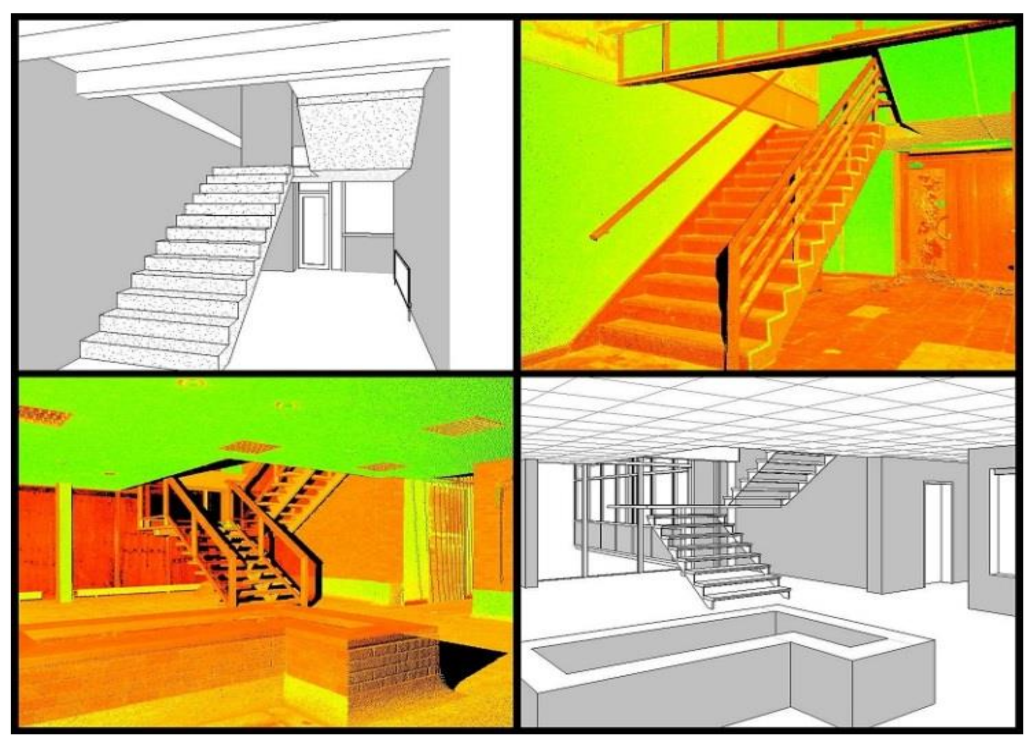
Automated Spatial Change Detection and Control of Curvilinear Building Components Using 3D Laser Scanning Data

Author: Vamsi Sai Kalasapudi Supervisor: Pingbo Tang
Arizona State University

INTRODUCTION

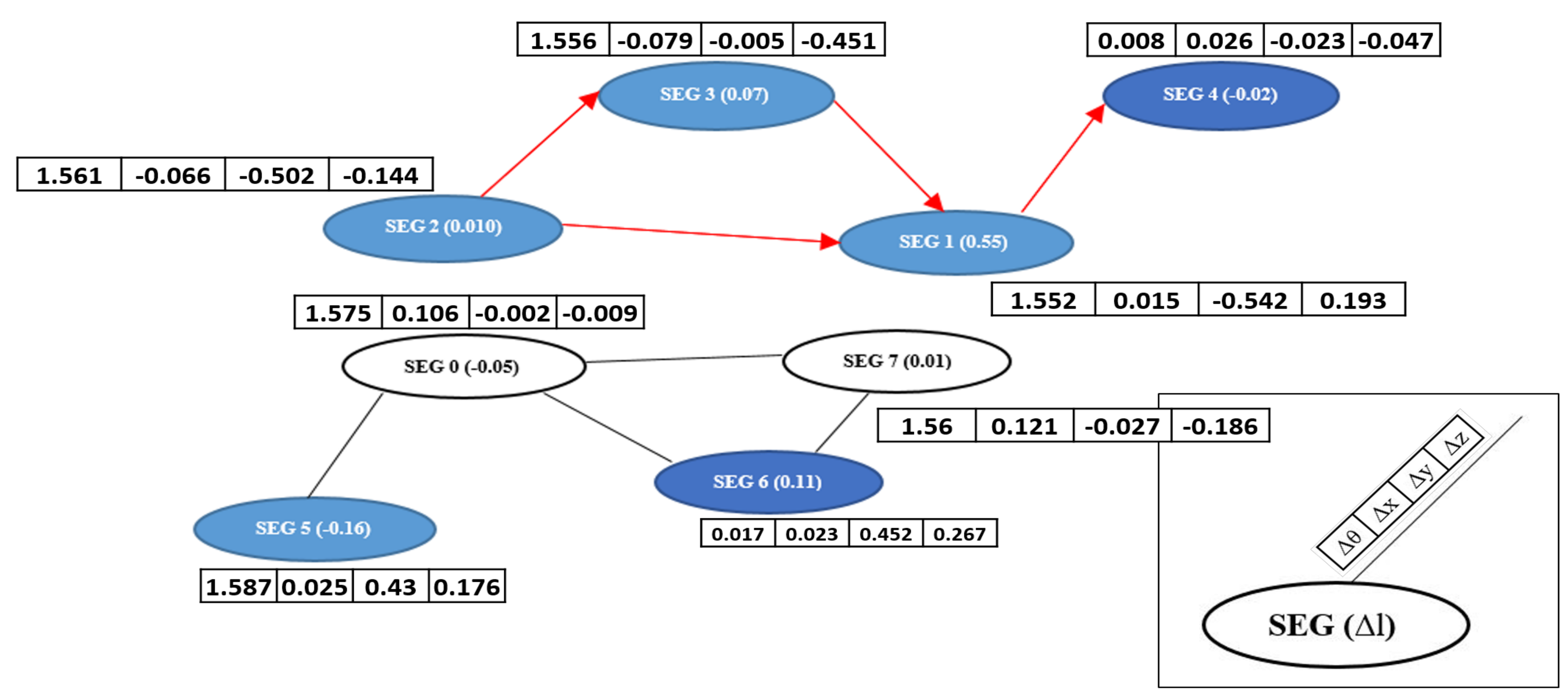
- The architectural, engineering, construction and facilities management (AEC-FM) industry have adopted BIM and 3D laser scanning for coordinating changes of building components during the life-cycles of buildings (planning, design, construction, and facility management).



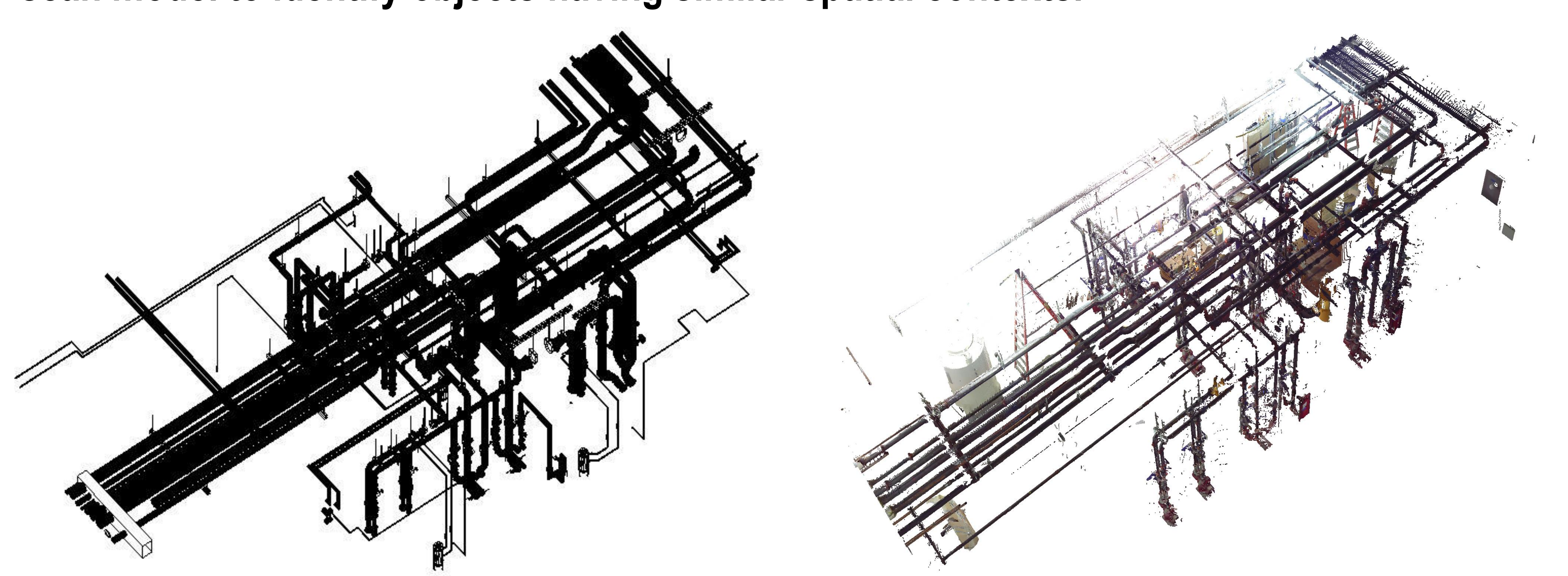
- Existing change detection algorithms either could not correctly detect changes of objects packed in small spaces due to difficulties of associating data with nearby objects, or could not handle the exponential computational complexity of large-scale building systems.
- Frequent spatial changes in construction projects pose challenges to design-construction collaboration due to unpredictable cascading interactions between design decisions and field activities.
- Previous efforts have faced significant challenges as they relied on "nearest neighbor searching" for associating as-built data with as-designed model, which could not reliably detect changes of densely located ducts.

METHODOLOGY

- The developed Spatial Change Detection approach first calculates the distances between as-designed objects in a BIM and their nearest neighbors in the corresponding laser scanning point cloud data to derive a "data-model deviation map".
- It then uses the deviation map to isolate the areas with large deviations and to use them for detailed relational-graph-based data-model comparisons.



- It associates attributes (local and global) and Spatial Contexts to every individual object in order to look for correspondences in both as-designed BIM model and as-built laser scanning point cloud.
- A spatial context represents the relationship of an object with respect to all other objects surrounding it and the algorithm automatically searches both as-designed model and laser scan model to identify objects having similar spatial contexts.



- The developed approach integrates a "nearest neighbor" algorithm and a spatial context analysis method for achieving rapid and reliable association of data points and objects in the as-designed model.

RESULTS

- The presented algorithm matched 95% (105 out of 110) of the extracted pipes from the 3D Laser scanning data with its as-designed model.

PIPES	*110 PIPES*	
ALGORITHMS	NN	NN&SC
TIME TAKEN (secs)	57.54	9.78

- Combining both the nearest neighbor and relational graph based matching, the presented algorithm achieved the highest computational efficiency.
- It is evident from such comparison that the developed algorithm in this paper can handle any number of pipes with accuracy and is computationally efficient.
- It overcomes the limitations of the conventional Nearest-Neighbor-Searching algorithm for change detection

CONCLUSION

- The methodology presents a computationally efficient approach that uses relational network analysis to reliably associate as-designed BIM and as-built laser scan model and to detect the spatial changes of large-scale building systems.
- The future work will include change classification and correlation analysis for comprehending change propagation and control.
- Tolerance analyses using relational graphs can assist adaptive redistribution of prefabrication and installation errors during construction