TECHNISCHE UNIVERSITÄT MÜNCHEN
Human-centered Assistive Robotics
Prof. Dr. Dongheui Lee

Advanced Seminar Autonomous System

Procedure:

The advanced seminar consists of the following events, which will be announced on TUM-online:

1. Kick-Off Meeting: presentation of individual topics and description of the schedule for the advanced seminar.
2. Report submission: submission of the final report, presentation and electronic copies of all publications read during the advanced seminar.
3. Final presentation: each participant has to present the results of his advanced seminar.

Participation in all events is a requirement for successful completion of the advanced seminar. Participation will be documented by means of an attendance list.

Final report submission:

A printed copy of the report and a CD have to be submitted (Room 5007@Karlstr.45). The CD must contain the presentation, report and all relevant scientific material. Thus, the presentation must be finished by the deadline. The report should be about 10 pages (title page, table of contents and bibliography excluded) and must be written using LaTeX. The supervisor should give you the template for the presentation and the report. The second page of the report has to contain the assigned topic sheet. The report should only be stapled two times on the left side (no spiral or adhesive binding).

The CD should be composed of two directories: Documents and Presentation. In the documents directory, either a Microsoft word document or all Latex files (including images) should be present as a zip file. In addition, a pdf copy of the report should also be present in this directory. The presentation directory should contain a PowerPoint presentation or a pdf version. All relevant (electronic) references have to be saved on the CD as a zip file entitled „references“.

Final presentation:

The duration of the final presentation is 10 minutes. The presentation format/style can be based on obtained from the supervisor. After the presentation, a 5 minutes discussion will take place in which everyone should actively participate. The contribution to the discussion is included in the final grade. It is compulsory to attend all presentations.

Grading:

The grading of the advanced seminar is based on the template attached below. In the assessment contains various criterion related to the preparation of the advanced seminar, the final report, presentation and participation during the discussion session.

I. Preperation phase

Nr.	Criteria	Grade
1	**Introduction:** understanding and overview given the difficulty of the task	
2	**Own Contribution:** creativity, Richness of ideas, initiative, self organization and decisiveness	

3	**Organization:** organization, time management, persistence and Diligence	
4	**Scientific Work:** rigor, systematic approach, analysis of results	

II. Written report (Documentation)

5	**Formatting:** structure, completeness, sources Formatting and graphic design	
6	**Didactics:** style, expression, comprehension, conciseness of pictures and diagrams	
7	**Scientific Content:** technical correctness, discussion and evaluation of results	

III. Participation

8	**Active participation:** Discussion during presentations	

IV. Final presentation

7	**Technical content:** scientific content, classification and evaluation, discussion	
8	**Presentation:** presentation style, time discipline, slides and videos etc.	

Role of Supervisors:

The supervisor is the reference person in case of any inquiries. Together with the supervisor you agree on the specifics of the topic and the expectations. The supervisor supports you in technical matters, final report and presentation of the results. If desired students can give their presentations prior to the final presentations in order to get some feedback concerning style and content. Your supervisor also shows you the workstations available for students and can introduce you to the computer programs required to complete the seminar.

It is necessary that the written report and the final presentation be submitted to the supervisor at least 1 week before the deadline.

Literature research:

The literature review should be carried out independently. Your supervisor will support you by providing appropriate reference books and scientific papers. In order to facilitate your introduction to the topic, your supervisor also provides a list of introductory articles.

Regulations for absence:

There are strict regulations concerning unexcused absence from the advanced seminar. Unexcused absence in any of the advanced seminar events will lead to failure in the course. In case of illness, a doctor’s certificate must be presented. Overlap with other courses is not a sufficient excuse, because in this case a decision must be made in favor of one course at the beginning of the semester.

Timetable:

Events	Date	Time
Kick-off meeting	26.04.2019	14:00 – 15:00 (2026@2906)
Report submission	15.07.2019	12:00 (5007@2906)
Final presentations	19.07.2019	14:00 – 15:30 (5016@2906)

* 5016@2906 is a seminar room (5016) on the fifth floor in Karlstr. 45, München.

I have read and acknowledge the above information and guidelines for the advanced seminar:

Matriculation number: ____________________

First Name, Last Name: ______________________________

Date: ____________________

Signature: ______________________________

TECHNISCHE UNIVERSITÄT MÜNCHEN
Human-centered Assistive Robotics
UNIV.-PROF. DR.-ING. DONGHEUI LEE

April 16, 2019

A D V A N C E D   S E M I N A R

Integrating Task and Motion Planning for Robotic Executions of Manipulation Tasks

Problem description:

In order to allow complex robotic platforms to execute tasks in real environments it is necessary to provide the robot, on the one hand, with task planning mechanisms [1] that permit defining the sequence of actions to fulfill the task from the current physical configuration and, on the other hand, with motion planning mechanisms [3] to define the specific movements of the robot to successfully execute each of these actions. The integration of these two planning mechanisms is a challenging problem since task and motion planning were originally conceived independently of each other. This demands the definition of new strategies to generate "physically feasible" task plans that can be successfully executed through motion planning approaches [4, 2].

Bibliography:

[1] Malik Ghallab, Dana Nau, and Paolo Traverso. *Automated Planning: theory and practice*. Elsevier, 2004.

[2] Chris Paxton, Felix Jonathan, Marin Kobilarov, and Gregory D Hager. Do what i want, not what i did: Imitation of skills by planning sequences of actions. In *2016 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, pages 3778–3785. IEEE, 2016.

[3] Stefan Schaal. Dynamic movement primitives-a framework for motor control in humans and humanoid robotics. In *Adaptive motion of animals and machines*, pages 261–280. Springer, 2006.

[4] Marc Toussaint. Logic-geometric programming: An optimization-based approach to combined task and motion planning. In *Twenty-Fourth International Joint Conference on Artificial Intelligence*, 2015.

Supervisor: Dr. Alejandro Agostini

(D. Lee)
Univ.-Professor

TECHNISCHE UNIVERSITÄT MÜNCHEN
Human-centered Assistive Robotics
UNIV.-PROF. DR.-ING. DONGHEUI LEE

April 15, 2019

P R A C T I C A L C O U R S E
for
Student's name, Mat.-Nr. 0815

Arm movement during human walking

Problem description:

Walking is a complex physical activity which requires synchronous movement of the legs and upper body. Research has been conducted in understanding the dynamics of foot contact during walking. This is because feet are responsible for the propagation of external forces through the body causing minor perturbations. The stance and swing phases of the leg generate torques in the upper body which lead to instability in the movement. This instability is balanced by the counter movement of the arms [1]. Counter movement here denotes the forward swing of the left arm simultaneously with the swing of the right leg and vice versa.

Tasks:

- Conduct a literature survey about how the arm movements synchronizes with leg movement at different walking speeds.

Bibliography:

[1] Steven H Collins, Peter G Adamczyk, and Arthur D Kuo. Dynamic arm swinging in human walking. *Proceedings of the Royal Society B: Biological Sciences*, 276(1673):3679–3688, 2009.

Supervisor: Dipl.-Ing./ M. Sc. Karna Potwar

(D. Lee)
Univ.-Professor

TECHNISCHE UNIVERSITÄT MÜNCHEN
Human-centered Assistive Robotics
UNIV.-PROF. DR.-ING. DONGHEUI LEE

April 15

ADVANCED SEMINAR

A survey on 3D point cloud reconstruction methods

Problem description:

Autoencoder is a powerful method to compress high-dimensional data into low-dimensional latent space. Especially, deep neural network based autoencoders has shown strong performance for 2D images, where deconvolutional layers are used to decode images. 3D point cloud processing and understanding are usually more challenging than 2D images due to the irregular structure of point cloud, while 2D image samples (pixels) rely on a 2D grid in the image plane. In this seminar, the student will conduct a literature survey on deep neural network based point cloud reconstruction methods [2][3][1][4]. The student should understand the main concepts of the state-of-the-art methods and compare their advantages and disadvantages.

- Literature survey
- Description and comparison of different methods
- Propose own ideas for future research
- Writing report

Bibliography:

[1] Thibault Groueix, Matthew Fisher, Vladimir G Kim, Bryan C Russell, and Mathieu Aubry. A papier-mâché approach to learning 3d surface generation. In *Proceedings of the IEEE conference on computer vision and pattern recognition*, pages 216–224, 2018.

[2] Charles R Qi, Hao Su, Kaichun Mo, and Leonidas J Guibas. Pointnet: Deep learning on point sets for 3d classification and segmentation. In *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition*, pages 652–660, 2017.

[3] Yaoqing Yang, Chen Feng, Yiru Shen, and Dong Tian. Foldingnet: Point cloud auto-encoder via deep grid deformation. In *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition*, pages 206–215, 2018.

[4] Yongheng Zhao, Tolga Birdal, Haowen Deng, and Federico Tombari. 3d point-capsule networks. *arXiv preprint arXiv:1812.10775*, 2018.

Supervisor: M. Sc. Shile Li

(D. Lee)
Univ.-Professor

TECHNISCHE UNIVERSITÄT MÜNCHEN
Human-centered Assistive Robotics
UNIV.-PROF. DR.-ING. DONGHEUI LEE

April 11, 2019

A D V A N C E D   S E M I N A R

Interactive Teaching and Active Learning in Programming by Demonstration

Problem description:

Learning from Demonstration (LfD) of robotic tasks, also known as Programming by Demonstration, is in the focus of research since many years. There are two open challenges. First, the behaviors are often demonstrated in a non optimal way, which leads to a non optimal robotic reproduction. Second, the robot is restricted to the learned behavior and does not know how to cope with novel situations. Active learning strategies can alleviate this problems, as the robot is able to incrementally gain knowledge from the user or environment. Therefore, the user provides further demonstrations in an interactive manner. Hereby, both robot and user can decide when new information should be provided, which combines active learning with an interactive teaching strategy.
Your baseline should be a system which is programmed by demonstration. Evaluate active learning approaches which are able to improve the robotic task outcome and how such systems are programmed by the user, e.g [1, 2, 3].
You can follow these research guidelines:

- Find and group active learning approaches in the context of LfD
- Which approaches could be useful for intuitive PbD?
- How do the approaches detect novelties and errors during execution?
- Compare the approaches and find their advantages and drawbacks

Bibliography:

[1] Andrea Bajcsy, Dylan P Losey, Marcia K O'Malley, and Anca D Dragan. Learning robot objectives from physical human interaction. *Proceedings of Machine Learning Research*, 78:217–226, 2017.
[2] Guilherme Maeda, Marco Ewerton, Takayuki Osa, Baptiste Busch, and Jan Peters. Active incremental learning of robot movement primitives. In *CoRL 2017-1st Annual Conference on Robot Learning*, pages 37–46, 2017.
[3] Mattia Racca and Ville Kyrki. Active robot learning for temporal task models. In *Proceedings of the 2018 ACM/IEEE International Conference on Human-Robot Interaction*, pages 123–131. ACM, 2018.

Supervisor: M. Sc. Thomas Eiband

(D. Lee)
Univ.-Professor

TECHNISCHE UNIVERSITÄT MÜNCHEN

Human-centered Assistive Robotics

UNIV.-PROF. DR.-ING. DONGHEUI LEE

April 12, 2019

A D V A N C E D   S E M I N A R
for
N.N., Mat.-Nr. XXXXXXX

Variable impedance control for human robot interaction

Problem description:

Robots nowadays are expected interact with uncertain enviornments and work in close contact with humans. Instead of pure position/force control, impedance control [3] aim at achieving a speficifc dynamic behavior between the robot and the environment for stable interaction control. Assigning this behavior neverhteless is not trivial and is highly dependent on the task at hand. Humans on the other hand, excel at their ability to physically interact with different environemnts by contiously modulating the stiffness, damping and inertial properties throughout the body, which allows them to effortlessly perform a variety of tasks [2]. Inspired by that, variable impedance control methods [1] have emerged enabling robots to adaptively modify their behaviour through a time-varying regulation of the controller impedance paramters. In this seminar, the student is expected to:

- Carry out a literature review on the different approaches used for variable impedance control methods.
- Identify application scenarios for variable impedance control with a specific focus on human-robot interaction.

Bibliography:

[1] Jonas Buchli, Freek Stulp, Evangelos Theodorou, and Stefan Schaal. Learning variable impedance control. *The International Journal of Robotics Research*, 30(7):820–833, 2011.

[2] Etienne Burdet, Rieko Osu, David W. Franklin, Theodore E. Milner, and Mitsuo Kawato. The central nervous system stabilizes unstable dynamics by learning optimal impedance. *Nature*, 414(6862):446–449, 2001.

[3] N. Hogan. Impedance control: An approach to manipulation. In *1984 American Control Conference*, pages 304–313, June 1984.

Supervisor: M. Sc. Youssef Michel

(D. Lee)
Univ.-Professor