Developing Robotics Technologies: Academic Perspective

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Outline

- Main focus in academia: developing and prototyping solutions for new technologies
- Examples: What does EU support in robotics research?
- Robotics education in Norway: facts and figures

New Technologies in Robotics

- Developed by small teams
- In collaboration with universities, research institutes
- Based on conceptual prototypes
- With substantial public support
  - Grants from Research Funds (EU, National programs, …)
  - Donations
  - Government subsidies
  - Tax reduction, research related costs compensation
  - Strategic initiatives
    - The Wallenberg Autonomous Systems Program, 1.8 billion SEK
    - Centre for autonomous marine operations and systems, 1.7 bNOK

EU funding in industrial robotics (COMET)

- Title: Plug-and-produce **CO**mponents and **MET**hods for adaptive control of industrial robots enabling cost effective, high precision manufacturing in factories of the future

- Duration: 30 months

- Partners: AMRC Manufacturing Ltd, ARTIS, BTU Cottbus, Delcam, DemoCenter-Sipe, Fraunhofer IPA, Gizelis Robotics, **Lund University**, N. Bazigos S.A, Nikon Metrology, Nisaform, SIR, TEKS, **University of Patras**

- Budget: ~8 MEuro (6 from EU)

EU funding in industrial robotics (HEPHESTOS)

- Title: Hard Material Small-Batch Industrial Machining Robot

- Duration: 38 months

- Partners: Fraunhofer IPK, Comau, **Universitetet i Agder**, **Universidad Politécnica de Madrid**, Easy-Rob, ME Messsysteme GmbH, G-Robots, VTT Technical Research Centre of Finland, Master Automation Group

- Budget: ~3,6 MEuro (2.4 from EU)

NTNU

Department of Engineering Cybernetics / Studies

Studies at the Department of Engineering Cybernetics

Programmes of Study

- Master in Cybernetics and Robotics (5 years)
- Master in Cybernetics and Robotics (2 years on top of a Bachelor degree)
- Master in Industrial Cybernetics (2 years on top of a Bachelor degree)
- PhD in Engineering Cybernetics (3 years on top of a Master degree)

Courses

All courses at Department of Engineering Cybernetics

Hint: Choose tick for **Taught in English** to only see courses offered in English.

Contact

E-mail: studinfo@itk.ntnu.no

Ph. D. studies

- PhD in Engineering Cybernetics
- Starting, progress, completion and forms of the PhD-studies at IME.
- Introduction seminar for PhD-students
- PhD opportunities at NTNU
- For doctoral students and staff at NTNU
- DION - The interest organization for doctoral candidates at NTNU

NTNU

Studies / All courses / Courses A - Z

Under each course you will find information about exams, schedules and faculty.

Courses NTNU Gjøvik

Courses NTNU Ålesund

Courses for exchange students

Teaching location

- ☐ Gjøvik
- ☐ Trondheim
- ☐ Ålesund

Filter

- ☐ With multimedia
- ☐ Taught in English
- ☐ Phd courses

Course start

- ☐ Autumn
- ☐ Spring
- ☐ Summer

Show exam date for

Search for **courses**

Search courses

Autumn 2016/Spring 2017

Faculty of Information Technology, Mathematics and Electrical Engineering

Department of Engineering Cybernetics

Code	Course name	Location	Exam date
TTK4210	Advanced Control of Industrial Processes	Trondheim	
TK8103	Advanced Nonlinear Systems	Trondheim	
TK8109	Advanced Topics in Guidance and Navigation	Trondheim	

TTK4101	Instrumentation and Measurements	Trondheim	
TTK4115	Linear System Theory	Trondheim	2016-12-02
TTK4200	Mathematical Modelling of Physical Systems	Trondheim	2016-12-16
TTK4160	Medical Imaging	Trondheim	2016-12-07
TTK4195	Modeling and Control of Robots	Trondheim	
TTK4170	Modelling and Identification of Biological Systems	Trondheim	2016-11-28
TTK4130	Modelling and Simulation	Trondheim	
TK8116	Multivariate Data and Meta Modelling: Preparing for Big Data Cybernetics	Trondheim	
TTK4150	Nonlinear Control Systems	Trondheim	2016-12-10
TK8102	Nonlinear State Estimation	Trondheim	
TK8115	Numerical Optimal Control	Trondheim	
TTK4135	Optimization and Control	Trondheim	
TTK4205	Pattern Recognition	Trondheim	2016-12-15
TTK4145	Real-time Programming	Trondheim	
			2016-

- (•) Autumn
- ( ) Spring
- ( ) Summer

TTK4605	Applied Parameter and State Estimation	Trondheim	2016-11-30
TTK4100	Computerized Control, Introduction	Trondheim	2016-12-12
TTK4230	Control Systems	Trondheim	2016-12-07
TTK4105	Control Systems	Trondheim	
TTK4220	Dynamics in Social Systems	Trondheim	2016-12-12
TTK4235	Embedded Systems	Trondheim	
TTK4155	Embedded and Industrial Computer Systems Design	Trondheim	2016-12-06
TTK4900	Engineering Cybernetics, Master's Thesis	Trondheim	
TTK4555	Engineering Cybernetics, Specialization Course	Trondheim	2016-11-30
TTK4550	Engineering Cybernetics, Specialization Project	Trondheim	
TTK4551	Engineering Cybernetics, Specialization Project	Trondheim	
TK8107	Estimation in Nonlinear Systems	Trondheim	
TTK4190	Guidance and Control of Vehicles	Trondheim	2016-12-07
TTK4240	Industrial Electrotechnics	Trondheim	2016-12-19
TTK4175	Instrumentation Systems	Trondheim	

TTK4147	Real-time Systems	Trondheim	12-17
TTK4165	Signal Processing in Ultrasound Imaging	Trondheim	
TTK4215	System Identification and Adaptive Control	Trondheim	2016-11-29
TTK4225	Systems Theory, Introduction	Trondheim	2016-11-29
TK8112	The Theory of Concurrency in Real-Time Systems	Trondheim	
TK8108	Topics in Fisheries and Aquaculture Cybernetics for PhD students	Trondheim	
TK8111	Topics in System and Control Theory	Trondheim	
TTK4625	UNIK, Specialization Course	Trondheim	2016-11-30
TK8105	Ultrasound imaging in Heterogeneous, Non-Linear Tissue	Trondheim	
TTK4600	Understanding Technology, Innovation and Product Development	Trondheim	2016-11-30

Information on the program

- The department accepts
  - about 150 students for 5 year MSc program
  - about 20 students from colleges outside of NTNU for 2 year MSc program
- ¾ of courses in the program are compulsory and ¼ are volunteered
- Specialization in robotics is taught on the last two years
- The main courses are
  - 4th year: Robot Modeling and Control; Nonlinear Control Systems
  - 5th year: Advanced Topics in Robotics; Advanced Topics in Guidance and Navigation; Autonomous Systems; Identification

Principles and content

- Студенты должны познакомится с различными подразделами (topics) робототехники
- Студенты должны поделать эксперименты на оборудовании (и иногда можно что-то поломать)
- Студенты должны увидеть, что просто и можно купить, и что не просто и купить невозможно или очень дорого
- Упор делается
  - на разработку математических моделей,
  - на решение задач идентификации,
  - на разработку алгоритмов поиска движений и синтеза систем управления
- Work in contact with active researchers!

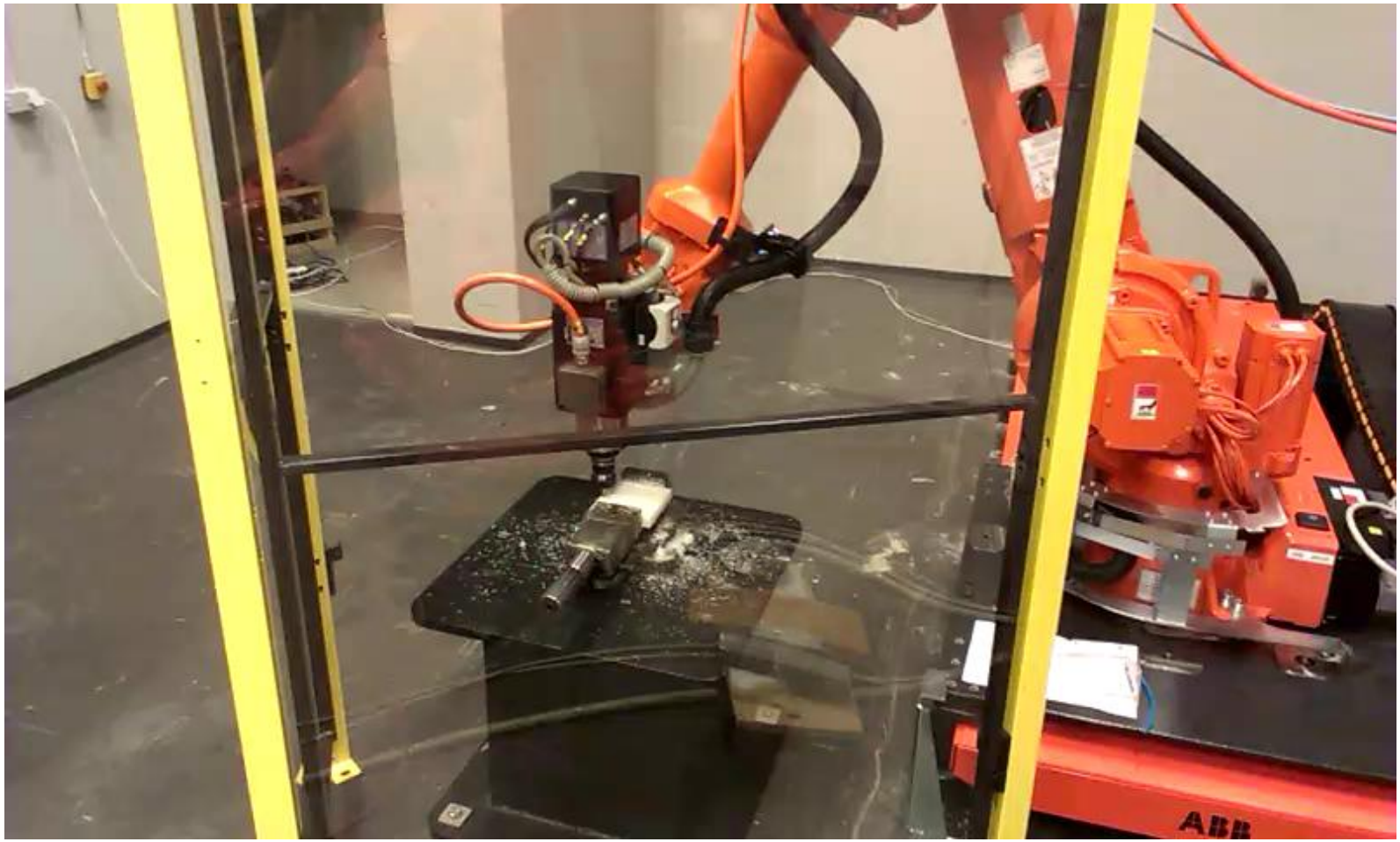
Equipment

- ABB IRB 140, 1600, 4600 + any available software (MultiMove, Force Control for assembly, machining)
- KUKA LWR4+
- Educational robots from EdRob and Quanser
- Self-designed and developed (locomotive) machines/robots

- Robotiq adaptive grippers
- Schunk servo-electric 2-finger parallel grippers
- Spindles

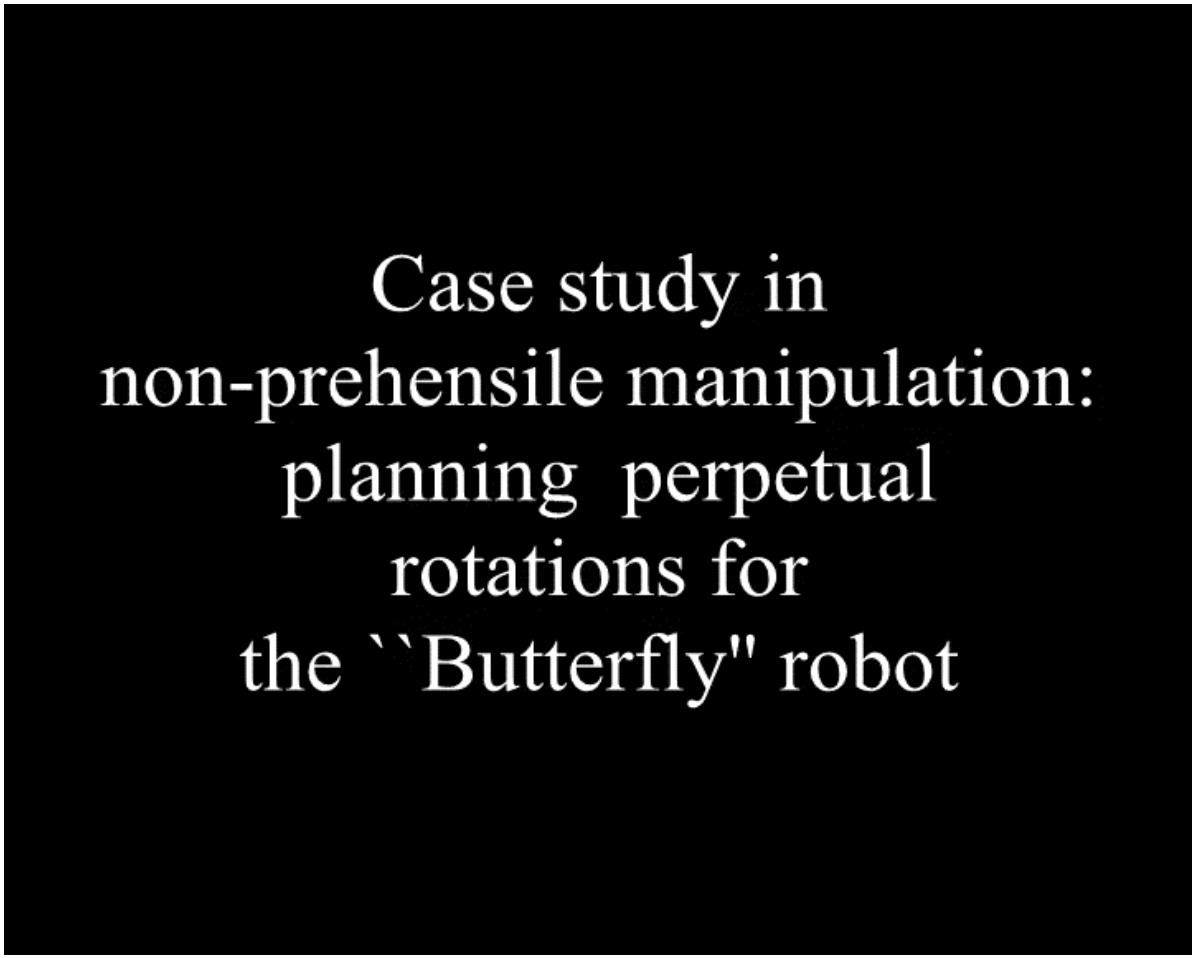
- Metrological equipment
- Cameras
- Force/torque sensors

Movies



Movies

Movies


Case study in
non-prehensile manipulation:
planning perpetual
rotations for
the ``Butterfly'' robot