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. Presentation techniques seminar: participants will be given advice and suggestions on presentation techniques, i.e. how to give scientific talks.
3. Report submission: submission of the final report, presentation and electronic copies of all publications read during the advanced seminar.
4. 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 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	19.10.2018	11:00 – 12:30 (2026@2906)
Final report submission	14.01.2019	12:00 (5007@2906)
Final presentations	17.01.2019	13:00 – 14:30 (5016@2906)

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

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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
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October 4, 2018

ADVANCED SEMINAR

Understanding upper torso movement during stable running

Problem description:

Human torso is stabilized by the counter torque provided by the movement of arms. During walking the arms oscillate with low flexion of the elbow while during running we observe a high flexion at the elbow. During sprints, athletes start with the torso angles forwards and towards the end the torso gets upright. A reason for such a strategy is to allow the body to accelerate without losing balance at the beginning of the sprint. A lot of generic walking and running models explore effect of lower limb dynamics but not the movement of the trunk and the arms. In this seminar the student will"

- Carry out a literature survey of existing walking/running models which utilize the upper body dynamics.

Bibliography:

Supervisor: M. Sc. Karna Potwar

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Univ.-Professor

TECHNISCHE UNIVERSITÄT MÜNCHEN
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September 27, 2018

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

A Comparison of Model-based and Data-driven Approaches for Dimensionality Reduction

Problem description:

Robotic systems, like humanoid robots, are becoming more and more complex. Humanoids have redundant limbs and articulated hands, which make their state space representation high dimensional. Reduce the dimension of the state space seems a promising approach to speed-up the simulation of humanoid robot dynamics and to prevent the course of dimensionality that affects standard learning approaches.

In this Advanced Seminar work, the student has to investigate and review state-of-the-art approaches for dimensionality reduction. In particular, the student is asked to compare data-driven [1, 2, 3, 4] and model-based [5] approaches and to identify the better suited for robotics applications. To this end, the student will compare existing approaches considering the accuracy of the approximation and the execution time.

Bibliography:

[1] N. D. Lawrence, "Gaussian process latent variable models for visualisation of high dimensional data", in *Advances in neural information processing systems*, pp. 329–336, 2004.
[2] P. Li and S. Chen, "A review on Gaussian Process Latent Variable Models", in *Transactions on Intelligence Technology*, vol. 1, n. 4, pp. 366–376, 2016.
[3] T. Lin and H. Zha, "Riemannian manifold learning", Transactions on Pattern Analysis and Machine Intelligence, vol. 30, n. 5, pp. 796–809, 2008.
[4] X. Wei, M. Kleinsteuber, and H. Shen, "Invertible Nonlinear Dimensionality Reduction via Joint Dictionary Learning", "International Conference on Latent Variable Analysis and Signal Separation", pp. 279–286, 2015.
[5] K. Carlberg, R. Tuminaro, and P. Boggs, "Efficient structure-preserving model reduction for nonlinear mechanical systems with application to structural dynamics", Structures, Structural Dynamics and Materials Conference, 2012.

Supervisor: Dr.-Ing. Matteo Saveriano

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TECHNISCHE UNIVERSITÄT MÜNCHEN
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October 4

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

6 DoF object pose estimation using RGB-D data

Problem description:

Estimating the 6D pose, i.e. 3D translation and 3D rotation, of a rigid object has become an accessible task with the introduction of consumer-level RGB-D sensors. An accurate, fast and robust method that solves this task will have a big impact in application fields such as robotics or augmented reality [1]. State-of-the-art 6D object pose estimation methods can be divided into hand-crafted feature based [3] and learning based methods [2]. Unlike some other computer vision tasks, for 6D object pose estimation, learning based methods haven't outperformed the hand-crafted feature based methods yet [1]. In this seminar, the student will conduct a literature survey for the state-of-the-arts 6D object pose estimation methods. The student should understand the main concepts of both categories and analyze their advantages and disadvantages. In the end, own ideas about future research direction will be proposed.

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

Bibliography:

[1] Tomas Hodan, Frank Michel, Eric Brachmann, Wadim Kehl, Anders Glent Buch, Dirk Kraft, Bertram Drost, Joel Vidal, Stephan Ihrke, Xenophon Zabulis, et al. Bop: Benchmark for 6d object pose estimation. *arXiv preprint arXiv:1808.08319*, 2018.

[2] Wadim Kehl, Fausto Milletari, Federico Tombari, Slobodan Ilic, and Nassir Navab. Deep learning of local rgb-d patches for 3d object detection and 6d pose estimation. In *European Conference on Computer Vision*, pages 205–220. Springer, 2016.

[3] Joel Vidal, Chyi-Yeu Lin, and Robert Martí. 6d pose estimation using an improved method based on point pair features. In *2018 4th International Conference on Control, Automation and Robotics (ICCAR)*, pages 405–409. IEEE, 2018.

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October 4, 2018

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

Learning Robot In-Contact Tasks from Demonstration

Problem description:

Robots have been long used with predefined pick and place operations. Beside free movements, more advanced robot task require contact situations, e.g. part assembly, surface processing, insertion skills, pressing. Hereby, learning by demonstration provides a fast and intuitive way of robot programming. With kinesthetic teaching, the human is able to demonstrate a task just by guiding the robot manually around while at the same time, the interaction behavior with the environment can be directly learned, including forces and compliance [3]. Besides kinesthetic teaching, motion tracking approaches can be found, such as [2] and [1], where instead of the robot, a tool is used for demonstration.
For the robotic task reproduction, a variety of control schemes are possible. On the one hand, specialized controllers perform well on specific tasks but fail to generalize. On the other hand, generic controllers can solve a variety of tasks but require more effort in learning.
An important point is, how the robot interprets the demonstrations in order to fulfill a desired behavior and account for constraints. Your task is do explore different methods for learning and reproduction of in-contact tasks. Focus on robot interactions with the environment first, and possibly extend it to interactions with humans.
You can start with the following research guidelines:

- Which method is used to demonstrate the task (e.g. single/multiple demonstrations, kinesthetic teaching etc.)
- How is the motion and force of the task encoded?
- Which type of controller is used for the reproduction of the interaction forces (e.g feed-forward, feed-back)?
- Is the stiffness/compliance of the robot adapted to execute the skill?
- How general is the learning scheme and can it be applied to novel situations?
- Can we specify rules on which method should be used in which context?

Bibliography:

[1] Giusti, Zeestraten, Icer, Pereira, Caldwell, Calinon, and Althoff. Flexible automation driven by demonstration: Leveraging strategies that simplify robotics. *IEEE Robotics & Automation Magazine*, 2018.
[2] Mohammad Khansari, Ellen Klingbeil, and Oussama Khatib. Adaptive human-inspired compliant contact primitives to perform surface–surface contact under uncertainty. *The International Journal of Robotics Research*, 35(13):1651–1675, 2016.
[3] Mattia Racca, Joni Pajarinen, Alberto Montebelli, and Ville Kyrki. Learning in-contact control strategies from demonstration. In *Intelligent Robots and Systems (IROS), 2016 IEEE/RSJ International Conference on*, pages 688–695. IEEE, 2016.

Supervisor: M. Sc. Thomas Eiband

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