

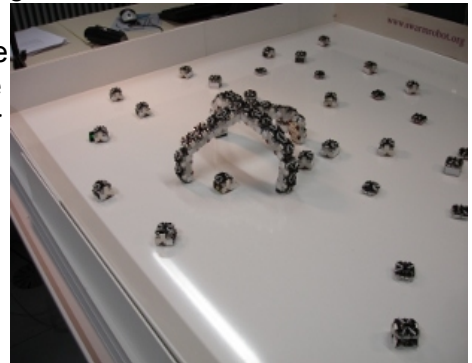
## Internship - A theater in the mind of a robot organism

Almende B.V.

### Introduction

Situated in Rotterdam, Almende B.V. (2000) is a research company, which performs research in a diverse range of disciplines, building on principles of *self-organization*. This ranges from networks of people, represented by software agents, enabling self-organization on a communication level; to networks of entities, on-the-fly planning within logistics acknowledging the fact of a dynamic environment, incidents, and hence, the infeasibility of static planning; to networks of sensor nodes - enabling anonymous (compared to cameras) monitoring of expected or suspected movement patterns in a health-care institute or airport; to networks of robot modules, the subject of this internship. Daughter companies of Almende apply the research in commercial products.

Almende participates in the European FP7 project, Replicator. Within this project a so-called *Replicator organism* is created. Such an organism contains a multitude of concatenated cube-sized 9x9x9 cm robots. Those cube-sized robots, or cells, allow the organism to take different forms and append the organism with sensory and motor capabilities. The control architecture needed for such a Replicator - which is able to morph, adjusting to its environment: take the form of a snake to go through a hole in the wall, reform to a spider to climb over obstacles - has an enormous amount of degrees of freedom, is very adaptive to its environment, needs to combine sensory information from many and heterogeneous sensors, has to express this information in a useful format for assembly, locomotion and self-reconfiguration and has to compress and distribute its capabilities on a limited, embedded distributed robotic platform. One of the roles of Almende within this project is so-called *morphodynamic control*. The control of the metamorphosis process. Within Replicator other partners develop robot hardware and electronics such as the Universität Stuttgart, Universität Graz, Universität Karlsruhe and Scuola Superiore Sant'Anna. Sensors are built by the Sheffield Hallam University, Fraunhofer Gesellschaft, Institut Mikroelektronických Aplikací, Ubisense and Ceske Vysoke Ucení Technické v Praze.



Within the Replicator project Almende implements morphodynamic control as one of the multiple controllers in a robot organism. The well-known *subsumption architecture* does have modern cognitively inspired variants in the form of *global workspace theory* ("scholar google" on Brooks, Baars, Shanahan and Franklin). So, this is not an old-fashioned *Cartesian theater of mind*! This "agent"-based approach is not very different from a modular approach like the one proposed by Edelman (taken into the realm of *neural darwinism*), or Kozma (with Kachalsky sets). See also Maniadakis and Trahanias with "Design and Integration of Partial Brain Models Using Hierarchical Cooperative CoEvolution". In this case the supposed model consists out a collection of *neural agents*, each one representing a brain area. To incorporate *evolution* might be crucial to create architectures with hundreds of modules (Popescu-Belis). All this research tries to address this: to come up with the *dynamic successor of the subsumption architecture*.

In the Replicator project the robots driven by this dynamic architecture are simulated in the Delta3D game engine and hooked up by ethernet to boards with a Blackfin dual core processor running C/C++ programs in a lightweight Linux version.

## Function description

The internship will exist out of developing a scenario for *bio-inspired dynamic control*. This might range from a scenario in which *docking* controllers negotiate with *collision avoidance* controllers, to an extensive global workspace that fits modular robots as well as sensor network nodes, in which trade-offs between *energy-aware*, *functional* and *perceptual* units are played out. This internship will focus on *controller (and action) selection*. It builds on top of already developed software for visual, acoustic and other types of perceptual processing, so this does not need to be implemented from scratch. The scenarios will be implemented in the Delta3D HIL (Hardware-In-the-Loop) simulator.

## Function requirements

A student in the master Artificial Intelligence, Knowledge Engineering, Robotics, Neuroscience, Cognitive Psychology, Synthetic Biology, Electrical Engineering, with deep interest for bio-inspired artificial intelligence. This is a vast and multidisciplinary topic, hence, *affinity* with topics like embodiment, robotics, is considered very important, because in-depth knowledge about all following "pros" will take a lifetime, and cannot be a prerequisite. The company has international employees and lots of international partners, hence, fluent English is essential. It is *not* required to speak Dutch.

*Pros*: knowledge about:

- Artificial neural networks;
- Thalamus, cortex;
- Cognitive psychology;
- Programming on embedded devices, C/C++.

For further information, see <http://replicator.almende.com> and <http://www.replicators.eu>.

## Contact:

MSc./Ir A.C. van Rossum

Researcher

Almende B.V.

Westerstraat 50

3016 DJ Rotterdam

The Netherlands

Email: [anne@almende.com](mailto:anne@almende.com)

Phone: +31 (0)10 85 119 25

Website: <http://www.almende.com/>