The MotionMonitor xGen Hardware Guide:
The MotionMonitor xGen Interface to Qualisys Cameras

Overview

The MotionMonitor xGen provides two methods for interfacing and collecting data from Qualisys Cameras. Each involve different levels of complexity and are appropriate for different research situations. These include:

1. The MotionMonitor's C3D Model Builder

2. Rigid-body 6 DOF Tracking

The MotionMonitor's C3D Model Builder is a post-processing capability. It uses standard C3D files generated within QTM as input to create rigid body 6 DOF sensors; locate joint centers and define segment co-ordinate systems. If analog data were collected within QTM they can also be exported by way of the C3D file format.

The Rigid Body 6 DOF Tracking assumes that each segment is being tracked by at least 3 markers rigidly attached directly to the skin or to a rigid plate. **The MotionMonitor xGen** records the position and orientation of markers assigned to each rigid body or "virtual sensor", computes the centroid and coordinate system of these rigid bodies and then uses that data to perform The MotionMonitor's standard analytical and visualization routines. The user has the option to use a fixed marker set to locate joint centers using methods similar to C3D Model Builder or alternatively, can digitize landmarks using a stylus whose position and orientation are tracked using one of the 6DOF sensors.

The two methods ultimately generate the same information for the researcher. However, where and how certain functions are performed will vary significantly for the two methods.

The MotionMonitor's C3D Model Builder

See the Knowledge Base article entitled "Getting Started C3D Model Builder The MotionMonitor xGen".

Rigid Body 6 DOF Tracking

Rigid Body 6 DOF tracking works on the following set of principles. The subject is instrumented with a minimum of 3 markers on each tracked body segment. The markers are relatively rigid (the more so the better) relative to each other. Within QTM, the markers are identified using an AIM model. The purpose is to provide robust marker identification within QTM so accurate, identified marker x,y,z's can be streamed directly to **The MotionMonitor xGen.**

Within **The MotionMonitor xGen** "virtual sensors" or rigid bodies are computed from the markers x,y,z values being streamed from QTM or the 6DoF Rigid Body data streaming from QTM can be used directly. The computed position and orientation of these "virtual sensors" is used within **The MotionMonitor xGen** to track objects, define subject segment lengths, locate joint centers, digitize and track landmarks of interest, etc.

Step by step procedures to setup this method are as follows:

1. After launching the QTM application and ensuring that the cameras are connected, begin the process of calibration by selecting the "tools" pull down menu, selecting "project options" and then selecting "calibration" on the left hand side (another way to begin the calibration process would be to select the "workspace options" icon on the toolbar). This window allows for the selection of appropriate calibration parameters. After the parameters have been set, click "Apply" and then "OK".
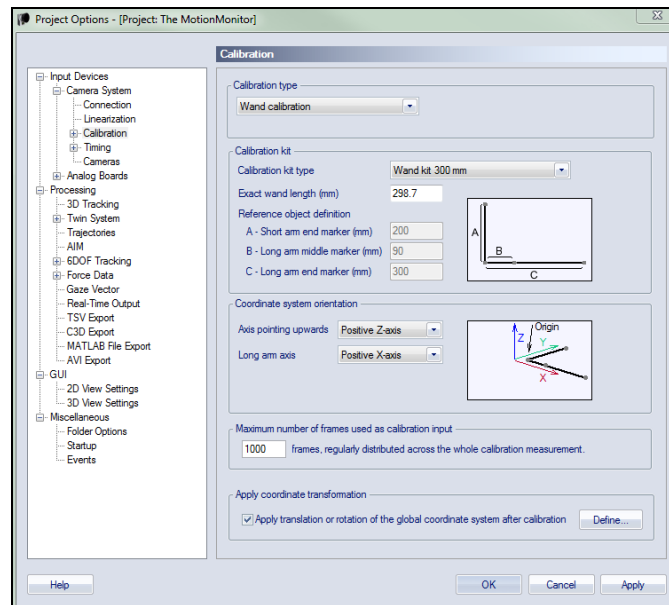

2. Next, open the calibration window by going to the "capture" pull down menu and selecting "calibrate" and select the proper parameters for the calibration data collection.
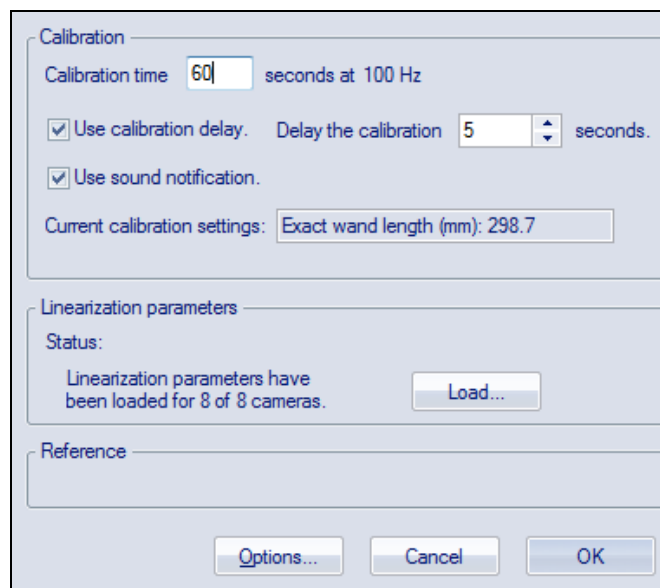

Click "OK" to begin the calibration process. The following image depicts the dialog window which follows the collection of the calibration data. The "Calibration results" dialog shows the results of the calibration and notifies the user of whether or not the calibration was successful (i.e. did the calibration pass).
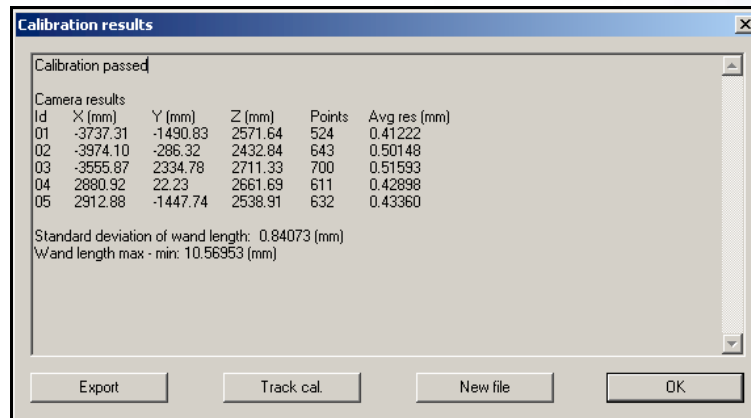
3. The next step will be to generate an AIM Model. Select File|New then attach markers and/or rigid body clusters to the subject or object to be tracked. Have the subject/object enter the capture space and the markers should be displayed in real-time. Collect an activity by navigating to Capture|Capture or use the "Capture" icon on the toolbar. Specify the collection period parameters in the "Start Capture" dialog window and then click "Start".
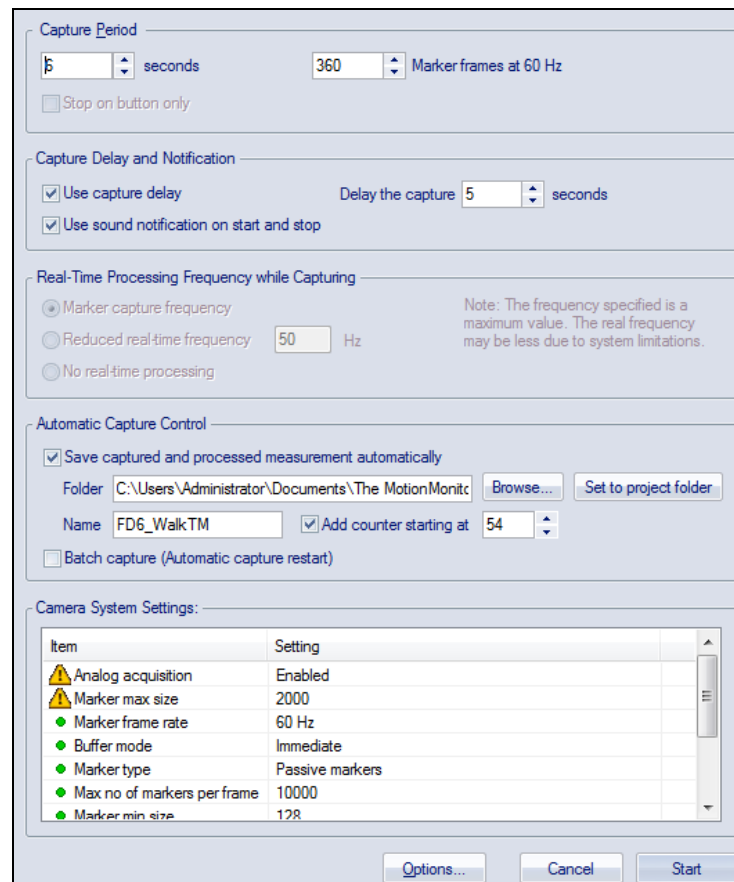
4.   After the collection, open the activity using File|Open File. Several windows will be associated with each QTM trial, including the "3D view" window, "2D view" window, "labeled trajectory" window and "unidentified trajectory" window. Restructuring of windows may be necessary, as some windows may be occluded. The reorganizing may consist of double clicking on a window, selecting the "2D view" or "3D view" icons on the toolbar, looking for tabs on a window, or right clicking on a window to change its configuration. Organize the workspace so that the 3D view, labeled trajectory, and unidentified trajectory windows are easily accessible.
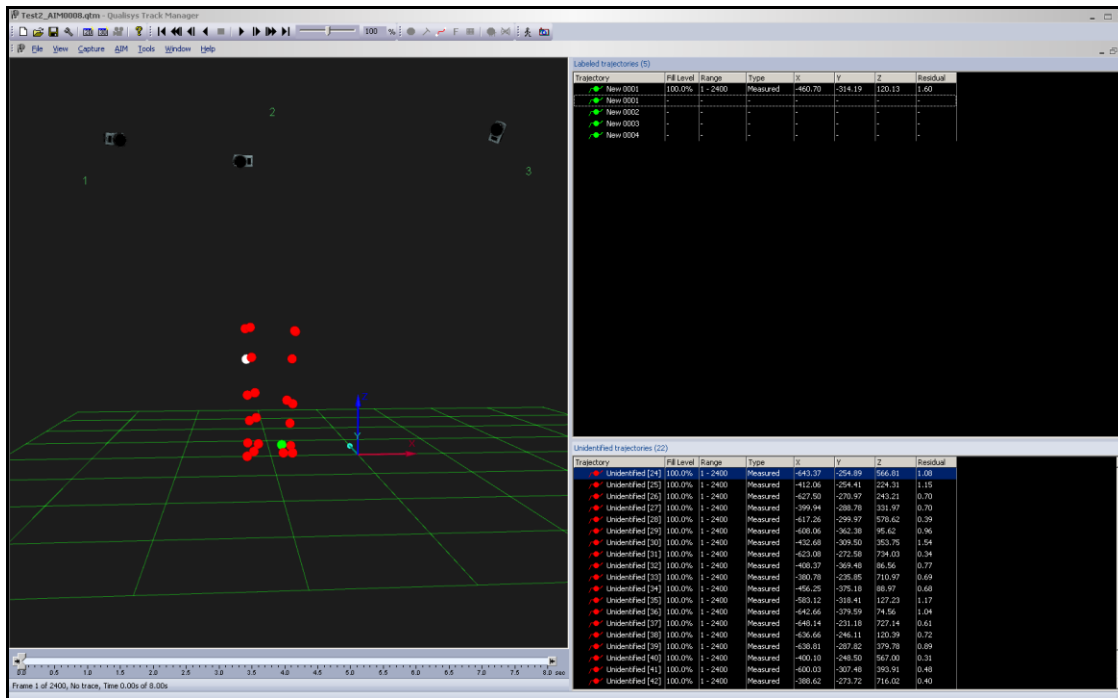

5.   Right click the "Labeled Trajectory" window (upper right window in above image) and select "Add new label" (do this for each marker used). Click on each "Labeled Trajectory" that was added and re-assign an appropriate marker label in sequential order. This will make it easier and more intuitive to assign markers to virtual sensors once streaming to TMM.

6.   Next, the unidentified markers will be assigned to the Labeled Trajectories. Select an "Unidentified Trajectory" (lower right window in image above) and note the marker in the "3D View" window (left window in image above) which becomes illuminated. Then drag the unidentified trajectory onto the appropriate labeled trajectory, repeat this process for all unidentified trajectories. Some labeled trajectories may consist of multiple unidentified trajectories. Note: one unidentified trajectory has already been identified in the image above, which is indicated by the green marker.

7.   Select the measurement range of frames to be used in generating the AIM model by using the scroll boxes on the timeline control bar (at the bottom of the 3D view window). Go to AIM|Generate Model or click the generate AIM model icon on the toolbar. Depending on the complexity of the activity and/or marker set, subsequent collections may result in "unidentified markers". Repeating the collection, identification and AIM model generation with increasingly complex activities will result in a progressively more robust model.

8. To reload the AIM model or have it automatically apply, go to Tools|project options|AIM. Then, select and move the model from the "AIM models" window on the left to the "Applied Models" window on the right. If the AIM model is not in either window, click "Add Model" to browse to the desired location of the saved AIM model and add it to the list. To automatically apply the AIM model to a capture or real time action, please see step 11.
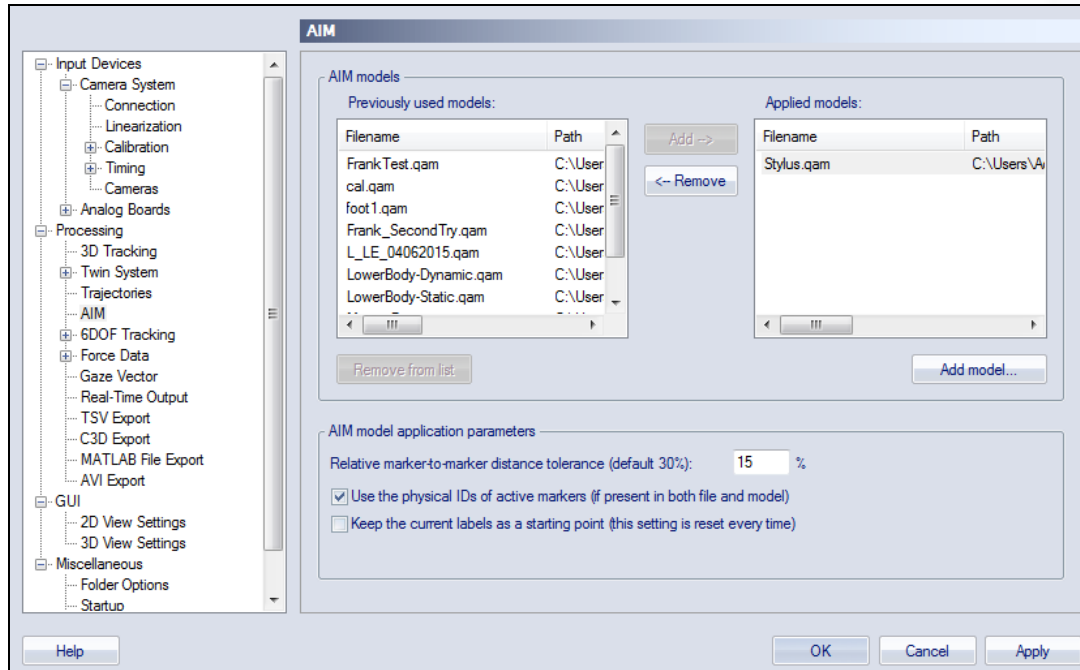

9. Save the workspace file with the menu item File|Project (*New* or *Rename*) using the desired name for the marker set to be used. This workspace will be the base workspace loaded at the beginning of future sessions prior to each day's calibration. The following steps reflect the workspace options that should be selected.

10. Capture frequency will depend on the type of camera being used and the type of connection between **The MotionMonitor xGen** and the QTM server computer. It is important that the RT capture frequency remain stable during streaming. This setting may need to be adjusted in Tools|project options|Camera system.
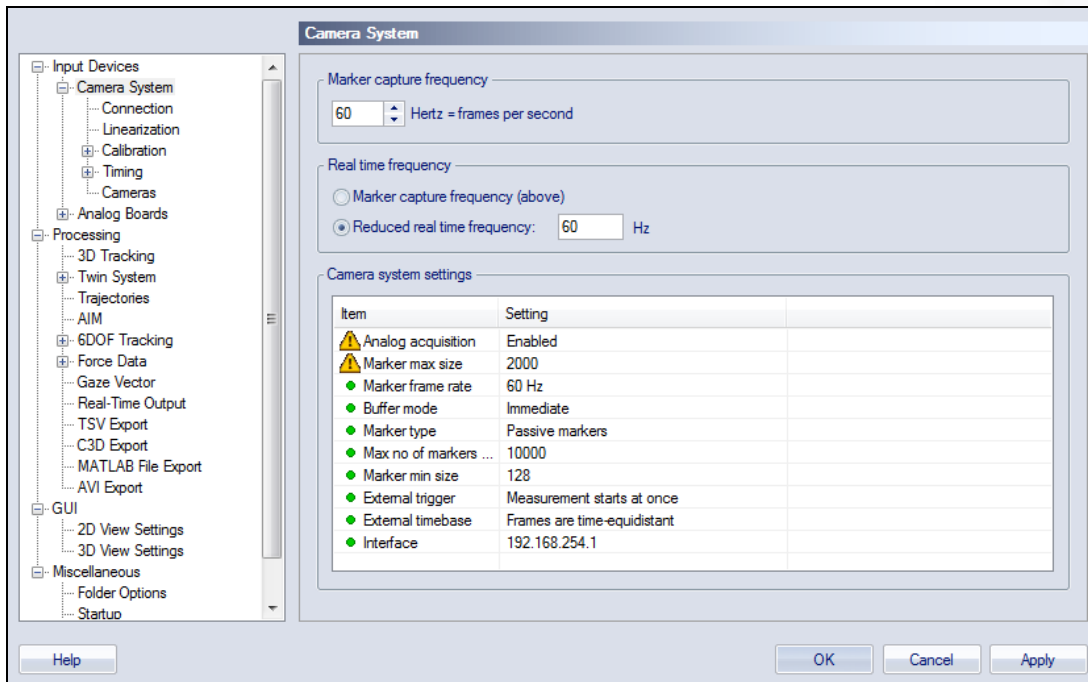

11. The Tools|project Options|Processing settings for Capture and Realtime actions should be checked as shown below when streaming from cameras. If streaming a previously collected file using the menu item Capture|Run realtime processing on file, both sections should be completely unchecked. Note: these are the settings that allow the user to automatically apply the selected AIM models, as selected in step 8, to a capture or real time action.
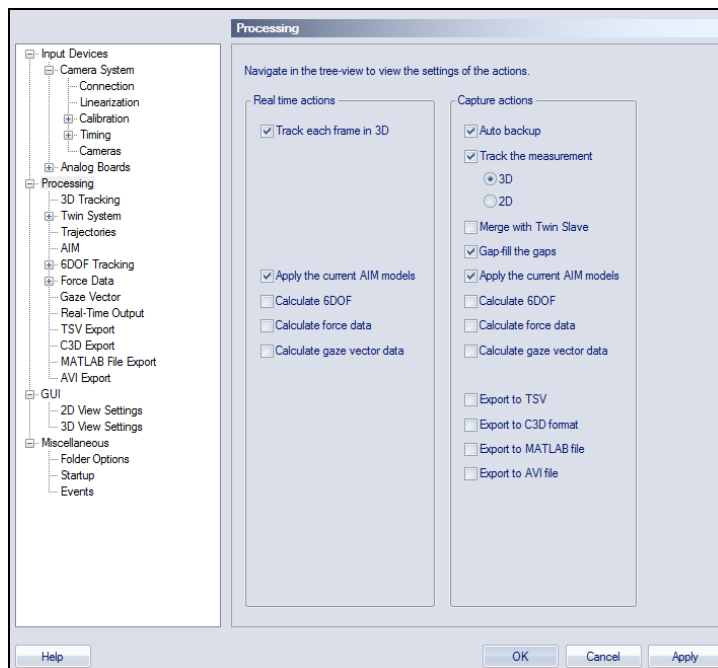
12.   The Tools|project options|Real-Time output defines the connection to **The MotionMonitor xGen**. The typical connection will be TCP/IP to port 22222.
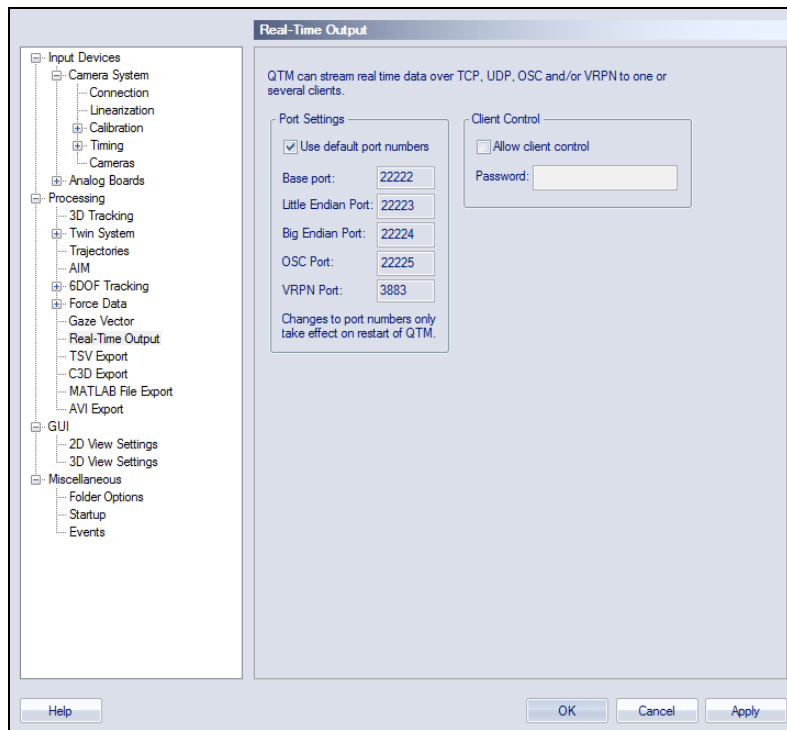
13.   At this point, save the workspace for use in future sessions; attach markers and/or rigid body clusters to the subject or object to be tracked; and step into the measurement space. The AIM model will automatically identify markers and begin streaming data as indicated by the status bar in the lower right-hand corner of the application.****NOTE: When QTM is restarted, it will automatically load the last AIM model used when the software was last closed. QTM will stream markers out in a different order, and/or marker data may not stream out properly when an AIM model is loaded mid-session. To ensure robust realtime streaming, after an AIM model is loaded, close QTM and restart the application.**
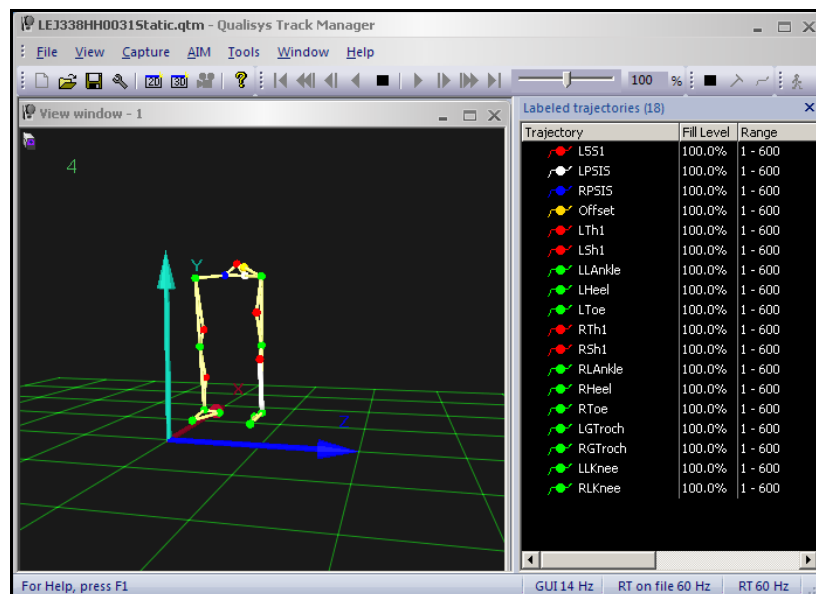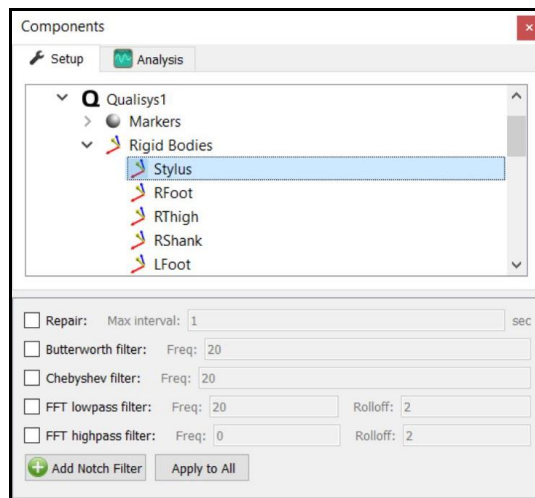
14.	In **The MotionMonitor xGen**, go to the Setup tab in the Components Window and add or click on the Qualysis hardware component in order to configure the hardware. Confirm that the settings entered here match the settings of QTM for the measurement rate, number of markers, number of rigid bodies and the IP address of the computer running QTM. The Protocol Version field should be updated to ensure compatibility with the Real-Time protocol version supported by the QTM build being used. To determine the Real-Time protocol versions support by the QTM build being used, go to Help|About Qualisys Track Manager in QTM. The default protocol version used by **The MotionMonitor xGen** is 1.17, but up to version 1.19 is currently supported. Click the Activate button to initialize communication with the QTM.
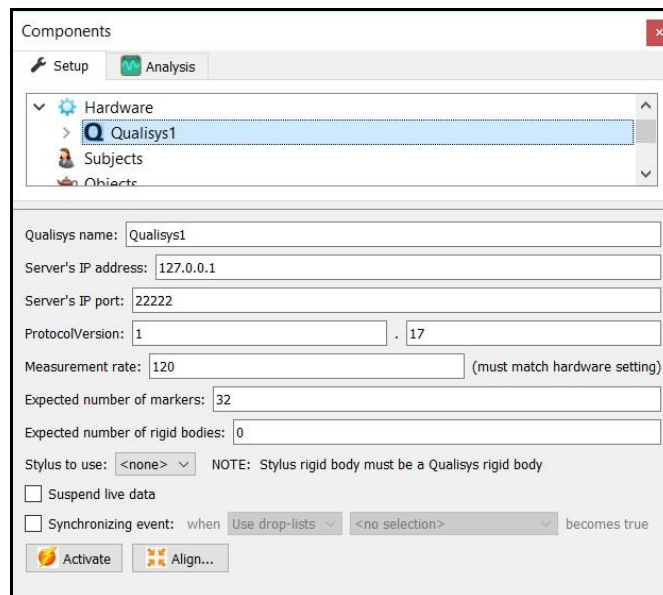

The display of data in the Live window can be suspended by placing a mark in the checkbox for Suspend live data. The processing and display of data in a live mode uses computer resources, so this options allows the user to optimize computer resources and free up more processing power for data collection. This settings is independent for each hardware device and once an activity has been recorded data from the full measurement rate will be accessible for analysis.

The stylus that is being used for aligning this hardware device (i.e. digitizing a new world axes, unique from what was defined in QTM) must be selected here for the Stylus to use.

15. After successfully activating the Qualysis device, the marker list and rigid bodies list configured within QTM will be populated under the appropriate headers for the Qualysis component. Data repair and smoothing settings can be enabled or disabled here, pre or post data collection.


16. 6 DOF rigid bodies can be defined through **The MotionMonitor xGen** as seen in the dialog below. Rigid Body Collections can be added to the Setup Components dialog window as a Hardware device. Multiple Rigid Bodies can be added to a Rigid Body Collection, each of which can be defined using different combinations of marker assignments. Remember that 3 or more markers are required to create a Rigid Body. Markers can be selected for a rigid body either by selecting them through a drop down menu or defining them using a formula. Do not include markers in the rigid body definitions which will be removed for dynamic recordings. Markers can also be lassoed in the Animation window using the Shift key + Left Mouse button to create and add to an existing Rigid Body. Clicking on the Highlight button will highlight the selected Rigid Body markers in the Animation Window.
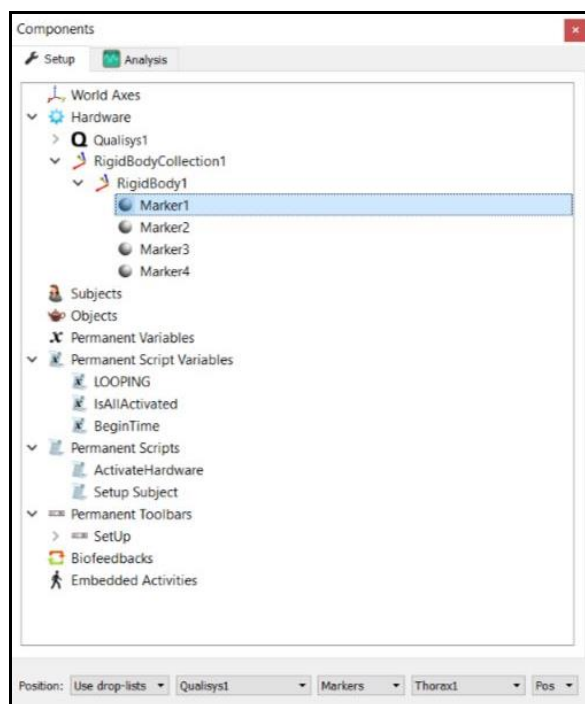
The Calibrate Rigid Bodies button takes a reading of the markers, computes centroids, creates sensor axes, establishes the relationship between markers and generally prepares the system to track the cluster of markers as 6 DOF data. Rigid Bodies can be calibrated one by one or all at the same time by going to the top level of the Rigid Bodies Collection and clicking the Calibrate All button. After this step, markers and their "sensor" axes can be viewed in Animation window or graphed and recorded as position and orientation data.

17. The next step is to define your biomechanical model within **The MotionMonitor xGen**, which entails selecting which body segments you'll be tracking, assigning rigid bodies to track each body segment, defining segment endpoints or joint centers and generating customized segment axes, if desirable. To begin this process, right click on the Subjects header within the Components Setup tab and add a new subject.
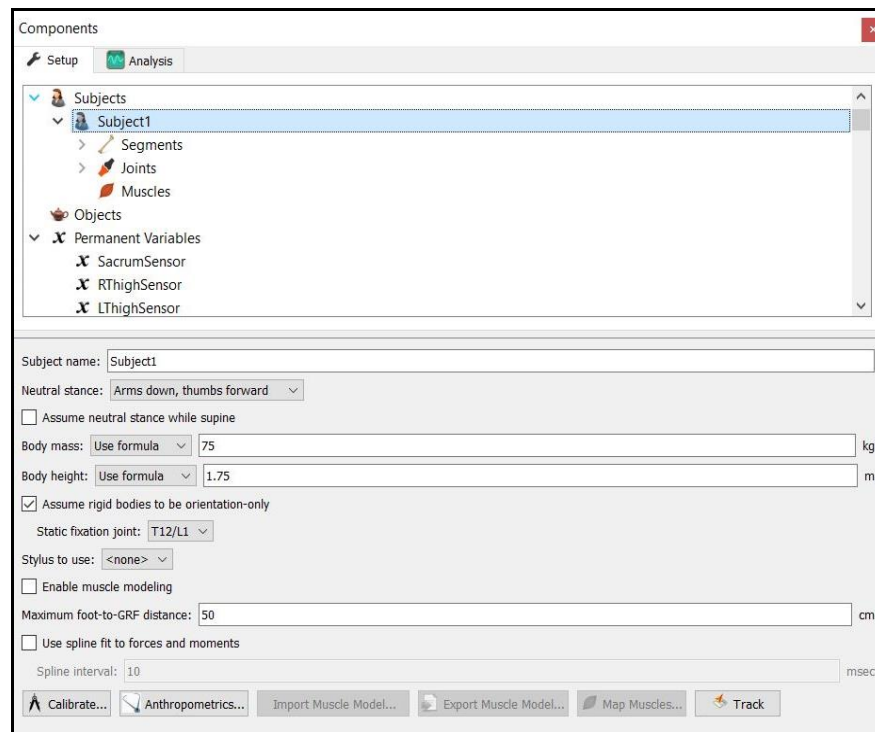

As seen above, a name can be assigned to the subject and basic anthropometric data can be entered. Confirmation for the orientation of the subject during the static reading and selection of a stylus to be used for digitizing, if required, are also selected here. The Calibrate button can be clicked after all of the required setup information has been entered.

18. The Segments header located under the Subject is where the desired segments to be tracked can be enabled as well as where the assignment for which rigid body will be used to track the segment is defined. Additional basic anthropometric information can be defined here for each segment as well.
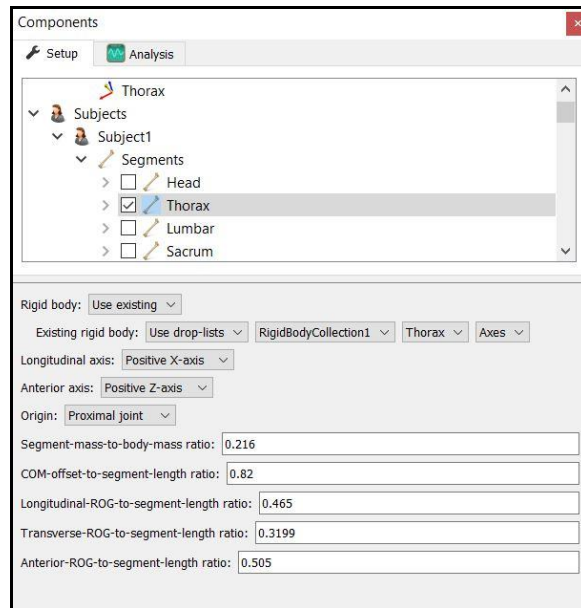

19. Each body segment which is enabled will require the definition of a proximal and distal endpoint or joint centers. The required joint centers will be automatically populated based on the selection of segments.
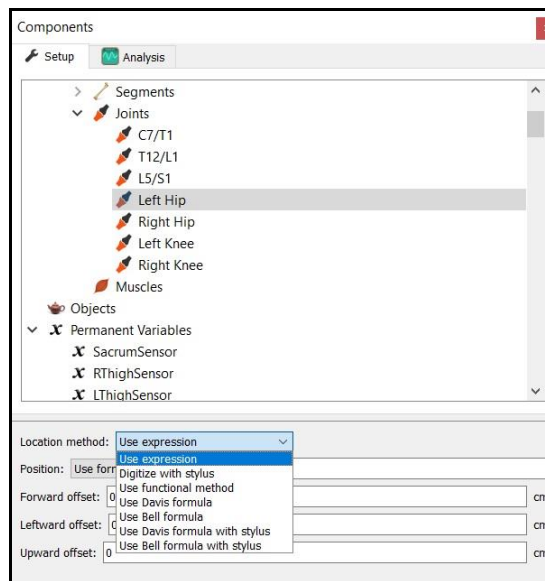
20. As seen above, each joint center can be defined using a digitizing method or expression based on marker positions. Alternatively, the hip and shoulder joints can be defined using linear regression algorithms or functional (rotational) methods.

21.   Once these definitions are completed, the Subject Calibrate button can be clicked. A warning message will be displayed for any definitions have not been appropriately defined.

27.   Additionally, if alternative or anatomically based local coordinate systems are desired, they can be defined by right clicking on a segment and selecting Add Axis System. First, the Rigid Body axes tracking the segment and general axes layout are selected. Then, points can be defined for the proximal and distal endpoints of the primary axis, a point along the secondary axis and a point for the Origin. The default local coordinate axes generated by **The MotionMonitor xGen** are defined as having a long axes through the joint centers and A/P and M/L axes being orthogonal to the long axes and parallel to the world when the subject was standing in the neutral position.
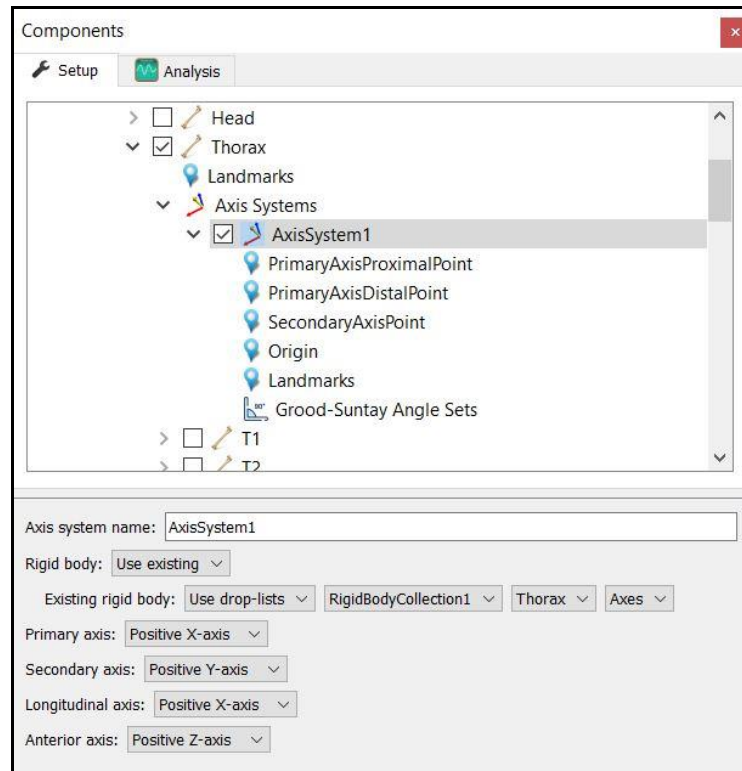
28.   At this point, the **The MotionMonitor xGen** subject is fully defined and can be used for **biomechanical models, recording activities, performing computations and reducing data**.

See "Getting Started Biomechanics Guide" for more information on these aforementioned topics.