Generating Architectural Drawings with Photogrammetry

Background

Architectural drawings, the most basic of which are the Plan, Section, and Elevation, have been used for centuries to communicate the structure and form of buildings. Historically, architects have been influenced by the great architecture of the past, often making record drawings in order to emulate forms and structures in their own work. More recently, record drawings have been used to preserve architectural heritage—the 1894 Survey of London and the 1933 Historic American Buildings Survey are two well known examples. Along with giving an accurate depiction of the building as it stands, these measured drawings are invaluable to preservation or restoration projects, allowing the reconstruction of features.

Before the advent of modern imaging techniques, teams of surveyors might spend weeks measuring a single building by hand. In the last few years, laser scanners and other technology has been combined with hand measurements to drastically reduce the time required to generate drawings. However, the data must still be processed and painstakingly assembled by hand, and it must still be captured using specialised equipment operated by experts.

Photogrammetry, a method of taking measurements from photographs offers a potential solution. Using a technique called Structure from Motion, we can capture a rough three-dimensional interior of a building and generate the corresponding architectural drawings.
Project Goals

This project aims to build a system capable of generating Plan, Section, and Elevation drawings of buildings. While software already exists to estimate 3D models of objects, the challenge of this project will be to generate drawings that are precise and thorough enough to accurately represent twisting interior rooms and corridors. Since we are content with 2D drawings, we will ideally get good results while collecting less data than is required to recreate the entire 3D model. Working with a point cloud created from a set of pictures by SfM, we will attempt to eliminate noise, distortion, and drift to create 2D drawings that are close matches to the actual architectural drawings.

If time permits, I will experiment with additional features. Automatic exclusion of non-structural elements such as people, furniture, and lighting elements, would prove very useful. If the software can recognise windows and doors, we will be able to create more polished drawings that more accurately reflect the modern style of architectural drawings.

If successful, this project will has the potential to improve the architectural preservation workflow by allowing the generation of architectural drawings quickly and without specialised equipment.

Deliverables:

- Software pipeline for creating Plan, Section, and Elevation drawings from buildings.
- Documentation detailing the design and operation of the pipeline and associated code.
- Evaluation and analysis of my results compared against known drawings from the same buildings.

Potential Challenges:

This is an ambitious project, and it comes with it’s own set of unique challenges. For instance, Photogrammetry has traditionally not worked well when capturing reflective or transparent surfaces, such as windows, which are very common in buildings. Another major challenge will be keeping drift and alignment to a minimum. When
photogrammetry is used to image relatively small objects, the camera is able to see a large portion of the surface, and is thus able to very accurately compose the model. However, when imaging the interior of buildings, each photograph will likely depict only a tiny portion of a room, let alone the entire structure. Small errors, compounded over a maze-like interior layout, could result in a warped and unrecognisable drawing. I will perhaps experiment with different methods, such as pre-placed markers, in order to minimise this distortion.

Methods:

Data Acquisition and Processing

I will image and process two different buildings, one with a simple internal layout and one more complex, that have known architectural drawings with which I can later make comparisons. I will then use COLMAP to generate dense reconstructions.

Acquisition Side Improvements

I will experiment with fixed reference point markers, which will potentially lower the amount of error in aligning images. I may test wide angle lenses to see if the capture of more data per image reduces drift. Additionally, I will test how reducing the number of input images affects the accuracy of the 2D drawings.

Analysis Side Improvements

I will attempt to refine the processed model through noise reduction and primitive extraction, in order to reduce the effect of small alignment errors that may be significant across the large scale of the building.

References:
