmosphere's presence. The sensor generates a relevant potential difference depending on the concentration of the gas by adjusting the resistance of the material within the sensor, which can be determined as the output voltage. We have used gas sensor to detect the presence of hazardous gasses.

C. Wireless Camera:

The cameras are the optical sensors which captures the images. We are using wireless camera sensor which captures the images of wall of the pipeline and send it to computer for further processing. The capture image is processed with help of MATLAB software using different algorithms.

D. WiFi:

WiFi connectivity is used for commanding or controlling the robot movement. The captured information from the sensors is send to master computer with help of WiFi connectivity.

E.Microcontroller:

A micro-controller is a one type of computer on an integrated circuit which have a memory, processor core, and programmable input/ output peripherals that can be controlled by programming. We have used a microcontroller to collect the information from sensors and send it to the master computer via WiFi. This microcontroller also control the robot movement as commands received from the master computer.

F. Stepper Motor and Motor drivers:

A stepper motor is an electrical motor whose main feature is that its shaft rotates by performing steps, that is, by moving by a decided amount of degrees. We are using such motor to measure the distance travelled by robot and actual position of defect.

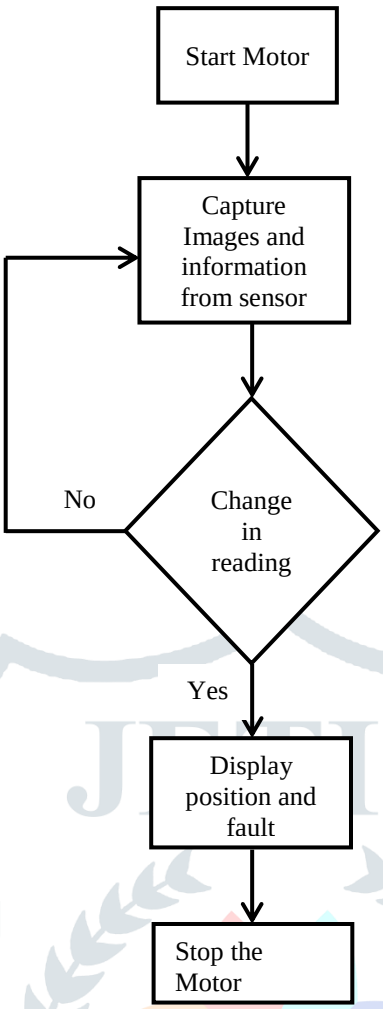

Fig 2: Flowchart of system

The flowchart of the system is shown in the figure. First we have to power on the system and insert the robot inside the pipeline. Wireless camera and sensors are mounted on the robot. Wireless camera capture images of inside wall of pipeline. These images then send to master computer for further processing. In processing using MATLAB software different algorithms are implemented on image. If there is any finding from the algorithms we will display that finding and position of that that finding on the display. The position is calculated based on the distance traveled by the robot, that distance can be calculated by steps traveled by stepper motor of robot. The ultrasonic sensor is used to detect the obstacles in the path and distance from the robot. If is there any obstacle then it will show a warning and further necessary action can be taken by the maintenance team. The robot's movement or speed is controlled by the master computer by sending commands via WiFi connectivity. All the sensor data is received at master computer via same WiFi connection.

IV. CONCLUSION:

Robots play a vital role in inside pipe-network maintenance and their repairing. Some of them were designed to realize definite tasks for pipes, and other may get used to the structure function of the variation of the inspected pipe. We addressed the design and development of a pipe crawler for inspection of water pipes. A description of its working principle, design details, and practical aspects are provided. As a future step, we look to further increase in driving speed in order to improve the pipe inspection efficiency. The various types of inspection tasks are quite diverse. A modular design was considered so that it could be easily adapted to new environments with minor changes. The presence of obstructions within pipelines is a difficult issue. The proposed mechanism solves the problem by utilizing a spring actuation and increasing the mechanism's flexibility. Several types of pipe inspection minirobot modules have been presented. Many of the Pipe inspection robot's design goals have been completely met.

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