Open Position for a PhD Student

Languages and Development Environments for Mobile Autonomous Robots

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1 Context

This position aims at contributing to the u-Robot project which goal is to propose a running solution to the problem of using robots in a shopping mall. Such robots are said to be *mobile* since they are able to move in their environment. They are also qualified as *autonomous* since their behavior and actions are computed solely by the software they embed. No human intervention is required. One of the challenges of this project is the dynamicity of the environment. While the shopping mall map is precisely known, the behavior of clients inside the building and more specifically their movements are totally unpredictable. Robots have then to adapt their behavior and more specifically their path planning in order to take into account this dynamicity while performing their missions.

There exist different architectures for robots' control software. Deliberative architectures such as PRS (Procedural Reasonning System) [GF89] as part of the BDI (Belief-Desire-Intention) [RG95] architectural family are best suited for performing complex tasks. Such an architecture enables robots to build and pursue plans that describe complex sequences of actions. However, such an approach is criticized for the processing delays that are too long compared to what is required to preserve the security of the robot, and more importantly the security of humans that may be in its neighborhood.

Robotic reactive software architectures such as the subsumption architecture [Bro85] or Manta [DCL95] are inspired by primitive animals such as ants. In this context, the robot's behavior results from the combination of a set of simple rules. Such rules are triggered directly in response to stimuli perceived from the environment (e.g. distance to an obstacle). Thus, robots are able to react quickly and perfectly face a dynamic environment. However, complex missions are difficult to express in such an architecture.

Hybrid architectures such as the one of the LAAS [ACF+98] combines the best of the two previous ones. It has a deliberative layer that manages mission's high-level goals. It also includes a reactive layer that ensures fast response to preserve the physical integrity of the robots and their surrounding.

2 Problem to Address

Developing hybrid architectures is a challenge. Indeed, every facet/layer of the architecture (deliberative or reactive) has its own specificities requiring different language constructs. The

use of different languages raises the interoperability issue between both languages and their respective IDEs.

The PhD student will have to study abstractions and specific mechanisms offered by programming languages used for developing robotic control software such as URBI [Bai08] ou NxTalk [BHH09]. The study should also cover development tools (e.g. debuggers to remotely analyze code deployed on a robot). The expected outcome is a proposal of a set of symbiotic programming languages (probably DSLs, *Domain Specific Languages*) that ease the development of complex robotic software.

The symbiosis between these programming languages should be studied both at the runtime level, as well as the programming environment level (e.g. inspectors, browsers, version managements).

3 Salary and Administrative Information

The PhD student will receive as a salary approx. 1500 Euros per month. He/She have to move to France in order to physically work with the team.

References

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[BHH09] Martin Beck, Michael Haupt, and Robert Hirschfeld. Nxtalk: Dynamic object-oriented programming in a constrained environment. In *Proceedings of the International Workshop on Smalltalk Technologies (IWST)*, Brest, France, August 2009. ESUG, ACM DL.

[Bro85] R. Brooks. A robust layered control system for a mobile robot. Technical report, 1985.

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[RG95] Anand S. Rao and Michael P. Georgeff. Bdi agents: From theory to practice. In *Proceedings of the first International Conference on Multi-Agent Systems (ICMAS)*, pages 312–319, 1995.