

# Design And Motion Planning of Two Module Indoor Pipeline Robot

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**Abstract**— This paper deals with a design and motion planning algorithm of a pipeline robot that can be used for inspection of 80–100 mm pipelines in an indoor pipeline environment. The robot system uses a four dc motor to drive and steer the robot and spring loaded mechanisms to assure that the robot moves through difficult paths like pipe curves. To grip the pipe walls, it uses two supporting wells. One supporting wheel is fixed tightly to grip and the other wheel loosely. Unique features of this robot are the 6 wheels, the analysis of the spring balance is to supporting the movements, a closed-form kinematic approach, and an intuitive user interface. In addition, a new motion planning approach is proposed, which uses springs to interconnect two robot modules and allows the modules to cooperatively navigate through difficult segments of the pipes. Furthermore, an analysis method of selecting optimal compliance to assure functionality and cooperation is suggested. Simulation and experimental results are used throughout the paper to highlight movements and approaches.

**Keywords**—DC motor , PIC microcontroller, Relay,LED, web camera;

## I. INTRODUCTION

Recently many pipeline inspection robot systems have been developed. Development of pipeline robots began for inspecting large pipelines ranging from 100 to 300 mm. These pipelines are commonly used in manufacturing sites as sewer pipes and gas and oil pipelines. They are also used in nuclear power plants. Pipeline inspection robot systems improve safety and reduce work time. In-pipe robots can be classified into several elementary forms according to movement patterns. Wheel-type pipeline inspection robots are popular and have been investigated in the laboratory. Inchworm-type mechanisms are suitable for pipelines with a diameter smaller than 30 mm. However, these were not effective because of their low speed and poor reliability. The inchworm robot is similar to the snake-like robot. Snake-like robots use a number of active joints or modules; thus, their development cost is expensive and they need more energy for operation. Crawler-type robot mechanisms are able to adapt to changes in the pipeline's environment. Usually, wheel-type robots use a four wheel system. With this type, it is easy to inspect a collapsed part or choked part of a pipeline.

## II. RELATED WORKS

### A. SNAKE ROBOT MODELING :

Snakes utilize irregularities in the terrain, such as rocks and vegetation, for faster and more efficient locomotion. This motivates the development of snake robots that actively use the terrain for locomotion, this paper presents a novel

nonsmooth (hybrid) mathematical model for wheel-less snake robots, which allows the snake robot to push against external obstacles apart from a flat ground. The framework of nonsmooth dynamics and convex analysis allows us to systematically and accurately incorporate both unilateral contact forces (from the obstacles) and isotropic friction forces based on Coulomb's law using set-valued force laws.

### B. FAMPER

The design and implementation of a robot based on caterpillar navigational mechanism. A Fully Autonomous Mobile Pipeline Exploration Robot (FAMPER), for exploring pipeline structures. The design of a robot based on wall-pressed caterpillar type for not only horizontal, but also vertical mobility in pipeline elements such as straight pipelines, elbows and branches, and its autonomous navigational system providing useful information for pipeline maintenance. FAMPER has been designed for 6 inch sewer pipes, which are predominantly used in urban constructions. The proposed design enables FAMPER to display formidable mobility and controllability in most of the existing structure of pipeline, and provides a spacious body for housing various electronic devices.

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### C. TUNNEL INSPECTION ROBOT

The tunnel inspection robot should be small and easily controlled. The tunnel inspection robot is made up of a moving platform controlled by two dc motors. On top of the moving platform is a turntable controlled by a stepper motor via wireless system made up of transmitter and receiver. On top of the turn-table is a miniature camera connected remotely to a computer system for monitoring and manual steering of the robot. Together with the camera is a searchlight for lighting up dark areas. The whole platform should be able to move in rugged areas. This tunnel inspection robot is controlled by a fully wireless system to avoid wire entanglements. This robot can be used as a surveillance robot in dangerous areas.

#### D. A SIMPLE ARCHITECTURE FOR IN-PIPE INSPECTION ROBOTS

This is an original robot architecture for in-pipe inspection. The robot consists of two parts articulated with a universal joint. One part is guided along the pipe by a set of wheels moving parallel to the axis of the pipe, while the other part is forced to follow an helical motion thanks to tilted wheels rotating about the axis of the pipe. A single motor is placed between the two bodies to produce the motion. All the wheels are mounted on a suspension to accommodate for changing tube diameter and curves in the pipe. The robot is autonomous and carries its own batteries and radio link. For smaller diameters, the batteries and the radio receiver may be placed on an additional body attached to the others. The autonomy of the prototypes is about 2 hours. This architecture is very simple and the rotary motion can be exploited to carry out scrubbing or inspection task.

#### E. SENSOR-BASED AUTONOMOUS PIPELINE MONITORING ROBOTICS SYSTEM

Spram System (Sensor-Based Autonomous Pipeline Monitoring Robotic System). It Combines Robot Agent Based Technologies With Sensing Technologies For Efficiently Locating Health Related Events And Allows Active And Corrective Monitoring And Maintenance Of The Pipelines. The Fixed Sensors Provide Event And Mobile Sensor Location Information And Contribute Efficiently To The Study Of Health History Of The Pipeline. Using The Output Of Event Analysis, A Robot Agent Gets Command From The Controlling System, Travels Inside The Pipelines For Detailed Inspection And Repairing Of The Reported Incidents The Robot Is Autonomous And The Localization Technique Allows Controllable Errors. In This Dissertation, Some Simulation Experiments Described Along With Prototyping Activities Demonstrate The Feasibility Of The Proposed System.

#### III. PROPOSED SYSTEM

This project deals with a design and motion planning algorithm of a pipeline robot that can be used for inspection of 80–100-mm pipelines in an indoor pipeline environment. The robot system uses four dc motor to drive to steer the robot and spring loaded mechanisms to assure that the robot moves through difficult paths like pipe curves. To grip the pipe walls, it uses two supporting wells. one supporting wheel is fixed tightly to grip and the other wheel loosely. Unique features of this robot are the 6 wheels, the analysis of the spring balance is to supporting the movements, a closed-form kinematic approach, and an intuitive user interface. In addition, a new motion planning approach is proposed, which uses springs to interconnect two robot modules and allows the modules to cooperatively navigate through difficult segments of the pipes. Simulation and experimental results are used throughout the project to highlight algorithms and approaches.

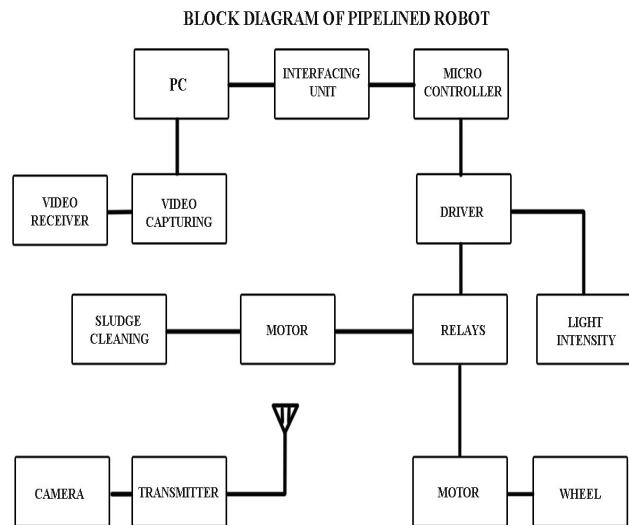


Figure 1 System Overview

The following hardware are used in project

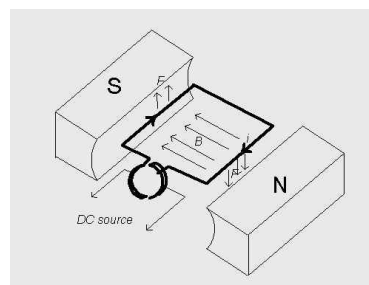
- Relay
- Dc motor
- Pic micro controller
- Web camera
- LED

#### A. Relay Driver

A relay is an electrically operated switch. Current flowing through the coil of the relay creates a magnetic field which attracts a lever and changes the switch contacts. The coil current can be on or off so relays have two switch positions and most have double throw (changeover) switch contacts as shown in the diagram.



#### B. DC MOTOR



DC motors are part of the electric motors using DC power as energy source. These devices transform electrical energy into mechanical energy. The basic principle of DC motors is same as electric motors in general, the magnetic interaction between the rotor and the stator that will generate spin.

Simple motor has six parts:

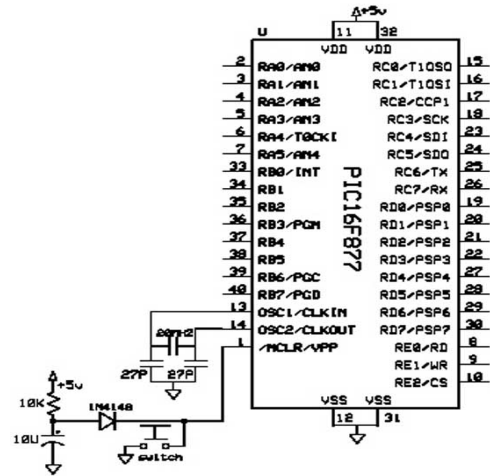
1. Armature or rotor
2. Commutator
3. Brushes
4. Axle
5. Field magnet
6. DC power supply of some sort
- 7.

**C. PIC MICROCONTROLLER(PIC16F877A)**

PIC is a family of Harvard architecture microcontrollers made by Microchip Technology, derived from the PIC1640. The name PIC initially referred to Programmable Interface Controller.

**FEATURES OF PIC16F877A**

- High-performance RISC CPU
- Only 35 single word instructions to learn
- All single cycle instructions except for program branches which are two cycle
- Operating speed: DC - 20 MHz clock input DC - 200 ns instruction cycle
- Up to 8K x 14 words of Flash Program Memory,
- Interrupt capability (up to 14 internal/external)
- Eight level deep hardware stack
- Direct, indirect, and relative addressing modes
- Power-on Reset (POR)



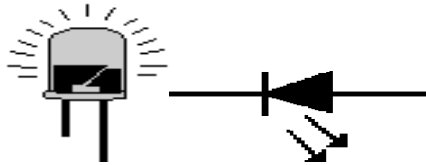
**D.WEBCAM**



A webcam is a video capture device that is connected to a computer or computer network, often using a USB port or, if connected to a network, Ethernet or Wi-Fi, or build in for certain types of laptops. Their most popular use are for video links, permitting computers to act as videophones or videoconferencing stations. Webcams can also be used with various computer video telecommunication programs .

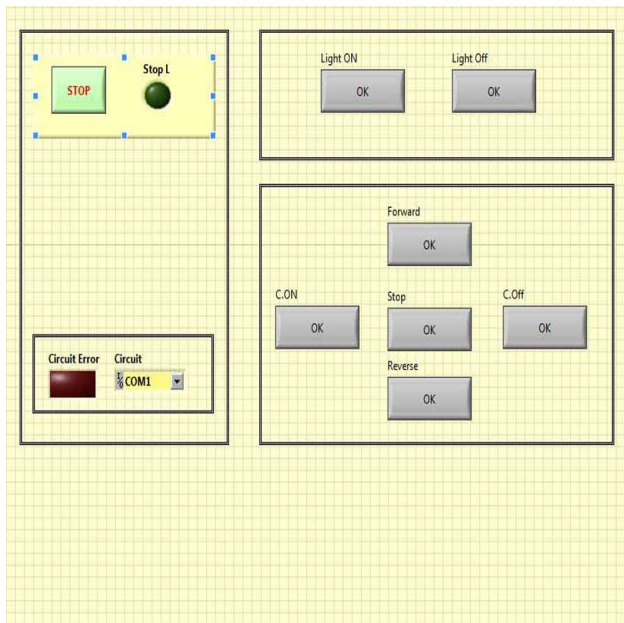
**E.LIGHT EMITTING DIODE**

Light emitting diode (LED) is basically a P-N junction semiconductor diode particularly designed to emit visible light. There are infrared emitting LEDs which emit invisible light. The LEDs are now available in many colours red, green and yellow. A normal LED emits at 2.4V and consumes MA of current. The LEDs are made in the form of flat tiny P-N junction enclosed in a semi-spherical dome made up of clear coloured epoxy resin. The dome of a LED acts as a lens and diffuser of light. The diameter of the base is less than a quarter of an inch. The actual diameter varies somewhat with different makes. The common circuit symbols for the LED are shown in Fig. It is similar to the conventional rectifier diode symbol with two arrows pointing out. There are two leads- one for anode and the other for cathode.

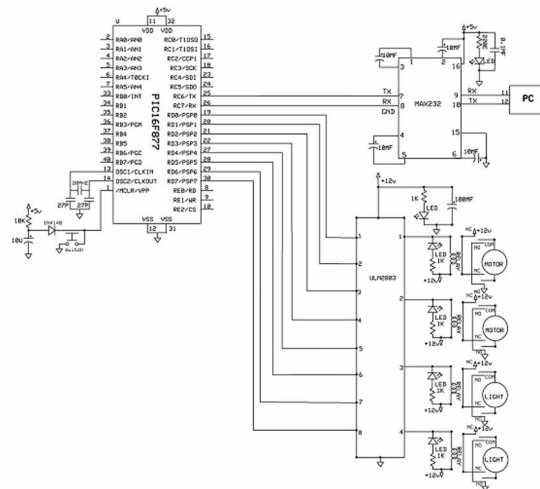


#### IV. EXPERIMENTAL RESULTS

The Labview is the simulation tool used in experiment. LabVIEW programs are called virtual instruments (VI) because their appearance and operation imitate physical instruments, such as oscilloscopes and multimeters. Every VI uses functions that manipulate input from the user interface or other sources and display that information or move to other file or other computers. The figure below shows the front panel the experiment. The robot is controlled through pc and uses RF module to control the web camera.



#### V. CIRCUIT DIAGRAM



#### VI. CONCLUSION

The project can be used for the sludge cleaning and indoor pipeline views. The PIC microcontroller makes fast access of the modules which is connected to the pins. We can use this robot in many industries for the effective cleaning and motion through the pipeline.

#### VII. FUTURE SCOPE

In future we can use this project in several applications by adding additional components like temperature sensor, smoke sensor, etc.

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