TECHNISCHE UNIVERSITÄT MÜNCHEN
INSTITUTE OF AUTOMATIC CONTROL ENGINEERING
ORDINARIUS: UNIV.-PROF. DR.-ING./UNIV. TOKIO MARTIN BUSS

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 to Miss Renner (Room N2515). 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 every one 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 preperation 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, dicussion 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 persion 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 refrence 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	21.10.2016	13:00 – 14:00 (5016@2906)
Lecture on presentation techniques	24.10.2016	9:30 – 11:30 (N0507)
Registration deadline	11.02.2017	23:59 (TUM Online)
Final report submission	12.01.2017	12:00 (Ms. Renner / N2515)
Final presentations	23.01.2017	13:00 – 14:20 (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: ______________________________

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14.10.2016

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

A literature review of approaches for multi-task movement primitive learning

Problem description:

Humans are very good at learning and reproducing complex tasks, but it is often tedious and cumbersome to program a robot to perform them. Programming by Demonstration (PbD) alleviates this problem, where a human teaches a skill to a robot through demonstrations. A seemingly complex demonstration can be decomposed into a set of simple primitives, which can be learned efficiently [1]. It has been shown that the learning of movement primitives can be extended to tasks that can compactly be parameterized [2]. Furthermore the learning of movement primitives can also consider multiple tasks at a time [3].
In this seminar work the student will:

- Study and compare existing multiple tasks movement primitives learning approaches.
- Identify problem domains where some multiple tasks movement primitives approaches are preferable over the others.

Bibliography:

[1] Schaal, Stefan. "Dynamic movement primitives-a framework for motor control in humans and humanoid robotics." Adaptive Motion of Animals and Machines. Springer Tokyo, 2006. 261-280.
[2] Stulp, Freek, et al. "Learning compact parameterized skills with a single regression." Humanoid Robots (Humanoids), 2013 13th IEEE-RAS International Conference on. IEEE, 2013.
[3] Lober, Ryan, Vincent Padois, and Olivier Sigaud. "Multiple task optimization using dynamical movement primitives for whole-body reactive control." Humanoid Robots (Humanoids), 2014 14th IEEE-RAS International Conference on. IEEE, 2014.

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16.10.2016

ADVANCED SEMINAR

Locomotion models to improve understanding of transition from walking to running in humans

Problem Description:

At a given cost of locomotion, humans prefer to run at a higher speed than walk at a lower speed. Minetti et al. [1] demonstrated that at a particular metabolic cost of locomotion humans prefer to run at 2.3 m/s than walk at 1.8 m/s. Geyer et al. [2] used this similar principle of metabolic cost of locomotion to show that a spring mass model can optimize itself to run or walk at a given speed and leg stiffness. Geyer et al. tried to generalize his results by exploring the domain space of the leg stiffness, landing angle and energy consumption. But there can be other influential locomotion parameters that dictate this transition from walking to running.

In this seminar the student will:

- Study existing locomotion models to evaluate other parameters apart from leg stiffness, energy consumption and touch down angle that can help in better understanding of the walking to running transition.
- Normalization technique for these parameters so as to negate individual anthropometric differences.

BIBLIOGRAPHY

[1] A. E. Minetti, L. P. Ardigò, and F. Saibene, “The transition between walking and running in humans: metabolic and mechanical aspects at different gradients.,” *Acta Physiol. Scand.*, vol. 150, no. 3, pp. 315–323, 1994.

[2] H. Geyer, A. Seyfarth, and R. Blickhan, “Compliant leg behaviour explains basic dynamics of walking and running.,” *Proc. Biol. Sci.*, vol. 273, no. 1603, pp. 2861–2867, 2006.

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UNIV.-PROF. DONGHEUI LEE

17 October 2016

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

Fast and accurate algorithms for robot-obstacles distance computation

Problem description:

Robots which safely operate in close interaction with humans are required to adapt their behavior in real-time in partially unknown and potentially dynamic environments. To avoid dangerous situations, the robots workspace has to be continuously monitored with visual sensors and the robot's motion on-line modified via reactive collision avoidance algorithms. Collision avoidance algorithms require the robot-obstacles minimum distance, which can be computed given the mesh model (CAD) of the robot and the current frame from the visual sensor. The algorithm used to compute the distance has to be fast, in order to match real-time requirements, and accurate.

In this Advanced Seminar, the student has to investigate fast algorithms for robot-objects distance evaluation [1, 2, 3]. The advantages and disadvantages of these algorithms will be discussed. In particular, the student has to focus on four aspects: *i)* computational cost, *ii)* memory requirement, *iii)* accuracy, and *iv)* possibility to parallelize the algorithm.

Bibliography:

[1] H. Samet. An Overview of Quadtrees, Octrees, and Related Hierarchical Data Structures *Springer Berlin Heidelberg*, 1988.
[2] S. Quinlan. Efficient distance computation between non-convex objects *International Conference on Robotics and Automation*, 1994.
[3] K. Kaldestad et al. Collision avoidance with potential fields based on parallel processing of 3d-point cloud data on the gpu *International Conference on Robotics and Automation*, 2014.

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10 October 2016

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

On-line Gaussian Processes for Robotics

Problem description:

Gaussian Processes (GP) [1] are statistical modelling tools that has been successfully used in a number of robotics applications, such as imitation [2] and reinforcement learning [3].

In this Advanced Seminar, we aim at investigating on-line, incremental learning algorithms for GP [4], [5]. These algorithms are useful to update the learned parameters according to new incoming data, without considering all the previous data. The advantages and disadvantages of these algorithms will be discussed, as well as possible robotics applications that requires to continuously refine or increase the robot knowledge.

Bibliography:

[1] C. E. Rasmussen and C. K. I. Williams. Gaussian processes for machine learning *MIT Press*, 2006.
[2] K. Kronander, S. M. Khansari Zadeh and A. Billard. Incremental Motion Learning with Locally Modulated Dynamical Systems *Robotics and Autonomous Systems*, 2015.
[3] M. P. Deisenroth and C. E. Rasmussen. PILCO: A Model-based and Data-Efficient Approach to Policy Search, in *International Conference on Machine Learning*, 2011.
[4] L. Csató. Gaussian Processes - Iterative Sparse Approximations *Aston University - PhD dissertation*, 2002.
[5] D. Nguyen-Tuong and J. R. Peters and M. Seeger. Local Gaussian Process Regression for Real Time Online Model Learning *Advances in Neural Information Processing Systems*, 2009.

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16. Oktober 2016

H A U P T S E M I N A R

Vision-based methods to track human hand

Problembeschreibung:

A key challenge in modern robotics and biomedical engineering is to design artificial hands able to reproduce human abilities [1]. The difficulty to handle human-like manipulation problems is mainly due to the high number of Degrees of Freedom (DOFs) concentrated in a small volume. As a consequence, the control of robotic grasp and manipulation is an interesting challenges for engineers and scientists in the fields of robotics and machine learning. In order to apply imitation learning methods to control anthropomorphic hands, techniques are required to track human hand motion. The objective of the Hauptseminar is to carry out a literature research concerning method to track human hand with vision systems.

- Literature review on vision-based methods to track human hand

Literatur

[1] Antonio Bicchi. Hands for dexterous manipulation and robust grasping: A difficult road toward simplicity. *Robotics and Automation, IEEE Transactions on*, 16(6):652–662, 2000.

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TECHNISCHE UNIVERSITÄT MÜNCHEN
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October 2016

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

Discontinuous Dynamical Systems

Problem description:

Many practical systems contain discontinuous components. For example, the motion of a rigid body becomes discontinuous when there is a collision with other rigid body. Also, discontinuity can be caused by the discontinuous algorithm that is connected to the system. The sliding-mode control is a popular example. Whenever a dynamical system has a discontinuous right-hand side, the existence of a solution is not guaranteed by the Peano's existence theorem; indeed, there is not a theorem that shows sufficient and necessary condition of the existence of a solution of the discontinuous initial value problem. Also, many important properties of continuous systems, e.g., uniqueness and continuation of solutions, controllability, stability, stabilizability, etc, cannot be discussed by the usual manner that are used in the continuous system. A mathematical tool to handle this problem is to extend the discontinuous system to the differential inclusion that has a set-valued map on the right-hand side and find the solution and properties of the solution with the differential inclusion [1]. In this advanced seminar, an elementary study of the discontinuous system and differential inclusion will be carried out.

- Literature survey of the discontinuous dynamical systems
- Documentation

Bibliography:

[1] Jorge Cortes, "Discontinuous Dynamical Systems," In *IEEE Control Systems*, 2008

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October 12, 2016

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

A literature review of approaches for depth based hand pose estimation

Problem description:

Hand pose estimation plays an important role in some 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. In case of continuous hand tracking, model-based optimization method can be used [2, 4]. For single frame based estimation and pose initialization, learning methods such as Random Forest and Neural Network are good options [3, 1, 5]. In this seminar work, the student will conduct a literature review on recent hand pose estimation works.

- Literature review on hand pose estimation.

Bibliography:

[1] Markus Oberweger, Paul Wohlhart, and Vincent Lepetit. Hands deep in deep learning for hand pose estimation. *arXiv preprint arXiv:1502.06807*, 2015.

[2] Iason Oikonomidis, Nikolaos Kyriazis, and Antonis A Argyros. Efficient model-based 3d tracking of hand articulations using kinect. In *BmVC*, volume 1, page 3, 2011.

[3] Danhang Tang, Jonathan Taylor, Pushmeet Kohli, Cem Keskin, Tae-Kyun Kim, and Jamie Shotton. Opening the black box: Hierarchical sampling optimization for estimating human hand pose. In *Proceedings of the IEEE International Conference on Computer Vision*, pages 3325–3333, 2015.

[4] Jonathan Taylor, Lucas Bordeaux, Thomas Cashman, Bob Corish, Cem Keskin, Toby Sharp, Eduardo Soto, David Sweeney, Julien Valentin, Benjamin Luff, et al. Efficient and precise interactive hand tracking through joint, continuous optimization of pose and correspondences. *ACM Transactions on Graphics (TOG)*, 35(4):143, 2016.

[5] Xingyi Zhou, Qingfu Wan, Wei Zhang, Xiangyang Xue, and Yichen Wei. Model-based deep hand pose estimation.

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