TECHNISCHE UNIVERSITÄT MÜNCHEN
Human-centered Assistive Robotics
UNIV.-PROF. DR. GORDON CHENG

April 26, 2022

PRACTICAL COURSE
for
Student's name, Mat.-Nr. XXX

Updating goals of parameterized tasks taught via kinesthetic teaching using vision

Problem description:

Nowadays robots need to be more adaptable and easily programmed, even by non-expert users, to be used in a large variety of fields such as assistive robotics or collaborative robotics. A way to make programming accessible to all is learning from demonstration methods [1] among which are kinesthetic teaching, tele-manipulation, or visual demonstrations. The tasks to be taught can be difficult to demonstrate due to the difficulty to edit them, re-use knowledge, know what is taught. This is why an intuitive graphical user interface (GUI) [2] that enables an interactive learning process can be an important tool to ease the teaching process for the non-expert user. This interface can be inspired by the task-level programming interface [4] to visualize the skills composing the task-graph. The aim of this practical project is to allow the user of the robot to update the goal of a task/skill by clicking on the object to be considered for the task/skill inside this GUI.

Tasks:

During this project your task will be to:

- Use an intel realsense depth camera to obtain the visual information of the scene
- Work on detecting the objects used for the taught task using yolov5 [3]
- Create/improve a GUI that gives the user access to this visual information and allows the user to select an object
- Update the goal information of the task with the center position of the object

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TECHNISCHE UNIVERSITÄT MÜNCHEN

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April 25, 2022

PRACTICAL COURSE

Dependence of the effect of vibrotactile biofeedback on postural control on stimulus and reference system location

Problem description:

Wearable devices have been developed and investigated [8] for improving postural control. They provide a good opportunity for the application in everyday life [7]. Especially vibrotactile feedback is feasible for applications in everyday life, since it is unobstrusive [9] and not restricting other sensory functions, such as seeing, hearing, tasting[1].Previous studies have used vibrotactile feedback at different locations [2], most commonly around the waist [4, 5, 10, 12]. However, reaction times to vibrotactile feedback are faster at locations closer to the head, except for the fingertips due their higher tactile sensitivity [2]. Thus, recently a vibrotactile vest was investigated [11]. However, only a local reduction of tilt angle deviation at the lower back could be observed, while center of pressure (CoP) displacement did increase [11]. Though, previous studies with a vibrotactile belt showed a reduction of body sway at both low back and CoP [3, 6]. It remains unknown, if these different observations are due to the location of the feedback or to what extent also the location of the reference system plays a role.

Tasks:

- Change vibration motors in vibrotactile vest
- Build vibrotactile belt
- Prepare scripts

  compute body sway threshold based on different reference locations and systems: upper back (IMU), lower back (IMU), feet (pressure insoles)

  data collection and analysis
- Answer the following research question: Does the effect of vibrotactile biofeedback on postural control depend on the body location of stimulation and reference system?

  Therefore, compare the effect of repulsive biofeedback on body sway 1) resulted from a vibrotactile vest vs. a vibrotactile belt compared to no feedback condition, 2) resulted from different reference sensor locations (upper back, lower back, feet).

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April 26, 2022

PRACTICAL COURSE
for
Student Name, Mat.-Nr. XXXXXXX

A comparison between EMG and Regression based stiffness estimation methods for Variable Impedance Control

Problem description:

Variable Impedance Control [1] has recently emerged as one of the promising techniques to control the robot behavior for a wide variety of applications and task requirements. The main idea is to adapt the robot impedance parameters (inertia, stiffness and damping) to enable the robot display the required behavior to its environment, and even adapt these parameters in a continuous manner. Out of the three impedance parameters, the stiffness has received the most attention in the literature. Several approaches were proposed with the aim to transfer and extract human stiffness adaptation skills to robots. For example, EMG-based approaches [2] rely on the idea of measuring the human arm configuration and muscle activation, and using it to estimate the end-point stiffness. On on the other hand, regression based approaches [4, 3] collect data from the robot and use it to fit a second order model of mass-spring-damper. In this PP, our aim is to compare between the two approaches in terms of the resulting stiffness profiles from conducting the same task via teleoperation on a robot.

Tasks:

- Prepare a hardware setup that can be used for EMG-based stiffness extraction
- Conduct a calibration procedure in order to fit the EMG model parameters.
- Perform a teleoperated contact task and extract the data
- Analyze the data and compute the resulting stiffness profiles, both via regression and EMG.

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April 26, 2022

PRACTICAL COURSE
for
Student Name, Mat.-Nr. XXXXXXX

Design and verification of a force sensor observer on a haptic device

Problem description:

Estimating external forces acting on a robotic device is a extremely useful feature that provides the robot an additional sense of touch. This is crucial whether from a control perspective where applications such as force control requires an estimation of forces acting on the robot end-effector for an accurate regulation of these forces, or from a safety perceptive to react appropriately to potential robot collisions. Furthermore, recent works in shared control [3] rely on the idea of estimating human applied external forces to estimate human intent. Unfortunately, force sensing typically require the presence of expensive force sensors. To solve that, recent works proposed the use of sensorless force estimation techniques such as momentum [1] and sliding mode observers. In this work, our aim is to adapt the approach from [2] to estimate the external forces acting in real-time on a haptic device. Furthermore, in order to verify the sensor results, we would like to compare the results with measurements obtained from a real-force sensor.

Tasks:

- Understand the approach from [2] and verify in simulations
- Implement the approach on the haptic device
- Design of a force sensor handle that can be mounted on the haptic device
- Analyze and compare the results.

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