Software engineering and control theory for adaptive resources management

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Keywords

formal methods, component-based systems, dynamic adaptation, control theory

Context: Dynamic adaptation of component-based systems

Complex systems that integrate a software part need adaptation mechanisms to manage limited resources in their execution environment. If these systems are structured in modules/components, this organization allows for a coordinated dynamic adaptation based on components. Control theory provides solutions for resource management, and in particular hierarchical control is concerned with complex structured systems.

The research in our team contributes to the implementation of component systems by developing a formal framework to model, validate and coordinate their dynamic behaviors. The scientific challenges consist in particular in the ability to model the dynamic evolution of this type of complex systems – adaptation of their functionalities – by taking into account constraints on resources, as well as events in their runtime environment. We explore in particular the adapative management of modular robots regarding their available energy. Modular robots are composed of entities that are able to compute and communicate with their neighbors by using sensors and actuators Blinky Blocks). We consider modular robots, seen as component-based systems, structured using motifs and hierarchy (e.g., three lines in a flag). Each hierarchy level can be associated with physical parameters (e.g., for light or sound intensity), and the energy consumption depends on the values of the parameters, which are set dynamically.

Expected work

The project studies component-based approaches to adapt modular robots functionalities depending on the available energy to ensure their operation, possibly in a degraded mode, using hierarchical control theory.

In this context, the student is expected to study the use of hierarchical control from component-based systems structured in motifs. More precisely, we are interested in studying the conditions for the stability of hierarchical control in such setup.

As a first step in the study of general stability, we will consirder the example of modular robots, organized to form a image such as a flag with hierarchical structure.

Benefits

You will get an in-depth understanding of the principles of automatic control, a theory dedicated to the analysis and regulation of dynamical systems with stability and optimality guarantees. A successful project can lead to a research publication.

Required skills

Good analytical skills will definitely be required. The candidate must have good understanding of maths and analytics.

Location

The internship will be carried out in the Spirals project team at Inria Center at the University of Lille under supervision by Sophie Cerf, Simon Bliudze, and Olga Kouchnarenko (FEMTO-ST institute).

Contact and application

For additional information and to apply please send an e-mail to Sophie Cerf, Simon Bliudze and Olga Kouchnarenko (in English or French) with the subject "Modular robots project".

References

1. Filieri, A., Maggio, M., Angelopoulos, K., d'Ippolito, N., Gerostathopoulos, I., Hempel, A. B., ... & Vogel, T. (2015, May). Software engineering meets control theory. In 2015 IEEE/ACM 10th International Symposium on Software Engineering for Adaptive and Self-Managing Systems (pp. 71-82). IEEE. [PDF]
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