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

Scientific Seminar Autonomous System

Procedure:

The scientific 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 scientific 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 scientific seminar.
4. Final presentation: each participant has to present the results of his scientific seminar.

Participation in all events is a requirement for successful completion of the scientific 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 scientific seminar is based on the template attached below. In the assessment contains various criterion related to the preperation of the scientific 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 scientific seminar. Unexcused absence in any of the scientific 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	19.04.2016	09:00 – 10:20 (5016@2906)
Lecture on presentation techniques	28.04.2016	10:00 – 12:00 (N0507)
Registration deadline	07.04.2016	23:59 (TUM Online)
Final report submission	01.07.2016	12:00 (Ms. Renner / N2515)
Final presentations	11.07.2016	13:00 – 14:20 (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 scientific seminar:

Matriculation number: ____________________

First Name, Last Name: ______________________________

Date: ____________________

Signature: ______________________________

TECHNISCHE UNIVERSITÄT MÜNCHEN
LEHRSTUHL FÜR STEUERUNGS- UND REGELUNGSTECHNIK
ORDINARIUS: UNIV.-PROF. DR.-ING./UNIV. TOKIO MARTIN BUSS

01.03.2016

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.

Supervisor: M.Sc. Affan Pervez

(D. Lee)
Univ.-Professor

TECHNISCHE UNIVERSITÄT MÜNCHEN
LEHRSTUHL FÜR STEUERUNGS- UND REGELUNGSTECHNIK
ORDINARIUS: UNIV.-PROF. DR.-ING./UNIV. TOKIO MARTIN BUSS

01.04.2016

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

Similarity Measure of Anthropomorphic Motion

Problem description:

Imitation learning is a popular way of generating human-like movements for anthropomorphic robot systems [1]. In this context human motion data have to be modified in order to fit robot's physical constraints [2]. Similar strategy is also popular in the animation industry to generate natural looking motions. However how human-like the robot motion is seems to be an subjective judgment [3]. Researchers have defined different measures to support their algorithms. This seminar topic is to do an literature survey about the similarity measure of anthropomorphic motion, and come to a conclusion and suggestion for robot applications.

- Literature survey of similarity measure in robotics field.
- Literature survey of similarity measure in computer graphics field.
- Documentation

Bibliography:

[1] Schaal, Stefan. Is imitation learning the route to humanoid robots. In *Trends in cognitive sciences, 1999*.

[2] Kim, Seungsu and Kim, ChangHwan and You, Bumjae and Oh, Sangrok. Stable whole-body motion generation for humanoid robots to imitate human motions. In *IEEE/RSJ International Conference on Intelligent Robots and Systems, 2009*.

[3] Jeff K. T. Tang, Howard Leung*, Taku Komura andHubert P. H. Shum. Emulating human perception of motion similarity. In *Computer Animation and Virtual Worlds, 2008*.

Supervisor: M.Sc. Kai Hu

(D. Lee)
Univ.-Professor

TECHNISCHE UNIVERSITÄT MÜNCHEN
LEHRSTUHL FÜR STEUERUNGS- UND REGELUNGSTECHNIK
ORDINARIUS: UNIV.-PROF. DR.-ING./UNIV. TOKIO MARTIN BUSS

14.04.2016

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.

SUPERVISOR: M.Sc. Karna Potwar

D. Lee
(Univ. Professor)

TECHNISCHE UNIVERSITÄT MÜNCHEN
LEHRSTUHL FÜR STEUERUNGS- UND REGELUNGSTECHNIK
ORDINARIUS: UNIV.-PROF. DR.-ING./UNIV. TOKIO MARTIN BUSS

01 April 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.

Supervisor: M. Sc. Matteo Saveriano

(D. Lee)
Carl-von-Linde Fellow

TECHNISCHE UNIVERSITÄT MÜNCHEN
LEHRSTUHL FÜR STEUERUNGS- UND REGELUNGSTECHNIK
ORDINARIUS: UNIV.-PROF. DR.-ING./UNIV. TOKIO MARTIN BUSS

March 31, 2016

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

Deep Learning in Robotic Grasping and Manipulation

Problem description:

Robotic grasping in unstructured environments is still an open problem in the robotic community. In order to increase the flexibility and to avoid manually programming robotic systems, paradigms based on imitation learning and reinforcement learning are a potential, promising solution. Such learning approaches leverage parametric representations of motion trajectories. A well-known method to parameterize trajectories is based on Dynamical Movement Primitives (DMPs) [3]. Recently, robotic community started investigating the possibility to leverage deep learning methods to improve autonomy and flexibility of autonomous system. First promising results are shown in [1] and [2]. The student will carry out a literature review about deep learning methods applied in robotics, with particular emphasis on grasping and manipulation applications.
Task:

- Literature research on deep learning methods applied to robotic manipulation and grasping

Bibliography:

[1] Sergey Levine, Chelsea Finn, Trevor Darrell, and Pieter Abbeel. End-to-end training of deep visuomotor policies. *arXiv preprint arXiv:1504.00702*, 2015.
[2] Sergey Levine, Peter Pastor, Alex Krizhevsky, and Deirdre Quillen. Learning hand-eye coordination for robotic grasping with deep learning and large-scale data collection. *arXiv preprint arXiv:1603.02199*, 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.

Supervisor: Dr. Pietro Falco

(D. Lee)
Univ.-Professor

TECHNISCHE UNIVERSITÄT MÜNCHEN
LEHRSTUHL FÜR STEUERUNGS- UND REGELUNGSTECHNIK
ORDINARIUS: UNIV.-PROF. DR.-ING./UNIV. TOKIO MARTIN BUSS

April 2016

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

Stability of Prioritized Inverse Kinematics

Problem description:

There are many robotic applications that require us to consider multiple tasks with priority on the same time, e.g., obstacle avoidance, humanoid walking, dual arm manipulation, etc. In the prioritized inverse kinematics (PIK) problem, multiple tasks are defined on the kinematics level, usually velocity or acceleration, with priority and find the robot's joint motion that minimizes task errors [1]. To guarantee the convergence of the robot under the influence of uncertainties, the PIK usually contains a closed loop that may generate instability. So, there have been several studies related to the stability analysis of the PIK [2][3].

- Literature survey of the stability analysis of the prioritized inverse kinematics
- Documentation

Bibliography:

[1] S. An and D. Lee, "Prioritized Inverse Kinematics using QR and Cholesky Decompositions," In *IEEE International Conference on Robotics and Automation*, 2014

[2] G. Antonelli, "Stability Analysis for Prioritized Closed-Loop Inverse Kinematics Algorithms for Redundant Robotic Systems," In *IEEE Transactions on Robotics*, 2009

[3] S. Moe, A. Teel, G. Antonelli, and K. Pettersen, "Stability Analysis for Set-based Control within the Singularity-robust Miltiple Task-priority Inverse Kinematics Framework," In *IEEE Conference on Decision and Control*, 2015

Supervisor: M. Sc. Sang-ik An

(D. Lee)
Univ.-Professor

TECHNISCHE UNIVERSITÄT MÜNCHEN
LEHRSTUHL FÜR STEUERUNGS- UND REGELUNGSTECHNIK
ORDINARIUS: UNIV.-PROF. DR.-ING./UNIV. TOKIO MARTIN BUSS

01.04.2016

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

Motion segmentation and object discovery from image pair

Problem description:

For a dynamic scene without prior knowledge, motion is an important cue to discover unknown objects. Giving image pair or sequence, pixels can be grouped to different objects based on the motion information. Motion segmentation is an essential building block for many applications such as scene understanding, video surveillance, traffic monitoring. Different methods has been developed for motion segmentation task [1, 2, 3]. The student has to do a literature survey in this topic:

- Literature survey of motion segmentation.
- Comparison of different approaches.
- Documentation.

Bibliography:

[1] G. Zhang, J. Jia, and H. Bao. Simultaneous multi-body stereo and segmentation. In Proc. of the IEEE Int. Conf. on Computer Vision (ICCV) , 2011

[2] D. Cremers, S. Soatto. Motion competition: A variational framework for piecewise parametric motion segmentation. International Journal of Computer Vision, 2005

[3] M. Jaimez, M. Souiai, J. Stueckler, J. Gonzalez-Jimenez, D. Cremers. Motion Cooperation: Smooth Piece-Wise Rigid Scene Flow from RGB-D Images, In Proc. of the Int. Conference on 3D Vision, 2015

Supervisor: M.Sc. Shile Li

(D. Lee)
Univ.-Professor