



Batched Incremental Structure-from-Motion

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Incremental Structure-from-Motion

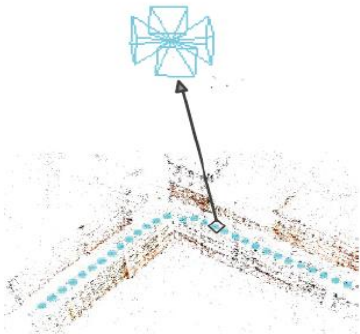


Image Feature
Detection and Matching

Epipolar Geometry
Graph Construction

Camera Poses
Initialization

Bundle Adjustment:
Refine Camera Poses
and Scene Structure



Drawbacks:

1. Sensitive to Seed Selection
2. Error Accumulation and Drift
3. Poor Efficiency and Scalability

1. Seed Reconstruction
 2. Camera Registration
 3. BA and Outliers Filtering
- Repeat 2 and 3

Batched Incremental SfM

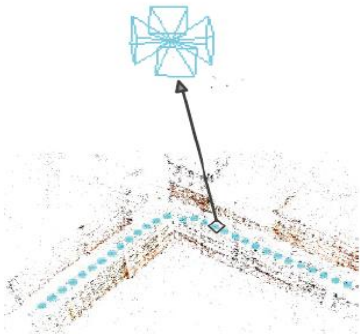


Image Feature
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Strengths:

1. Smaller Error Accumulation
2. Less Bundle Adjustment
3. Faster Scene Reconstruction

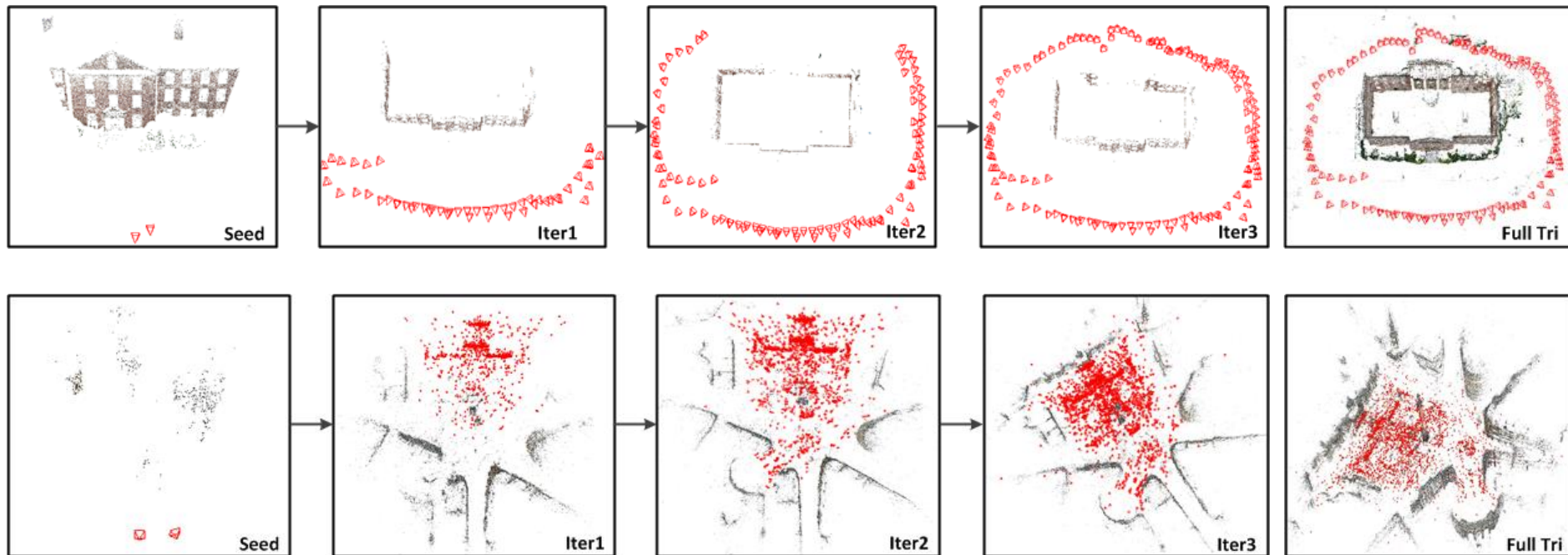
Two Iteration Loops

Inner Loop: Tracks Triangulation,
Selection and Bundle Adjustment

Outer Loop: Batched Camera
Registration and Filtering

Main Contributions

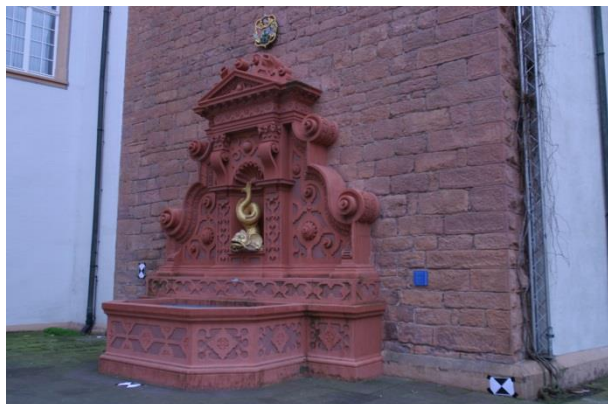
- Batched camera registration
- Tracks selection



Quantitative Evaluation



- Three median-scale benchmark image datasets



FountainP11



HerzJesuP25



CastleP30

Method	Accuracy (mm — deg)					
	FountainP11		HerzJesuP25		CastleP30	
	C_{err}	R_{err}	C_{err}	R_{err}	C_{err}	R_{err}
Bundler [35]	7.0	0.28	21.9	0.25	206.1	0.36
VSFM [42]	36.0	0.28	55.0	0.29	264.0	0.40
Theia [38]	1.9	0.08	4.7	0.07	21.5	0.05
COLMAP [34]	4.9	0.30	23.6	0.40	99.3	0.34
our BSfM	1.9	0.06	4.7	0.04	20.6	0.06

Quantitative Evaluation

- One large-scale image dataset Quad
 - Median error: DISCO 1.16m, Bundler 1.01m, VSFM 0.89m, COLMAP 0.85m, and our BSfM 0.69m.



(a)



(b)


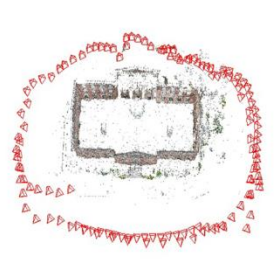
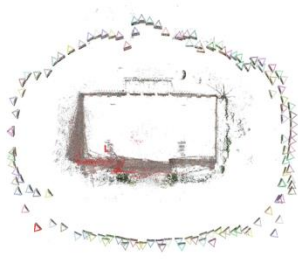

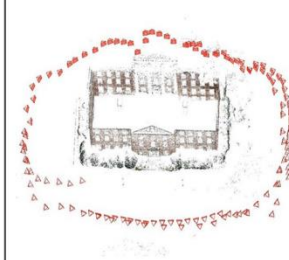
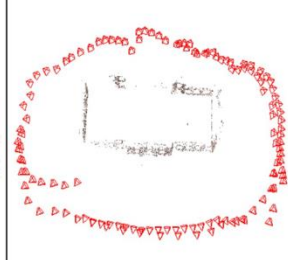



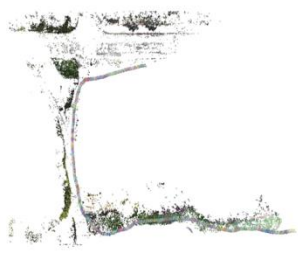



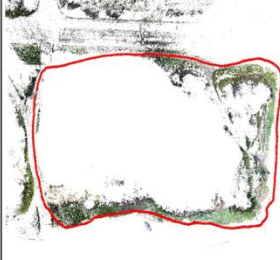



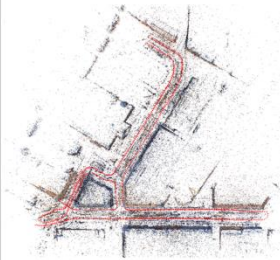



- a: with tracks selection (257K points)
- b: without tracks selection (3048K points)

Similar accuracy

Qualitative Evaluation




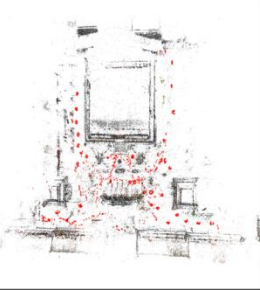
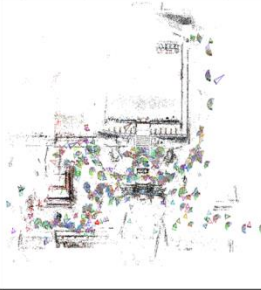
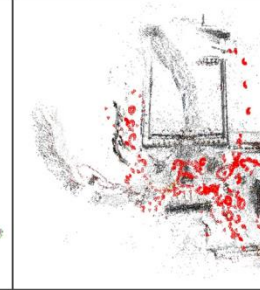
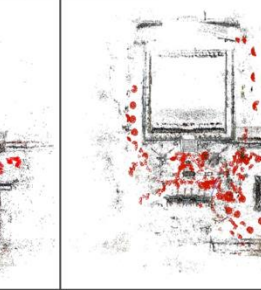
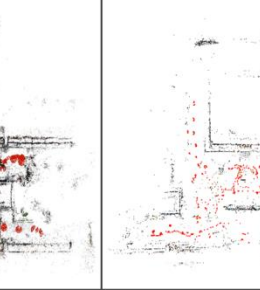


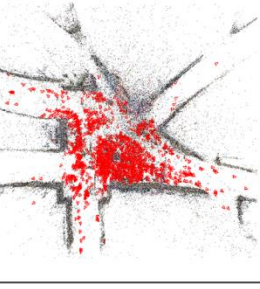
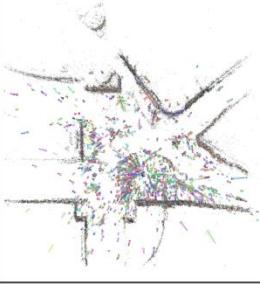
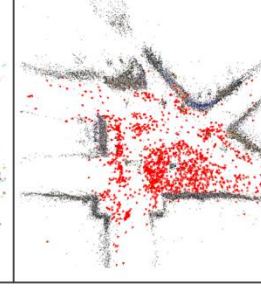
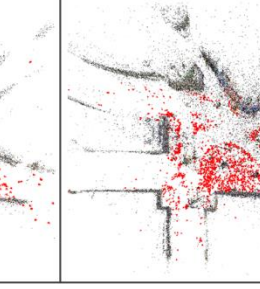
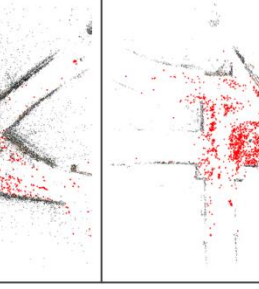

- Sequential image datasets

	Bundler	VSFM	Theia	COLMAP	Our BSfM	Our BSfM + Full Tri
 Building						
 Campus						
 Street View						

Qualitative Evaluation

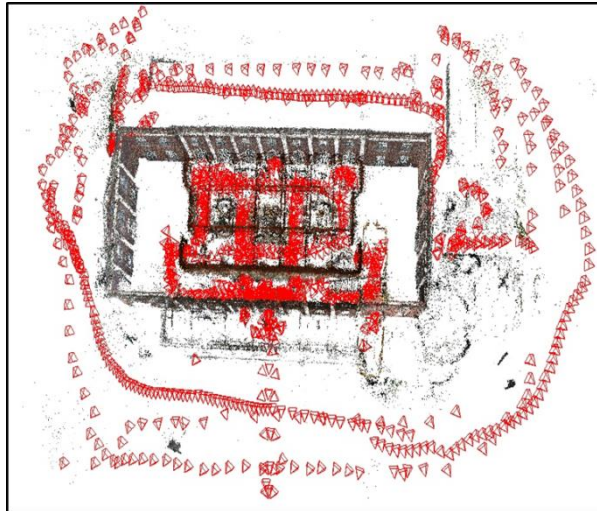


- Unordered image datasets

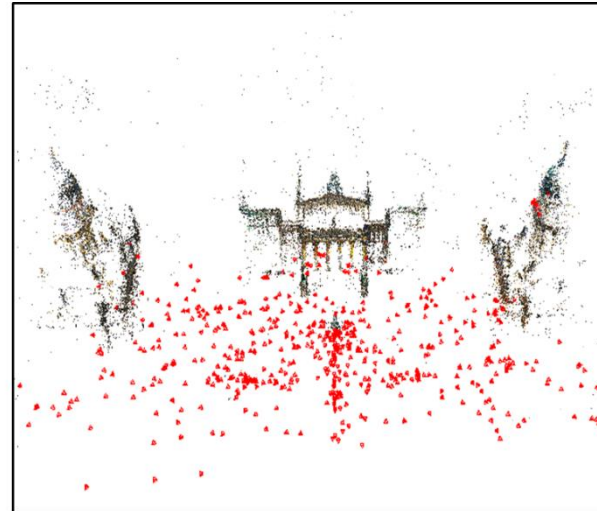
	Bundler	VSFM	Theia	COLMAP	Our BSfM	Our BSfM + Full Tri
 Temple						
 Piccadilly						

Qualitative Evaluation

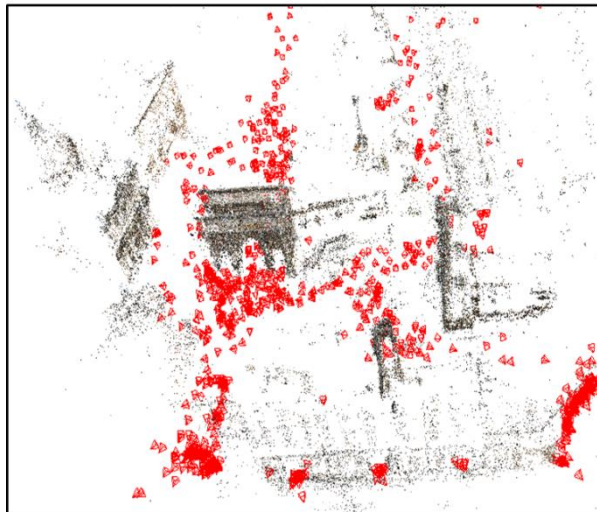
- More results



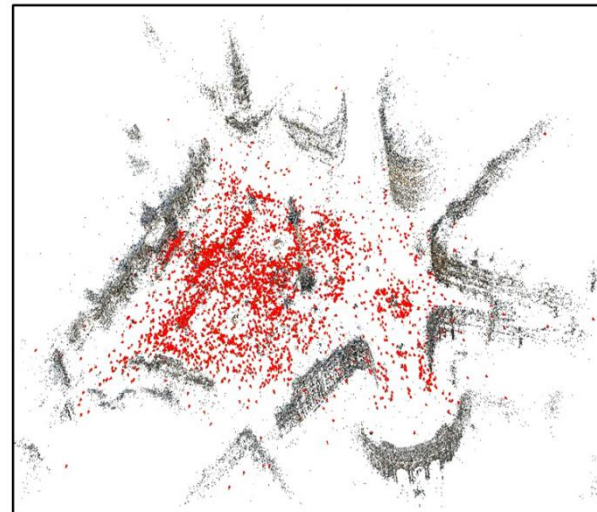
(a) Graham Hall



(b) Gendarmenmarkt



(c) Roman Forum



(d) Trafalgar

Conclusion



- We propose a novel batched incremental SfM algorithm to tackle the **efficiency** and **scalability** challenges in a unified framework.
- **Batched camera registration** registers many cameras at a iteration, which aims to alleviate the **error accumulation**.
- **Tracks selection** finds a compact subset of tracks for the bundle adjustment, which makes the SfM become more **efficient** and **scalable**.



Thank you!