IvyWire

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Large Scale Vine Robotics For Cable Installation

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Background

Cable installation is a lengthy, labor-intensive process that is often costly and unreliable. Delays and cable damage during installation can hinder project progress across industries. As cables are pulled through conduit, a pathway for cables, bends, inclines, and long runs increase tension, making installation more difficult and increasing the risk of cable damage and failure.

Project Overview

This project demonstrates large-scale cable installation using vine robot eversion, in which an everting vinyl hose carries cables through conduit without damaging them. To comply with university safety requirements, a low-pressure housing was constructed to demonstrate vine storage and deployment into free space, while a separate high-pressure system demonstrated successful navigation of complex 4 in. diameter conduit geometries.

Pressure Vessel Exploded View

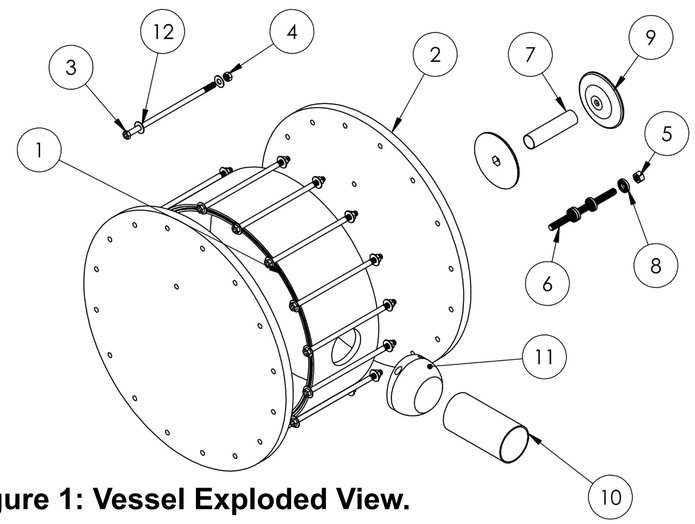

Figure 1: Vessel Exploded View.

1) PVC cylinder, 2) PVC endplates, 3) ½-13 12” steel bolts, 4) ½-13 steel nut, 5) ⅝-11 Embedded spool nut 6) ⅝-11 8.75” threaded rod, 7) ABS bearing roller, 8) Steel ball bearings, 9) ABS embedded nut plate, 10) ∅4” aluminum outlet pipe, 11) ABS outlet bracket, 12) Steel washers.

Custom Pressure Vessel Housing

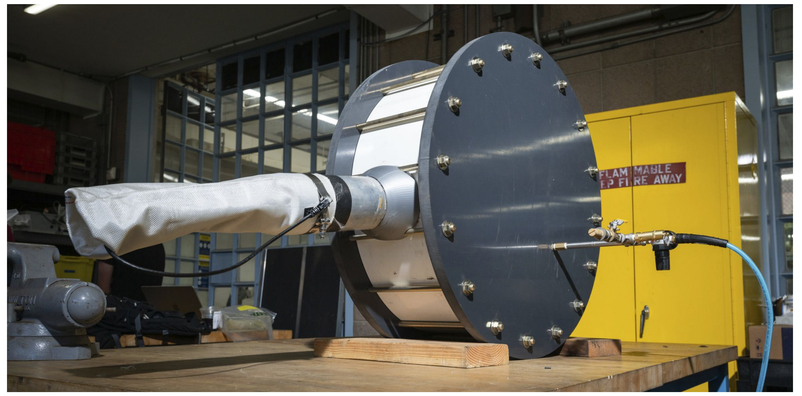

Figure 2: Custom Pressure Vessel.

Purpose: Store and deploy 200 ft of cable-lined everting hose.

- 10 psi maximum pressure
- Threaded rod spooling system with tensile loading
- Hydrostatically tested
- Aluminum outlet with structural bracket

High Pressure System

Figure 3: Scaled-down High Pressure System.

Purpose: Demonstrate vine navigation through conduit.

- 30 psi maximum pressure
- Rubber fire hose serves as housing for everting hose
- Hydrostatically tested
- T-bolt clamp barbed connector

Pressure Regulation System

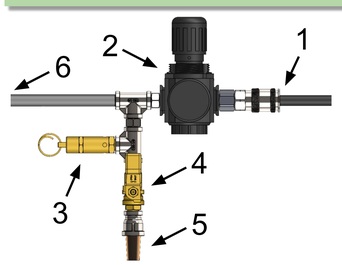

Figure 4: Fitting Diagram.

1. Compressed air inlet
2. Pressure regulator with gauge
3. Emergency relief valve
4. Manual on/off valve
5. Diffuser
6. Outlet to vessel/high-pressure system

Cable Installation Demonstration

Figure 5, 6: Conduit Track Setup, Deployed Cables.

Result: Successfully installed two 100-ft CAT6 cables through 90 ft. of 4 in. conduit.

- 3 90° bends, 10 ft. rise
- Cable integrity maintained
- Deployed at 20 psi maximum pressure

Eversion Model

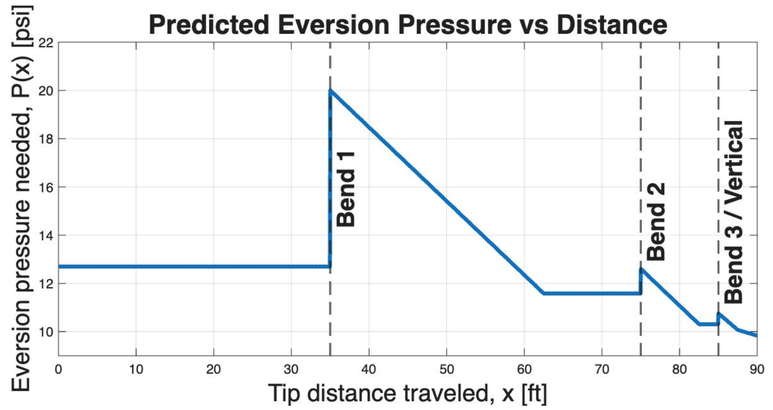

Figure 7: Conduit Track Predicted Pressure Plot.

Deployment behavior validated the custom eversion model.

Conclusions

This project demonstrated a novel large-scale cable installation method using vine robot eversion. Low-pressure vine storage and high-pressure conduit navigation were successfully demonstrated. Future developments include a high-pressure metal vessel, active pressure control, and motorized tensioning and vine retraction.

NORTHROP GRUMMAN

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