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Automated Spatial Change Detection and Control of Buildings and Construction Sites Using 3D Laser Scanning Data

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Spatial changes during building construction usually manifest as deviations between the as-designed model and the as-built conditions. These deviations can lead to errors that result in delays and additional costs. Project engineers often spend significant time, money, and resources to manually track and analyze changes between the as-designed models and the as-built conditions. While there are technologies that model building features, they are often unreliable and slow. For example, tools such as Building Information Modeling (BIM) and 3D Laser Scanning cannot reliably detect changes of densely-located curvilinear objects, such as Mechanical, Electrical, and Plumbing (MEP) objects. Additionally, if the data sets are too large or complex, it will take a substantial amount of time to process and analyze the changes. Spatial-context based matching was demonstrated for small regions and provides accuracy locally, but it is difficult to extend it to entire structures. Therefore, there is a need for a reliable and efficient method to track building changes on a large scale.

Researchers at Arizona State University have developed a novel relational-graph-based framework for automated spatial change analysis of large-scale building components. It compares 3D imagery data against as-designed models by following a multi-step process. The process extracts objects and generates spatial relationships from 3D laser scanned point clouds. It then uses spatial relational structures of objects in data and designed BIM models for associating 3D data with as-designed BIM. This invention enhances the speed and accuracy of tracking changes in large-scale construction projects. Additionally, this method increases efficiency by reducing the need for human involvement and maximizing computational efficiency through hierarchical change analysis.

Potential Applications

- Construction and Renovation
- Building Information Modeling (BIM)
- Computer-Aided Design (CAD)
- Facility Management

Benefits and Advantages

- Increased Efficiency –
  - Enhances efficiency by automating the spatial change detection process and significantly reducing human involvement.
  - Demonstrations computational efficiency through a hierarchical process of

analyzing the changes in largescale building systems for proactive construction quality control.

- Improved BIM tools – Uses a network decomposition approach integrated with a "nearest neighbor" algorithm for achieving a faster and reliable data model matching and change analysis.
- Improved accuracy – Generates relational graph of each object and matches as-designed relational graph to that of as-built relational graph rather than directly comparing model to data.

For more information about the inventor(s) and their research, please see

Dr. Pingbo Tang's directory webpage