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

Project Practical Course

(Human Centered Robotics)

Procedure:

The practical course (PP) will take place under the guidance of a supervisor individually, or with a team of maximum 3 students. The students have to plan tasks, document their progress and present results regarding the assigned topic. The PP includes the following events:

1. Kick-off Meeting: presentation of topics and description of time schedule for PP.
2. Project plan presentations: presentation and discussion of the project plan (after 2 weeks of kick off meeting)
3. Project progress meetings: presentation of project progress (after 6 weeks)
4. Final Deadline: Final report and presentation submission (approximately 2 weeks before end of lectures).
5. Final presentations: each participant presents the result of his PP.

Participation in **all** of the above events is a requirement for successful completion of PP. Participation of students will be documented by means of an attendance lists.

Final Deadline:

A printed copy of the report with a CD attached to last page should be submitted to (Room 5007@Karlstr.45). The CD should 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 should be made by using LaTeX or word. The supervisor should give you the template for the presentation and the report. The second page of the report should contain the assigned topic sheet. The report should only be stapled two times on the left side (no spiral or adhesive binding).

To evaluate the contribution of each student it is important to ensure that authors of each section is clearly evident. The report is supposed to provide an orderly description of the objective, the methods used, developed algorithms and discussion of results. The documentation should help the reader to understand the experimental setup, usage of the software and the hardware. The readers should be able to reproduce the experiment after reading the report. A comprehensive description of the topic is desirable, however, you should avoid lengthy statements. Experimental protocols, computer print outs etc. should be arranged clearly and attached in Appendix.

The written copy should preferably be available to the supervisor at least 1 week before the deadline of the final submission.

Final presentation:

The duration of the final presentation is 10 minutes. After the presentation, a 5 minutes discussion session will take place in which the students should actively participate. The contribution of each student in the discussion session is included in the grading.

Since the audience might contain people who are not familiar with your work, a clear and comprehensive outline of your ideas and presentation is essential. Explain the problem and the results in detail. The following presentation sequence is recommended:

- 2-3 slides for introduction and explanation of task,
- 4-6 slides for the work conducted,
- 2-3 slides for the results.

Grading:

The final evaluation is based on the attached template. It includes different criterion regarding the preparation of the project description, the final presentations, report and participation in the discussion.

I. Preparation phase

No.	Criteria	Grade
1	**Introduction:** understanding and overview given the difficulty of the task	
2	**Organization:** organization, time management, persistence and diligence	

II. Results (Theory, Software, Hardware)

3	**Goal:** to what extent was the goal achieved considering the requirements/expectations	
4	**Applicability of results:** Generalizability of theory and methodology, functionality of the hardware and the software	

III. Written report (Documentation)

5	**Formatting:** structure, completeness and resources	
6	**Writing content:** style, expression and comprehension of discussion / evaluation of results	

VI. Final presentation

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

Role of supervisors:

The supervisor is your reference person in case of any inquiries. The supervisor supports you in technical matters, introduces you to the required tasks, final report and presentation of the results. In addition to answering your inquiries he helps you with procurement of software and hardware, work orders from the work shop and working on the weekends. The initiative should be taken from the student side.

Project resources:

At the beginning of the project you should have a rough time plan for the milestones. You should constantly update your time schedule and talk about this with your supervisor to avoid unnecessary waste of time. The literature related to your topic is a major help during the beginning. The literature search can be carried out at the central library of TUM or also at the library of the available department.

You are free to carry out work on your private computer or the institution computer. For working at the institute's computer a working account is necessary. All the data should be stored in your home directory.

Absence:

There are strict regulations against unexcused absence during the practical course. Unexcused absence in any of the practical course events will lead to failure in the course. In case of illness a medical certificate must be presented. Overlap with other courses in 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	18.10.2019	14:00 – 15:00 (2026@2906)
Project plan presentations	15.11.2019	14:00 – 15:00 (2001@2906)
Project progress presentations	13.12.2019	14:00 – 15:00 (2001@2906)
Final report submission	27.01.2020	12:00 (5007@2906)
Final presentations	31.01.2020	14:00 – 15:00 (2001@2906)

* 2001@2906 is a seminar room (2001) on the second floor in Karlstr. 45, München.

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I have read and acknowledge the above information and guidelines of the practical course:

Matriculation number:

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First name, Last name:

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Date:

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Signatures:

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P R A C T I C A L   C O U R S E

Training an object autoencoder using synthetic data

Problem description:

Object pose estimation plays an important role in many robotic applications, such as grasp planning, learning from demonstration. Using state-of-the-art deep learning methods, the object pose can be estimated using the captured camera image without using markers[2, 3]. To better interpret the image data, the autoencoder was widely used to encode a good representation of input data. In this project, the student will firstly generate a small synthetic dataset using textured mesh model [1] and then train an autoencoder on the generated dataest, and finally test the model with real captured data.

Tasks:

- Literature study
- Use synthetic rendering to generate dataset
- Training and testing on several object models
- Test with real captured data

Bibliography:

[1] Berk Calli, Arjun Singh, Aaron Walsman, Siddhartha Srinivasa, Pieter Abbeel, and Aaron M Dollar. The ycb object and model set: Towards common benchmarks for manipulation research. In *2015 international conference on advanced robotics (ICAR)*, pages 510–517. IEEE, 2015.

[2] Martin Sundermeyer, Zoltan-Csaba Marton, Maximilian Durner, Manuel Brucker, and Rudolph Triebel. Implicit 3d orientation learning for 6d object detection from rgb images. In *Proceedings of the European Conference on Computer Vision (ECCV)*, pages 699–715, 2018.

[3] Yu Xiang, Tanner Schmidt, Venkatraman Narayanan, and Dieter Fox. Posecnn: A convolutional neural network for 6d object pose estimation in cluttered scenes. *arXiv preprint arXiv:1711.00199*, 2017.

Supervisor: M. Sc. Shile Li

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Univ.-Professor

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September 30, 2019

PRACTICAL COURSE

Planning in the Force Domain with Continuous Observation Space

Problem description:

When transferring a new skill to a robot, it should be as intuitive as possible. Therefore, Learning from Demonstration can outperform traditional programming techniques and even conditions in the execution can be considered [1]. On the other hand, robotic tasks might not only be learned from demonstration but can be also be solved by a planner. Hereby, a goal state is provided and the planner finds autonomously all intermediate steps which are required to achieve the goal. The problem with symbolic planners is that they can hardly be applied to continuous spaces. One solution is presented in [2].
The goal of this project is to evaluate to what extend a planning framework is able to reproduce a task that has been learned by demonstration, which additionally involves interaction forces with the environment.
You will be provided with data from a weight-based sorting task, that has been learned by demonstration. Further, you will use open source code for the planning environment.

Tasks:

- Use an existing planning framework such as POMDP or POMCP [2] to reproduce a force based sorting task.
- Report which kind of prior knowledge and parameterization is required to make the planner work.
- Evaluate your results in terms of computational requirements and feasibility to the given problem.

Bibliography:

[1] T. Eiband, M. Saveriano, and D. Lee. Intuitive programming of conditional tasks by demonstration of multiple solutions. *IEEE Robotics and Automation Letters*, pages 1–1, 2019.
[2] David Silver and Joel Veness. Monte-carlo planning in large pomdps. In *Advances in neural information processing systems*, pages 2164–2172, 2010.

Supervisor: M. Sc. Thomas Eiband

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October 4, 2019

P R A C T I C A L   C O U R S E
for
N.N., Mat.-Nr. XXXXXXX

Evaluating the effect of biomemetic light touch contact on postural balance

Problem description:

Light touch contact (Force < 1N) with a stationary surface reduces body sway improving the postural balance control [1]. This contact is not sufficient to support the body mechanically, and thus the reduction can be attributed to improved sensory feedback through light touch cues. In contrast, light touch with a human partner [2] or a moving reference [3] leads to sway entrainment effects. In this Projektpraktikum, the student will use an existing postural balance model to generate reference trajectories for a robotic manipulator (haptic device) which will be then used to evluate the effect of a light touch feedback that mimics the biological sway properties of humans, on the postural balance of a contact reciever.

Tasks:

- Use a postural balance model for generating reference motions for a Haptic device
- Perform pilot testing with human participants.

Bibliography:

[1] James R. Lackner, Ely Rabin, and Paul DiZio. Stabilization of posture by precision touch of the index finger with rigid and flexible filaments. *Experimental Brain Research*, 139:454–464, 2001.
[2] Raymond F. Reynolds and Callum J. Osler. Mechanisms of interpersonal sway synchrony and stability. *Journal of The Royal Society Interface*, 11(101):20140751, 2014.
[3] Alan M. Wing, Leif Johannsen, and Satoshi Endo. Light touch for balance: influence of a time-varying external driving signal. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 366(1581):3133–3141, 2011.

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