Parallel Rigidity Matters for Bundle Adjustment

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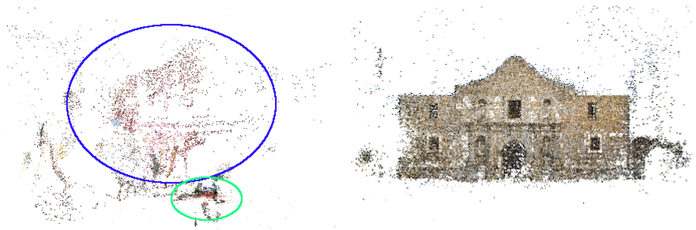
Project Page

Motivation



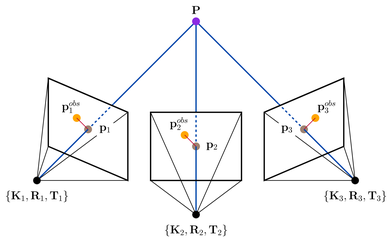
Entire Reconstruction

Zoomed View in the Green Ellipse

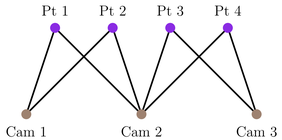
Question: Why 3D points in blue are similar to the central structure in green?

They are collectively misplaced!

Bundle Adjustment



Optimization Problem



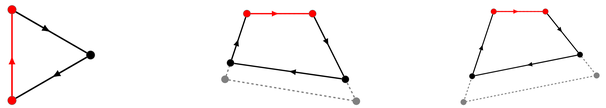
Underlying Graph

$$\min_{\{\mathbf{K}_i,\mathbf{R}_i,\mathbf{T}_i\},\{\mathbf{P}_j\}} \sum_{(i,j)\in\mathcal{E}_{BA}} ||\mathbf{p}_{ij}^{obs} - \text{proj}(\mathbf{K}_i, \mathbf{R}_i, \mathbf{T}_i, \mathbf{P}_j)||^2$$

- Camera: Measures Directions ($\mathbf{p}_{ij}^{obs}$)
- Bundle Adjustment (BA): Underlying Bipartite Graph

Answer: Camera Measurements + Graph Representation in BA!

Parallel Rigidity

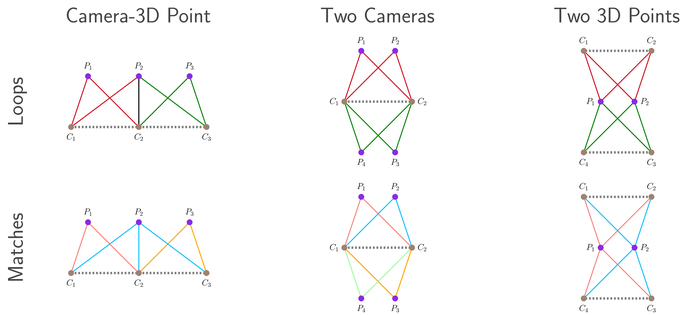


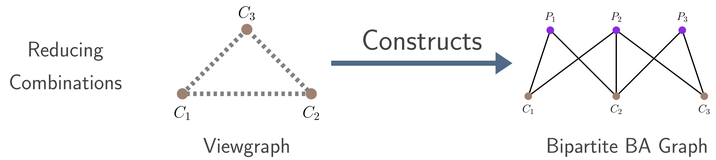
- Parallel Rigidity: Uniqueness of solutions (vectors) with directional inputs
- One solution: red + **black** nodes; Another solution: red + gray nodes

Unique Solution → $\mathbb{R}^2$: Loop length 3; $\mathbb{R}^3$: Loop lengths 3 and 4

Our Method - GPRBA

Core idea: Check Parallel Rigidity of the Bipartite BA Graph via 4-length loops

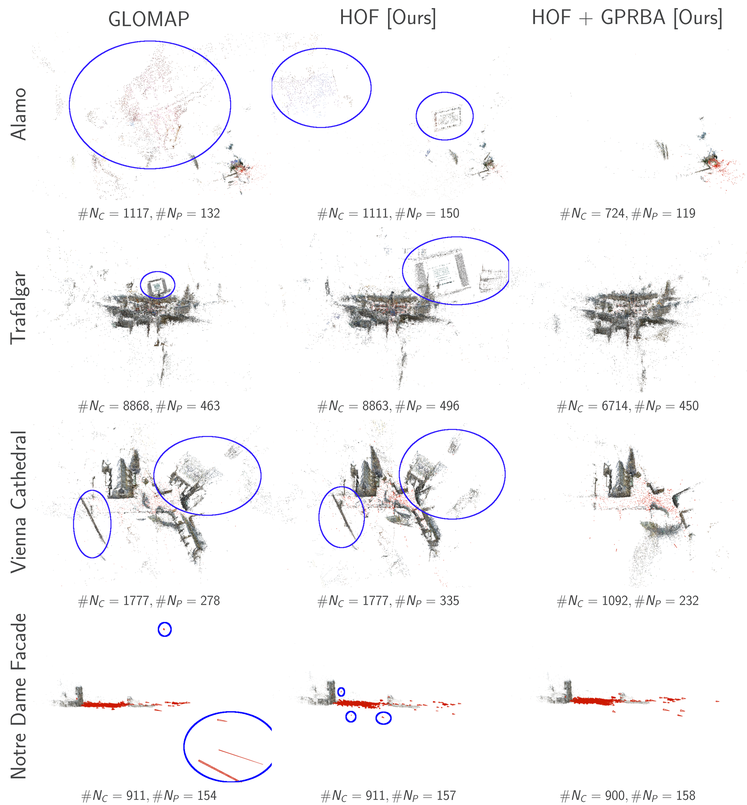




Viewgraph

Bipartite BA Graph

Results



$\#N_C, \#N_P$: Number of Cameras and 3D Points (in 10^3)

HOF: Removing Edges in Bipartite BA Graph not supported by Viewgraph

Our HOF + GPRBA methods remove misplaced parts in blue

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