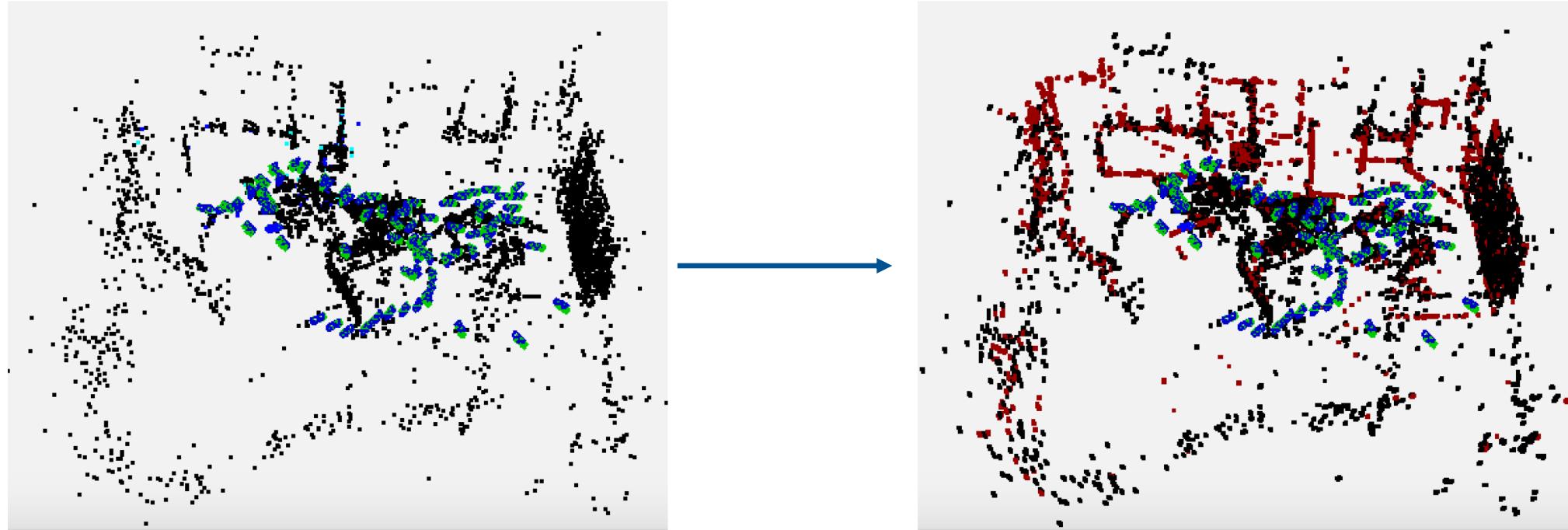


Photometric Structure-from-Motion



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Project for the Practical Course: Vision-based Navigation

Garching, February 1, 2019

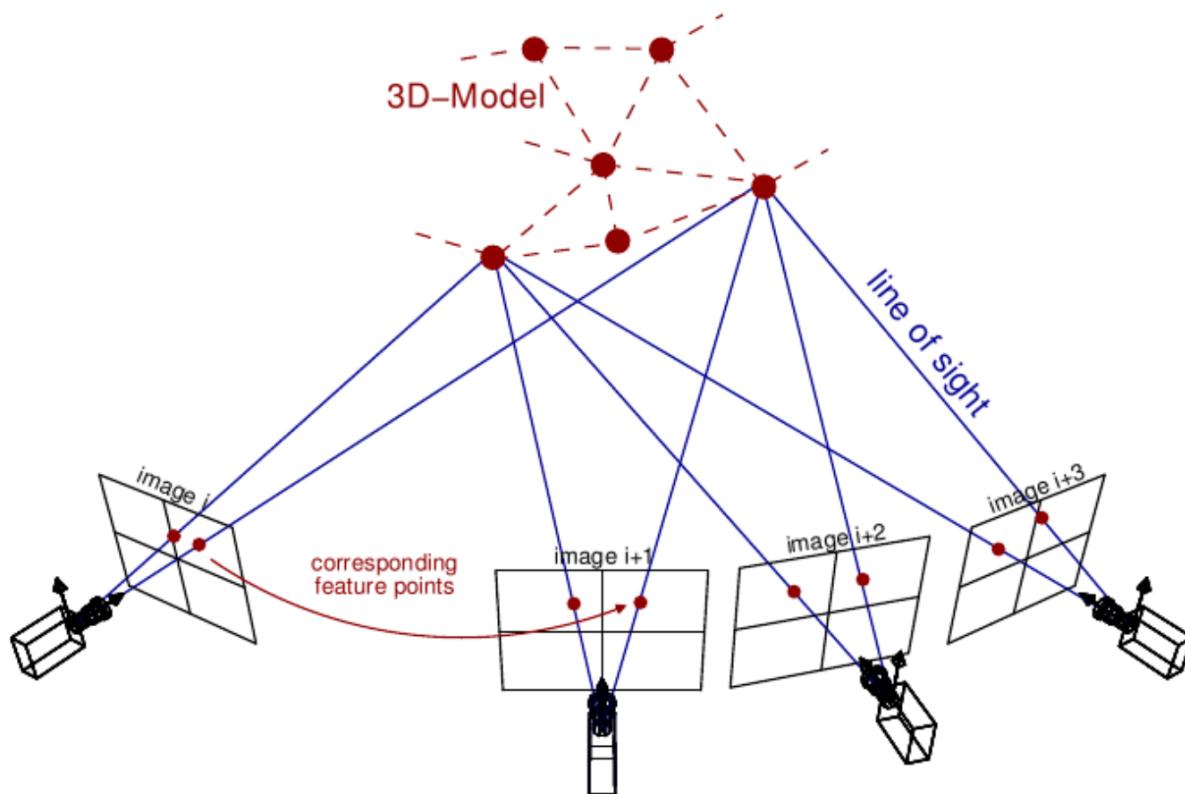
Outline

- Introduction
- Contribution
 - Photometric BA to refine Geometric SfM
 - Adding new landmarks
- Experiments and Results
- Summary

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Introduction



- Reprojection error
- Photometric error

Introduction

Photometric error

$$E_{photo} = I_j[\mathbf{p}'] - I_i[\mathbf{p}]$$

$$E_{\mathbf{p}j} := \sum_{\mathbf{p} \in \mathcal{N}_{\mathbf{p}}} w_{\mathbf{p}} \left\| (I_j[\mathbf{p}'] - b_j) - \frac{t_j e^{a_j}}{t_i e^{a_i}} (I_i[\mathbf{p}] - b_i) \right\|_{\gamma}$$

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Photometric BA to refine Geometric SfM

1. Initialization

- Assign a “host frame” to existing landmarks.
- Compute inverse distance for all landmarks.
- Except host frame, rest of observations of a landmark become target frames.

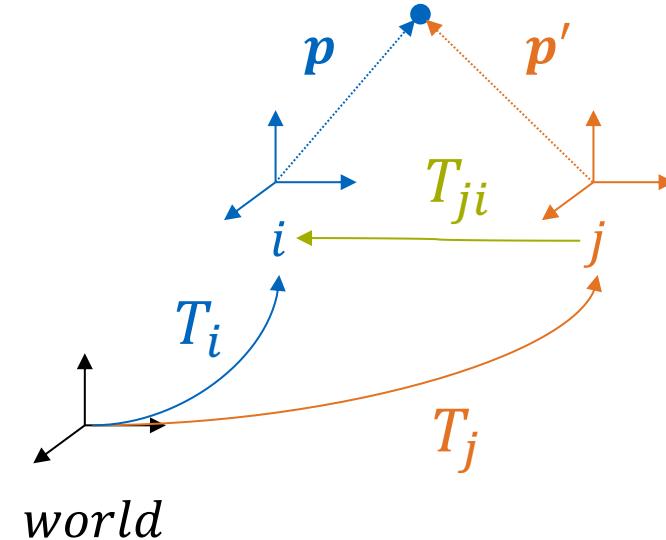
Photometric BA to refine Geometric SfM

2. Optimize by minimizing Photometric Error

$$E_{\mathbf{p}j} := \sum_{\mathbf{p} \in \mathcal{N}_\mathbf{p}} w_\mathbf{p} \left\| (I_j[\mathbf{p}'] - b_j) - \frac{t_j e^{a_j}}{t_i e^{a_i}} (I_i[\mathbf{p}] - b_i) \right\|_\gamma$$

$$\mathbf{p}' = \Pi_{\mathbf{c}}(\mathbf{R} \Pi_{\mathbf{c}}^{-1}(\mathbf{p}, d_{\mathbf{p}}) + \mathbf{t})$$

$$\begin{bmatrix} \mathbf{R} & \mathbf{t} \\ 0 & 1 \end{bmatrix} := \mathbf{T}_j^{-1} \mathbf{T}_i$$



Outline

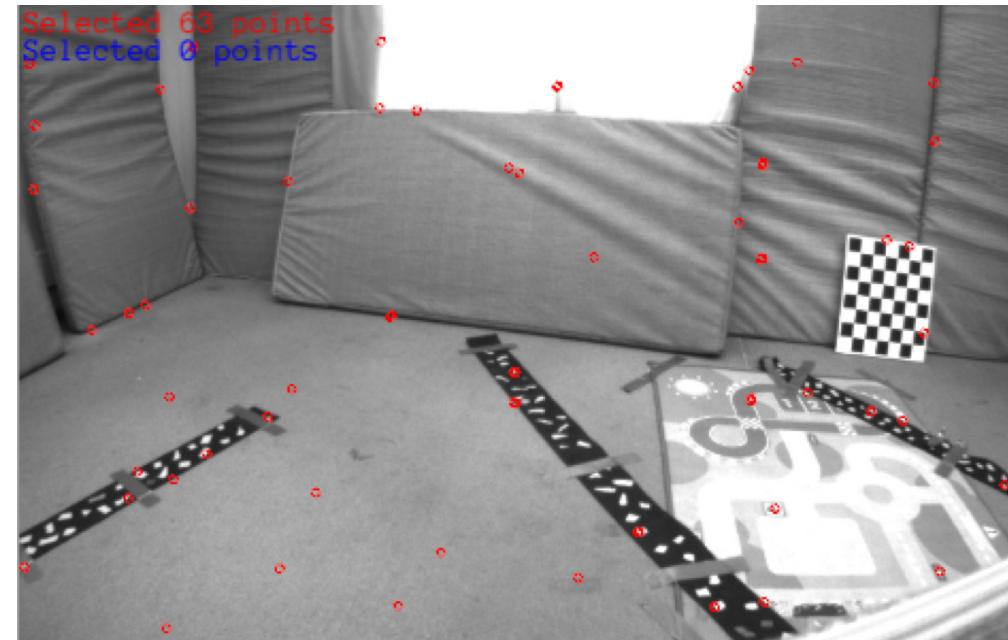
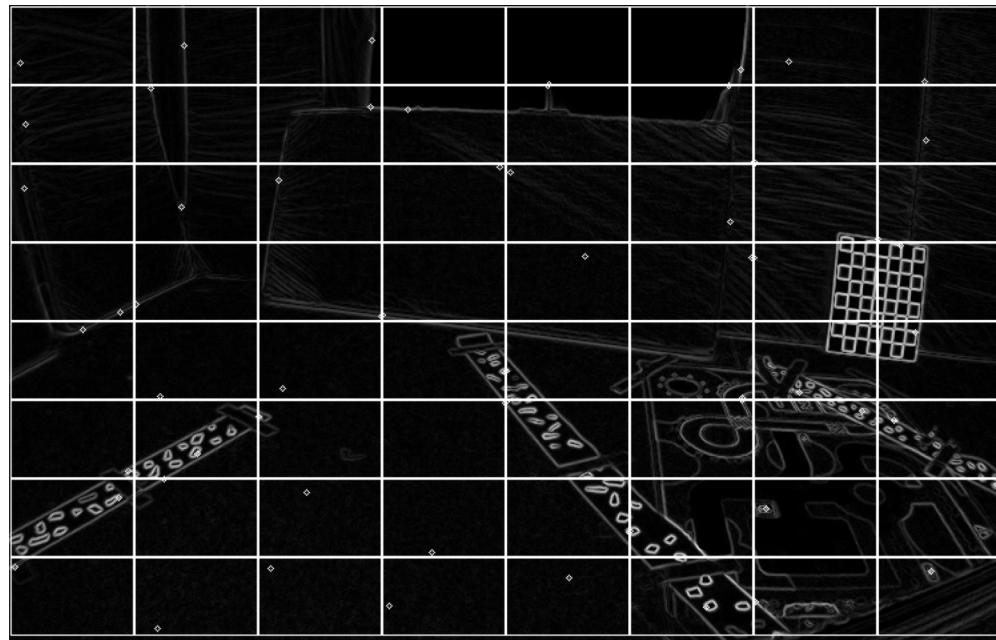
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Adding new landmarks

- Select candidates in every frame (host frames)
- Find matches in rest of frames (target frames)
- Add new landmark to map.
- Photometric optimization afterwards

Adding new landmarks

1. Candidate selection



Adding new landmarks

2. Candidate matching



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Experiments and Results

Camera calibration	ATE geometric	ATE photometric	ATE photo + new + photo
kb4	0.0437577	0.0406419	0.0404956
ds	0.0841705	0.0751423	0.0730535
eucm	0.0442077	0.0444199	0.043117

Huber width = 50

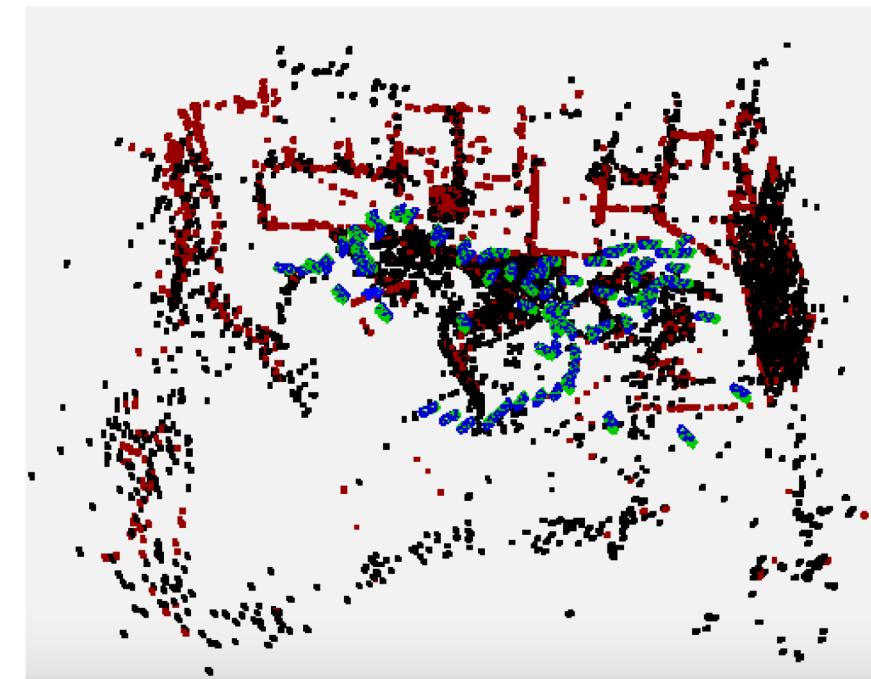
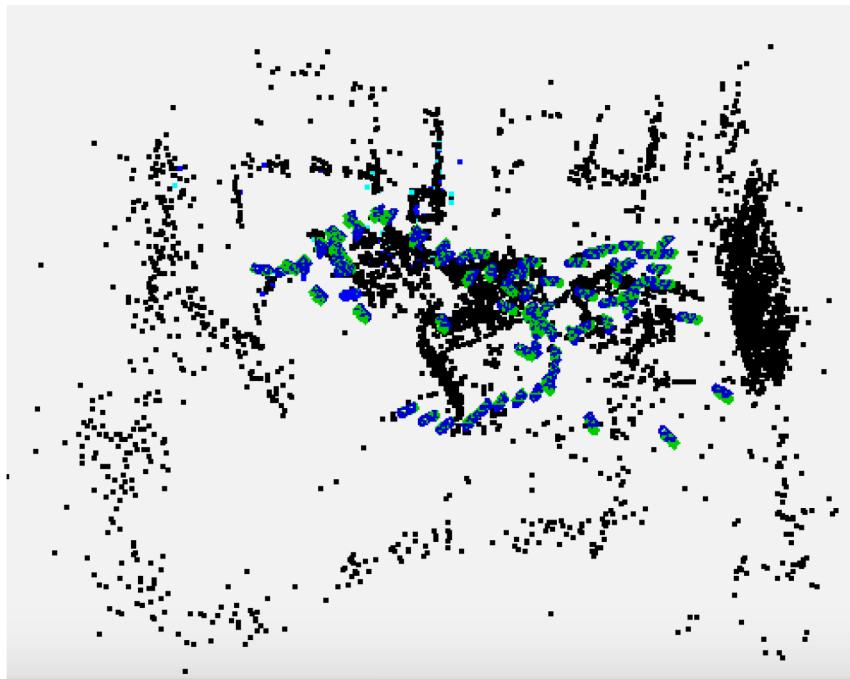
Optimize for intrinsics = false

Optimize for affine params = true

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Thank you!