Detecting and Fixing Pipeline Faults in a Non-Invasive Manner

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SITUATION

- Pipes are usually fixed invasively, or even replaced completely which costs a lot of resources. Inspection of the pipelines and their repair can be automated with the help of autonomous robots and other machinery that aids in reducing the resources required.
- This research looks into some of the complications that occur in pipelines in addition to the methods used to detect and repair these complications
- Solutions considered should lead to reduced time consumption, cost and manpower.

PROBLEM

- Head loss caused by:
  - Friction between pipe walls and the fluid.
  - Fouling.
- Fracture in the pipes caused by:
  - Corrosion inside or outside the pipes.
  - Improper welding of the pipes.
  - Manufacturing errors in seamless pipes.
- Growth of cracks on pipes, accompanied by environmental load or interior fluid pressure on unaccounted weak points(fractures), could lead to serious damage [1].
- Pigging robots in market are getting outdated and needs a faster and better alternative.
- The robots need to be able to identify the specific destinations that need to be fixed and navigate through pipelines to get to them, while overcoming any obstacles encountered [2].

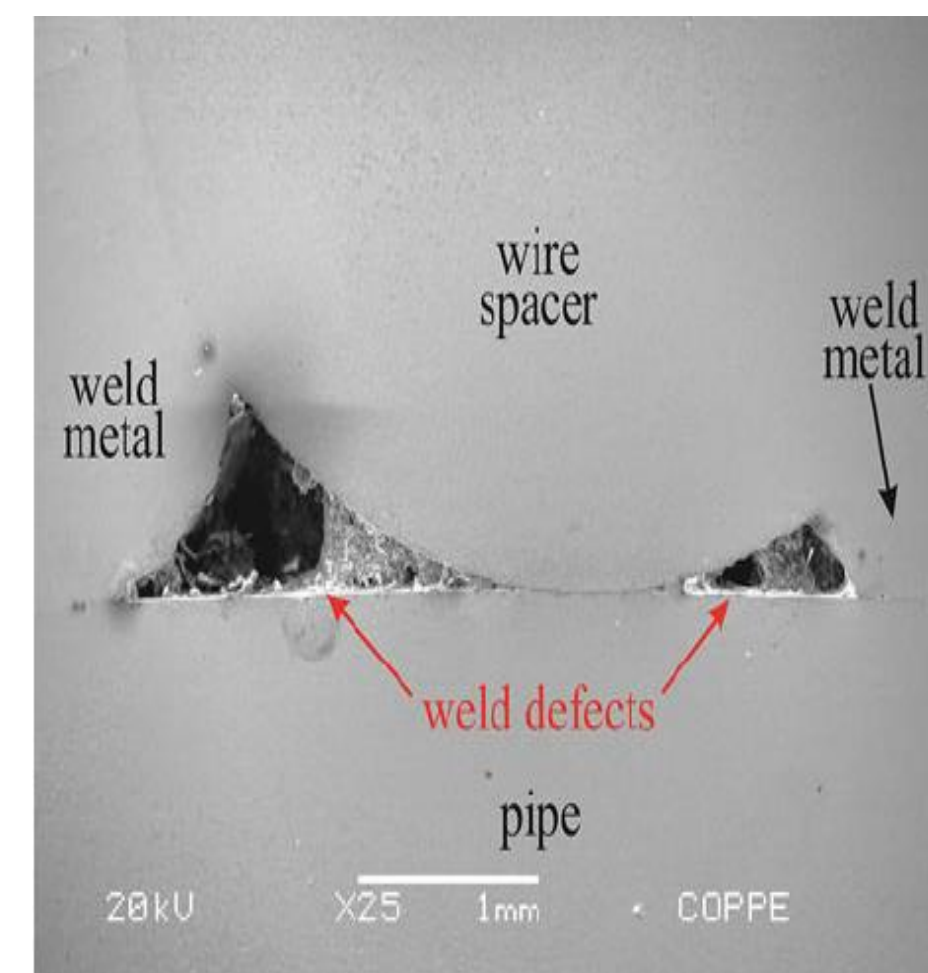Figure 1: Improper welding of a pipe [3].

Figure 2: Weld metal and pipe interface (transverse view), showing lack of fusion [4].

SOLUTION

Pigging is the traditional method used to fix these problems. The solutions provided below can be integrated onto pigging systems.

Non-Destructive Testing:

- The **C**reeping/**H**ead wave **I**nspection **Me**thod (CHIME)
  - Medium range screening
  - Full volume coverage up to one meter [5].
- Eddy Current Array Technology
  - Solution uses existing standard phased array scanner.
  - High scan speed and instant results.
  - Environment-friendly [6].
- Magnetic flux leakage Method
- Time of Flight Diffraction Ultrasonic
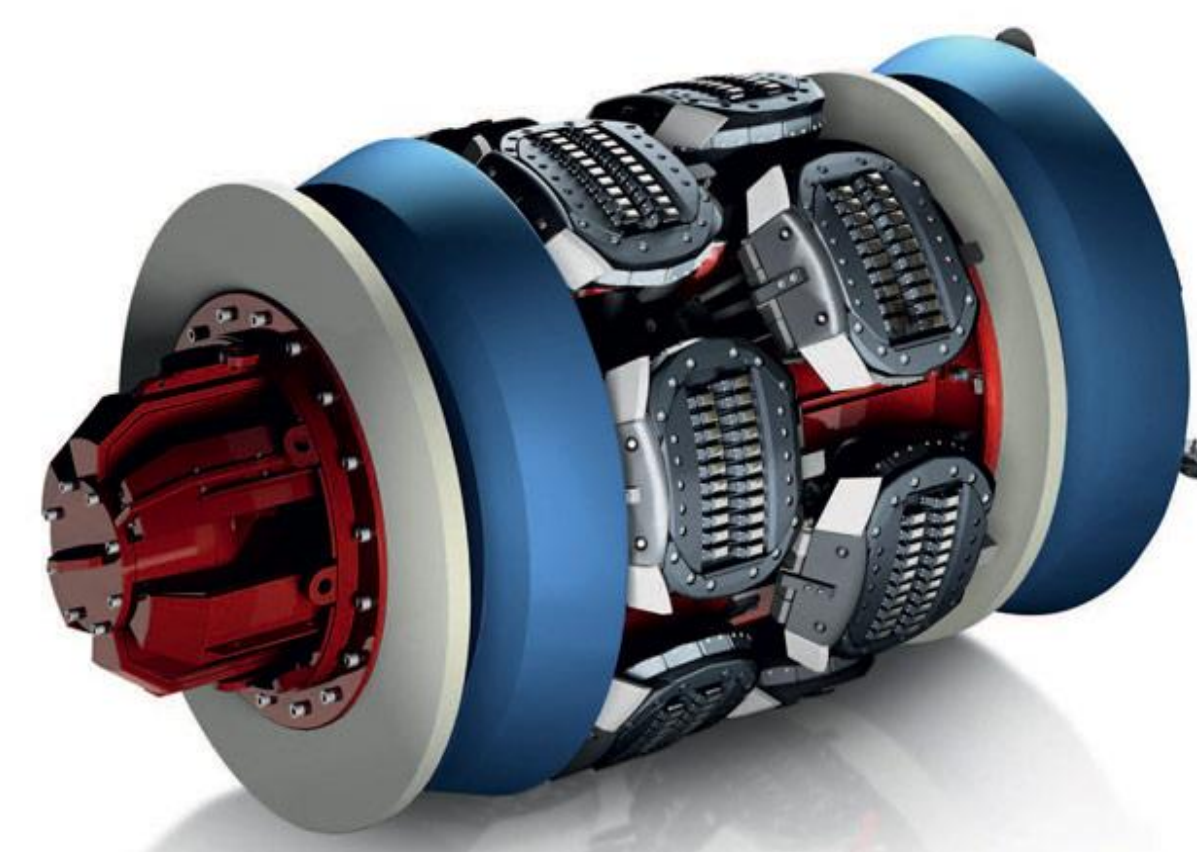- 3D Laser Scanner for Corrosion

Figure 3: Magnetic Flux Pigging Robot [7].

Figure 4: Evaluation Robot inside Pipeline [8].

Algorithms used to navigate the robots:

- Rule-Based Navigation
  - Assign a path quality.
  - Information used by the robot is collected before the operation.
  - Cannot modify behavior based on knowledge collected during the operation [2].
- Evolutionary navigation
  - Uses evolutionary algorithms.
  - Allows robots to make decisions on their own based on their environment, the application, and the priority of the task [9].

EVALUATION

- Cost Analysis
  - Significant decrease in manpower
  - Less equipment required
  - Since these inspection and fixing procedures are faster, they cost the pipeline company less time without the pipe running.
- Time Analysis
  - Work done in weeks rather than months[5][6].

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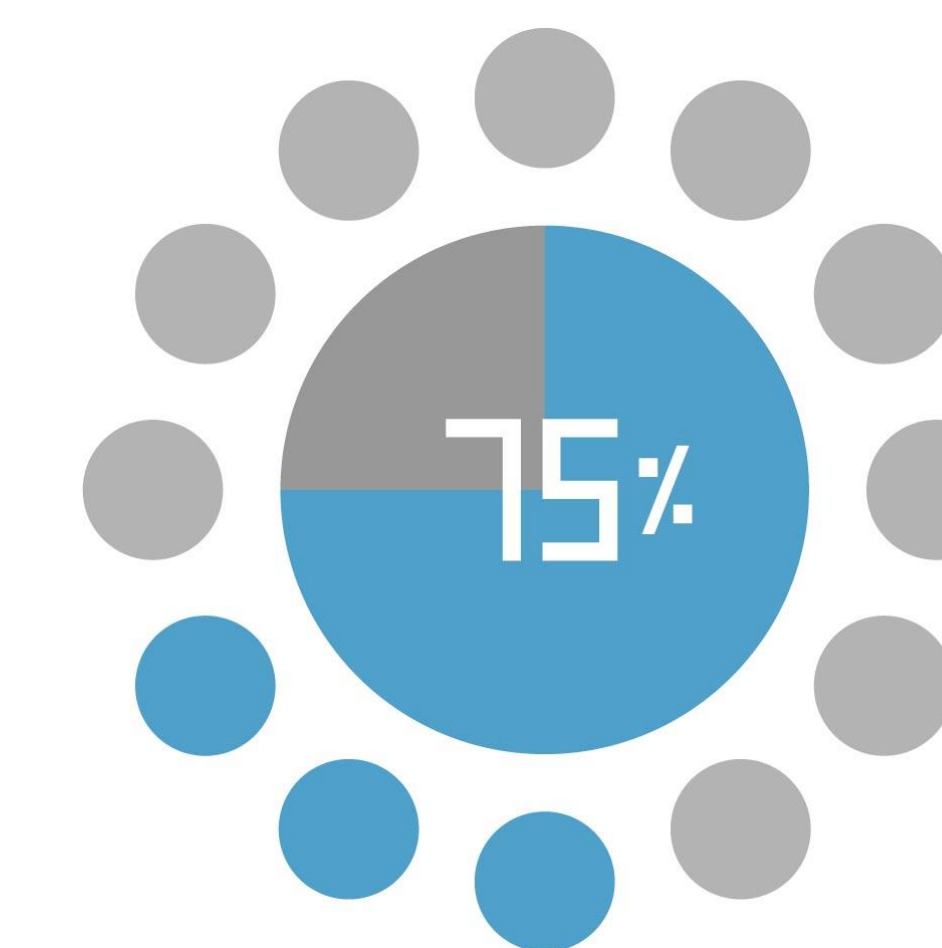
Reduction in Time

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