Biologically Inspired Localization

Seminar: Intelligent Robotics

Marc Bestmann

Universität Hamburg
Fakultät für Mathematik, Informatik und Naturwissenschaften
Fachbereich Informatik

Technische Aspekte Multimodaler Systeme

15. December 2014

Table of Content

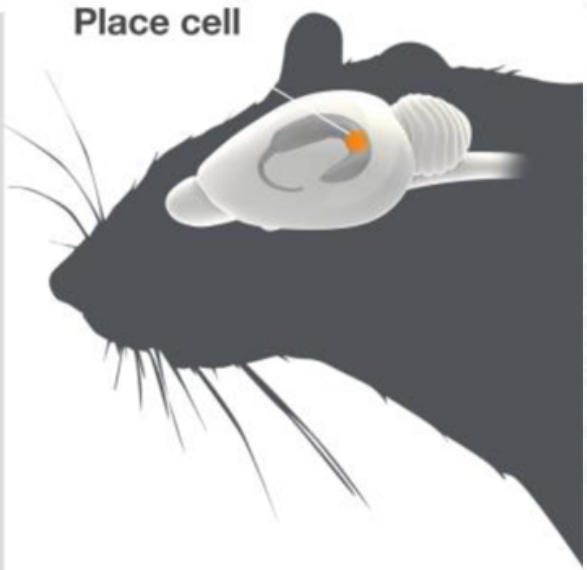
SLAM

- **S**imultaneous **l**ocalization **a**nd **m**apping
- Examples: Particle filter, extendet Kalman filter
- Laser range sensors often used

[2]

Place Cells

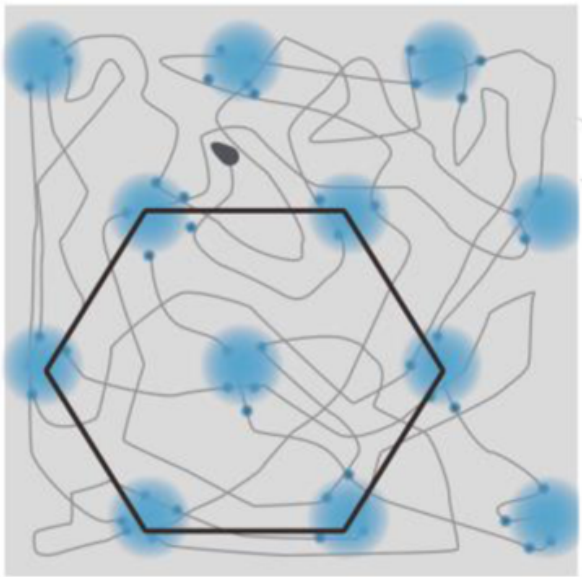
- Discovered by John O'Keef in 1971[10]
- Certain nerve cells get activated at particular places
- Build a map
- Located in the hippocampus

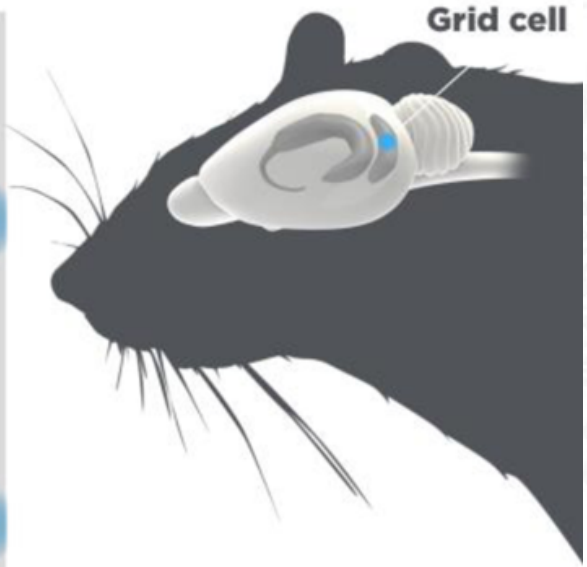


[1]

Grid Cells

- Discovered by May-Britt and Edvard Moser in 2005[7]
- Other similar cells in entorhinal cortex
- Forming a hexagonal grid
- Allowing spacial navigation

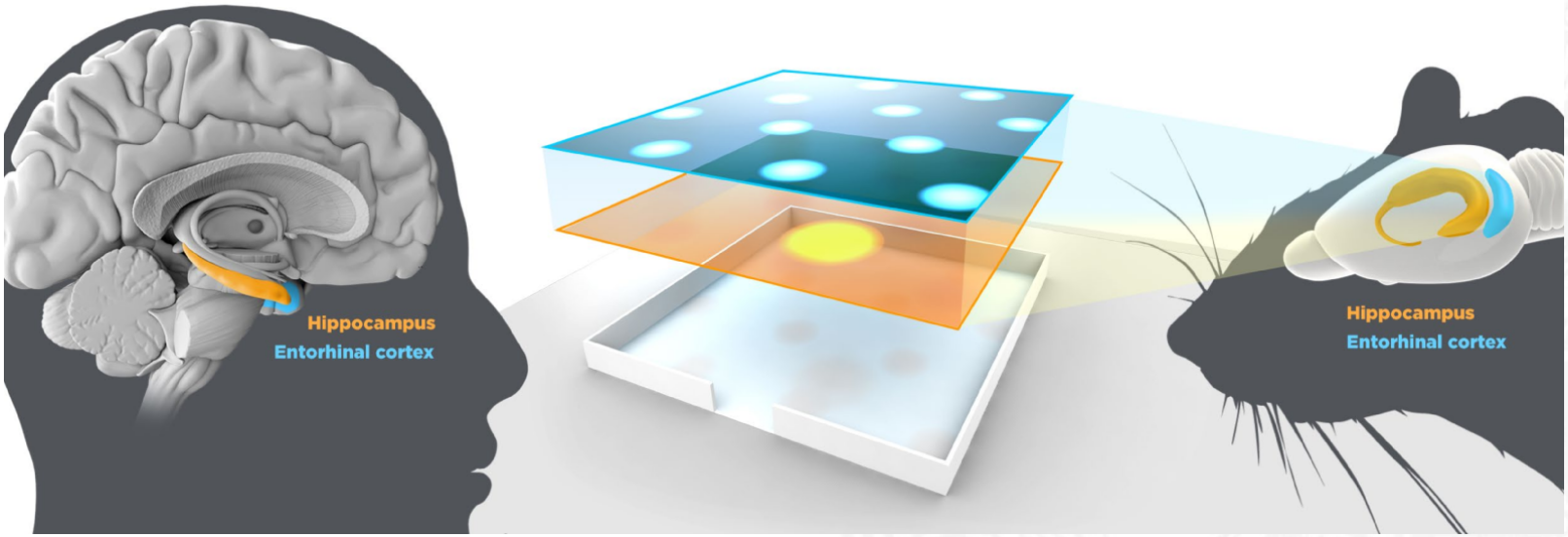




[1]

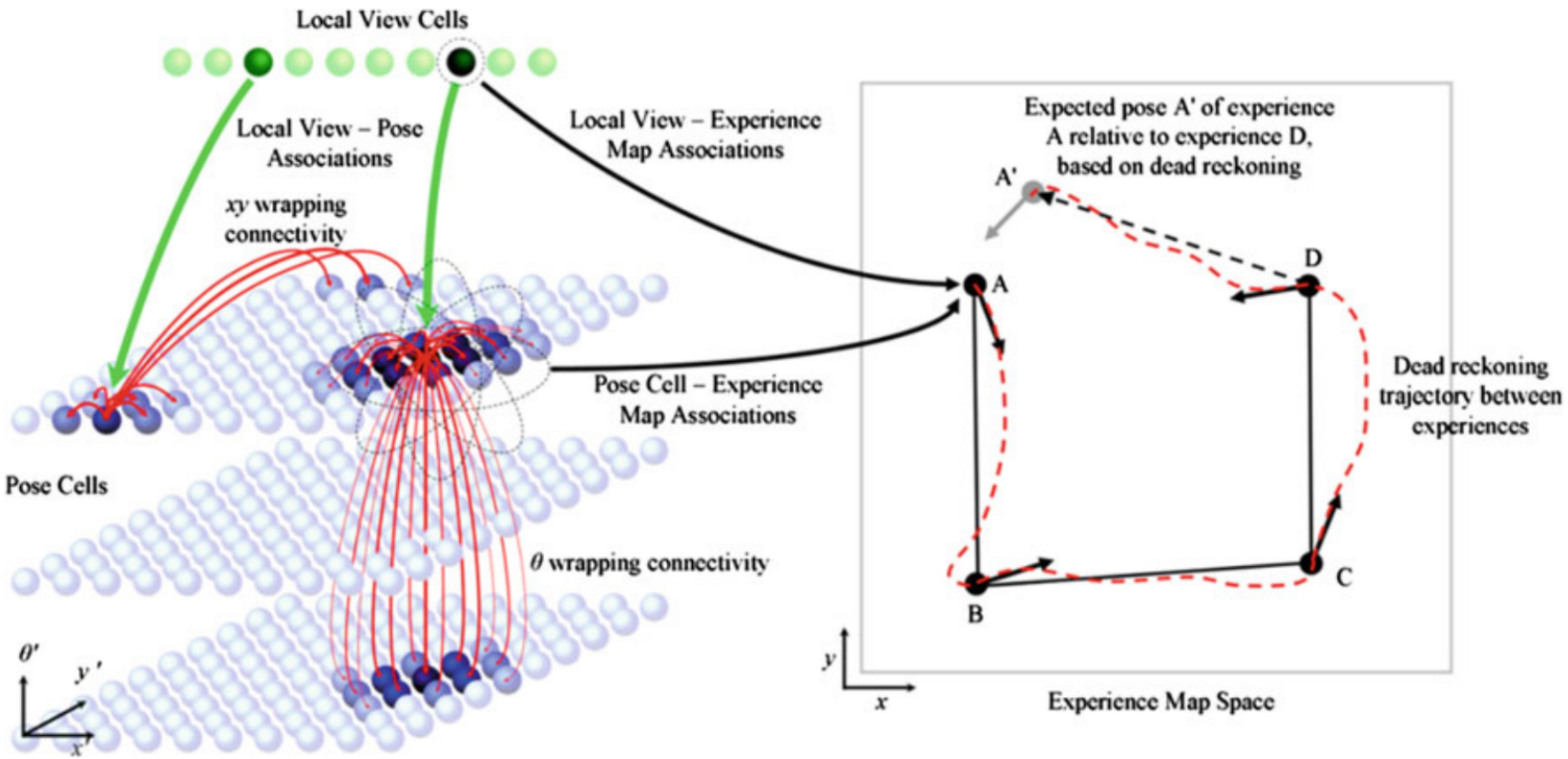
Other Important Cells

- Head direction cells
- Border of the room cells
- Forming together a positioning system[4]
- Human brain appears to have similar components



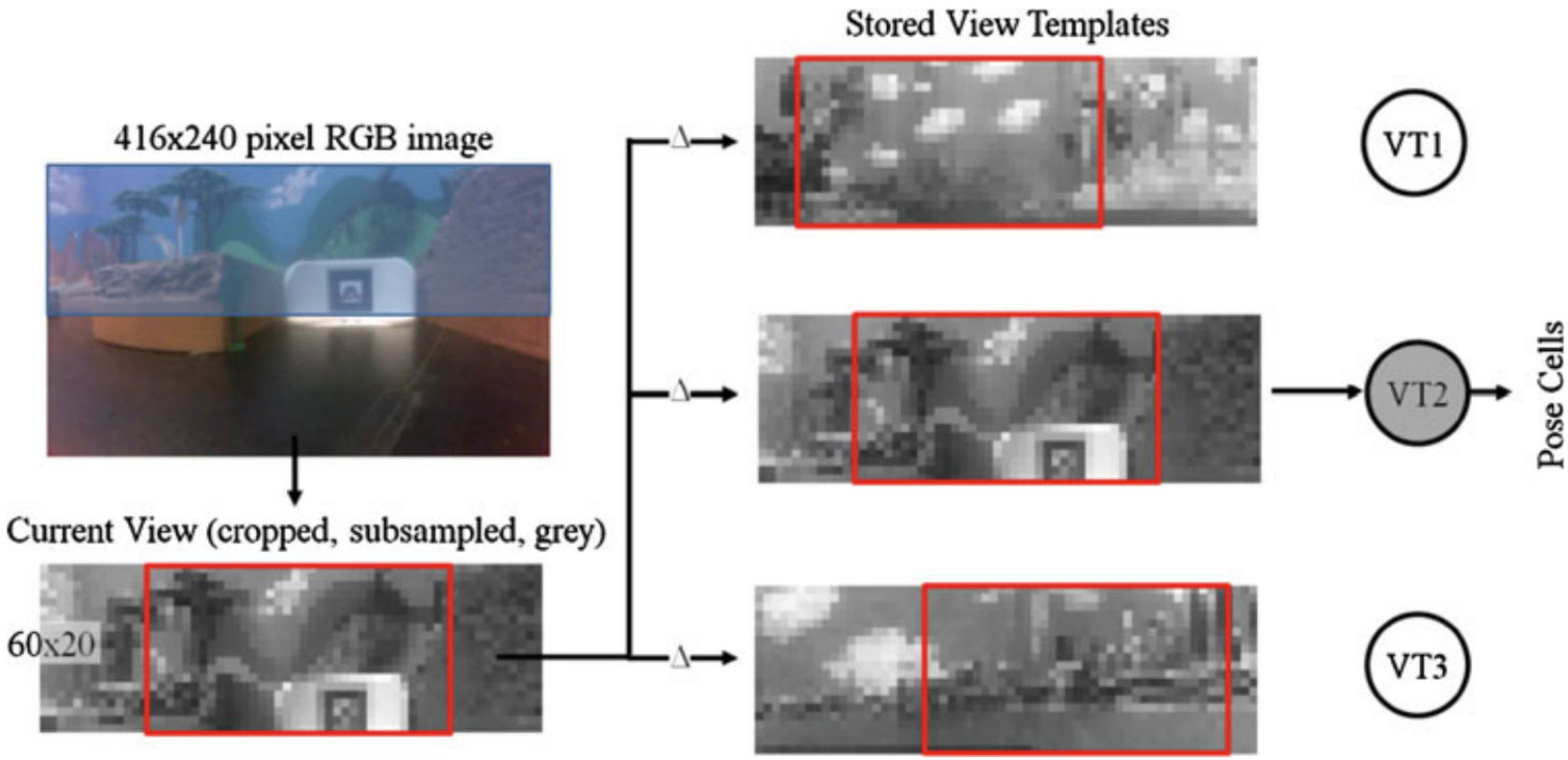
[1]

RatSLAM: Overview



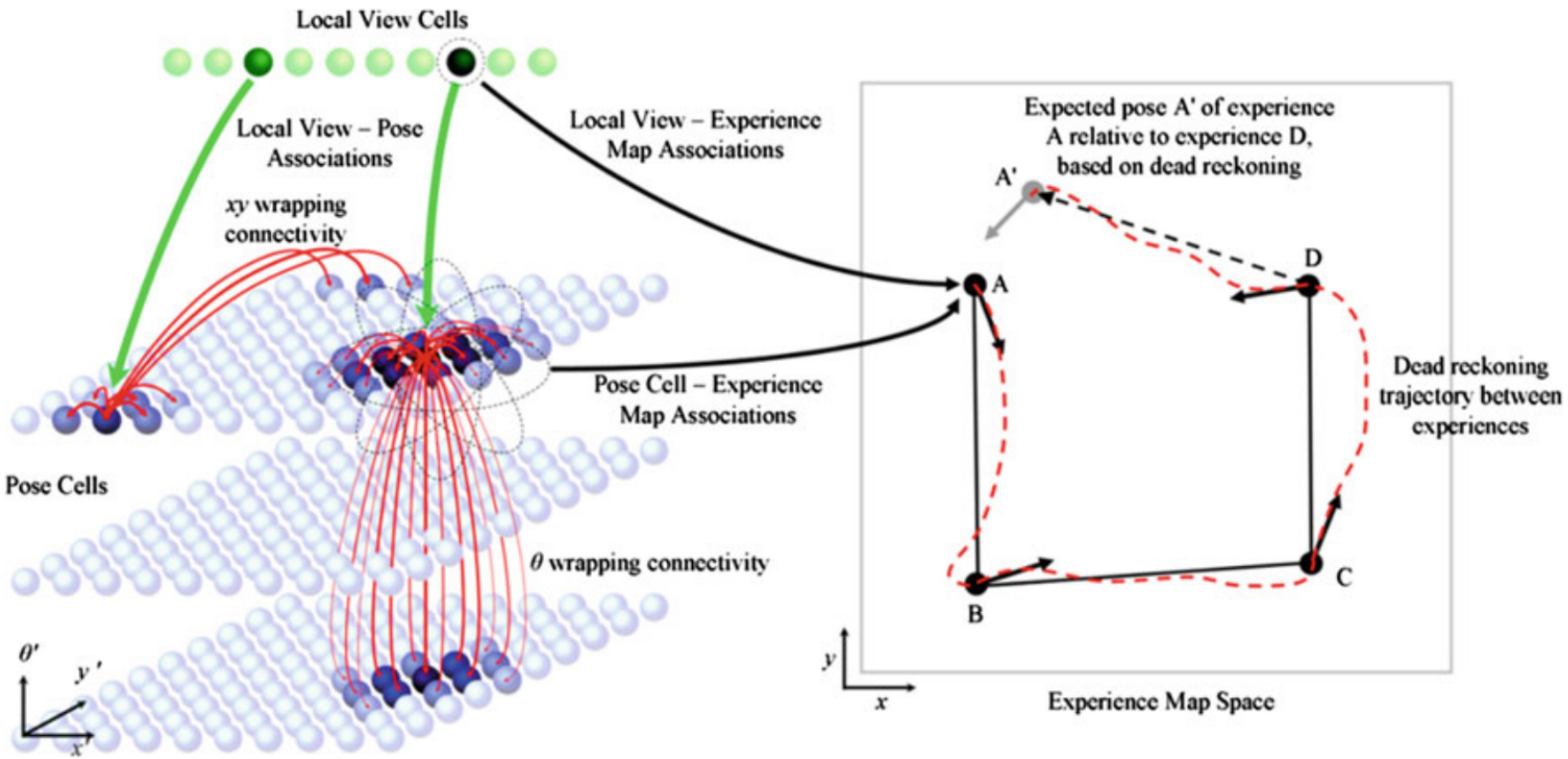
[6]

RatSLAM: Local View Cells



[6]

RatSLAM: Pose Cells

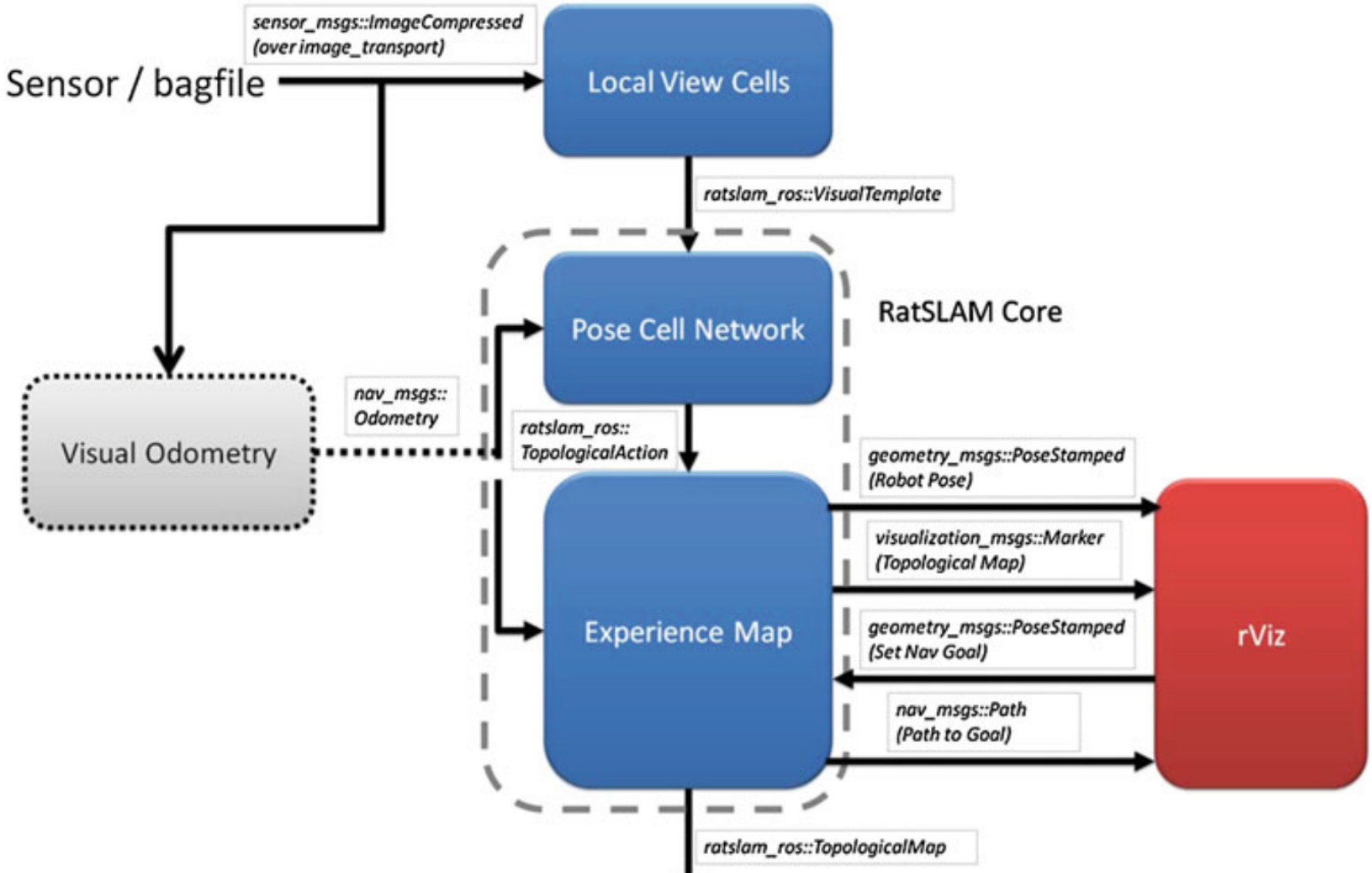


[6]

RatSLAM: Discussion

- Good for wheeled robots, more difficult on humanoids
  - No Head direction
  - Depending on stable images
- Just single camera needed
- On wheeled robots: Odometry from camera good enough
- Low in ressource consumption[9]
- Has to be calibrated for different robots and types of environment[8]

Open RatSLAM



Open RatSLAM Demonstration

Video[3]

Other Similar Algorithms

- CatSLAM[8]
  - Further development of RatSLAM, better loop closure
  - No open source code yet
- Landmark-tree map[5]
  - Storing known positions in a tree
  - Good for long distance navigation
- Biologically-inspired Monte-Carlo localization[11]
  - Extracting vision features like humans
  - Generating the map with the Monte-Carlo algorithm

Conclusion

- Biological Background is not completely clear
- Different Approaches
  - Also in connection with standard algorithms
- Already usable for different scenarios
  - Often just wheeled robots
- Sometimes open source (ROS) code available

Questions

Questions?

References

[1] Cell images.
https://www.sciencenews.org/sites/default/files/images/fig1-2_advanced-medicineprize2014-2.png, 2014.
[Online; accessed 14.12.2014].

[2] Map.
http://www2.informatik.uni-freiburg.de/~stachnis/research/rbpfmapper/gmapper-web/freiburg-campus/fr-campus-20040714.carmen.gfs.png, 2014.
[Online; accessed 14.12.2014].

[3] Video open ratslam.
https://www.youtube.com/watch?v=p8mf0SZKneY, 2014.
[Online; accessed 14.12.2014].

[4] The Nobel Assembly.
The nobel prize in physiology or medicine 2014.
http://www.nobelprize.org/nobel_prizes/medicine/laureates/2014/press.html, 2014.
[Online; accessed 26.11.2014].

[5] Marcus Augustine, Frank Ortmeier, Elmar Mair, Darius Burschka, Annett Stelzer, and Michael Suppa.
Landmark-tree map: a biologically inspired topological map for long-distance robot navigation.
In *Robotics and Biomimetics (ROBIO), 2012 IEEE International Conference on*, pages 128–135. IEEE, 2012.

References (cont.)

[6] David Ball, Scott Heath, Janet Wiles, Gordon Wyeth, Peter Corke, and Michael Milford.
Openratslam: an open source brain-based slam system.
Autonomous Robots, 34(3):149–176, 2013.

[7] Torkel Hafting, Marianne Fyhn, Sturla Molden, May-Britt Moser, and Edvard I Moser.
Microstructure of a spatial map in the entorhinal cortex.
Nature, 436(7052):801–806, 2005.

[8] Will Maddern, Michael Milford, and Gordon Wyeth.
Cat-slam: probabilistic localisation and mapping using a continuous appearance-based trajectory.
The International Journal of Robotics Research, 31(4):429–451, 2012.

[9] M. Milford, Gordon Wyeth, and D. Prasser.
Ratslam on the edge: Revealing a coherent representation from an overloaded rat brain.
In *Intelligent Robots and Systems, 2006 IEEE/RSJ International Conference on*, pages 4060–4065, Oct 2006.

[10] J. O'Keefe and J. Dostrovsky.
The hippocampus as a spatial map. preliminary evidence from unit activity in the freely-moving rat.
Brain Research, 34(1):171 – 175, 1971.

[11] Christian Siagian and Laurent Itti.
Biologically-inspired robotics vision monte-carlo localization in the outdoor environment.
In *Intelligent Robots and Systems, 2007. IROS 2007. IEEE/RSJ International Conference on*, pages 1723–1730. IEEE, 2007.