Modified Gait Extraction Toolbox

Quick User Manual

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Introduction

This GUI toolbox utilises Matlab and the Biomechanical ToolKit (btk) to extract and convert experimental data (e.g. c3d file) into OpenSim compatible files. This toolbox works for any laboratory setup (e.g. force plate and marker labels) and can be used to extract data from any static or dynamic movement such as walking, running, jumping, drop landing, throwing, etc. and any number of force plates.

This toolbox combines two extraction toolboxes created by Tim Dorn (Stanford University) and Glen Lichtwark (University of Queensland). For an in-depth description of some of the functions used in this toolbox and to download unmodified versions of these toolboxes, please follow the links below,

- Tim's toolbox: https://simtk.org/home/c3dtoolbox/
- Glen's toolbox: https://simtk.org/home/matlab_tools.

It is also recommended that you have Mokka installed onto your computer to visualise and label the c3d trials. It can be downloaded at http://btk.googlecode.com/svn/web/mokka/index.html.

Installing toolbox and setting paths

1. Load Matlab
2. To include all the toolbox functions into your Matlab workspace, add the **c3d2opensimTools_public** folder directory and all the sub-directories in **Set Path** function in Matlab
3. Depending on the version of MATLAB (i.e. 32-bit or 64-bit), go to https://code.google.com /p/b-tk/wiki/MatlabBinaries and download the version of the BTK Matlab binaries that matches your operating system. Add the downloaded folder to Matlab using the **Set Path** function.
4. Run **btk_c3d2opensim_GUI.m** to verify that all the paths are set correctly. You should be presented with a GUI interface similar to the following.

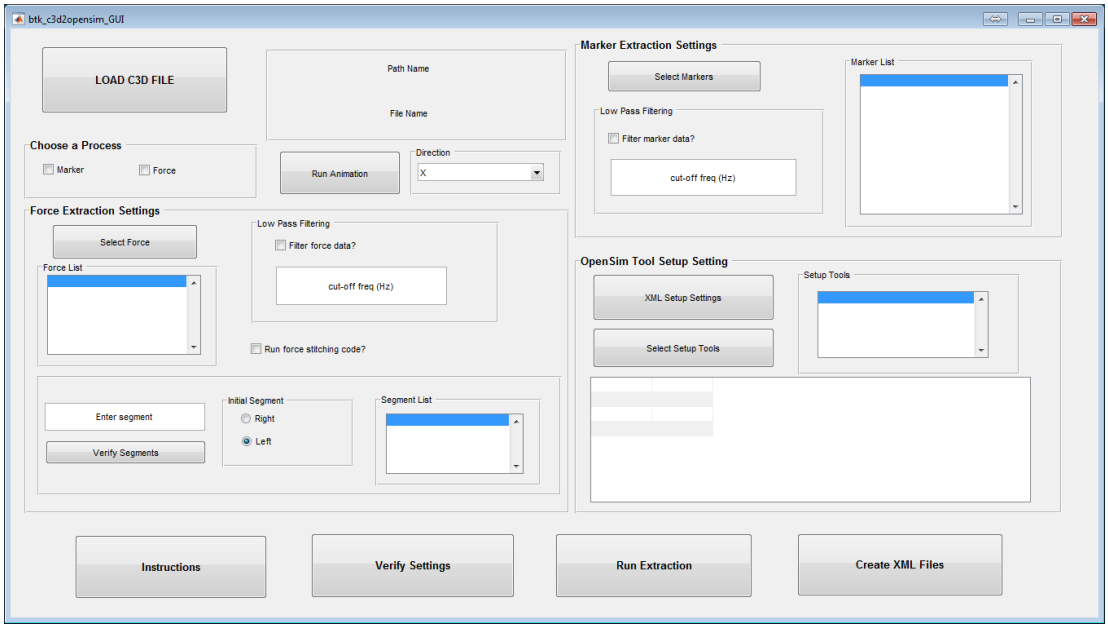


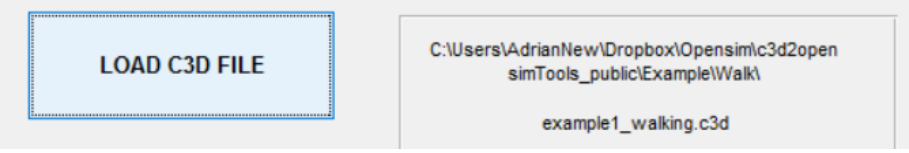
Figure 1: Screenshot of the extraction GUI interface

Running Gait Extraction Toolbox

This section details the steps required to run the extraction pipeline correctly.

Loading a c3d file

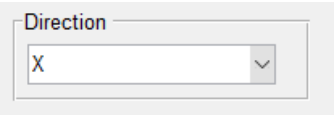
1. Prior to loading the c3d file, make sure two arbitrary events (e.g. Right foot strike and Right toe off) are labelled in the c3d file representing the start and end frames of the c3d trial that you want to extract. This can be done in the motion capture system or in Mokka.
2. Run btk_c3d2opensim_GUI.m and you should be presented with a graphic user interface containing all the functions required for extraction.
3. Load the c3d file. This step utilises the Matlab scripted functions in the BTK toolbox to extract all the data from the c3d file into Matlab. If the c3d file is loaded successfully, it should display the path and file name.



4. To view the extracted c3d data, click run animation. You should be presented with a new figure that will play an animation of the trial in the Matlab environment.

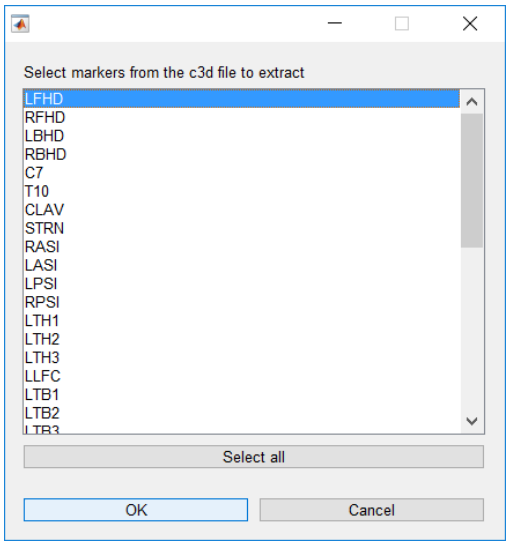
Direction of travel

The direction of travel option specifies the rigid body transformations from the motion capture and force plate global coordinate system to the OpenSim coordinate system. The most common difference between experimental and OpenSim coordinate systems is the definition of the vertical direction. In experimental coordinate systems, the Z direction is usually defined as the vertical direction, while in OpenSim, Y direction is the vertical direction. This toolbox performs the rigid body transformations based on the specified direction of travel of the participant in the loaded c3d trial (i.e. X, -X, Y, -Y).



Marker Extraction

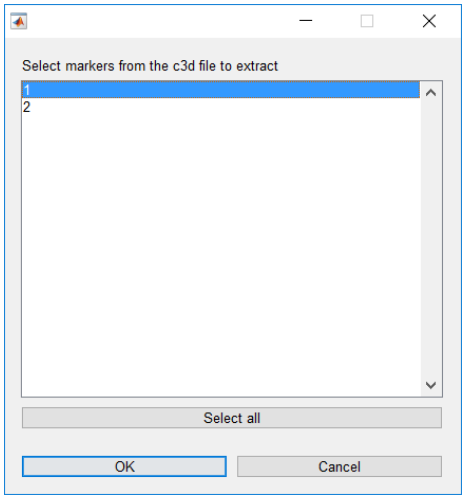
1. Check the marker extraction process checkbox.
2. Select the markers to extract. Hold ctrl to individually select multiple markers or hold shift to select a list.



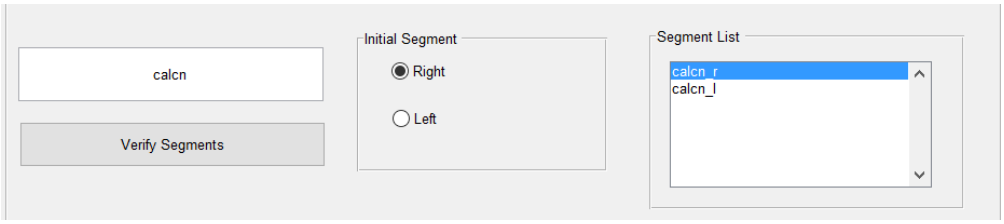
3. (Optional) If you would like to filter the marker trajectories, check the filter checkbox and enter a cut-off frequency (in Hz). The filter is a low-pass, 4th order Butterworth filter.
4. Verify the settings.
5. Run the extraction.
6. Creates a *.trc file containing all the marker trajectories in an OpenSim compatible file.

Force Extraction

1. Check the force extraction process checkbox.
2. Select the force data to extract.



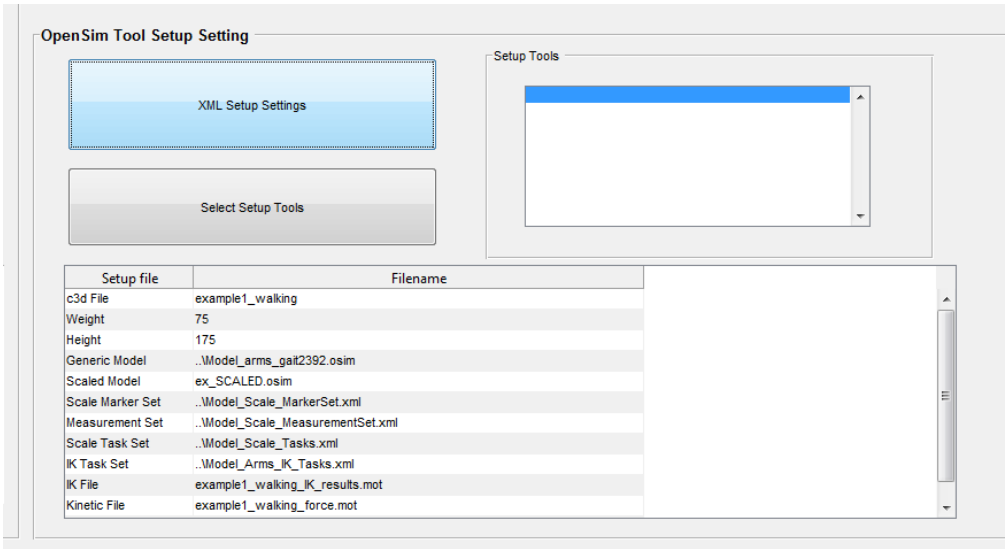
3. Input the name of the segment in which to apply the point force vector (i.e. attach a point force vector to a body segment, e.g. "calcn" (calcaneus)).
4. Specify either the right or left side as the side to apply the first point force vector.
5. Click "Verify segments" to match the number of force data with a sequence of alternating segments (i.e. right, left, right, etc.).



6. (Optional) If you would like to filter the force data, check the filter checkbox and enter a cut-off frequency (in Hz). The filter is a low-pass, 4th order Butterworth filter.
7. If force data needs to be stitched together (e.g. foot contacts two force plates simultaneously) you can run the force stitching code, see below.
8. Verify the settings.
9. Run the extraction.
10. Creates *force.mot and *force.xml files containing all the force data in an OpenSim compatible file and the external load setup settings, respectively.

OpenSim Tool Setup Settings

1. Enter the location of the required XML setup tool files. This includes,
    a. *.osim: generic musculoskeletal model
    b. *Scale_MarkerSet.xml: virtual marker set used to generate a subject-specific model
    c. *Scale_MeasurementSet.xml: defines the markers used for scaling each segment (can be uniform or non-uniform scaling)
    d. *Scale_Task.xml: task file containing the marker weightings
2. After entering the setup settings, the subject information and XML setup file locations should be displayed in the main window as shown below.



3. Select the tools you want setup files to be created for.
    a. Scale = static scaling
    b. IK = inverse kinematics
    c. ID_IK = inverse dynamics (using inverse kinematic results)
    d. SO = static optimisation
    e. MA = muscle analysis
    f. RRA = residual reduction algorithm
    g. CMC = computed muscle control
    h. ID_RRA = inverse dynamics (using RRA results)
    i. ID_CMC = inverse dynamics (using CMC results)
    j. BK = body kinematics
4. Click “Create XML File” to create XML setup files in the working directory.

Extra Functionality

Force stitching function

This function stitches together two adjunct force data such as when a foot comes in contact with two force plates simultaneously. The stitching algorithm is taken from the Visual3D software. The algorithm superimposes the ground reaction forces and free moments from both force plates together to generate a resultant force and moment vector. While the resultant centre of pressure is calculated based on a weighted average between the two centre of pressure measurements. Two general events must be labelled for the function to run correctly. For instance, a “GeneralFootStrike” event label must be entered at the instant when the foot is in contact with both force plates and a “GeneralFootOff” event label must be entered at the instant when the foot leaves one of the force plates. The resultant force, free moments and centre of pressure data are labelled as the first force measurement.

Troubleshooting

Error message	**Possible solution**
Please select either marker and/or force extraction process	Check either the marker and/or force process checkbox
Please verify marker and/or force setting	Click the "Verify Settings" button before running the extraction to make sure all settings have been entered correctly
Please check XML setup tools and filename	Make sure both XML setup settings and tools have been entered