Description of Mocap to Robot Dataset

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1 Data Organization

The **Mocap to Robot** dataset is divided into 3 folders:

1. `Motion_Capture_Data`
2. `Motion_Verification_Data`
3. `Optimization_Algorithm_Data`

`Motion_Capture_Data` contains the original motion capture data as exported from **Visual3D** and all post-processing done to generate a FANUC motion program. `Motion_Verification_Data` contains all the files that were captured via the NDI Optotrak Certus while recording the trajectory of a rigid body attached to the robot end-effector. These files are utilized to verify that the robot closely matched the programmed motion capture trajectories. `Optimization_Algorithm_Data` contains the necessary input files for the optimization algorithms that map the motion capture trajectories to the robot joint space.

2 Motion Capture data

The motion capture data is organized first by activity, then by subject. Each subject will have up to 3 trials per activity. Each trial will contain the following files:

1. `UEK_[SubjectId]_[Activity][TrialId]._V3D.c3d.txt` - motion capture data as exported from Visual3D
2. `UEK_[SubjectId]_[Activity][TrialId].smoothFrames.txt` - smoothed motion capture trajectory expressed as n 4x4 homogeneous matrices, where n is the number of timepoints in the trajectory
3. `UEK_[SubjectId]_[Activity][TrialId].indices.txt` - indices (starting at 1) of timepoints to keep once the trajectory has been non-uniformly subsampled at 20%.
4. `UEK_[SubjectId]_[Activity][TrialId].indicesUniform.txt` - indices (starting at 1) of timepoints to keep once the trajectory has been uniformly subsampled at 20%.
5. `UEK_[SubjectId]_[Activity][TrialId].ssErrors.txt` - subsampling error at each timepoint resulting from non-uniform subsampling for the proximal (mm) and distal (mm) humerus position, as well as the humeral orientation (deg).
6. `UEK_[SubjectId]_[Activity][TrialId].ssErrorsUniform.txt` - subsampling error at each timepoint resulting from uniform subsampling for the proximal (mm) and distal (mm) humerus position, as well as the humeral orientation (deg).
7. `UEK_[SubjectId]_[Activity][TrialId].plot.txt` - the normalized (with respect to the first frame) components of the proximal and distal humerus position, as well as the rotation vector associated with the humeral orientation, expressed in the motion capture reference frame. This file is simply utilized for plotting.
8. `UEK_[SubjectId]_[Activity][TrialId].joints.txt` - the joint space trajectory corresponding to the `*.smoothFrames.txt` trajectory as determined from the optimization algorithm.

9. [Activity]_[SubjectId]_[TrialId]_[SpeedMultiplier]_[(Non)UniformSubampling][DeprecatedIdentifiers]_INIT.ls - the initialization FANUC motion program for the trial. This motion program is run in order to put the robot in its starting position. It is comprised of the first timepoint in *.joints.txt.

10. [Activity]_[SubjectId]_[TrialId]_[SpeedMultiplier]_[(Non)UniformSubampling][DeprecatedIdentifiers].ls - the FANUC motion program that robotically replicates the trial. This program is comprised of the timepoints of *.joints.txt that are specified in *.indices.txt - except for the 1st timepoint.

3 Motion Verification data

The robot trajectory verification data is organized first by activity, then by date upon which the experimental session took place. Each date will contain files related to robot frame identification procedure and one or more trial verifications. The verification data was collected using a custom hemisphere rigid body comprised of 16 light emitting diodes and the Northern Digital Inc. (NDI) Optotrak Certus. The NDI software outputs both the 3D positions of each of the markers and the 6D pose (position and orientation) of the rigid body. The files related to the robot frame identification procedure are:

- Joint13D.csv - marker trajectories while robot rotates its 1st joint
- Joint16D.csv - hemisphere trajectory while robot rotates its 1st joint
- Joint23D.csv - marker trajectories while robot rotates its 2nd joint
- Joint26D.csv - hemisphere trajectory while robot rotates its 2nd joint
- Joint43D.csv - marker trajectories while robot rotates its 4th joint
- Joint46D.csv - hemisphere trajectory while robot rotates its 4th joint
- Position3D0.csv - marker trajectories while robot rotates (without translating) about its end-effector joint
- Position6D0.csv - hemisphere trajectory while robot rotates (without translating) about its end-effector

The files related to the trial verification are:

- [Activity]_[SubjectId]_[TrialId]_[SpeedMultiplier]_[(Non)UniformSubampling][DeprecatedIdentifiers]_3D.csv - marker trajectories while robot performs the activity for the subject and trial indicated.
- [Activity]_[SubjectId]_[TrialId]_[SpeedMultiplier]_[(Non)UniformSubampling][DeprecatedIdentifiers]_6D.csv - hemisphere trajectory while robot performs the activity for the subject and trial indicated.
- [Activity]_[SubjectId]_[TrialId]_[SpeedMultiplier]_[(Non)UniformSubampling][DeprecatedIdentifiers]_jointPos.csv - positions of the robot's joints as captured from the M20ia robot controller.
- [Activity]_[SubjectId]_[TrialId].toolframe.xml - if the main humerus tool frame was not utilized to recreate this trajectory (activity/subject/trial), then this file contains the tool frame that was utilized.
- [Activity]_[SubjectId]_[TrialId]_[SpeedMultiplier]_[(Non)UniformSubampling][DeprecatedIdentifiers].csv - simply a summary file that contains a pointer to the original trial file (*.c3d).
- [Activity]_[SubjectId]_[TrialId]_[SpeedMultiplier]_[(Non)UniformSubampling][DeprecatedIdentifiers]_sum.txt - a summary file containing the results of processing the trial verification data.
- [Activity]_[SubjectId]_[TrialId]_[SpeedMultiplier]_[(Non)UniformSubampling][DeprecatedIdentifiers].pdf - a visual summary file containing the results of processing the trial verification data.
- [Activity]_[SubjectId]_[TrialId]_[SpeedMultiplier]_[(Non)UniformSubampling][DeprecatedIdentifiers]_trunc.pdf - a visual summary file containing the results of processing the trial verification data.

4 Optimization Algorithm Data

The `URDF` folder contains the Unified Robot Description Format file for the robot utilized in this investigation. The `Seeds` folder contains seeds (the robot's initial joint angles) utilized in the optimization algorithm. The `Toolframes` folder contains the virtual and physical humeral tool frames that were utilized in this investigation.