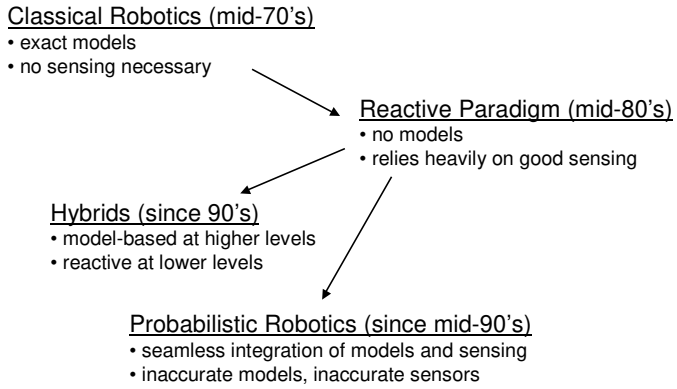
590DF
Introduction to AI-based Mobile Robotics

Discussions

Trends in Robotics Research



Topics in Robotics

- Navigation / control
- Localization / state estimation
- Map building
- Path planning
- High-level control / architectures

Behaviors

- Advantages?
- Good software engineering principles?
- Easy to program?
- Robustness?
- Scalability?
- Subsumption vs. potential field?
- Alternatives?

Bayes filters

- Bayes rule allows us to compute probabilities that are hard to assess otherwise.
- Under the Markov assumption, recursive Bayesian updating can be used to efficiently combine evidence.
- Bayes filters are a probabilistic tool for estimating the state of dynamic systems.

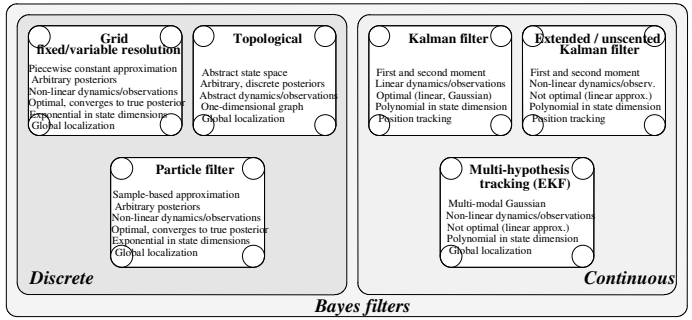
Sensor Models

- Explicitly modeling uncertainty in sensing is key to robustness.
- Models should be adjusted using real data.
- It is extremely important to be aware of the underlying assumptions!
  Probabilistic approach forces us to do this.

Localization

- Virtually all approaches are instantiations of Bayes filters.
- Since ’96, global localization problem can be addressed.
- Most recent research focuses on rich representations using particle filters and multi-hypothesis tracking.

Localization Algorithms



- Which one is best? When?

Mapping

- Hard estimation problem.
- Once positions are known, building metric, sub-symbolic maps is not too hard (occupancy grids).
- Most active research in concurrent mapping and localization.
- SLAM estimates full posterior using EKF.
- Data association problem!
- EM computes maximum likelihood map.
- FastSLAM uses particles for robot poses.
- Ongoing work on 3D maps, symbolic maps.

Robot Planning Frameworks

	Classical AI/robot planning	**Value Iteration in MDPs**	**POMDP**	**Augmented MDP**
State/actions	discrete & continuous	discrete	discrete	discrete
State	observable	observable	partially observable	partially observable
Environment	deterministic	stochastic	stochastic	stochastic
Plans	Sequences of actions	policy	policy	policy
Completeness	Yes	Yes	Yes	No
Optimality	Rarely	Yes	Yes	No
State space size	Huge, often continuous, 6 dimensions	millions	dozens	thousands
Computational Complexity	varies	quadratic	exponential	polynomial

Architectures

- Hierarchy and modularity
  - Provide design flexibility
  - Allow reuse of software
- Executive plays key role in bridging gap between high-level reasoning and control.
- So far not many applications for complex high-level planning.