Minor Adaptive Robotics: Minor regulations 2023-2024

1. Name minor: Adaptive Robotics (AR)

2. English name: Adaptive Robotics (AR)

3. Content of the minor

The minor Adaptive Robotics (AR) is an innovative minor both in terms of teaching form and the related examination method. The minor is talent-based and there is considerable focus on talent development among the individual students. The minor will be taught in English.

The minor consists of an intensive kick-off phase (2 weeks) followed by an orientation phase (5 weeks). During these phases, the students will be given assignments (individually and in groups) and will receive teaching in the following modules:
- *Principles of Robotics*
- *ROS for Engineers (Robot Operating System)*
- *Vision, Sensors & Perception*
- *Norms, Standards & Safety*
- *Hardware Abstraction & Embedded Hardware*

In each of these subject areas, examination will often be based on the work undertaken, including videos, posters, presentations, development of own teaching material, etc. On that basis, students will demonstrate that they have achieved both general learning objectives (given by the program) and self-defined personal learning objectives.

The knowledge acquired will be applied and expanded within a multidisciplinary group project of 12 weeks. During these 12 weeks, students will spend 4 days a week on their project, and 1 day a week on acquiring in-depth knowledge in classes and workshops. Within specified frameworks, the students will have the opportunity to define their own project, in close consultation with relevant subject lecturers and preferably connected to a relevant company for a professional perspective. These projects will be coached by lecturers (both in terms of process and technical content).

The minor offers an educational model in which students will learn to recognize and use their own talents and in which teaching will be offered in the form of (multiday) workshops.

This minor is suitable for students with a technical background (specifically mechanical engineering, mechatronics, electronics, ICT and automotive) and students who demonstrate sufficient prior technical knowledge. This minor is ideal for students open to self-development, talent development, technology and who demonstrate a proactive attitude.

Within the minor AR, students will work on the following competences:

- *Analysis:* Students themselves are capable of defining a project, formulating objectives and drawing up a schedule of requirements. The students will also learn to prepare safety requirements for the product in the module *Norms, standards & safety.*
- *Design:* Students are capable of producing a design for their (robot) system within their project. Design will also be dealt with in the module Model Based System Engineering.
- *Realization:* The end product of the project is a working demonstrator. As part of a group, students will be able to build the demonstrator during the course of the project.
- *Control:* Within the project, students will be able to evaluate whether their product complies with the requirements drawn up, and whether it complies with (existing) safety standards.
- *Management*: Students learn to manage a project using the SCRUM method. Every two to three weeks, the students define the tasks in their project, and every two to three weeks deliver a subproduct. The results of each period (sprint) are presented in a project pitch for their fellow students and coaches.
- *Research:* Supervised by coaches, students learn to study the material in depth from the modules that form part of the minor, together with other knowledge needed to implement their main project.
- *Professionalization:* Supervised by coaches, students learn to define (and achieve) their own learning objectives, define their talents and reflect on those talents.

4. Overview of teaching activities in the minor (see article 12 general section of the Teaching and Examination Regulations)

The minor AR consists of four phases:

1. Kick-off (2 weeks): During the kick-off phase, students and lecturers are introduced to one another and to the content of the minor. Students are introduced to mechanics, motor control and motion control, 3D printing and the SCRUM method. The majority of this phase consists of a project carried out within a team of 2 to 3 persons.
2. Orientation (5 weeks): In the orientation phase, students become conversant with all aspects (modules) of the minor AR. This is achieved on the basis of a series of workshops within the module. The most important (multiday) workshop is learning to work with ROS (Robot Operating System). This phase is concluded with a project in which students use ROS to control a real robot. During this phase, students also start investigating their talents and (in consultation) define the project they wish/intend to carry out in the project phase.
3. Project (12 weeks): In the project phase, students use their talents, knowledge and skills within a multidisciplinary team. During the project, they deepen their knowledge of the various modules/subject areas, with the assistance of their coach lectures and their self-defined learning objectives are tested. Students also develop their talents.
4. Conclusion (2 weeks): In the conclusion phase, students examine their final outstanding learning objectives, conclude the project work and present the project in a symposium.

The minor consists of the following modules:

ROS for Engineers
ROS (Robot Operating System) is a flexible framework for the development of robot software. It is a collection of tools, libraries, programming constructions and programming agreements. The most important use for ROS is the building of simple, platform-independent, complex robot applications.

Within the module ROS for Engineers, the basic principles and most commonly used tools and software components of ROS are discussed, to assist in the construction of various robot applications. This is achieved without programming code. This grants an insight into the possibilities of ROS. The programming of new robot software components is dealt with in the higher levels of this module.

Principles of Robotics
Robots are evolving rapidly from factory workhorses, limited physically to their work cells, into increasingly complex machines capable of implementing challenging tasks in a day-to-day environment. The aim of this module is to understand the basic concepts and algorithms on which the development of mobile robots and robot arms are based. The focus is on mobile travel and arm kinematics, observation of the environment, localization and the production of a model of the environment (map) and path planning.

Vision, Sensors & Perception
A traditional robot in manufacturing industry is programmed to carry out a specific task, for example blindly picking up or setting down an object. The robot observes nothing of what is going on in its environment, and to protect factory workers, the robot is placed in a cage. An adaptive robot observes its environment with sensors such as cameras, laser range finders and with ultrasonic systems, and is required to act in a changing environment. This may be the observation of a factory worker or perceiving whether there is a cup of coffee on the draining board in a house. In this module, a series of camera and observation techniques are discussed (1D, 2D and 3D), together with a number of filter techniques, aimed at extracting relevant information from sensor data.

Norms, Standards & Safety
Machines and robots are required to comply with a series of regulations and standards. For industrial robots (fixed in their cell), these standards are already available (i.e. ISO10218-1 and ISO10218-2). For the next generation of robots (e.g. mobile platforms that move freely or robots that collaborate with other robots and people), these standards are currently being defined. In this module, students will be introduced to the world of standards, and will learn the basic principles of designing safe machines/robots both for industrial applications and for the next generation of robots.

Hardware Abstraction & Embedded Hardware
In this module, students will be taught how robot hardware, such as actuators and sensors can be combined using ROS and how abstraction from this hardware is possible, for ROS. Students learn which design choices they have to make in order to implement hardware abstraction for example for embedded systems or industrial buses. Students will learn about:
- different types of actuator
- motor controllers
- position sensors on wheels and joints
- image sensory systems and distance sensory systems
- the translation of sensor signals
- the translation of motor commands

The minor also includes a talent line. In this flanking learning line, students are taught by talent coaches to understand and recognize their talents, based on a personal test. They also learn to recognize obstacles in their day-to-day life to making full use of their talents. The result of the individual test is discussed in person with the student and used as a basis for a personal learning goal during the group projects. The final product is a reflection on personal and professional growth.
A talent is different from a competence. A competence can for example be design and a supporting talent can be drawing by hand.

5. Registration for teaching activities in the minor

Students participate in course levels, challenges and projects of their own choice. Subscription lists will be available in the online environment of the minor. Subscription via the student administration is not applicable.

6. Minor examination and registration for examinations (articles 18 and 22 general section of the Teaching and Examination Regulations)

Within the minor AR, six technical modules have been defined: Principles of Robotics, Vision & Perception, Norms, Standards & Safety, System Engineering, Hardware Abstraction & Embedded Hardware and ROS for Engineers (robot programming). Within each module, a student can achieve 4 levels. Learning objectives have been defined for each level, by a subject-competent lecturer (also the module owner). These learning objectives have been defined according to the Taxonomy of Bloom and range from understanding (level 1) through to application (level 2-3) and analysis/evaluation/ creation (level 4). The students are required to achieve at least level 1 for each module. Students can then opt to specialize further within the 6 modules. This further learning is based on a personal learning plan.

For example:
- Level 1: The student is able to *explain* typical terms as SLAM, Kinematics, omni wheel (PoR)
- Level 2: The student is able to *apply* the key safety principles in system development (Safety)
- Level 3: The student is able to *apply* software *beyond* the knowledge that is offered in class to program a robot, for example using new versions or functionalities (ROS)
- Level 4: The student is able to combine information from a number of sensors to *create* an accurate 3D image of a complex environment (Vision)

Learning objectives for levels 1 and 2 are fixed for each module. For levels 3 and 4, students can attempt to achieve the learning objectives defined in advance, or select their own learning objectives (with a comparable degree of difficulty). These learning objectives must then be approved by the relevant module owner. A student cannot skip any levels; if a student wishes to achieve the learning objectives of level 4, he must first achieve the learning objectives of level 3.

For each technical module, examinations have been laid down for achieving level 1 and 2, that are the same for everyone. These learning objectives are examined for example via projects, video presentations, standard presentations and poster presentations. To achieve the learning objectives for levels 3 and 4, agreements must be reached concerning the form and submission method, with the module owners in question. Certain learning objectives can be examined according to specific workpieces undertaken by the student within his group project. Within the group project, each student has their own tasks. These are defined by the students themselves. Each student who produces a subdesign of a mechatronic system can in this way demonstrate his learning objectives for example for level 3 or level 4 of the module system engineering. The student is required to reach agreements on the demonstration requirements with the module owner. The module owner will determine whether the intended level has been achieved according to the work, the documentation and possibly additional explanation (e.g. viva) of the student.

Students can also opt to demonstrate learning objectives in the form of work that goes beyond the project. This can for example be achieved by producing a teaching module on a particular subject that relates to the learning objective and is approved by the module owner. An item of evidence must be presented with every examination.

The progress of the group projects is examined on the basis of two to three-weekly project pitches, in which students talk about what they have achieved and describe their next steps. Pitches are presented to the group mentor and the minor coordinator decide on a Go or No-Go. In case of a No-Go, feedback is given and a back-on-track-plan is discussed within 48 hours.

Talent education is concluded with a poster and video presentation in which the student demonstrates those areas in which he has achieved personal growth within this minor (which talents he has learned to recognise and how he has made use of those talents within the project).

There are no fixed intervals/moments for students, at which they 'complete' their subjects. In other words, the level can be determined at any moment the student and lecturer consider suitable (this will facilitate greater flexibility in the learning process). It does however mean that any retakes (of opportunities to demonstrate a level achieved) must always take place during the course of the minor, in consultation with the relevant lecturer(s).

7. Concluding the minor (see article 19, lid 3 general section Teaching and Examination Regulations)

If a student passes a level within a module, points will be awarded. Reaching level 1 for all modules will be awarded with 6 points. At the end of the minor, the student must have scored at least 22 points. He or she is therefore required to achieve a number of extra levels, and specialise in a number of modules. For each extra level achieved, the student will be awarded 2 additional points.
For example: all courses are finished on level 2 (meaning 1+2 points for each course) and Principles of Robotics is elevated to level 3 (meaning an additional 2 points on top of the 3 points already gained).

Subject	Level	Points
ROSE6	4	7
PR6	2	3
VSP6	2	3
HA6	2	3
SAFE6	1	1
ARGC6	passed	1
ARHC6	passed	2
ARNC6	passed	2
	Total	**22**

In addition to individual learning objectives, students must also successfully complete their group project. This is evaluated according to the following elements:

- The technical level of the finished product is sufficient.
- The work attitude within the group is sufficient.
- The project results are sufficiently described (technical reporting of the entire project).

These requirements are assessed by the group tutor and at least one relevant lecturer to implement the four-eyes-principle. The specific criteria are announced to the students at the start of the minor.

Talent development has the following specific learning objectives, shown in a written reflection:

1. You are able to explain how your talent influences your work in a project team,
2. You are able to explain how you intend to use the knowledge and experience of the talent in applying for a suitable job.
3. You are able to explain what personal and professional development you have undergone.

The minor is accomplished when all learning objectives are met: courses (at least 22 points), group project and talent line. A total of 30 ECs will be awarded then in one time; no ECs will be allocated for individual modules. Students are entitled to one retake for each module during the group projects. Retakes for the group project or talent line need to be discussed with the coordinator and, depending on the nature and size of the needed work, executed in the last two weeks of the minor or in the next semester.

8. Board of Examiners (article 38 general section Teaching and Examination Regulations)
Fontys School of Engineering acts as secretary for this minor. As a result, the Board of Examiners of the Fontys School of Engineering will determine whether the student has passed the minor and ensures that the student receives a certificate. The Board of Examiners can be contacted by e-mail (examencommissie-engineering@fontys.nl) for information about additional facilities and examination of the minor.

9. Validity
This information is valid for academic year 2023-2024.

10. Admission requirements minor
To be able to participate in this minor, the student must have completed a propaedeutic program of 60 ECs. Students from outside Fontys Engineering must have received permission from the Board of Examiners of their study program, to participate in the minor.
The minor aims at students of a technical study program in higher professional education (Engineering or ICT) and students with a technical background otherwise at higher professional education level. In the latter case, a motivational statement is required.

11. Not open to:
Students with no demonstrable technical background at higher professional education level.

No other requirements for participation and completion of the minor are imposed on students, than those laid down in the minor regulations presented in this document.