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Wireless Internal Pipe Crawling Robot for Health Monitoring Of Pipelines

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***Abstract*— Advancement in Wireless networking and in the field of robotics has enabled to the development of a new range of wireless based internal pipe crawling robot for the detection of cracks in pipelines. The industrial robots are replacing the human counter parts for loading, unloading, inspection, maintenance, welding, painting, drilling, precision manufacturing process and in hazardous environment. So this project focuses on the health monitoring of pipelines and motion control of internal pipe crawling robot using wireless network IoT (Internet of Things).**

***Keywords*—Crack sensor,Industrial inspection, Microcontroller, IoT (Internet of Things), pipe crawler mechanism, position sensing.**

I. INTRODUCTION

Inspection in underground environment with great accuracy can be achieved through autonomous robots. In olden days inspection of pipelines were performed by human technicians which become difficult when inspecting pipelines of smaller diameter and pipes which are underground. This also consumed lot of time and was not efficient. These industrial pipelines are usually large and are mostly located underground. The inspection has to be performed while the plant is completely shut down.

Recent developments in autonomous robots are pipe crawling robots which provides some access in performing inspection in larger pipelines with excellent accuracy. The robots carries out the inspection in a way that future loses can be avoided. This also reduces the time consumption and provides safety for the human technicians.

The next advancement in this robot is to make it attend L- shaped bends and T- shaped bends to inspect for cracks, corrosion and improper weld.

This paper describes some developments of internal crawling robots which includes wireless motion control, wireless transmission of data, exact location and position of flaws in the pipelines. Some of the advantages of this design includes accuracy of data obtained, easy transmission of data through wireless communication.

II. METHODOLOGY

The inspection of cracks in pipelines has been a difficult and most expensive task. This has been leading to huge loss to industries and also an impact on the environment. Pipelines lying under the soil beds and water bodies have difficulties in maintenance and damage detection. In this proposal we have a introduced a cost efficient technology which is capable of determining cracks and damages in industrial pipelines.

The inspection robot moves through the pipeline internally with a linear crawling motion. The robot is attached to a crack sensor. The crack sensor used here is an infrared sensor. The sensor is designed to detect cracks with greater accuracy and precision. The robot crawls through the pipeline scanning every portion of the pipeline. The sensor is attached to the servo motor which covers 180^{o}. There are two sensors attached to the two arms of the servo motor each covering a region of angle 360^{o}. The sensor covers 360 degree of the pipeline at that particular region and this process takes place until the crack or damage is determined.

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If the crack or damage is determined, it's programmed in order to alert the control station regarding the position of the crack, such that location of the crack from the origin and the angular position of the crack. This enables the maintenance team to determine the location of the crack easily and rectify them immediately with least cost and time. The wireless technology implemented here is the Wi-Fi module which works on the IoT Technology.

III. BLOCK DIAGRAM

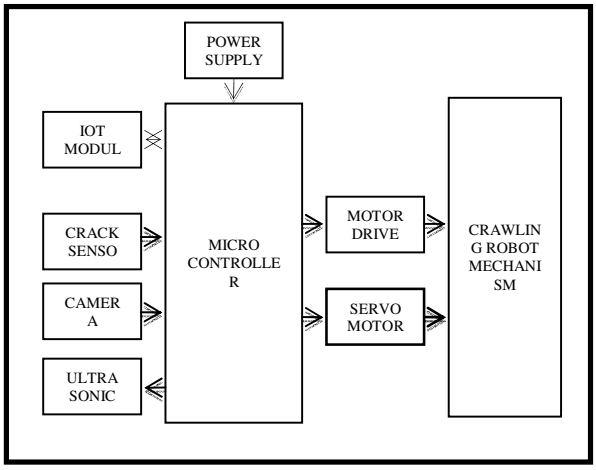
The block diagram consists of two sections

- Robotic section
- Control and Monitoring section

Robotic section:

The robotic section includes three mechanisms in it.

1. Crawling mechanism
2. Sensing mechanism
3. Controller mechanism



1. CRAWLING MECHANISM

The crawling robot consists of three rubber wheels on the front and rear side. The three wheels align themselves on the inner surface of the pipeline. The direction of movement of the robot can be either forward or backward. The robot moves in a manner that at each position of the robot the pipeline is inspected for cracks.

The three rubber wheels are attached to the motor which serves as the driver.

2. SENSING MECHANISM

The sensing is done with the help of Infrared sensors. These infrared sensors are attached to a servo motor which provides 360 degree scanning of the pipeline. For every movement of the robot the infrared sensors coupled with servo motor scans for crack.

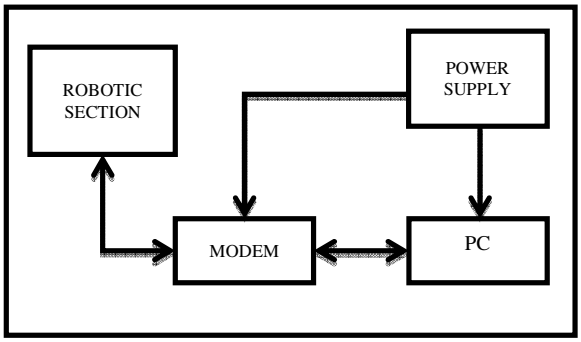
3. CONTROLLER MECHANISM

The control for the crawling and sensing mechanism is provided by the microcontroller ATmega328p. The driver, servo motor and the infrared sensors are connected to the microcontroller. The controller gives command to the driver and gets back the information sensed by the sensors.

Control section:

The control section includes two mechanisms in it.

1. Control mechanism
2. Monitoring mechanism



1. CONTROL MECHANISM

In the control room the personal computer (PC) acts as the controlling part. The operator gives command through the virtual terminal. Based on the command given the robot is operated in the working station. The commands given are passed to the robotic section via wireless protocol IoT. The commands to make the robot move in upward, downward and to stop are given from the control room.

2. MONITORING MECHANISM

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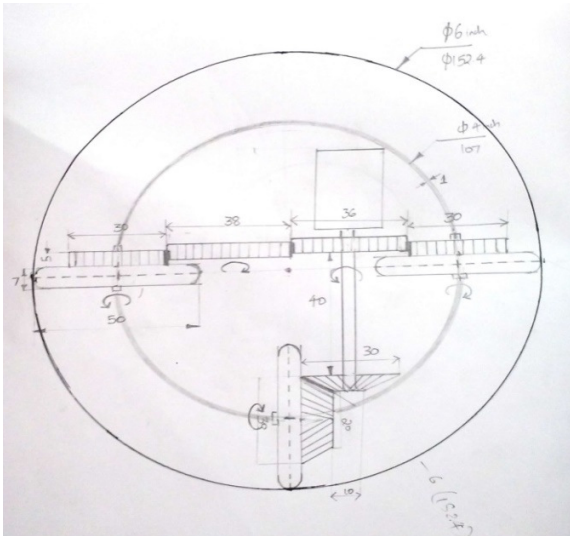
In the control room the monitoring section is also the PC. Through the wireless medium the information's are received in the control room. This information's are constantly monitored in the virtual terminal. The presence of cracks is annunciated via IEEE 802.15.4 protocol.

IV. WIRELESS COMMUNICATION

The data transfer between the workstation and the control room is carried out through wireless media. The wireless media which has been used in this project is nothing but the IoT (Internet of Things) protocol which is connected through a modem with network. The command for the robot to turn on and off and the transmission of the process data are made wireless through this method.

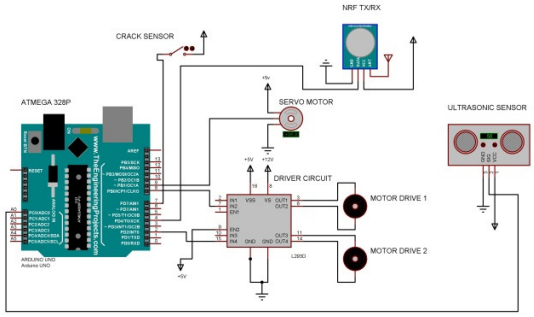
V. HARDWARE DESIGN

The hardware design of the pipe crawler is designed to enable the robot carrying the required crack detection sensor, drive mechanism and the controller. This design is capable of attending all bends since it is attached with a flexible pipe between the front and rear portion of the robot. The dimensions of the robot are as marked on the diagram. The robot can be designed based on the required configuration pipeline.



VI. SIMULATION

The simulation for the robot is done using Proteus application



. The drive motors and the servo motor are interfaced with the microcontroller and the program for simulation is executed. The simulation is done for the required aspect of the process.In the simulation the direction control of robot is executed. The 360 degree scanning using a servo motor at every interval is also executed. As by the program, if crack is detected robot halts its motion and gives feedback to control room.

VII. CONCLUSION

The wireless internal robot presented here is designed to obtain access to large pipelines in industries or those that are buried underground. The sensors interfaced to the robot provide a way to find defects such as cracks, corrosion and improper welds or joints.

Use of robots for inspection speeds up the process and also reduces cost. This is because the time and cost required for the preparation of the site for the human to perform the inspection is more. So in this case deployment of wireless autonomous robot is the only means.

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