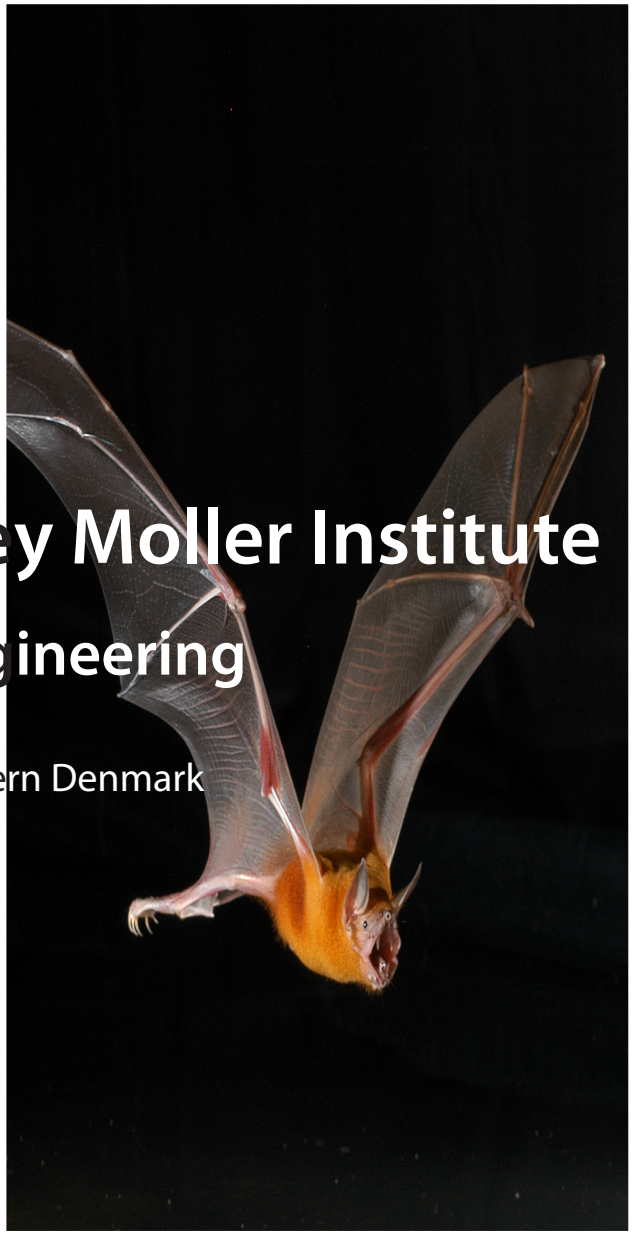
The Maersk Mc-Kinney Moller Institute

Faculty of Engineering

University of Southern Denmark



The Maersk Mc-Kinney Moller Institute
University of Southern Denmark

Foreword

The Maersk Mc-Kinney Moller Institute was established in 1997 as part of the Faculty of Science at University of Southern Denmark. In 1999 the Institute moved into new premises donated by The A. P. Møller and Chastine Mc-Kinney Møller Foundation.

The Institute performs intensive research within the field of robotics with the aim of developing robots that can optimize industrial as well as medical and other scientific goals and make significant contributions to basic research in areas such as:

- Biologically-inspired robotics
- Modular and cellular robots
- Cognitive vision (2D image handling and 3D interpretation of images) in the context of grasping, object recognition and scene interpretation
- Applied mathematics for mathematic modelling of mechanical systems and processes as well as for motion planning
- Software technology, especially modelling, architecture, evolution of software and knowledge management
- Embedded systems

The scientists working within these areas collaborate across disciplines as well as across sectors. The result is an effervescing research and development environment inspired by issues emerging from the surrounding world.

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Basic ~~Research~~ Eco-Social Sustai

The general domain of expertise and innovation of Ecosoc (The Sun Center of Excellence in Software Technology for Eco-Social Sustainable Development, which is part of The Maersk Mc-Kinney Moller Institute) is software-based solutions for facilitating eco-social sustainable development within a broad range of application areas.

Application-driven research and development projects are conducted in close collaboration with industry and end-users. Within these projects software technology is used to improve living standards and to help preserve the eco-habitat by reducing the environmental impact of human-related activities through optimized utilization of natural resources.

Ecosoc was founded in 2006 and builds upon the experience and expertise of The Maersk Mc-Kinney Moller Institute within the fields of software engineering, robotics and mechatronics.

Selected Projects

Predict

A major Danish research effort has resulted in an epoch-making climate-control concept named IntelliGrow. The IntelliGrow concept uses mathematical models of plant photosynthesis to calculate optimal greenhouse climates, such that energy in the form of lighting and heat is provided only when needed by the plants.

Each function in the climate control scheme, e.g. determination of the rate of the photosynthesis, is described as a component. The function of the individual component is determined by the information it possesses about concrete biological or physical circumstances. A variety of climate-control strategies are obtainable by combining components in various ways.

A series of trials of the IntelliGrow concept has shown that dynamic climate control may generate annual energy savings of 10-30% depending on the kind of culture grown. It is the aim of the Predict project to redevelop the present IntelliGrow proof-of-concept prototype to become a modern component-based software platform that is able to transfer these results into hands-on applications in the greenhouses.

Greenhouse Light Control

In Central and Northern Europe pot plants must be grown in greenhouses equipped with artificial lighting systems, as the level of light is a restricting factor for growth. These systems use fixed setpoints for controlling the light level within the greenhouses. However, both from an economical and environmental point of view this is not a sustainable strategy, as the use of fixed setpoints has a tendency to result in an overconsumption of energy. A more economical and sustainable strategy is to control the use of artificial lighting according to the needs of the plants. In short, artificial lighting should only be applied when the plants need additional light to support an efficient level of photosynthesis for continued growth. At the same time, artificial lighting must be used in the most cost-efficient way to keep the expense of production at a minimum. This optimization problem is addressed by developing a software system that automatically controls the use of artificial lighting according to the spot market price of electricity and the needs of the plants.

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nable Development

IntelliCare

The growing number of elderly, care-requiring people and a decreasing number of available hands is becoming a problem in many countries. The IntelliCare project will show how to solve the problem by means of modern technology.

However, introducing modern technology in the elderly care sector is a delicate matter and requires not only efficiency and safety but also ethical and social considerations.

The technology platform to be developed during the project period will ensure optimal integration and collaboration between the surrounding environment and the intelligent aids to be used. The platform development is based on individual activity patterns and the needs of both elderly people and their carers.

As part of the IntelliCare project a care home will be built, a so-called demonstrator, where technology and applications based on the IntelliCare platform can be studied and explored. Thus, the project may be a leader in terms of development and deployment of intelligent, autonomous systems, and thereby pave the way for a new billion-dollar industry for coherent welfare systems.

http://ecosoc.sdu.dk/coe/

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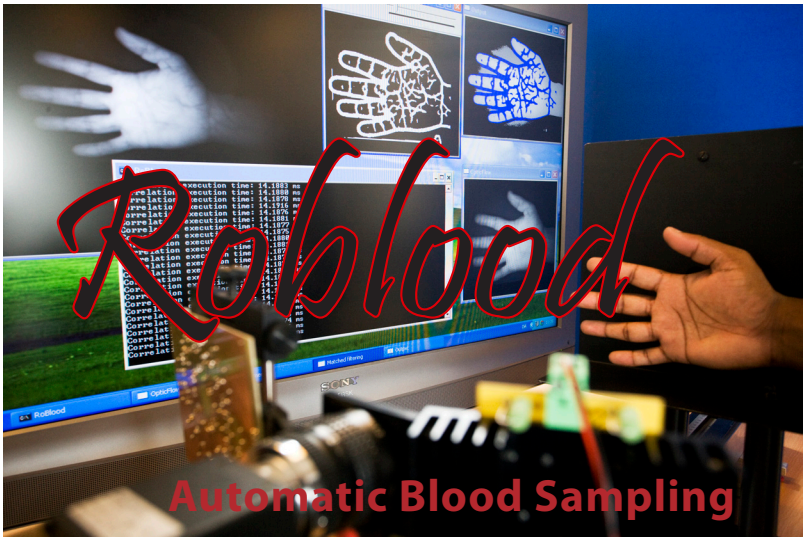
PhD Project



The Roblood project is about finding an automatic method for the process of taking blood samples.

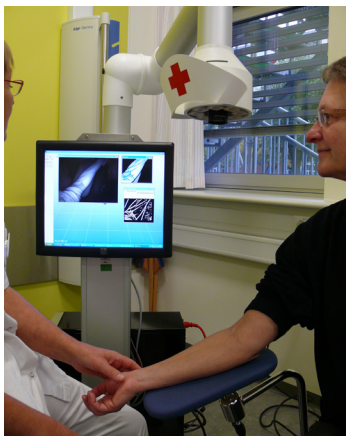
Blood tests are of vital importance world-wide for obtaining information about patients' health and well-being. Improvements in test facilities are generating an increasing amount of detailed information, and Denmark, with a total population of 5.5 million (2008), is producing more than 12 million blood samples a year with an annual increase of 7% since 1987.

All these blood samples impose a tremendous pressure on the blood sampling laboratories and it is believed that the number of blood samples will become a 'bottleneck' for the Danish health care system, if not dealt with soon. Until now the answer to the problem has been optimization of the sampling process by centralizing the procedure at large departments with highly specialized staff.

In many hospitals this approach has already produced fine results even though recent reviews show that there are some disadvantages to this solution. The personnel who take blood samples on a daily basis experience injuries to their shoulders and wrists. These injuries are caused by the skilled movements and fixed grips used during the process of taking a sample.

The idea of this project is to use Near-InfraRed (NIR) light, so the robot is able to detect the blood vessels in the forearm of the patient. An advanced computer vision algorithm calculates in which vessels to insert the needle, and then a custom-made device inserts the needle into the vessel.

The results so far show that it is possible to detect the vessels by applying two independent methods, and current research is focused on optimizing these methods.



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PhD Project

Javeleon - Extending NetBeans with Dynamic Update of Active Modules

Javeleon takes a novel approach to extending the NetBeans IDE and Rich Client Platform with dynamic update of active modules. NetBeans modules can be seamlessly updated at runtime whether they are NetBeans IDE modules or modules which are part of an application built on top of the NetBeans Platform. When a NetBeans module is compiled, Javeleon will reload the module and effect all changes to class code while preserving the state of all existing class instances. Javeleon reduces the traditional development cycle of change, compile and deploy to simply change and compile.

Dynamic software update reduces development time and maintenance cost.

Not only does Javeleon improve developer productivity during initial development by allowing developers to see the effect of their changes immediately after each compilation, it also improves maintenance of already deployed NetBeans applications as these can be dynamically updated while they are running.

The more transparent an updating approach, the more developers are likely to use it.

Running NetBeans applications no longer have to go through the traditional halt, redeploy, and restart scheme before changes to class code take effect, as these are seen immediately with Javeleon. Furthermore, Javeleon makes dynamic updating transparent to developers by eliminating the need for writing additional code for serializing and deserializing non-persistent application state before and after halting and restarting an application. By adding transparency to the dynamic update process, Javeleon effectively reduces the complexity of writing dynamically updateable applications.

Project partners are Sun Microsystems Inc. and The Maersk Mc-Kinney Moller Institute. The technical sponsor at Sun Microsystems Inc. is software engineer Jesse Glick, and associate professor Bo Nørregaard Jørgensen, PhD candidate Allan Raundahl Gregersen and software engineer Michael Rasmussen participate from The Maersk Mc-Kinney Moller Institute.

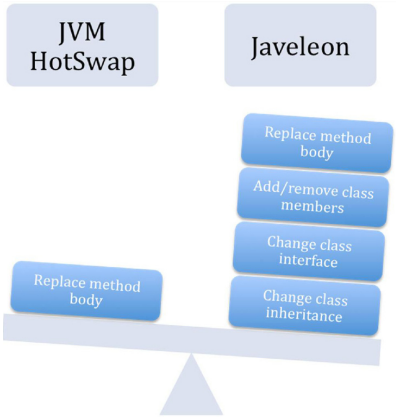

Figure 1. Changes supported by Javeleon

More information about the project can be found on the project's homepage at www.javeleon.org or on ecosoc.sdu.dk, a Sun Center of Excellence in Software Technology for Eco-Social Sustainable Development.

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The Maersk Mc-Kinney Moller Institute
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Modular and C

Basic Research

The vision of the Modular Robotics Lab is to develop modular robots whose software and hardware can be adapted to perform a wide range of tasks by a non-expert user. The Lab is interested in all questions related to realizing this vision. Questions central to our current work include: what is a good set of basic modules from which to build modular robots? What is a good implementation of these basic modules in terms of mechatronics? How do we control a distributed robot such as a modular robot? Can we create programming languages that will accelerate and ease the programming of modular robots?

Selected Projects

Locomorph

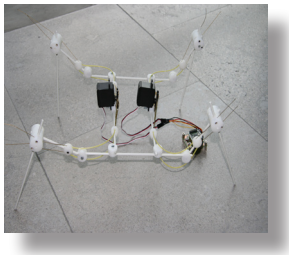
The goal of the EU project Locomorph (2009-2013) is to push beyond the state of the art in robotic locomotion and movement by increasing efficiency, robustness, and thus usability in unknown environments. Locomorph combines multidisciplinary approaches from biology, biomechanics, neuroscience, robotics, and embodied intelligence to investigate locomotion and movement in animals and robots, focusing on two concepts: morphology and morphosis.

The project partners will build many diverse robots using heterogeneous modules to explore various morphological factors (shape, materials, sensors, compliance, etc.) and sensory-motor-control strategies, in order to generate novel and optimal robotic designs which exploit the physical dynamics emerging from the interaction among the physical morphology, control, and environment.

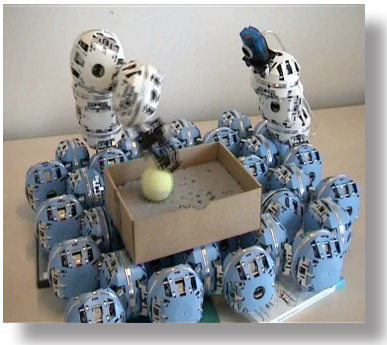
The second concept, morphosis (changing of morphology) extends this concept further. Voluntary morphosis is a valuable skill for robots, as it can increase their adaptivity to current tasks/environments. Adopting two complementary approaches, the project partners will conduct animal/human experiments to study biological strategies in dealing with voluntary and involuntary morphosis.

The results will be used to develop strategies for effective robotic morphosis and motor control solutions for dealing with morphosis. This, combined with the robot's modularity, will create highly robust robots, able to deal with body changes such as limb losses.

http://modular.mmmi.sdu.dk/



Morphing Production Lines



The purpose of the Morphing Production Line project (2006-2010) is to push self-reconfigurable robots towards application in automated production environments.

Automated production lines are typically based on a combination of fast, but inflexible, custom-made machines and flexible, but slow, industrial robot arms. As an alternative, we propose morphing production lines that can change their shape automatically to adapt to the task at hand. This will create a production line that is both flexible and fast. Morphing production lines can be based on self-reconfigurable robots and are an innovative application of recent developments in this research field.

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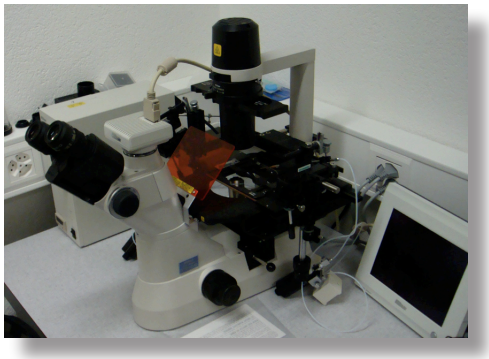
ellular Robotics

Chemical Modular Robot

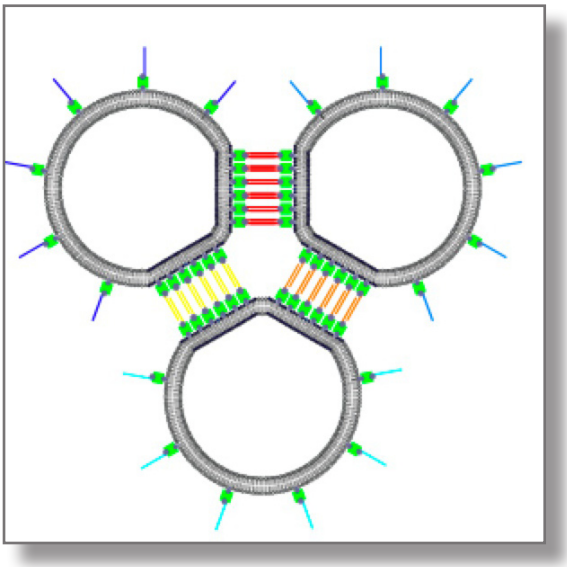
In this interdisciplinary project, the partners will develop an autonomous robotic system, a chemical modular robot, which is a novel type of modular micro-robot assembled from vesicles and oil droplets. Vesicles are built from amphiphilic molecules which, in water, spontaneously self-assemble into microscopic spheres.

The researchers intend to develop and use functionally differentiated vesicles equipped with sensors, actuators, and simple chemical communication mechanisms as modules of a microscopic modular robot. The motility of the modular robot can be provided by oil droplets, which have been demonstrated to move autonomously, fuelled by a particular instability. Self-assembly of small groups of vesicles has been demonstrated in small-scale experiments. The goal of this project is to develop the means to control the assembly of larger structures as well as the ability of the oil droplets to move these vesicles.



To this end, simulation must be used to understand and predict the behaviour of larger numbers of vesicles and droplets. A simulation tool will be developed to support experimentation with massive numbers of microscopic modules and such that it can be continuously evolved as the approach to controlling self-assembly changes.

The main result of this project will be a chemical modular robot that can sense and respond to its environment. For example, such a robot could detect a specified chemical (e.g. a toxin), follow its gradient (fuelled by the oil droplet) and release a substance (from within the vesicle) which neutralizes the toxin. This is an example of a robot that can be used in detoxification applications. In general, chemical modular robots are versatile and have a significant commercial potential, finding uses as a drug delivery system, a monitor of environmental hazards, or even as the basis for the development of programmable materials.



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Research Project

ChiRoPing

Many bats can use sonar for high-precision tasks such as "seeing" a fish fin break the water surface or picking an insect from a leaf *by the neck*. If humans could understand the information present in the echo of a bat's call, then they may be able to build sonar sensors sensitive enough to help blind people or be used on a robot in a dark environment e.g. down a mine, on the seabed, or in a pipeline.

The ChiRoPing project aims to collect precise information about the calls of four different bat species while they are hunting. This information will then be analysed so that theories about how the bat extracts information about the real world from this data can be developed. These theories will be programmed onto a robot "demonstrator", and evaluated. Six groups from four European Universities are involved in the project.

Bats use high-frequency sound and fly fast in the near dark, causing research problems for both sound and vision. **Microphones** capable of recording in the frequencies produced by bats (up to 150kHz) can be purchased, but the project partners had to develop one themselves that could both record this frequency and be light enough (less than 5g) so that the bat could carry it.

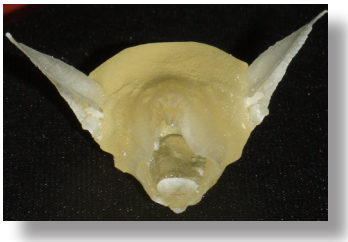
High-speed **cameras** capable of recording in low levels of infra-red light exist, but cannot produce the high definition or resolution required to measure the bat's facial expressions. A novel stereo acquisition system was designed for the project, a 500 frame/second **3D scanner**, which can give submillimetre accurate depth data over a 20 cm (typically 50 frames) flight range. In other words, it can collect detailed 3D film of the bat, *while it is flying*, inside a small capture window.

Bat hunting over water while carrying a microphone

Individual bats of the correct species were captured and placed in a large **flight cage** containing a long, thin pond. The pond was too thin for the bats to hunt across, so they had to hunt along it. Each piece of recording equipmenl was placed in a precisely known position and orientation around one end of the pond. Mealworms (the prey) were placed near the equipment, at a location which meant that the bats should be on film when they collected the prey and for as long as possible beforehand.

Project data

The streams of **audio data** collected by each microphone were synchronised so that a complete picture of the sound emitted by the bat could be obtained. Differences in time-of-arrival between the microphones give the bat's location. Differences in intensity were significant - the shape of the bat's mouth and head alter and block the sound emitted, creating a characteristic intensity pattern which depends on the orientation of the head.



Plastic bat head

A mathematical model of this pattern was developed for each bat species during the project. The pattern of sound intensities collected from the real bats at the different microphones at each instant of time can then be used to determine the bat head orientation when the call was made.

Each call in the audio stream was analysed and annotated manually according to what the bat was doing at the time. It was found e.g. that during pursuit, as the bat gets closer to its prey its calls become shorter, the bandwidth increases and the repetition rate increases steeply.

3D-reconstructed range data will be combined with a deformable mesh model produced from the plastic bat heads to give 3D-animated mesh data for the specific bat, so that the acoustic effects of facial expressions can be computed. Important features of the bat's head were located in 3D and used to measure e.g. the bat's speed or the width of its mouth. Enough texture was visible to the cameras so that the stereo algorithm was able to recover 3D geometry of the bat head in flight.

Synchronization of the high-speed video data with array recordings of the sounds, coupled with manual labelling of the different phases of the bat's behaviour, give unprecedented access to the detail of bat behaviour during prey capture for all four species.

Avoiding the microphone array

Current status and future work

Vast amounts of data have already been collected for all four bat species, processing this data naturally follows on afterwards.

The project partners have accurate plastic heads of individuals from each species, have measured how the shape of the head affects sound projection, and have developed detailed mathematical models of this transfer effect. They have the data to show in detail how head morphology and call characteristics change during the different phases of prey capture.

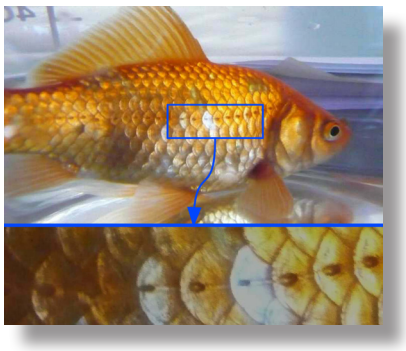
For further information, please visit: ***http://www.chiroping.org/***

Bio-Robotics

Many animals, like the bats studied in ChiRoPing, have versatile and robust sensory skills or useful and interesting behaviour that researchers would like to be able to exploit in robotic systems.

Basic research in bio-robotics investigates the mechanisms that enable animals to perform as they do, by building working models of the mechanisms that may be responsible for their abilities. These working models are normally robots.

Other examples of bio-robotics research include the lizard robot (mentioned later in this brochure) and modelling of fishes' lateral line sense organ that is part of another EU FET project (CILIA 2005-2010).



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Basic Research Counterterror

> "The goal is that the developed prototypes evolve into real products at a later stage."

The Counterterrorism Research Lab (CTR Lab) is part of The Maersk Mc-Kinney Moller Institute. The CTR Lab was established as a response to the increased threat of terrorism towards civilian society.

Over the last few years intelligence agencies have gathered an immense amount of information from different sources in their effort to predict and prevent terrorism. There is now a pressing need to develop new mathematical and computational techniques to assist in the analysis of this information, both to quantify future threats and to measure the effectiveness of counterterrorism operations and strategies.

The overall objective of the CTR Lab is to specify, develop, and evaluate advanced mathematical models, novel techniques and algorithms, and useful software tools to assist analysts in harvesting, filtering, storing, managing, analysing, structuring, mining, interpreting, and visualizing terrorist information. In particular, tools and techniques for open source intelligence have been chosen as an important area of research and development for the Lab.

Knowledge about the structure and organization of terrorist networks is important for both the investigation of terrorism and the development of effective strategies to predict and prevent terrorist attacks. Theory from the knowledge management field plays an important role in dealing with terrorist information. Knowledge management processes, tools, and techniques can help analysts in various ways when trying to make sense of the vast amount of data being collected. Several manual knowledge management processes can be either semi-automated or supported by software tools.

The tool philosophy of the Lab is that the analysts are in charge and the tools are there to assist them. Thus, the purpose of the tools is to support as many of the analysts' knowledge management processes as possible to assist them in performing their work more efficiently. In this context, efficient means that the analysts arrive at better analysis results much faster. In general, the tools fall into two overall categories:

- Semi-automatic tools that need to be configured by the analysts to perform dedicated tasks. After configuration, the tool will automatically perform the dedicated task.
- Manual tools that support the analysts in performing specific tasks by providing dedicated features that enhance work efficiency when performing manual analysis work.

The overall research and development strategy is based on end-user involvement and evolutionary prototyping:

- End-user involvement is important to produce useful prototypes that address real problems, and supports the tasks and workflows of the end-users (analysts).
- Evolutionary prototyping is a way to build robust prototypes in a structured manner and to constantly evaluate and refine the prototypes in collaboration with end-users (analysts).

The goal is that the developed prototypes evolve into real products at a later stage.

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rism Research

Selected Projects

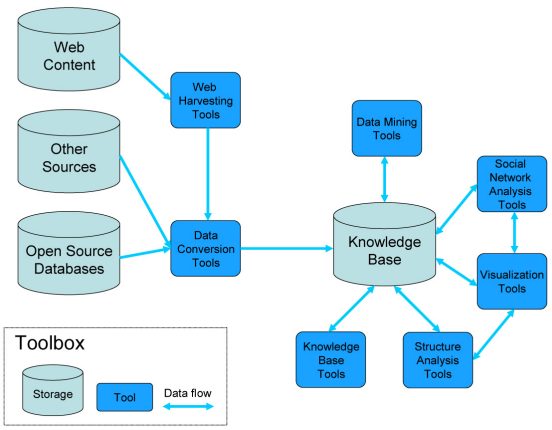
CrimeFighter

The CrimeFighter toolbox is based on past experiences working with investigative data mining, mathematical modelling, social network analysis, graph theory, link analysis, knowledge management, and hypertext.

CrimeFighter builds on ideas, concepts, algorithms, and user interfaces previously developed in relation to tools such as iMiner, focusing on counterterrorism, as well as ASAP and Construct, focusing on knowledge management and structuring.

CrimeFighter consists of a knowledge base supporting advanced mathematical models of terrorist networks and a set of tools, techniques, and algorithms that each support different activities in intelligence analysis work: data acquisition tools supporting web harvesting, structure analysis tools supporting emergent and evolving structures of terrorist networks, explorer tools for searching and exploring the knowledge base, algorithms for data mining, algorithms for visualization, algorithms for social network analysis, etc.

CrimeFighter introduces a new terrorism domain model with both nodes and links as first-class entities. This will allow additional features to be built into social network analyses and visualization tools such as use of links weights, finding missing links and identification of key links.



Early Warning System (EWaS)

EWaS is a project targeted at developing an early warning system to prevent terrorist attacks.

EWaS will go a step beyond the capabilities of previous tools such as iMiner, which makes use of descriptive data mining techniques to make sense of open source information. These techniques are useful in reasoning about terrorist network structures (such as detection of hidden hierarchies and subgroups). However, iMiner does not make use of predictive data mining techniques which are relevant when trying to detect patterns in open source information that should trigger warnings of possible future terrorist activities.

EWaS will support the five steps that have been identified to process the raw data from heterogeneous data sources to generate warnings:

- Acquisition. EWaS will harvest data from heterogeneous data sources on the web (such as RSS feeds, blogs, web pages, forums, etc.).
- Extraction. Data will go through semantic analysis to extract information hidden in the data. The extracted entities and their relations are kept in the data store.
- Information Generation. The information in the data store is further filtered and only those entities and relations related to the domain are selected.
- Investigation. The information will be evaluated using terrorist network analysis techniques such as dependence centrality, position role index, and also geodesic measurements like average path length, clustering coefficient, density are applied.
- Warning Generation. If the warning generation engine encounters changes in measurements and characteristics, a warning will be generated. Users can manipulate patterns for the warning generation engine to test and fine tune theories regarding terrorist behaviour and activity.

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The Maersk Mc-Kinney Moller Institute
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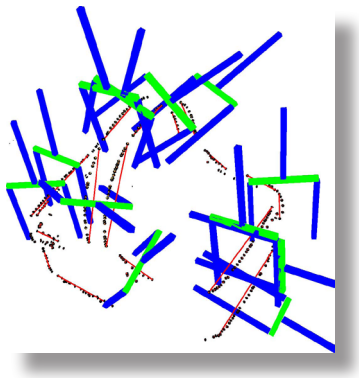
Basic Research Cognitive Vision an

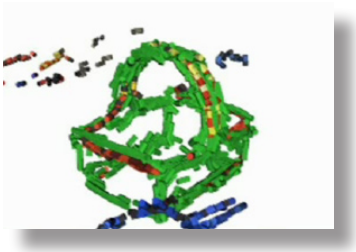
Selected Projects

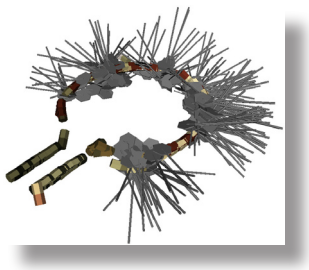
The early cognitive vision system developed by the Cognitive Vision Lab (CoViL) computes semantically rich, reliable and task-independent visual information from stereo image sequences. The Lab has been applying this system in a number of contexts ranging from cognitive research to industrial applications.

Currently, CoViL is a partner in two EU projects, PACO+ and Drivsco. PACO+ (2006-2010) focusses on the modelling of cognitive processes in the area of humanoid robotics, and Drivsco (2006-2009) is concerned with learning in the driver-assistance domain.

CoViL is also involved in a number of Danish projects in the area of industrial robotics (Handyman, MoveBot) and image analysis (NISA). New projects starting in the autumn of 2009 are concerned with intelligent robots grasping flexible objects (2009-2012) as well as Bin-Picking (2009-2012).







Background

CoViL focusses on the understanding of the human visual and cognitive system and the development of artificial systems with similar structure and strength. So far, only biological systems show strong cognitive capabilities such as object categorisation, advanced reasoning, planning and communication. Based on an elaborated stage of 'early cognitive vision', CoViL aims at the modelling of such cognitive functions in embodied systems.

http://www.mip.sdu.dk/covig/index.html

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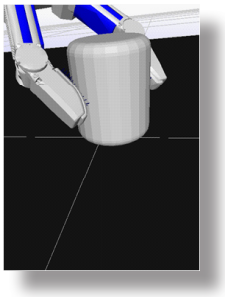
d Applied Robotics

Selected Projects



Movebots

In Movebots (Innovation Consortium; 2006-2010), the partners develop technologies that will be incorporated into an advanced multi-robot demonstration platform equipped with the sensors that will be used in the robot systems of the future. The platform will be unique in its ability to catch and manipulate random items, from a series of complex assignment tasks and in close cooperation with humans. The associated research topics are: Simulation, planning and control of grasp operations, multi-robot coordination, motion planning in scenes where humans interact, and object recognition and pose estimation.

TailorCrete

TailorCrete (EU, FP7; 2009-2013) will initiate a transition from the rectangular monotony of today's industrialised concrete buildings that dominate the European landscape, to new industrialised unique concrete structures without the need for expensive and labour-intensive manual construction processes. This will be achieved by developing new industrialised processes for concrete, and thus the project will play a significant role in transforming the construction sector from a resource-based to a knowledge-based industry.

TailorCrete combines the knowledge resources of architects, designers, concrete technologists, civil and structural engineers and robot experts with the practical experience of key players in the construction sector in a 4-year collaborative research. It will involve intensive testing and validation of results at laboratory scale and in full-scale demonstrations in experimental buildings.

It is the task of the Robotics Lab to develop software for robot automation of a variety of associated highly complex processes.

Background

The robotic systems of the future will be much more flexible so that they can operate in unpredictable environments and cooperate in close contact with humans. Thus, they will also be much more complex, containing a variety of sensors such as cameras, range scanners and various types of tactile sensors. It is the vision of the Cognitive Vision and Applied Robotics Lab to be a key player in the development of algorithms and software for task planning and motion planning, and control of such robotic systems, so that the robots will become natural and reliable partners in future contexts. The key topics of the Lab are: Motion planning in unpredictable environments, mobile manipulation, modelling of the processes that robots are expected to handle.

Contact: Professor Henrik Gordon Petersen, hgp@mmmi.sdu.dk

Spinn-off

Lizard Technology

Lizard Technology ApS was established in 2009 as a result of a collaborative PhD project between The Maersk Mc-Kinney Moller Institute and Institute of Biology, University of Southern Denmark.

At this stage, Lizard Technology is a development and sales company that licences/sells its products to business partners, who then implement the technology in their own applications/products.

The overall purpose of the company is to identify, develop and commercialise new leading edge audio and sound technologies, and platforms, in close cooperation with universities, research institutions, industry and public and private investors.

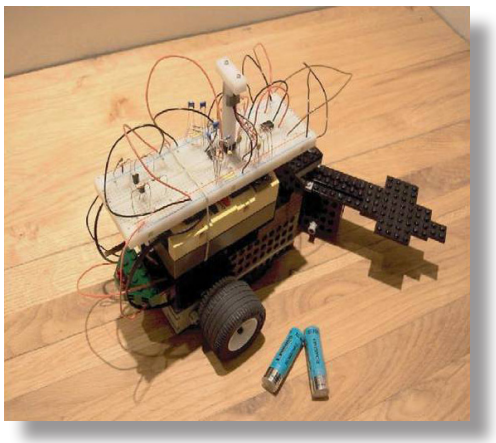
The main focus of the coming years will be on the development of leading base technologies within the areas of:

- Active Sound Localization (ASL) which is one of the key technologies being developed by Lizard technology. It is a new, unique and intelligent sensor and pointing technology applicable within a wide range of areas such as sensor systems, surveillance systems and medico/disability support aid systems. ASL is based on many years of research on hearing characteristics and dynamics of lizards, frogs and insects. The key component of the ASL technology is the mathematical modelling of the lizard ear - researchers call it the lizard ear model. This model is based on understanding the structure of the lizard ear, the directionality and neural processing of which can be modelled by an electric circuit.

- Virtual Spatial Sound Presentation (VSS), which is a new leading-edge 3-dimentional sound and voice change technology - called artificial colouring of sound - applicable within areas such as virtual training systems, surveillance systems, teleconference systems, mobile phones/PDAs, computer games and maybe even hearing aids.

- Combinations of ASL/VSS with other sound technologies.

Lizard Technology has developed a prototype robot based on the characteristics of the lizard ear and the processing involved. Simulation in a digital signal processor shows excellent sound localization behaviour.



First robot prototype with lizard-like ears

http://www.lizard-technology.com/

Enterprises

Scape Technologies

Winner of the KUKA Application Award for spectacular application ideas and exceptional robotic solutions

The SCAPE Bin-Picker system enables robot arms to locate and pick up individual items randomly piled in a container.

Bin-picking robots are applicable in many production and manufacturing areas, e.g. in the automobile and aerospace industries.

Scape Technologies works closely with integration companies to provide state-of-the-art bin-picking robots for flexible feeding systems. They increase the productivity of manufacturers and reduce manual repetitive work, which includes physically demanding and monotonous tasks, detrimental to the workers' health.

Scape Technologies was founded in 2004 after many years of research and development at The Maersk Mc-Kinney Moller Institute. The result of these efforts is SCAPE, an acronym for Smart Classifier and Pose Estimator. SCAPE is the core of the Scape Technologies' bin-picking product, the SCAPE Bin-Picker.

Shortly after the company was established, a partnership between the leading Danish pump manufacturer, Grundfos A/S, and Scape Technologies came about to develop and commercialise the SCAPE Bin-Picker. The partnership with Grundfos is growing in the wake of new development activities and commercial bin-picking projects being initiated.

Scape Technologies A/S is located in Odense and has still close ties to the University of Southern Denmark.

http://www.scapetechnologies.com/

Universal Robots

Universal Robots has developed a highly specialized, flexible, low-cost robot arm that can be used in almost any industry, where traditional robots are too large, expensive, noisy or inflexible.

Since the robots weigh only 18 kilos, they are easy to move around and the user-friendly software makes the re-programming of the robots a very straightforward process. The idea was to develop a robot that would add value as quickly as possible.Therefore, it can be used in the production process from day one - no need for a cumbersome setup or installation.

The idea of creating a light and relatively inexpensive robot that is easy to install and program arose in 2003. Kristian Kassow, one of the founders of the company, was working on an analysis of the requirements for robots in the food industry. At the same time, Esben Østergaard and Kasper Støy, also founders of the company, were working in their PhD projects on modular robots. Together, they discovered that the robotics market was characterised by heavy, expensive and unwieldy robots and decided, with help from an investor, Syddansk Innovation, to establish Universal Robots with the ambition of making robot technology available to all.

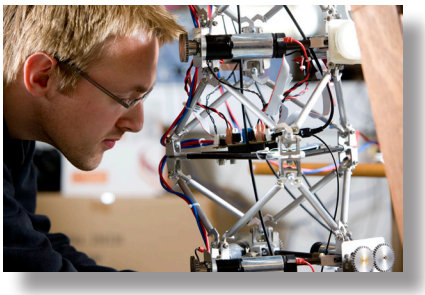
http://www.universal-robots.com/

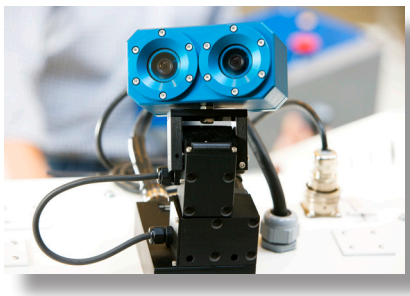
Undergraduate Studies

Bachelor/Engineer in Information and Communication Technology

The programme provides graduates with comprehensive skills in two principal areas: Programming and IT systems development. Additional deep skills are acquired in industrial automation. The programme thus aims at preparing graduates for a variety of jobs in industry.

The programme lasts for 3½ years, i.e. seven semesters. The pedagogical approach can best be described as project-based learning. In the first four semesters skills from courses are combined in a semester project, which takes up around one third of the total effort. During the first three semesters students acquire basic skills in programming and IT systems development. Semesters four and five concentrate on more advanced topics in these areas plus industrial automation. In the sixth semester students take internship in domestic or foreign companies, thus preparing for the bachelor's project, which takes up all of the seventh semester. A very important feature of the programme is to provide all graduates with general engineering skills enabling them to add value to their first job from day one.





Graduate Studies

Master of Science in Robot Systems Engineering

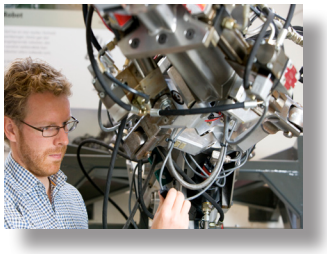
Focusing on robotics, artificial intelligence, software systems, embedded systems and computer vision, this programme offers a unique combination of creative activities and advanced technology.

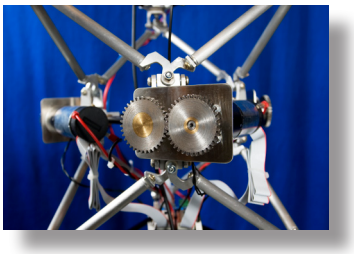
Through this programme graduates acquire skills that prepare them for work across disciplines in industry or research.

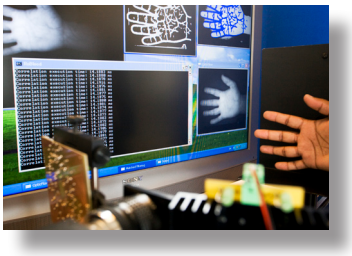
Today robots are used in many different contexts appearing in various shapes and sizes e.g. as static components in industrial manufacturing or high-tech medical gadgets.

The Master's degree in Robot Systems Engineering is for students who want to work with the technologies of the future.

The study environment of the programme is highly valued because of the close collaboration among researchers, students and industrial partners.







Postgraduate Studies

PhD Programme

Intelligent autonomous systems are becoming increasingly important to master in the wake of the current trend towards more and more advanced end-user products (e.g. within education and entertainment) and more and more advanced industrial components and production platforms. This is one of the reasons why the Research School of the Faculty of Engineering offers five Researcher Education Programmes:

- **Robot Systems Engineering**
- **Energy and Environmentally-efficient Technologies**
- **Functional Materials and Nanotechnology**
- **Applied Mathematical Modelling**
- **Product Design and Innovation**

Study Programmes

Master's

- Master of Science (MSc) in Engineering (Robot Systems Engineering)
- Master of Science (MSc) in Engineering (Welfare Technology)
- Master of Science (MSc) in Engineering (Learning and Experience Technology)

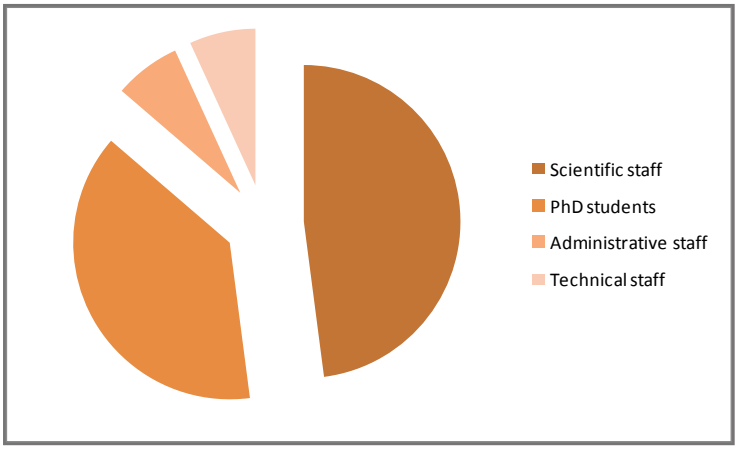
Bachelor's

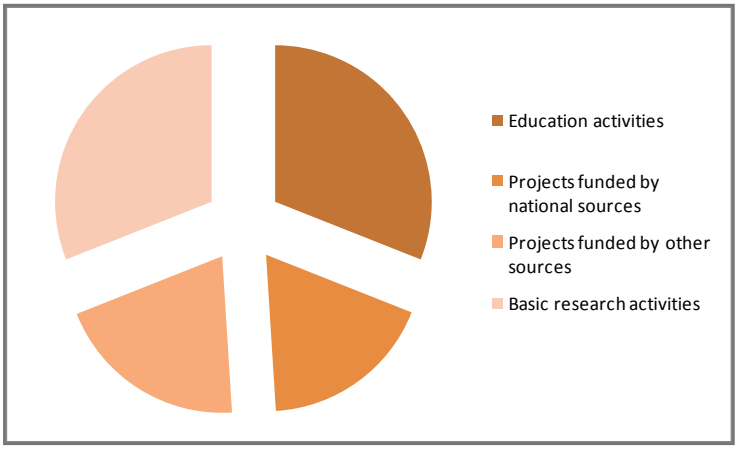
- Bachelor of Engineering (BE), Information and Communication Technology
- Bachelor of Science (BSc) in Engineering (Robot Systems Engineering)
- Bachelor of Science (BSc) in Engineering (Welfare Technology)
- Bachelor of Science (BSc) in Engineering (Learning and Experience Technology)

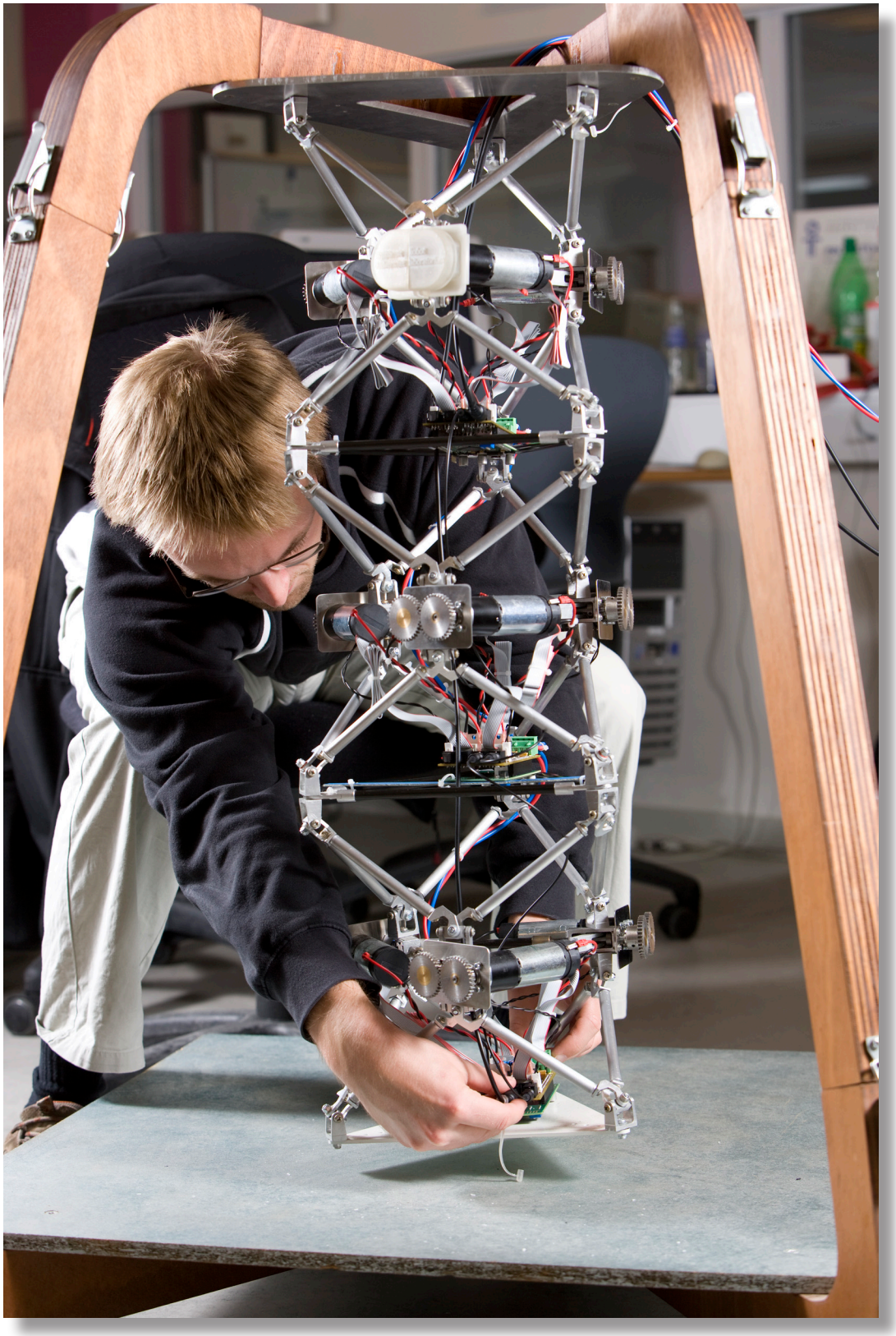
Exchange

- Exchange programme at Bachelor's level (Software Engineering)
- Exchange programme at Bachelor's level (Robot Systems Engineering)
- Exchange programme at Master's level (Robot Systems Engineering)

December 2009


Scientific staff
PhD students
Administrative staff
Technical staff


Education activities
Projects funded by national sources
Projects funded by other sources
Basic research activities



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