



# Internship – Adaptivity and Learning in Wireless Sensor Networks

Almende B.V.

## Introduction

In recent years, the field of Wireless Sensor Networks (WSNs) has become a hot and exciting new field of research. Wireless Sensor Networks consist of many small computational units, called nodes, that possess limited facilities for computation, data storage and radio communication with other nodes. Furthermore, nodes are equipped with one or more sensors, possibly of different modalities, through which they sense their environment. These nodes cooperate to perform tasks, which can range from monitoring the activities of elderly and disabled people to monitoring the structural health of buildings, and from detecting forest fires to actively controlling an environment according to the wishes and needs of a user.

Two such applications are defined as use cases in projects that Almende is involved in. In the ALwEN project WSNs will be used to monitor the activities of COPD patients; in particular, the activities of daily life the patients engage in. Using this information, patients can be advised to for instance be more active or to take it easy. In the STORM project the objective is to use WSNs in greenhouses to both monitor and influence variables such as air humidity and temperature. Because greenhouses can be quite large, variables may differ per area, and thus local monitoring and actuating is required. In both these projects, the MyriaNed WSN platform is used.

MyriaNed is developed by DevLab, a cooperation between a number of small-medium sized Dutch companies, of which Almende is a member.



Almende's objective in these use cases is to develop an adaptive framework that allows a WSN to *learn* to perform the tasks described above, thereby abandoning the traditional approach of using the WSN to gather a lot of data which is processed by a central, rule-based reasoning system. In the COPD use case, the objective is to have nodes automatically find *correlations* and *repeating patterns* in sensor data streams. These data streams may be from different nodes and different modalities, and patterns may occur on different time scales. Patterns that may constitute an activity of daily life can then be presented to a user for *feedback*. This way, a WSN will be able to adapt itself to an environment, and will learn to recognize those activities that are of interest to a user. In the greenhouses case, the challenge is to let the WSN learn what the effects are of using actuators. A WSN should evaluate the effects of turning on a heater, so that it may operate its actuators ever more efficiently in the future.

## Function description

The internship will include searching for ways to include multi-modal distributed pattern recognition and sensor-actuator loops in the framework that is currently being developed by Almende. This framework allows for creating functionalities by stringing together a number of *components*, each implementing a very basic function, to operate on data streams. Following steps include implementing the results, and testing them both in simulation, and in a real WSN. Initially a WSN deployed at Almende can be used to solve some toy problems such as day-night detection or

detecting the presence of humans. Finally, the implemented mechanisms can be tested in the scenarios described above, in an house outfitted with sensors to monitor a COPD patient or in an actual greenhouse.

### **Function requirements**

We are looking for a creative and enthusiastic master student in Artificial Intelligence, Knowledge Engineering, Electrical Engineering, or Informatics with a deep interest for artificial intelligence. Keywords are machine learning, distributed, sensor fusion, auto-association. The MyrisNed hardware is available at Almende, and you will be supported where necessary when programming the hardware or using the simulator. You will be provided several ideas on how and where to start your research, but also have ample opportunity to your research in a direction of your choice. The company has international employees and lots of international partners, hence, fluent English is of more importance than being able to speak Dutch.

*Pros:* knowledge about:

- Machine learning;
- Artificial Neural Networks
- Signal Processing;
- Programming on embedded devices, C/C++.

For more information on Almende's activities in the field of Wireless Sensor Networks, see <http://sense.almende.com>.

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### **About Almende**

Almende is an ICT research company in Rotterdam that mainly focuses on research and technological development in the areas of self organization and multi-agent systems. The main research domains of Almende are: complex adaptive systems, artificial learning, multi-agent systems and architectures, and (social) network theory. Almende works together with universities, knowledge institutes and application partners to further develop and apply the multi-agent systems to enable cooperation, coordination and learning in complex business networks.