Quintic Software

Tutorial 7b

Automatic Digitisation

V35

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1. Digitisation

Digitisation allows you to track the location of certain parts of the body or pieces of equipment throughout the duration of a video clip. Quintic software can then calculate linear and angular distances, velocities and accelerations of the points you have tracked.

The 3 different levels of software will allow you to digitise a different number of points:

Quintic Sports v35 – 1 Point Automatic Digitisation

Quintic Coaching v35 – 2 Point Automatic Digitisation

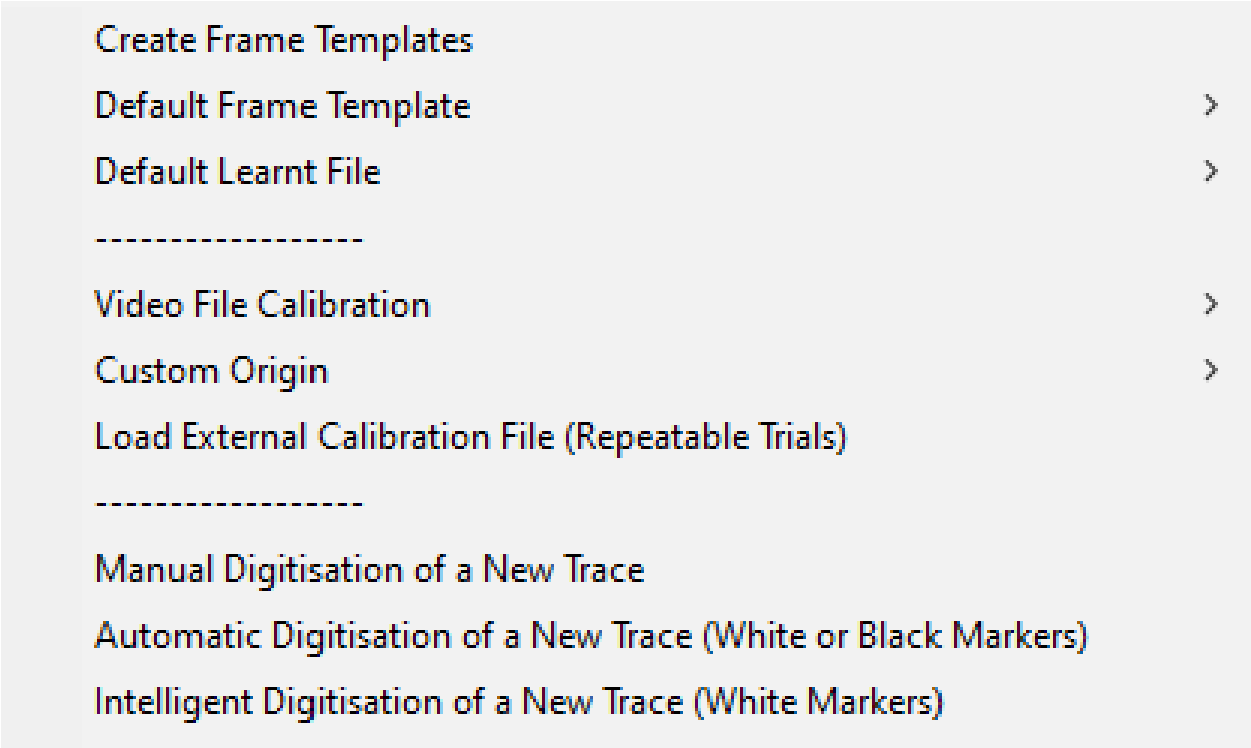
Quintic Biomechanics v35 – 21 Point Automatic Digitisation

2. Calibration

To begin digitisation, you must first calibrate the video clip. This means that the computer can then convert a distance on the computer screen (pixels) to its relative distance in the real world. Video recording speed also needs to be set so that time-based data e.g. velocity and acceleration, can also be calculated accurately.

Open the video you wish to digitise within Quintic software.

Click on the **'Digitisation'** tab and then on the **'Digitisation'** menu.



Either:

a) Select **'Video File Calibration'** from the drop down menu, if you know the length of something that is part of the action (e.g. a javelin, cricket bat, leg length or stump height).

Choose one of the options presented:

- If you know certain distances in both the horizontal and vertical directions then choose '**Horizontal and Vertical Lines'**
- If only the horizontal distance is known then choose **'Horizontal Line only'**
- If only the vertical distance is known then choose **'Vertical Line only'**
- If any other distance is known then choose **'Line in any Direction'**.

Hold the cursor over one end of the known distance, click the left mouse button and drag the cursor to the other end. Enter the distance and click **'Accept'**

Once the distance has been completed, the software will ask for the frames per second (FPS) of the video. If a Quintic High Speed Camera is used, this will be the true frames per second of the video. If a mainstream camera is used, you may be required to input the frames per second that was used.

Or

b) Select **'Load an external calibration file'** if you have used the same background and camera position as a previous video that has already been calibrated.

Important: The camera must not have been moved between the filming of the two clips.

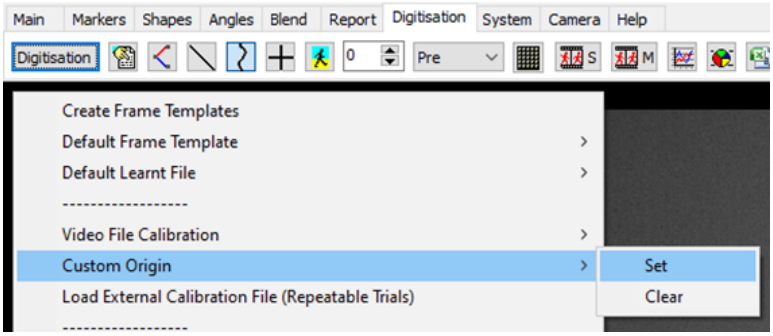
An accurate video recording speed is required to calculate accurate velocity and acceleration. Please make sure this is correct before using the linear or angular analysis functions.

3. Custom Origin

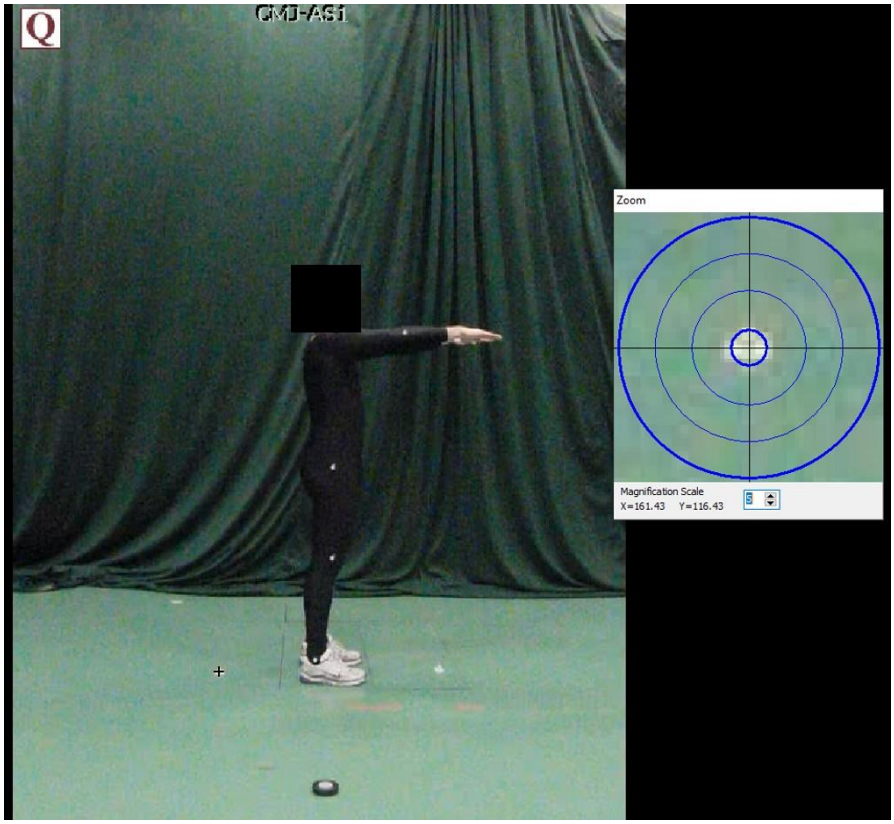
Users are able to set their own custom origin point for the video. This is ideal for users who would like their linear data to be relative to the floor for example.

Please note that the video must already be calibrated before the user is able to move the origin.

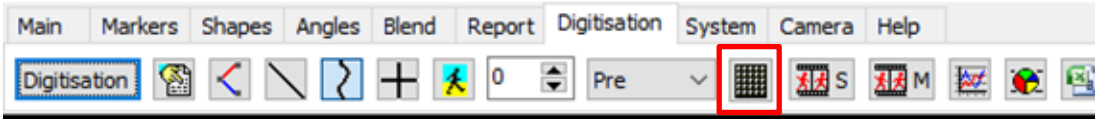
The Custom Origin can be changed by going into the Digitisation Tab > Digitisation > Custom Origin > Set.



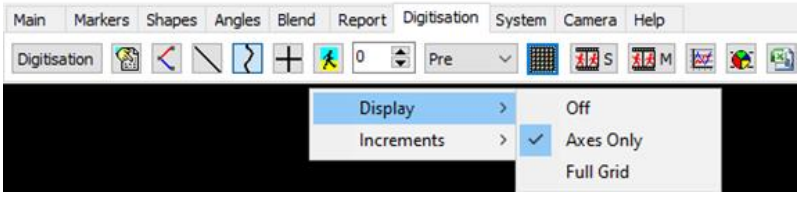
The user then simply clicks on the video where they would like their new origin point to be. A magnifier will appear on the screen so that the user is able to click their origin precisely.



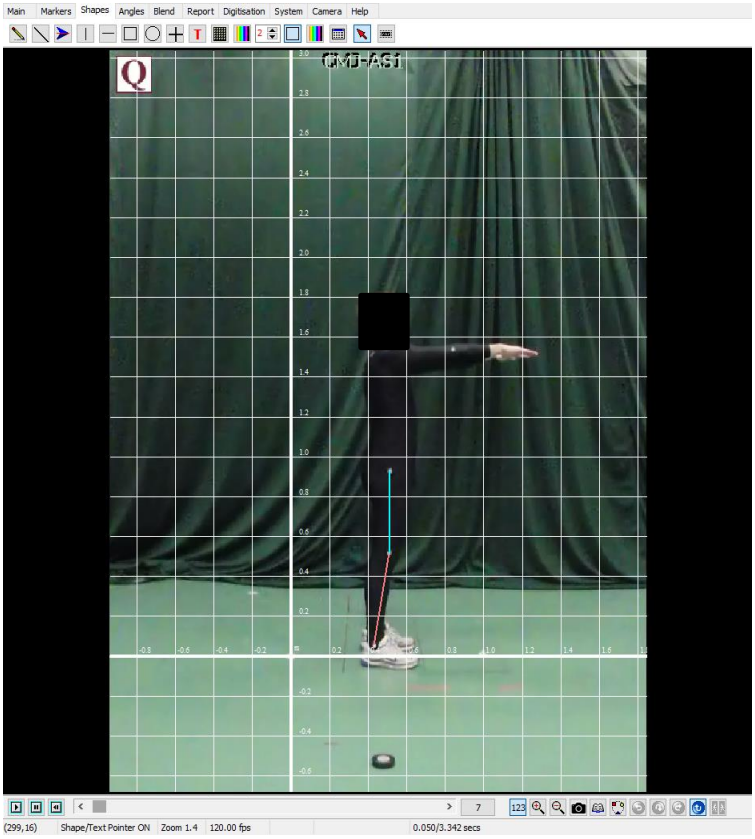
Once the origin of the video has been changed, users are able to check the new origin point by selecting the ‘Calibrated Grid’ option within the Digitisation tab.



Users can then go to Display > Axes Only, which will display the new origin point on the video in a graphical format. Users can also show the Full Grid if they prefer and change the increments of the grid.



Please see below an example of the custom origin, with the full grid displayed.



Once you have digitised your video, you are then able to use your custom origin within the linear analysis windows (single or multi). Please see Tutorial 8b & 8c for further information on how you are able to use the Custom Origin within the Linear Analysis.

4. Create a Frame Template

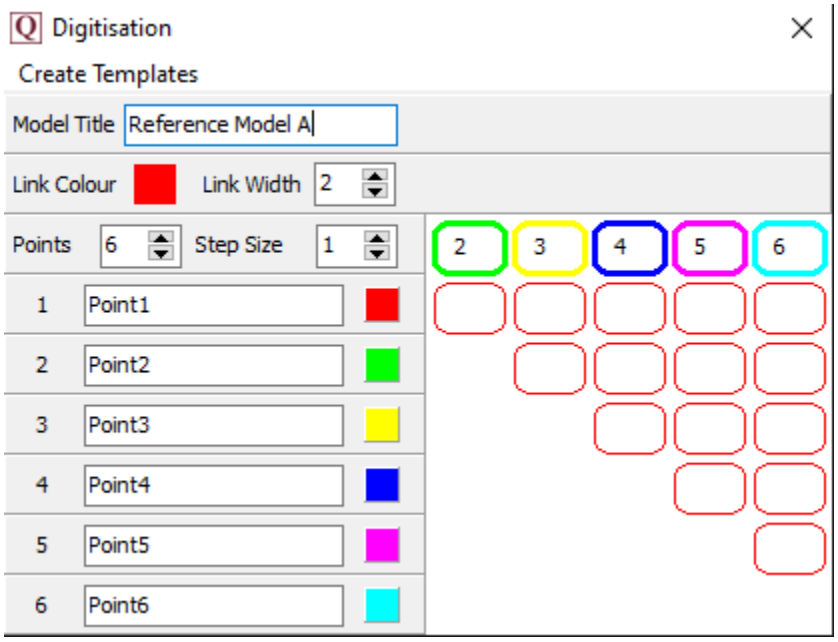
In order to start Automatic Digitisation, a suitable **Single Step** template must be used.

Quintic have already created a range of templates that you are able to use, depending on which level of Quintic software you are using. You are able to find these within your **'Quintic Sample Videos'** folder then **'Templates'**.

N.B. Only one point is available in Quintic Sports, 2 points in Quintic Coaching and 21 points in Quintic Biomechanics. The following template has been created in Quintic Biomechanics.

Should you wish to create your own template, please see below.

From the **'Digitisation'** menu click '**Create Frame Template'**. The following window will appear.



Model: Name your model so that in the future you can use it again.

Points: Select the number of points you are going to track in the movement. Sports is able to do 1 point, Coaching 2 points and Biomechanics 21 points.

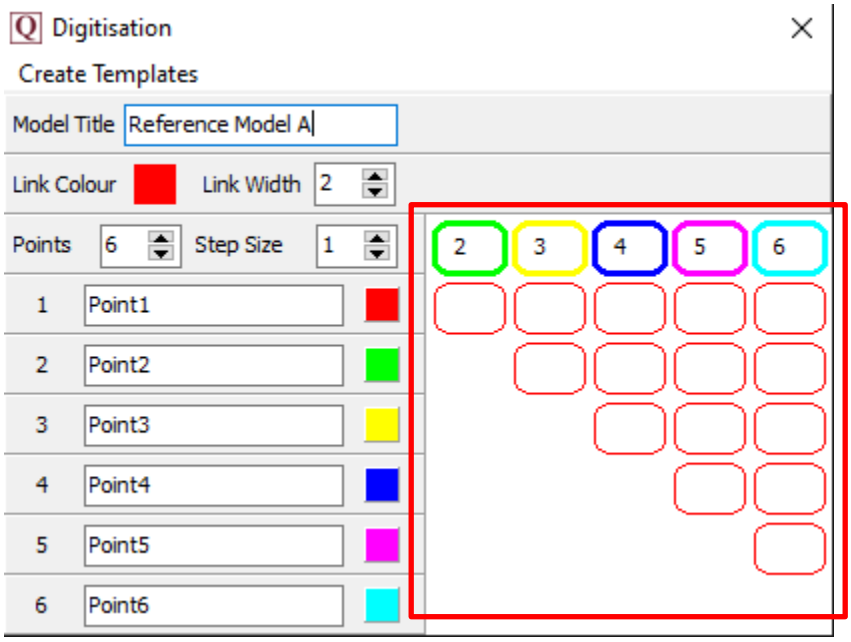
Step Size: This states how frequently frames will be digitised (1 = every frame, 5 = every 5th frame etc).

Link Width: This is the width of the lines that join up the points. 1 = Thin line, 10 = Thick line.

Point Names: You can change the names from **'point 1'**, **'point 2'** etc to specific names of the anatomical points you are going to use.

Point Colour: Left click on the coloured box next to each point and select a colour from the palate. This will allow you to change the colour of each point.

Links between points: To join points together simply click on the box which links the two points you wish to join together. You can find this next to the named points. If you click the coloured box next to **'Default Colour**' this will control what colour you would like the link to be between each point. To remove the colours from one of the squares, right click on it.

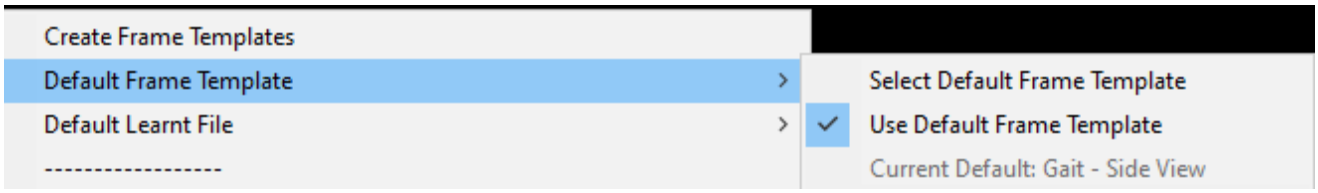


To save the template Click **'Create templates'** in the top-left of this window and click **'Save As'**.

N.B. This will replace any previous traces with the same name.

a. Default Digitisation Template

Users also have the option to choose a default digitisation template, removing the need to select it each time. Ideal for users who use the same digitisation template on a regular basis.

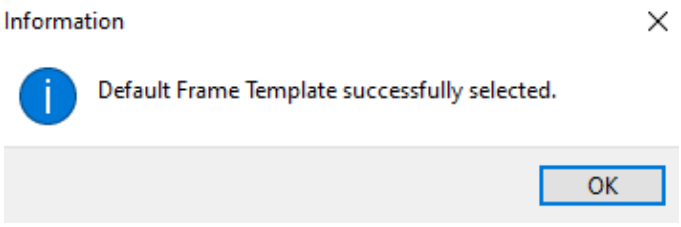


To begin, click on ‘Default Frame Template’ within the Digitisation Menu.

Then click ‘Select Default Frame Template’ and choose your preferred template.

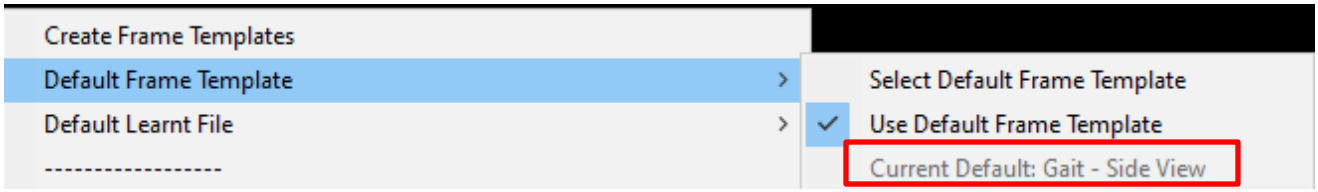
Please bear in mind that for Automatic Digitisation, a suitable **Single Step template** must be used.

Once you have selected your preferred digitisation template, the following pop up will appear, confirming you have selected your default digitisation template:



To use the default template, simply click ‘Use Default Frame Template’ if you want this to be used all the time.

The current default template is shown at the bottom of this menu:



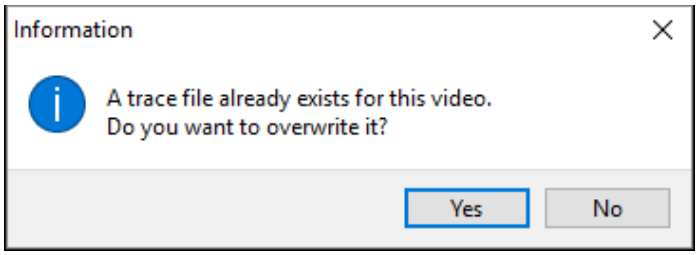
5. Automatic Digitisation

Now that the video has been calibrated and a suitable digitisation template has been created/located, you are ready to begin Automatic Digitisation. Automatic Digitisation requires a contrast in order for the markers to be identified. This can be “white on black” marker or a “black on white” marker.

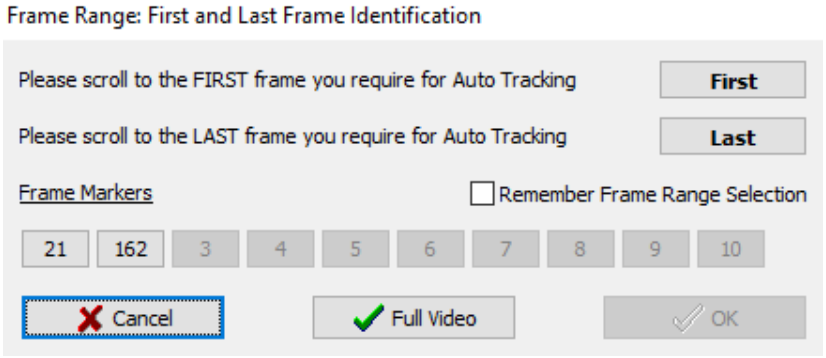
N.B The video you are digitising must be all “white on black” markers OR all “black on white” markers. The user is unable to mix and match marker types.

Within Quintic software, click on the **‘Digitisation’** Tab, then **‘Digitisation’** menu and then **‘Automatic Digitisation of a New Trace (White or Black Markers)’**.

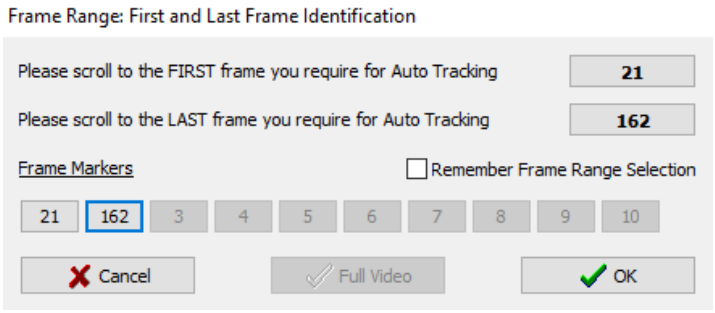
If the video has already been digitised, a pop-up asking if you want to ‘overwrite the existing trace’ will appear. Click ‘No’ if you do not want to, or click ‘Yes’ if you do want to overwrite the trace, which will enable you to continue with the Automatic Digitisation process.



If the video does not have a previous digitisation trace, or you pressed “Yes” to the above pop-up, a new window will open asking you to locate the digitisation template you wish to use for digitisation. Once selected, a new window will appear containing the same video that is in the main window along with the Frame Range window.



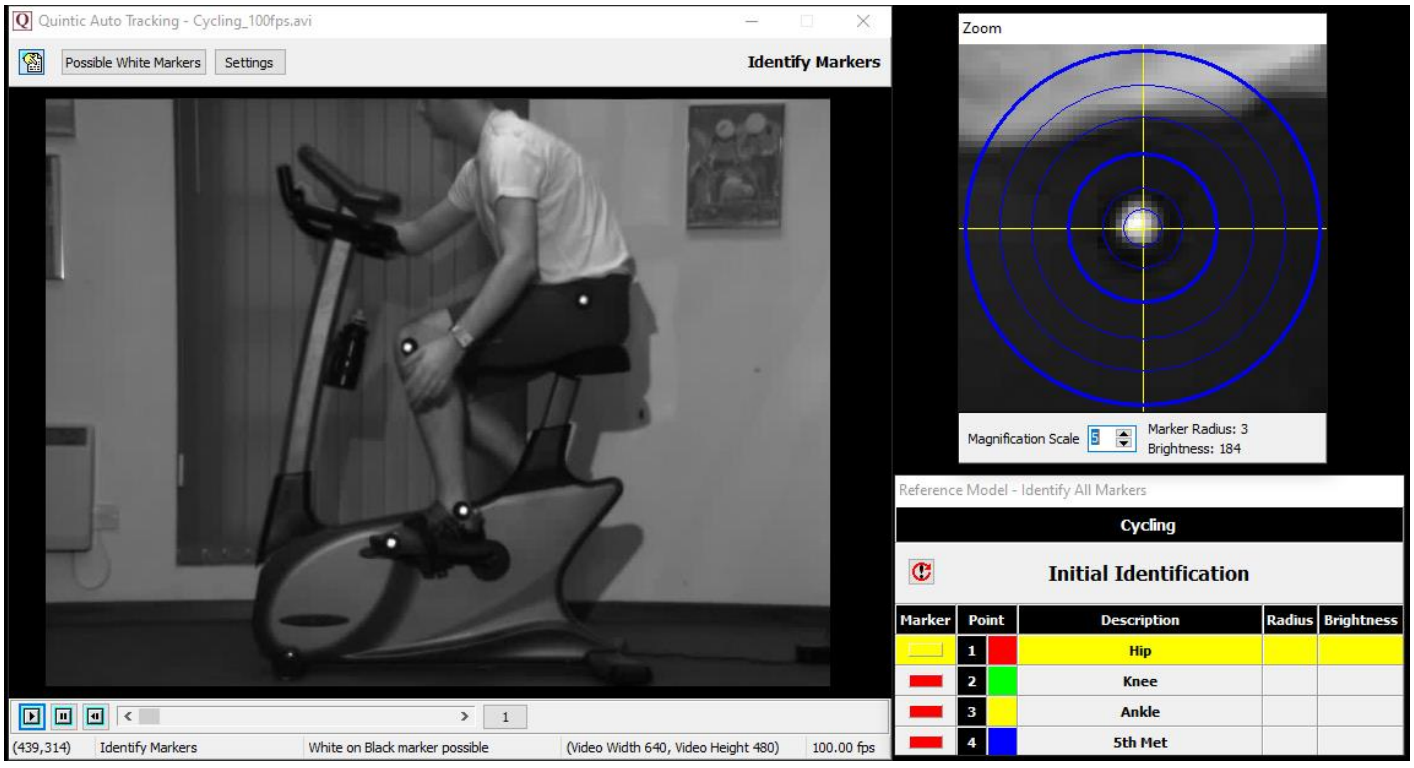
Scroll to the frame you wish to start the tracking from and click on **‘First’**. Now scroll to the last frame that you wish to digitise and click on **‘Last’**. Alternatively, click **‘Full Video’** if all markers are visible at the start and end of the video and you wish to digitise the whole video.



If Frame Markers have been set for the video, these will be displayed within the Frame identification window. This is ideal if a user wants to digitise between two key events for example. The user can click on the first frame marker then FIRST, then the last frame marker then LAST to set the frame markers as the digitisation range.

Should you be using the same frame ranges (i.e for a multi camera digitisation), you can select the ‘Remember Frame Range Selection’ box which will remember the frame ranges next time you digitise a video.

Once you have set the range of frames you wish to automatically digitise, click on the **‘OK’** button to begin identifying the points within the selected digitisation template



a. Possible White Markers

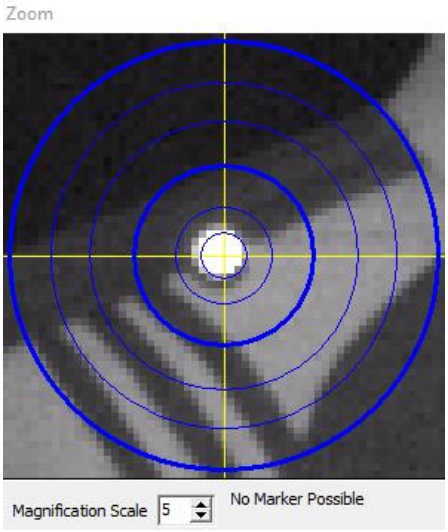
The ‘Possible White Markers’ feature available in the Quintic Automatic Tracking windows allows the user to see all the possible White on Black markers on the video before assigning any markers. This includes any actual markers, as well as any unwanted reflections.

To see all the Possible White Markers on a video, simply click the Possible White Markers button within the Automatic tracking window.

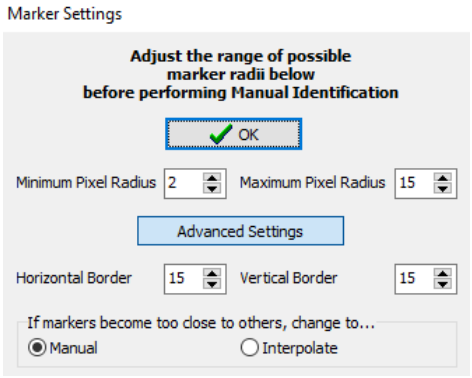
Once selected, this will then show all possible markers for the current frame on the video. Possible markers are highlighted by a light blue cross with a number next to it. The number is the brightness value out of 255.

Right Clicking the ‘Possible Markers’ button will remove all the possible markers from the video.

Should you hover over a marker that the software is unable to identify, or Possible White Markers is unable to identify, it may because the marker is too big and you may need to increase the marker radius range or the border settings.



You are able to adjust the range of possible marker sizes, by clicking on the **'Settings'** button, which is displayed in the top left-hand corner of the automatic tracking window. Once you have clicked settings, you will be able to adjust the minimum and maximum pixel radius by adjusting the counters accordingly. Press OK to accept the changes to the radius sizes once you are happy with them. The default range is between 2 and 15, however this can be changed to 1 to 25 to help identify smaller/larger markers accordingly.



Users are also able to change the Identification Border Settings by clicking **'Advanced Settings.'** This is particularly useful if a marker is close the edge of the image. Users are then able to change increase or decrease the horizontal/vertical borders so that the marker is able to be identified.

If you make a mistake identifying the markers, you are able to undo the last marker identified by pressing the button.

b. Initial Identification

As the cursor moves across the screen, the magnification window shows a larger version of the area under the cursor. The magnification window allows the user to pinpoint the exact marker locations. This must be done in the correct order. The reference template illustrates the order of marker identification.

Reference Model - Identify All Markers

Auto Tracking Cycling 4 Points

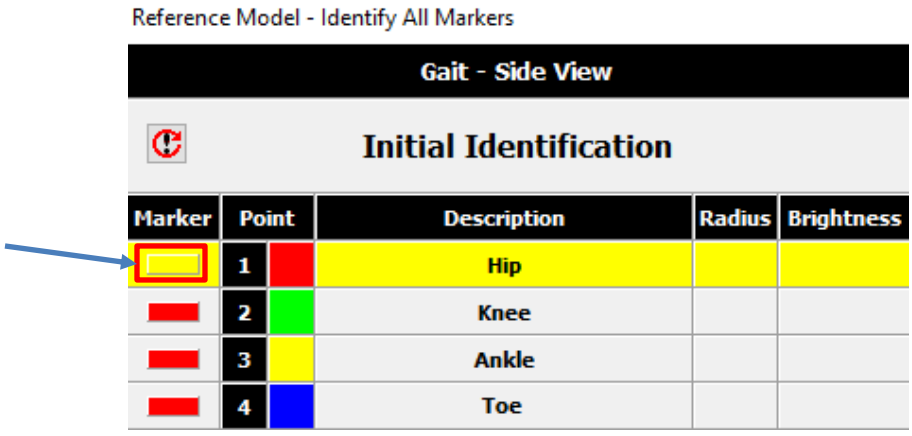
Initial Identification

Marker	Point	Description	Radius	Brightness
	1	Hip	4	206
	2	Knee	3	233
	3	Ankle		
	4	Toe		

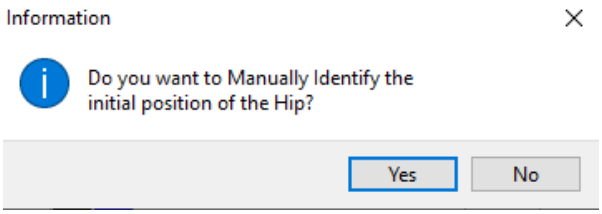
To identify a marker position, move the cursor over the relevant marker and click the screen. The program will automatically calculate the centre of mass of that marker to improve the accuracy. Once a marker has been successfully identified the symbol next to the point description will become Green - the next marker can then be identified. If the symbol is Yellow, this indicates the marker is currently the one being identified. If it's Red, this indicates the marker has not yet been identified.

Users may want to start an Automatic tracking with markers in manual identification mode. This is ideal if users want to start a digitisation trace where all markers are not in shot. To do this, double click in the marker box for the marker you want in Manually identify within the Initial Identification window.

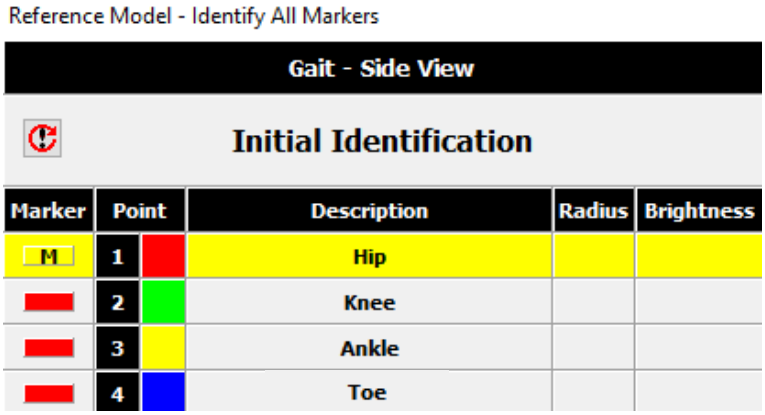
Double clicking this box will put this marker into manual tracking, and will continue to be manually tracked until the user puts it into Automatic when the marker is visible



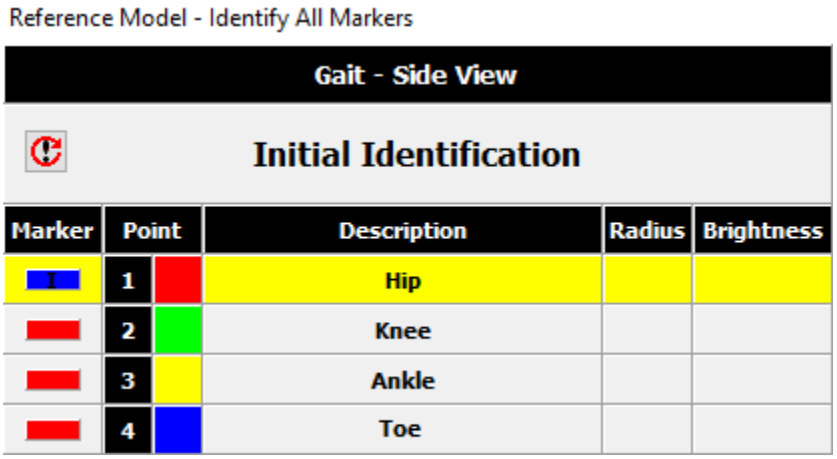
A Pop up will appear confirming that you are able to put the selected marker into Manual Tracking, confirm if you want to do this.



The box next to the associated marker has now got an M within it to signify the marker being in Manual tracking mode.

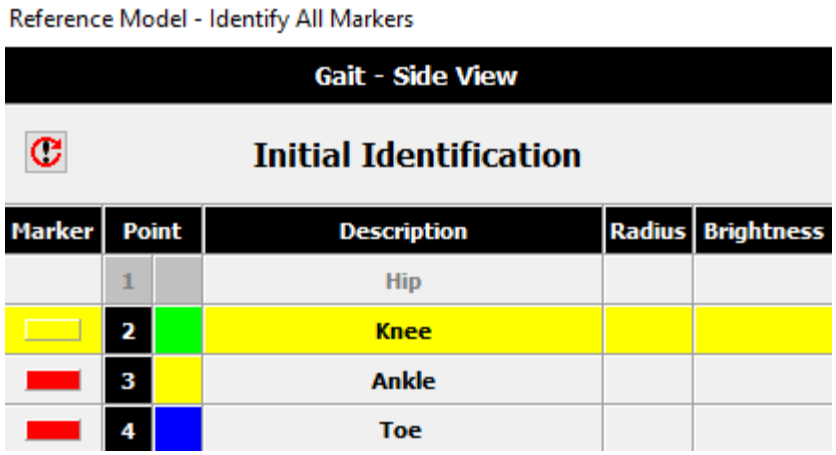


If users double click the same box when a marker is in Manual tracking, they will also have the option to ‘Ignore’ this marker. This is to be used when the user does not want the marker to be considered at the start of a digitisation trace, however it does come into shot towards to the end, which they are able to identify at that point.

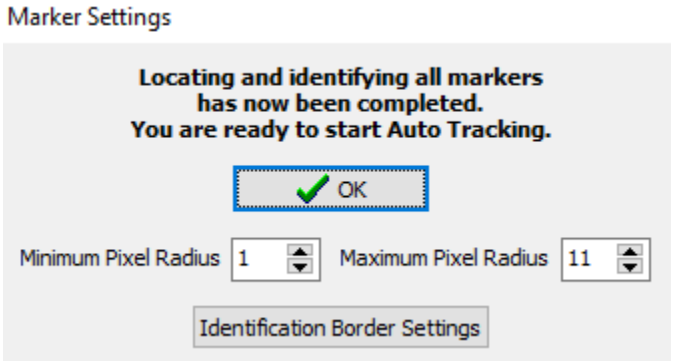


Double clicking the same box will then put the marker back into Automatic Tracking’s Initial Detection.

Users also have the option to ignore a marker for the whole digitisation trace. This can be done by double clicking the marker name, which will grey out that marker. If the user double clicks again, it will undo this.

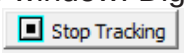


Once all the markers have been accounted for, click **‘OK’** on the pop-up window to start tracking the identified markers.



The system is now ready for Auto Tracking

Select “OK” and the video will begin to play and the identified markers will be tracked automatically.

The digitisation process can be sped up or slowed down by using the scroll bar at the top of the window. Digitisation can also be stopped at any point by using the stop tracking 

button located at the top of the digitisation window.

Show/Hide Marker Descriptions

Digitisation Speed Scroll bar

Reference Template

Digitisation Progress

Auto Tracking

Auto Tracking Cycling 4 Points

Frames Tracked: 40 - 313/532 (55%)

Marker	Point	Description	Radius	Brightness	Manual	Auto	Interpolate
	1	Hip	3	216	☐		☐
	2	Knee	3	219	☐		☐
	3	Ankle	3	239	☐		☐
	4	Toe	3	237	☐		☐

c. Lost Marker

During automatic tracking, markers can become obstructed by moving limbs, lost due to rotation, or the marker moving out of the field of view. If a marker cannot be automatically digitised at any particular frame, the digitisation process pauses for the user to select **'Manual Tracking'** or **'Interpolation'** of the selected marker – see below.

Auto Tracking

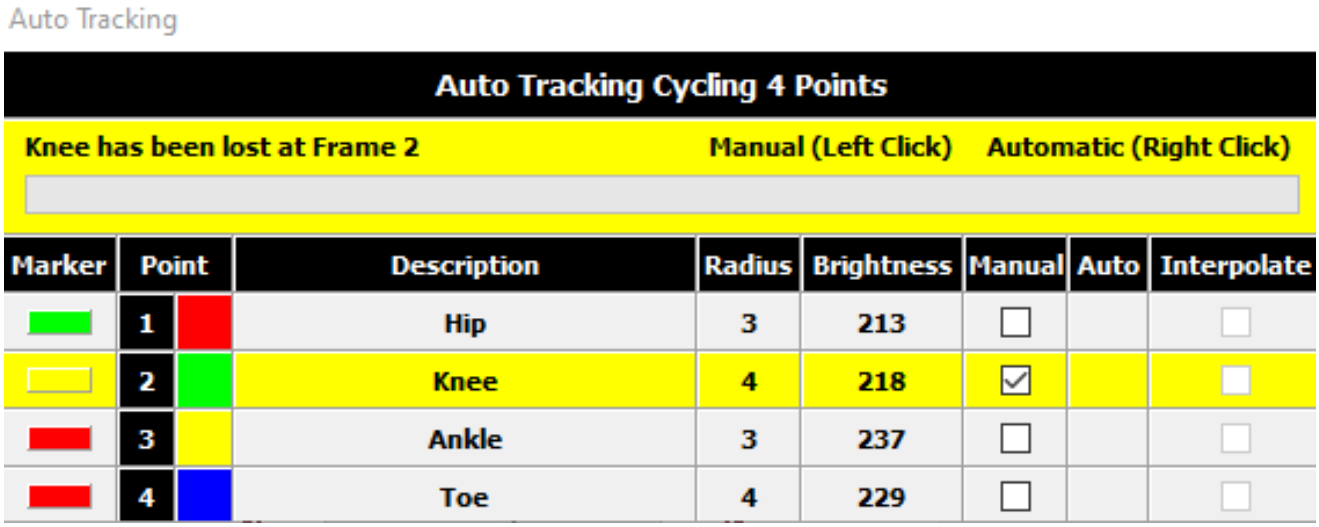
Auto Tracking Cycling 4 Points

Knee has been lost at Frame 2 **Manual (Left Click)** **Automatic (Right Click)**

Marker	Point	Description	Radius	Brightness	Manual	Auto	Interpolate
	1	Hip	3	213	☐		☐
	2	Knee	4	218	☑		☐
	3	Ankle	3	237	☐		☐
	4	Toe	4	229	☐		☐

d. Manual Tracking

The picture illustrates a marker being obstructed by a moving limb, causing the marker to be lost and the digitisation to pause. To be able to continue automatically digitising, manual digitisation may be performed for this frame. Also notice that the manual column has now been selected for the knee marker, e.g. the picture illustrates that the knee marker has been lost.



This will load a magnification window so that you can pinpoint the marker position more accurately.

To manually track the ‘lost’ marker, left click on the area of the screen that the knee marker should be (you may have to estimate if the marker is completely obstructed).

The lost marker has now been successfully tracked and digitisation can now continue.

If the marker remains ‘lost’ for a couple of frames, continue to left click in the area of the screen that you perceive the marker to be in, using the magnification window to improve the accuracy. Once the marker reappears, right click on it to set the tracking process back to automatic tracking. The digitisation process will now continue automatically, until another marker is lost or the end of the video is reached.

e. Marker Interpolation

This function can also be used when a marker becomes ‘lost’ (it can save time when the marker is ‘lost’ for several frames and the movement is regular).

Interpolation instructs the software to join the gaps between where the marker was last seen to where the marker was reidentified. A curve of best fit will then be applied through the interpolated frames.

Auto Tracking

Auto Tracking Cycling 4 Points

Knee has been lost at Frame 446 — **Manual (Left Click)** — **Automatic (Right Click)**

Marker	Point	Description	Radius	Brightness	Manual	Auto	Interpolate
	1	Hip	3	221	☐		☐
	2	Knee	3	234	☑		☐
	3	Ankle	3	242	☐		☐
	4	Toe	4	241	☐		☐

Once a marker has been lost, the digitisation process will pause as before and the manual column will be selected, however Quintic recommends pausing the video before the marker is lost for increased accuracy.

To use interpolation, select the interpolation option for the lost marker in the reference model window, once this is selected the tracking will continue. Every frame from this point onwards will be interpolated. The software will now continue to track all of the markers except the interpolated point. Once the interpolated marker can be seen again click on the Manual tick button to set the interpolated point back to manual within the reference model window.

After **‘Manual’** has been selected, manually track at least the first following frame. More frame reference points will result in better interpolation - Quintic suggest at least 3 following frames are manually digitised. You can now right click to identify the marker on the next frame and the software will return to automatic tracking.

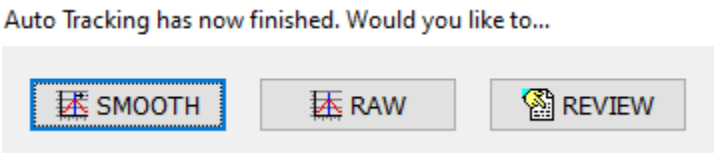
The digitisation process will now continue automatically, until another marker is lost or the end of the video is reached.

Because of the need for a final reference point for calculation, Interpolation Mode must be finished before the end of the video or before the marker moves off the screen. Quintic suggest at least 3 frames are manually digitised after interpolation finishes.

6) Ending the Automatic Digitisation Process

The digitisation process will continue until the video has played through, the stop or pause button is pressed or one of the markers is lost.

When the last video frame has been digitised or if the user clicks stop tracking, a pop-up window will appear to inform the user that Automatic Tracking has now finished. The user then has to choose one of the three options before the digitisation trace is saved.



Smooth – Saves the data of the trace with the optimal Butterworth filters, without review of the trace. The window will then close.

To change or add filters at a later time, click “Digitisation” on the Main window and select “Load an Existing Trace” and then “Data Smoothing of Current Trace”. This will bring up filtering options (refer to section 6d for further information).

Raw – Directly saves the raw data of the trace without editing or filtering.

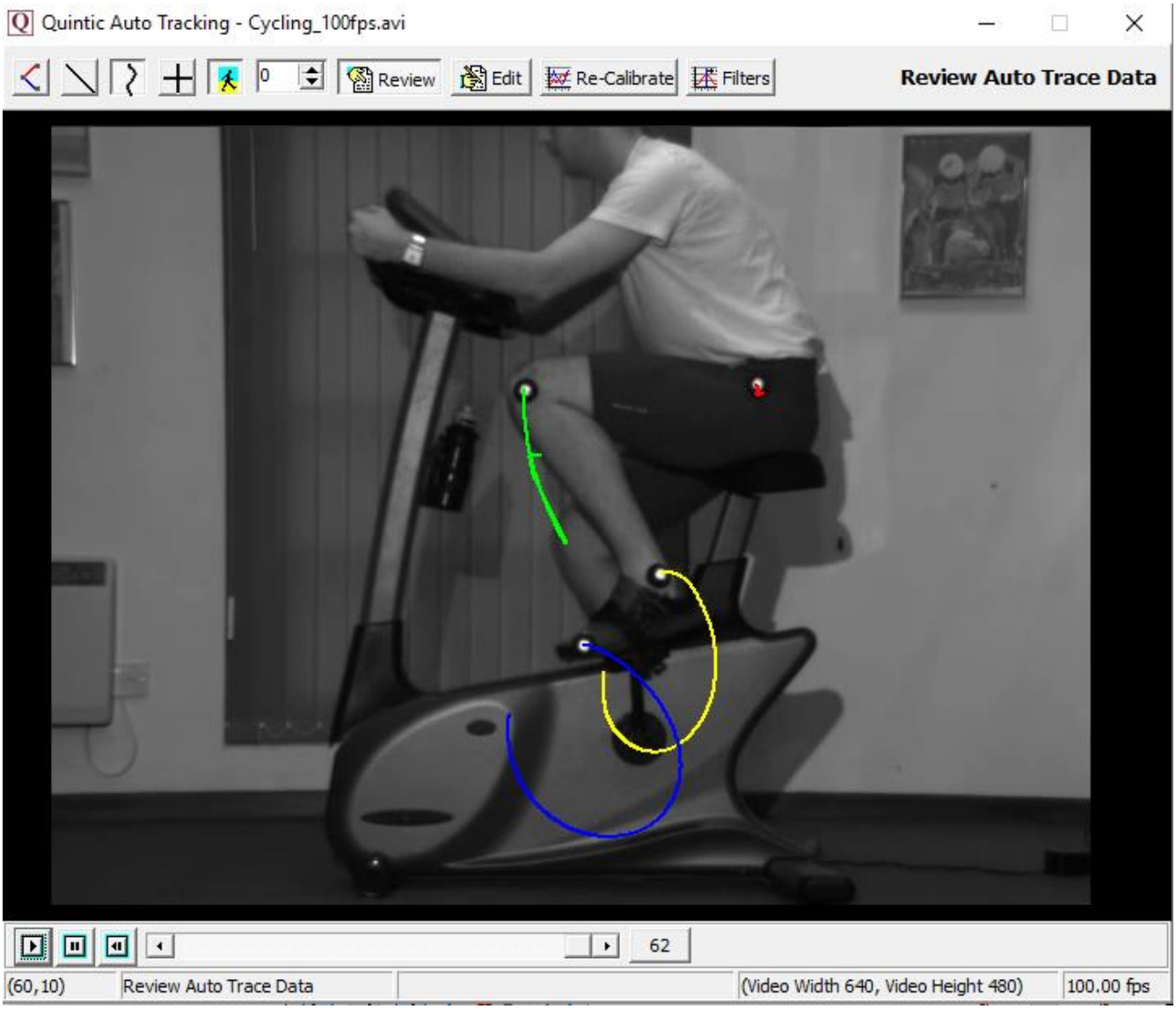
To change or add filters at a later date, click “Digitisation” on the Main window and select “Load an Existing Trace” and then “Data Smoothing of Current Trace”. This will bring up filtering options (refer to section 6d for further information).

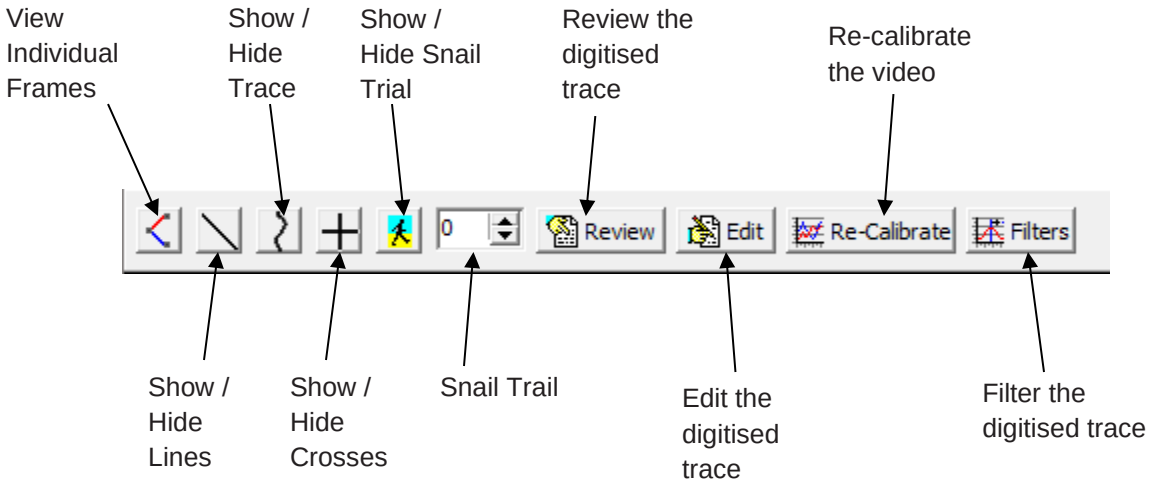
Review – Opens the review screen allowing you to edit the digitised points before the trace is finalised. The user is able to review, edit, re-calibrate or apply filters to the digitisation trace.

a. Reviewing the Digitisation Trace

If you have pressed the ‘Review’ trace button, this will bring up the following window where you are able to Review, Edit, Re-Calibrate or Filter the digitisation trace.

IT MUST BE A SINGLE STEP TRACE IN ORDER FOR IT TO BE EDITED.





View Individual Frames – Shows the digitisation trace at that particular frame. If there are any links joining the points together, this will be displayed.

Show / Hide Lines – Shows the lines between the digitisation points. This will also include the current and all previous digitised frames (depending on whether the snail trail is in use).

Show / Hide Trace – Shows the smoothed digitisation trace. This will also include the current and all previous digitised frames (depending on whether the snail trail is in use).

Show / Hide Crosses – Shows the crosses of where the software has tracked each point. This will also include the current and all previous digitised frames (depending on whether the snail trail is in use).

Show / Hide Snail Trace – Shows a snail trail, where the user is able to control how many previous frames are to be displayed.

Snail Trail – Allows the user to control how many frames are to be displayed behind the current frame.

Review the digitised trace – This will allow the user to review the digitised trace.

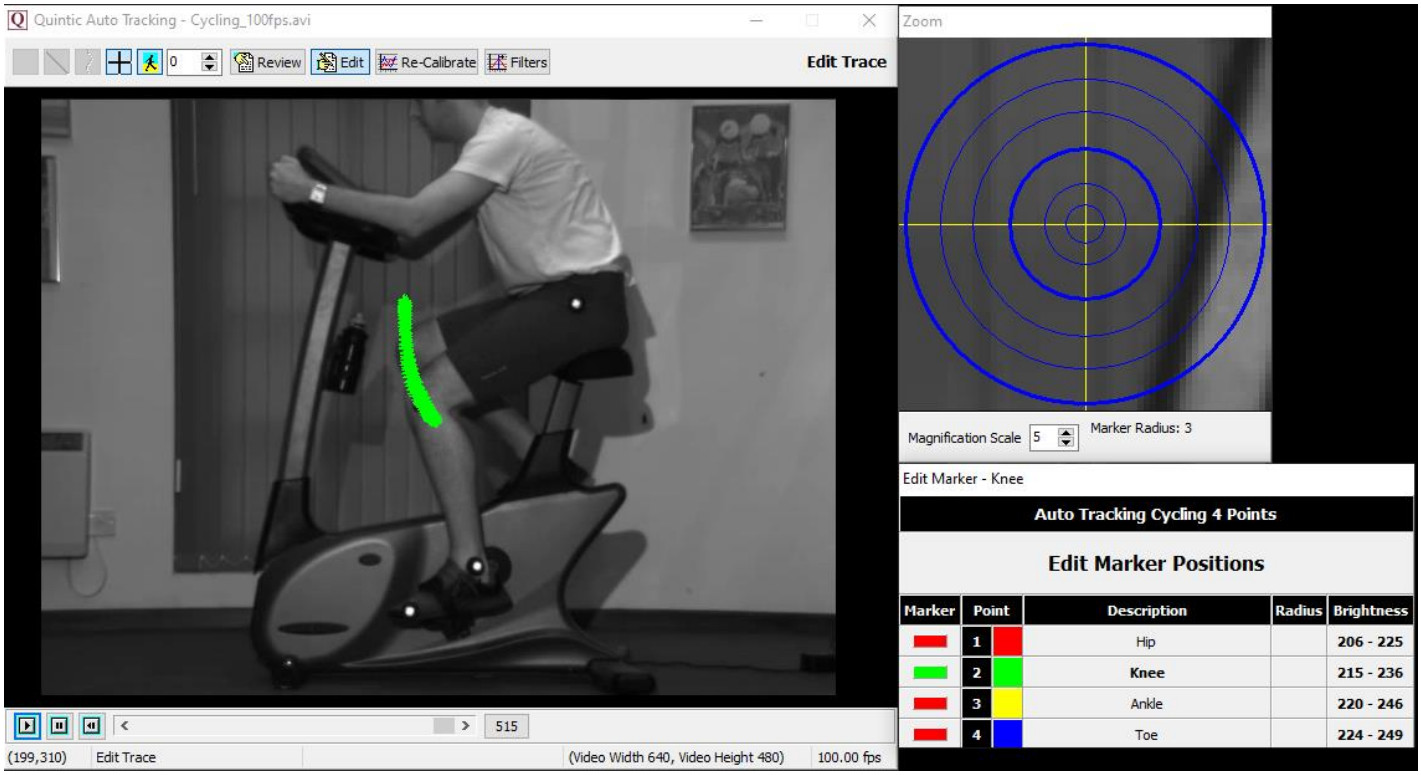
Edit the digitised trace – This will allow the user to edit the digitisation trace. Please see the heading ‘Editing a Digitised Trace’ below for more information on how to do this.

Re-calibrate the video – This will allow the user to re-calibrate the video. Please see the heading ‘Re-Calibrating an already Digitised Video’ below for more information on how to do this.

Filter the digitised trace – This will allow the user to filter the digitisation trace using a Butterworth filter. Please see the heading ‘Filtering a Digitised trace’ below for more information on how to do this.

b. Editing a Digitised Trace

Press ‘Edit’ within the Edit Trace Data Window, which will pop up the ‘Edit Marker Position’ window.

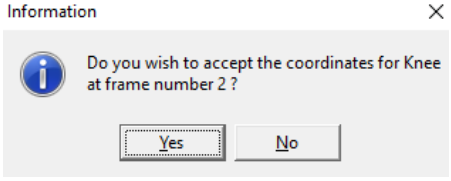


This will bring up all of the digitisation points for every frame that has been digitised, one point at a time. The point that is currently active will be displayed in green, so for the example above, the hip point is displayed. All the other points in the marker set will be highlighted in red within the Edit Marker Positions box.

N.B. You can only edit one trace at a time.

To edit, simply click on the marker point of interest and scroll to the frame(s) of which you want to edit and click on the screen to overwrite that digitisation point for that frame.

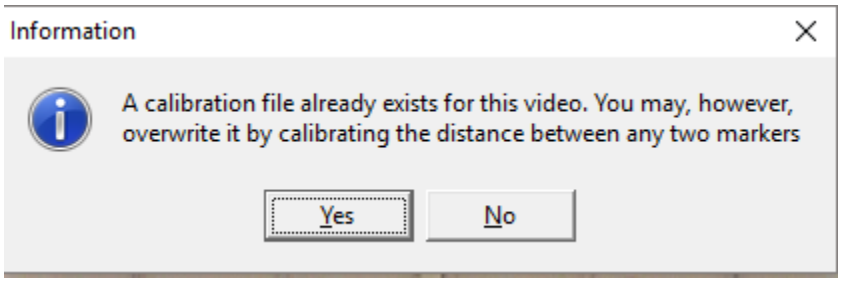
Once clicked, it will bring up a pop up to confirm that you are happy to accept the new point in the digitisation trace. Simply click YES if you are or NO to locate that point again.



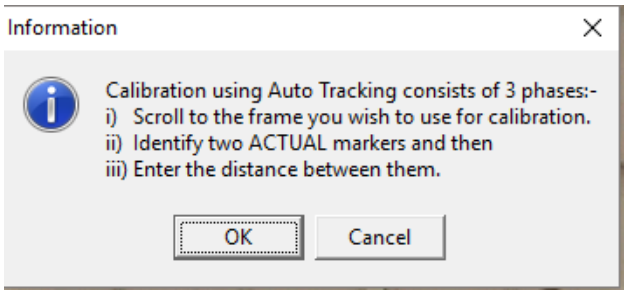
To exit from the editing mode, select one of the other options from the top menu bar or close the window.

c. Re-Calibrating an Already Digitised Video

Should you ever be required to re-calibrate a digitised video, please select the 'Re-Calibrate' Button within the Edit Window. This will pop up a new window stating this video already has a calibration file and asking if you would you like to Re-Calibrate. If you would like to, simply click yes, if not, click no and this will continue to use the existing calibration file.

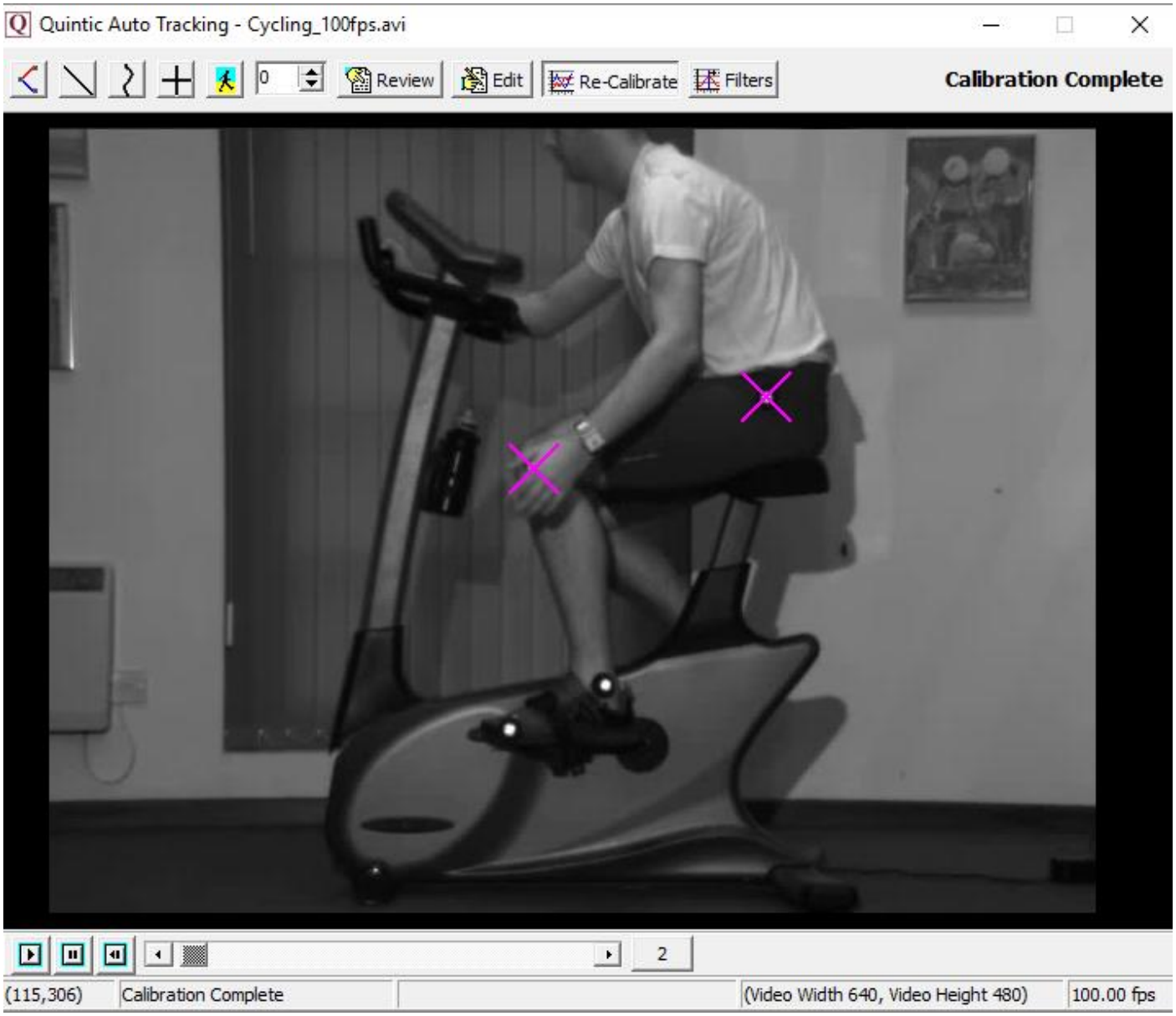


If you clicked yes, you will be brought to the following pop up window, where you will be required to scroll to the frame you wish to use for re-calibration, identify the two markers you wish to use for re-calibration, then enter the distance between them.



When re-calibrating, the software will only calibrate between two markers that have been digitised. Once you have selected the two markers and entered the distance between them, it will say calibration complete. Please see example below.

The software will 'lock on' to the nearest real marker point to where the user clicks.

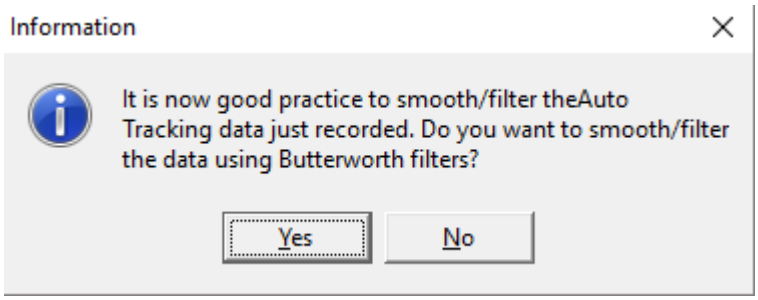

Quintic Auto Tracking - Cycling_100fps.avi
0
Review
Edit
Re-Calibrate
Filters
Calibration Complete
2
(115,306)
Calibration Complete
(Video Width 640, Video Height 480)
100.00 fps

d. Filtering a Digitised Trace

It is important to smooth data that has been produced by digitising to remove any errors that may have occurred during the digitisation process, e.g. marker /skin / clothing movement errors.

If you would like to filter the digitised data, please select the ‘Filters’ Button within the Edit Window.

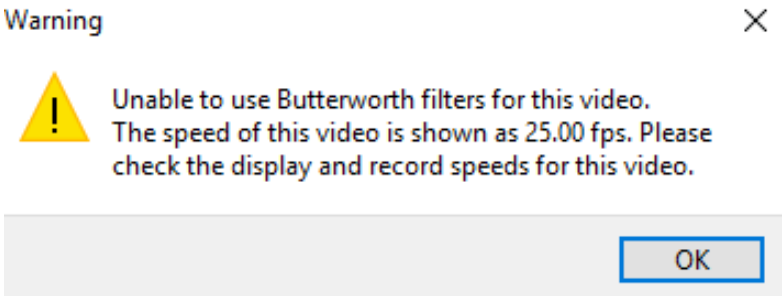
This will bring up the following window.



N.B The recording speed of the video has to be above 25 fps in order for that video to be filtered.

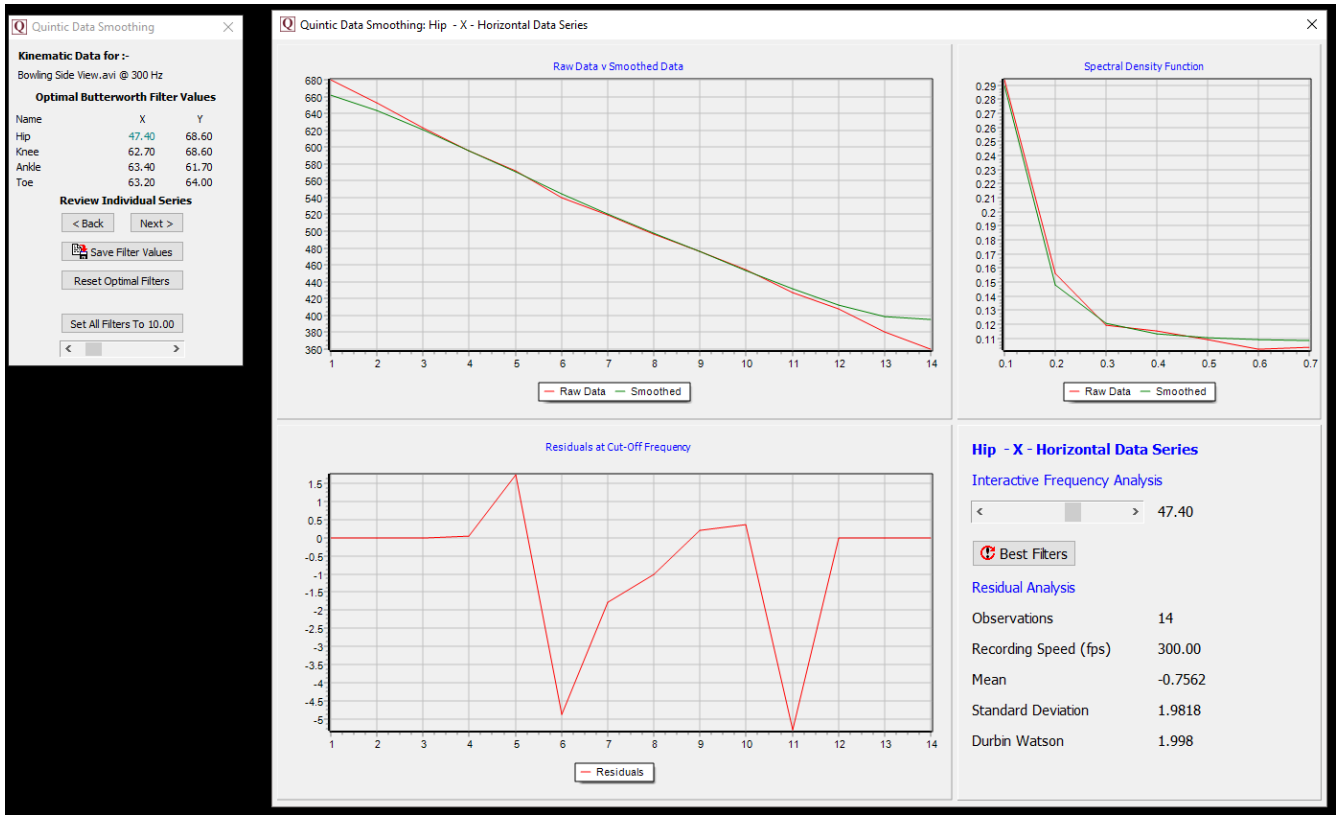
If you click No, no Butterworth filters will be applied.

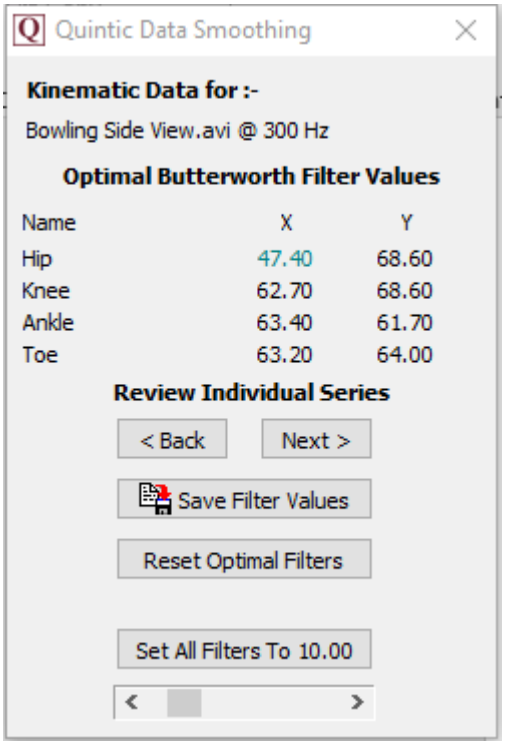
If you click Yes but your video is less than or equal to 25 fps, the following message will appear.



If you clicked Yes and your video is greater than 25 fps, you will be brought to the screen below, to begin the data filtering procedure.

The **‘Quintic Data Smoothing’** window will now load, illustrating the optimal Butterworth Filter values that have been placed on the data to smooth any data anomalies that may have occurred during the digitisation process.


Quintic Data Smoothing
Kinematic Data for :-
Bowling Side View.avi @ 300 Hz
Optimal Butterworth Filter Values
Name X Y
Hip 47.40 68.60
Knee 62.70 68.60
Ankle 63.40 61.70
Toe 63.20 64.00
Review Individual Series
< Back
Next >
Save Filter Values
Reset Optimal Filters
Set All Filters To 10.00
Quintic Data Smoothing: Hip - X - Horizontal Data Series
Raw Data v Smoothed Data
Raw Data
Smoothed
Spectral Density Function
Raw Data
Smoothed
Residuals at Cut-Off Frequency
Residuals
Hip - X - Horizontal Data Series
Interactive Frequency Analysis
47.40
Best Filters
Residual Analysis
Observations 14
Recording Speed (fps) 300.00
Mean -0.7562
Standard Deviation 1.9818
Durbin Watson 1.998


Quintic Data Smoothing
Kinematic Data for :-
Bowling Side View.avi @ 300 Hz
Optimal Butterworth Filter Values
Name X Y
Hip 47.40 68.60
Knee 62.70 68.60
Ankle 63.40 61.70
Toe 63.20 64.00
Review Individual Series
< Back
Next >
Save Filter Values
Reset Optimal Filters
Set All Filters To 10.00

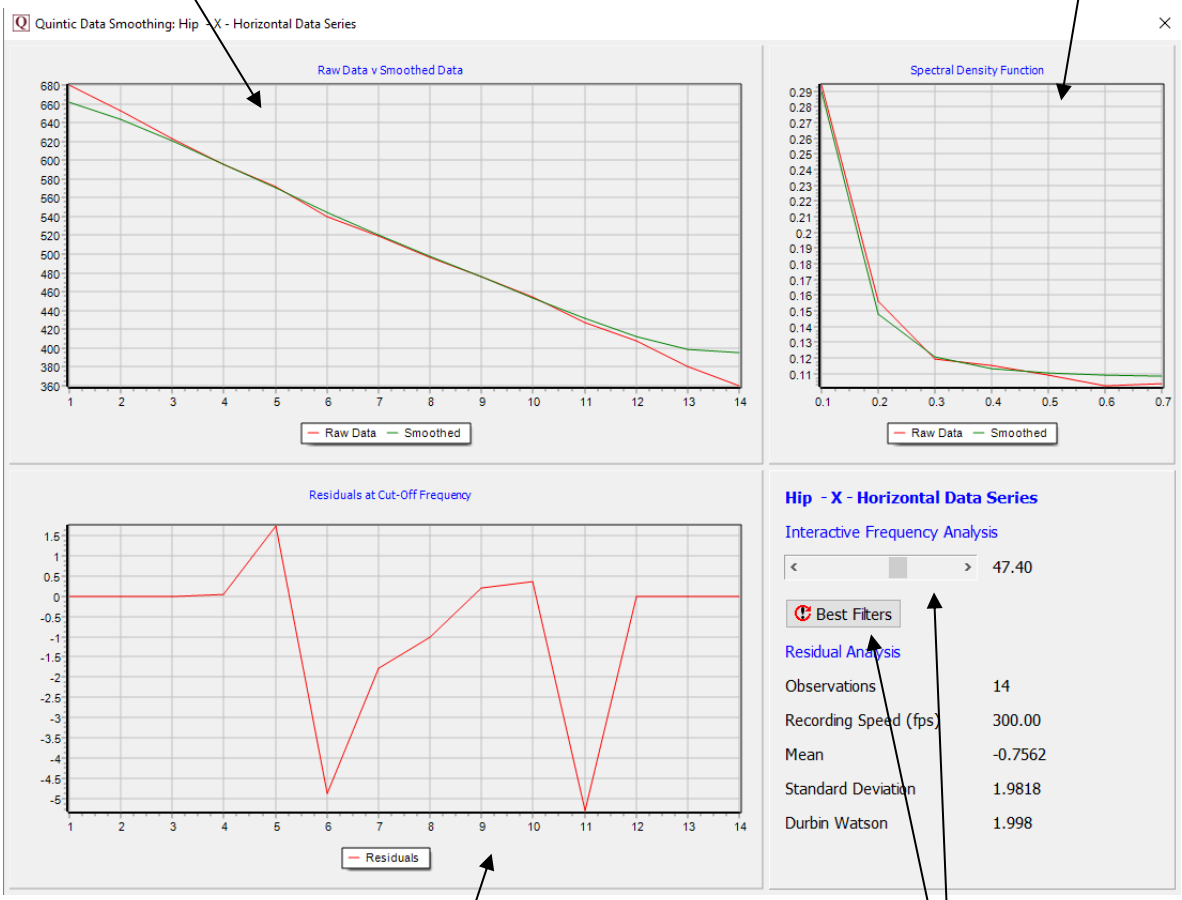
Each point that has been digitised has its X and Y co-ordinates smoothed independently. These smoothing values are show in the Quintic Data Smoothing window above, e.g. 47.40.

To move between each filter value, please click on the Next or Back buttons.

Should you like to review the filter settings to confirm optimal filters have been used, you are able to consider these values in the additional window. Please see below for more information on this window.

Raw Data v Smoothed Data

Spectral Density Function



Residuals at Cut Off Frequency

Interactive Frequency Analysis

Raw Data v Smoothed Data - This graph illustrates values for both the raw and smoothed data.

Spectral Density Function - Describes how the energy (or variance) of a signal or a time series is distributed with frequency. In physics, the signal is usually a wave, such as an electromagnetic wave, random vibration, or an acoustic wave. The spectral density of the wave, when multiplied by an appropriate factor, will give the power carried by the wave, per unit frequency.

Residuals at Cut off Frequency - This illustrates the difference between the raw and smooth data. Good values should oscillate around 0. If predominantly positive or negative values are produced, an incorrect filter value has been used.

Interactive Frequency Analysis - This function allows the user to control the level of filtering that is placed upon the raw data, by using the scroll bar. To reset the filters back to their optimum value, click on the 'Best Filters' button.

Once you are happy with the filter values that have been applied, simply click the Save Filter Values button and close the smoothing window(s).

7. Continue Manual Digitisation of an Existing Trace

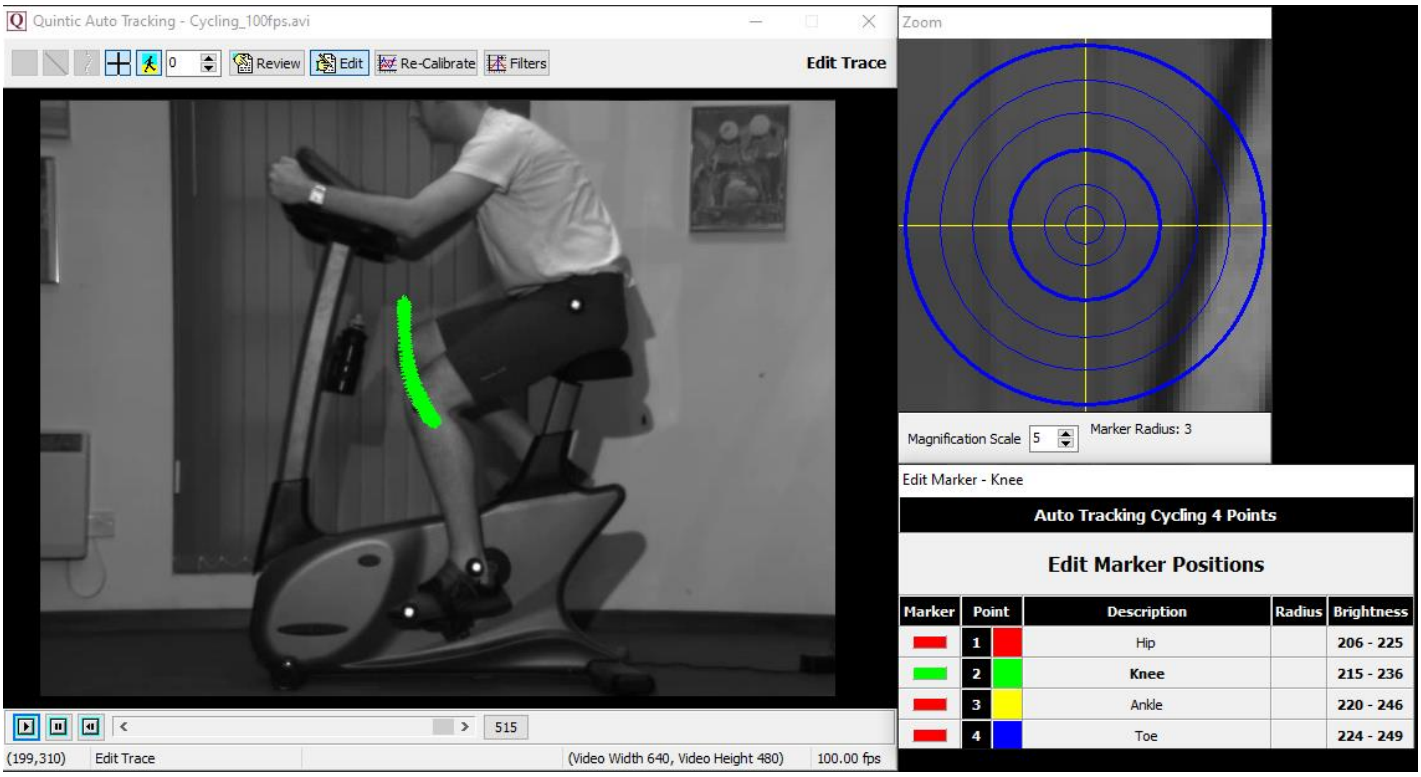
You are able to save a digitisation trace and then carry on Manually digitising it at a later time. This can be done by clicking the Digitisation button within the Digitisation tab, then clicking **'Continue Manual Digitisation of an Existing Trace'.**

This will allow the user to carry on digitising from the next frame after the last frame previously digitised. Please note, you are unable to re-edit previously digitised traces within this window.

8. Editing an Existing Trace

Should you like to edit a trace, you are able to do this by clicking on the 'Review/Edit an Existing Trace' button which is found by clicking the Digitisation button, within the Digitisation Tab.

This will pop up the following window, where you are able to Review, Edit, Re-Calibrate or Filter the digitisation trace, as detailed earlier in this tutorial.



PRACTICAL EXAMPLE

Open the video "**Cycling_100fps.avi"** from the **'Cycling'** folder**.**

Use Automatic Tracking to digitise the video. You may have to create your own Digitisation template.