A SLAM-oriented Taxonomy of ICP Algorithm (Synthesis)

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Section 1. Surface Registration

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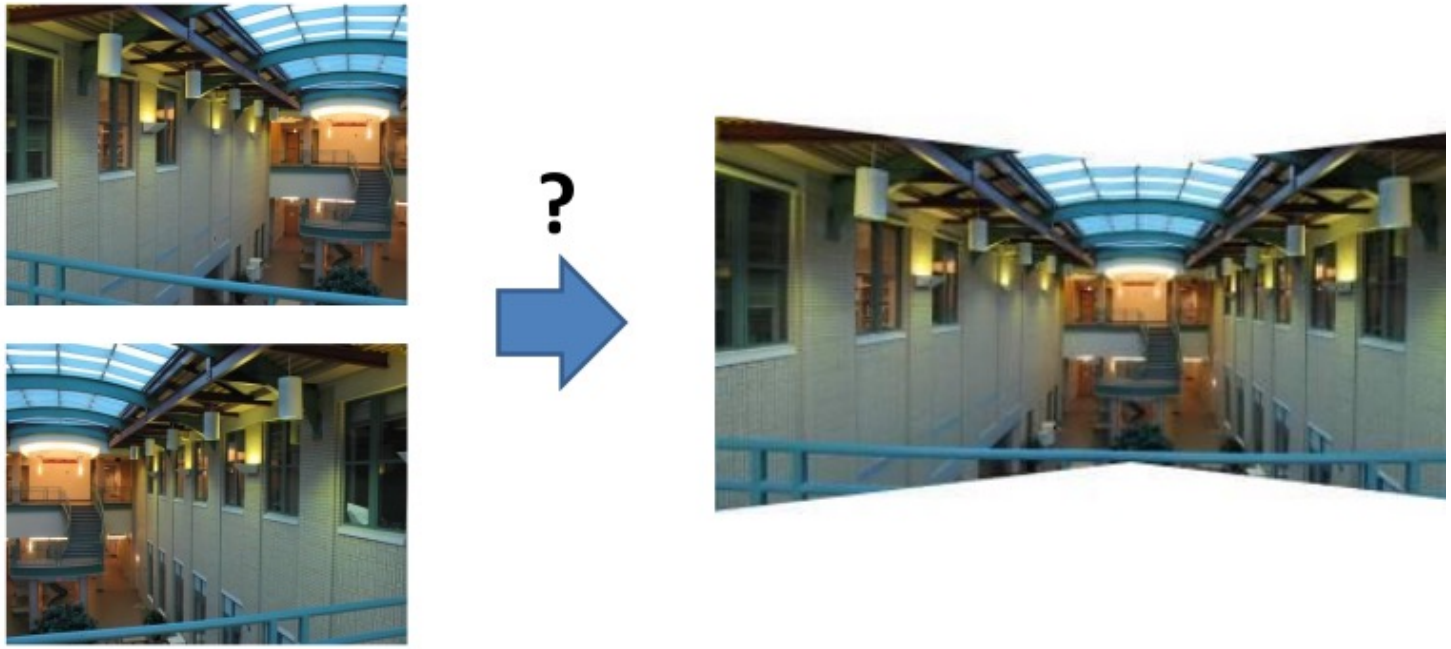
The Background: Image **Registration**

- Image registration is the process of transforming different sets of data into one coordinate system.

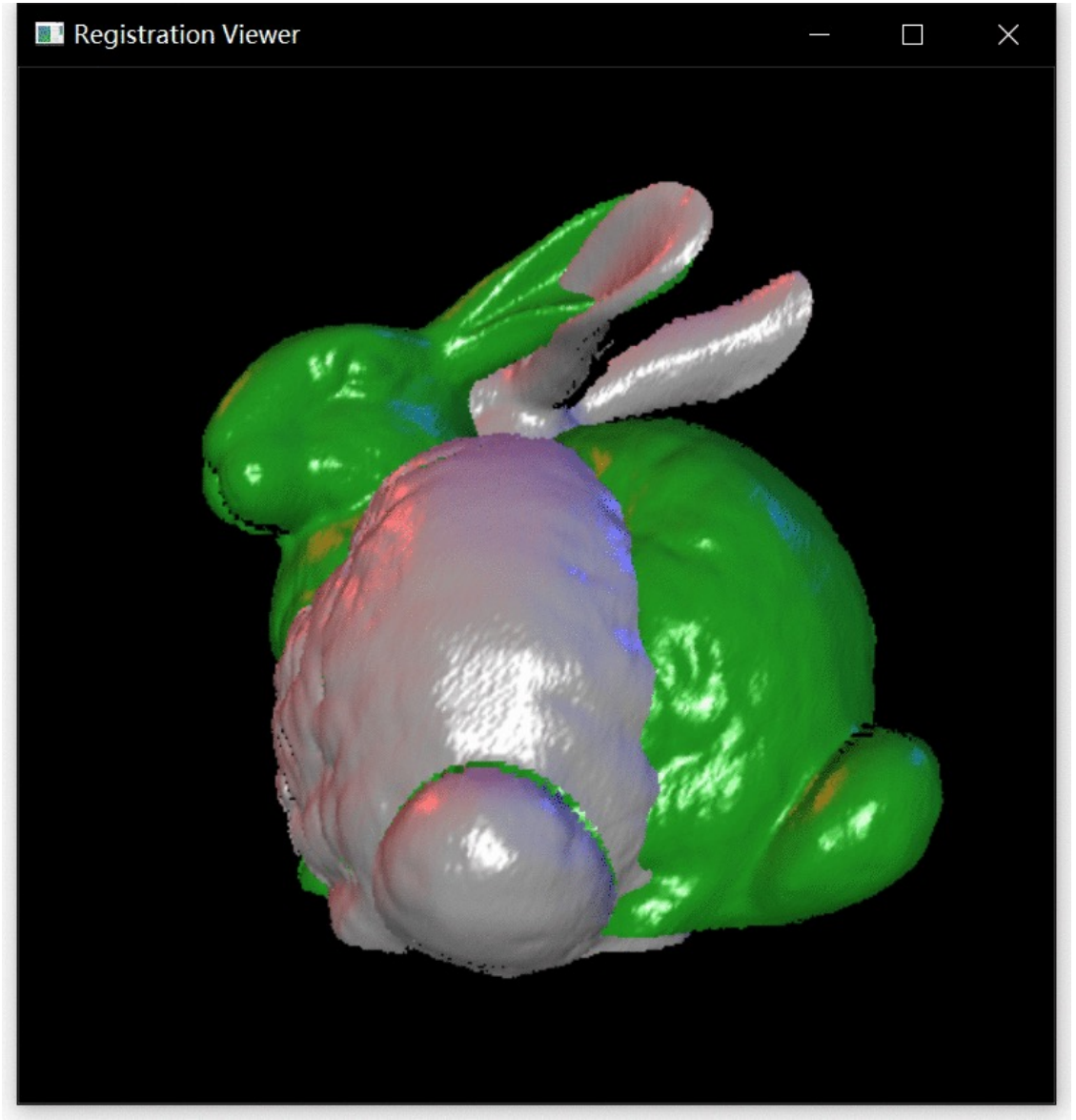


Registration is to match

Hao Bai(*). "A SLAM-oriented Taxonomy of ICP Algorithm." The 4th International Conference on Computing and Data Science (CONF-CDS 2022).

3D Surface Registration

- Stanford Bunny which I worked on – using ICP algorithm.
- Details on the basic ICP algorithm? Turn to my paper!



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Section 2. SLAM

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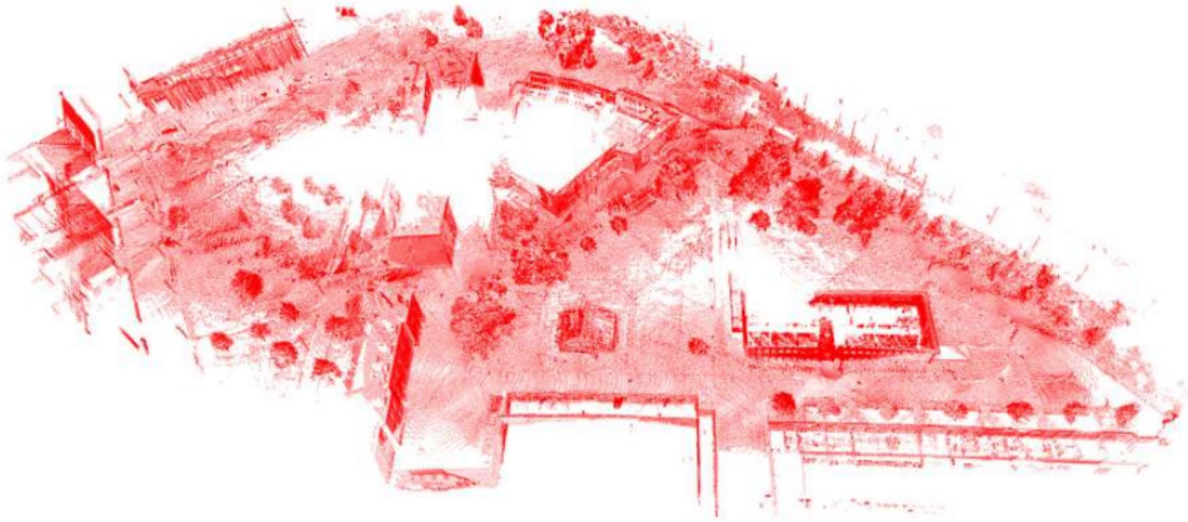
SLAM: Simultaneous Localization And Mapping



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Surface Registration in SLAM

In the **pose estimation** part, 3D surface registration can be used to align the partial overlaps between the point clouds in two continuous frames, and in the **loop closure** part, 3D surface registration can be used for registering the pair of the images where the closure is achieved.

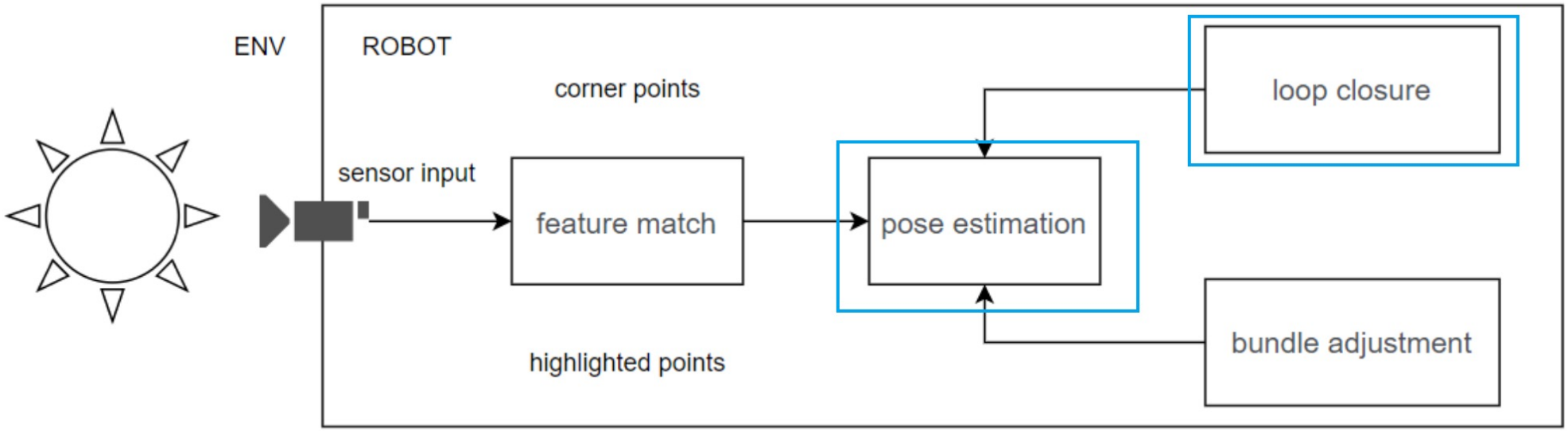

Fig. 2. A graphical explanation of the basic SLAM system.

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Section 3. How to choose which ICP algorithm to use in different SLAM tasks?

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Online and Offline SLAM

- Online learning means that the learning process is going on when the data is coming in.
- Online: time!
- Offline learning means the dataset is already static for learning.
- Offline: precision (efficiency)!

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ICP for online SLAM

- Soft-ICP: **elastic** transformation (amazing! simultaneous global positioning and local blending)
- Incremental ICP: add new points to a **point model**.

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ICP for offline SLAM

- Segmented ICP
- Coarse-to-fine ICP
- De-skewing ICP

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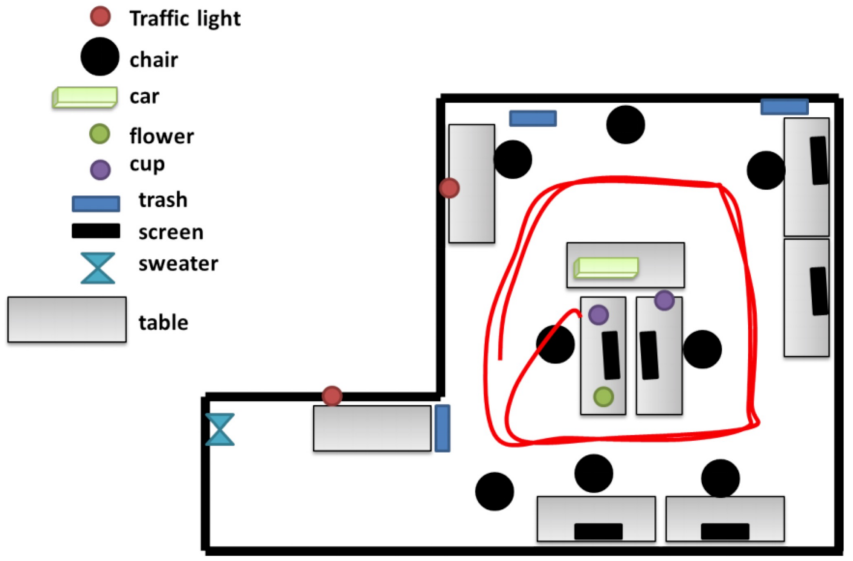
SLAM with/without landmarks?

- The landmark-based SLAM utilizes landmarks detected in the input images, like trees, tall buildings, obstacles, or some artifact landmarks.



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ICP for SLAM with landmarks

- Landmarks are sparse → use submaps → few lines/planes → P2P ICP
- P2P is not good… → create artifact lines → P2L ICP

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ICP for SLAM without landmarks

- No landmarks → less feature… → apply geometric matching first → then use ICP (geo-ICP)

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Thank you!

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