

Planning on Autonomous Robots

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Autonomous robots

Autonomous robots are intelligent machines capable of performing tasks in the world by themselves, with minimal human control.

Sensing, Planning and Acting

Why robot planning is challenging?

- Partial observability
- Non-deterministic action outcomes
- Dynamically changing environments
- Non-expert/expensive human feedback
- Real-time processing
- Unreliable multi-robot communication

Goal

- Model uncertainty in observations and actions.
- Plan sensing and information processing:
 - Where to look?
 - What to process?
 - How to process?
- Represent and reason with knowledge acquired from non-expert humans and sensory inputs.

POMDP

Partially Observable Markov Decision Process

Markov assumption

The agent maintains a probability distribution (belief state) over the set of possible states.

Hierarchical POMDPs

- To decompose a complex problem into a set of tractable sub-problems.
- A hierarchical decomposition of POMDPs was used for visual processing in a tabletop scenario.

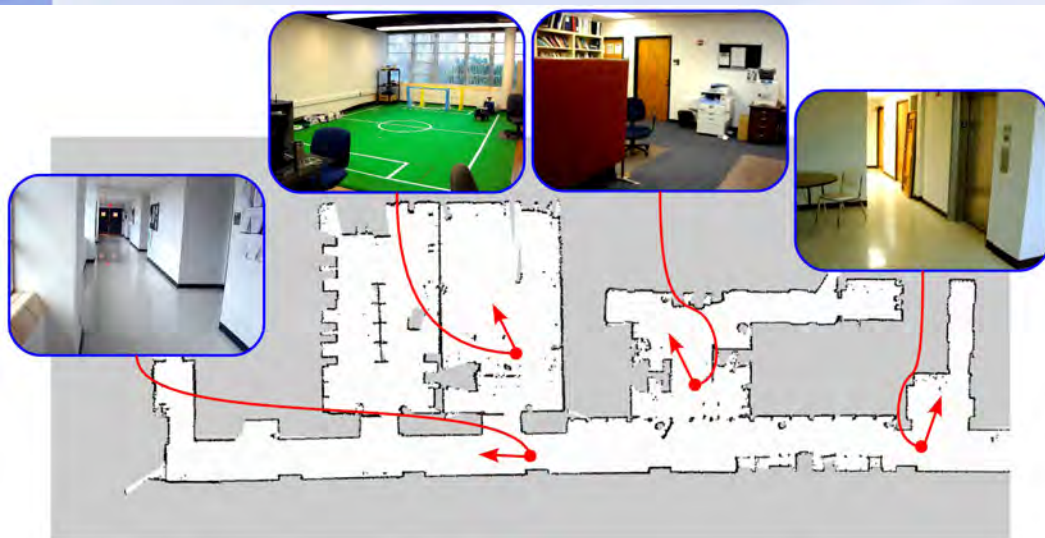
Related work was published in **Artificial Intelligence Journal (2010)**:

Mohan Sridharan, Jeremy Wyatt and Richard Dearden,

Planning to See: A Hierarchical Approach to Planning Visual Actions on a Robot using POMDPs

Hierarchical POMDPs (cont.)

- A layer added to hierarchy to perform active sensing in addition to information processing.
- Convolutional policies enable real-time operation in large complex environments.



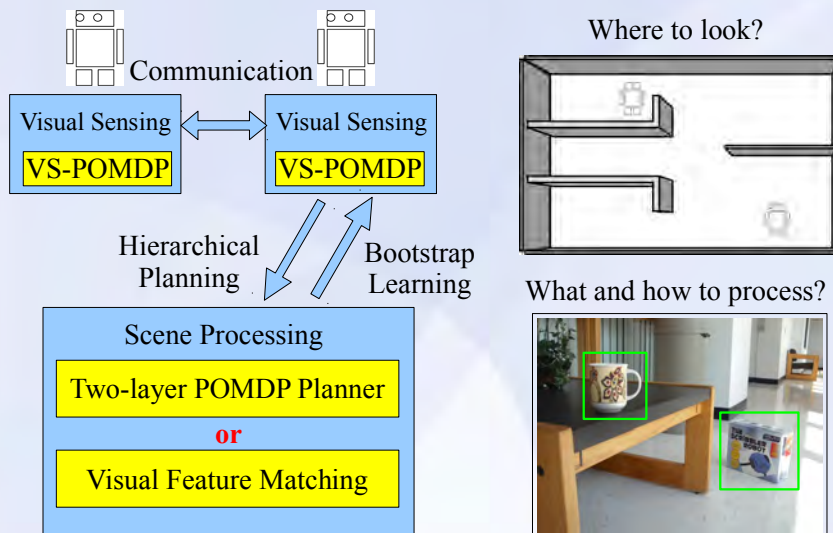
Shiqi Zhang, Mohan Sridharan and Xiang Li,

To Look or Not to Look: A Hierarchical Representation for Visual Planning on Mobile Robots,

International Conference on Robotics and Automation (**ICRA**), 2011

Multirobot collaboration

- Multiple robots collaborate on a target localization problem by sharing POMDP beliefs.
- Algorithms are fully implemented using Robot Operating System (ROS)



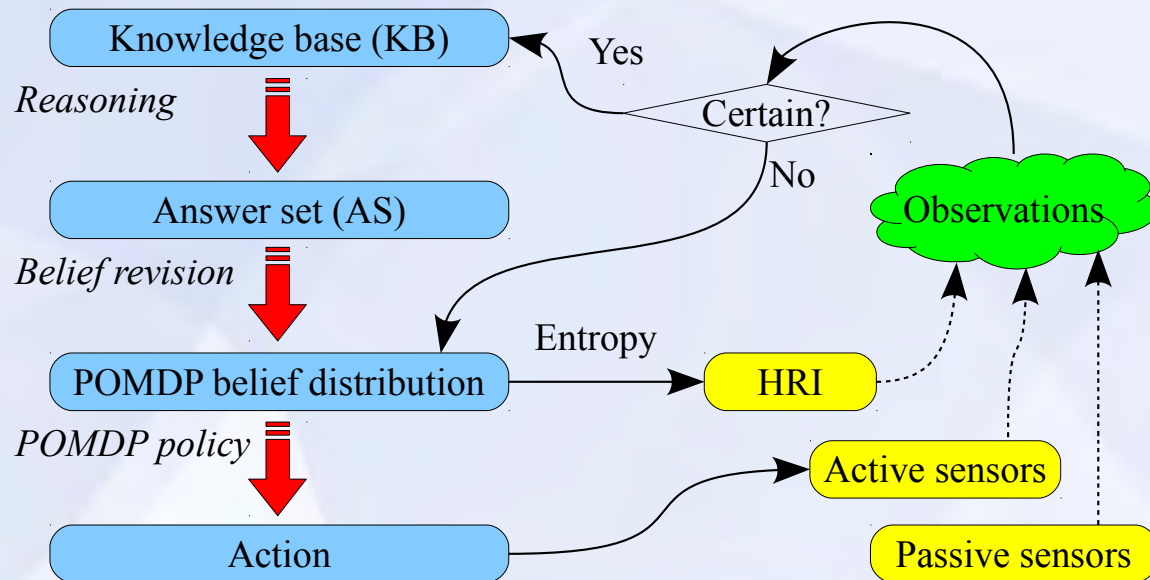
Shiqi Zhang and Mohan Sridharan,

Active Visual Sensing and Collaboration on Mobile Robots using Hierarchical POMDPs,

International Conference on Autonomous Agents and Multiagent Systems (**AAMAS**), 2012

ASP+POMDP

- POMDP models uncertainty in sensing and actions.
- ASP is well-suited for knowledge representation and logical reasoning, especially default reasoning.
- Integrate POMDP and ASP to exploit complementary properties.



Questions?