Autonomous Construction by a Mobile Robot in Unknown Environments with Scarce Resources

Stéphane Magnenat, Patrick Schoeneich, Frédéric Rochat, Philippe Rétornaz, Michael Bonani, Daniel Burnier, Pierre Noirat, Tarek Baaboura, Florian Vaussard, Francesco Mondada

LSRO
http://mobots.epfl.ch

Context

Autonomous construction by mobile robots would be useful in various situations, such as in outer space, in hazardous environments, but also for the building industry.
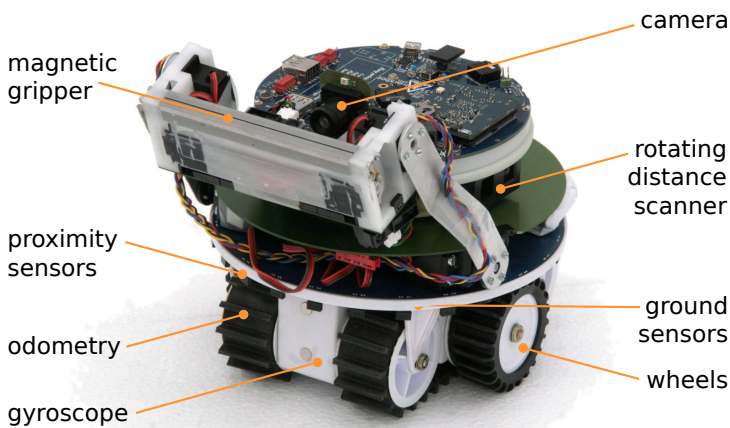
Related work

Cartoon by Emmanuel Eckard

- flat environments
- readily available resources
- simples structures
- single structure type

Applications demand

Cartoon by Emmanuel Eckard
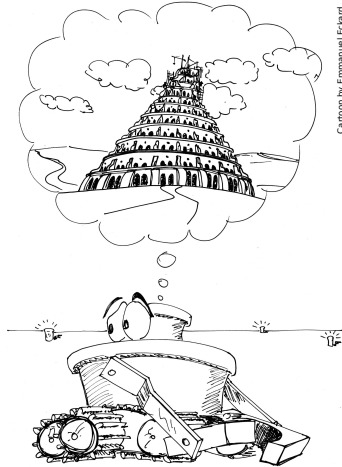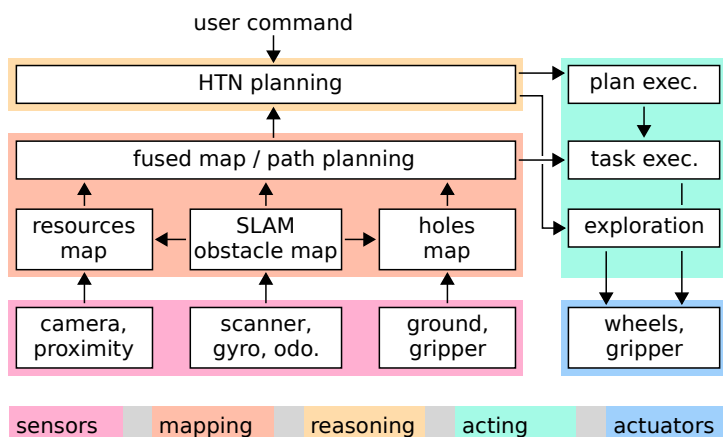
- complex, 3D environments
- remote resources
- multi-layers structures
- various structures types

Hardware

- magnetic gripper
- camera
- rotating distance scanner
- proximity sensors
- odometry
- gyroscope
- ground sensors
- wheels

Software architecture

- user command
- HTN planning
- plan exec.
- fused map / path planning
- task exec.
- resources map
- SLAM obstacle map
- holes map
- exploration
- camera, proximity
- scanner, gyro, odo.
- ground, gripper
- wheels, gripper

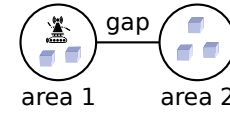| sensors	mapping	reasoning	acting	actuators

Symbol grounding

- probabilistic maps
- morphological operations
- fusion using by-pixel op.
- map regions labelization

Execution

- plan using symbols only
- ref. to geometrical data
- state machine for actions
- low-level through ASEBA

Target experiment

Initial situation:

gap

area 1   area 2
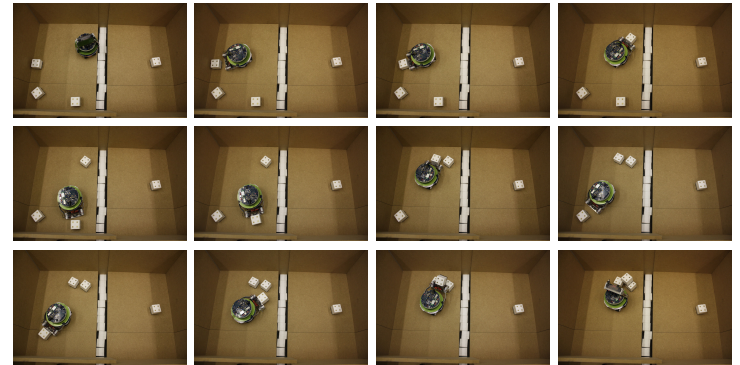
Goal:
- build a structure in area 1
- not enough res. at area 1
- must harvest from area 2
- must fill the gap first

current status: no camera, no sensing of remote resources

Preliminary result: gap passing

Preliminary result: structure building

Conclusion

We achieved autonomous construction, with reliability:
- gap passing: ~80%
- structure building: ~50%
Imperfect score due to imprecisions in positionning

Outlook

- cam. for remote resources
- quantitative results
- continual planning
- multiple robots
- complex structures
- raw building blocks

Contact and probe further

Stéphane Magnenat <stephane at magnenat dot net>

Affordable SLAM through the Co-Design of Hardware, Software, and Methodology. Stéphane Magnenat, Valentin Longchamp, Michael Bonani, Philippe Rétornaz, Paolo Germano, and Francesco Mondada. Accepted in ICRA 2010.

Planner9, a HTN planner distributed on groups of miniature mobile robots. Stéphane Magnenat, Martin Voelkle, Francesco Mondada. In *Proceedings of the Second International Conference on Intelligent Robotics and Applications (ICIRA)*, 2009.

ASEBA, an event-based middleware for distributed robot control. Stéphane Magnenat, Valentin Longchamp, Francesco Mondada. In *Workshops DVD of International Conference on Intelligent Robots and Systems (IROS)*, 2007.