Apical Robotics

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Background

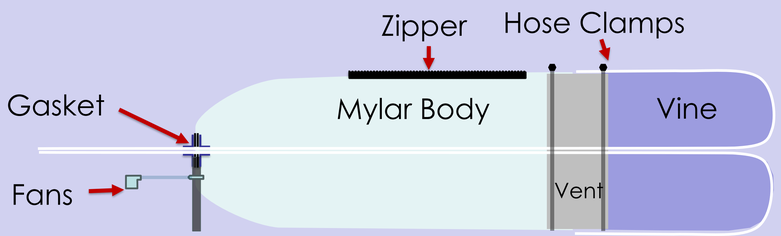
Industrial facilities such as chemical factories, gas terminals, and power plants can contain miles of piping that require meticulous inspection for leaks and defects prior to operation. This is a costly and time-consuming process that sometimes requires dismantling sections of pipe. While current internal inspection devices such as borescopes, “pipe inspection gadgets,” rovers, and drones serve specific purposes, none can effectively maneuver through multiple bends with large diameter changes while pulling a tethered sensor.

Overview / Design Specs

We tackled this mobility challenge by developing a 60’ long, 18” diameter soft, inflatable vine robot for deploying a tethered borescope in hard-to-reach spaces in industrial facilities.

Our device uses a vine robot to propel a tethered borescope camera and an inflatable centering device to the end of the pipe. The entire assembly will then be pulled through the pipe, inspecting the pipe section in reverse.

Base Station Diagram



Final Product

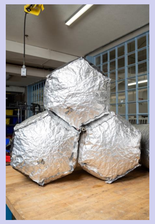
Key Components

Base Station

The base station pressurizes the vine robot and passes through new material via the gasket mechanism.

Vine

The vine consists of an 18” diameter, heat sealed mylar tube that propels the borescope to the front of the pipe.

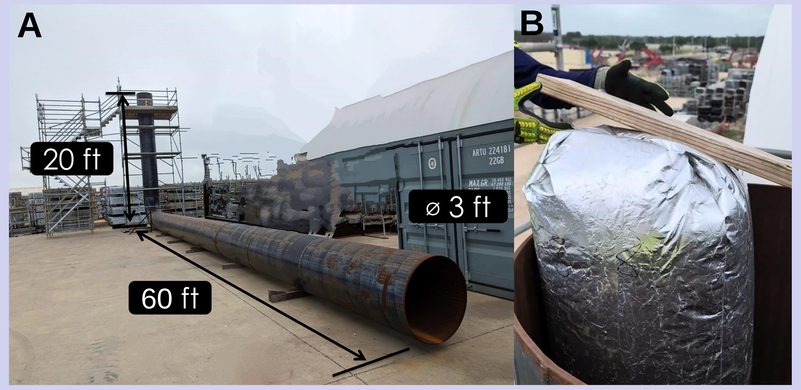


Tip Mount

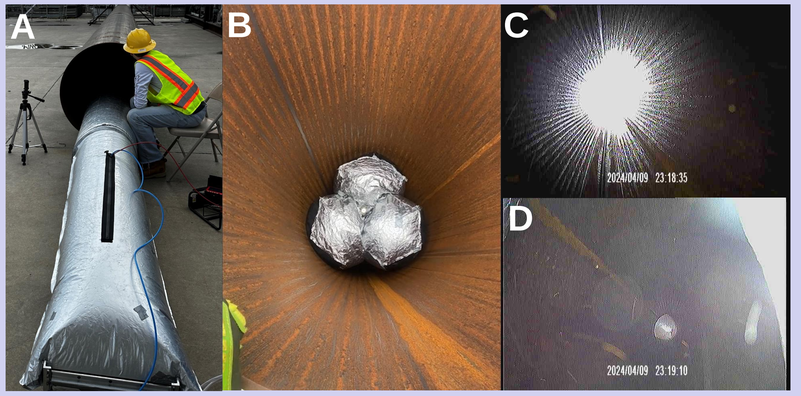
The tip mount consists of 3 inflatable mylar chambers coated with Ballistic Nylon to prevent abrasion. It serves to center the borescope in the pipe and prevents free fall in vertical sections.

Validation

We created a portable, modular design that we were able to validate through on-site testing at a Bechtel facility in Houston, Texas. Our device successfully inspected an 80’-long section of oil and gas piping, negotiating a 90-degree bend, a vertical section, a blockage, and an open chamber.



(A) Houston test pipe dimensions. (B) Unconstrained vine robot clearing a blockage from the top of the pipe.



(A) Deployed base station in test pipe. (B) Tip mount deployed in vertical pipe section. (C) Borescope view from vertical pipe section(t =10s). (D) Borescope view from horizontal pipe section(t =45s).

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