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Design of Pipe Cleaning and Inspection Robot

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ABSTRACT

In pipe robot is important research to achieve automated pipeline cleaning. However, the variety of pipe diameter restricted the development of various types of pipe robot. In this Product, a new pipe cleaning and inspection robot based on Automation is developed for long distance cleaning of pipelines with different diameter series. Its physical design adopts a new umbrella-like open-and-close structure and a tail positioning system. This structural design makes it possible to realize the adaptation to pipe diameter and the stability of body posture. The entire robot system combines the two ways of auto run and remote control mode through controlling system, which make it real-time and flexible. According to the experimental, the robot have a highly adaptability and can work stably so that it has a high practical value and spread value.

Keyword:- DC Motor, Sensors, Microcontroller, Design and manufacture

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I. INTRODUCTION

The use of robots is more common today than ever before and it is no longer exclusively used by the heavy production industries 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 738 | Page most attractive solutions. Pipelines which are tools for transporting oils, gases and other fluids such as chemicals, have been employed as major utilities in a number of countries for long time. Recently, many troubles occur in pipelines, and most of them are caused by aging, corrosion, cracks, and mechanical damages from the third parties. Currently, the applications of robots for the maintenance of the pipeline utilities are considered as one of the most attractive solutions available should have high magnetic susceptibility and should be good conductor of electricity. The materials are copper and so on. But aluminum is chosen as the materials for the linkages and central body because of its much-desired properties. Pipe inspection is necessary to locate defects due to corrosion and wear while the pipe is transporting fluids. This ability is necessary especially when one should inspect an underground pipe. In this work, Pipe Inspection Robot (PIR) with ability to move inside horizontal and vertical pipes has been designed and fabricated.

Inspection robots are used in many fields of industry. One application is monitoring the inside of the pipes and channels, recognizing and solving problems through the interior of pipes or channels. Automated inspection of the inner surface of a pipe can be achieved by a pipe cleaning robot. The materials used for this machine are light and rigid. Different materials can be used for different parts of the robot. For optimum use of power the materials used should be light and strong. Material should be ductile, less brittleness, malleable, and high magnetic susceptibility.

II. LITERATURESURVEY

[1]MA WENQI, XIAO ZHIYONG, ZHANG MEIXIA: Numerical Simulation of Cavitation Washer in Pipe Cleaning Cavitation, Water jet can take advantage of the power generated from vacuole rupture to enhance the performance of the jet. Studies have shown that the pressure of the capitation jet is 8.6-124 times as high as continuous pressure in the same pump conditions; therefore the cavitation jet is widely utilized in cutting, cleaning and descaling's. The study focused on blade-type cavitation washer, using three-dimensional periodic modeling, combined with structured and unstructured grids, analyzed the two-phase Signal cavitation model in a finite volume CFD way. By taking turbulence intensity and non-condensable gas into account, the cleaning mechanism was analyzed and flow characteristics were gain. The results show that the cavitation effect mainly produced in two zones, the blade Tip area around the pipe wall and the double-blade staggered narrow gap. Throttling effect is the main cause of the cavitation effect. The cavitation number is used to evaluate the strength of the cavitation, and the cavitation number is between 0 and 0.5.

[2]YOON-GU KIM1, DONG-HWAN SHIN1, JEON-IL MOON1, JINUNG AN1: Design and Implementation of an Optimal In-pipe Navigation Mechanism for a Steel Pipe Cleaning Robot, this study focuses on the design and implementation of an optimal pipe navigation mechanism and a driving unit to overcome the variable situations inside steel pipes. It also offers adaptability to different pipe diameters. The important problems considered in the design and implementation are a self-sustaining property when in the center of a pipe, optimal navigation ability to adapt to in-pipe unevenness, the capability to remain stable without slipping in pipes, and the efficient operation of cleaning equipment. The robot developed here based, on carefully determined design specifications, was tested to verify the performance of its navigation mechanism and driving ability. In addition, a control system was developed for the test. The ultimate goal is the application of the verified in-pipe cleaning robot to industrial and practical applications.

[3]ANDREI ȘTEOPAN, MIHAI STEOPAN & ANDREI NICU: Competitive Design and Mockup of a Modular Pipe Cleaning Mobile Equipment, designing application oriented products require dedicated approaches. One possible approach is the use of competitive design tools and techniques in the conceptualization phase of the product. In this paper the authors present the development process for a mobile platform meant for cleaning / maintenance operations of flatbed ventilation tubing. Special attention was given to the main 2 mechanical modules: the motion module and the ventilation module.

[4]JOSÉ SAENZ, FRAUNHOFER IFF, NORBERT ELKMANN,FRAUNHOFERIFF,THOMASSTUERZE,FRAUNHOFERIFF,SVENKUTZNER,FRAUNHOFER IFF AND HEIKO ALTHOFF: Robotic systems for cleaning and inspection of large concrete pipes, Concrete pipes are used in a variety of areas for conducting media underground (e.g. wastewater, cooling water, etc.) or for transportation purposes. Regular cleaning and inspection is required to ensure the static integrity of the pipe

And to insure against the problems associated with failure of the pipe. In this paper, the SVM-RS system for cleaning and inspecting large concrete pipes will be presented. Various aspects of the robot including its kinematics, the cleaning system, the sensor system, the media supply, communications, as well as the control system and operator interface will be discussed in detail. The use of robust robotics for accurate positioning of high-pressure water

Nozzles in combination with non-destructive sensing techniques for navigation and inspection during normal pipe operation allows for a new standard in high-quality pipe cleaning and inspection. The latest cleaning and inspection results from tests in real sewers will be presented.

III. PROBLEMSTATEMENT

- Now a day's many of industries used different diameter pipes for different application like to carry chemicals, high pressure steam and gases hence there may be chances of problems like corrosion, leakages.
- It is not possible to avoid all these problems manually.
- The conventional method is very difficult and tiring.

IV. OBJECTIVE

- To develop efficient and automated pipe cleaning Robot.
- To design and develop cost-effective pipe cleaning Robot.
- To traverse a robot inside a pipe with forward and backward motion and should also do horizontal climbing in pipe.
- It should be able to move in various diameters of pipe.
- To design a robot that can move horizontally and vertically inside the pipe.
- To analyses the suitability of the pipe cleaning robot for various applications.

V. SCOPE

- The reason of scoping the project work to a boundary is to ensure the project will be done in a systematic manner and prevent overlapping of work occurs. This project focuses on cleaning the inner of the pipeline water system.
- In industrial pipe lines and gas pipe lines it is applicable to detect crack and leakages.
- It's applicable for to detect the problem of blockage in pipe.
- It's applicable for long and different diameter of pipes, cleaning and spray painting.

IV. BLOCK DIAGRAM

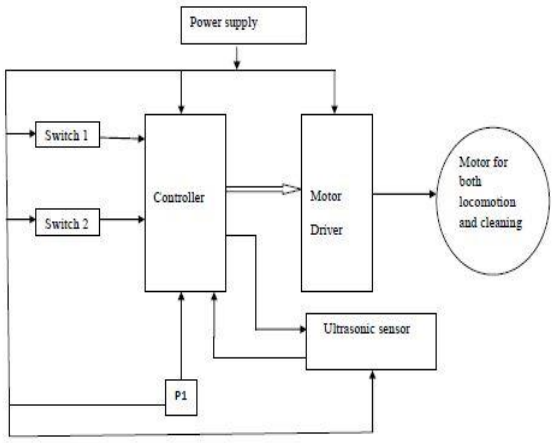

Fig 1. Block diagram

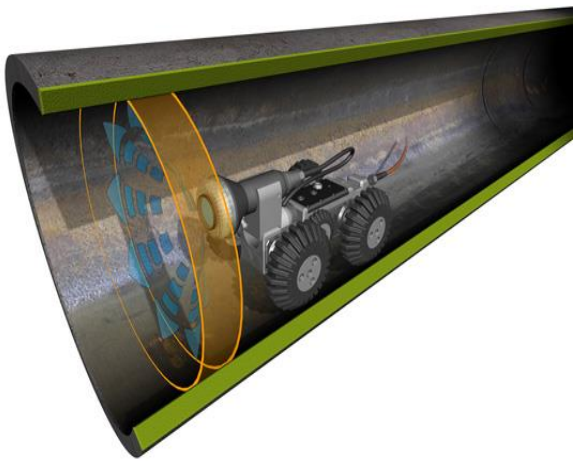

Fig 2. Design View

VI. DESIGN MODULE

This is the finally developed concept. In this the model is developed in such a way that it overcomes all most each and aspect of the previous design. The design is focused to use only one DC motor for both transmission and cleaning. There is a mechanism which uses a bevel gear to provide both locomotion and cleaning simultaneously. The piston cylinder mechanism is also used here but in a different manner.

Figure is showing the control circuit used for the in-pipe robot. The control is very simple and easy to operate. Even person with little knowledge in electronics can easily control the in-pipe robot. The control circuit has various components like

1. Controller
2. Ultrasonic sensor
3. DC motor
4. Motor driver
5. Power supply
6. Switches

Controller

Controller is the major component in any control circuit. It is like brain of the body. The main concern in design is to provide a very simple controller. There are many types of controllers in the market but according to our need it should be compatible to all the components. When we are going to write the code for controlling the robot, it supposed to be easy. Hence we decided to use the Arduino mega 2560 controller for the in-pipe robot.

The control is very is to handle. There are predefined slots for power supply, PWM, etc. so it will be very easy for us to make connection with the remaining components. The size of the controller is also very small and it can easily accommodate large number of devices. Coming to the coding part, it is open source to everyone. One can go through the site and can get the code.

What we have to do is to make modification in the code according to our needs.

Ultrasonic sensor

The ultrasonic sensor is a simple device that is generally used for distance measurement. The working principle of the ultrasonic sensor is just like a bat. There are two portions in an ultrasonic sensor 1 trigger 2 echo. The trigger portion will emit the ultrasonic waves. When the ultrasonic waves hit some object in front of it, it will be reflected back to sensor.

The echo portion is going to receive the reflected ultrasonic waves. The time gap between the trigger signal and received signal is calculated and according that the distance between the sensor and obstacle is measured. The same principle has been used here to detect the obstacles in the pipe.

The main reason behind using the ultrasonic sensor in this in-pipe robot is the cost of the device is very less. The sensor is also very accurate compared to other devices.

DC motor

The motor is one of the major components in the control circuit. It is used to provide both transmission and cleaning. For performing the task it has to provide high amount torque. Since we require very high torque there is need to use a geared motor with low RPM. For this we are45using a 300 RPM geared motor. The motor is tested and is giving very good amount of torque. It Can able provide cleaning and transmission.

Motor driver

Motor driver play a prominent role in controlling the DC motor. The motor driver helps in changing the direction of rotation of the DC motor. The driver is going to receive the signals from controller. According to control signal the driver is going to change direction of rotation. There will be H-Bridge in the motor driver which is making the task possible. The working principle of the H-bridge is very simple. The construction is showed below. The direction of rotation of the motor depends on the flow of current in the motor. The motor driver is the main component that changes the flow of current according to the control signal.

Power supply

Power supply is very important for electronic devices to function. In this all the components are of electronic

background. So we are using the 5 volts DC power supply to all the components except the motor. The motor ratings are different compared to the other devices in the circuit. The motor requires 12 volts DC supply.

Switches

The switches S1 and S2 are used to give control signal to the robot. By using the switches we can make the robot to move in and out.

V. ELECTRONIC COMPONENTS

L293D Driver IC

L293D is a typical Motor driver or Motor Driver IC which allows DC motor to drive on either direction. L293D is a 16-pin IC which can control a set of two DC motors simultaneously in any direction. It means that you can control two DC motor with a single L293D IC. In a single L293D chip there are two h-Bridge circuit inside the IC which can rotate two dc motor independently. H-bridge is a circuit which allows the voltage to be flown in either direction. H-bridge IC are ideal for driving a DC motor. Due its size it is very much used in robotic application for controlling DC motors.

ESP8266 with Wi-Fi module

Espressif Systems' Smart Connectivity Platform (ESCP) is a set of high performance, high integration wireless SOCs, designed for space and power constrained mobile platform designers. It provides unsurpassed ability to embed Wi-Fi capabilities within other systems, or to function as a standalone application, with the lowest cost, and minimal space requirement. The ESP8266 is a low cost wi-fi microchip with full TCP / IP stack & microcontroller capability produced by Shanghai-based Chinese manufacturer, Espressif Systems. This small module allows microcontrollers to connect to a Wi-Finetwork and make simple TCP/IP connections. ESP8266 offers a complete and self-contained Wi-Fi networking solution; it can be used to host the application or to offload Wi-Fi networking functions from another application processor.

When ESP8266 hosts the application, it boots up directly from an external flash. Inhas integrated cache to improve the performance of the system in such applications.

Alternately, serving as a Wi-Fi adapter, wireless internet access can be added to any micro controller-based design with simple connectivity (SPI/SDIO or I2C/UART interface). Espressif Systems' Smart Connectivity Platform (ESCP) demonstrates sophisticated system-level features include fast sleep/wake context switching for energy-efficient VoIP, adaptive radio biasing for low-power operation, advance signal processing, and spur cancellation and radio co-existence features for common cellular, Bluetooth, DDR, LVDS, LCD interference mitigation.

Features

•802.11 b/g/n

•Integrated low power 32-bit MCU

•Integrated 10-bit ADC

•Integrated TCP/IP protocol stack

Ultrasonic Sensor (HC-SR04)

This is the HC-SR04 ultrasonic ranging sensor. This economical sensor provides 2cm to 400cm of non-contact measurement functionality with a ranging accuracy that can reach up to 3mm. Each HC-SR04 module includes an ultrasonic transmitter, a receiver and a control circuit.

There are only four pins that you need to worry about on the HC-SR04: VCC (Power), Trig (Trigger), Echo (Receive), and GND (Ground)

Features

•Operating Voltage: 5V DC

•Operating Current: 15mA

•Measure Angle: 15°

•Ranging Distance: 2cm - 4m

Battery

The Klann bot uses Lead Acid battery with specification of 12 V.

Arduino

Arduino is an open source computer hardware and software company, project, and user community that designs and manufactures microcontrollers and microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical and digital world. The project's products are distributed as open-source hardware and software, which are licensed under the GNU Lesser General Public License (LGPL) or the GNU General Public License (GPL),[1] permitting the manufacture of Arduino boards and software distribution by anyone. Arduino boards are available commercially in preassembled form, or as do-it-yourself (DIY) kits. Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards or Breadboards (shields) and other circuits. The boards feature serial communications interfaces, including Universal Serial Bus (USB) on some models, which are also used for loading programs from personal computers. The microcontrollers are typically programmed using a dialect of features from the programming languages C and C++. In addition to using traditional compiler toolchains, the Arduino project provides an integrated development environment (IDE) based on the Processing language project.

VI. CONCLUSION

The work performed in this project is to develop a wall-pressed in-pipe robot for cleaning andinspection. In developing the wall-pressed in-pipe robot we require various mechanisms for cleaning, moving, actuation and inspection. For cleaning there are four cleaning wipers mountedon the cleaning portion. The wipers are self-adjustable according to the size of the pipe. The cleaning portion contains springs for automatic adjustment.

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