Surveying Goal Extraction from Dense 3D Point Clouds to Support Bridge Inspection

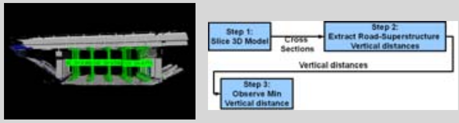
Advisor: Burcu Akinci, Student: Pingbo Tang
Civil and Environmental Engineering Department, Carnegie Mellon University

Introduction and Motivation

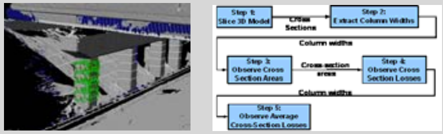
● State-of-art geometric data collection technologies, such as 3D imaging systems, enable bridge inspectors to collect large amounts of 3D point clouds capturing detailed geometries of constructed bridges for detailed geometric assessments.

●While dense 3D point clouds contain rich geometric information regarding the conditions of bridges, they also bring unique challenges related to geometric information retrieval.

● Manually taking measurements on 3D point clouds for answering queries such as "minimum vertical underclearance of the bridge", "cross section losses of all columns", is time consuming due to repetitive manual operations as well as calculations.



Manually extracting vertical under clearances of a bridge



Manually extracting cross-section loss of a column of the bridge

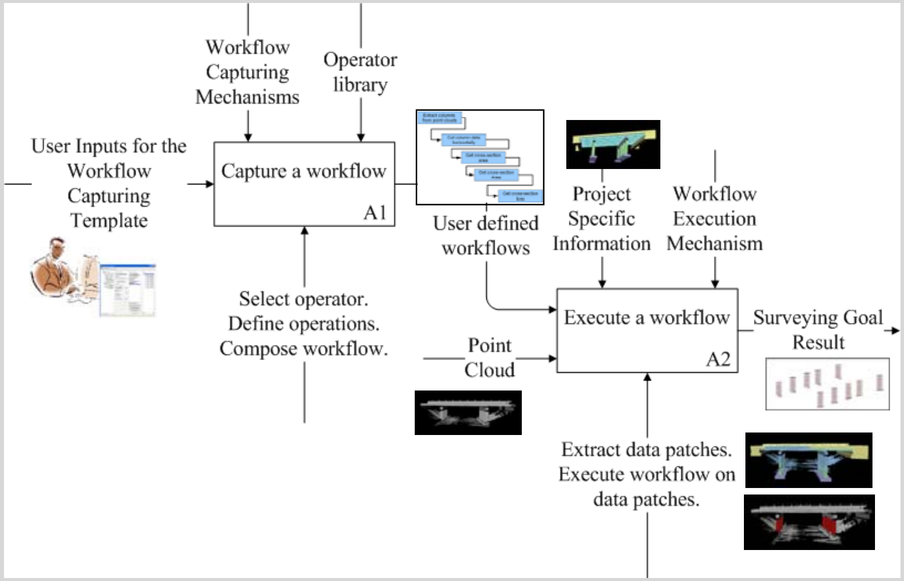
● This research aim at eliminating repetitive manual operations for extracting bridge surveying goals.

Overview of the Approach

● Computer interpretable representation of surveying goal extraction workflow

● Operator library: recognize components, extract geometric primitives, extract geometric attributes of geometric primitives, extract spatial relationships between geometric primitives, accuracy analysis, etc.

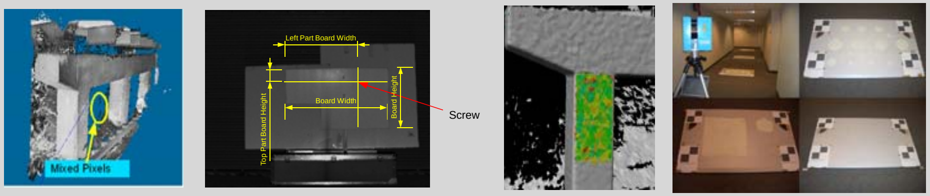
● Two stages: compose work flows → execute work flows on 3D point clouds



● Accuracy analysis operators: 1) edge loss estimation at spatial discontinuities; 2) evaluation of the reliability of the surface flatness defect detection results.

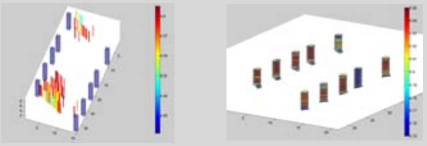
● Characterization of two sensors, multiple data processing algorithms

● Quantification and formalization of the relationships between surveying goals accuracies and various factors: performance models of scanners and algorithms.



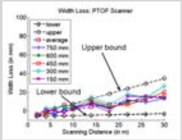
Current Status

● Developing and testing a prototype system for automated work flow composition and execution.



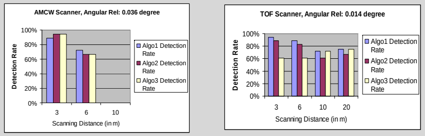
Automatically generated vertical under clearances (in m) | Automatically generated column cross-section areas (in m^2)

●A model have been shown to be able to predict actual edge positions with 1 cm accuracy (without this model the edge loss is on average 5 cm)



Edge loss estimation model: edge loss vs. scanning distance

●Two scanners and three surface deviations detection algorithms have been tested. Result analysis is in progress.



Scanning distance vs. Performance of scanners/algorithms

Practical Implications

● Automated data-driven bridge management data base updating

●Automated data-driven construction schedule updating and quality control

● Automated generation of facility inspection reports