

## Development of Technologies to Support Robotic Systems for the Inspection of Unpiggable Natural Gas Pipelines

**Description:** A number of technologies, such as pipeline cleaning devices, rescue tools, in-line recharging system, and crack detection sensors are being developed to enhance NYSEARCH's commercial robotic system for the in-line inspection of unpiggable natural gas pipelines.

**Status:** Undergoing Proof-of-Concept, prototype development and testing

### BENEFITS

A robotics technology for the inspection of unpiggable pipelines, developed with funding from NYSEARCH and its industry and government partners, was commercialized in late 2010. A related effort is now supporting efficient, reliable and safe deployment of the robotics systems in order to continue to increase application to several natural gas industry challenges. A number of technologies are under development. Upon completion of this work, the capabilities of these robotic systems will be enhanced and the efficiencies associated with their deployment will increase significantly thus resulting in their wider application and use.

### BACKGROUND

A major milestone of NYSEARCH's effort in developing technologies for the inspection of the thousands of miles of unpiggable pipelines in the U.S. was reached in late 2010 when Pipetel Technologies Ltd. introduced the technology to the market by unveiling Explorer 6/8 a tool designed for the inspection of 6" – 8" unpiggable pipelines. This is a tetherless, self powered (via batteries), modular robotics platform with a wall loss sensor integrated on it that communicates with the operator via wireless technology and is able to be launched, operated and retrieved under live pipeline conditions. As additional sizes are being built to cover the entire range of pipeline

sizes encountered, the research and development effort is addressing issues pertaining to increased efficiencies in the deployment of these technologies and introduction of additional sensors for increased application and value to the members and industry.

There are two areas of need for new technologies to support the robotic platforms deployed or to be deployed in the near future. The first is the introduction of additional sensing capabilities. The current systems are equipped with sensors able to measure wall loss due to corrosion. Additional capabilities need to be introduced in these systems, especially capabilities in detecting and sizing mechanical damage in pipelines, mainly in terms of dents and ovality issues, given that following corrosion, these are known to be the next most prevalent defects encountered in pipelines. In addition, crack detection is important. The second area is that of increasing the efficiencies, and thus lowering the cost of the gas company's job support for the robots. Technologies that could increase the reliability of the robots, extend their operational range, and provide cleaning capabilities that would allow inspection of "dirty" pipelines would be very valuable.

## TECHNICAL APPROACH

NYSEARCH retained Invodane Engineering of Toronto, Canada, to carry out engineering studies and develop prototype systems for a number of technologies that will enhance the performance and market of the robotics technologies for inspecting unpiggable pipelines. In one of the two projects, four different tasks are being carried out.



**Figure 1: In-Line Charging System; System Design  
Applicable to all Pipelines Sizes**

In the first task, an effort is underway to develop capabilities for sensing mechanical damage, dents and ovality in pipelines. Various mechanical and optical options are being explored and analyzed in the context of integrating them on the robotic platforms. Particular emphasis is being placed on optical methods given their advantages in terms of space and power required. In the second task, an in-line battery charging system is being designed (see Figure 1) and built that will allow the robots to be recharged while in the pipeline, i.e. without having to remove them from the pipeline, which will further accelerate the charging process. It is envisioned that the same access point created on the pipeline for deploying the recharge system could be used for deploying an antenna in order to increase the wireless range of the robot. In the third task, a working prototype system is being designed and built for cleaning debris and liquids found in pipelines as well debris (shavings) generated at the access point where the pipeline is tapped in order to install the launcher system. In the fourth task, a feasibility study is underway to identify and develop solutions for a vehicle able

to retrieve the robots in case of failure inside a pipeline. A complete failure mode analysis is being carried out prior to developing the specifications of the rescue system. As with all systems under consideration in the overall program, this system is designed to be scalable to all sizes.

In a separate project, NYSEARCH is also investigating with Invodane/Pipetel means for adding crack detection sensors to the unpiggable inspection platform. In addition to searching for off-the-shelf sensors, the project is studying the state-of-the-art in crack detection and working with funders to carefully define what types of cracks are most important to address in their systems. Many years of work have been done by others in the area of crack detection and it appears as if a successful program will have to be clearly focused on advantages and limitations of each technology type and consider the physical and engineering challenges of not only the types of orientations of cracks but the configuration of the pipes.

## PROGRAM STATUS

The effort was initiated in mid-2011 and its first elements are being completed in early 2012. The entire range of sizes will be developed over the next two years in conjunction with the deployment of the corresponding platforms.

The crack detection effort is underway in late 2011 and will target testing and implementation in 2012.

### Highlights

- New application being addressed
- Crack Detection
- Mechanical Damage; dents and ovality
- Live Rescue
- Cleaning
- In-Line Charging

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