Industrial Path Solutions

Virtual Driver Lua

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Virtual Driver Lua

WHAT IS VIRTUAL DRIVER LUA (VD-LUA)?
This is an open-source project containing Lua files that enables automatic simulation and evaluation of vehicle ergonomics in the software tool IPS and the module IMMA.

LICENSE
This project is licensed under the MIT License - see the LICENSE.txt file for details.

The origin of the Lua functionality comes from different research projects carried out by University of Skövde, Fraunhofer Chalmers Research Centre and IPS. It should be noted that this is not actual functionality in the IPS software. Feel free to use and modify it, and please provide feedback for additional development!

Setup information

LUA INIT FILE
An instance of the file *ipsVirtualDriver.luainit* has to exist in the Lua Init directory. This directory is found by navigating to *Edit->Preferences->Scripting*. See the document *API for lua scripting in IPS* for more information.

ADDED FILES IN IPS DIRECTORY
In addition, two files need to be pasted into the IPS directory.

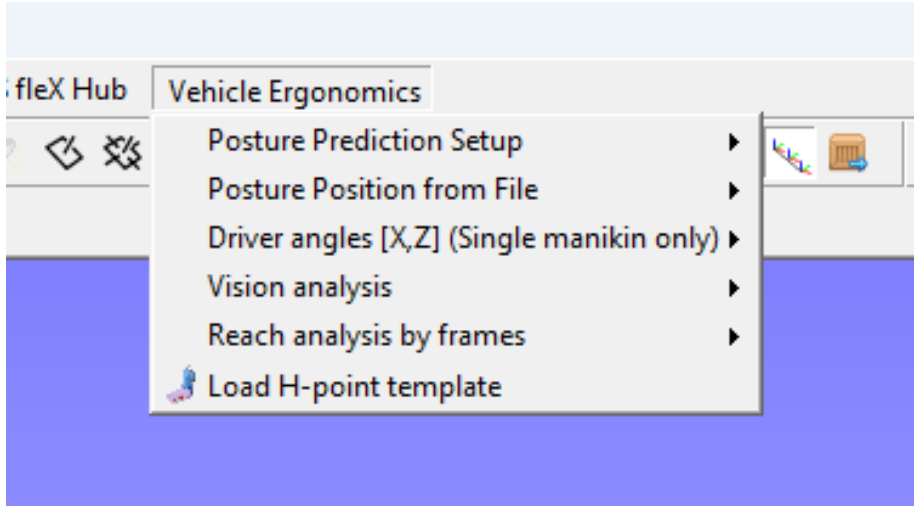
- *3DriverListAdd.json* should be pasted into …*Data**IMMA**TCPLists*
- *SeatedListAdd.json* should be pasted into …*Data**IMMA**TCPGroups*

If the scripts do not work as intended, make sure that the output folders of the scripts are writeable.

Functionality of Virtual Driver Lua, May 2025

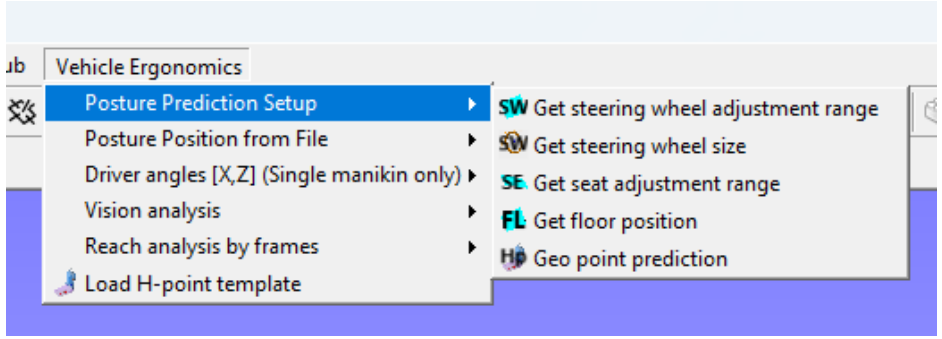
INCLUDED FUNCTIONS FOR DRIVER POSITIONING AND EVALUATION
The Lua project contains six main functions:

1. Posture Prediction Setup
2. Posture Position from File
3. Driver Angles [X,Z] (Single manikin only)
4. Vision Analysis
5. Reach Analysis by frames
6. Load H-point template



The functions can be reached via “Vehicle Ergonomics” under the top menu. The following images explains how to use the Lua functionality and what actions that are required to execute each function in a successful way. As the functionality is implemented with Lua the interface is limited.

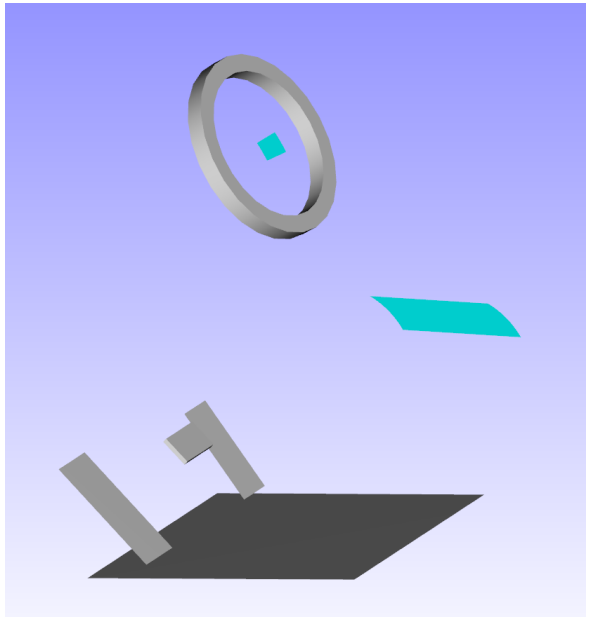
Posture Prediction Setup



DESCRIPTION OF FUNCTION

This main function, *Posture Prediction Setup*, consist of five minor functions:

1. Get steering wheel adjustment range
2. Get steering wheel size
3. Get seat adjustment range
4. Get floor position
5. Geo point prediction



These minor functions require CAD geometry which size and position is used to automatically generate attachment points for seated manikins. Some additional manual adjustments are required for the feet attachment points.

The first four functions (*Get steering wheel adjustment range* to *Get floor position*) can be done in any order. The fifth function *Geo point prediction* is run after manikins have been attached and put into a driving position.

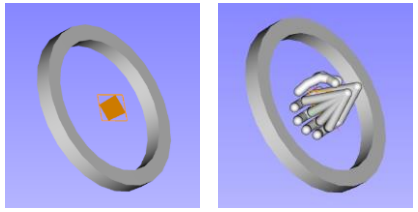
Posture Prediction Setup – Steering wheel

GET STEERING WHEEL ADJUSTMENT RANGE AND GET STEERING WHEEL SIZE

The two functions *Get steering wheel adjustment range* and *Get steering wheel size* are both related to the steering wheel and will create two handgrips that are aligned to the steering wheel size and add translational tolerances based on the adjustment range geometry. They can be called in any order and the functions automatically checks if the relevant handgrips already exist or needs to be created.

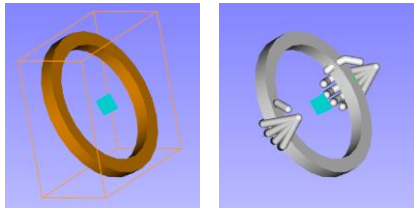
USE OF *GET STEERING WHEEL ADJUSTMENT RANGE* FUNCTION

1. Click on the steering wheel adjustment range geometry, see image.
2. Click on / Call the function *Get steering wheel adjustment range*



USE OF *GET STEERING WHEEL SIZE* FUNCTION

1. Click on the steering wheel geometry, see image.
2. Click on / Call the function *Get steering wheel size*



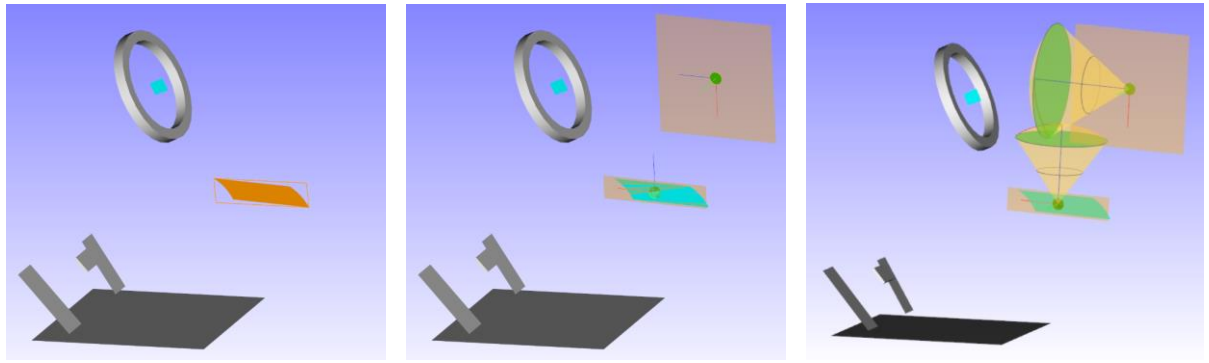
Posture Prediction Setup - Seat

GET SEAT ADJUSTMENT RANGE

The function *Get seat adjustment range* will create a *Driving Seat* attachment group that are aligned to the seat adjustment range geometry. The attachment group includes two attachment points, *Hip-Centre Seated* and *T6T7*, where the *Hip-Centre Seated* point is modified with translational tolerances based on the seat adjustment range geometry. Both attachment points have a support force so that the manikins can rest on/in the seat.

USE OF *GET SEAT ADJUSTMENT RANGE* FUNCTION

1. Click on the seat adjustment range geometry, see image.
2. Click on / Call the function *Get seat adjustment range*



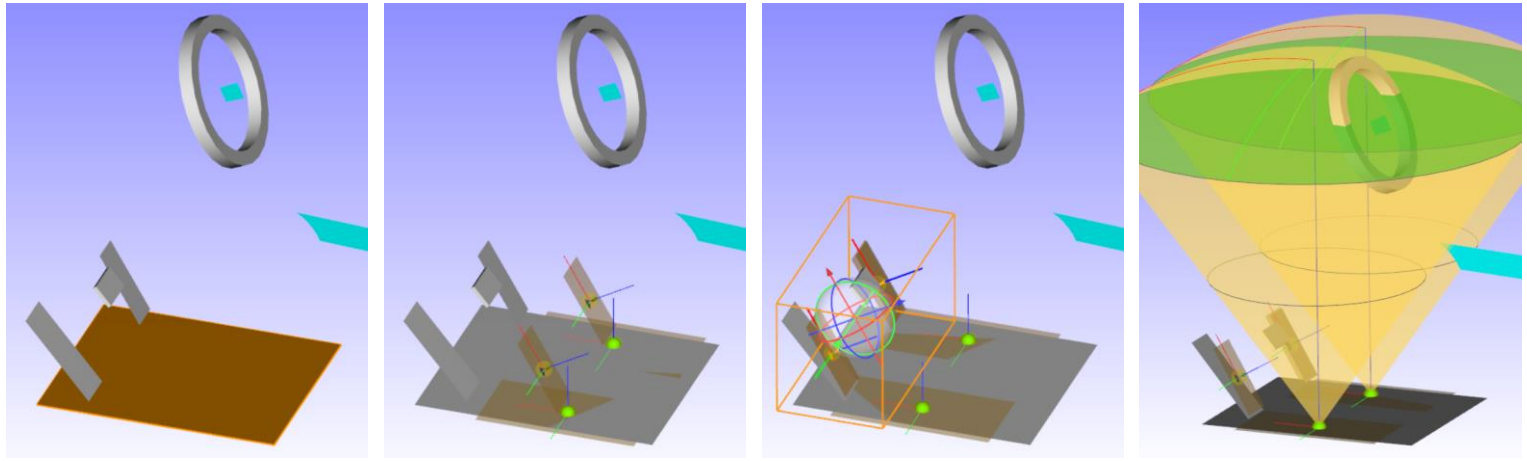
Posture Prediction Setup - Floor

GET FLOOR POSITION

The function *Get floor position* will create a *Driving Feet* attachment group that are aligned to the floor geometry. The attachment group includes four attachment points, left and right *Heel Point* and *Ball of Foot*, where the heel points are aligned in Z direction to the floor geometry. All four attachment points will in most cases need to be adjusted by translational and rotational movement. Both heel attachment points have a support force so that the manikins can rest their feet on the floor.

USE OF *GET FLOOR POSITION* FUNCTION

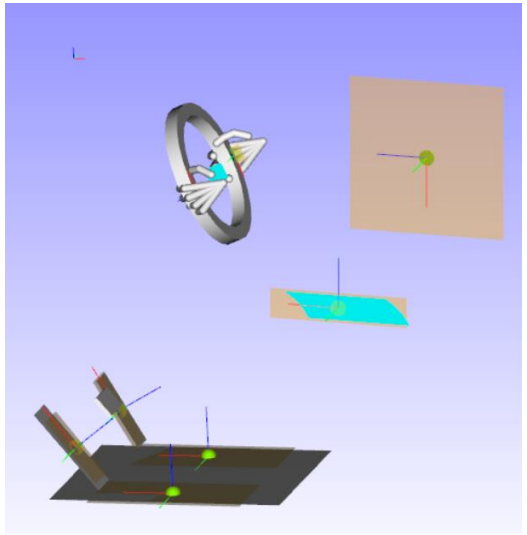
1. Click on the floor geometry, see image.
2. Click on / Call the function *Get floor position*
3. Adjust the four attachment points

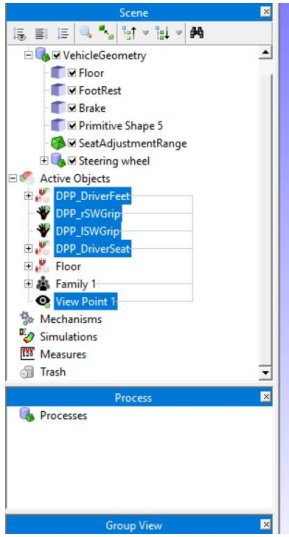


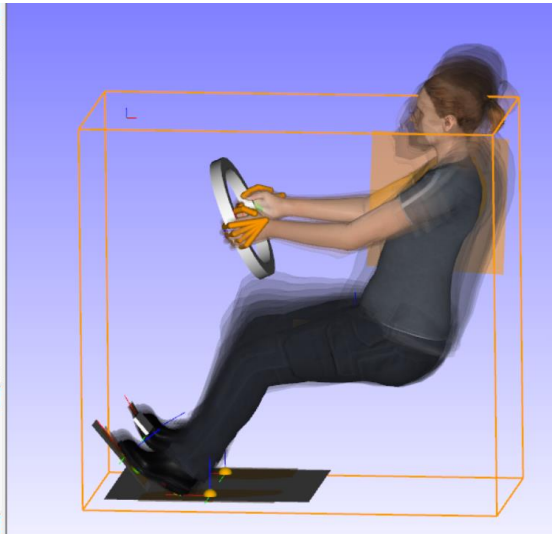
Posture Prediction Setup – Attach manikins

ATTACH MANIKINS TO ATTACHMENT AND GRIP POINTS
When all necessary/wanted attachment and grip points have been added to the scene a manikin family can be attached to them. It also suggested to create a view point to control the gaze of the manikins.

1. Mark all necessary attachment groups/points, grip points and view point.
2. Drag and drop on manikin family.



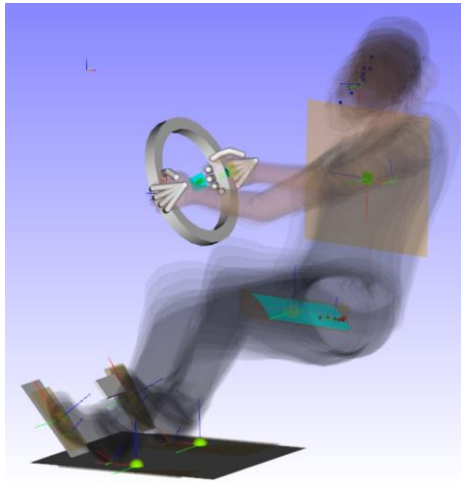




Posture Prediction Setup – Geometry point export

GEO POINT PREDICTION
When a manikin family has been attached to all necessary attachment groups/points, grip points and view point specific geometry points (H-point, SW-point, Eye point) of the manikins can be generated and exported to a CSV-file.

1. Click on Geo Point Prediction function
2. Select place and name for the generated CSV-file.



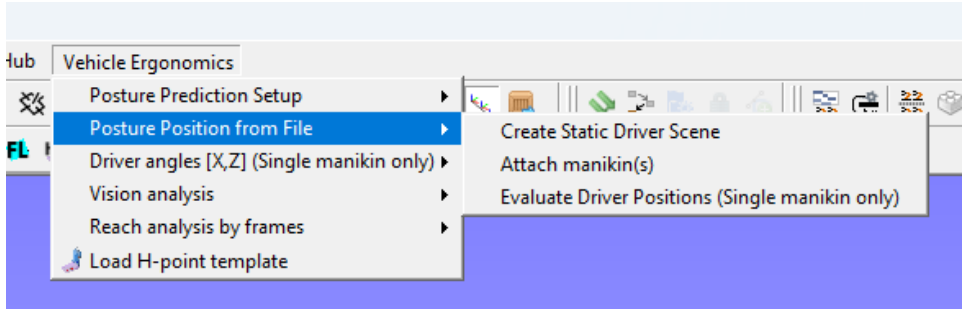
Manikin	H-pointX	H-pointZ	SWpointX	SWpointZ	EyepointX	EyepointZ
Female_w=62_s=1629	3.0333687219971	0.8783372011172	2.5925764529276	1.236013599164	3.1166959924661	1.5525242331061
Male_w=78_s=1755	3.0467153430317	0.88066796281411	2.5991106985166	1.2394108099317	3.1348393108977	1.584455246978
Female_w=79_s=1765	3.0475401682135	0.87957369814726	2.5937705665908	1.2371039566079	3.1561936855017	1.6009565672616
Male_w=102_s=1899	3.0513038923206	0.88454530058907	2.6003710343228	1.2407460955899	3.1617103727301	1.6342928999234
Female_w=52_s=1704	3.0473057507398	0.8783076855224	2.5927889659037	1.2364710157783	3.1285879385554	1.5757057356865
Male_w=65_s=1833	3.0475550661494	0.88075219128906	2.5973779765815	1.2391202341506	3.1363531383923	1.6006229499958
Female_w=44_s=1493	2.9729091896565	0.87862884215397	2.5850516183884	1.2314613819385	3.0563135023139	1.49683776936
Male_w=54_s=1612	3.0214935629773	0.87937357475865	2.5962081138438	1.2377791240268	3.0855940136501	1.5404198924617
Female_w=71_s=1553	2.9982842431163	0.88062797753187	2.5900609353016	1.2341528003862	3.0936908308723	1.5265908440087
Male_w=91_s=1677	3.0438895348424	0.88114478889599	2.6000862360484	1.2402727468327	3.134253382025	1.5674142618222

Posture Position from File

DESCRIPTION OF FUNCTION

This main function, *Posture Position from File*, consist of three minor functions:

1. Create Static Driver Scene
2. Attach manikin(s)
3. Evaluate Driver Positions (Single manikin only)



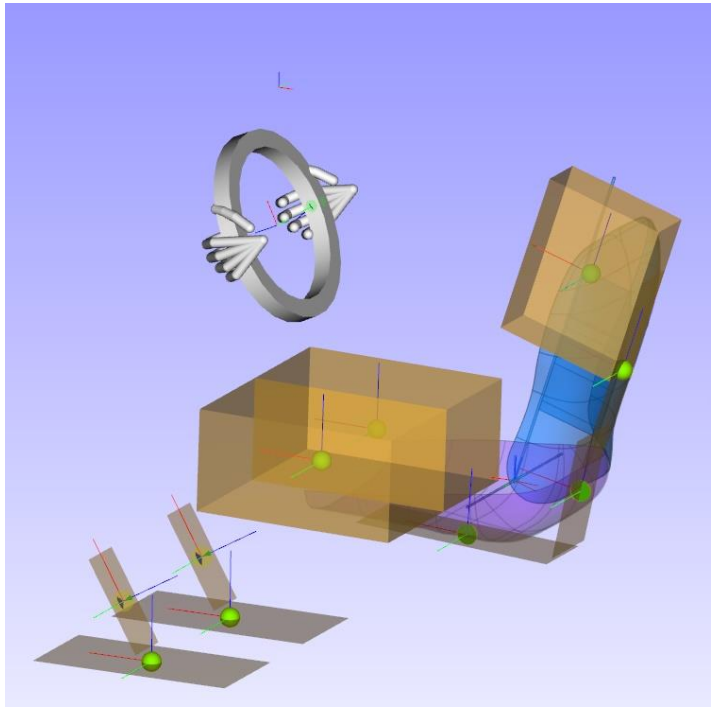
These minor functions do not require CAD geometry but instead creates a driving scene based on input from a CSV-file that contains information about steering wheel size and position, seat position and seat angle, feet position (BOF and AHP) and position of a view point. The content and what is used of the data in the CSV-file might change in future versions.

testId	swDiameter	swThickness	swPositionX	swPositionY	swPositionZ	swAngle	seatPositionX	seatPositionY	seatPositionZ	torsoAngle	buttockAngle	xBOF	zAHP	feetBOFAngle	viewPointX	viewPointY	viewPointZ
0	0.37	0.035	2.5	-0.38	1.23	25	3	-0.38	0.8	12	4	2.27	0.4	30	2.5	-0.38	1.5

Posture Position from File – Create Driver Scene

CREATE STATIC DRIVER SCENE

The function *Create Static Driver Scene* uses the information in the CSV-file to create a steering wheel with grip points and loads a CAD geometry called H-point template which is a virtual replica of the H-point machine. The H-point template consists of two parts, torso and buttock that have rotational origin at the H-point. Both parts have attachments point aligned to the geometry to make the manikin attached and aligned to the H-point template. The function *Create Static Driver Scene* also creates a *Driving Feet* attachment group that are aligned to the AHP and BOF defined in the CSV-file. Last a view point is created and placed according to the information in the CSV-file.



USE OF *CREATE STATIC DRIVER SCENE* FUNCTION

1. Click on / Call the function *Create Static Driver Scene*
2. Select CSV-file for input data
3. Click on Open

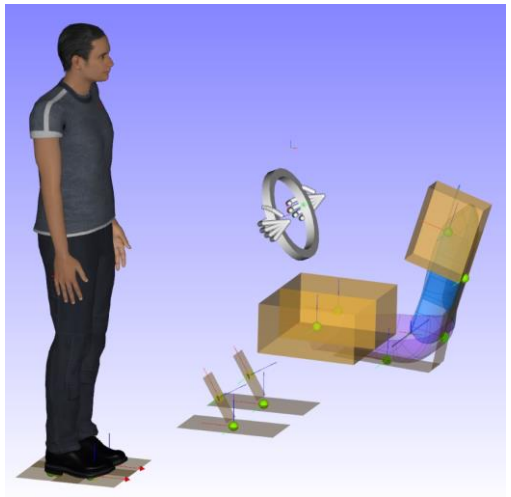
Posture Position from File – Attach manikin(s)

ATTACH MANIKIN(S)
The function *Attach manikin(s)* attaches the selected manikin family to the grip points of the steering wheel, attachment points of the H-point template, the driving feet attachments points and the view point. If more than one manikin family exists a drop down menu is shown.

Note: If more than one manikin family should be attached to the same attachment/grip points the Unique grip/attachment setting of that point needs to be unchecked manually!

USE OF *ATTACH MANIKIN(S)* FUNCTION

1. Click on / Call the function *Attach manikin(s)*
2. If more than one manikin family exist in scene select the relevant family.



Posture Position from File – Evaluate driver positions

EVALUATE DRIVER POSITIONS

The function Evaluate Driver Positions (Single manikin only) automatically updates the position of steering wheel and seat for any number of tests to evaluate the driver positions. The test data can be included in the same file as the original input for creating the driver scene but can also come from a different file. The output for each test driver position, in the form of joint angles, specific driver angles and positions of mid-hip and eye, are saved automatically in a CSV-file.

USE OF *EVALUATE DRIVER POSITIONS (SINGLE MANIKIN ONLY)* FUNCTION

1. Click on / Call the function *Evaluate Driver Positions (Single manikin only)*
2. A yes/no drop down selection is presented. If the additional test iterations are included in the same file as the original input for creating the driver scene, select Yes. If not, select no and select the CSV-file with the additional test data.
3. Select place and name for the generated CSV-file. Part of output example data can be seen below.

TestId	Manikin angles	HiptoEyeAngle	HeadAngle	NeckAngle	ThoraxAngle	AbdomenAngle	PelvisAngle	ThighAngle	RightKneeAngle	LeftKneeAngle	MidHipX	MidHipZ	MidEyeX	MidEyeZ
testId0	...	-2.88	-5.78	-19.32	-8.03	22.49	43.06	13.32	94.42	94.92	2.991	0.791	2.962	1.485
testId1	...	-5.27	-12.13	-24.77	-12.93	22.52	52.65	-3.55	128.85	127.78	3.129	0.866	3.070	1.534
testId2	...	-6.39	-11.94	-24.37	-16.29	23.00	57.60	-3.19	127.74	126.69	3.124	0.867	3.052	1.528
testId3	...	-11.07	-11.80	-30.72	-24.18	23.23	60.20	-2.73	128.40	125.07	3.121	0.863	3.002	1.489
testId4	...	-5.90	-14.55	-29.15	-12.85	22.29	54.49	-3.59	127.77	127.90	3.127	0.869	3.064	1.523

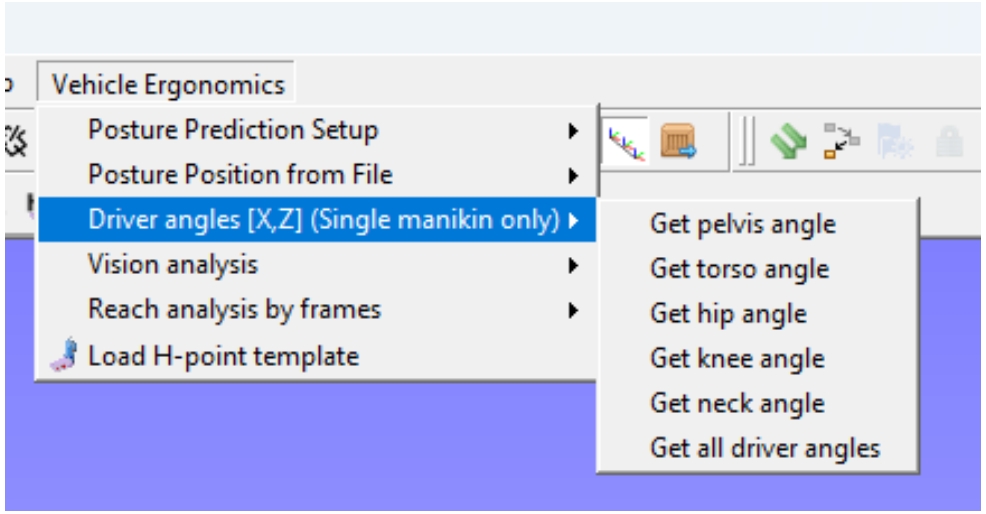
Driver angles [X,Z]

DESCRIPTION OF FUNCTION
This main function, *Driver Angles [X,Z] (Single manikin only)*, consist of six minor functions:

1. Get pelvis angle
2. Get torso angle
3. Get hip angle
4. Get knee angle
5. Get neck angle
6. Get all driver angles

These minor functions is relatively self explanatory, click and get defined angles, the output is given in the information/log window. For definitions of how the angles are calculated, see \DriverAngles\jointAngleTranslation.lua.

Note: Currently, driver angles are only calculated on single manikins. Angles for a full manikin family and clear definitions of these angles is the focus in future versions.



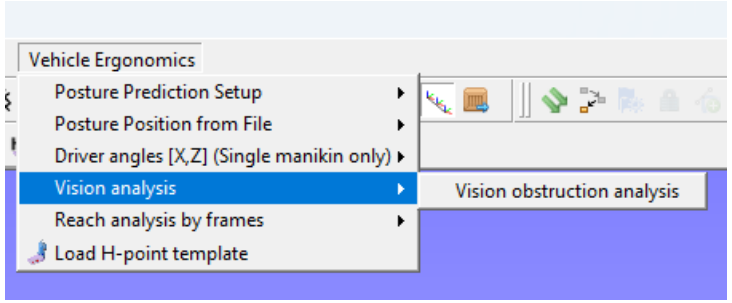

```
Pelvis angle: 26.137207682385
Torso angle: 8.8424811388034
Hip angle (from torso to thigh): 72.500959748862
Hip angle (from vertical to thigh): -63.658478610058
RightKneeAngle: 109.13672902538
LeftKneeAngle: 106.33226493756
Neck angle: -10.53157292705
```

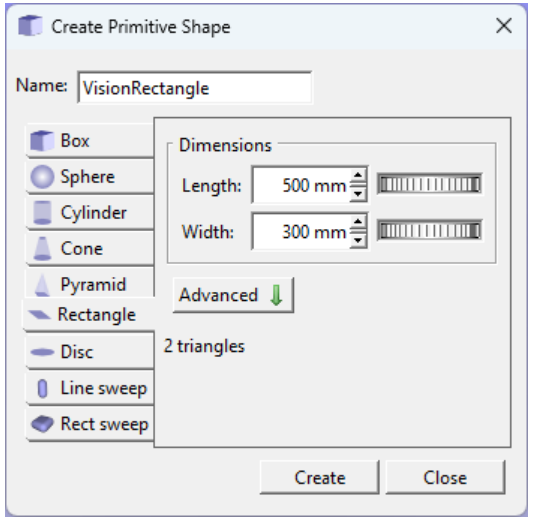
Vision Analysis

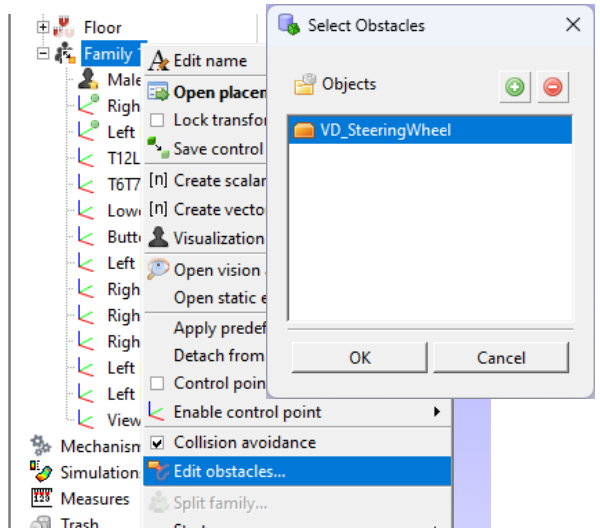
DESCRIPTION OF FUNCTION

This main function, *Vision analysis*, consists of just one minor function, *Vision obstruction analysis*. The function evaluates visibility of a planar surface and how much of the surface that is obstructed. To get a successful result a rectangular surface should be selected and collision avoidance for the manikin family should be on where obstacles are set to objects in front of rectangle.

1. A rectangle needs to be created via Create > Shape > Primitive Shape. Select rectangle and set length and width. Position it where you want to make an analysis.
2. Right click on manikin family, select Collision avoidance and click on Edit obstacles.
3. Add objects in front of the vision rectangle, for example steering wheel.







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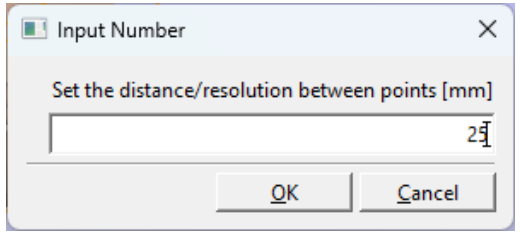
Vision Analysis - Vision obstruction analysis

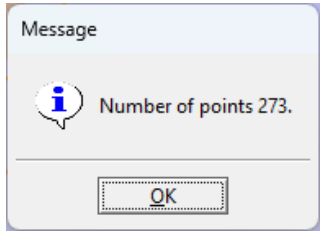
VISION OBSTRUCTION ANALYSIS

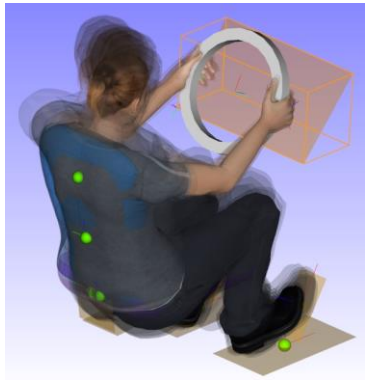
The function *Vision obstruction analysis* will move the view point to a number points defined by the distance/resolution between points. For each point an automatic check is done whether the manikins can see the point or not. For a single manikin the points are red (not visible) or green (visible). For a manikin family the points can vary green-yellow-orange-red depending on how many of the manikins in the family can see the point (Green = everyone can see, Red = none can see, Yellow = 50% can see).

USE OF *VISION OBSTRUCTION ANALYSIS* FUNCTION

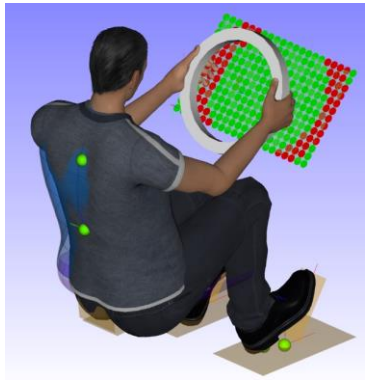
1. Click on the vision rectangle geometry, see image.
2. Set the distance/resolution between points [mm], see image
3. Click Ok on information about number of points.

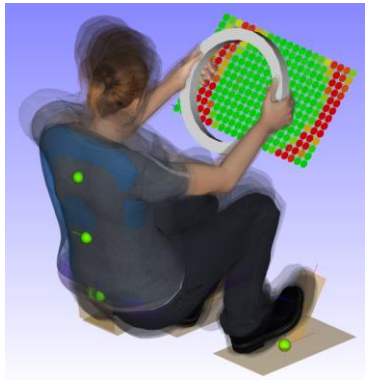






Output:





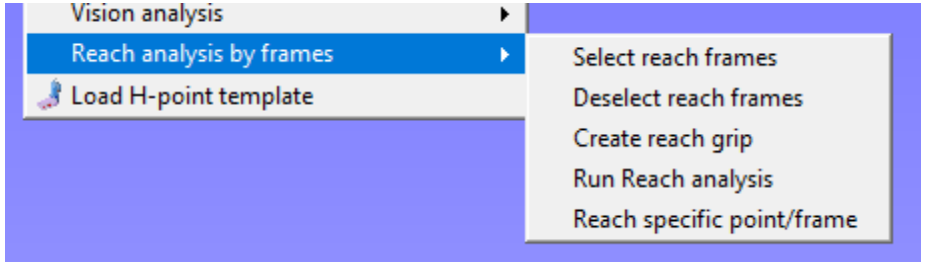
Reach analysis

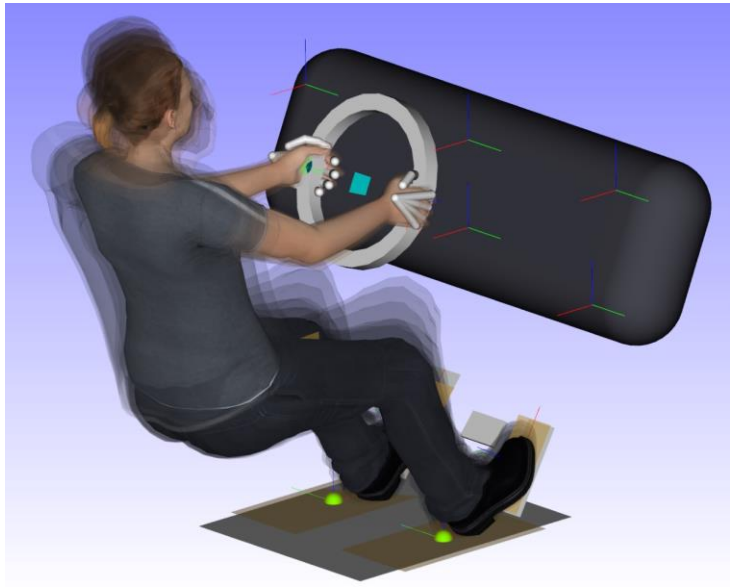
DESCRIPTION OF FUNCTION
This main function, *Reach analysis by frames*, consist of five minor functions:

1. Select reach frames
2. Deselect reach frames
3. Create reach grip
4. Run Reach analysis
5. Reach specific point/frame

The first three minor functions are done to be able to run the function *Run Reach Analysis*. After the analysis is done the reaching of specific points can be recreated with the *Reach specific point/frame* function.

The reach analysis is done by moving a grasp to different frames to check if the manikins can reach each point defined by the position of the frames. The scene needs to be prepared with a number of frames, see image.

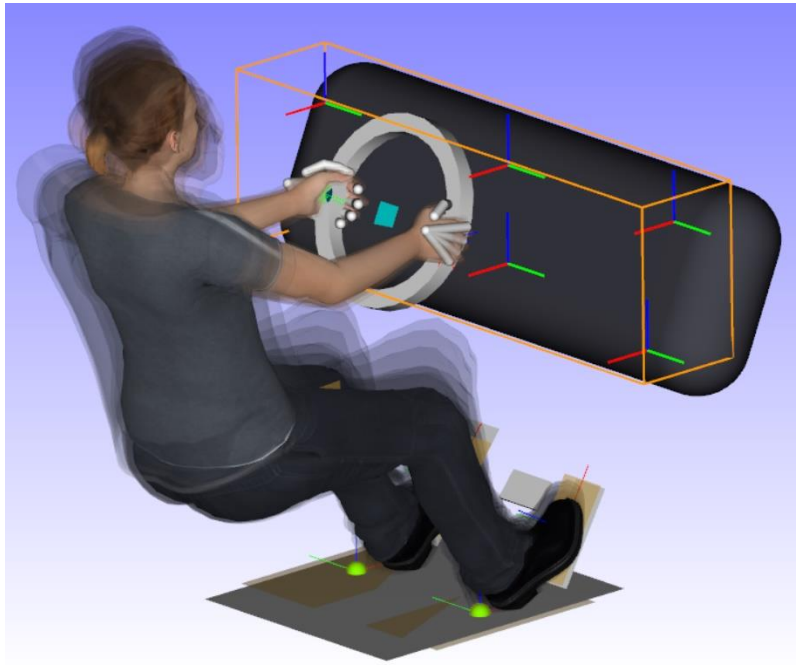




Reach analysis – Select/Deselect reach frames

SELECT REACH FRAMES

The two functions *Select reach frames* and *Deselect reach frames* handles which frames that should be included in the reach analysis. The *Select reach frames* function creates Attribute called *VD_reachAnalysis* and sets that to *True*. The *Deselect reach frames* function sets any Attribute called *VD_reachAnalysis* and to *False*.



USE OF *SELECT REACH FRAMES* FUNCTION

1. Select reach frames to include in the reach analysis
2. Click on / Call the function *Select reach frames*

USE OF *DESELECT REACH FRAMES* FUNCTION

1. Select reach frames to exclude from the reach analysis
2. Click on / Call the function *Deselect reach frames*

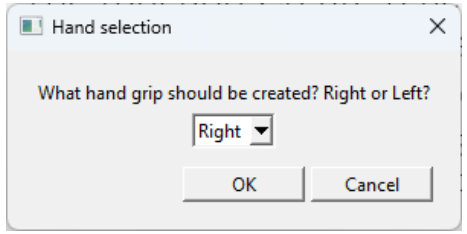
Reach analysis – Create reach grip

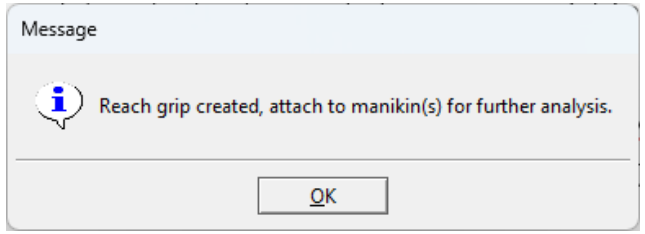
CREATE REACH GRIP

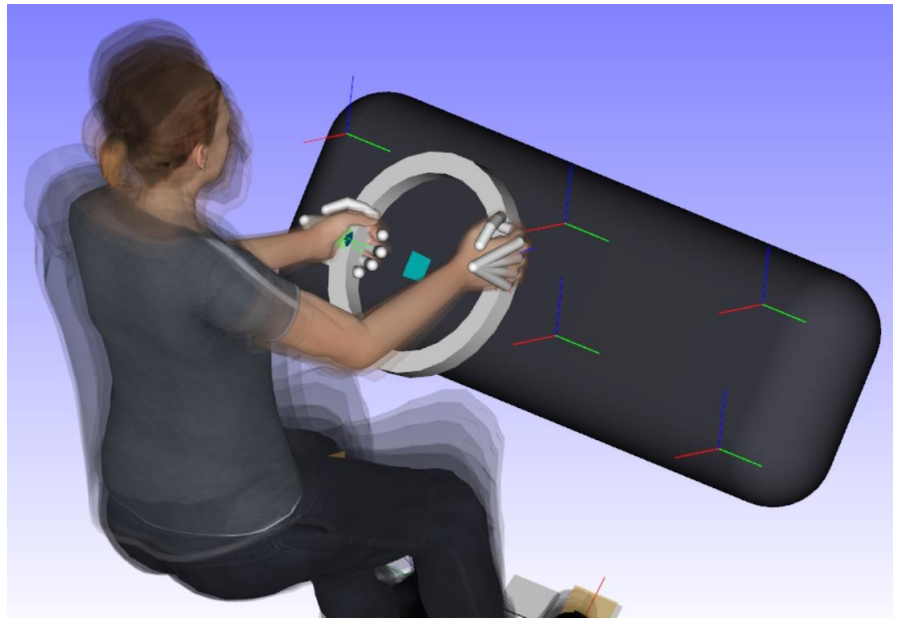
The function Create reach grip automatically creates a reach grip, left or right, with an Attribute called *VD_reachAnalysisGrip* set to *True*. After the grip has been created it needs to attached to the manikins and positioned in an Ok start position where all manikins in the family can reach it without issues.

USE OF *CREATE REACH GRIP* FUNCTION

1. Click on / Call the function *Create reach grip*
2. Select what hand grip that should be created, right or left.
3. Position the hand grip and attach it to the manikin family



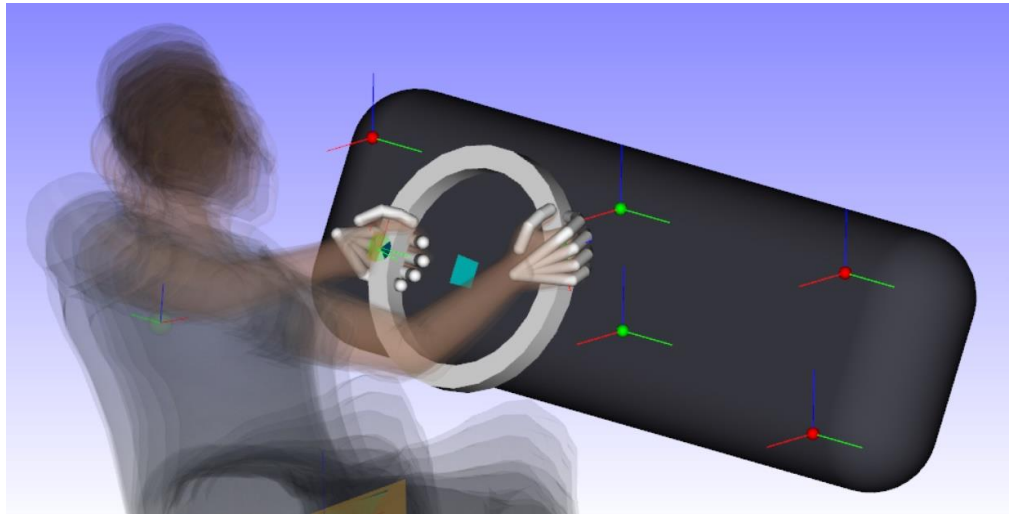




Reach analysis – Run Reach analysis

RUN REACH ANALYSIS

The function Run Reach analysis will automatically move the reach grip to each reach frame and for each frame an automatic check is done whether the manikins have been able to reach the point or not. For a single manikin the points are red (not reached) or green (reached). For a manikin family the points can vary green-yellow-orange-red depending on how many of the manikins in the family reached the point (Green = everyone can reach, Red = none can reach, Yellow = 50% can reach).



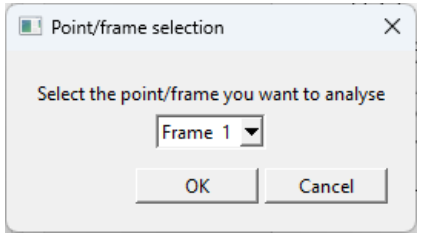
USE OF *RUN REACH ANALYSIS* FUNCTION

1. Click on / Call the function *Run Reach analysis*

Reach analysis – Reach specific point/frame

REACH SPECIFIC POINT/FRAME

The function Reach specific point/frame will automatically recreate the reach of a selected frame/point. Information about deviations between the point and the hand position of each manikin is given in the information/log window



USE OF *REACH SPECIFIC POINT/FRAME* FUNCTION

1. Click on / Call the function *Reach specific point/frame*
2. Select the point/frame you want to analyse and click Ok