

# Robot Navigation

## Proseminar & Seminar

WS 2014/15

---

**Wolfram Burgard, Barbara Frank,  
Andreas Wachaja, Michael Partheil,  
Abhinav Valada, Tim Caselitz, Tim  
Welschehold**



# Organization

- One presentation per topic:  
45 min (30+10+5)
- One seminar report per topic:  
7 pages text (+ figures & literature)
- Collaborative (Proseminar only, if necessary): team of 2 students per topic

# Schedule

- Assignment of topics: this week please contact your supervisor for literature
- Discussion of slides with your supervisor: 2 weeks before presentation
- Presentations during 1 or 2 full days Jan/Feb 2015
- Reports due: 1 week after presentation

# Grading

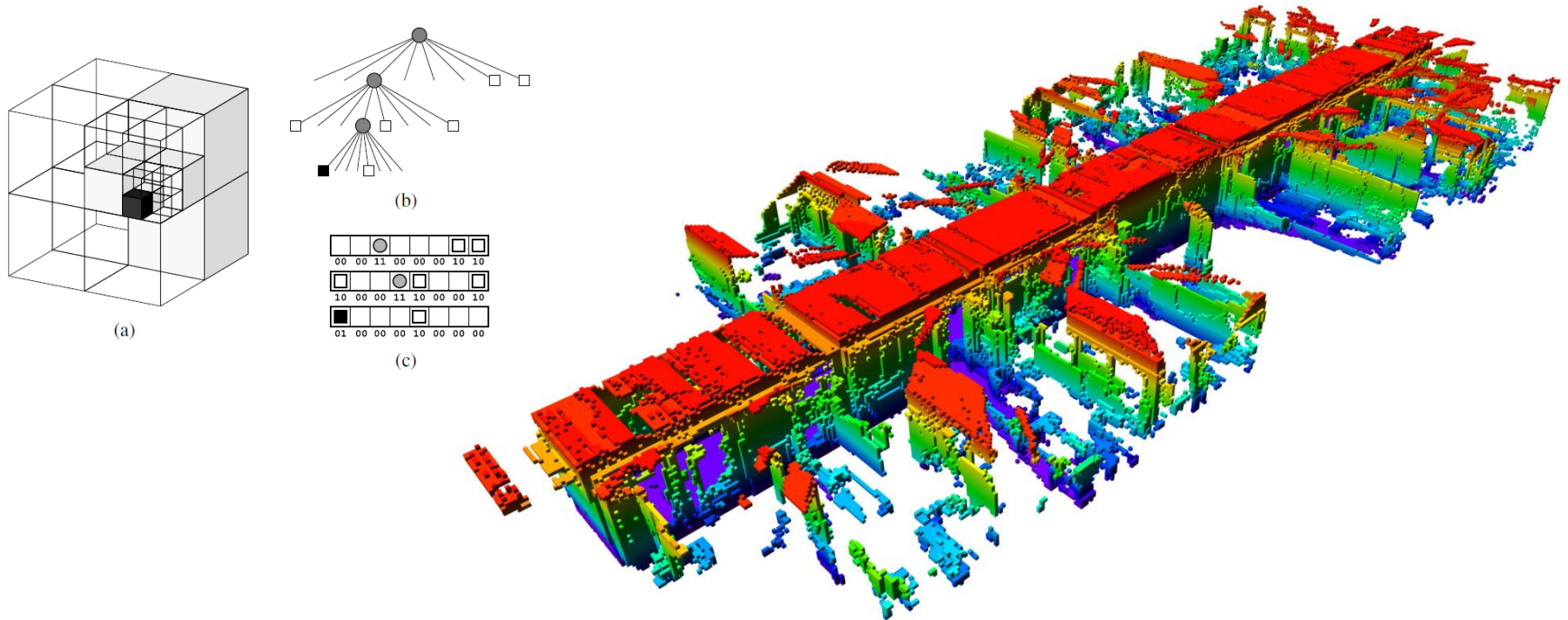
- 60 % presentation
- 30 % report
- 10 % contribution in discussions
  
- Giving and receiving feedback after presentations will be practiced

# What is Robot Navigation?

- How does the environment look like?  
➔ Mapping
- Where is the robot in the environment?  
➔ Localization
- How can the robot reach its goal?  
➔ Path planning
- How can it navigate safely?  
➔ Collision avoidance

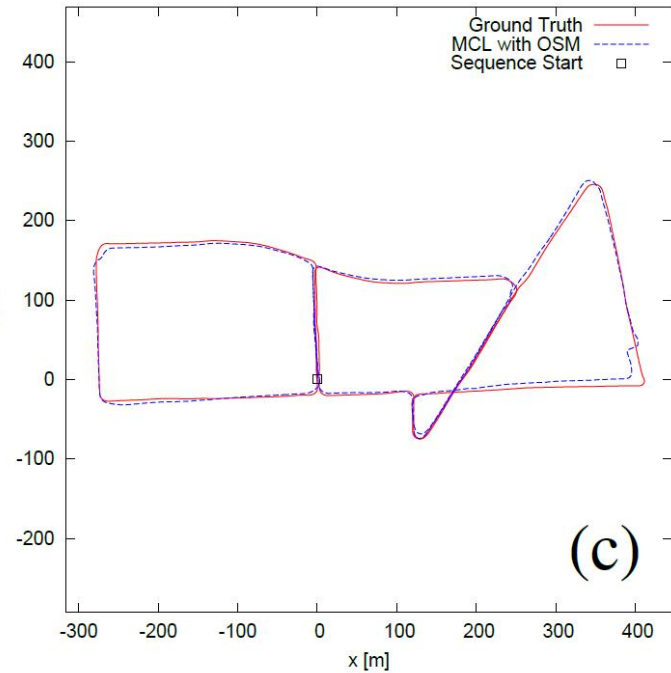
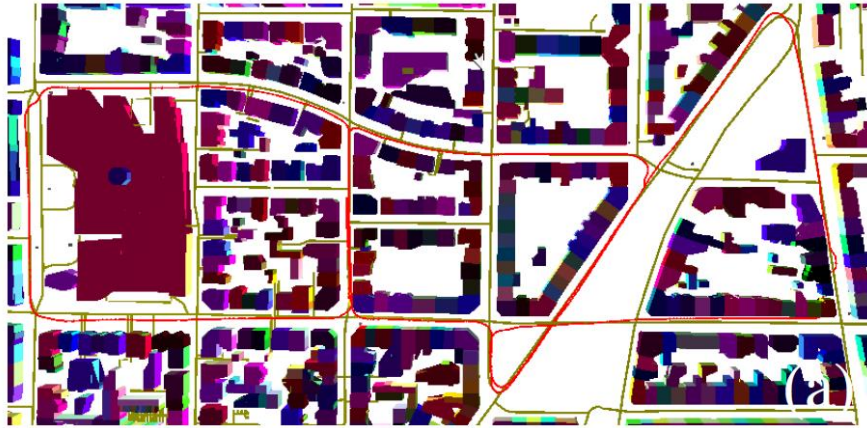
# Proseminar

# 1. 3D Mapping



- “OctoMap: A Probabilistic, Flexible, and Compact 3D Map Representation for Robotic Systems”  
Wurm et al. – ICRA 2010
- **Techniques:** Probabilistic occupancy, Octree

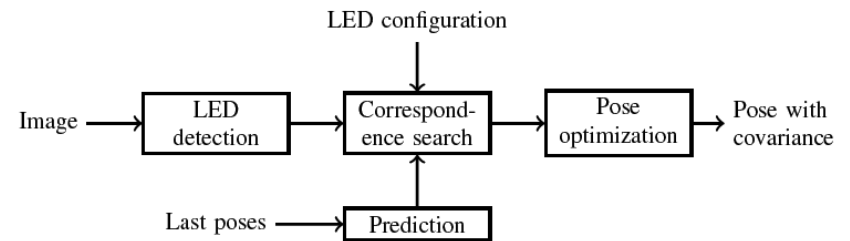
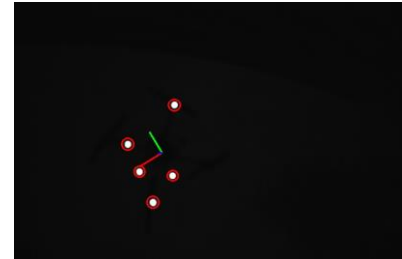
## 2. OpenStreetMaps Localization



- “OpenStreetSLAM: Global Vehicle Localization Using OpenStreetMaps” Floros, van der Zander, Leibe – ICRA13
- **Techniques:** Monte Carlo Localization

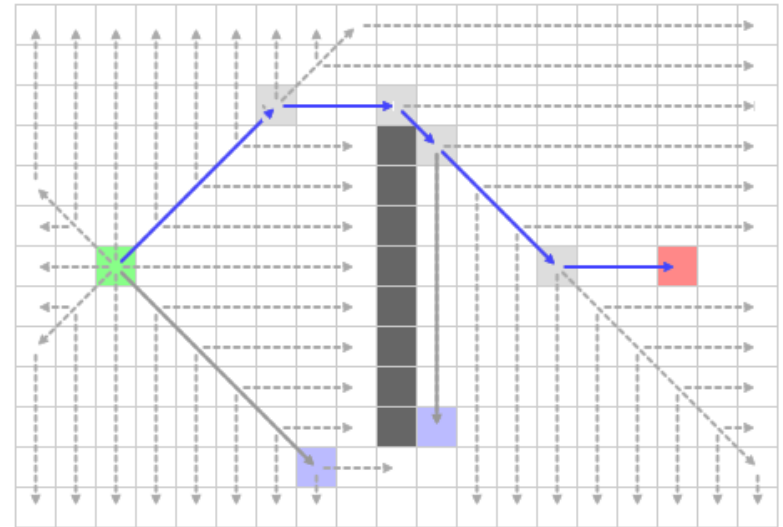
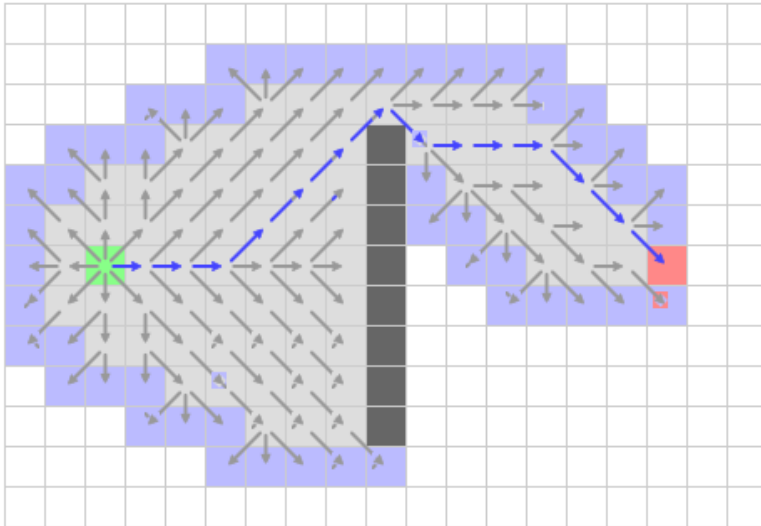


# 3. Pose Estimation



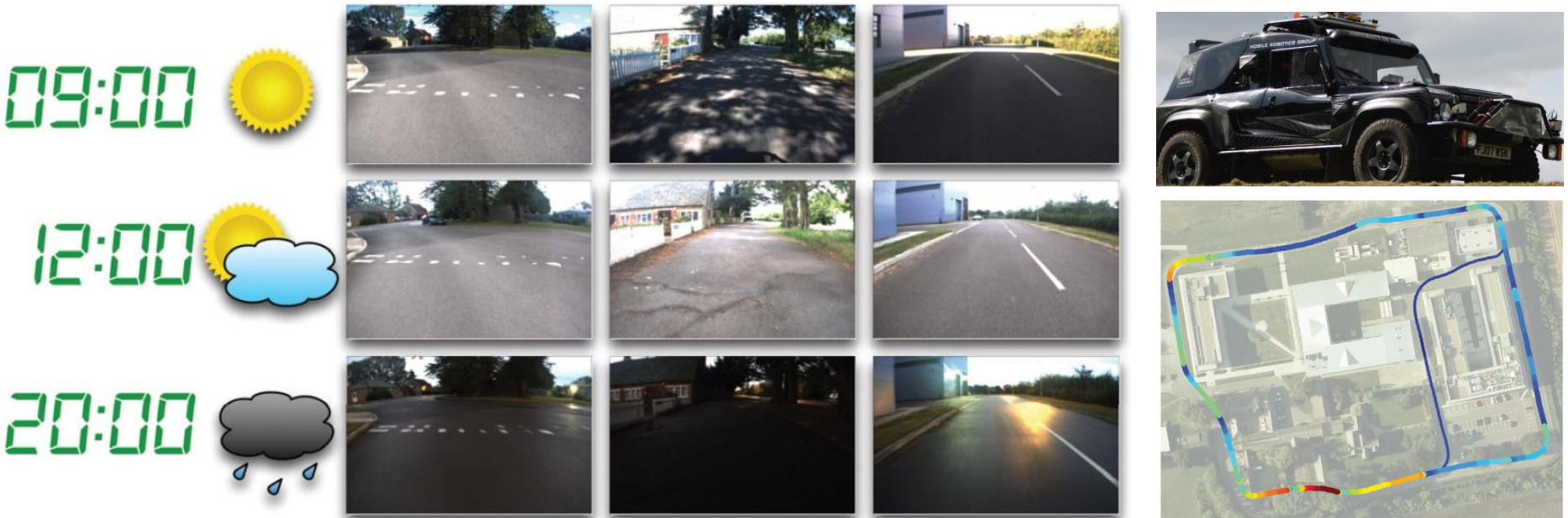
- “A Monocular Pose Estimation System based on Infrared LEDs” Faessler, Mueggler, Schwabe, Scaramuzza – ICRA14
- **Techniques:** Blob detection, P3P algorithm

# 4. Graph Pruning on Gridmaps



- “Online Graph Pruning for Path Finding on Gridmaps” Harabor and Grastien – AAAI11
- **Techniques:** A\*, jump point search

# 5. Experience-based Navigation



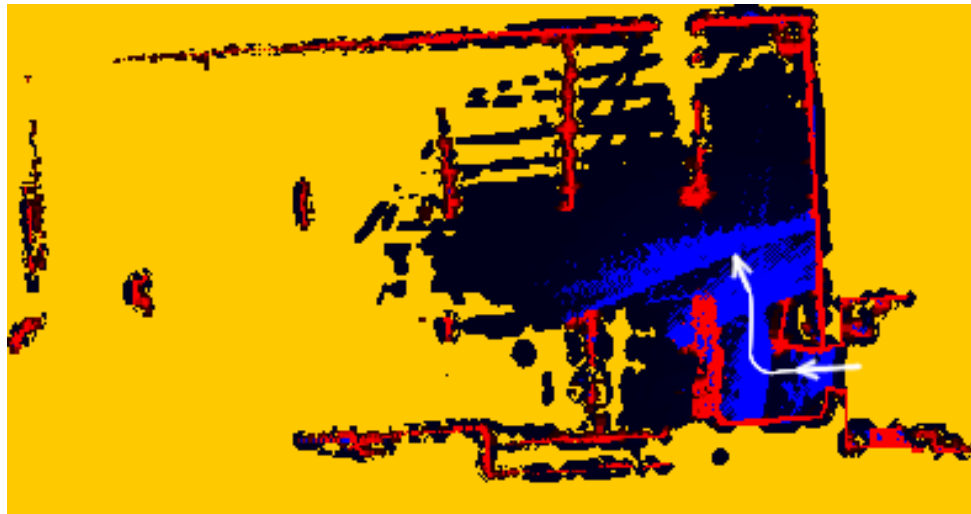
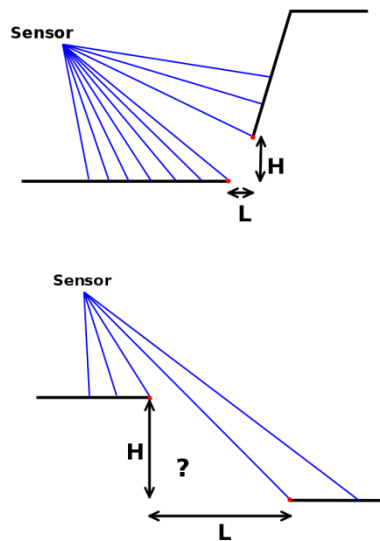
- “Experience-based Navigation for Long-term Localisation” Churchill and Newman - IJRR13
- **Techniques:** Visual odometry, mapping and localisation

# 6. Visual Route-based Navigation



- “SeqSLAM: Visual Route-Based Navigation for Sunny Summer Days and Stormy Winter Nights”  
Milford, Wyeth – ICRA 12
- **Techniques:** image sequence matching

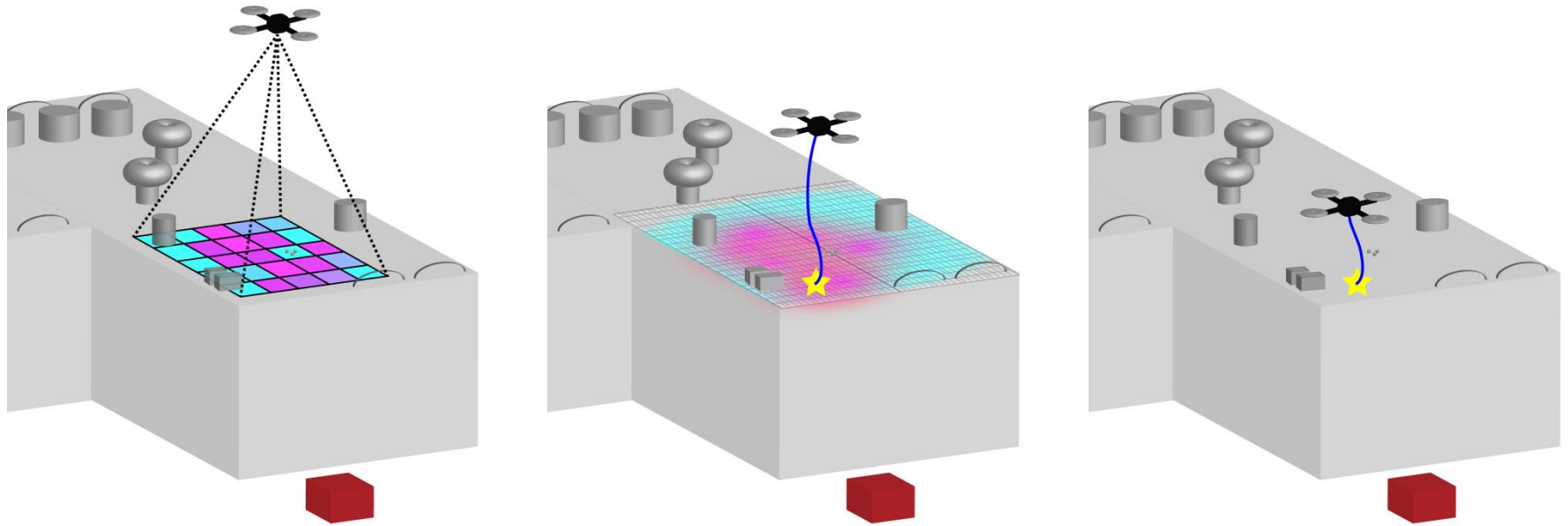
# 7. Traversability Analysis



- “Positive and Negative Obstacle Detection using the HLD Classifier” Morton and Olson– IROS 11
- **Techniques:** Message passing, Binary Classification with a Confidence

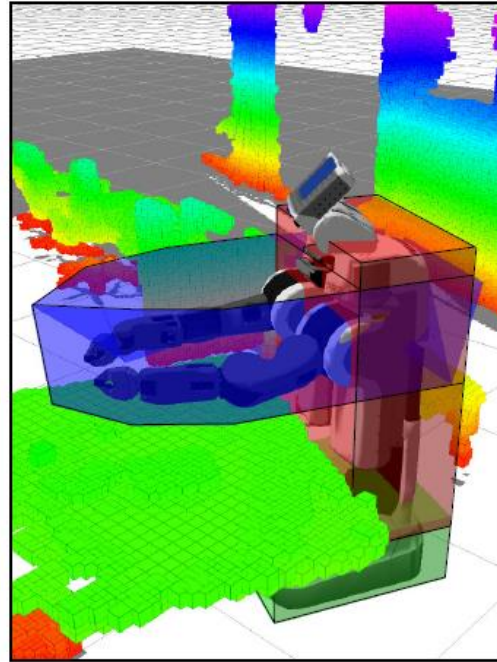


# 8. Vision-based MAV Landing



- “Vision-based Landing Site Evaluation and Trajectory Generation toward Rooftop Landing”  
Desaraju, Michael, Humenberger, Brockers, Weiss and Matthies - RSS14
- **Techniques:** Gaussian processes, trajectory optimization

# 9. Navigation in Cluttered Environments

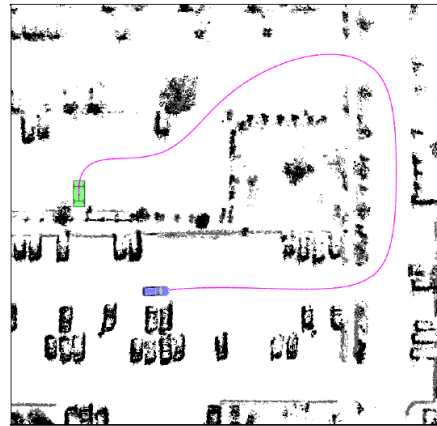
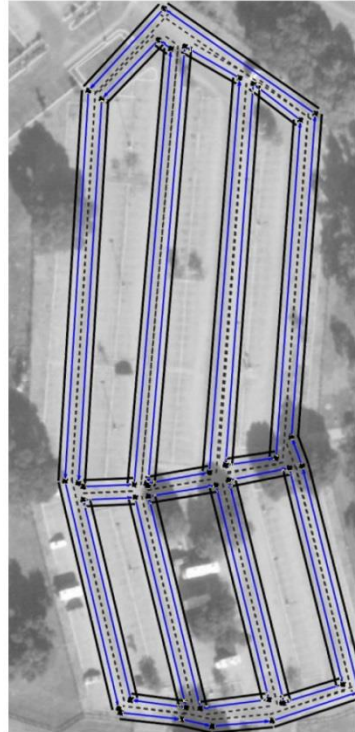


- “Navigation in 3D Cluttered Environments for Mobile Manipulation” Hornung, Phillips, Gil Jones, Bennewitz, Likhachev, Chitta – ICRA12
- **Techniques:** hierarchical representation, ARA\*

# Seminar

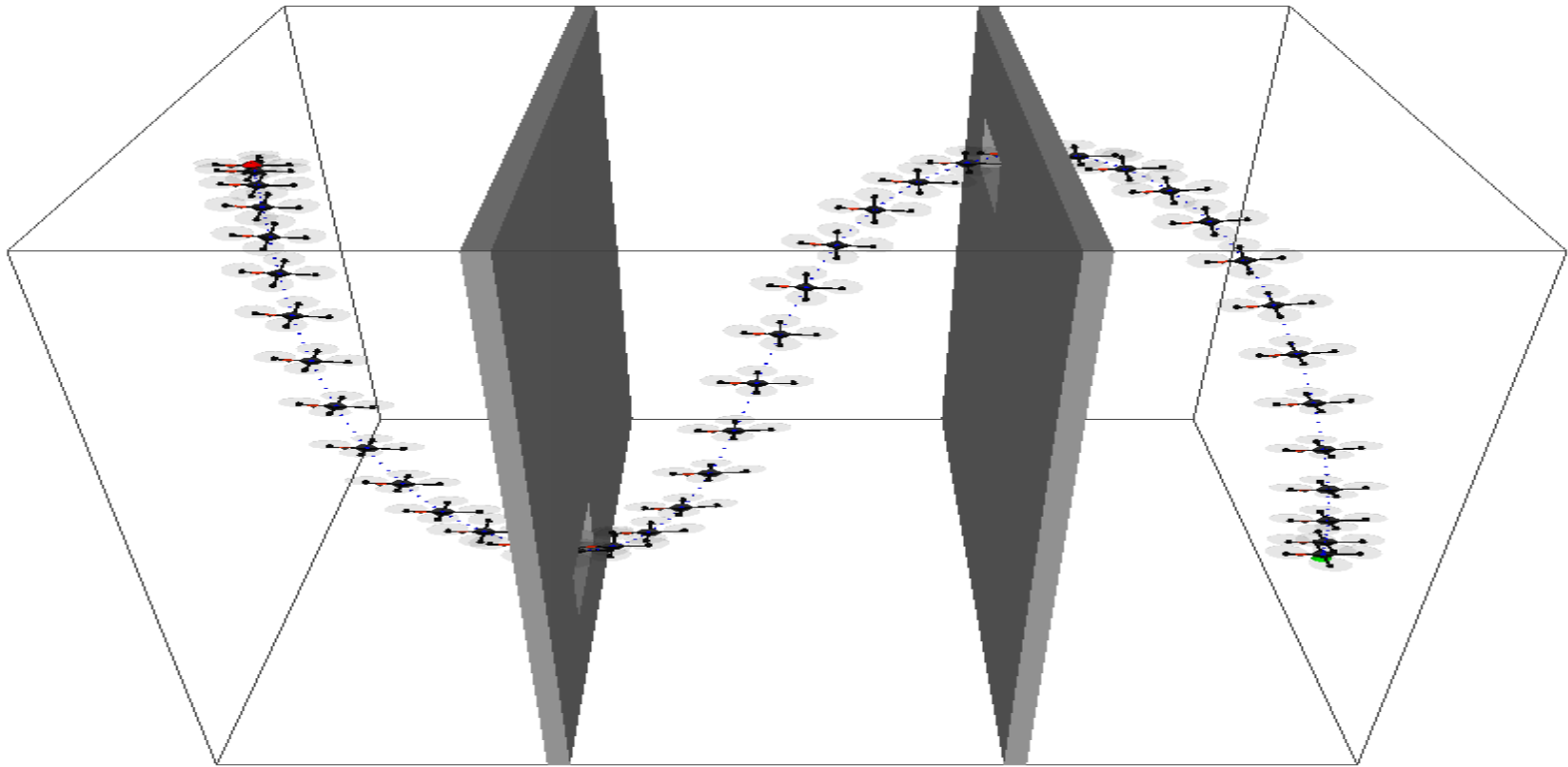


# 1. Principal Directions



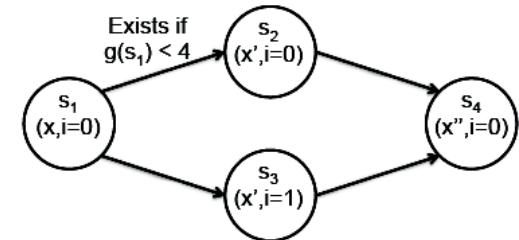
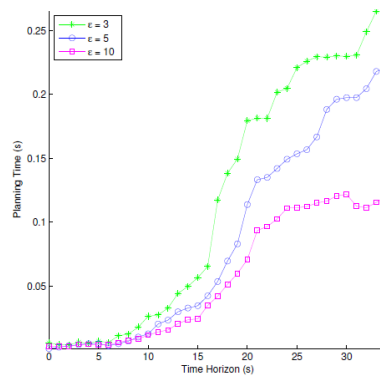
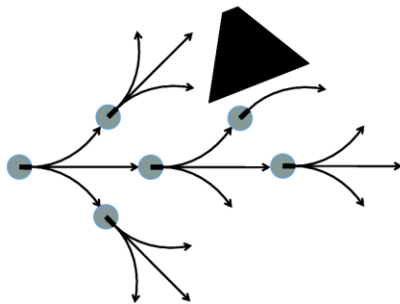
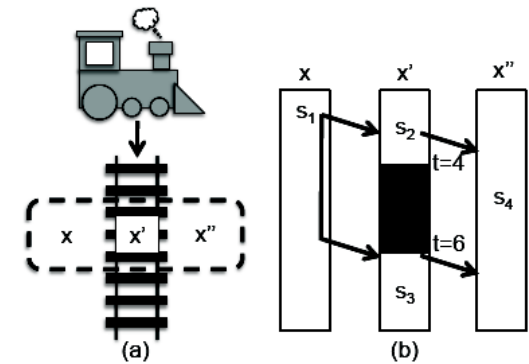
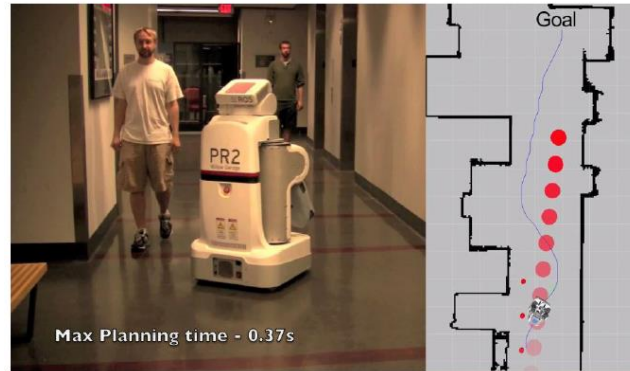
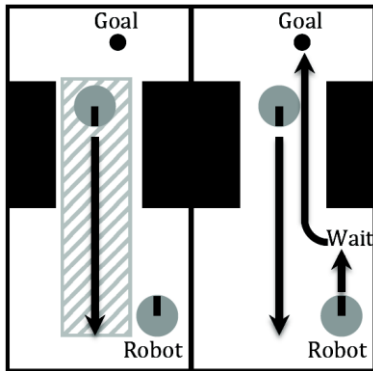
- “Detection of Principal Directions in Unknown Environments for Autonomous Navigation” Dolgov, Thrun – RSS08
- **Techniques:** Markov Random Fields

## 2. Kinodynamic RRT\*



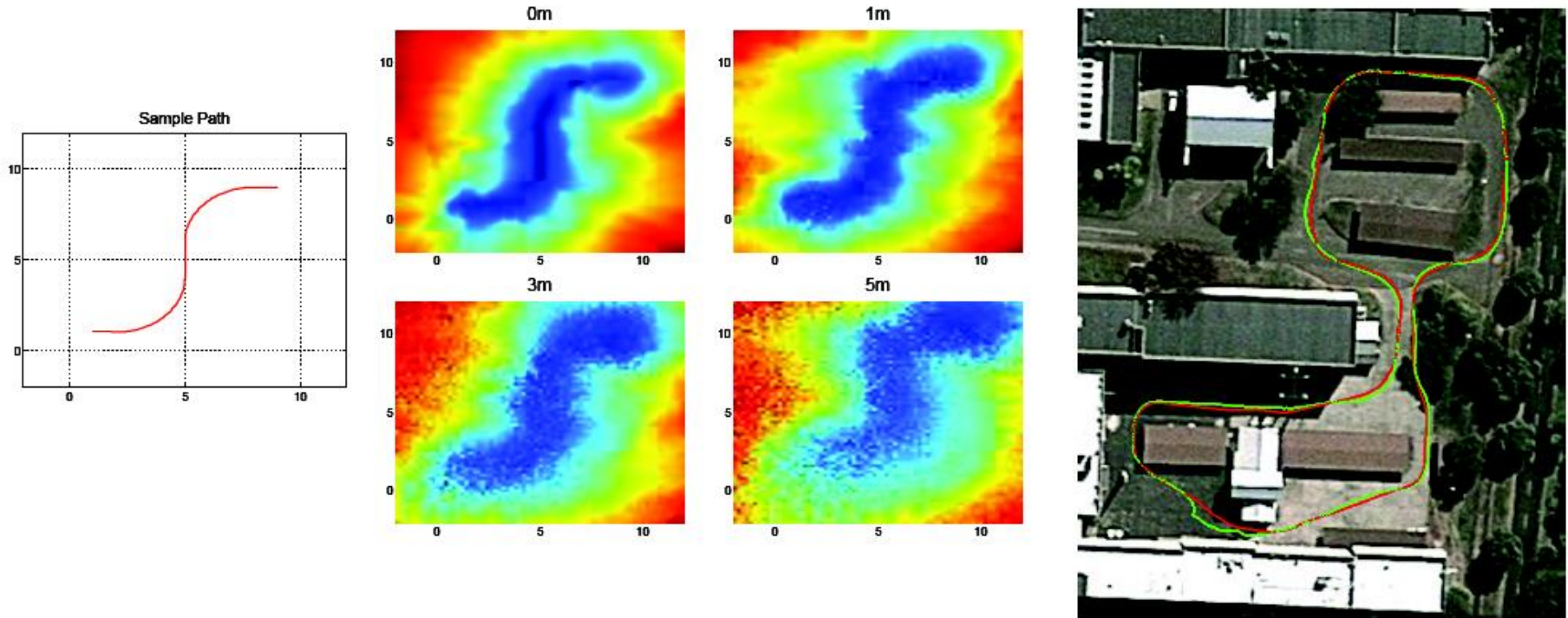
- “Asymptotically Optimal Motion Planning for Robots with Linear Dynamics” Webb and van den Berg - ICRA13
- **Techniques:** sampling-based planning, control theory

# 3. Anytime Safe Interval Planning



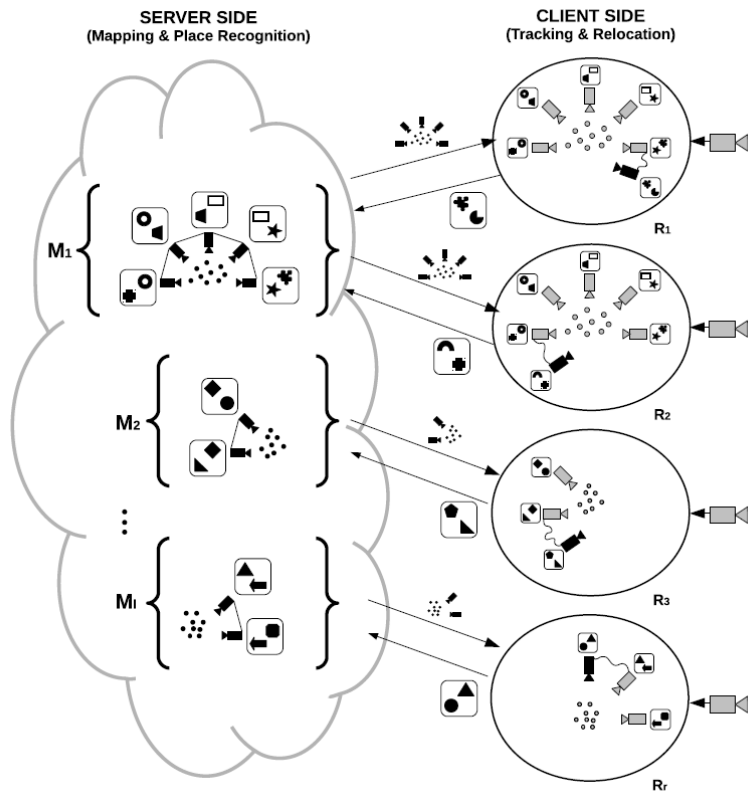
- "Anytime Safe Interval Path Planning in Dynamic Environments" Narayanan, Likhachev et al- IROS12
- **Techniques:** Safe intervals, ARA\*, Time-bounded lattice

# 4. Vision-based Path Following



- “Bearings-only Path Following with a Vision-based Potential Field” Sabatta and Siegwart- ICRA 14
- **Techniques:** Potential Fields, Teach and Repeat

# 5. Cloud-based Visual SLAM



- “C<sup>2</sup>TAM: A Cloud Framework for Cooperative Tracking and Mapping” Riazuelo, Civera, Montiel – RAS 14
- **Techniques:** Cloud computing, PTAM

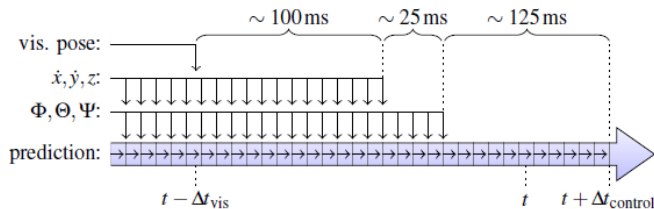
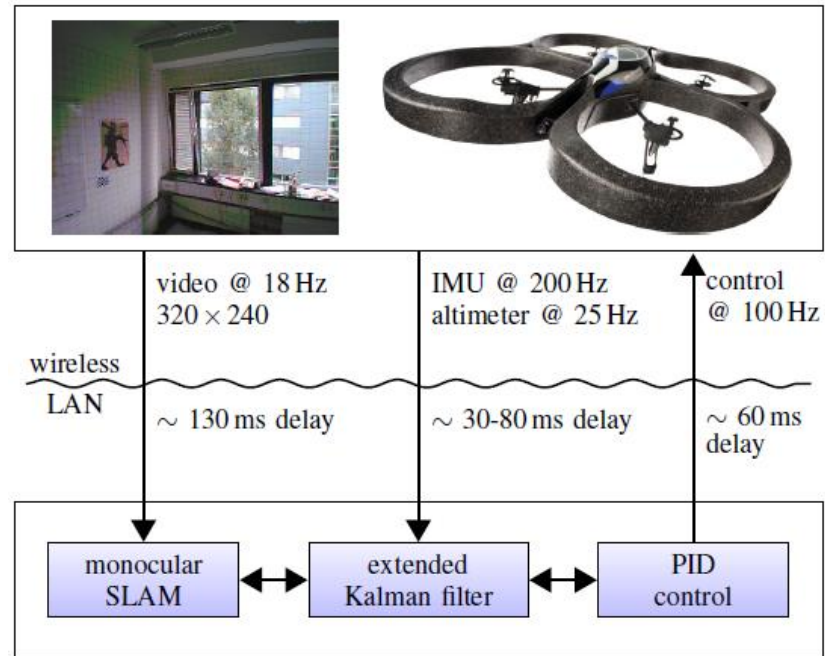


# 6. Terrain Classification and Planning



- “Planning Most-likely Paths from Overhead Imagery”  
Murphy and Newman – ICRA 10
- **Techniques:** Gaussian process classification, probabilistic planning on costmaps

# 7. Aerial Indoor Navigation



- “Camera-Based Navigation of a Low-Cost Quadcopter” Engel, Sturm, Cremers– IROS 12
- **Techniques:** Monocular SLAM, Expectation Maximization, Extended Kalman Filter

# Topic Assignment

- Globally optimal assignment based on your preferences
- Please fill out the form and hand it in by Friday, October 31, 2014 (Building 079-00-1020)