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 to 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 or word. 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	

06.04.2018

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. In addition the central library as well as the institute's library can be used.

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	16.04.2018	14:00 – 15:00 (5016@2906)
Final report submission	02.07.2018	12:00 (5007@2906)
Final presentations	09.07.2018	10:00 – 11:00 (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
Human-centered Assistive Robotics
UNIV.-PROF. DR.-ING. DONGHEUI LEE

April 4, 2018

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

Control Strategies for Robot In-Contact Tasks Learned from Demonstration

Problem description:

The field of robots learning from human demonstrations is still rapidly growing and found its way into industrial applications. Kinesthetic teaching provides a way of intuitive and fast robot programming, where the human is able to demonstrate a task just by guiding the robot manually around. Additionally, the interaction behavior with the environment can be directly learned from the demonstrations, including forces and compliance.
For the robotic task reproduction, a variety of control schemes is possible. These control schemes are provided with different levels of previous knowledge about the task. On the one hand, predefined 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. You can start with a survey for static environment interactions and possibly extend it to interactions with humans. A focus shall be on learning from kinesthetic teaching, where single or multiple demonstrations of a task are used.
Recent examples of robot in-contact learning and control strategies can be found in [1] [2].
You can start with the following research guidelines:

- Which type of controller is used for the reproduction of the interaction forces?
- How 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 controller should be used in which context?

Bibliography:

[1] Aljaž Kramberger, Andrej Gams, Bojan Nemec, Dimitrios Chrysostomou, Ole Madsen, and Aleš Ude. Generalization of orientation trajectories and force-torque profiles for robotic assembly. *Robotics and Autonomous Systems*, 98:333–346, 2017.

[2] 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.

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TECHNISCHE UNIVERSITÄT MÜNCHEN
HUMAN-CENTERED ASSISTIVE ROBOTICS
UNIV.-PROF. DONGHEUI LEE

April 5, 2018

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

Identify a Minimal Taxonomy of Human Grasp Types

Problem description:

Human beings are capable of manipulating objects of different types in a dexterous and fast manner. Understanding the way humans grasp is a needed step towards a dexterous robotic manipulation. Several authors have investigated the way humans grasp and categorized human grasp types into different taxonomies [1, 2].

In this Advanced Seminar, the student has to investigate and review state-of-the-art approaches for the categorization of human grasp types. In particular, the student is asked to identified a minimal taxonomy of human grasp types, i.e. the taxonomy that contains less elements. To this end, the student will compare existing taxonomies that focus on categorizing the way humans grasp simple shape objects like spheres, cylinders, and cubes.

Bibliography:

[1] T. Feix, J. Romero, H. B. Schmiedmayer, A. M. Dollar and D. Kragic The GRASP Taxonomy of Human Grasp Types, in *IEEE Transactions on Human-Machine Systems*, vol. 46, no. 1, pp. 66–77, 2016.
[2] M. Vergara, J.L. Sancho–Bru, V. Gracia–Ibáñez, A. Pérez-González An introductory study of common grasps used by adults during performance of activities of daily living, in *Journal of Hand Therapy*, vol. 27, no. 3, 2014.

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

Hand pose estimation for hand-object interaction

Problem description:

Hand pose estimation plays an important role in human-robot interaction tasks, such as gesture recognition and learning grasping capability by human demonstration. Since emergence of consumer level depth sensing device, a lot of depth image based hand pose estimation methods appeared. For simplicity, most of the past research assumes that the hand is not interacting with other objects [1, 2]. However, for some application such as learning from demonstration, we still want to estimate the hand pose in case of interaction. Estimating hand pose with presence of an interacting object is a challenging task. For generative tracking approach [1], the object often disturb the optimization procedure. And for discriminative learning approach [2], hand-object cases are hard to annotate. In this seminar work, the student should conduct a literature survey on existing methods for hand-object interaction cases.

- Literature study on hand pose estimation for hand-object interaction case.
- Categorization and analysis of the surveyed methods.
- Identify a possible solution for deep learning based method.

Bibliography:

[1] Chen Qian, Xiao Sun, Yichen Wei, Xiaoou Tang, and Jian Sun. Realtime and robust hand tracking from depth. In *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition*, pages 1106–1113, 2014.

[2] Jonathan Tompson, Murphy Stein, Yann Lecun, and Ken Perlin. Real-time continuous pose recovery of human hands using convolutional networks. *ACM Transactions on Graphics*, 33, August 2014.

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