SkillSpector
Version 1.2.4

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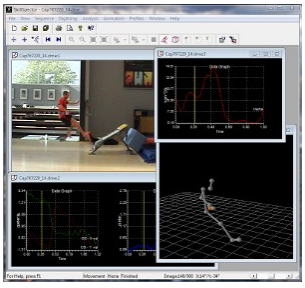
biomechanics made simple....



Author: Jan Brønd

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Video based movement analysis

Introduction

Video based movement analysis takes its offspring in a calibration object where the size and dimension is known.

The body position is calculated using a DLT algorithm (Direct Linear Transformation) which is found based on the calibration object.

Knowing the position of a movement in every frame/image in the video sequence its possible to calculate information like velocity, acceleration, centre of mass, angle, angle velocity and so on.

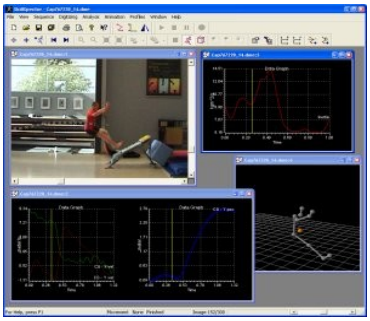
This is how the position of the model/body in world coordinates is calculated:

1. The calibration objects is digitized in the video image
2. Calibration object dimension is defined
3. DLT parameters is calculated
4. Position of the model/body is digitized in the video sequence
5. Using the DLT the world coordinates of the model is calculated
6. Interpolation of missing points
7. Filtering of the movement data

The process of video based movement analysis consists of the following steps:

1. Video recording of the movement and calibration object
2. Definition of the human model
3. Definition of the calibration object
4. Digitizing of the model in each frame/image of the video sequence
5. Digitizing of the calibration points
6. Transformation of the movement data to world coordinates
7. Movement analysis

Its possible to change the sequence of digitizing of calibration and movement. Its just important to know that if the calibration is digitized before the movement the transformation has to be don manually from the menu.
First point in the process can be done using SkillCapture and the rest SkillSpector.



In SkillSpector its possible to combine all the kinematic information, video and animation in one complete analysis. By navigating in the video its possible to follow the progression of kinematic information and animation of the movement.

Author: Jan Brønd

Terminology/Keywords

Sequence	Sequence is the SkillSpector's movement analysis.
View	”View” is the same as camera position.
Filtering	Filtering is the process of the smoothing data after digitizing.
Calibration	SkillSpector uses a object to transform image coordinates to real world coordinates. The know object, size and position in video is called calibration.
Digitizing	The process of marking the model positions in the video images.
Frame	Single image in the video sequence.
Model	Simplification of the human movement system.
DLT	DLT is Direct Linear Transformation and is the mathematical method use to transform image data to real worl coordinates.
Kinematic	The part in biomechanics describing position, velocity, acceleration, rotation and so on.
Sneak Zoom	Tool in SkillSpector to enable fast zoom in the digitizing process.
Interpolation	Feature in SkillSpector to mathematically predict missing (non visual) points.
Missing point	Option to mark as missing if it can't be digitized correctly.
Static point	Option for setting a points as static and only digitize it once.
Point	Point is a definition of a point on the body or an object. The points is part of the digitizing model. A point could be something like ankle, sholder, knee and so on, but it could also be a golf ball.
Segment	Segment is the definition of a body part like an arm or a leg.
Joint	
Graph	Graph is the X,Y coordinate system where its possible to insert movement data.

Curve	Curve is the actually movement data.
Interlaced	Video recorded as two half images but combined in a single frame.
Overlay	The option for viewing two video at the same time with the one having a certain amount of opacity.
Raw video file	The uncompressed video file where all image information is untouched.
.avi	Standard windows Video file format used by SkillSpector
Plane	In 3D coordinate system you have three planes (X,Y), (Y,Z) and (X,Z).
World coordinates	Coordinate system as its known from mathematics (X,Y,Z).
Image coordinates	2D coordinates (X,Y) in the video image.

Recording the movement on video

Video based movement analysis starts with the recording of the movement and the calibrations object.

Important: The camera is not to be moved between the recording of the movement and the calibration.

Video filming the movement there is several parameters that's important to consider:

1. Frames/sec
2. Position of the camera
3. Shutter time
4. Focus
5. Zoom
6. Wide angle
7. Compression
8. Image quality and optimization

Frames/sec

Analysis of fast movement it's important with an appropriate time resolution of the video recording. It's not all camera types that is capable of recording enough frames/sec.

Example video camera frame rates:

Mini DV camera – 50 frames/sec.
DV compressed – 25 frames/sec.
Web Camera – 10 frames/sec.

If the movement is recorded with SkillCapture and a Mini DV camera it's possible to work with 50 frames/sec (interlaced video). SkillCapture works with both non compressed and compressed video files. 50frames/sec is for most fast movements appropriate. It's possible to work with higher frame rates with SkillSpector.

Interlaced video

The normal TV video signal is composed of two half images captured at different time.

SkillSpector is capable of extracting the extra time resolution from interlaced video. This requires to work with “raw” DV video files.

Position of the video camera

Use a tripod to make sure the camera is stable. It's important that the movement utilizes the full image size.

With 2D analysis it's important that the camera is perpendicular to the movement (read later).

Shutter time

Even if the time resolution of the video sequence is “only” something like 50 frames/sec it's important that the shutter timer is short and optimal. The reason why the shutter time has to be short is due to the shutter mechanisem in the camera which enables the light to pass through to the image sensor (CCD). Every time the video camera “takes” an image the shutter is opened and the light reflection will hit the CCD. With long shutter time the light reflection from the moving person will hit the CCD while the person is in motion and the shutter is open. This will off course show on the video image and result in motion blur (unclear body segments).

Obviously it would be smart to choose a very short shutter time but the image quality is dependent on the amount of light getting through to the CCD and a short shutter time will result in dark images if there is insufficient light. In most cases a shutter timer of 1/100-1/250 /sec is sufficient. If the required shutter time can't be chosen it might be difficult to digitize the movement correctly.

For some Mini DV cameras it not possible to manually change the shutter time. The best alternative for these cameras it might be possible to chose a program called “Sports”. The Sports programme automatically selects a short shutter time and a large aperture.

Manuel focus

In all cameras there is automated focus. Automatic focus continuously search for the best and sharpest “image”. The problem with automated focus might be that it takes time from the person get into to view and until the camera has adjusted the focus. In this situation the first 10-20 frames might be “out” of focus. It's an advantage to use manual focus.

Zoom

Optical zoom is great but it requires more light. If there is insufficient light in the area where the video is to be recorded it might have consequences for the shutter time and the image quality.

Important: Avoid digital zoom it lowers the image quality.

Wide angle lens

It's not possible to use wide angle lens with SkillSpector.

Compression

Compression can have huge impact on the error of the analysis. Try to only work with “raw” video files. If you work with compressed video files it's important to consider the possible errors.

Image quality

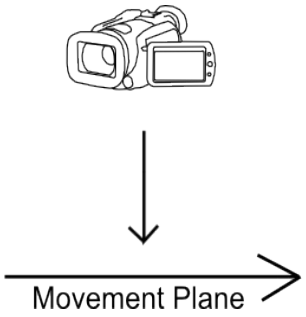
In the digitizing process it important to have high image quality. The image quality can be affected by several things but the following is easy to implement:

1. Make sure the movement utilizes the full image size.
2. Avoid a “noise” in the background
3. Avoid clothe covering joint angles
4. Make sure to have sufficient light

Video filming 2D motion analysis

2D Movement analysis is the simples kinematic analysis and it's only necessary to capture themovement from one single angle. It's important to place the camera perpendicular to the movement and also that no movement is done out of the plane which would lead to errors in the analysis.

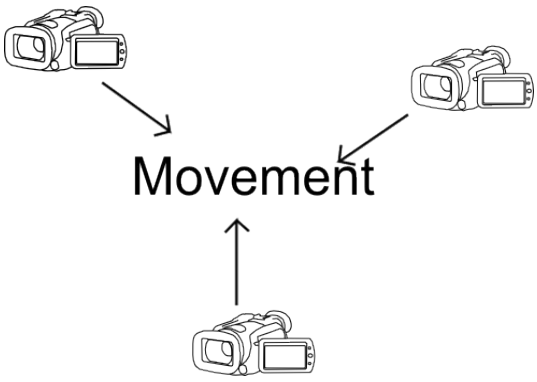
2D is limited to analysis in the single plane (X,Y).



Video filming 3D motion analysis

In 3D movement analysis it's possible to do analysis in 3 planes (X,Y), (Y,Z) and (X,Z).

By 3D motion analysis it's necessary with 2 or more camera angles/views.



Camera to camera synchronization

When using more than one camera to capture the movement it's important to synchronize the cameras to make sure that all cameras capture the images at the same instance of time. If synchronization is left out the analysis will contain large errors.

Calibration of camera to camera

This functionality is under development.

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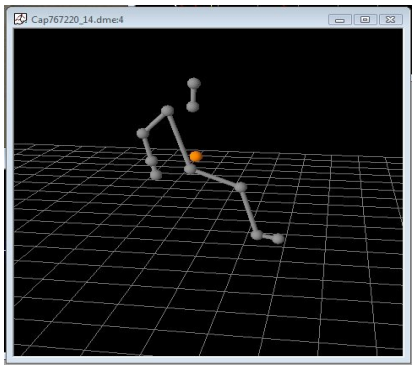
Analysis model

In order to work with kinematics of the human body it's necessary to simplify the body which can be used in SkillSpector. In SkillSpector the human body is simplified into a model composed of body positions which again is composed in to segments. Positions could be toe, ankle, knee, shoulder and so on where segments could be foot, hand, upper arm, thigh and so on. It's also possible to define other objects like football, golf club or tennis racket.



In the above image it's a human body right side which has been analysed. The model contains the points: toe, ankle, knee, hip, shoulder, elbow, wrist, finger, chin, forehead, which gives the segments foot, calf, thigh, torso, upper arm, forearm, hand and head. The orange point in the model is the calculated centre of gravity.

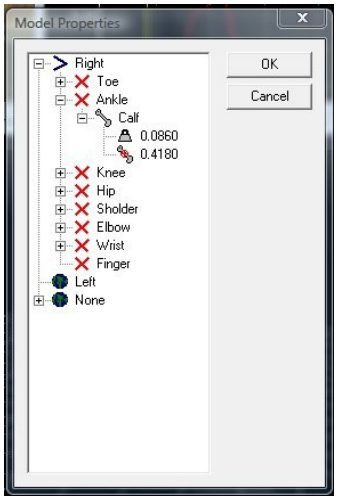
Points

Points is most often joint positions on the body like ankle, knee, hip but it can also be ball, bat or any other object.

Definition of segment

A segment is defined as an element going from one point to another. For example the calf segment is defined by the akle and the knee.

For each segment it's possible to define a relative centre of gravity and weight.



In the above image it's possible to view the model properties for the calf with a relative weight of 0.086 (body total weight is 1.0) and the relative centre of gravity placed 0.418 from the ankle (the

total length of the calf is 1.0).

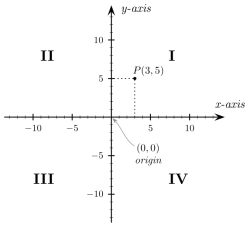
Analysis – 2D or 3D?

It's important to choose the right method of analysis not just for accuracy but also to minimize the amount work that has to be done in the digitizing process. It's possible to choose between a 2D or 3D analysis.

2D analysis

The 2D analysis is limited to a single plane where by it's only possible with movement in the X and Y direction.

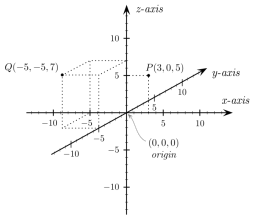
For many movements 2D is adequate but if the skill has movement out of the X,Y plane it's important to consider the error and consider the influence on the analysis.

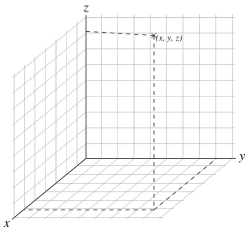


The above shows the X,Y plane (coordinate system) used in the 2D analysis.

3D analysis

3D analysis offers analysis of movements in all three planes. The 3D analysis requires that each point is viewed from minimum 2 camera views. The optimal is to have each points viewed from 3 camera views.





Digitizing the model in the video

After the model has been defined it's time for the digitizing process. The digitizing process is the finding and marking of the points in the video image. Each point has to be digitized in the sequence of frames selected for analysis. So, if only a small section of the video is to be analysed it's important that all points in all frames in the sequence has to be digitized.

It's important that the positioning of points is done as accurate as possible. During the digitizing process it's possible to simplify and increase the positioning accuracy using the following features in SkillSpector:

Zoom, Sneak Zoom
Standard zooming the the video image. A zoom and scroll position is keept for each point in order to enable large zoom values.

Sneak zoom enables a small zoom window by holding down the mouse button in the digitizing process. The zoom window can be use to position the points more accurately.

Image processing
Use of image processing to improve image quality.

Re-finding the points
SkillSpector has a built in feature (computer vision) which re-finds the point from previous image in the next image.

Missing points
It's possible to select a point as missing and have SkillSpector predict the possible position using interpolation.

Static points
It's possible to select a point as static which indicates a point that does not move. The is to be digitized in the first frame.

Views – Camera angle

By 3D movement analysis every point has to be viewed from minimum 2 camera angles. Camera angles in SkillSpector is called views.

Calibration

SkillSpector uses a calibration object in to calculate the kinematic movement information. The calibration object can be more or less anything. Important for the object is that there must be several well defined positions on the object that gives its dimensions.

The calibration object has to be digitized in the same way the movement has been done. It's possible to have the calibration video in a separate video as the movement.

The object could be a frame where one points is defined as (0,0) and the rest of the points defined from this. Remember to keep the frame stable and solid.

Important: 2D analyse requires minimum 4 defined positions on the calibration frame and 3D requires minimum 6 know positions. All calibrations points must be viewable from all camera views.

In SkillSpector its possible to use three different calibration objects:

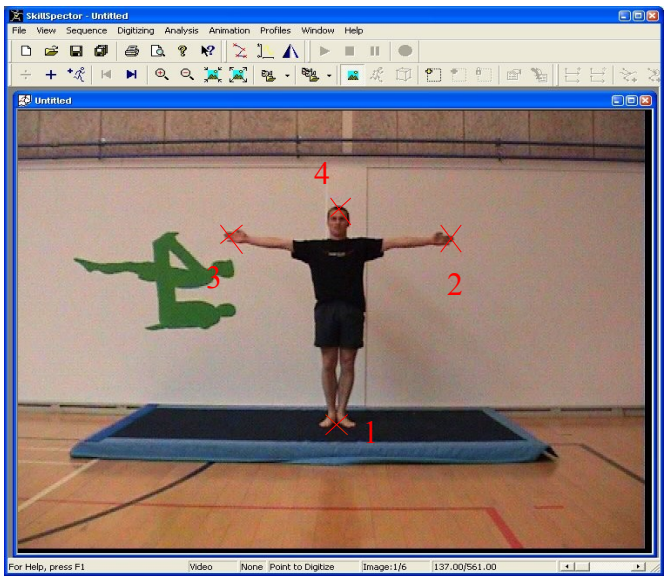
1. Posture
2. 2D Object
3. 3D Object

Posture

Posture calibration is a very simple calibration method and can only be used with 2D analysis. The concept is to use the body and thus find 4 positions. The 4 positions is between the heels, right hand, left hand and the top of the head.

***Importatn:* Posture can not be used in 3D analysis.**

The posture calibration is not very accurate but for repeated trials with the same person or as a pilot study it can be used.



When digitizing the posture calibration it's important to start with the heels, right finger, left finger

and finally the top of the head.

2D Object

2D calibration object has to define a single plane and is thus minimized to a simple frame with 4 points.

3D Object

3D calibration object has to define all 3 planes and has to be a cube like object. There must be more that 6 points in the 3D calibration object.

Transformation

After the movement and the calibration has been digitized it's time to transform the images coordinates to real world coordinates.

Important: If more images is digitized after transformation it's important to redo the transformation in order to include the data to the analysis.

DLT parameters

SkillSpector estimates DLT parameters for the transformation of the images coordinates.

Filtering

During analysis its possible to choose between raw or filtered data.

Interpolation

If points are selected as missing SkillCapture will use interpolation in order to predict their positions. It should be avoided to have missing points for more than 3-5 frames.

Motion data analysis

After the movement information from the video has been transformed a larger number of possibilities opens to look at the kinematics parameters.

Before starting any analysis it's important to consider what to look at and ask the question why would that be interesting? Here is some examples what to look for:

Example 1

sport: Shot-put

Purpose: To throw as far as possible

Typical focus points: Angle of release, speed of release

So what kinematic parameters has influence on the purpose?

Example 2

Sport: Long jump

Purpose: jumping as far as possible

Typical focus points: Running speed, angle of push off

So what kinematic parameters has influence on the purpose?

Overlay - Video on video

In SkillSpector it's possible to visually compare 2 video sequences. The “feature” can be found in the analysis menu where it's possible to open an overlay video.

It's possible to move the overlay video in time and physical position in respect to the other video.

Adjusting with respect to time: Activate Shift on the keyboard and use the right/left arrow.

Position: Activate Shift and Ctrl on the keyboard, left click with the mouse cursor in the video image and drag the overlay video into the optimal position.

Opacity: Activate Shift on the keyboard and use the up/down arrows to adjust the opacity of the overlay video.

Errors in the movement analysis

There is a lot of possible errors in video based motion analysis. Here is a list of possible errors:

1. Model
2. Low video image quality
3. Movement out of the plane in 2D analysis
4. Insufficient time resolution (frames/sec)
5. Bad positioned joints (mostly hip and shoulder)
6. Inaccurate calibration object

The errors can be dived into systematic and individual. The systematic errors is errors which is the same for movements analysed with the same calibration setup. Individual errors are errors that are specifically related to the single movement in question.

Description of the various errors:

Model

The simplification of the human body by using a model limits the analysis and the possible concussions that can be made. The model is a systematic error and thus the same for every movement analysed.

Low video image quality

Low video image quality can be caused by long shutter time, compression and automatic focus. If the video image quality is low it can be difficult to predict the correct positions of the model. Low video image quality can result in individual errors and has to be avoided.

Insufficient frames/sec

If the movement is fast it's important to have enough frames/sec.

Error in joint position

In some situations it can be difficult to estimate the joint positions due to the athlete wearing loose cloth. Inaccurate positioning of the joints is an individual error and must be avoided.

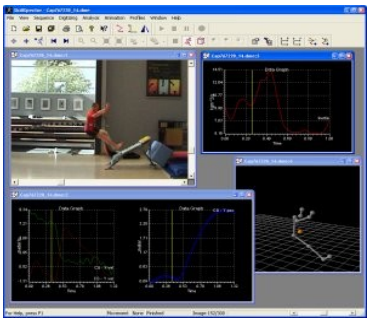
Movement out of the plane in 2D

Movement out of the plane in 2D analysis is both individual and systematic error. For some analysis the movement out of the plane can be accepted but most situations the 3D analysis must be considered.

Calibration object accuracy

The point positions of the calibration object must be as accurate as possible. A calibration object with bad accuracy is a systematic error. Comparison based on the same calibration object is possible but the comparison with other analysis based on different calibration object is not possible.

SkillSpector software



Analysis process

This is the typical analysis process by movement analysis:

1. Open movement video
2. Define model and calibration object using the Model Wizard
3. Switch to the Digitizing movement modes
4. Digitize the movement
5. Switch to Digitize calibration mode
6. Open the calibration video
7. Digitize the calibration
8. Switch to the movement mode
9. Transformation of the image data
10. Data analyse

Digitizing Modes

SkillSpector works in three different modes. The mode is changed in the toolbar or in the menu Digitizing->Mode

1. Video
2. Movement
3. Calibration

Important: Movement and Calibration mode can only be selected if the model and the calibration profile has been selected.

Video mode

In this mode its possible to do video navigation and video overlay analysis.

Movement mode

In this mode its possible to Digitize the model points positions and thereby the movement.

Calibration mode

In this mode its possible to digitize the points of the calibration object.

SkillSpector design

SkillSpector is designed as a standard Windows program. SkillSpector has its own document type called a Sequence. SkillSpector has three different windows:

1. Digitizing – Video and digitizing
2. Analysis – Movement data analysis
3. Animation – 3D representation of the movement.

Menus

The menus is organized to follow the work process of the movement analysis

1. File – General functions of SkillSpector
2. View – Enable/Disable view of the possible toolbars
3. Sequence – Parameters of the Sequence
4. Digitizing – Preferences and control of the digitizing process
5. Analysis – Movement data analysis
6. Animation – Preferences and control of the animation
7. Profiles – Configuration of mode and calibration objects
8. Window – Control of windows
9. Help – on-line help, version check.

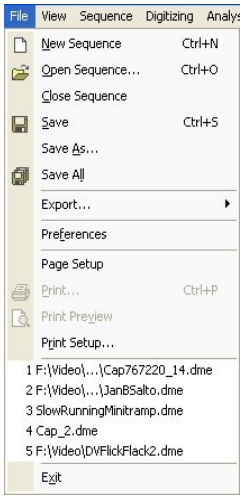
Toolbars

There is several different toolbars which enables easier access to the functionality:

1. Main – Same functionality as in the File menu
2. Window – Functionality from the Window menu
3. Digitizing – Functionality from the digitizing menu
4. Animation – Functionality from the animation menu
5. Analysis – Functionality from the analysis menu

SkillSpector menus

File Menu



New Sequence

Create new motion analysis Sequence.

Open Sequence

Open motion analysis Sequence.

Close Sequence

Close motion analysis Sequence.

Save

Save active motion analysis Sequence.

Save As

Save the active motion analysis Sequence in a new name.

Save All

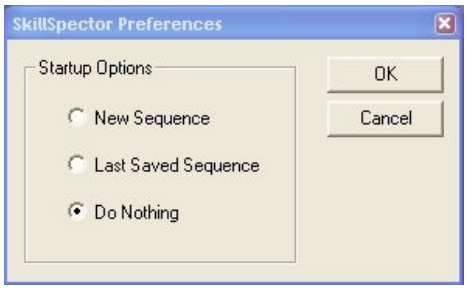
Save all open motion analysis Sequences.

Export

Export of movement data from the active motion analysis sequence. Export of movement data works in the same way as the data analysis. The only difference is that the data is save in a file stored on disk.

Preferences

Choosing the way SkillSpector start-up.



The three options:

1. New Sequence – Start with new motion analysis Sequence.
2. Last Saved Sequence – Open the last saved motion analysis Sequence.
3. Do nothing.

Page Setup

Choosing the paper for printing.

Print...

Print active window. Both analysis and video window can be printed.

Print Preview

Show preview of the print out.

Print Setup

Choosing printer and setup.

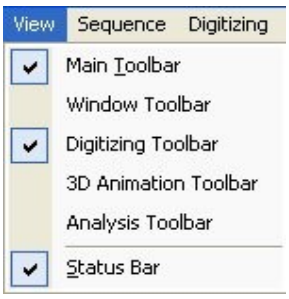
Recent Sequence files

List of last 5 opened motion analysis Sequences.

Exit

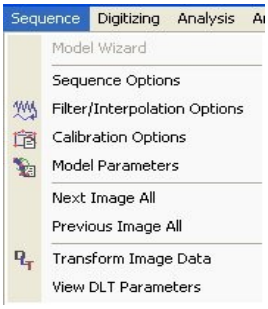
Exit SkillSpector.

View



In the view menu it's possible to enable and disable the various toolbars.

Sequence menu



Model Wizard

Definition of the model and calibration object.

Sequence Options

Modify the general information of the motion analysis Sequence.

Filter/Interpolation Options

Modify the filtering and the interpolation parameters.

Calibration Options

Modify the calibration information.

Model parameters

Model parameters (relative weight and centre of gravity distance of segments)

Next Image All

Next frame for all open motion analysis Sequences.

Previous Image All

Previous frame for all open motion analysis Sequences.

Transform Image Data

Transformation of the image positions to world coordinates.

View DLT parameters

Viewing the DLT parameters of the transformation.

Digitizing menuen

Mode

The video window works in three different modes. In the Mode sub-menu its possible to select the three possible modes.

View Mode

Mode where its possible to navigate in the video and do the video on video analysis (overlay).

Digitizing Mode

In this mode it's possible to digitize the movement.

Calibration Mode

In this mode it's possible to digitize the calibration object.

Views

Add

Add another camera view.

Remove

Remove active camera view.

Lock Views

Lock views.

Next

Show the next view.

List of views

Show list of camera views (list of camera angles).

Point/Marker

Missing

Mark a point as missing. During the transformation SkillSpector will use interpolation to predict a possible position.

Erase last point

Erase/Delete last digitized point.

Clear All points

Erase/Delete all points in the current frame.

Point Configuration

Modify the status of the points in the model. It's possible for each point to be missing (not viewable) or static (not moving).

Show Centre of gravity

Show Centre of gravity with the sick figure.

Hide Stick Figure

Enable/disable the stick figure.

Trace point

A trace point show how the point moved in time in the current frame.

Enable

Enable/Disable trace point

Set Point

Select the point that will display as trace point.

Automatic

Automatic Search options

Modify the automated search options.

Show Status window

Show the status window for the automated search.

Go (Short cut – G)

Start the automated Digitizing

Stop (Short cut – S)

Stop the automated Digitizing.

Single point (Short cut – N)

Select the next automated point.

Video Options

Modify the video options for the current active video.

Video Navigation

Sync Image

Mark the active frame as the synchronization image.

Next Image

Next image.

Previous Image

Previous image.

Next unfinished Image

Jump to next unfinished frame (frame with no points digitized).

Jump to Start

Jump to the start of the video sequence.

Jump to End

Jump to the last frame of the video sequence.

Zoom

SkillSpector works with fixed zoom. Following is possible:

x.5

x1.0

x2

x3

x4

SneakZoom

Setting the SneakZoom.

Image processing

This is an option to improve the image quality using image processing.

No Processing

Remove image processing.

Sharpen

Increase sharpness of the image.

Median filtering

Special method to smooth the image.

Smoothing

Standard smoothing method.

Blur

Removal of image noise.

Gaussian 3x3

Removal of image noise.

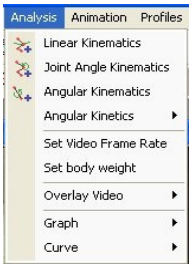
Gaussian 5x5

Removal of large amount of image noise.

Open Video (.Avi)*

Open video in to the current view.

Analysis



Linear Kinematics

Open new Analysis window and insert linear (position, velocity and acceleration) kinematic data of the movement.

Joint Angle Kinematics

Open new Analysis window and insert angle (joint angle, joint angle velocity and joint angle acceleration) kinematic data of the movement.

Angular Kinematics

Open new Analysis window and insert angular (angle, angle velocity and angle acceleration) kinematic data of the movement.

Angular Kinetics

Open new Analysis window and insert moment of inertia.

Set Video Frame Rate

Set the frame rate manually. Normally the frame rate is extracted from the video sequence. It's important that the frame rate is correct in order for SkillSpector to calculate velocity and acceleration.

Set body weight

Set subjects weight. This is used in the calculation of moment of inertia.

Overlay Video

Open Video

Open the video that is overlaid.

Video Options

Adjusting the Overlay video options.

Change opacity

Change the opacity of the overlay video.

Show

Enable/disable overlay video.

Graph

New Graph

Insert new Graph in the analysis window.

Remove Graph

Remove the active Graph from the analysis window.

Graph Properties

Modify the graph properties for the current active Graph.

Clear Graph

Remove all curves from the current active Graph.

Curve

Remove Curve

Remove the last added curve from the Graph.

Curve Properties

Modify the curve properties of the active curve.

Animation

Animation Options

Change animation options

Play

Play animation sequence

Stop

Stop animation.

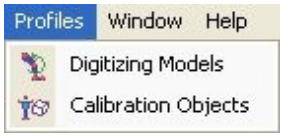
Pause

Pause animation.

Reset Orientation

Reset the position of the animation model.

Profiles



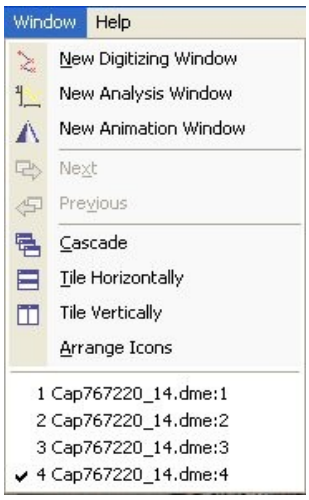
Digitizing Models

Adding and modify digitizing models.

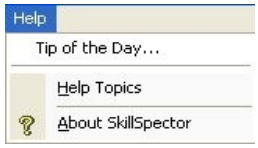
Calibration Objects

Adding and modify standard calibration objects.

Window



Help



Tip of the day

Show the “Tip of the day” dialog in the start-up.

Help topics

Not implemented.

About SkillSpector

Version of SkillSpector.

SkillSpector toolbars

Main Toolbar

From left to rigth:

1. New sequence
2. Open Sequence (or AVI file)
3. Save
4. Save all open sequences
5. Print active window
6. Print preview
7. Help
8. Help

Window Toolbar

From left to right:

1. Open new video window
2. Open new data analysis window
3. Open new animation window

Digitizing Toolbar

From left to right:

1. Previous frame
2. Next frame
3. Jump to the next unfinished frame
4. Go to first frame
5. Go to last frame
6. Zoom in
7. Zoom out
8. Fit window to image size
9. Fit images size to window size
10. Open video (if the arrow is selected the last 5 videos can be selected)
11. Open overlay Video (hif the arrow is selected the last 5 video can be selected)

Author: Jan Brønd

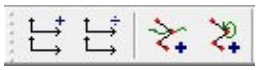
12. Switch to View mode
13. Switch to Digitizing Mode
14. Switch Calibration mode
15. Add another view
16. Delete the active view
17. Vis sequence options
18. Vis Model parameters

3D Animation Toolbar

From left to right:

1. Play the movement sequence
2. Stop
3. Pause
4. Reset orientation

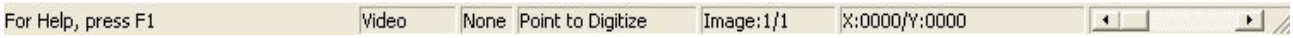
Analysis Toolbar



From left to right:

1. Insert new graph
2. Remove last graph
3. Insert Linear data curve
4. Insert angle data curve

Status bar



Status bar explained from left to right

General information from SkillSpector

Mode (Video/Motion/Calibration)

Point to be digitized

Frame number/of frames

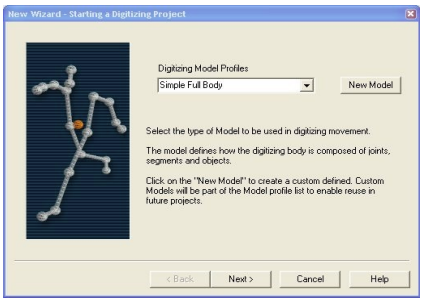
Information about mouse position

Slider for video navigation

Model Wizard – Definition of digitizing and calibration model

The model wizard is used to define the Digitzing model and the calibration object. After the Digitizing model has been defined it can not be changed. The calibration object can be changed at any time.

Choosing Model Profile



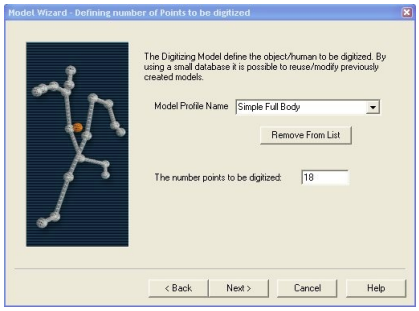
By installing SkillSpector serveral models is pre defined. If one of the models can be used it can be selected. After the model has been selected select “Next” to move on. If no model fits the analysis of interest select the “New Model” to define your own.

New Model

In order to create your own digitizing model the following has to be done:

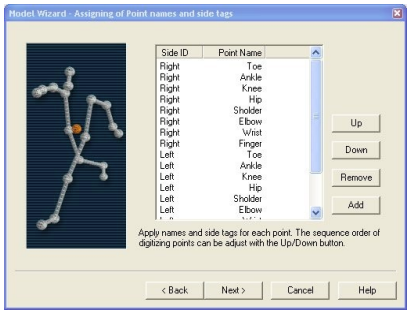
1. Create name and the number of points in the model
2. Definition of point names and side.
3. Definition of segments and their name.

Name of digitizing model and number of points



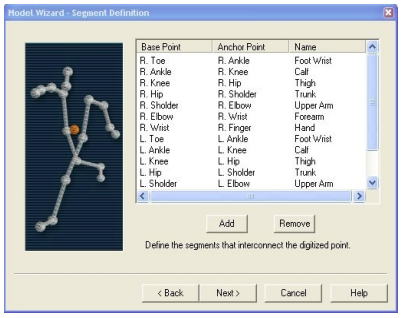
Type new name for your profile in the “Model Profile Name” and type the number of points in the model.

Definition of point names and side



First click in the cell activates and second enables the modification of the content.

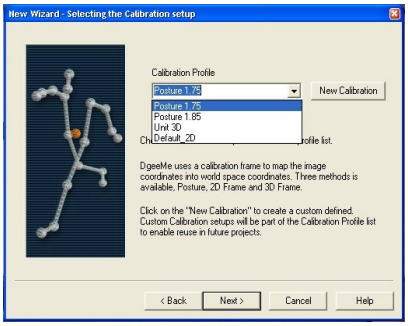
Segment definition and names



First click in the cell activates and second enables the modification of the content. Use “Add” to create new segment. Make sure to select the correct base and anchor point to define the segment. After finished with definition of the Segments select “Next” to move on.

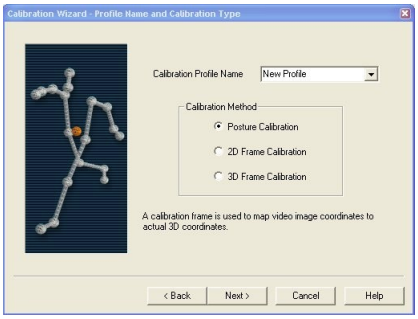
Choosing the calibration profile

If the calibration object is already in the list it's easy just to choose it and select “Next” to move on.



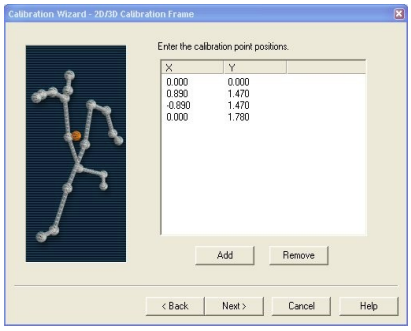
Create new Calibration profile

Choosing type and name



It's possible to choose three different types of calibration types. Remember to type a new name before moving on.

Defining calibration object dimension



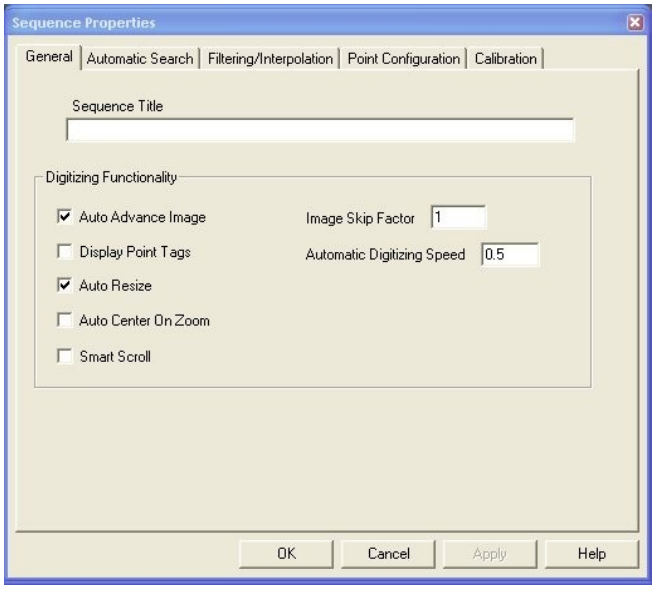
The dimensions of the calibration object is defined by multiple points. For posture the dimensions are the persons height, for 2D object X and Y values are given and for 3D both X,Y and Z values are given.

Ending the Model wizard

After the model and the calibration object has been defined it's possible to start Digitizing.

Properties for the Sequence

General properties



Sequence Title

Title of the Sequence

Auto advance Image

This will enable auto advance to the next frame in the movement digitizing mode when the last point in the model has been selected.

Display Point tags

Enable/disable point tags (point names) in the stick figure.

Auto resize

Automatically adjust video size to window size.

Auto centre on zoom

Automatically adjust the scroll to centre the stick figure in the window.

Smart Scroll

Adjusting the scroll during the digitizing to keep the point in the centre of the window.

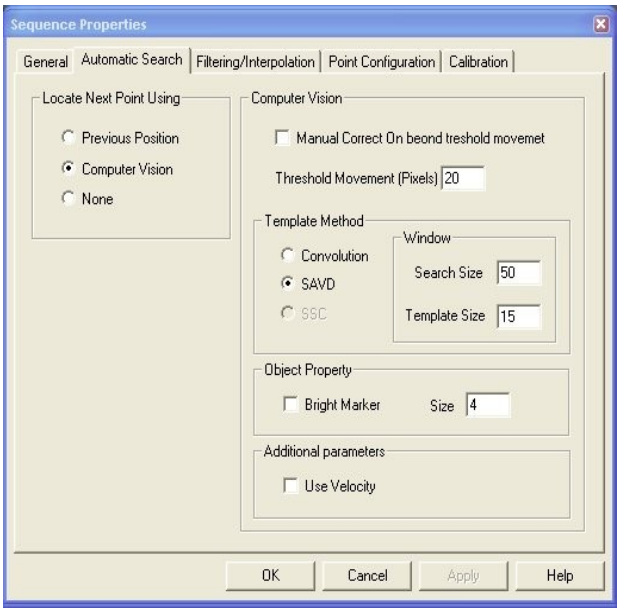
Image skip factor

Number of images to advance in the digitizing mode.

Automatic digitizing speed

Speed of the automated digitizing.

Automatic Options



Locate Next Point Using

SkillSpector has a feature to relocate the points from the previous frame in the next new frame. In this section it's possible to modify the search properties.

Previous Position

Use the last position.

Computer Vision

Prodict the new position based on image processing/computer vision.

None

Do nothing.

Computer Vision

Manual Correct On beond treshold movement

This is an option for SkillSpector to stop the automated digitizing if the new found point isto far away.

Threshold Movement (Pixels)

Template Method

Choosing the method of relocating the new point.

Search Size

Size of the window in which the new position is to be found.

Template Size

Size of the window which is to be relocated in the next frame.

Object Property

Bright marker

Search for “markers” attached to the body.

Size

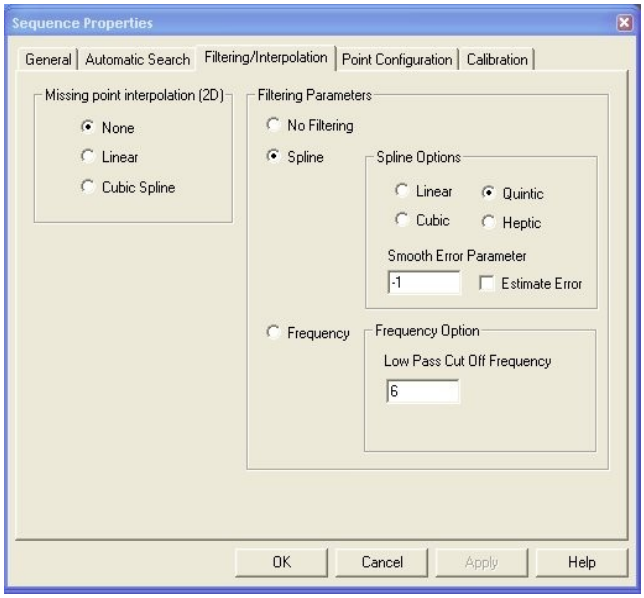
Size of the “markers”.

Additional

Use Velocity

Use velocity to predict the next point.

Filtering/Interpolation Options



Missing Point interpolation (2D)

If a point is marked at “missing” (in the case where it can't be visually selected in the digitizing process) SkillSpector will predict a possible position. Interpolation is a mathematical algorithm that uses what has happen before and after the “missing” incidence in order to predict a possible position.

None
No interpolation is used.

Linear
A linear interpolation is used.

Cubic Spline
The cubic spline is used for interpolation.

Filtering Parameters

Even though the digitizing process is carried out thoroughly to find exact positions there will be some errors which is not real part of the actual movement. No movements is rugged and for this SkillSpector has a built in filtering algorithm.

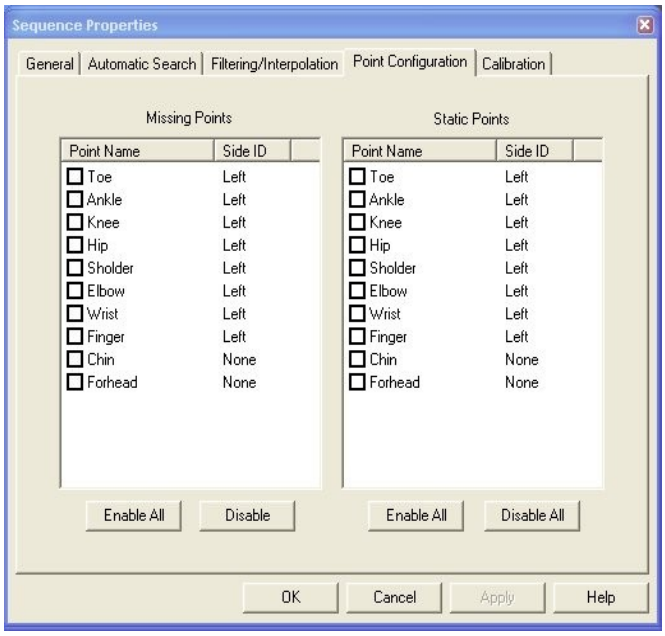
No filtering
No filtering is used. This means that filtered data and unfiltered data is the same.

Spline
A spline algorithm is used to filter the movement data.

Frequency

A standard butterworth filter is used.

Point Configuration



For every point it's possible to mark it missing or static. Missing is used to indicated that the point is not viewable. Static means that the point is a non-moving point.

In the Point Configuration it's possible to select points as missing and/or static. If a point is selected as missing or static you will not be prompted to Digitize the point.

Example: Digitizing subject running. When the arm is passing the hip it might be impossible to locate the joint. In this situation it's possible to do two things:

1. Right click and use in the Context menu use “Set Left Hip missing”.
2. Select from the menu Digitizing->Point/Marker->Missing

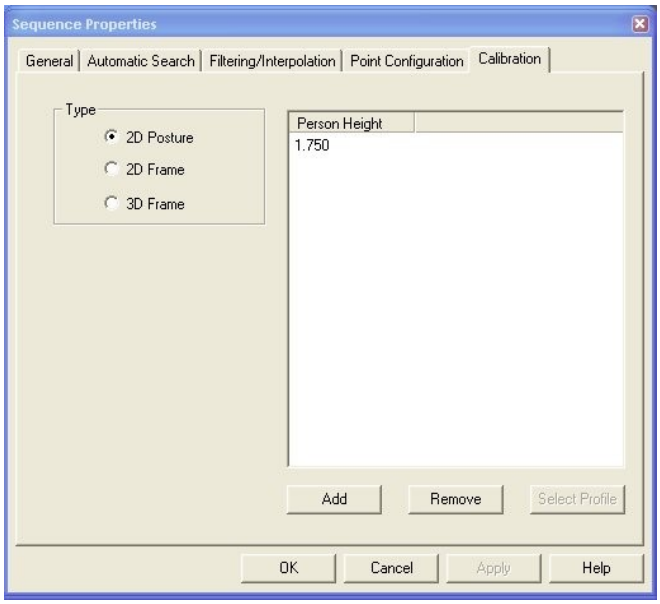
For the first option SkillSpector will set the Missing Point status for the point. Which will disable the Digitizing of the point until the missing status is removed.

The second option only set the point as missing for the current frame.

Calibration

In this tab it's possible to modify the calibration type and point dimensions.

2D/3D/Posture



Digitizing the model in the video sequence

Introduction

An important part of the movement analysis is the digitizing of the model points in the video image. The positions is the data that is used to calculate the kinematic information of the movement.

Finding points in the video frame

When finding the point positions on the body it's important that it's placed correctly. If ankle is to be digitized it's important that it's the centre of the joint and thus the rotation axis.

Sneak Zoom/Subpixel accuracy

In order to increase accuracy and simplify the digitizing of the points SkillSpector has a feature called sneak zoom. When digitizing points the left mouse button is activated but if the button is held down a small window will show with a zoomed sub-window of the image. Use the window to digitize the point. If the point is not found in the window the mouse cursor is moved out of the window and the button is released. The sneak zoom window uses an interpolation in order to increase the visibility and the accuracy.

Modifying a point position

If a point has been badly positioned it's possible to move the point by moving the mouse cursor close to the point activate the “Shift” button on the keyboard. Hold down the left mouse button and re-position the point. When the right position is found release the mouse button and the keyboard button.

Delete last point

Use the Ctrl-Z (undo) to delete the last digitized point. If all points has been digitized it's the last point that will be deleted.

Author: Jan Brønd

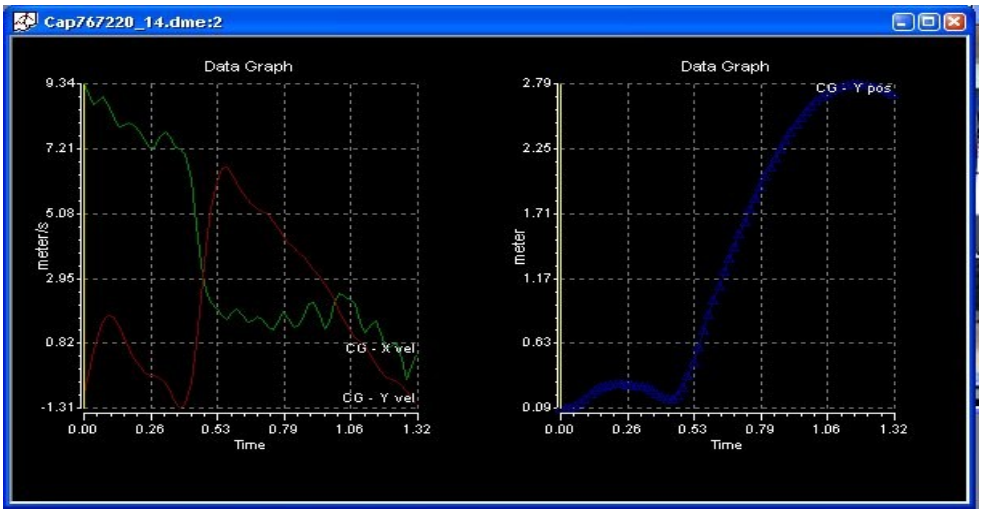
Data analysis

The movement data analysis is possible in the data window. The data analysis is actually not any specific analysis but the opportunity to view the different data created in the transformation.

In the data window it's possible to insert multiple graphs. In the graphs it's possible to add curves of kinematic data.

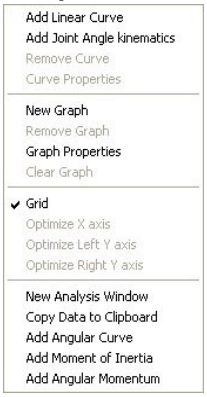
It's possible to insert two different data types in the same graph.

The graph consists of a time axis (X axis) and one or two Y axis (possible to two different data types).



The above example illustrates the velocity of the centre of gravity in the X and Y direction in the first graph. In the second graph it's the height of the CG.

Right click menu (Context menu)

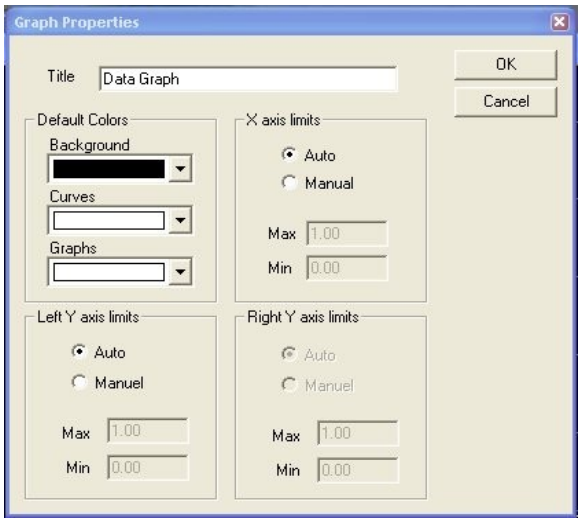


By right clicking in the data analysis window it's possible to get access to various actions to do with the graph and curves.

Author: Jan Brønd

Graph properties

Modify the graph properties.



Titel: Title of the graph

Default Colors:

Background: color of th background

Curves: Color of the added curves

Graphs: Color of axis and grids.

X Axis limits: Manually assigning X axis boundaries

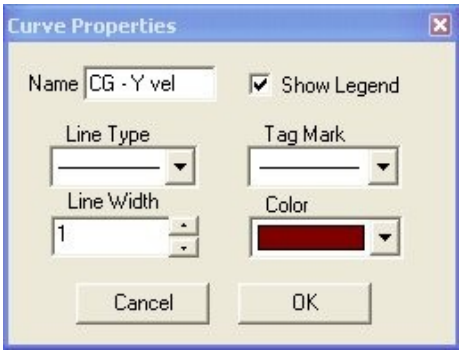
Left Y axis limits: Manually assigning left side Y axis boundaries

Right Y axis limits: Manually assigning right side Y axis boundaries

Curve properties

It's possible to change various properties of the curve.

Select the curve for which the properties will be changed. When the curve has been selected small rectangles will be insert along the curve.



Name: Name of the curve

Show Legend: Enable/Disable the display of the name in the graph

Line Type: How the line is drawn

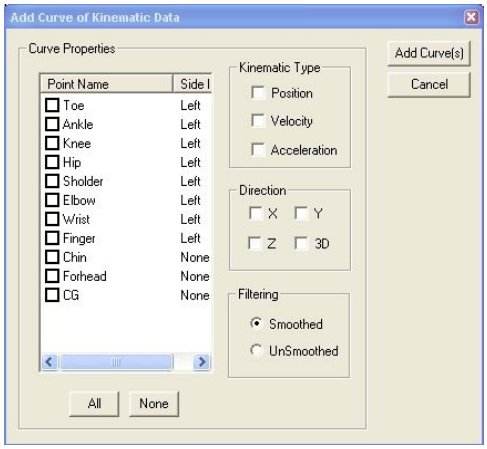
Tag Mark: Icons to show the actual data points

Line Width: Width of the curve

Color: Color of the curve

Linear kinematic data

When inserting linear kinematic curves in a graph the following dialog will show:

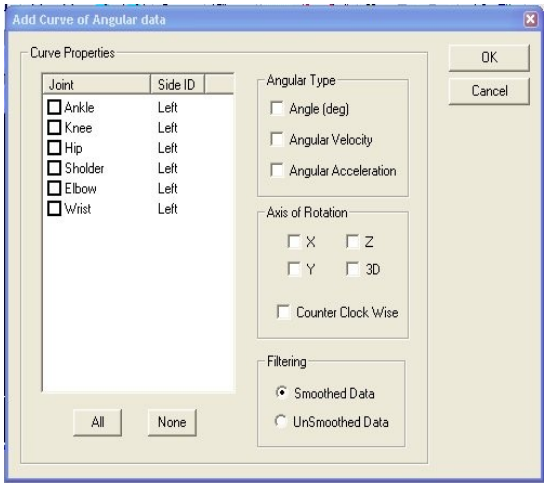


In this dialog it's possible to select two different data types (Kinematic Type). All points, directions can be selected at any number. Although this would be quite a number of curves in a graph.

In the Filtering section it's possible to choose between smooth data or unfiltered data (raw data).

Joint rotations data

By analysis or adding of joint rotation information the following dialog will show:

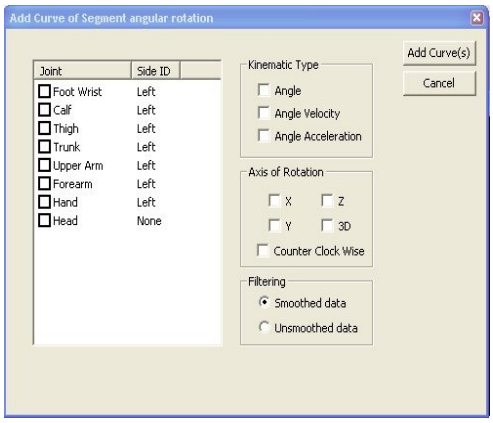


In this dialog it's possible to select two different data types (Kinematic Type). All points, directions can be selected at any number. Although this would be quite a number of curves in a graph.

In the Filtering section it's possible to choose between smooth data or unfiltered data (raw data).

Segment rotations data

By analysis or adding of segment rotation information the following dialog will show:



In this dialog it's possible to select two different data types (Kinematic Type). All points, directions can be selected at any number. Although this would be quite a number of curves in a graph.

In the Filtering section it's possible to choose between smooth data or unfiltered data (raw data).

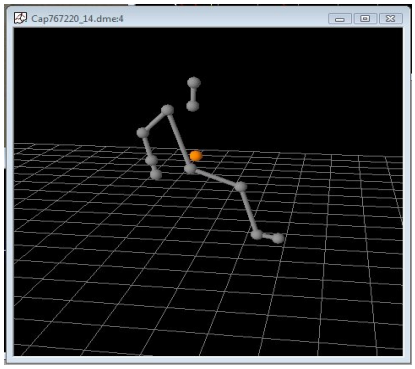
Kinetic data – Moment of Inertia

By the analysis of Inertia it's required to enter the subjects weight. If this is not done before the inertia is added in a graph the following dialog will show.

It's possible to set/modify the subject weight by selecting from the menu Analysis->Set Body Weight.

Animation/3D Representation

After the transformation of the movement information in the video image to world coordinates it's possible to view the movement as a 3D animation.



The animation can be played in the same speed as it has been captured. From the menu Animation it's possible to do the following:

1. Start animation
2. Stop animation
3. Pause animation
4. Reset orientation (default rotation, position and zoom)

I animations window it's possible to change the rotation, position and the zoom.

Rotation

Place the mouse cursor in the animation window and hold down the left button. Move the mouse to rotate the animation. When the correct rotation is optained release the mouse button.

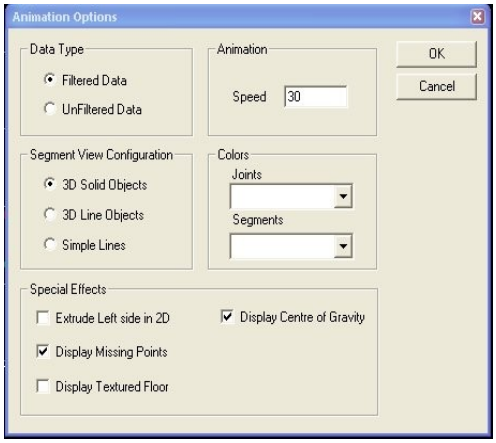
Position

Activate the Shift button on the keyboard, place the mouse cursor in the animation window hold down the left mouse button and move the mouse to place the animation. Release the left mouse button to end the positioning of the animation.

Zoom

Activate the Ctrl button on the keyboard, place the mouse cursor in the animation window hold down the left mouse button and move the mouse to zoom the animation. Release the left mouse button to end the zooming of the animation.

Animation Options



Data type – Choosing between filtered and unfiltered data.

Segment View Configuration – Segment representation in 3D space.

Animation

Speed – Speed of the playback in the animation window (frames/sec).

Special Effects

Extrude left side in 2D – Move the left side away from the right side (only useful in 2D).

Display Missing points – Show missing points.

Display textured floor – Show floor as textured.

Display Centre of gravity – Show centre of gravity on the model.

Colors

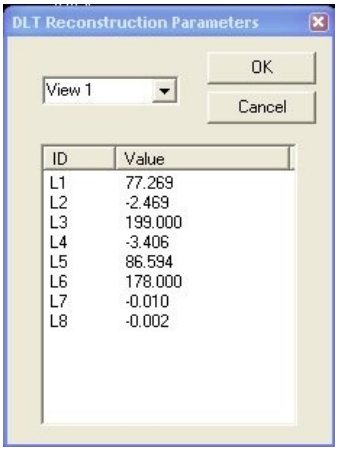
Joints – Color of the points.

Segments – Color of the segments.

Advanced functions

DLT parameters

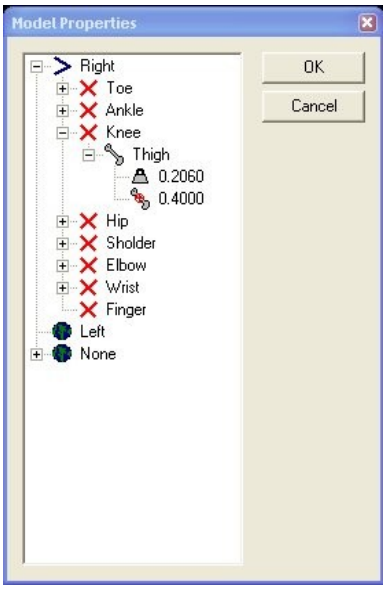
In the sequence menu it's possible to open the DLT reconstruction parameters. The DLT reconstruction parameters is the information used to calculate the kinematic information of the movement.



The above example shows a 2D analysis. In 3D analysis there is 11 parameters for each camera view.

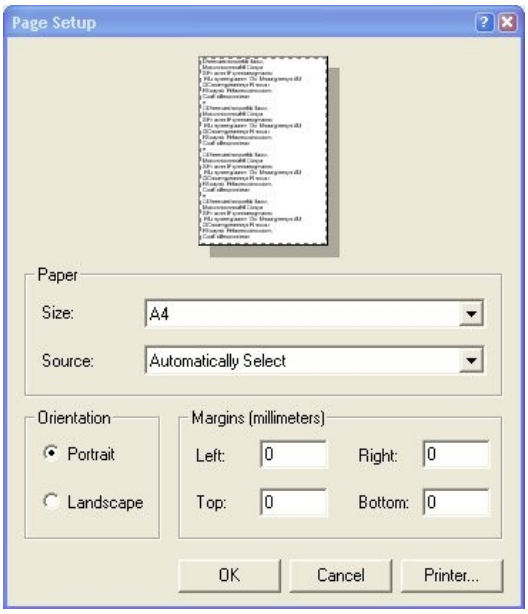
Model parameters

In order to calculate the centre of gravity SkillCapture uses segment parameters like relative weight and relative centre of gravity of each segment. The information can be entered in the model parameters dialog which can be found in the Sequence toolbar.



Printing

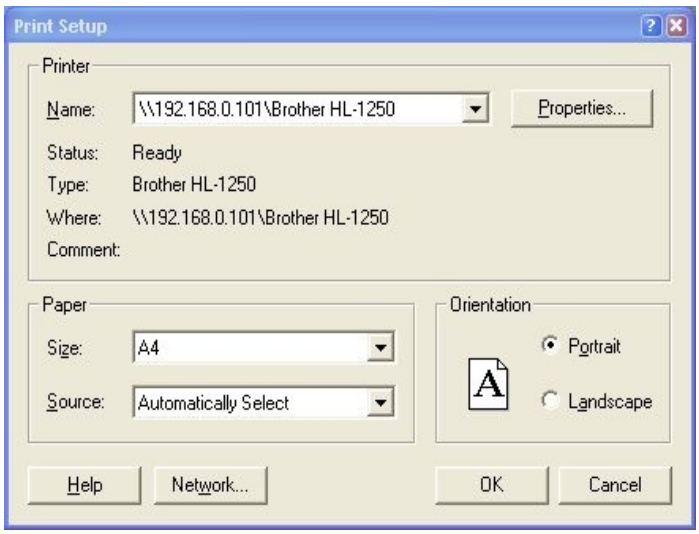
Page Setup



In ”Page Setup” it's possible to setup the paper size and orientation when printing.

Print Setup

In this dialog it's possible to change the setting os printer and paper.



Print

Print the current active window.

Print Preview

Show print preview of the current active window.