

Mapping And Inspecting Culvert Robots

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This paper describes the research and underlying developments of a system for inspecting and mapping culverts using low-cost robots equipped with advanced sensors. Culverts carry water under roadways and are integral components of flood and climate change resilience. Many culverts are aging and in poor condition. Failure of culverts due to blockage, leakage and collapse leads to a myriad of water-related problems, such as flooding, sinkholes and roadway washouts. The precise location relative to the above ground is often unknown, which hampers maintenance and repairs. Inspection and mapping culverts are keys to sustainable stormwater management. The task is challenging due the large number of culverts involved and the associated small diameters that prevent human access. This research developed prototype culvert inspection robots that provide low-cost high performance. The robots are improved versions of the culvert inspection robot, known as the (Hydraulic Inspection Vehicle) HIVE 2.0. This is a human-in-the-loop remote-control system built on a hobby-scale Sherman tank with uses camera sensors for inspection and longer-range wireless telemetry. The HIVE 2.0 design builds on an earlier generation HIVE 1.0 that used a 4-wheel drive vehicle, with bulkier cameras, and limited range wireless telemetry. Improvements under development are sensing and control that uses photogrammetric techniques for in-culvert localization, optional radar and multispectral camera systems for detection of voids in the surrounding soil, deployable flow sensors for culvert stormwater transport performance assessment, RFID tags for asset management and autonomous operation with multi-robot teaming capabilities. An optional magnet antenna broadcasts low-frequency earth penetrating magnetic signals that can serve as the basis for an above-ground tracking system. Results from field tests and recent laboratory developments will be presented.