Basic SLAM Tutorials for Everyone Lec. #2. Categories & Terminology of Robot Navigation

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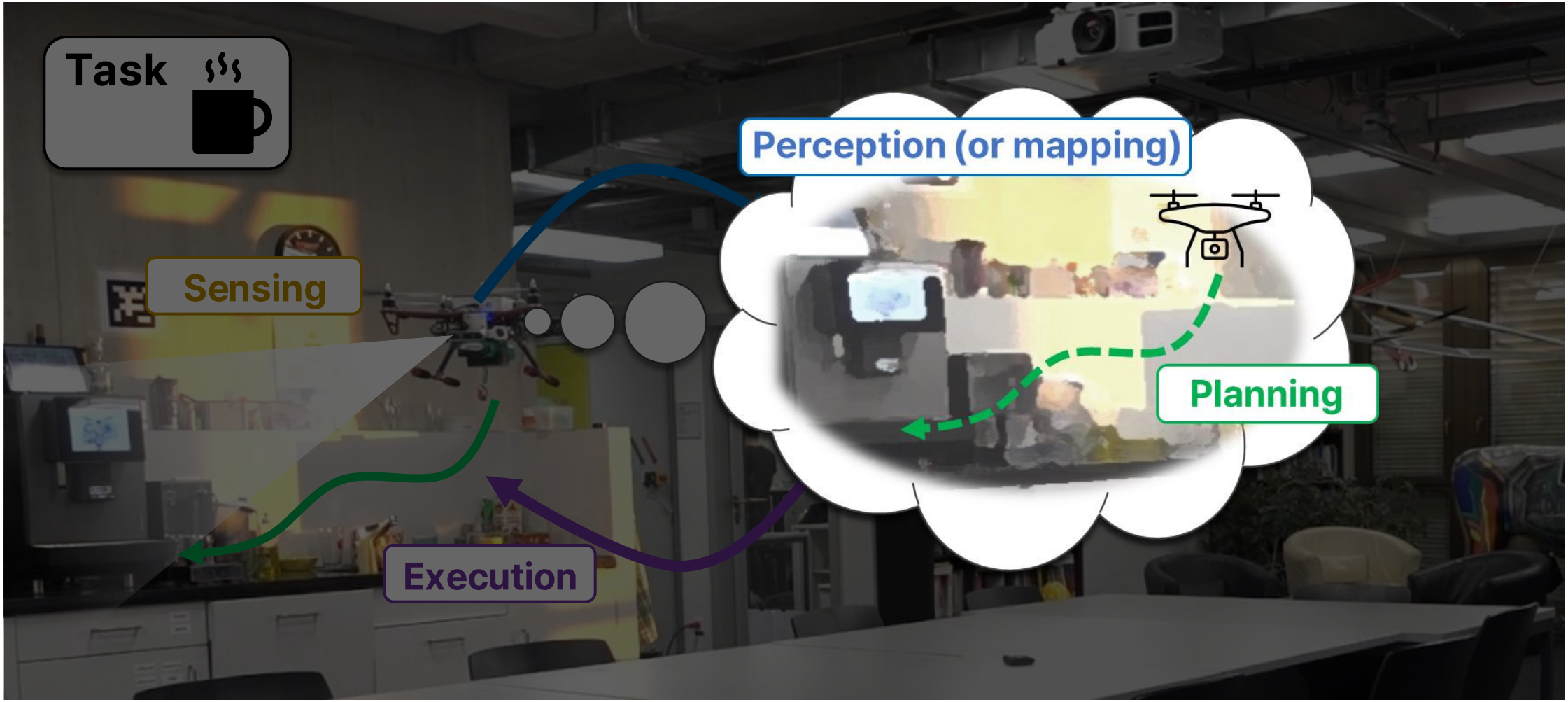
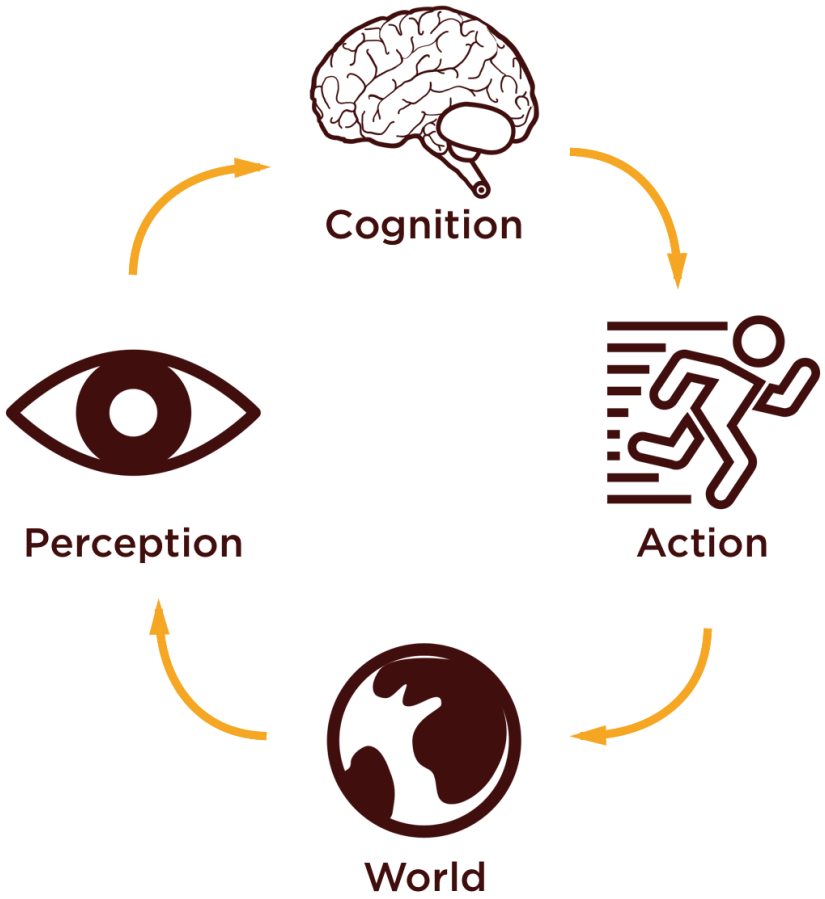
Components of Robot Navigation



[Courtesy of Lukas Schmid]

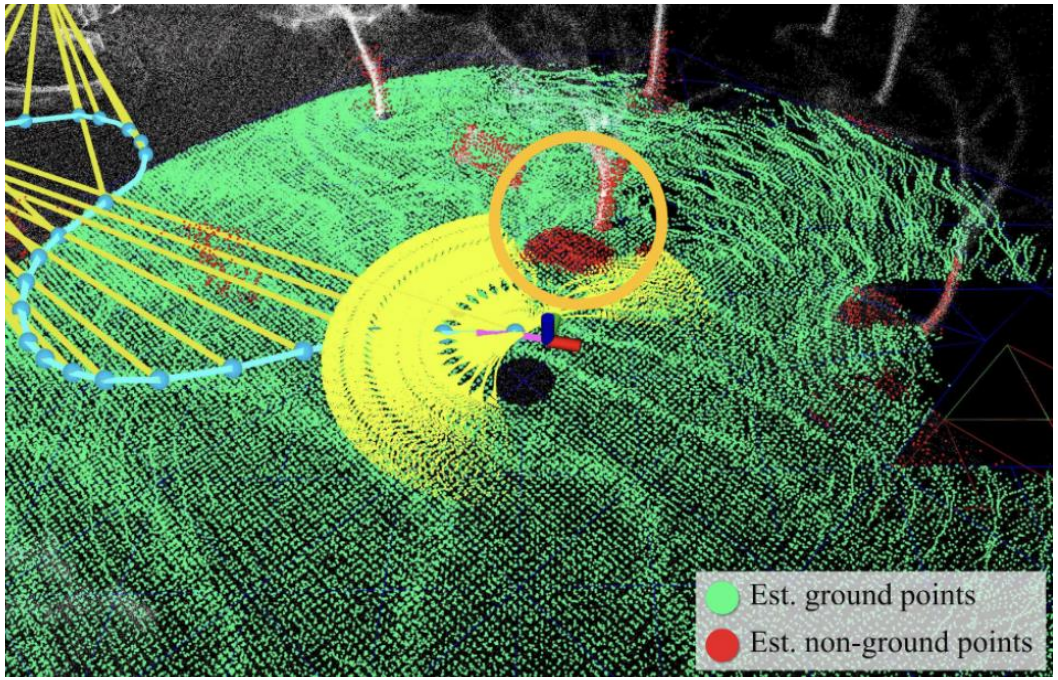
Perception vs Cognition



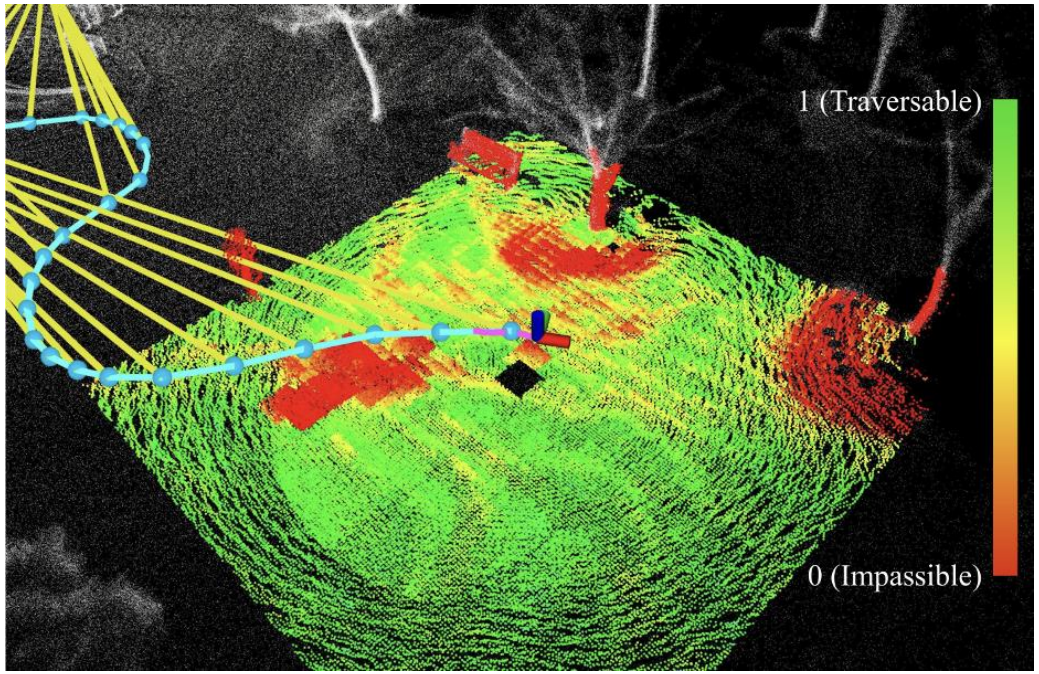
https://medium.com/@avimair/cognition-and-perception-in-hci-e134e3b4401f

Perception vs Cognition (Cont'd)

- Example: ground segmentation (perception) vs traversability (cognition)



Ground segmentation (perception)

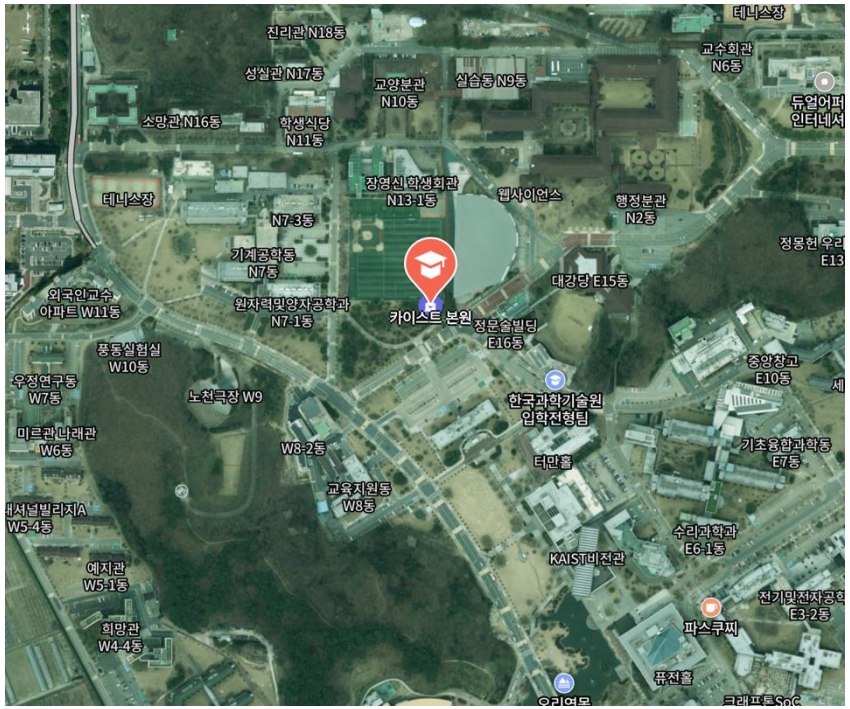


Traversability (cognition)

H Lim *et al.*, Similar but Different: A Survey of Ground Segmentation and Traversability Estimation for Terrestrial Robots, IJCAS, 2024
https://link.springer.com/article/10.1007/s12555-023-0826-4

Terminology: Localization

"The map is known. Where am I?"

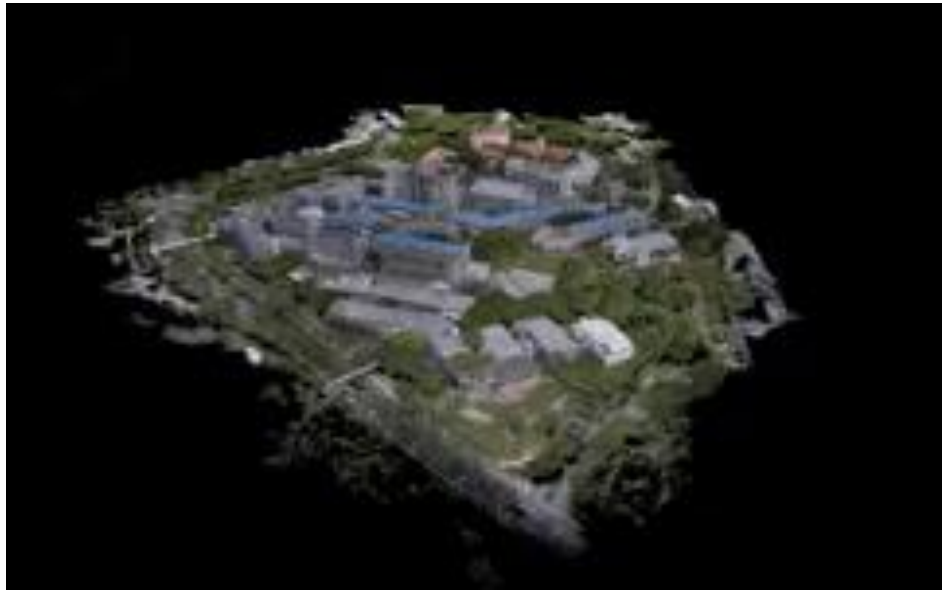


- Map is given
- Estimate robot pose

Like finding your blue dot on Google Maps

Terminology: Mapping

"The poses are known. What does the world look like?"



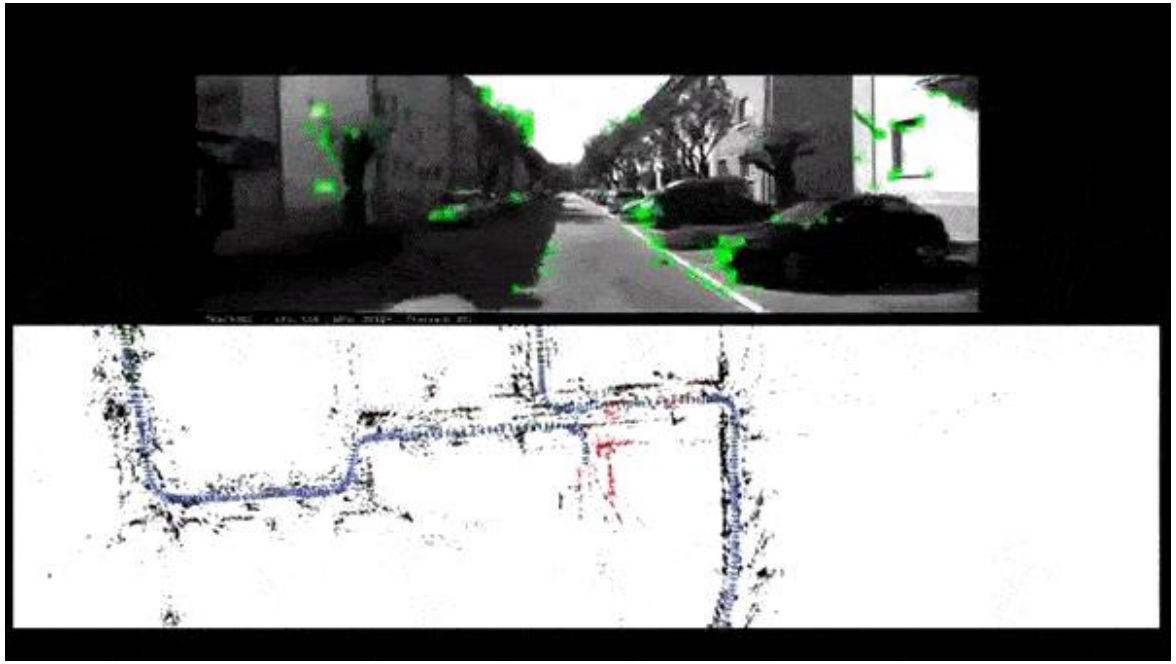
https://3d.nus.app/

- Pose is given
- Build a 3D map

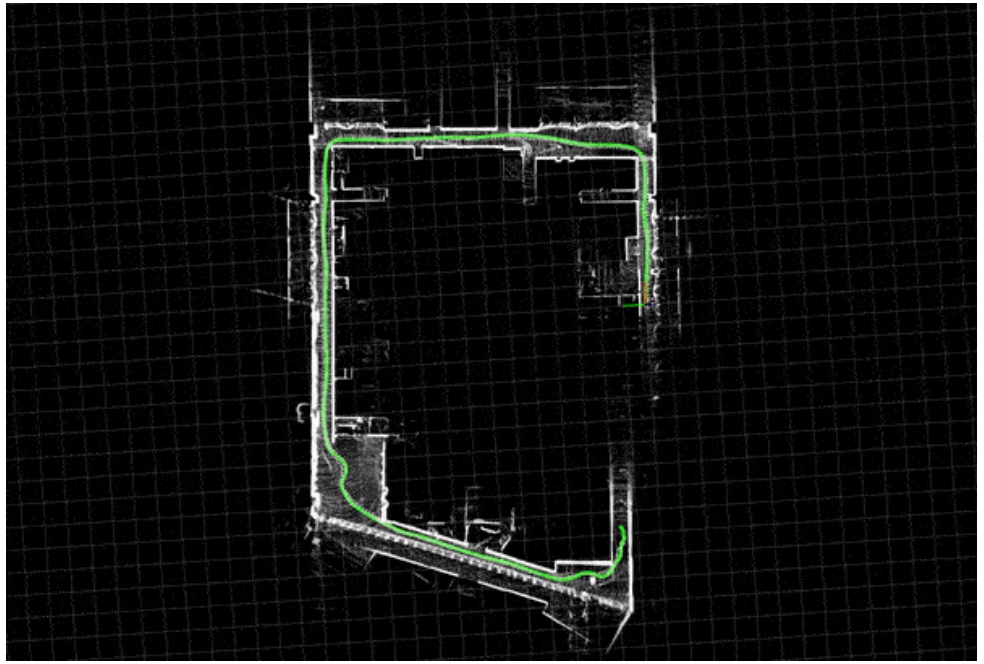
If you know exactly where the sensor is, you can reconstruct the scene

Terminology: Simultaneous Localization and Mapping (SLAM)

"Neither pose nor map is known (e.g., in GPS-denied regions)"



Example of Camera-based SLAM



Example of LiDAR-based SLAM

- Estimate the pose and map together
- Pose ↔ Map (joint optimization)

Build a map while figuring out where you are

History of Terminology

Concurrent Mapping and Localization (CML)

Simultaneous Map Building and Localization (SMBL)

Simultaneous Localization and Mapping (SLAM)

Prof. Hugh Durrant Whyte, Univ. Sydney

Prof. John Leonard, Professor of Mechanical and Ocean Engineering, MIT

IEEE TRANSACTIONS ON ROBOTICS AND AUTOMATION, VOL. 17, NO. 3, JUNE 2001 229

A Solution to the Simultaneous Localization and Map Building (SLAM) Problem

M. W. M. Gamini Dissanayake, *Member, IEEE*, Paul Newman, *Member, IEEE*, Steven Clark, Hugh F. Durrant-Whyte, *Member, IEEE*, and M. Csorba

TUTORIAL

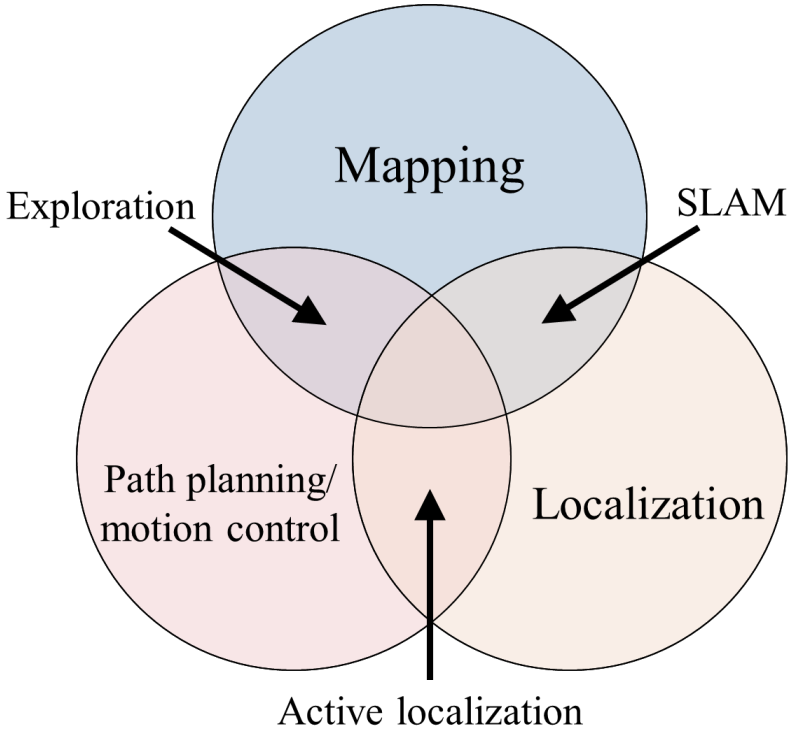
Simultaneous Localization and Mapping: Part I

BY HUGH DURRANT-WHYTE AND TIM BAILEY

IEEE Robotics & Automation Magazine, 2006

Conclusion: Note That SLAM Is Not an All-In-One Solution!

- For robot services,
  - Path planning and motion control are required



Conclusion

$$\text{SLAM} \neq \text{Robot navigation},$$
$$\text{SLAM} \subset \text{Robot navigation}$$