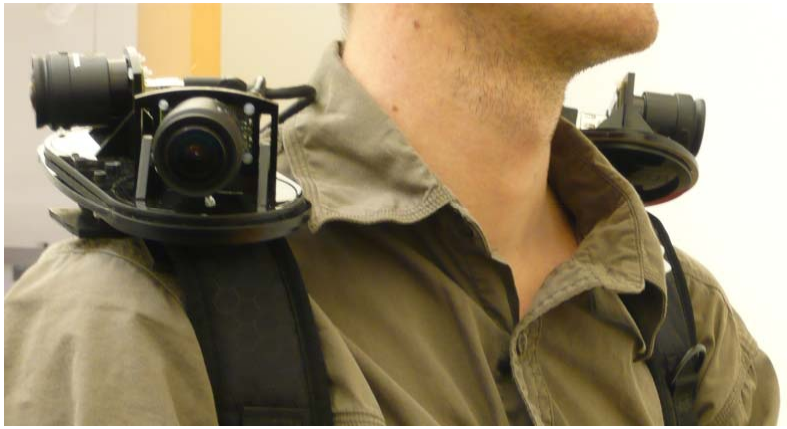


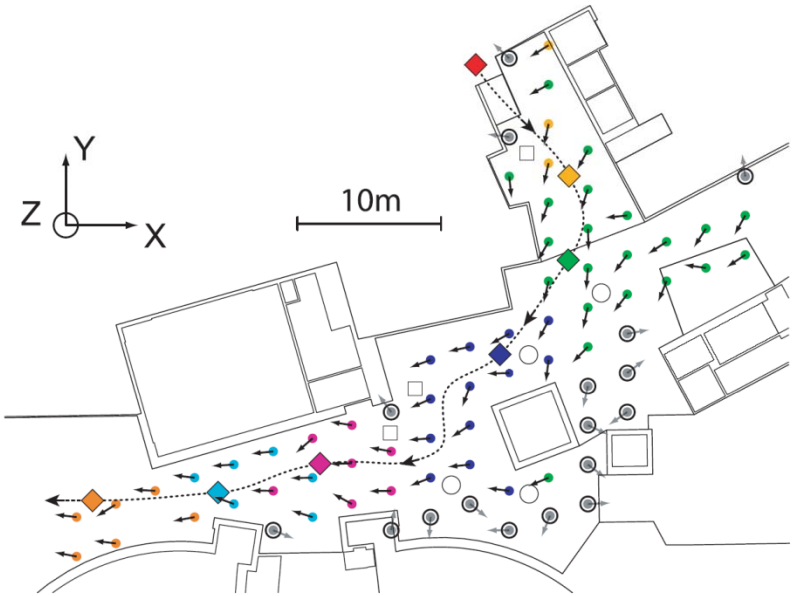
Body-Relative Navigation Guidance using Uncalibrated Cameras

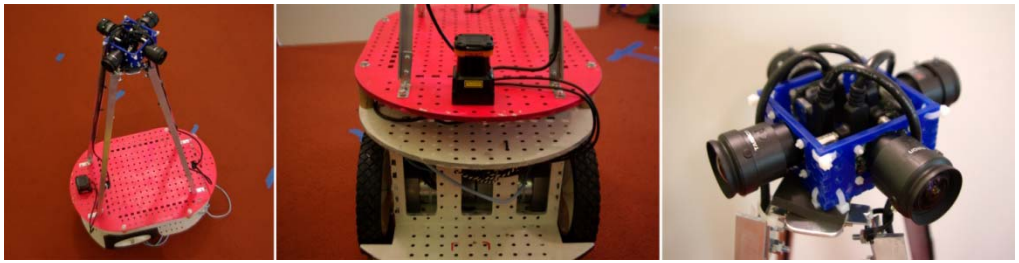
Olivier Koch

MIT Computer Science and Artificial Intelligence Laboratory

Committee Meeting #2

Nov 30, 2009





Last meeting's debriefing

- Method evaluation
  - "I want you to understand the trade-off between number of feature points used and reliability. If you didn't need as many feature points, you could increase your frame rate, or perhaps allow your subjects to run, etc. It would be nice to characterize that performance/frame-rate tradeoff." (B. Freeman)
- Incorporate 3D motion (up/down)
- Interest in user studies (with the blind?)
- Demonstrate a successful end-to-end system

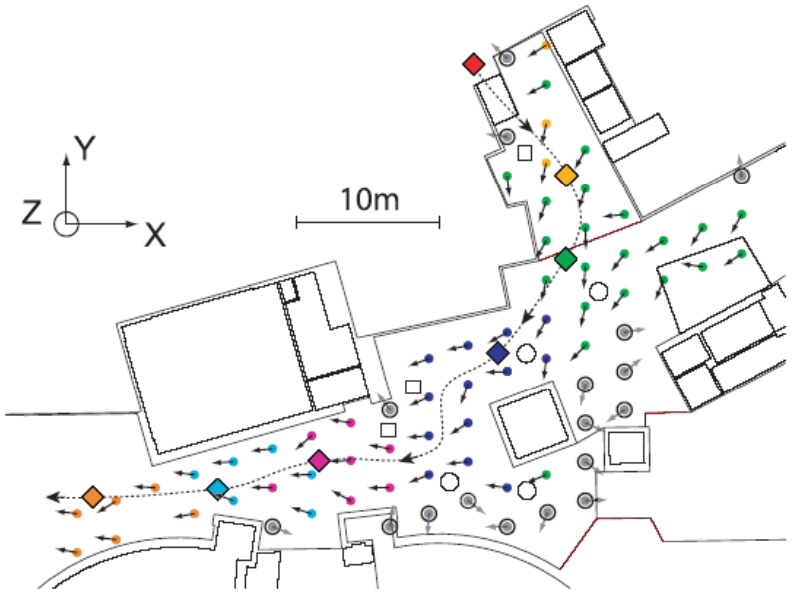
Outline

- Recent activities
  - ICCV 2009 Paper *(International Conference on Computer Vision)*
  - ICRA 2010 Submission *(International Conference on Robotics and Automation)*
  - Meeting with IBM Research Fellow Chieko Asakawa
  - Algorithmic & interface developments
  - Robustness vs Image resolution

- What's next?

ICCV 2009

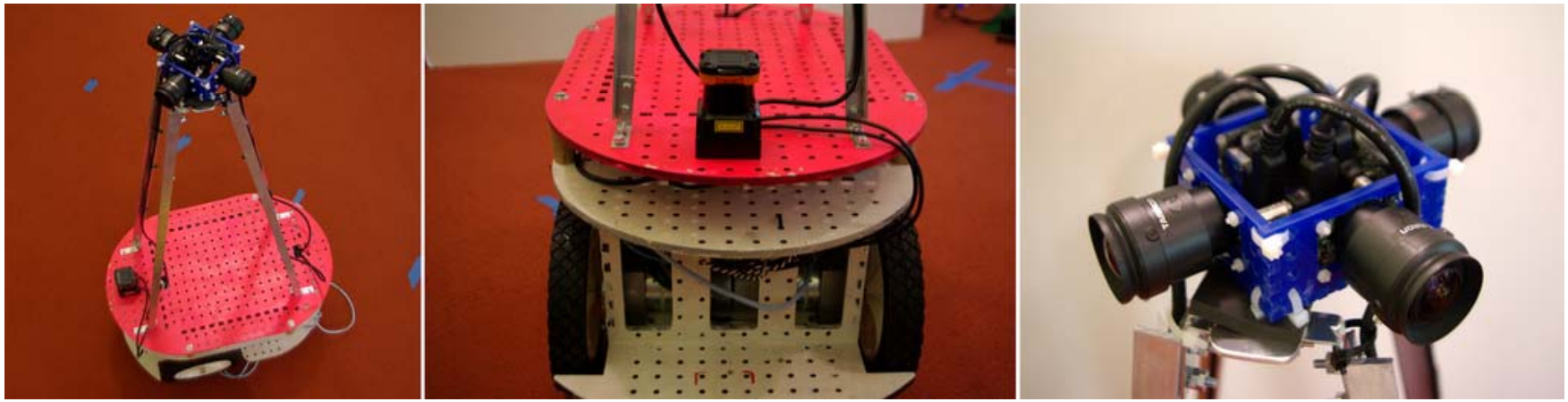
- "Body-relative Navigation Guidance using Uncalibrated Cameras", ICCV 2009, Olivier Koch and Seth Teller
- Presented at ICCV 2009 in Kyoto, Japan (*International Conference of Computer Vision*)
- Demonstrates a set of algorithms on a real system
- Conference feedback:
  - Algorithmic contributions
  - Real, end-to-end system (conf. demo)
  - Novel system design
  - Useful applications



A Robotics Application

- "Ground Robot Navigation using Uncalibrated Cameras", ICRA 2010, co-submission with A. Huang, M. Walter and S. Teller
  - demonstrate that our method can guide a robot doted of a low-level obstacle avoidance capability
  - Collect extended ground-truth data for validation purposes

International Conference on Robotics and Automation (ICRA)
Notification of acceptance: January 7, 2010



A Robotics Application

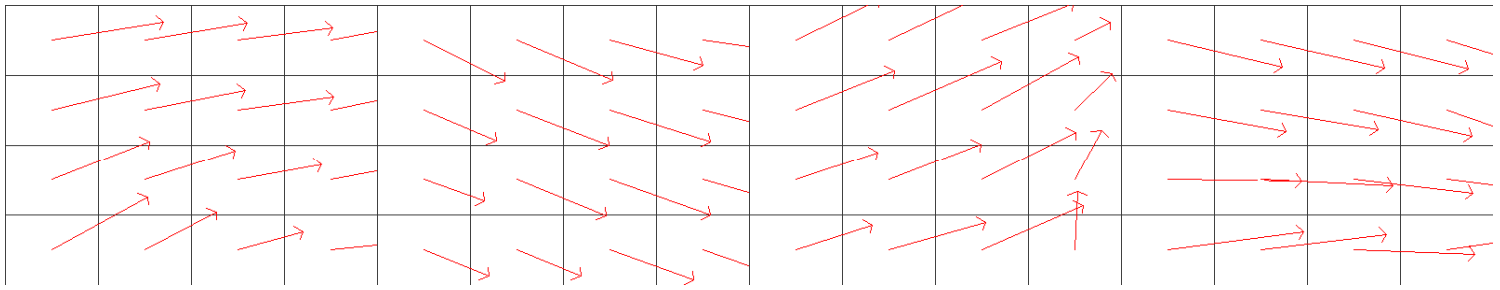
- ICRA 2010 movie

New Algorithmic Developments

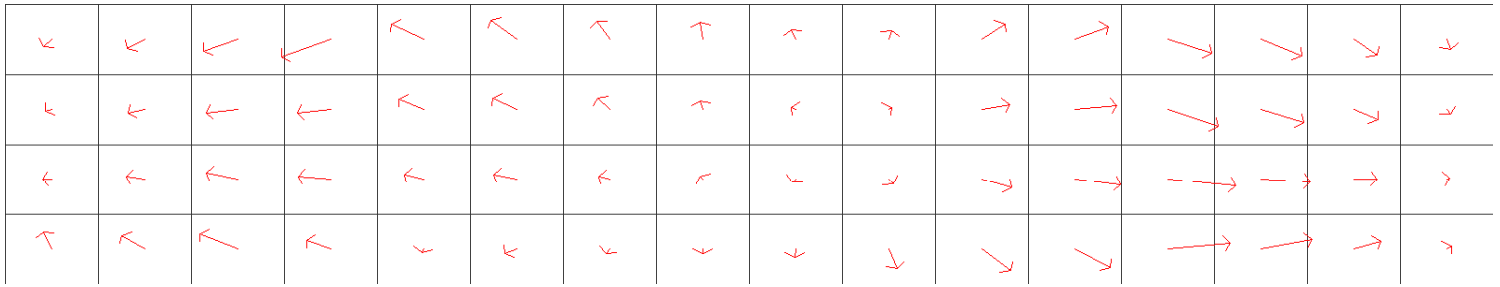
- Optical-flow based motion classification
- Automatic out-of-path detection
- Usability
  - Place labeling (text)
  - System confidence

Optical-flow based motion classification

- Train system to learn typical user motions (left turn, right turn, up, down, forward)
- 1 training video sequence / motion category (30 sec.)
- Average sparse optical flow over entire sequence



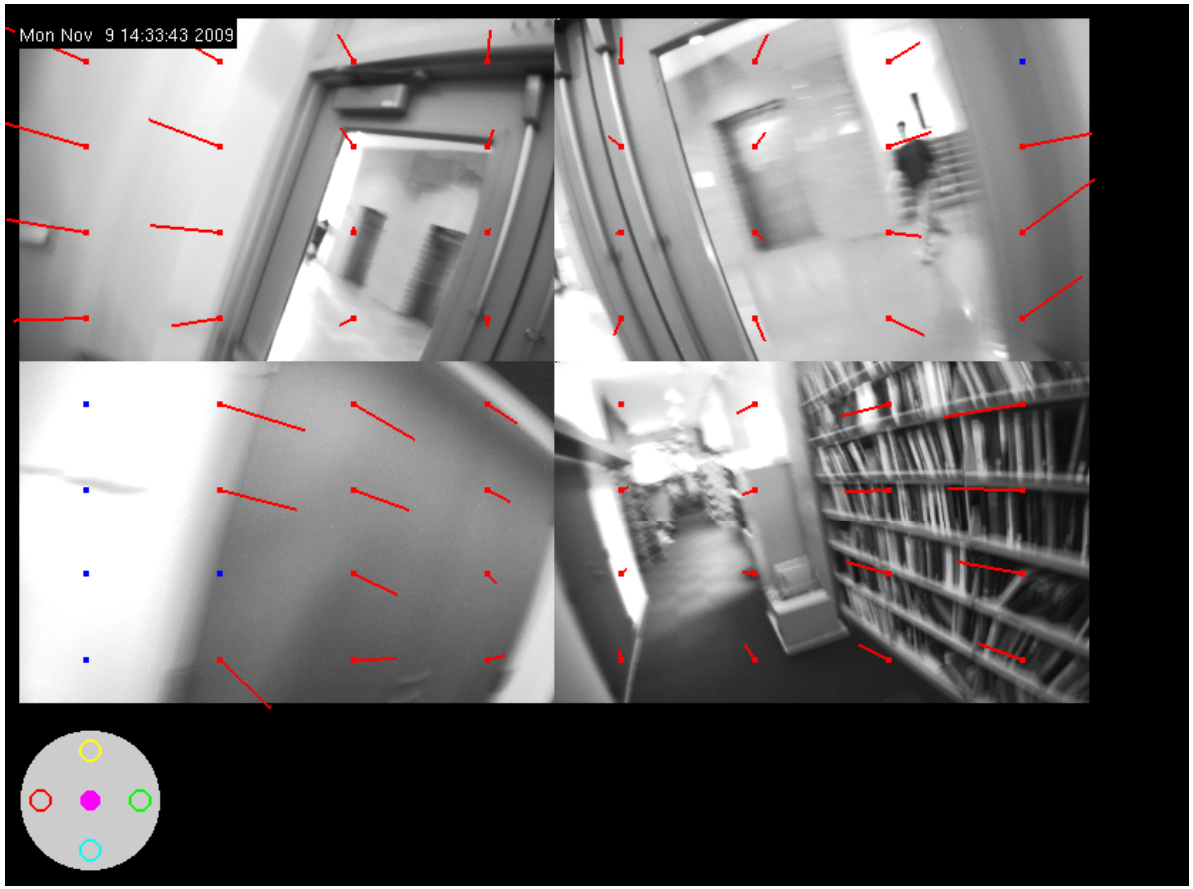
Left



Forward

Optical-flow based motion classification

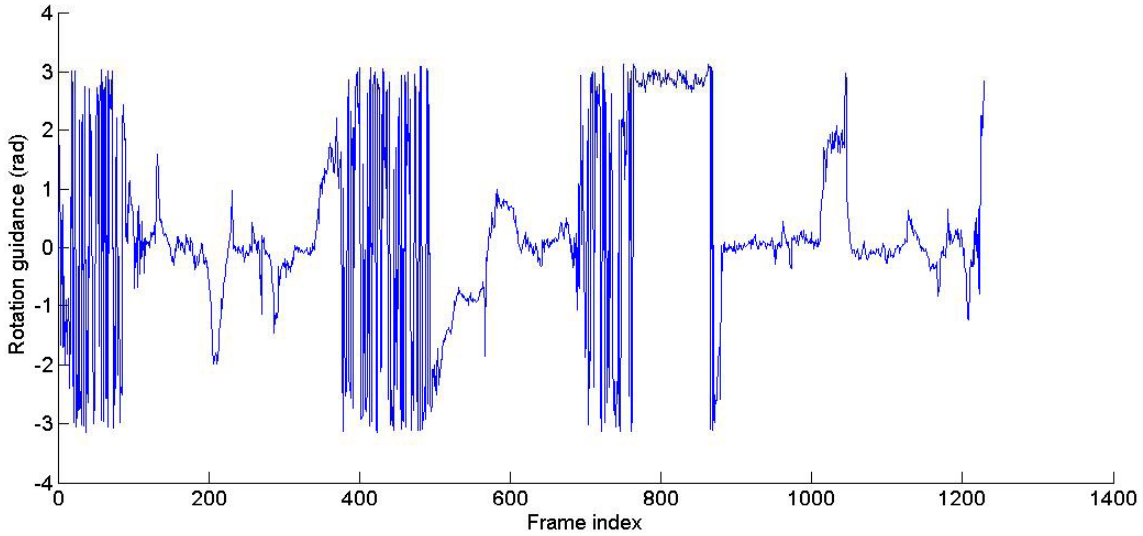
- During exploration, find top two motion categories using nearest-neighbor matching



Optical-flow based motion classification

- Movie

Automatic out-of-path detection

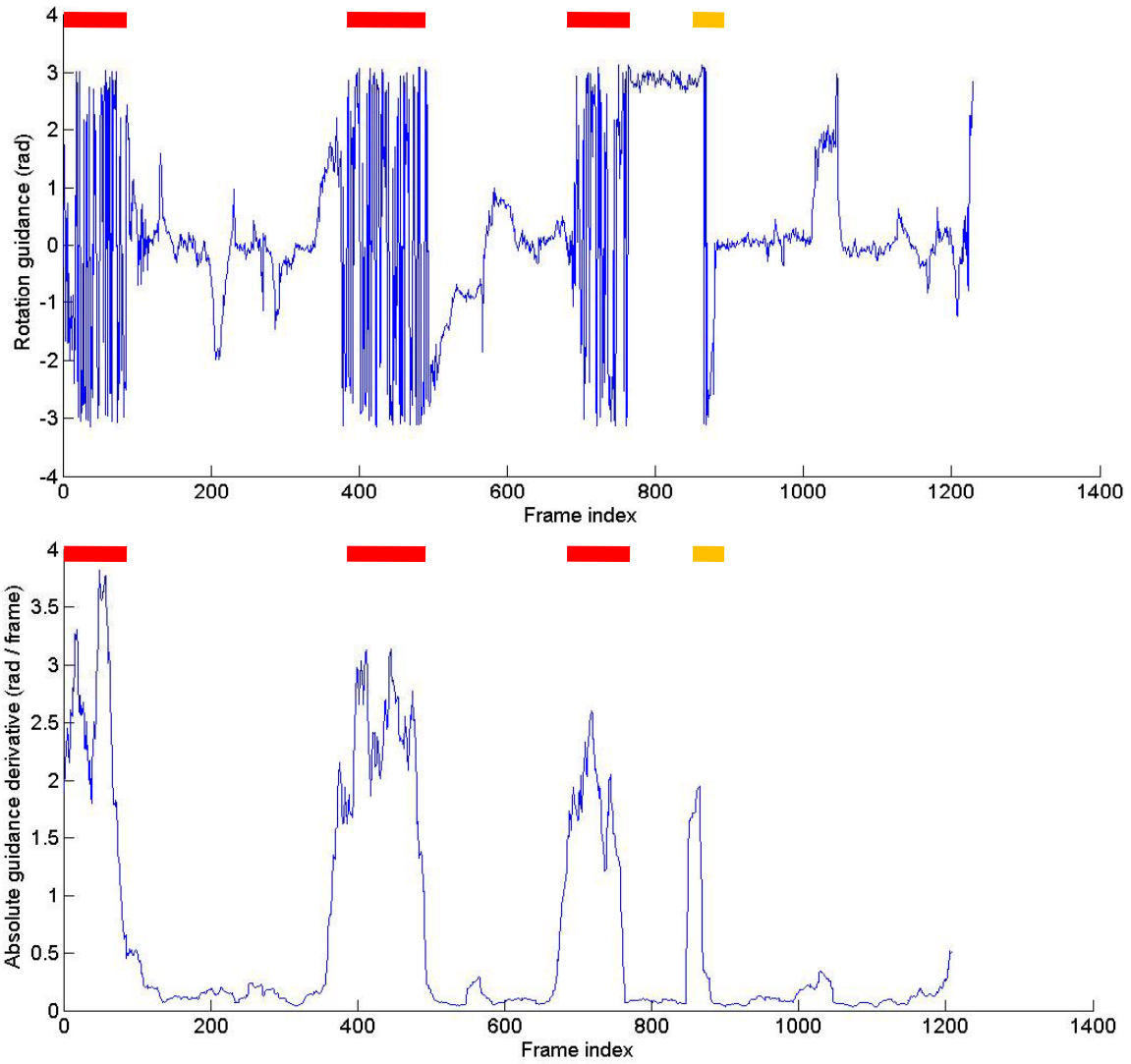


- Consider the evolution of rotation guidance over time
- Use high-frequency patterns to detect out-of-path events
- Use signal frequency as “system confidence”

Automatic out-of-path detection

Out of path

Motion blur



Automatic out-of-path detection

- Movie

Robustness vs Image resolution

- Localization robustness
  - STATA-33x robot-based dataset: 39 min, 220m

Image size	372×240	188×120	94×60	67×43	45×28
Image Scale factor	100%	50%	25%	18%	12.5%
Number of features	553 (189)	206 (62)	64 (20)	36 (11)	13 (5)
(μ_G)	0.51 (0.96)	0.51 (0.91)	0.46 (0.74)	0.65 (1.16)	31.9 (17.2)
(μ_N)	0.77m (0.44m)	0.87m (0.91m)	0.86m (0.63m)	0.94m (0.92m)	28.3m (15.3m)

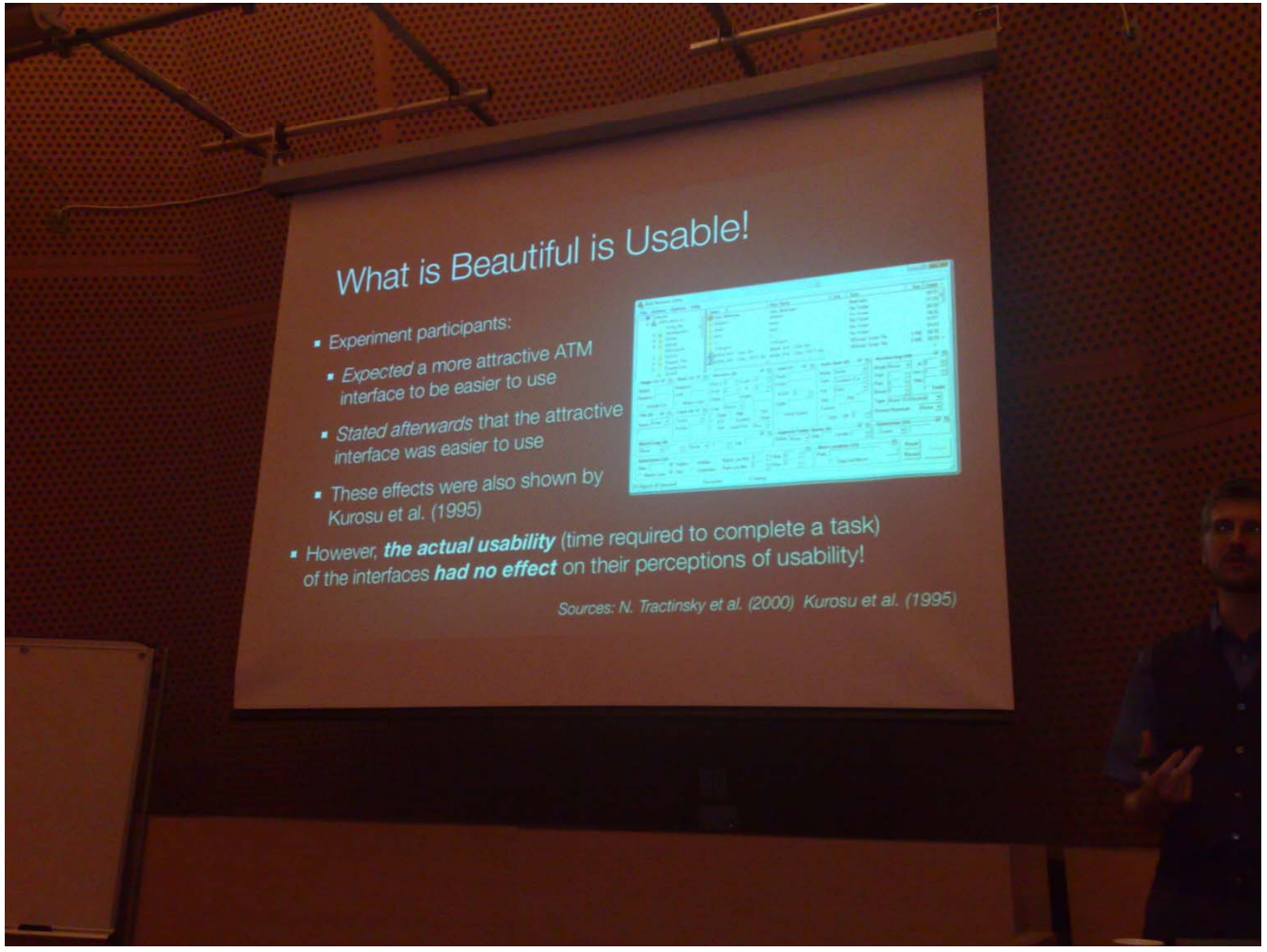
Figure 1-17: Localization performance for various image resolutions on the STATA-33X dataset.

- Rotation guidance robustness
  - todo

Meeting with Chieko Asakawa, IBM Research Fellow

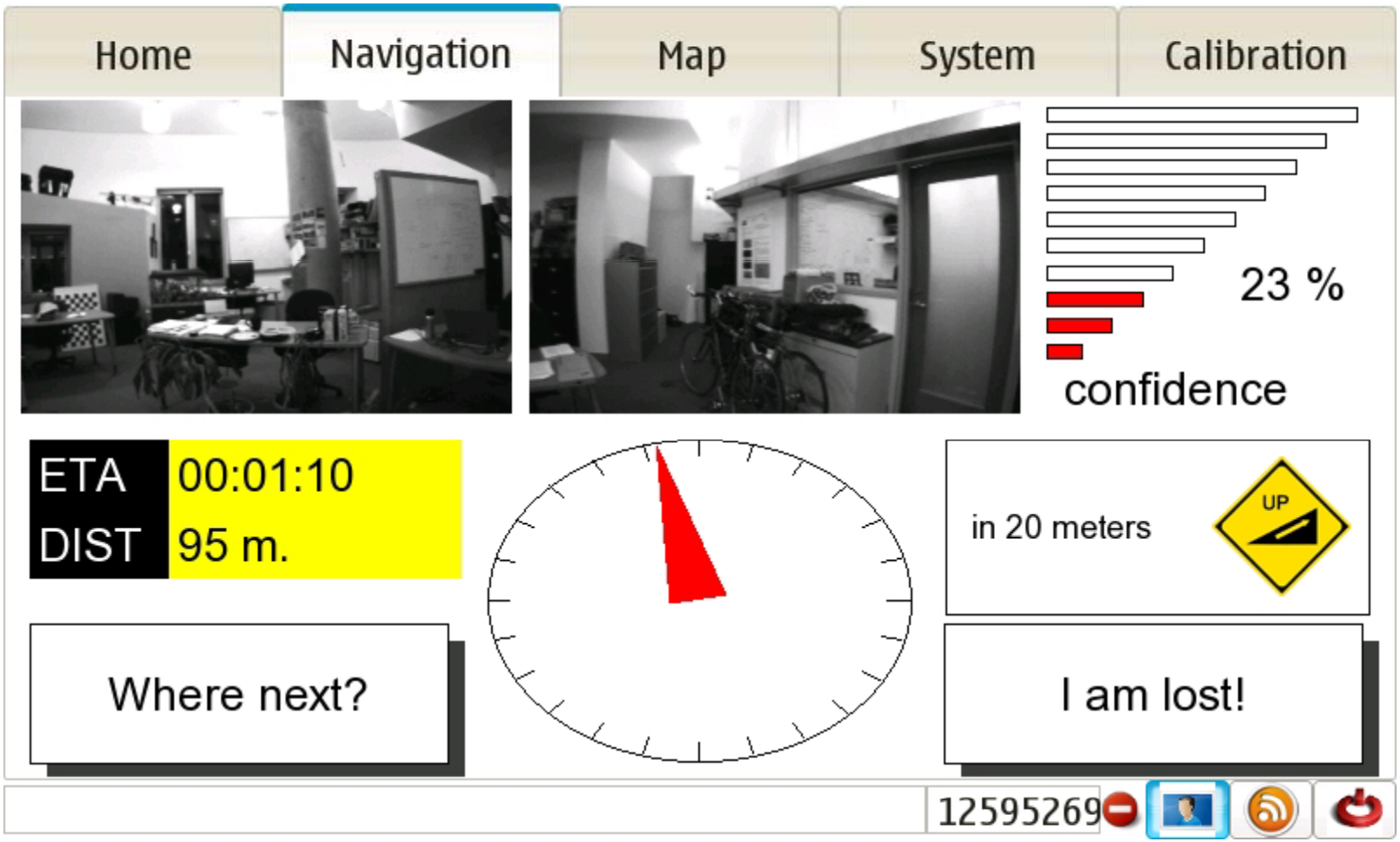
- Presented my research
- Strong interest and excitement
- Constant audio feedback disturbing
- Vibrating devices welcome. Belts present style & comfort issues. Bracelets would work well.
- Implementation out of the scope of the thesis but interesting stuff to document
- Related work on navigation systems for the blind

What is Beautiful is Usable!

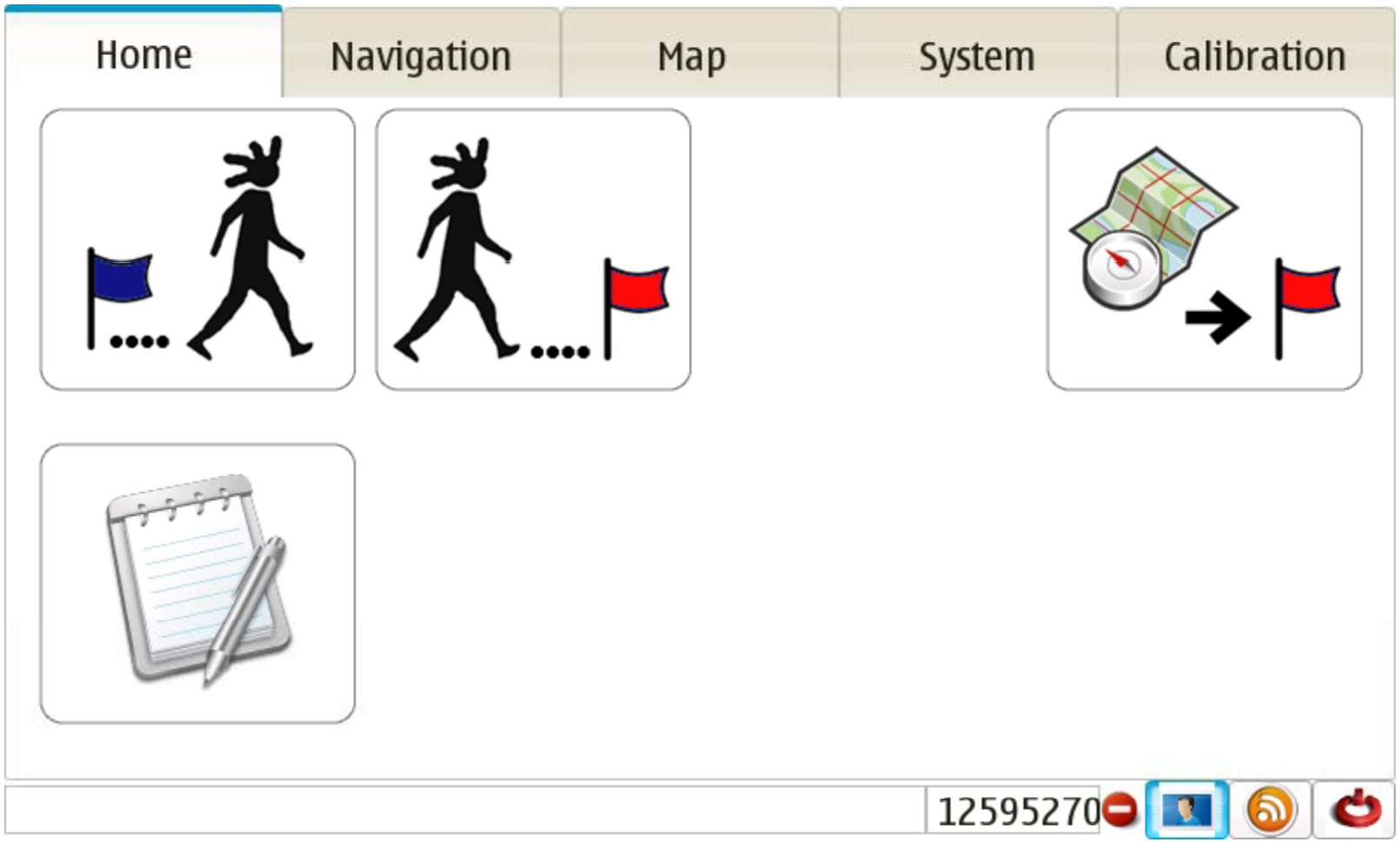


Space Invaders! (CSAIL Talk), by Jeff Norris, Planning Software Systems Group, JPL - 19-Oct-2009

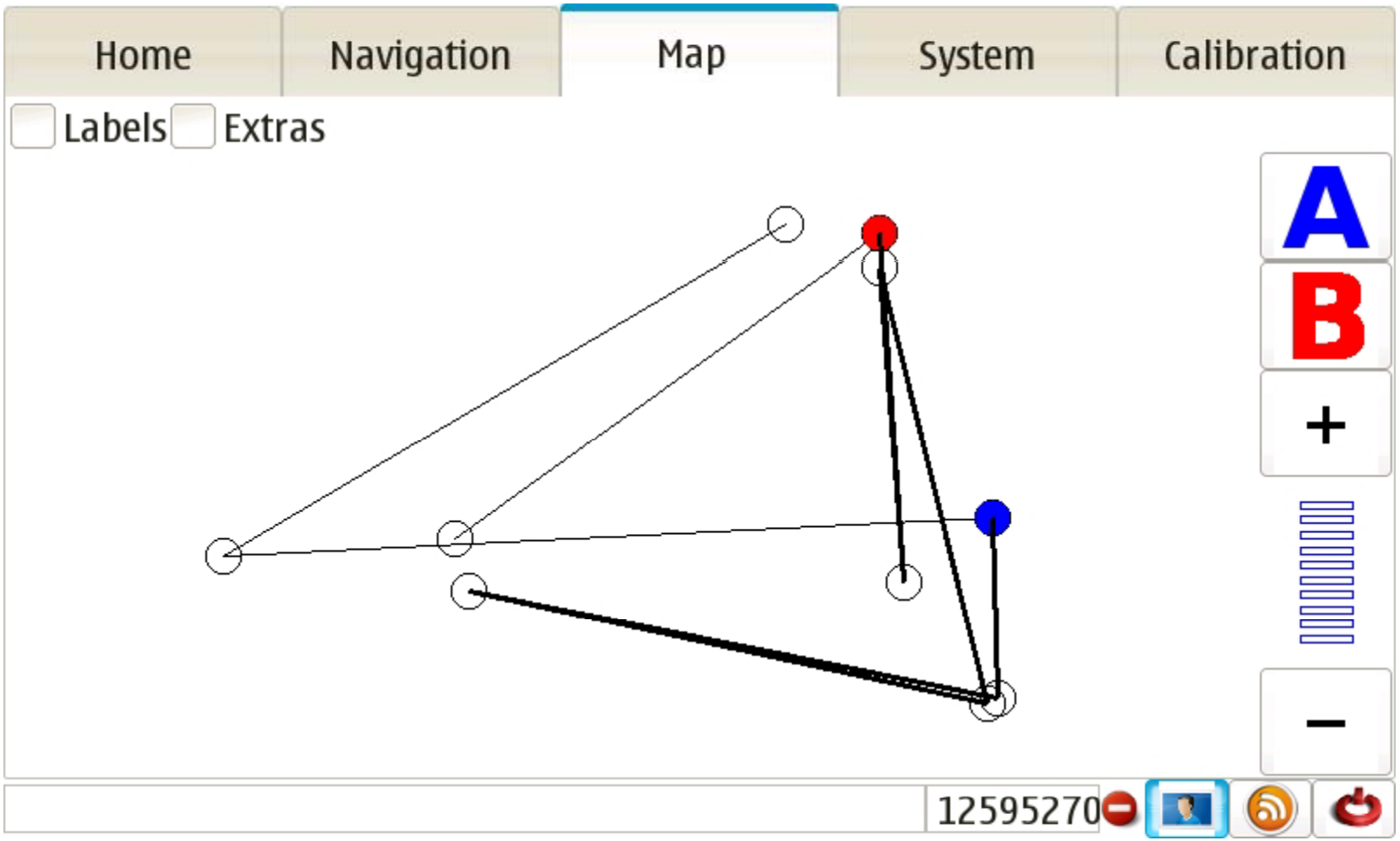
User Interface Developments



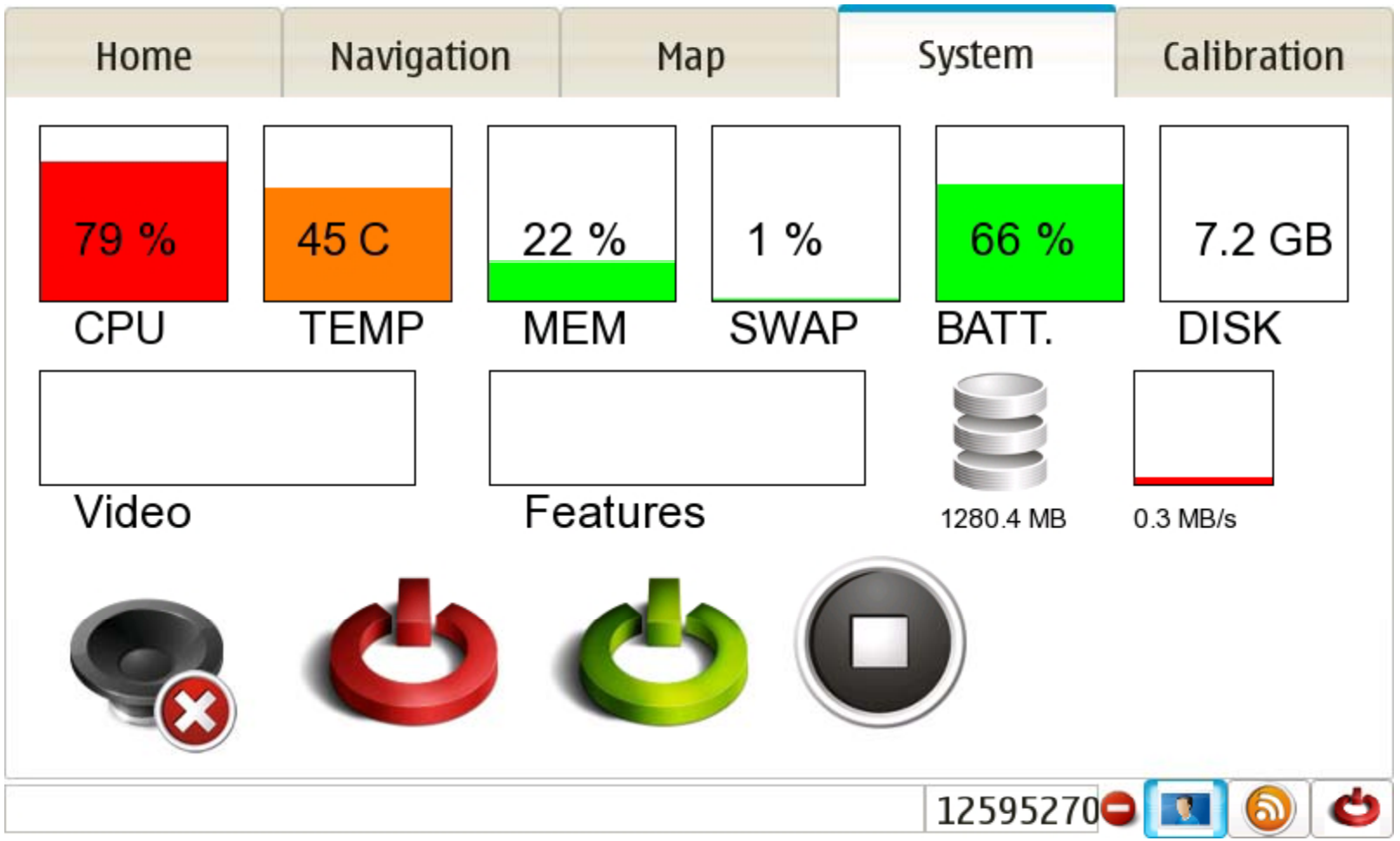
User Interface Developments



User Interface Developments



User Interface Developments



What's next?

- User study with MIT ROTC volunteers
- More method validation

- January 14: thesis draft submission
- January 21: 2pm, thesis defense (D463, Star)
- January 29: EECS thesis submission deadline for Feb list