

B3M33HRO HW4

Multisensorial Calibration

1 Introduction

You are provided with a model of the iCub robot. The model is created with **Denavit-Hartenberg (DH)** parameters. The model is based on **iCub V2** (without legs for simplicity). Some parameters were changed in the model. Your assignment is to calibrate them. The changed parameters can be checked in **Table 1** and in the provided whitelist, where only the changed parameters are marked with '1'. You are provided with three datasets created in the iCub simulation. Each of the datasets contains one subdataset for *self-touch* and one for *projections*. In the case of *self-touch*, the robot was touching with *rightHandFinger* and *leftHandFinger*. In the case of *projections*, both eyes were looking at these fingers. There are no **ArUco markers** in the simulation, so the reference points for *projections* were computed manually with a pinhole camera model. An example pose can be seen in **Figure 1**.

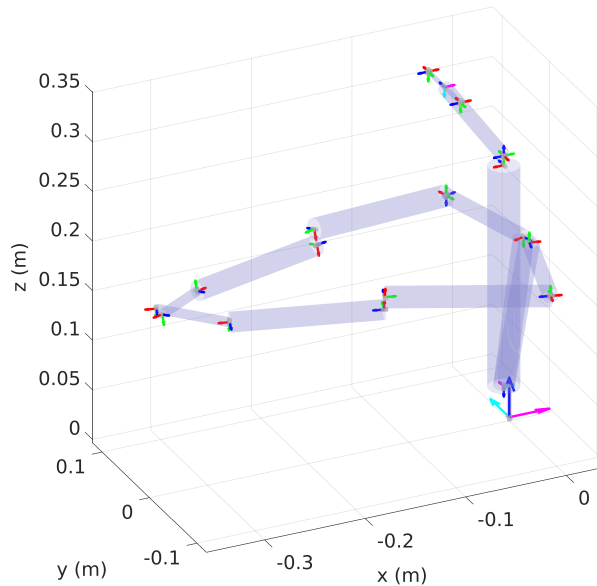


Figure 1: Example of one pose in the dataset.

	Dataset value [m/rad]	Model values [m/rad]
<i>rightHandFinger d</i>	0.016	0.02598
<i>leftHandFinger d</i>	-0.016	-0.02598
<i>rightWristPitch d</i>	-0.1373	-0.1413
<i>leftWristPitch d</i>	0.1373	0.1413
<i>rightShoulderYaw θ</i>	-1.5708	-1.6938
<i>leftShoulderYaw θ</i>	-1.5708	-1.4478
<i>rightWristProsup θ</i>	0	0.123
<i>leftWristProsup θ</i>	0	-0.123

Table 1: Changed parameters.

2 Assignment

You should do all tasks denoted with **T** in the following bullet points and send an archive with results folders (the one created automatically after calibration) for all of them—10 folders. In addition, the other output should be a PDF file that answers all the questions marked with **Q**.

- Get familiar with [Multisensorial robot calibration toolbox](#) (MRC).
 - Install it with instructions from README or the [course website](#).
- Download files with the model and other scripts from the [course website](#).
 - Extract them to the folder where you installed MRC—near the folders *Robots*, *Templates*, etc. The recommended structure (inside the MRC folder) can be seen in Figure 2.

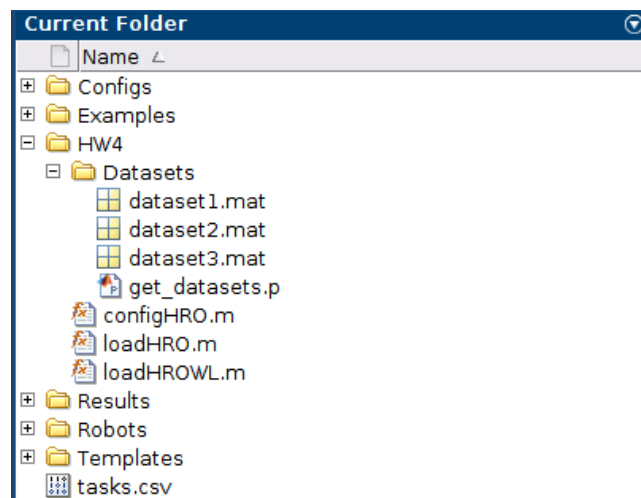


Figure 2: Recommended structure of MRC folder.

- In Matlab, navigate to `MRC_install_path/HW/Datasets` and run `get_datasets(your_CTU_username)`.
 - Use the *username* you use to log in *KOS*, *BRUTE*, etc.
 - Your personal datasets will be downloaded.
 - The files will get downloaded into the current folder, and it is recommended to do it in `MRC_install_path/HW/Datasets`.
- **T:** Edit parameters `options.TolFun`, `options.TolX`, `options.MaxIter`, `options.InitDamping`, `options.MaxFunctionEvaluations` in `configHRO.m` to make the calibration work as expected.
 - You can learn about the parameters at [lsqnonlin documentation](#).
 - **Q:** What parameters did you choose and why?
 - *Hint:* You will probably change the values often, and the first selected values may be wrong. So, it is a good idea to answer after all calibrations are done.
- **T:** Calibrate the robot with each of the three datasets with: *self-touch*, *self-observation*, and a combination of both—at least different 9 calibrations.
 - You can calibrate everything just once or sequentially—execute calibration, load the results into the *Robot* and calibrate again. **Q:** Describe what method you used and explain why.
 - **Q:** Select an appropriate number of repetitions (`optim.repetitions` in `configHRO.m`) and explain why you chose the given number.
 - * *Note:* Each calibration will run for the given number of repetitions without perturbations and also with perturbations defined in the config file.
 - **Q:** After the final calibrations (when you get the best results in your opinion), insert the figures of *Corrections* for each calibration without perturbations into the PDF—9 figures.

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- * **Important:** To do so please call function `plotCorrectionsHRO(name_of_the_results_folder)`. This function must be called directly from *Matlab command line* and cannot be called from GUI, because it is added specifically for this HW.
 - **Q:** Insert also figures with errors of your choice (Boxplots, Bars, Histogram, *etc.*)—now insert 9 figures for the results without perturbations and 9 with perturbations. Explain why you think these are the correct results.
 - **Q:** For each dataset describe which approach worked the best. Try to explain why. Explain also what is the problem with the other approaches—feel free to insert any figure that will support your claims. How would you fix it?
 - * *Hint:* Remember that the *self-touch* dataset is created directly in a simulation, and *self-observation* is created *a posteriori* with a pinhole camera **model**.
 - * *Hint 2:* Check some properties of the datasets we were talking about in the labs.
 - * *Hint 3:* Check the actual values in the datasets. Mainly *refPoints*.
 - * *Note:* You do not need to fix the problem, just describe what is wrong.
 - **T:** Select one dataset and one approach and calibrate the robot without loading the additional *Whitelist*—use only the default one in the loading function.
 - **Q:** Insert *Corrections* and errors figures—one figure without and one figure with perturbations. Describe the results. If the calibration precision changes, describe why you think it is like that.
 - **Note:** Each of you will have different datasets. If something works for your classmate, it does not mean it will work for you.