IN-PIPE ISPECTION ROBOT

Mechatronics Final Project Design

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Overview

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- Equipment list
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- Mechanical Design
- Sensor
- Storage Data
- Future Improvments
- Conclusion

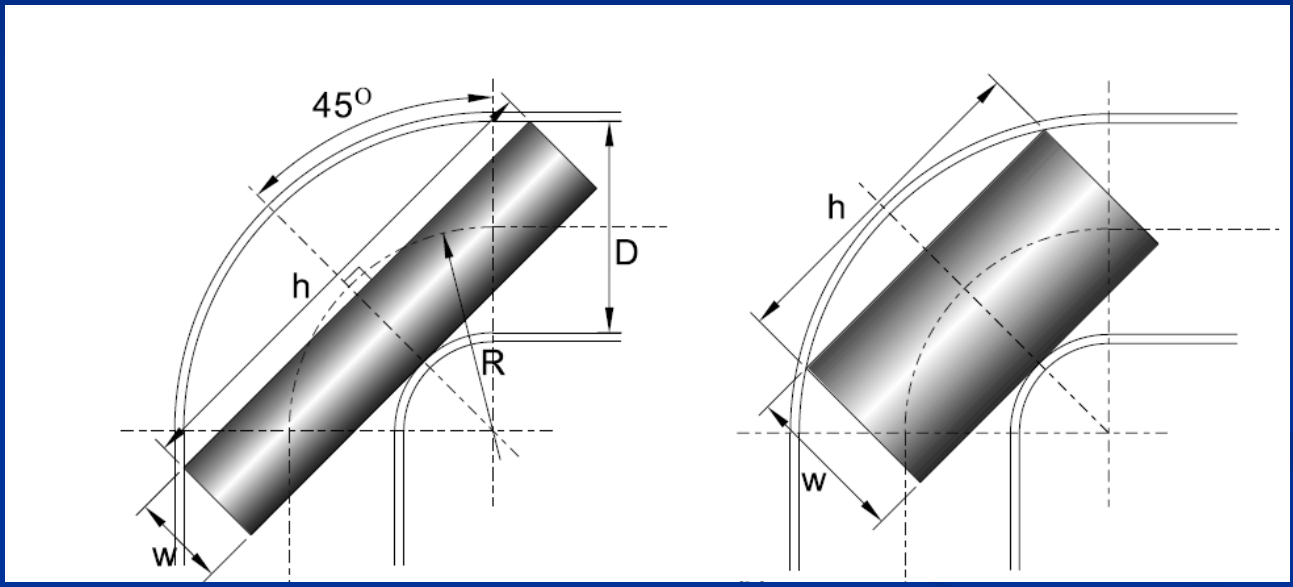
Goal

Building an in-pipe ispection robot capable of:

- **Moving inside pipes**
- **Climbing vertical pipes**
- **Measuring the inner diameter of a pipeline and therefore detecting the presence of limestone**
- **Storing the acquired data in a removable usb device**

Physical Constrain

Elbow



$$0 < w \leqslant \{(R + D/2)\sin 45° - (R - D/2)\},$$

Equipments List

Mechanic System:

- Plexiglass frame
- Aluminum arms
- Pinion Gears
- Linear springs
- Plastic Pulley
- Transmission Belt
- Bearings

Sensor

- Angular Potentiometers
- Safe switch

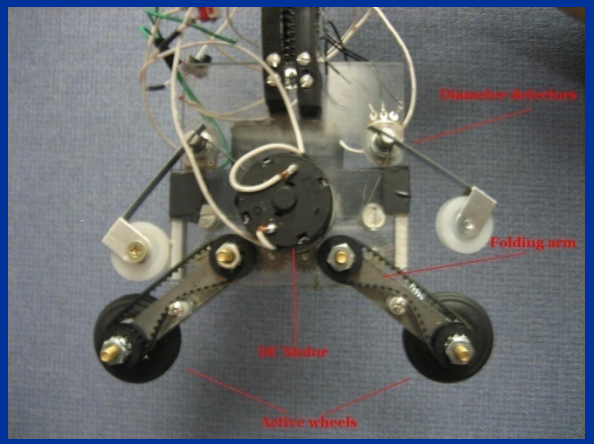
Robotic

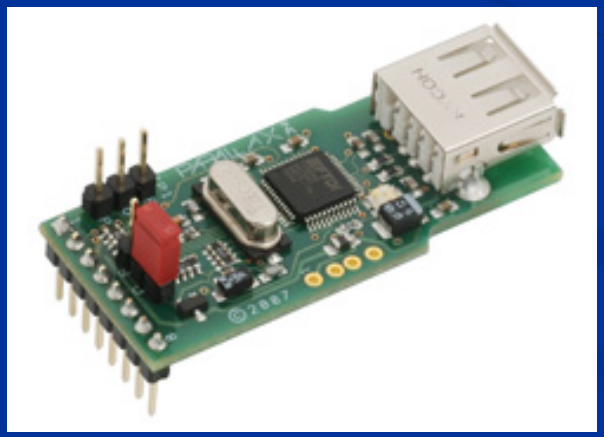
- Basic Stamp
- Usb data logger
- H-bridge

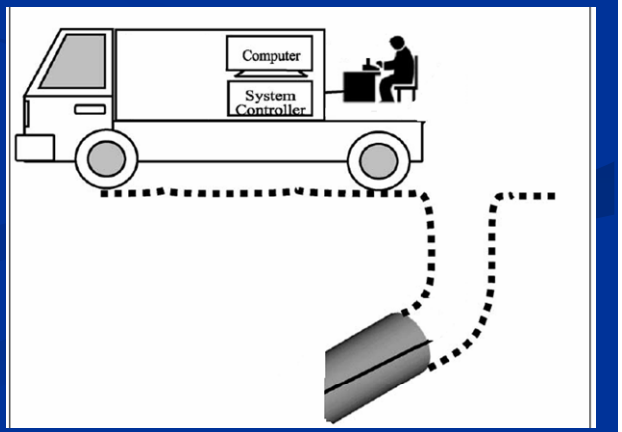
System Description

The Robot is only a part of a maintenance system composed by:

- **In-pipe Inspection Robot**
- **Removable data logger system**
- **External station for data analysis**







Mechanical Design

For the preliminar design, we took into account these critical parameters:

- **minimal and maximal dimensions**
- **weight**
- **moving ability**
- **power request**
- **cost issues**

Any of the above influences the others, a compromise must be found

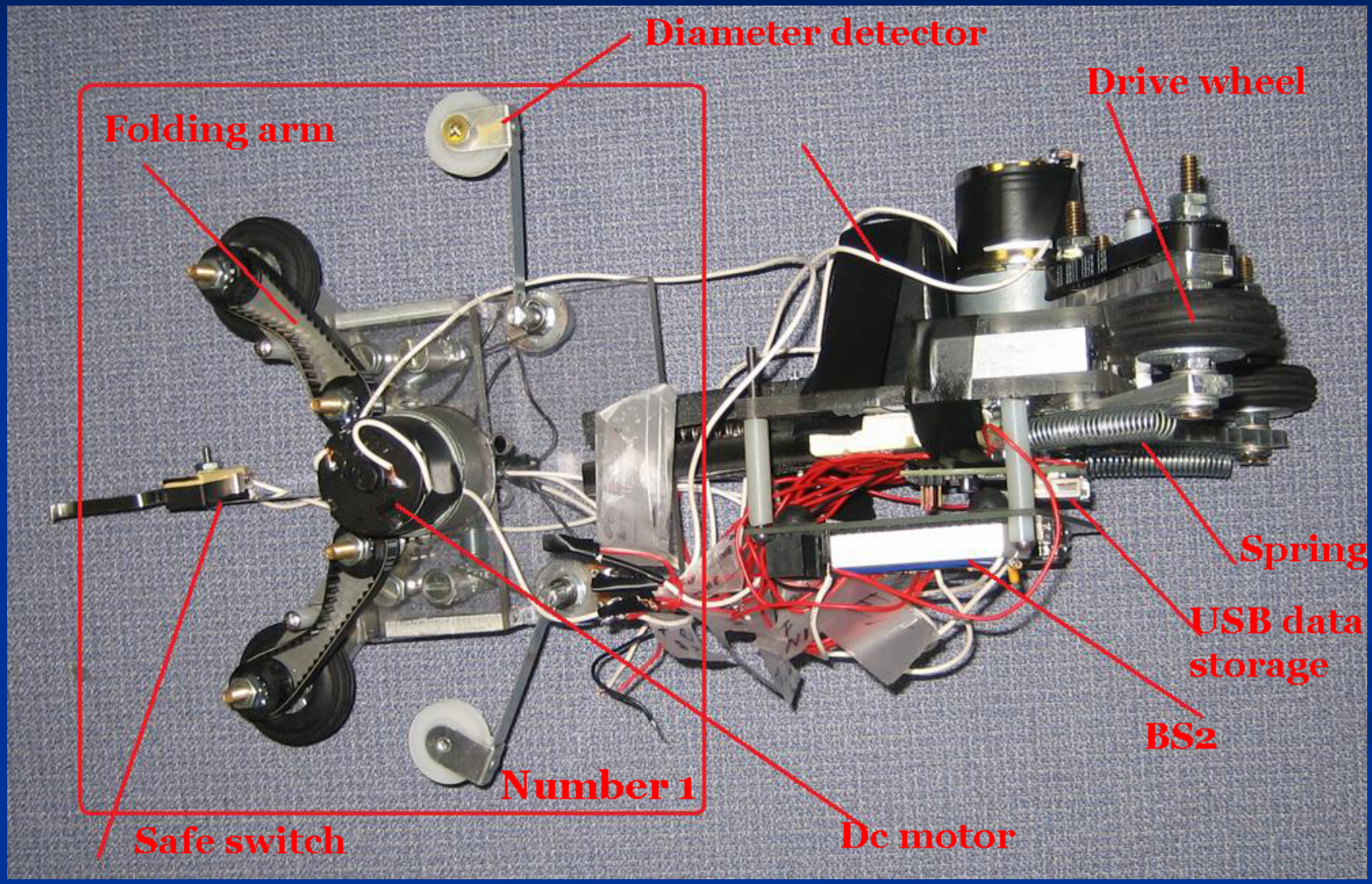
Mechanical Design

The result is a robot composed by two autonoumus vehicle connected with a rubber material and a spring.

Each vehicle is equipped with two driven wheeled arms and a dc motor.

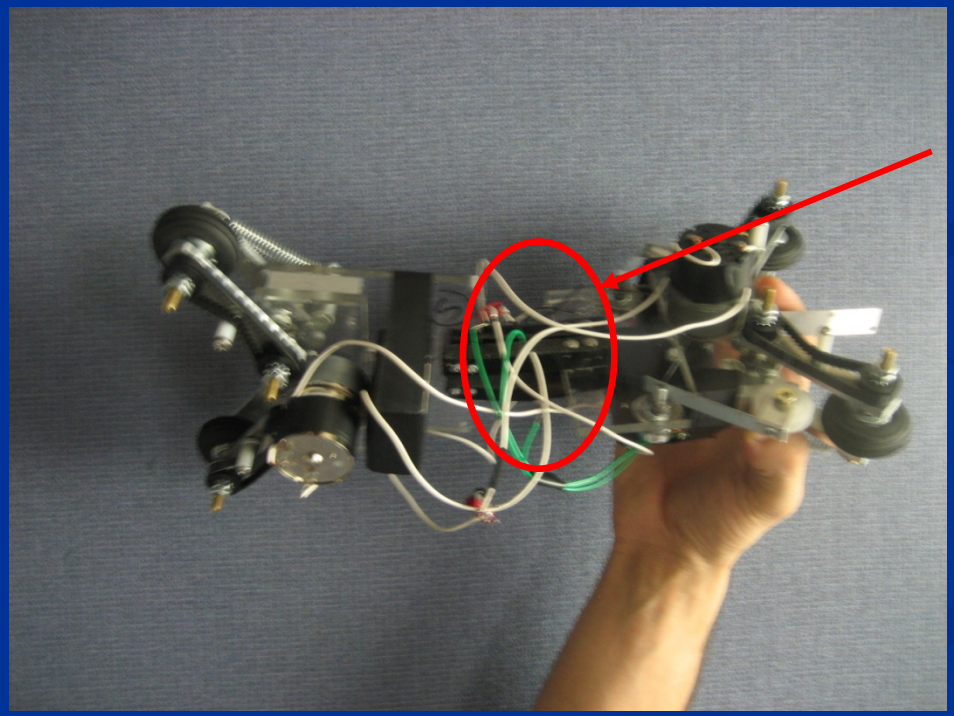
Each arm is pressed to the inner surface of the pipe by a linear spring, and can adapt to diameters changing by folding itself.

Mechanical Design



Mechanical Design

Since weight is a critical parameter, materials used have to be light and easily machinable: plexiglass, aluminun, plastic.



Bending deflection due to its weight

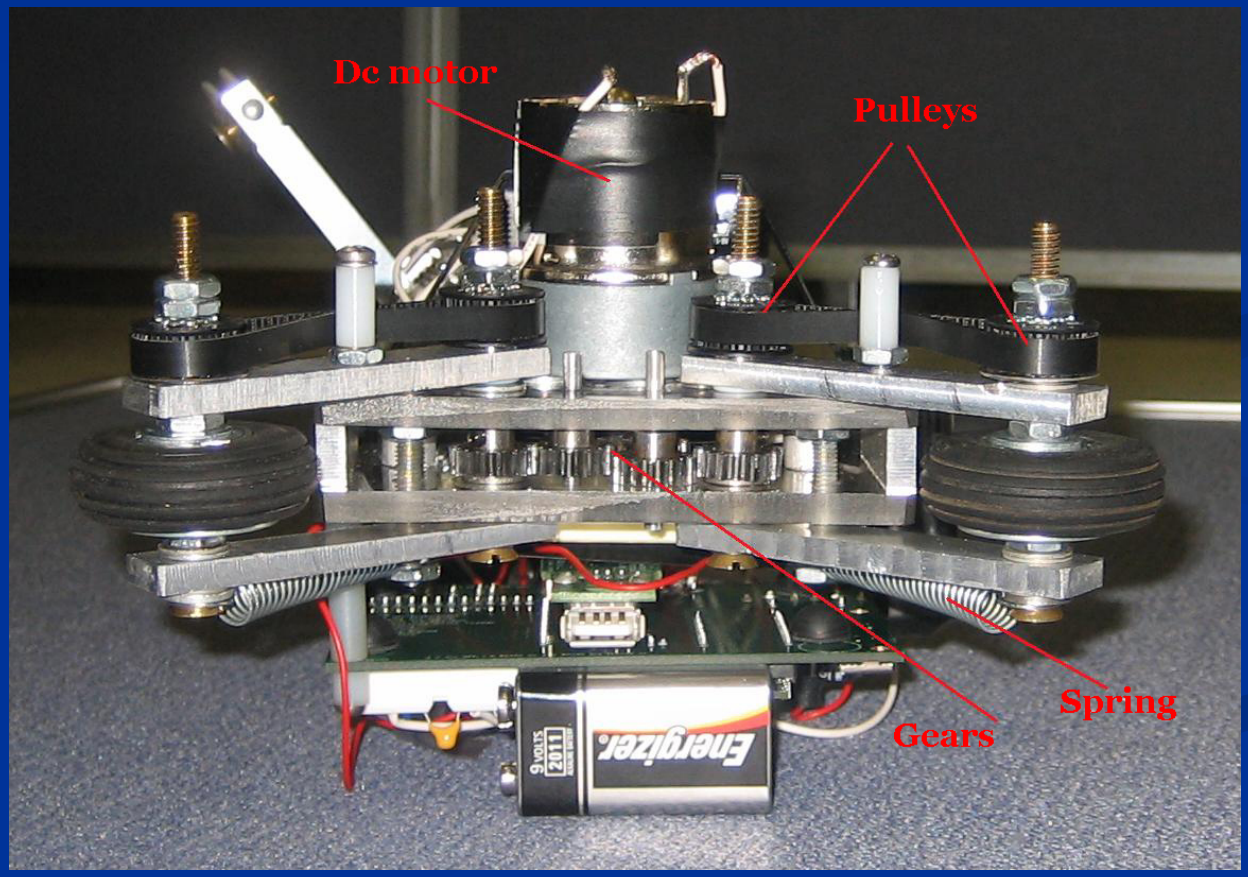
Mechanical Design

For the propulsion we chose two 12 V DC Reversible Gear Head Motors, one on each vehicle, to have high torque and low speed.

Unfortunately this means high current request and weight added by the batteries and heavy motors

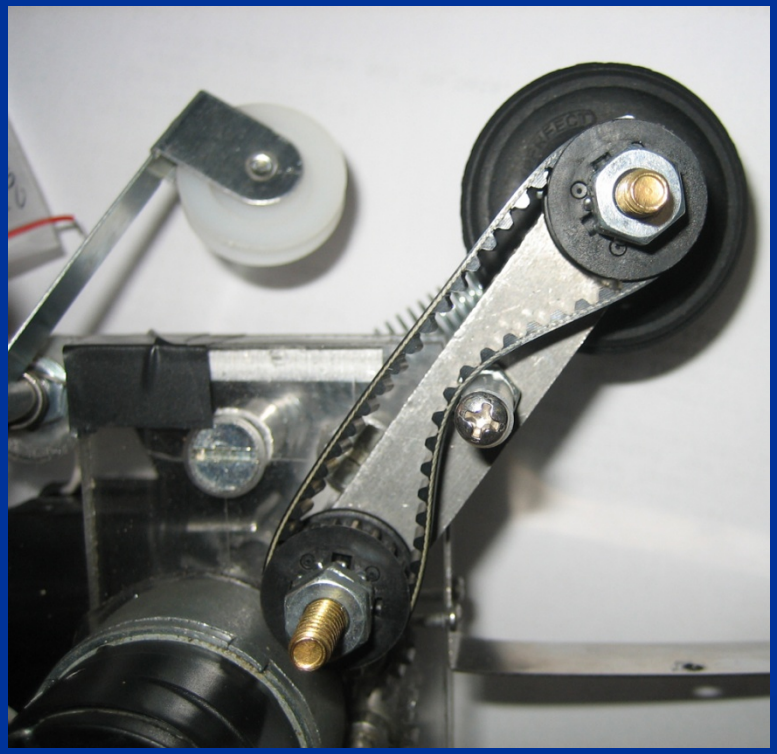
Mechanical Design

Each vehicle has an hybrid transmission made of two type of mechanical device: Gears and pulley



Mechanical Design

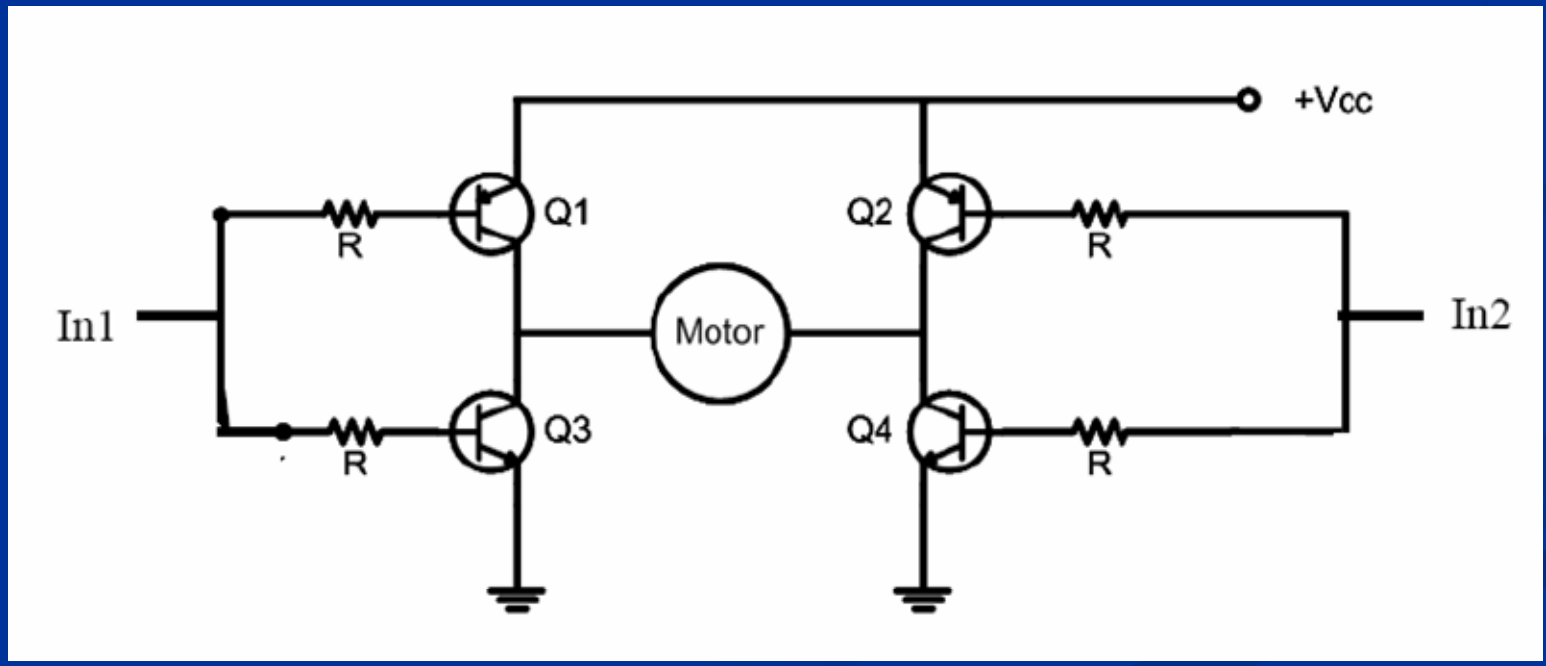
The motor transmit the torque to the wheeled arms through a pinion gear and then to the wheels by a transmission belt



In this way one motor moves two wheels, one clockwise and one contraclockwise

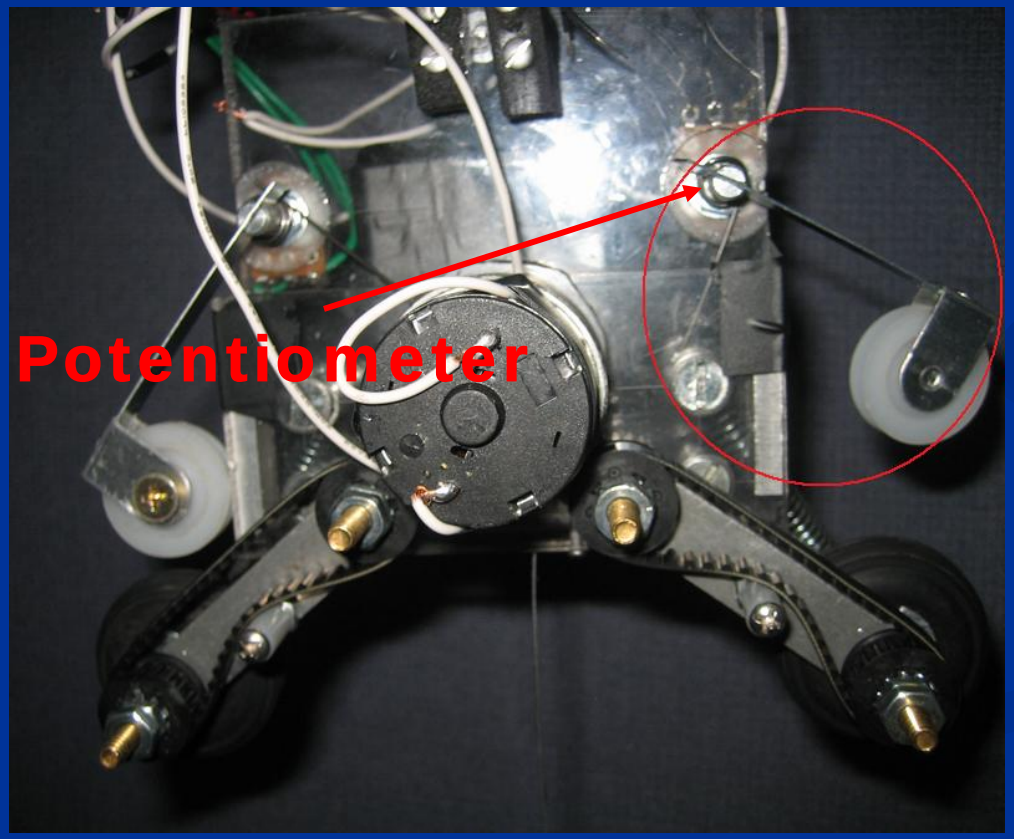
Motors

Motors: to activate them we will use a Full Bridge for each vehicle. Two inputs are used to control the base leads of a pair of transistors.



Sensors

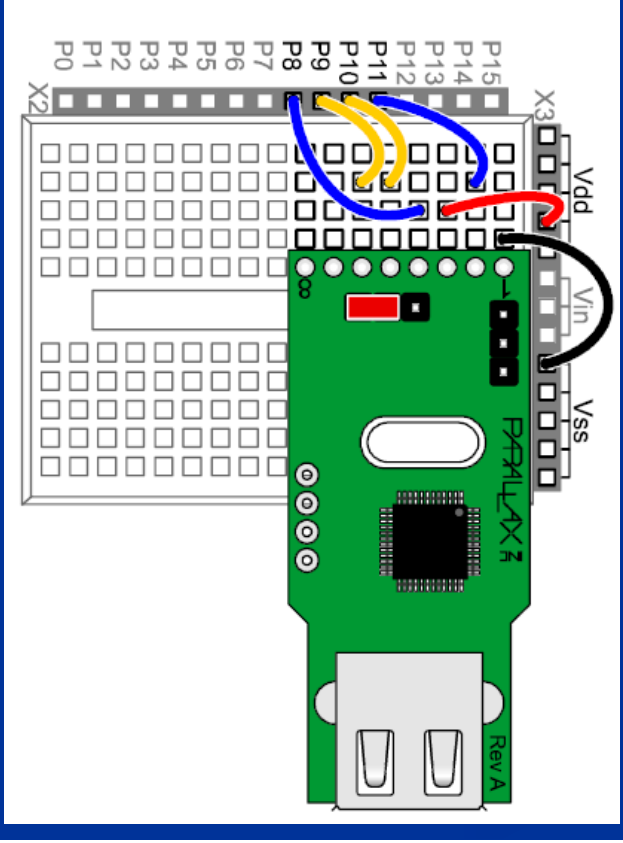
The folding arms are mounted on a potentiometer that can turn in presence of an obstacle.

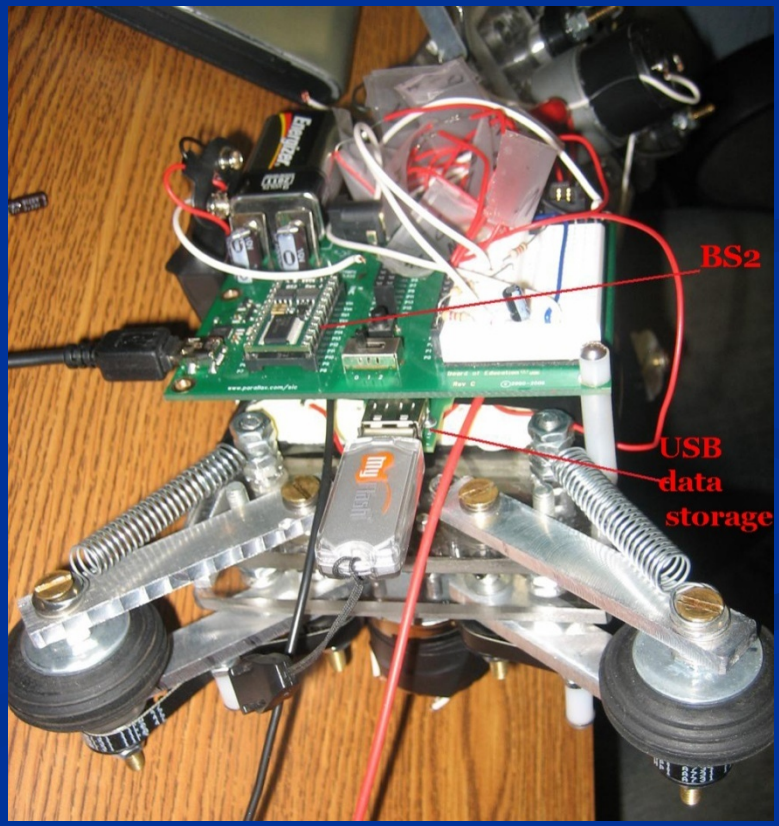


Angular displacement of the potentiometer is related to a variation of nominal diameter of the pipe and can be related to the presence of limestone

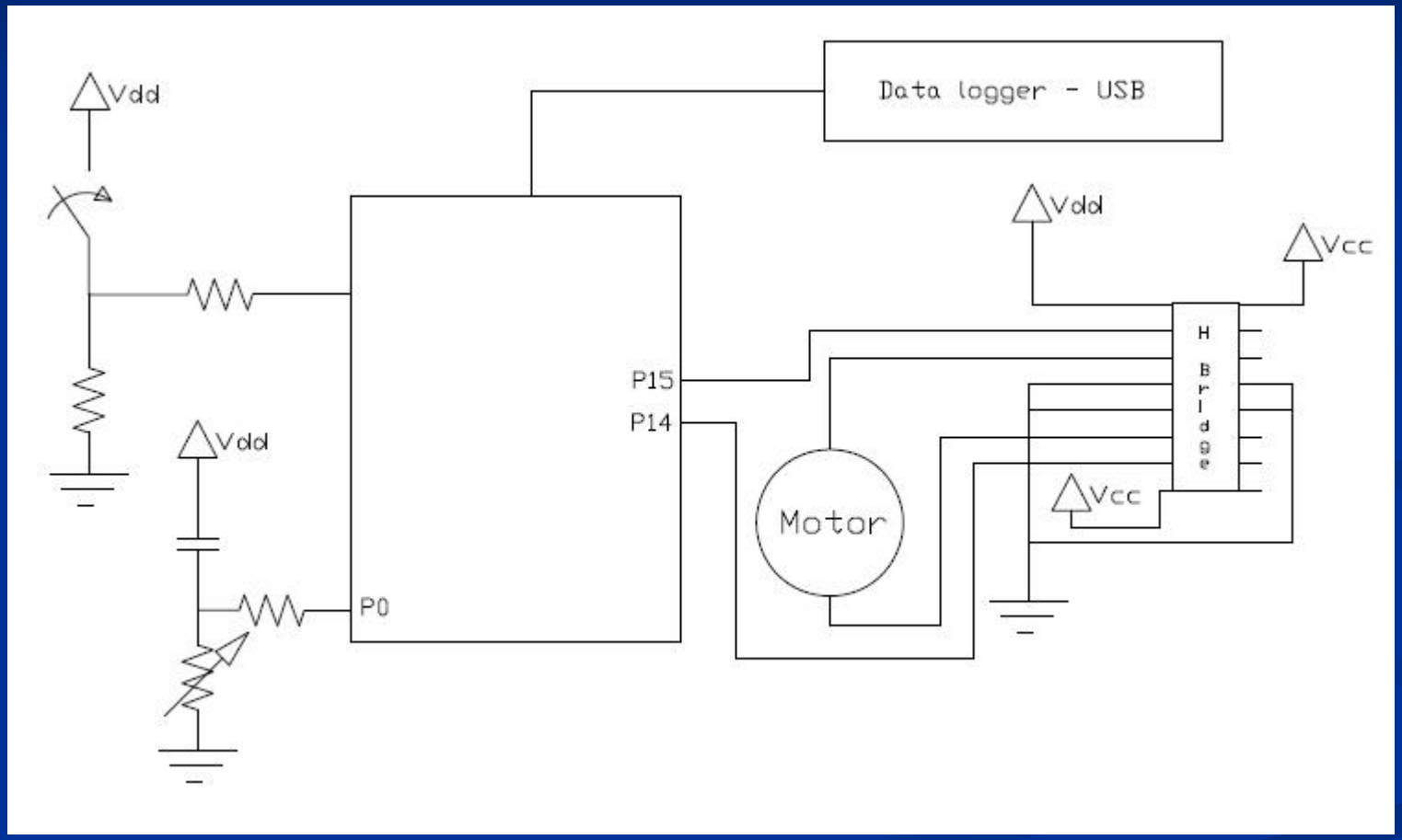
Storage Data

The Memory Stick Datalogger is a USB Host Bridge which allows to connect a USB Mass Storage Device, such as a Thumb Drive, to the BASIC Stamp.



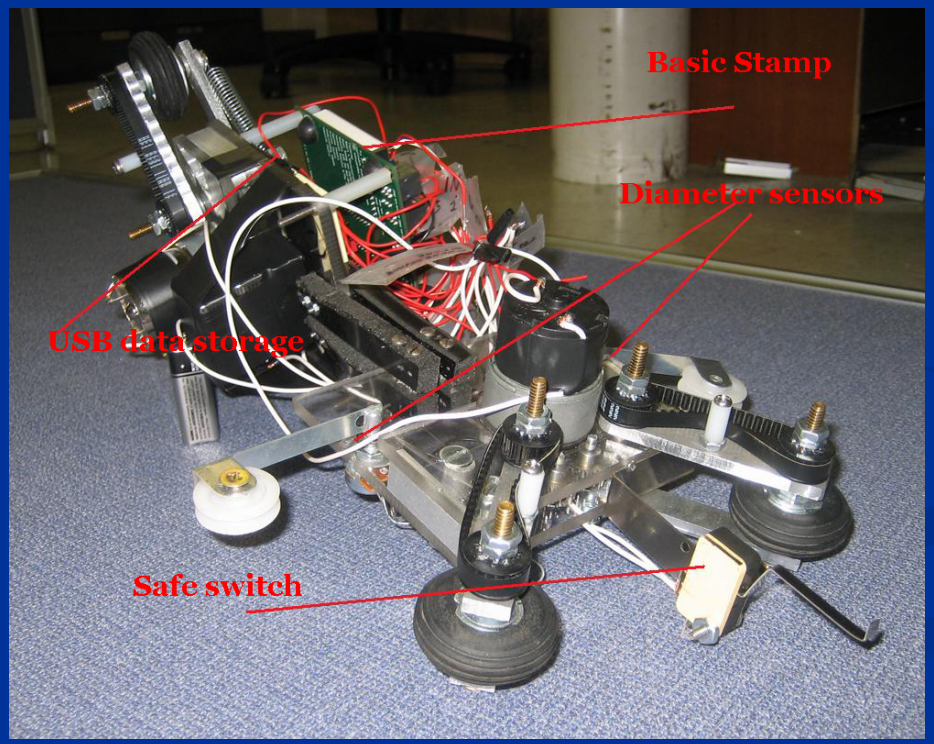


Circuit



Recovery switch

A switch is mounted in front of the robot. If it finds an ostruction in the pipes it is activated. The robot tries to go ahead three times. If it is not succesful it returns to the start point



Future Improvements

- **Build a smooth waterproof body to house the frame and the electrical components**
- **Improve the control system in presence of elbows and obstacles**
- **Reduce the mechanical loss**
- **Reduce the dimension of the robot and its weight**
- **Install a CCD camera on board for visual ispection**

Conclusion

The in-pipe inspection robot can be an usfull tool to drastically decrease maintenance expences

It is relatively cheap and easy to use

However its realization is complex

More time is required to enhance the robot features

Questions

Thank you.

Questions?