Photogrammetry based 3D Culvert Scanning System

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Culverts are a buried structure which conveys a water flow (that can cause flooding in case of heavy rain) under a road or railroad. Culverts are installed to satisfy several municipality requirements such as diversion of streams or rainfall runoff in order to prevent soil erosion or flooding on highways. Culvert is one of the most critical civil infrastructures in Texas and monitoring their health and repairing/replacing at-risk culverts poses significant financial burden to TxDOT. Furthermore, the current field inspection of culverts relies on manual field surveys, which are time-consuming and labor-intensive, and provide inside images of culverts where field inspectors think necessary rather than continuous image profile. The goal of study is to develop a customized 3D culvert monitoring system that scans entire inside surfaces of the culvert using multiple optical sensors attached to hand-held device that enables fast and efficient monitoring of culverts. We performed a preliminary experiment at a culvert (27.59 N, 97.79 W) located in Bishop, TX. This culvert consists of 11 barrels, and each barrel's dimension is 7ft in width and 6ft in height. The culvert had 5 barrels when initially built in 1947, and 6 barrels were added to the original structure in 1955. Due to an increased traffic, road on the culvert was widened from 2 to 4 lanes in 1968 (i.e., flowline length of the culvert became longer). The complicated history of the culvert makes it a perfect example to test the developed culvert mapping system owing to potential infrastructure condition variability. This presentation will cover; 1) developing a customized hand-held device with optical sensor and light source integrated and 2) developing an automated machine learning system that maps location and estimates size of cracks on the culvert surface, and 3) its application to the study site. The developed system is expected to provide an innovative framework to diagnose current status of culvert accurately in a manageable time frame with limited resources, which will open up tremendous opportunities to develop research collaboration among researchers with diverse backgrounds.