![VERMONT AGENCY OF TRANSPORTATION]

Assessing and Monitoring Performance of Small Culverts

Problem Statement

The Vermont Agency of Transportation (VTrans) has adopted a policy requiring all culverts to be inspected every 5 years, resulting in around 9,600 small culverts needing to be inspected annually. Many of these culverts have small diameters that preclude human inspection. Culvert failures can be expensive, such as the recent high-profile collapse under I-89S near Richmond, VT (this was a 96" culvert not a small culvert). With improved methods of monitoring and assessing the conditions of culverts, proper maintenance or replacement projects can be planned and implemented before catastrophic failure of a culvert occurs.

Fig. 1 HIVE 2 Culvert Inspector

Fig. 2 Distressed culvert

Methodology or Action Taken

This project will build on previous research by our team on improved low-cost robotic culvert inspection systems, i.e., the HIVE 2.0. The plan for the project is to work closely with the VTrans Project Champion, Michelle Redmond, and other VTrans personnel to develop performance specifications for the HIVE 2.1, followed by building and testing protypes. The research will fine tune the design for low-cost assembly and durability, then build a small fleet of tank-style robots, examine performance, add techniques for enhanced telemetry and surveillance. Additional research includes the development of low-cost flow sensors and explore the use of legged dog robots for culvert inspection. This research will span two years, with two summers being the primary time for field testing of prototypes.

Next Steps

1. Design, Build and Test HIVE 2.1 – This is to build a new and improved Hydraulic Inspection Vehicle Explorer based on the Sherman tank platform of the HIVE 2.0. These improvements include ease of manufacture, assembly and maintenance. Additional research will examine the development of low-cost wireless flow sensors and the use of a 4-leg dog robot to examine the inside of small culverts.

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2. Evaluate Performance of HIVE 2.1 in Culvert Tests – These tests will be conducted in collaboration with VTrans Project Champion, with the bulk of the activity in the summer seasons.
3. Deliver HIVE 2.1 Robots – These robots will be delivered for use in inspection of small culverts by VTrans maintenance personnel.
4. Technology Transfer and Guidelines for Implementation including information on the design, fabrication and use of HIVE 2.1

Potential Impacts and VTrans Benefits

Culverts are an important aspect of transportation infrastructure. They manage and channel stormwater flow under roadways and other structures. Unexpected culvert failures can lead to cascading damage and expensive repairs. Small culverts are impossible to inspect with humans. The new and improved HIVE 2.1 robot will enable efficient and cost-effective inspections of small culverts and provide information for timely maintenance and repair.