Consensus for Environment Characterization on Heterogeneous Robot Groups.

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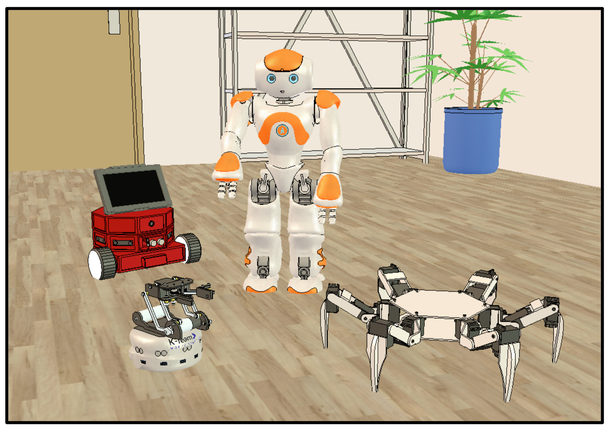
Introduction

Every day robot capabilities are increasing while hardware costs are reduced. Due of this evolution each robot can be set with different sensors from a wide range of available options in terms of physical magnitude measurement and data quality. This scenario opens the opportunity to robot cooperation in heterogeneous groups, where sensing deficiencies of a robot can be supplied through a sensor fusion process between partners using a common and standard representation of the environment. This results in an augmented representation of the perceived world, richer than what every robot can build by it self, allowing also complex behaviours.

Objectives

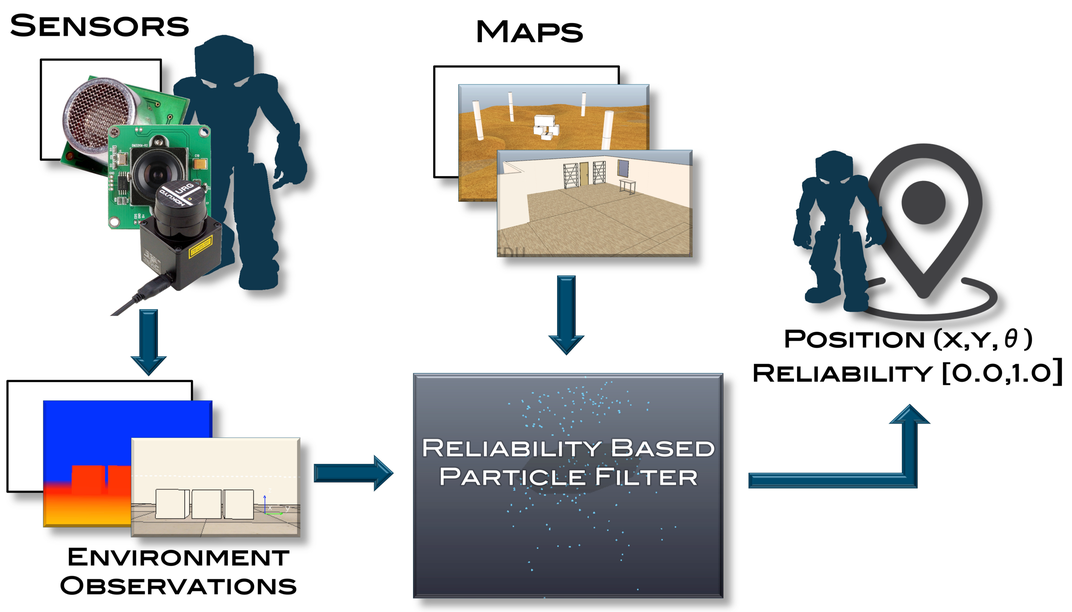
- Robots with different sensors must be able to localize itself in a formally defined environment, and generate a standard representation of its surrounding.
- By consensus between partners, individual perceptions are used to set an augmented representation of the common environment.
- Common representation must be used by the “mission system” for executing tasks related with environment interaction.
- Developments are based in the ”Control Kernel Middleware” [1] architecture.



Heterogeneous group of robots performing a mission task.

Environment Localization

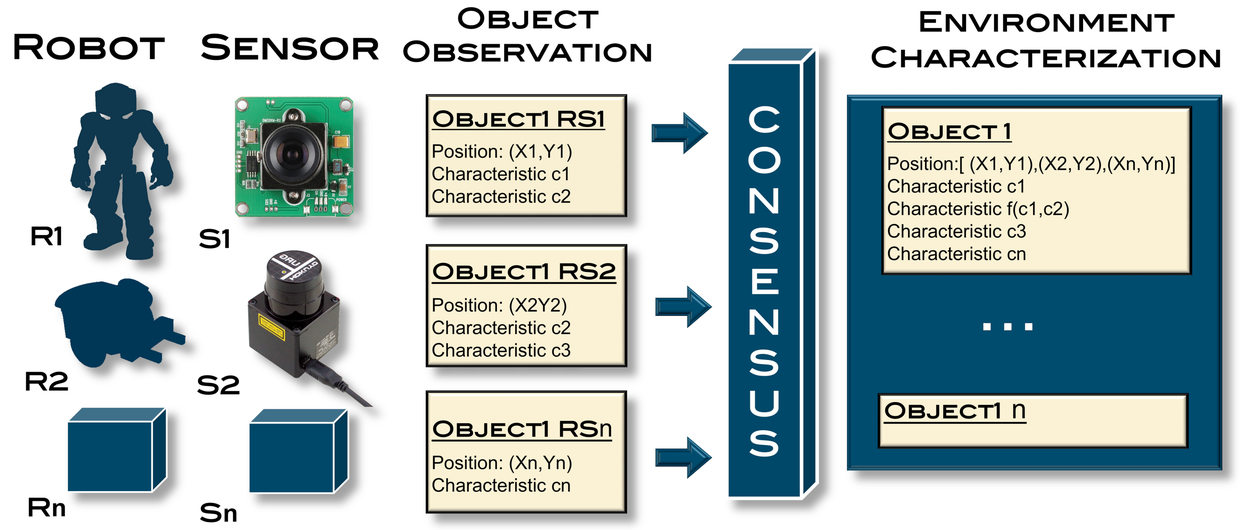
- **Localization:** Robot current position and local surrounding are computed using the “Reliability-based Particle Filter” [2], which offers an estimation associated to a reliability factor.
- **Standard map management**: A formal definition of environment and object allows to generalize localization for any map loaded.
- **Multi-sensor management**: Objects recognition can be performed with different arrangement of sensors.



Multi-sensor management and standard map loading system are integrated along with the “Reliabilty-Based Particle Filter” obtaining a flexible system.

Heterogeneous Robot Consensus

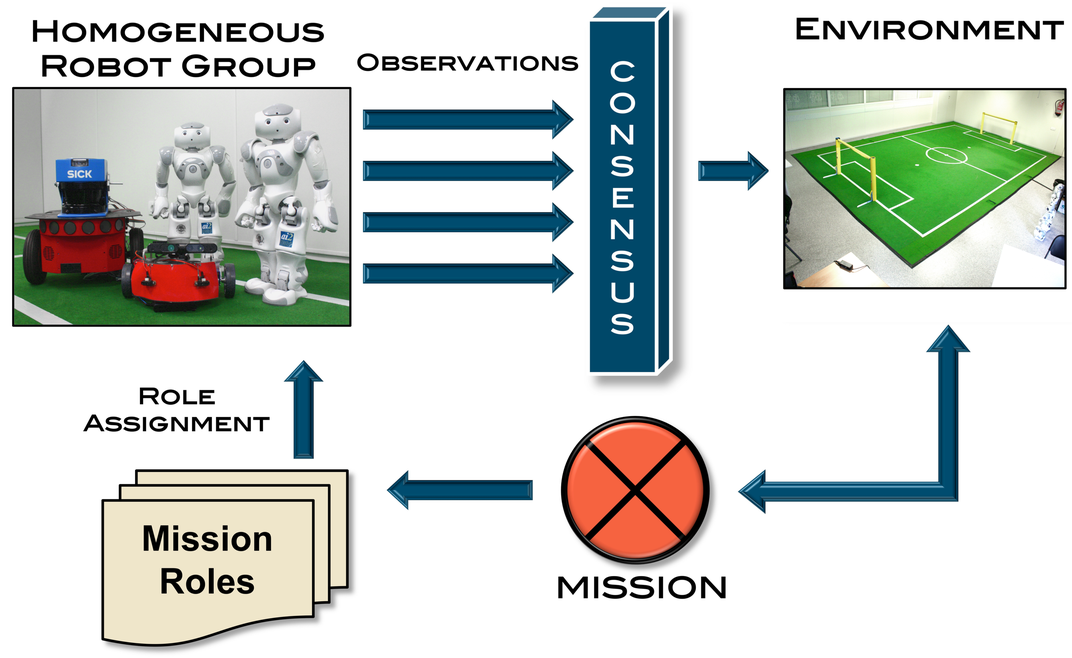
Distributed consensus between robots generates a common representation of the environment, in which each robot provides its perceived characteristics of its surrounding objects.



Different robots with different sensors establish a consensus for characterizing the common environment

Environment Interaction

Mission-based system can take the advantages of this system in order to interact with the environment [3].



Common environment observation can be used for determining the mission state and perform role assignment.

Conclusions

- Formalization of map and sensor management increases the flexibility of the system.
- Through consensus each robot improves the group common representation of the environment.
- Enables the execution of “missions-based tasks” which have an unavoidable requirement of environmental information.

References

[1]P Albertos, A Crespo, and J. Simó. Control kernel: A key concept in embedded control systems. In 4th IFAC Symposium on Mechatronic Systems, 2006.

[2] E. Munera, M. Muñoz, J.F. Blanes,G. Benet , and J.E. Simó. A reliability-based particle filter forhumanoid robot self-localization in RoboCup Standard Platform League. Sensors (Basel, Switzerland), 13(11):14954–83, January 2013.

[3]M. Muñoz, E. Munera, J.F. Blanes, and J.E. Simó. A hierarchical hybrid architecture for mission-oriented robot control. Advances in Intelligent Systems and Computing, vol. 252, pages 363–380. Springer, 2014.