TECHNISCHE UNIVERSITÄT MÜNCHEN

Human-centered Assistive Robotics

Prof. Ph.D. Dongheui Lee

Project Practical Course

(Human Centered Robotics)

Procedure:

The practical course (PP) will take place under the guidance of a supervisor 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 1 week 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 and a CD should be submitted (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 incase 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	16.04.2018	13:00 – 14:00 (5016@2906)
Project plan presentations	30.04.2018	09:00 – 10:00 (5016@2906)
Project progress presentations	04.06.2018	09:00 – 10:00 (5016@2906)
Final report submission	02.07.2018	12:00 (Ms. Schneider / 5006@2906)
Final presentations	09.07.2018	09:00-10:00 (5016@2906)

* 5015@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 of the practical course:

Matriculation number: ____________________

First name, Last name: ______________________________

Date: ____________________

Signatures: ______________________________

TECHNISCHE UNIVERSITÄT MÜNCHEN
Human-centered Assistive Robotics
UNIV.-PROF. DR.-ING. DONGHEUI LEE

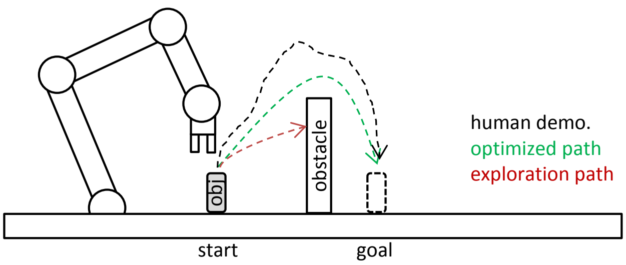
April 4, 2018

PRACTICAL COURSE

Tactile Exploration of Demonstrated Trajectories

Problem description:

Through kinesthetic teaching, a human is able to demonstrate a desired path just by guiding the robot manually around. These demonstrations might not be optimal in terms of speed, trajectory length or energy consumption, which leads to non-optimal reproductions. One strategy is to use tactile exploration, where the robot uses a force sensor at the tip to identify constraints of the environment and find an optimized trajectory, e.g. an efficient reaching path to an object.
As an example, Rey et al. [1] use reinforcement learning to optimize demonstrations. Your goal is to implement an applicable strategy of robotic exploration which optimizes a demonstrated robot path. The challenge is that the path cannot be arbitrarily shaped as start and end-conditions must be hold, e.g. to pick an object from a box. Furthermore, the variability in multiple demonstrations can be exploited to parametrize the robotic exploration strategy.
You are provided with Matlab-code for trajectory learning from multiple demonstrations with Gaussian Mixture Models (GMM) and Regression (GMR). Your optimization approach shall be tested in simulation with different obstacle configurations.



Tasks:

- Study the encoding of movements with GMM/GMR
- Implement the reinforcement learning approach based on [1] and adapt it for tactile exploration
- Evaluate your approach in simulation

Bibliography:

[1] Joel Rey, Klas Kronander, Farbod Farshidian, Jonas Buchli, and Aude Billard. Learning motions from demonstrations and rewards with time-invariant dynamical systems based policies. *Autonomous Robots*, pages 1–20, 2017.

Supervisor: M. Sc. Thomas Eiband

(D. Lee)
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TECHNISCHE UNIVERSITÄT MÜNCHEN
HUMAN-CENTERED ASSISTIVE ROBOTICS
UNIV.-PROF. DONGHEUI LEE

April 5, 2018

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

Learning Control Policies for In-Hand Manipulation using a Kinematic Hand Model and Model-based Reinforcement Learning

Problem description:

In-hand manipulation, which consists in modifying the pose of a grasped object using only finger movements, in an interesting open problem in robotics. Indeed, analytically deriving a model for an in-hand manipulation task is not trivial, due to the complexity introduced by physical contacts and under-actuated fingers. For this reason, reinforcement learning approaches [1] are promising in learning in-hand manipulation tasks, but not fully exploited so far.

In this Practical Course work the student has to implement the learning algorithm in [2] and apply the approach to learn in-hand manipulation tasks. A kinematic model of a five-fingered, under-actuated robotic hand will be used as an approximate model. The approach will be tested in a simulated environment.

Tasks:

- Implementation of the approach in [2] in Matlab/Simulink.
- Evaluation in a simulated environment.
- Experimental evaluation on the ADA Hand (optional).

Bibliography:

[1] J. Kober, D. Bagnell, and J. Peters. Reinforcement learning in robotics: a survey, in *IJRR*, 2013.
[2] M. Saveriano, Y. Yin, P. Falco, and D. Lee. Data-Efficient Control Policy Search using Residual Dynamics Learning, in *IROS*, 2017.

Supervisor: M. Sc. Matteo Saveriano

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

Implementation of a ROS package for human hand pose estimation

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. Current state-of-the-art methods [1][2] use Convolutional Neural Networks (CNN) to regress the hand pose directly from single image. In previous project, we obtained a trained Tensorflow model for hand pose estimation, however, this only works for pre-processed dataset samples. In this practical course, the student should implement a ROS package to transfer the trained model into a online hand pose estimation system. The ROS package should:

Tasks:

- read in image from the depth camera.
- localize the hand in the image with a blue wrist band.
- predict the hand pose using pretrained Tensorflow model.

Bibliography:

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

[2] Markus Oberweger and Vincent Lepetit. Deepprior++: Improving fast and accurate 3d hand pose estimation. In *ICCV workshop*, volume 840, page 2, 2017.

Supervisor: M. Sc. Shile Li

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