

**FOHEART®**

**Inertial Motion Capture FOHEART·X User Manual**

## Preface

- **Definition**

1.FOHEART refers to FOHERT Technology Co.,Ltd.

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- **Scope of application**

Products suitable for reference in this manual are inertial motion capture system FOHEART®·X and software MotionVenus®.As the software MotionVenus® is being upgraded constantly, it will be different according to different functions of the software version. This manual is prepared according to MotionVenus1.5.0. Please update the latest version of the software.

**Note: please refer to the latest version of the manual.**

**Manual update date: November 25, 2019, manual version number: 20191125150**

## Introduction

FOHEART·X inertial motion capture system adopts MEMS sensors such as accelerometer, gyroscope and magnetometer and outputs attitude data with higher accuracy through data fusion algorithm. Its software, MotionVenus, is the computer client software of FOHEART·X, which adopts inverse kinematics, kalman filtering, biomechanics and other algorithms, and can display 3D characters, various data and forward data in real time. It can also be compatible with Unity, UE, MotionBuilder, Maya, 3dMax and other software. FOHEART·X is widely used in sports, medical rehabilitation, animation film, television and game production, virtual anchors, human-computer interaction and other fields.

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## PART | HARDWARE

### 1 Attitude Sensor

Introduction: the sensor has built-in triaxial accelerometer, triaxial gyroscope and triaxial magnetometer.



#### 1.1 Sensor Parameters

NO.	Parameters		Note
1	Attitude accuracy	Dynamic accuracy Roll/Pitch $\leq$ 1 deg Pitch $\leq$ 2deg(RMS) static accuracy Roll/Pitch $\leq$ 0.2deg Pitch $\leq$ 0.5deg(RMS)	The measurement accuracy will be different under different environmental conditions.
2	weight	20g	_____
3	Acceleration range	$\pm$ 8g/ $\pm$ 16g	Factory default is $\pm$ 16g
4	Angular velocity range	$\pm$ 2000dps/s	_____
5	Angular resolution	0.02deg	_____
6	Attitude measurement range	Three axis 360deg	_____
7	Maximum rate	200fps	_____
8	Sensor working hours	3-3.5 hours	There will be attenuation as the battery is used
9	Sensors transmit frequency band wirelessly	2.4GHz	_____
10	Sensor size	The diameter of 44mm, The thickness of the : 16mm	_____

#### 1.2 Attitude sensor switch

Power on: short press (<1 second) switch button;Shutdown: long press the switch button for more than 2 seconds and release the button.

## 2 The router



### 2.1 Parameters

NO.	Parameters		Note
1	weight	87g	_____
2	size	The diameter of 100mm, The thickness of 23mm	_____
3	Connect to sensor mode	<b>wireless</b> 2.4 GHz	_____
4	Connect to computer mode	USB2.0	_____

### 2.2 External antenna

For further communication distance, connect the router external high-gain antenna.

## 3 Charging strip



**Description:** The distributor can charge 17 sensors at the same time.

Please insert the adapter plug into the charging base before inserting the other end plug, and then press the "round" switch button of the insertion row. When the switch light is on and the sensor light is on, it means that the sensor starts to charge normally.



### 3.1 Parameters

NO.	Parameters		Note
1	weight	670g	_____
2	size	The diameter of 230mm, The thickness of 37mm	_____

## PART II Quick service equipment

### 1 Links and software downloads

#### 1.1 Connect router

Step 1: plug one end of the USB cable into the computer and the other end into the USB port of the router.

Step 2: power on the router.

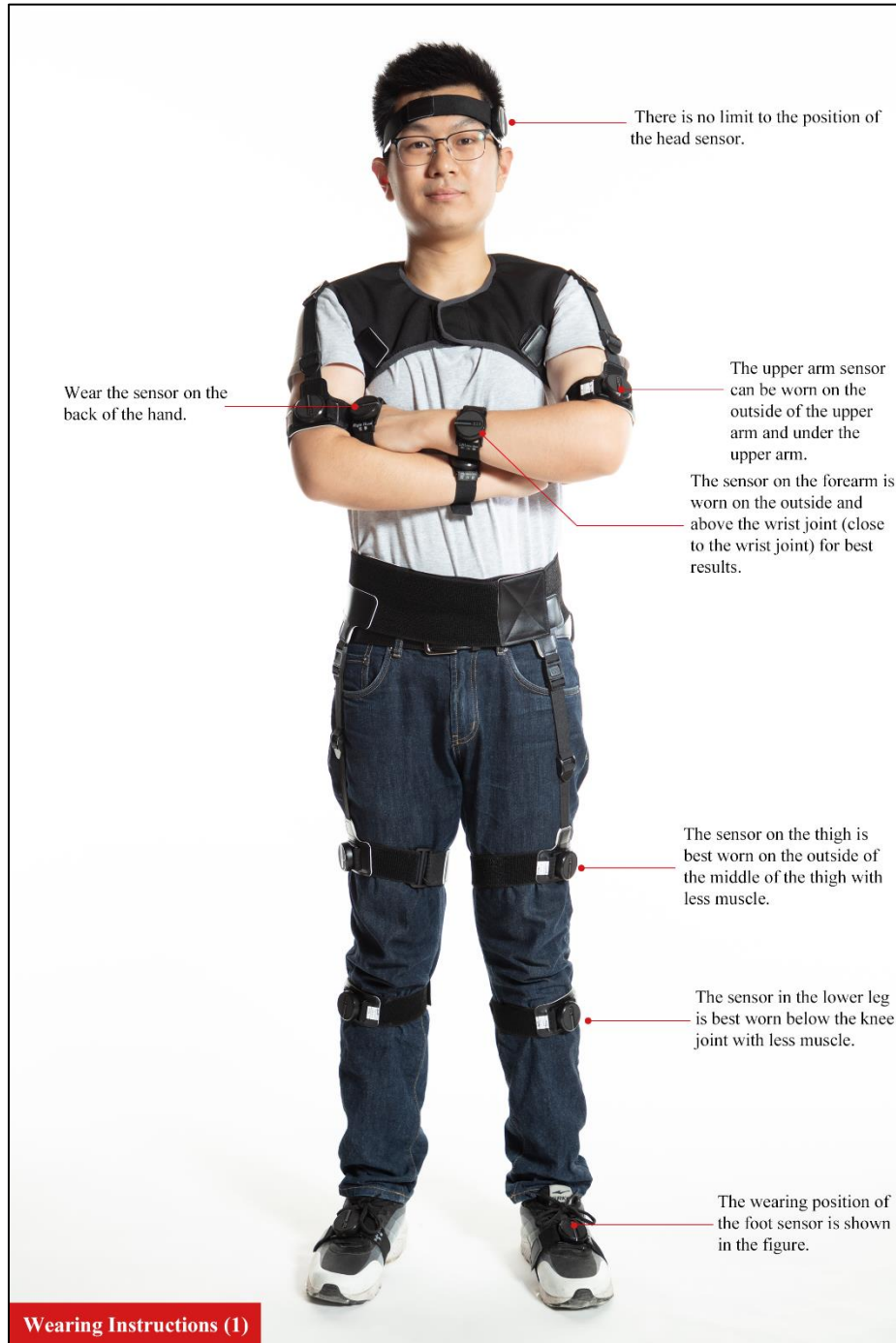
#### 1.2 Software downloads

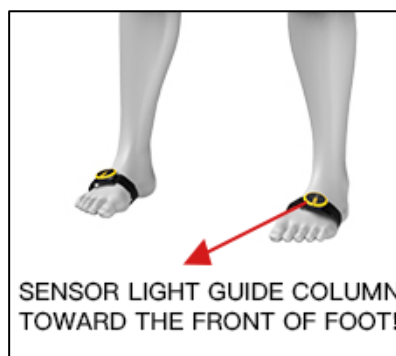
Download the latest version of the software from the official website

<http://www.foheart.com/software/motionvenus.html>.

## 2 Wear

### 2.1 Dressing diagram

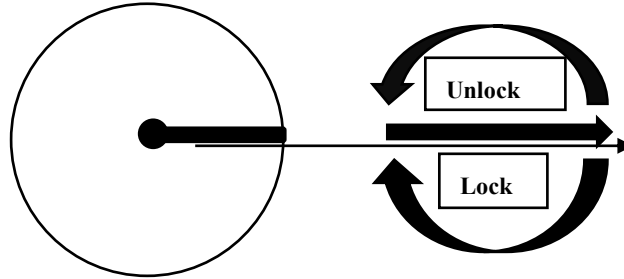




**Note:** the light guide column of the sensor on the foot must be parallel to the front. There is no

limit to sensors in other parts of the body, but they must correspond to the parts of the body labeled by the sensor label.

## 2.2 Install sensor



When installing the sensor, place the light guide column in the same direction as the arrowhead of the base, then rotate 90° clockwise to fix the sensor, and rotate 90° counterclockwise to remove the sensor.

## 1 Introduction

MotionVenus® is a computer client software that is compatible with the FOHEART·X motion capture system suite. Its main function is to fit the data of the sensor, record the data, and export the data into BVH, FBX and other commonly used data formats in the animation industry. In addition, it can also send the motion data stream of performers to Unity3D, Unreal Engine 4, Motionbuilder and other game engines in real time (or offline) to drive the movement of any virtual animated character. At the same time, it can also display various indicators of human kinematics data, such as acceleration, angular velocity, joint Angle.

## 2 Software download

- (1) Software and plug-in download address <http://www.foheart.com/software/motionvenus.html> or <https://github.com/foheart>
- (2) [www.foheart.com](http://www.foheart.com) and <https://github.com/foheart> Is currently the only official download address, Be sure to download software and plug-ins from the specified address.

## 3 Software installation and operation

### 3.1 Software installation

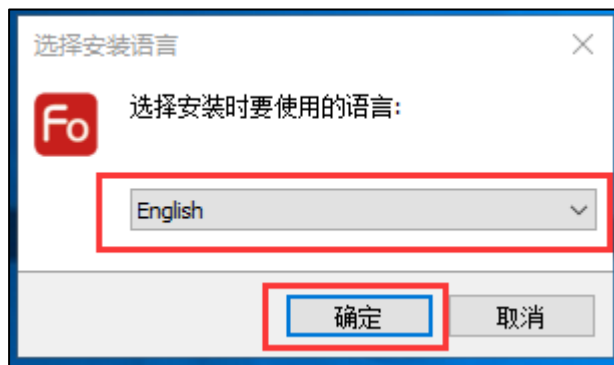


Fig.3.1.1. Installation page 1

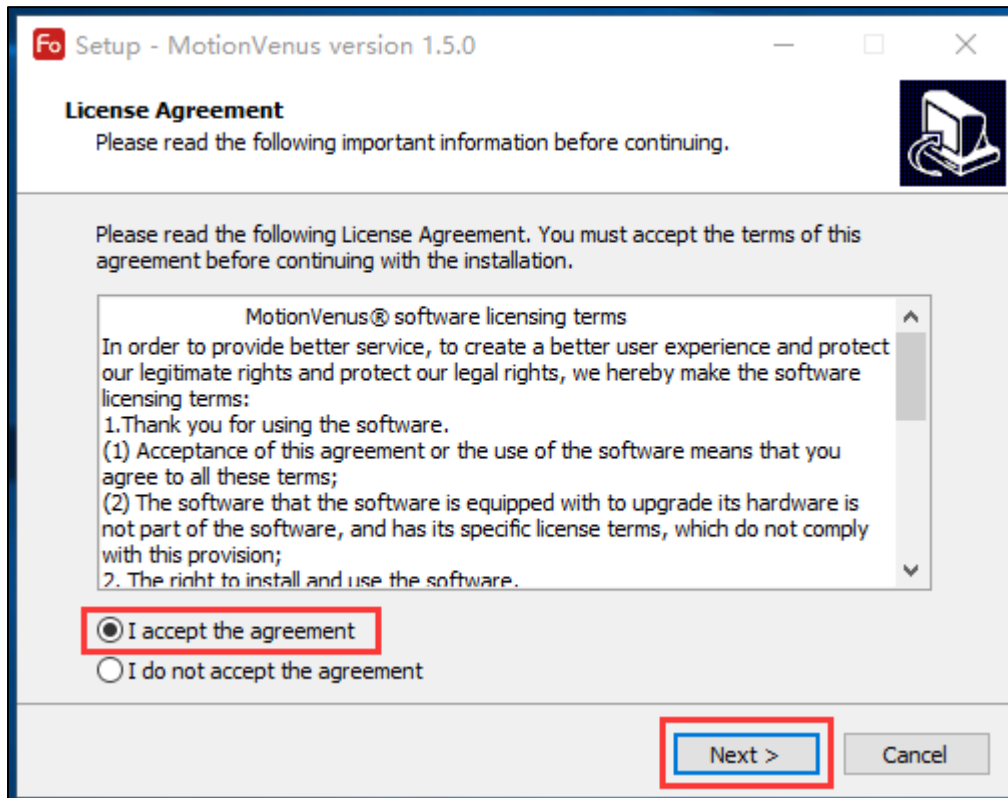


Fig3.1.2. Installation page 2

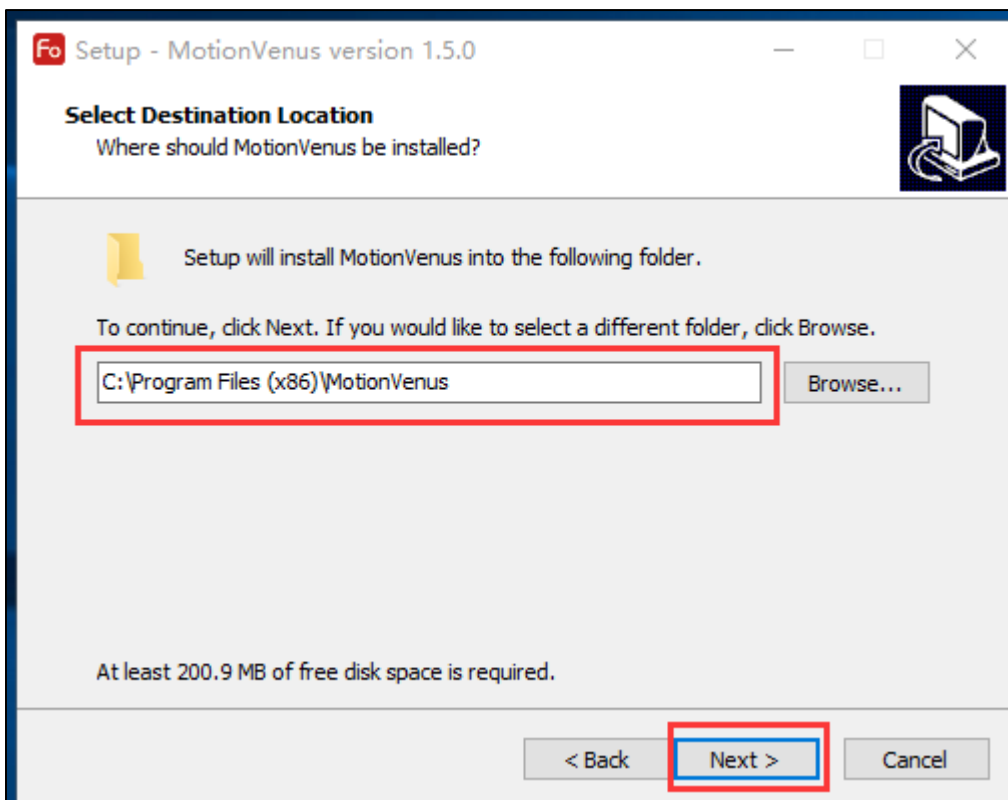


Fig3.1.3. Installation page 3

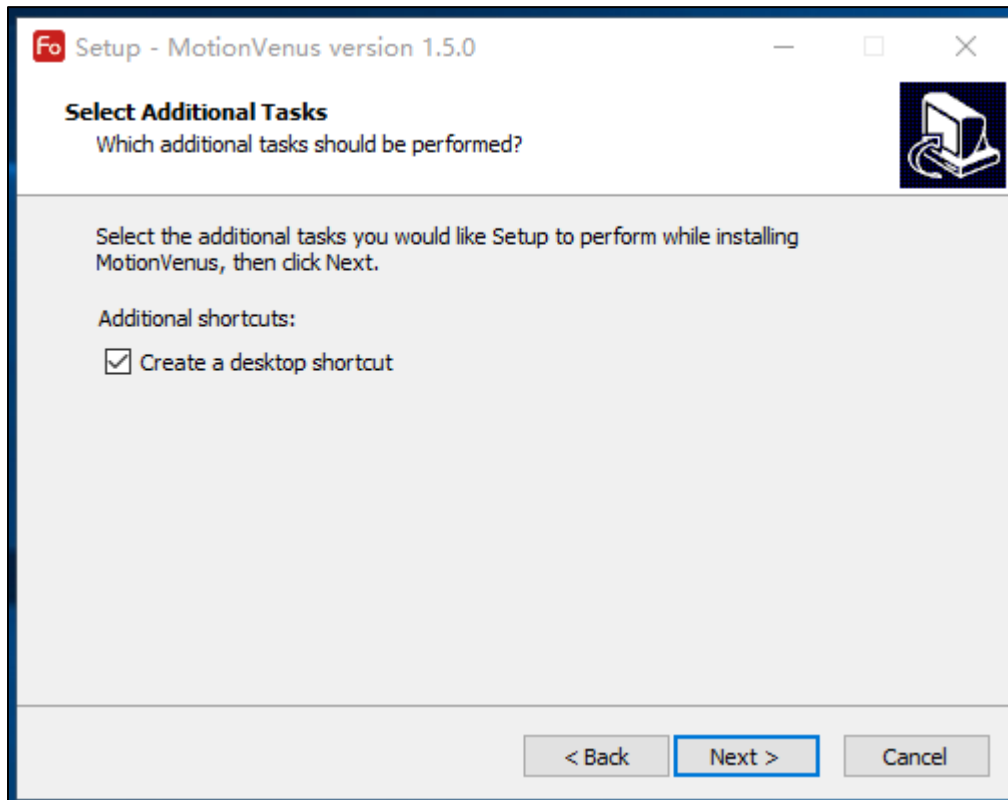


Fig.3.1.4. Installation page 4

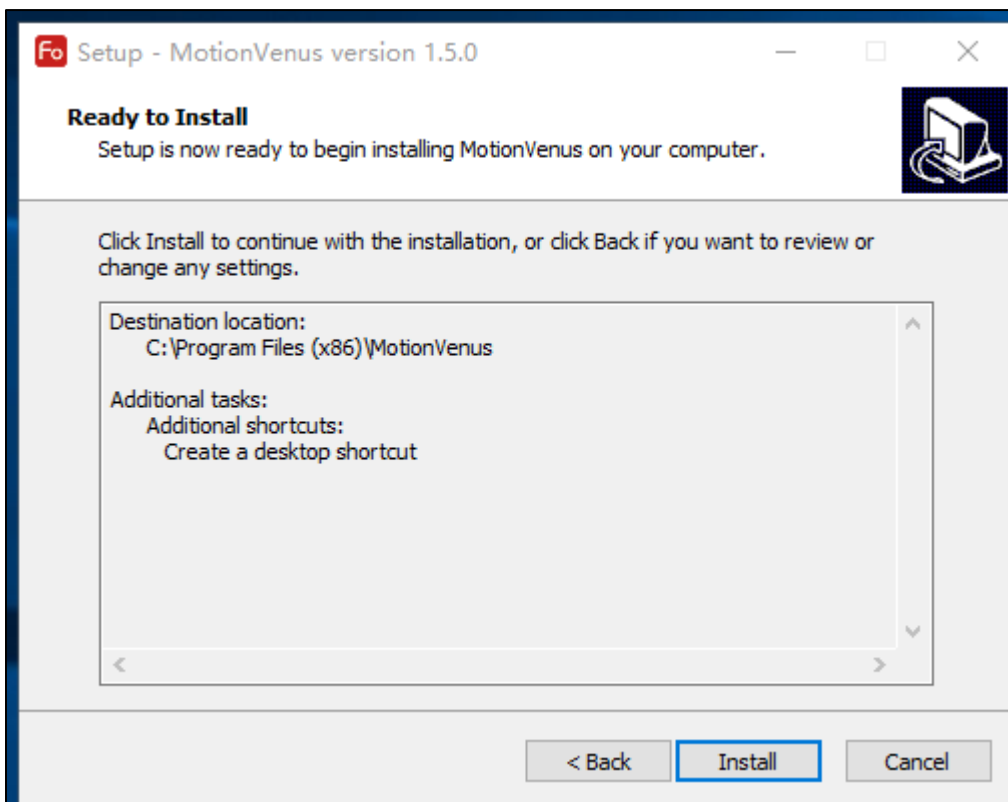
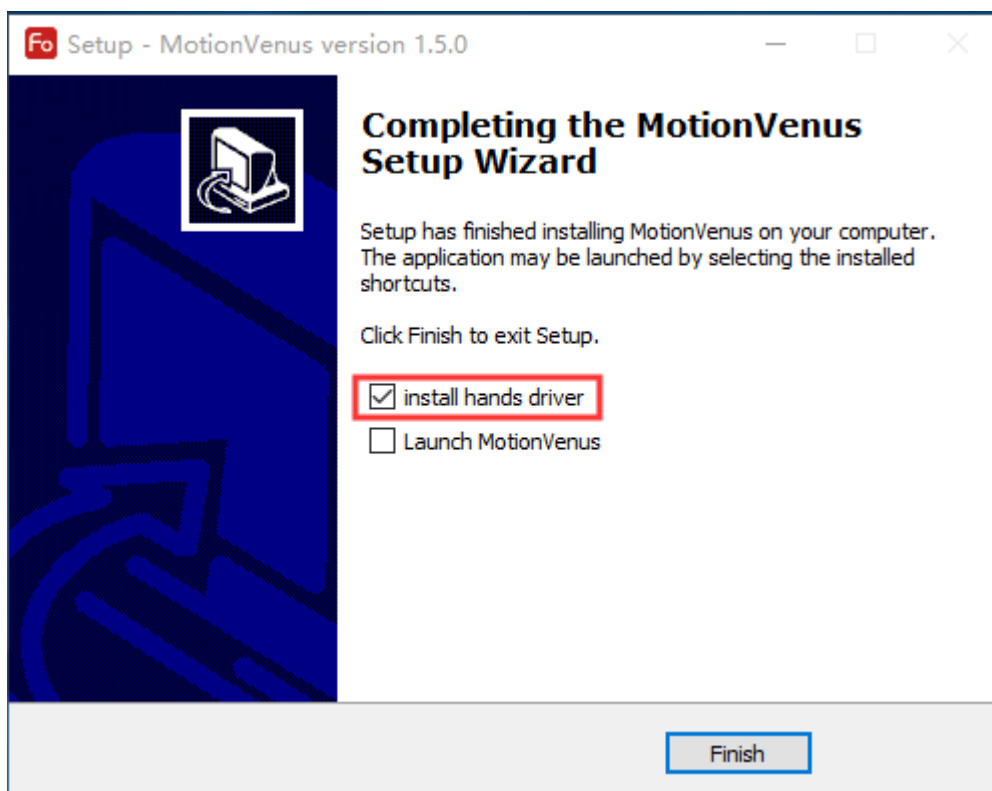


Fig.3.1.5. Installation page 5



**Fig.3.1.6. Installation page 6**

- (1) installation page 1 you can choose the initialization interface language after installation of the software. At present, the software supports "simplified Chinese", "English" and "Japanese". Click the "ok" button to enter the next page.
- (2) only if you agree to the software license terms can you enter the next installation page. As shown in figure 3.1.2.
- (3) select the installation directory. Click "next" to go to the next page. Note: installation directory does not appear in Chinese characters. As shown in figure 3.1.3. This page will appear when you install the software for the first time or after uninstalling the software. If you upgrade the software or install different versions, this page will not appear.
- (4) by default, it will "create desktop shortcut" and click next. As shown in figure 3.1.4.
- (5) click the "install" button to start installing the software. As shown in figure 3.1.5.
- (6) completion of installation. MotionVenus is not run by default. Click the "finish" button to complete the software installation. As shown in figure 3.1.6. Note: the red box "install hands driver" in figure 3.1.6 is the driver for installing the data glove of a third party company. If you do not need the data glove of a third party company, you do not need to check here.

## 3.2 Software runs

The software should run with the permission of "run as administrator".

## 4 Software version

Software version			
No.	Version	Release date	description
1	V1.0.1	January 9, 2017	
2	V1.2.1	April 17, 2017	



3	V1.2.6	June 10, 2017	
4	V1.2.8	July 24, 2017	
5	V1.3.0	August 26, 2017	<ol style="list-style-type: none"> <li>1. Added the network transmission of offline data, supported up to five groups, and played multiple offline data streams in Unity3D and UE4.</li> <li>2. Modify the network data transmission to be automatically forwarded in the background.</li> <li>3. Added details page of RAW file to view internal information.</li> <li>4. Added euler Angle rotation sequence setting in the drawing area, supporting all six rotation sequences.</li> <li>5. Multi-language switch has been added, and English is now supported.</li> <li>6. Interactive help function has been added. Click the question mark button in the upper right corner of each component to get the network help document related to this component.</li> <li>7. Added the Biped BVH format directly exported to 3Ds Max.</li> <li>8. Sensor calibration video is added.</li> <li>9. Fully support the selection of frame rate for all movie and TV playback and export, and add standard support such as PAL and NTSC.</li> <li>10. other details bug fixes.</li> </ol>
6	V1.3.2	December 3, 2017	
7	V.1.3.4	February 11, 2018	<ol style="list-style-type: none"> <li>1. Increase the obvious visual reminder after the sensor is subjected to serious magnetic interference.</li> <li>2. Add automatic monitoring function of recording folder, and the list will be updated automatically after adding or deleting files.</li> <li>3. Fixed incorrect number of detection router and charging base.</li> <li>4. Software automatic update function has been added. Please check whether there is a new version in help -&gt; check update.</li> <li>5. Corrected the slight difference of displacement data in network data stream (this problem will affect unity3d.ue4 and MotionVenusSDK).</li> <li>6. The sensor calibration interface adds a separate calibration button for each sensor.</li> <li>7. Optimized the algorithm to improve the speed and success rate of sensor calibration.</li> <li>8. Fixed non-integer frame rate playback bug.</li> <li>9. Fixed quaternion. Invalid rotation order of euler Angle in UDP sending configuration.</li> <li>10. Dozens of bugs and details optimization.</li> </ol>
8	V1.3.6	April 5, 2018	<ol style="list-style-type: none"> <li>1. Fixed incorrect frame number of BVH exported data.</li> <li>2. Built-in Unroll and Gimble repair mechanism, directly export the correct FBX,</li> </ol>

			without correction in MotionBuilder. 3. Added the function of using the game engine to control MotionVenus. See this function in the technical blog: <a href="http://blog.foheart.com/?P=66">http://blog.foheart.com/?P=66</a> 4. Bug and detail optimization.
9	V1.3.8	April 29, 2018	1. Attitude calculation can automatically deal with most problems such as jumping up and down, sliding, etc. 2. Added the file packaging function, which is convenient to copy the moving capture file to any location quickly. 3. Added the original data export function, see <a href="http://blog.foheart.com/">http://blog.foheart.com/</a> for details 4. Bug and detail optimization.
10	V1.4.0	May 19, 2018	1. Optimization of attitude solution performance. 2. Optimize the main page of the software. 3. User configuration retention function. 4. Custom animation library path /.RAW file association and other functions. 5. Bug and detail optimization.
11	V1.4.2	July 7, 2018	1. UDP protocol adds support for extended data (acceleration, magnetometer, gyroscope). 2. Correction of UDP protocol string type accuracy. 3. Modified. CSV file format and added data support for bone, joint and gravity. 4. Optimize the connection stability of USB devices. 5. Some bugs and details optimization.
12	V1.4.4	April 3, 2019	_____
13	V1.4.6	June 13, 2019	_____
14	V1.4.8	June 25, 2019	1. Added driven-free mode support for receiver, compatible with win7/8/10;This mode requires new hardware support.But this version of the software is compatible with all of fusin's motion-capture systems. 2. Bug and detail optimization.
15	V1.5.0	November 25, 2019	1. Optimized the calculation model of lower body posture. 2. Enhanced kinesiology data. 3. Improved the software interface.
<b>Note</b>	<b>For more information, please visit our official website.</b>		

## 5 Device list bar



Device	Magnetic	Batte	Firmware
Actor1(Live)			
● Hip	Weak	0%	v1.0.0
● Spine	Weak	0%	v1.0.0
● Head	Weak	0%	v1.0.0
● Left...	Weak	0%	v1.0.0
● Left...	Weak	0%	v1.0.0
● Left...	Weak	0%	v1.0.0
● Left...	Weak	0%	v1.0.0
● Righ...	Weak	0%	v1.0.0
● Righ...	Weak	0%	v1.0.0
● Righ...	Weak	0%	v1.0.0
● Righ...	Weak	0%	v1.0.0
● Left...	Weak	0%	v1.0.0
● Left...	Weak	0%	v1.0.0
● Left...	Weak	0%	v1.0.0
● Righ...	Weak	0%	v1.0.0
● Righ...	Weak	0%	v1.0.0
● Righ...	Weak	0%	v1.0.0

Fig.5.1. Device list bar

### 5.1 The basic function

(1) each device connected to the software is loaded into a tree list, which shows in detail the connection status, magnetic interference status and residual power of each sensor, as well as the firmware version.

(2) data files opened in the data files form will also be displayed here.

(3) when MotionVenus is connected to several sets of equipment at the same time, the system automatically Numbers the equipment, such as: Actor1(Live), Actor2(Live), Actor3(Live)..., under each list are all the sensors in the package; You can click "Actor1(Live)" with the mouse to indicate that this set of equipment is currently selected. The following operations (calibration and other operations) are carried out for this set of equipment, and the background color of famous city will become blue after the selection. (3) connection state: when the connection state is "red dot", the sensor is not connected to the software. Please check whether the sensor is on. When the connection status is "green dot", the sensor is normally connected. See Fig.5.1.

(4) magnetic interference: when the field of magnetic interference is shown as "Weak", it means that the sensor is not subject to the magnetic interference of the surrounding environment. When it is shown as "Strong", it means that the sensor is subject to the magnetic interference of the surrounding environment. When the magnetic interference is close to the software, the software will have a visual reminder of magnetic interference, so that even in the distance from the software, you can see a part of the magnetic interference.

(5) electric quantity: displays the electric quantity of the corresponding sensor, and the display of

electric

quantity refreshes every 10 seconds.

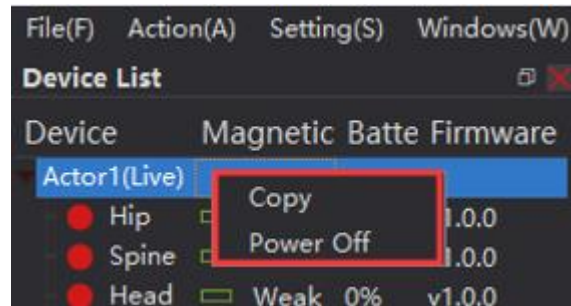


Fig.5.2. Shutdown and replication

(6) right click "**Power Off**" on the name power off all sensors. Click "**Copy**" to copy the current character name, such as "Actor1(Live)".

(7) note: in the process of use, because the feet are most vulnerable to magnetic interference, when the magnetic interference column shows abnormalities, check whether there is a strong magnetic interference source around, if there is, keep away from it, when away from the magnetic interference, the foot sensor can automatically return to normal state.

## 5.2 Display the data

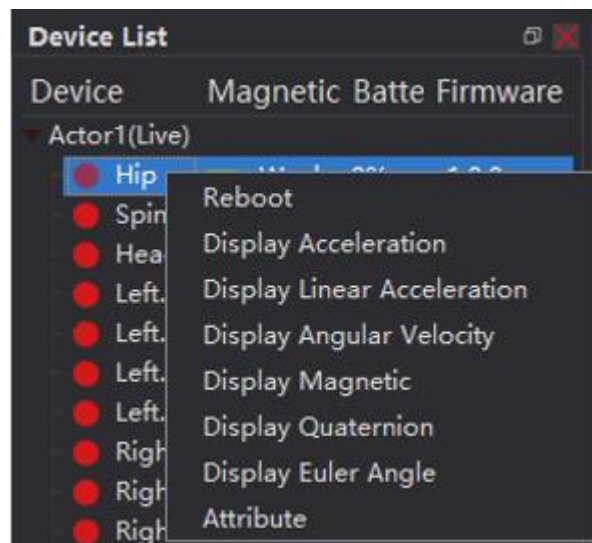
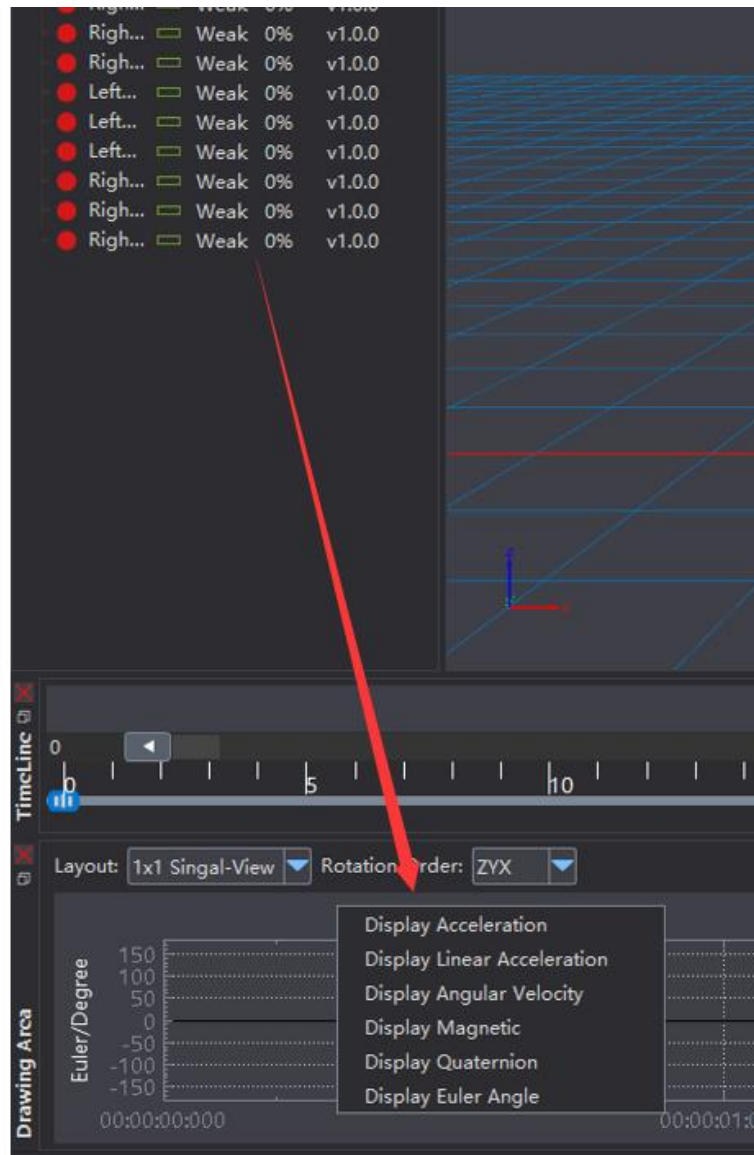


Fig.5.2.1. Display the data 1



**Fig.5.2.2. Display the data 2**

- (1) click any sensor with the left mouse button, and then the right mouse button can display various data indicators of the sensor. See figure 5.2.1.
- (2) drag any sensor to the drawing area and the right mouse button can also display various data indicators. See figure 5.2.2.

The acceleration	The acceleration of the sensor, unit g, coordinate system is the local coordinate system of the sensor itself
Linear acceleration	The linear acceleration of the sensor (the acceleration removes the gravity acceleration component), unit g, and the coordinate system is the local coordinate system of the sensor itself
The angular velocity	The angular velocity of the sensor, unit Degree/s, and the coordinate system is the local coordinate system of the sensor itself
quaternions	The rotation Angle of the sensor, the coordinate system is the local coordinate system of the sensor itself
Euler Angle	The rotation Angle of the sensor, the coordinate system is the local coordinate system of the sensor itself
Magnetic values	The magnetic field value of the sensor, unit mGauss, coordinate system is the local coordinate system of the sensor itself
MOD(Modulus value)	The current measurement value of XYZ triaxial is x,y,z,MOD =

$$\sqrt{x^2 + y^2 + z^2}$$

### 5.3 Advanced Settings

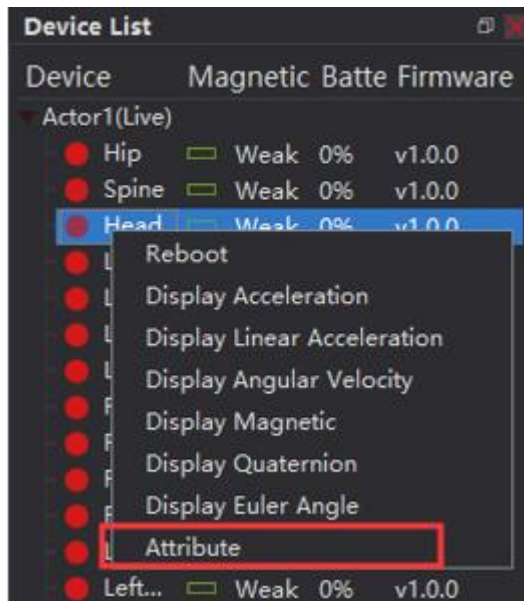


Fig.5.3.1. Advanced Settings 1

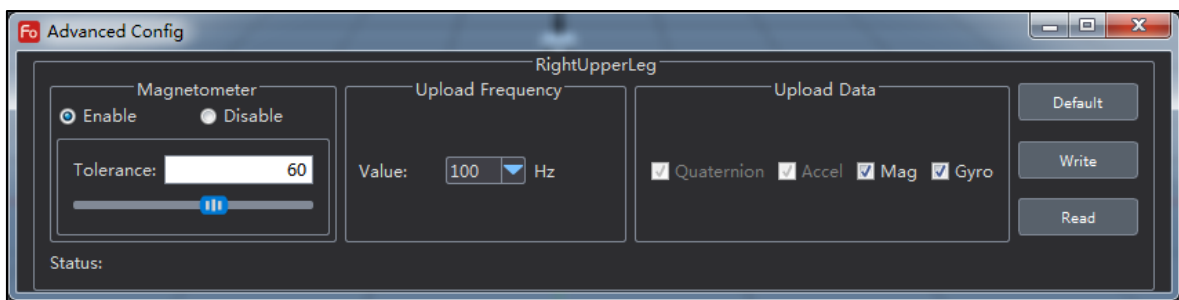


Fig.5.3.1. Advanced Settings 2

## 6 Sensor field calibration

Sensor magnetic field calibration, select software menu bar: motion-> sensor magnetic field calibration. Click the "start calibration" button at the bottom of the page, and the sensor calibration state becomes uncalibrated, as shown in figure 6.1

	Hip	Spine	Head	L Shoulder	Upper Arm	L Forearm	L Hand	R Shoulder	Upper Arm	R Forearm	R Hand	Upper Le	L Leg	L Foot	Upper Le	R Leg	R Foot
Progress	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Calibrate	Calibrate	Calibrate	Calibrate	Calibrate	Calibrate	Calibrate	Calibrate	Calibrate	Calibrate	Calibrate	Calibrate	Calibrate	Calibrate	Calibrate	Calibrate	Calibrate	Calibrate
Progress	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

In order to ensure the accuracy of the node calibration, please keep away from magnetic disturbance.  
Click calibrate button to calibrate all sensors.

✓ Complete     
 ✗ Not complete     
 ⚡ Strong magnetic disturb

Fig.6.1.

Each axial 360° rotation sensor, calibration progress will continue to increase, continue to rotate the sensor until the progress is 100%, as shown in figure 6.2.

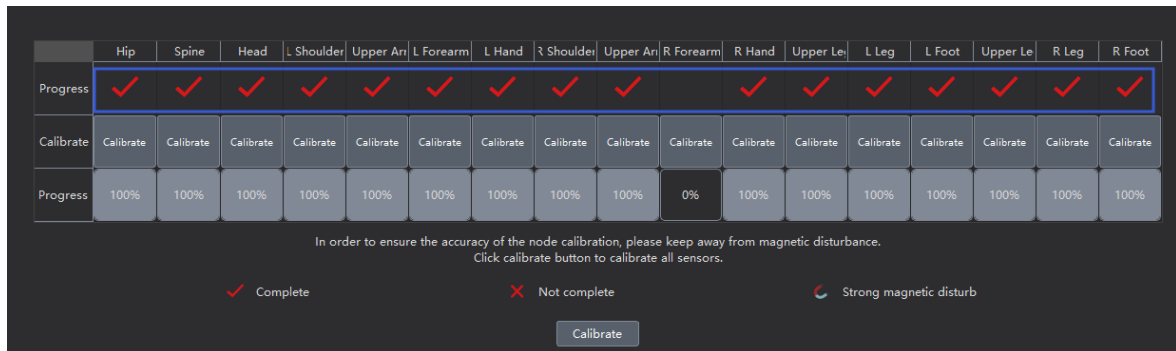
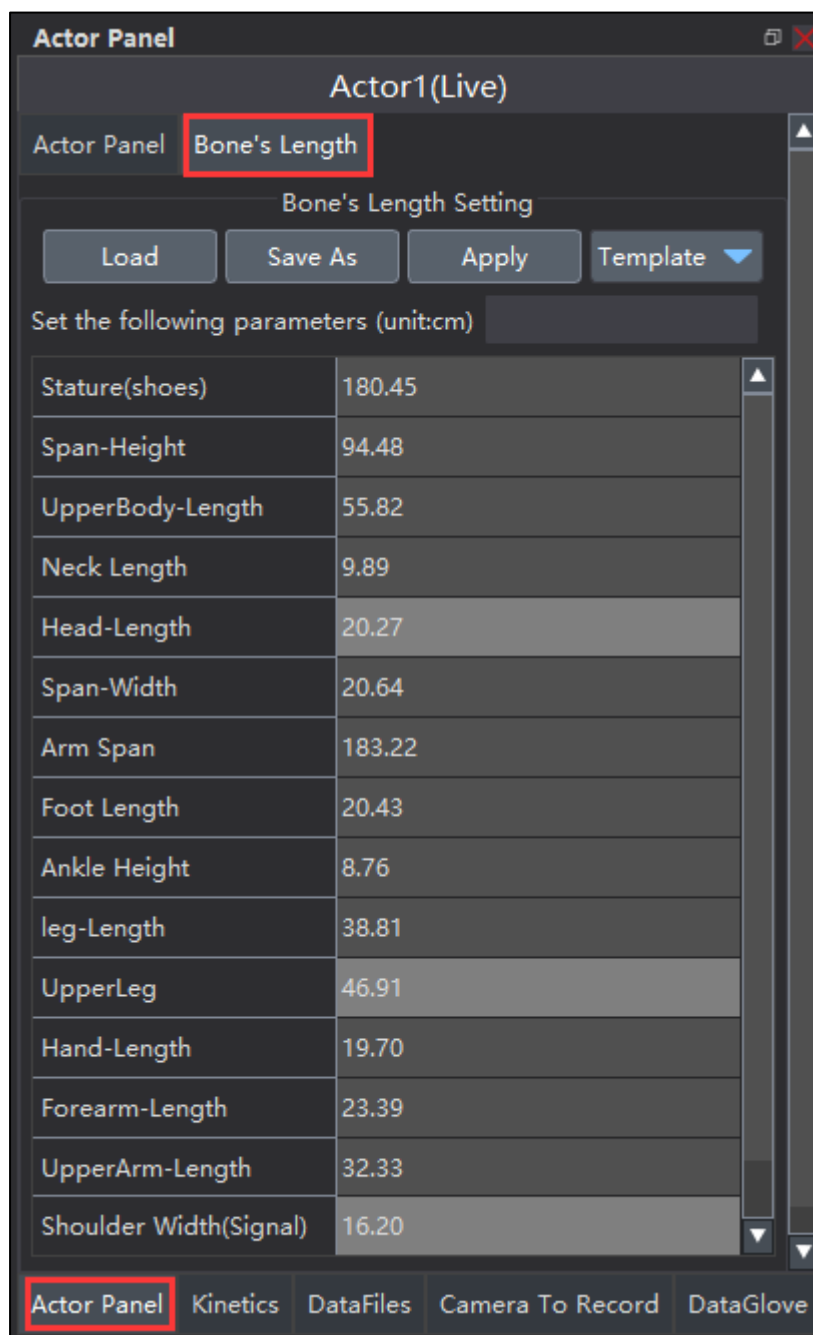


Fig.6.2.

Click the "finish" button at the bottom right of the page to end the sensor calibration.

**Special note: when the magnetic field of the sensor is not affected by the surrounding environment, it is not necessary to recalibrate the sensor every time it is switched on. Be sure to recalibrate the sensor when changing locations (such as taking it to another city for use). When the sensor using the environment magnetic field interference especially serious, you can open the calibration box, check to see if the corresponding calibration status of the is in a state of "x" or "M", when to display "x", would you please to calibration of the sensor, when the show is "M", please stay away from strong magnetic interference around (what is the magnetic interference and how to avoid? Recalibrate the sensor in this area.**

## 7 Set length of body bone

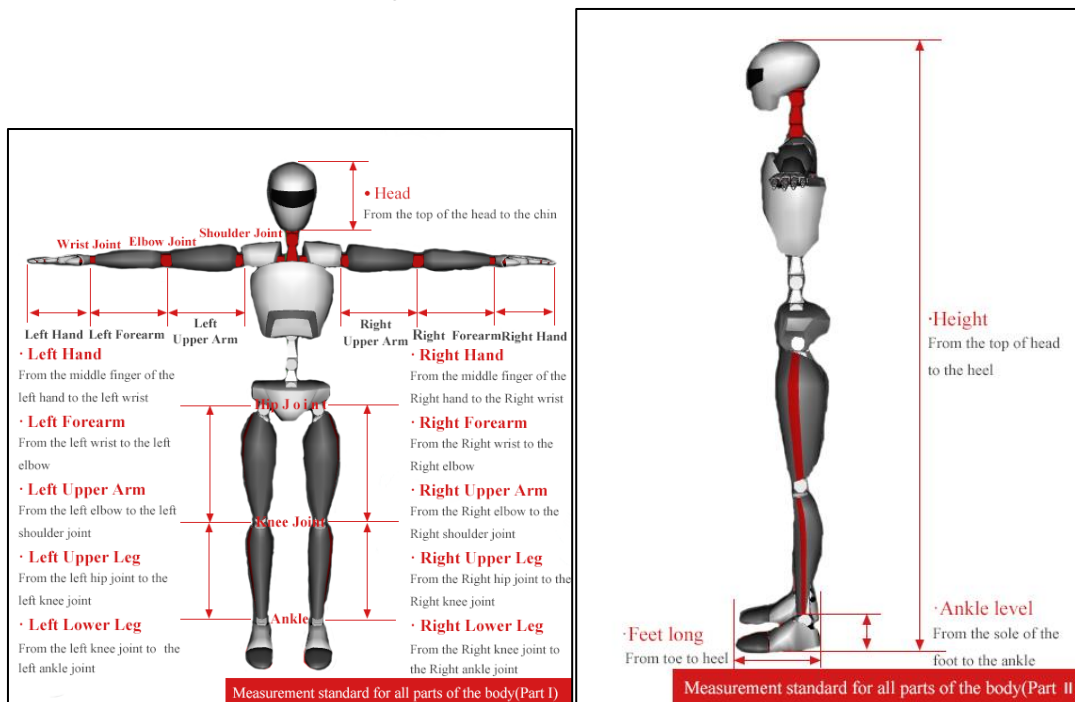


**Fig.7. Set length of body bone**

In the "bone length" section, you can select the bone length template that suits your height. Or precisely measure and set the length of the bone. You can click to set your actual height and bone length, so that the body parameters of the 3D character model are consistent with you. Correct body parameters can make your movements more accurate. For example, the right length of upper and lower arms as well as the length of hands should be set for the movement of folding hands. Otherwise, problems such as the failure of folding hands or crossing arms of 3D characters will occur. After selecting the template, you must click the "apply" button to use it. If you are using a self-modified



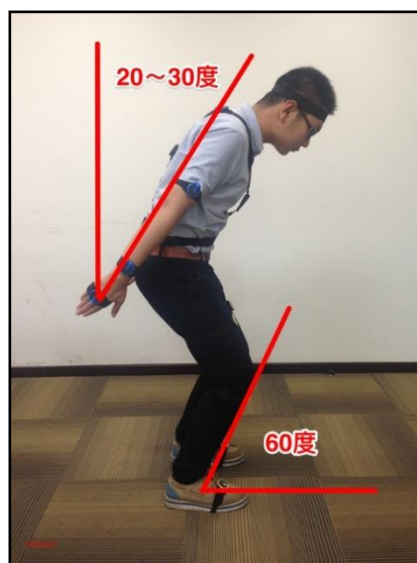
bone length, be sure to click "save as" to save the current configuration so that you can manually choose to load the customized bone length next time.



## 8 Posture calibration

The purpose of calibration is to eliminate the wearing errors of sensors on the body. There are four calibration methods: "Z\_Pose", "I\_Pose", "T\_Pose" and "S\_Pose". To calibrate the upper limb separately, check the box in front of the "arm". Click "start calibration" and you can view the figure picture above and make corresponding actions. The system default time of each calibration action is 3 seconds. You can click "Settings" and "options" in the software menu bar to customize the calibration interval time.

### 8.1 Z-Pose



### 8.2 I-Pose



### 8.3 T-Pose

Bring your arms to your sides, making sure they are straight.

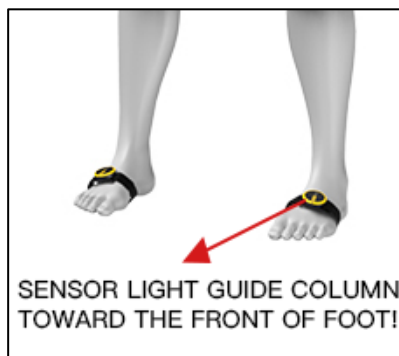


### 8.4 S-Pose

Hold your arms flat in front of you, making sure they are straight.



**Note: the light guide column of the sensor on the foot must be parallel and facing directly in front during calibration.**



## 9 3D character display window

### 9.1 View

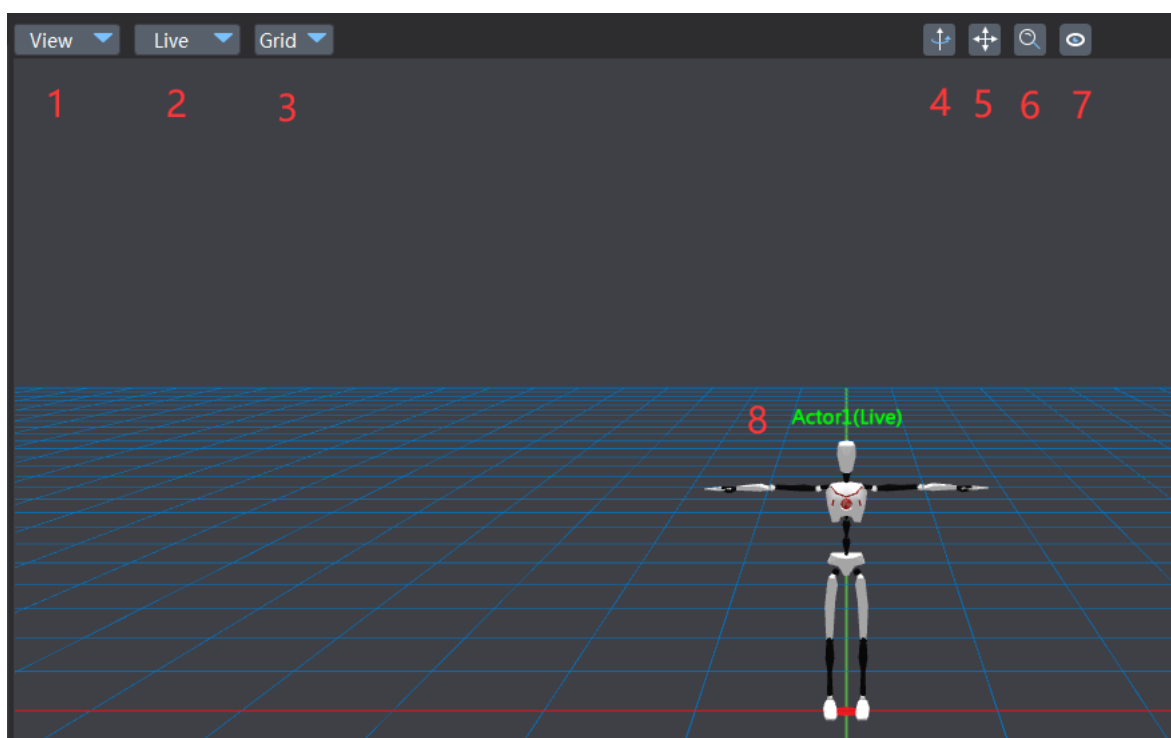
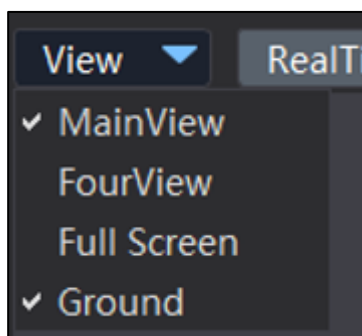


Fig.9.1.View

Click the 1 "view" button in figure 9.1 to display "main view", "four Windows", "full screen" and "horizon" successively. By default, the display status is "main view" and "ground plane".

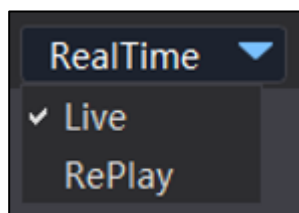


**Fig.9.2. View selection**

"Full screen" displays the currently selected view in full screen. You can press "Esc" to exit the full screen state.

## 9.2 Real-time mode and playback mode

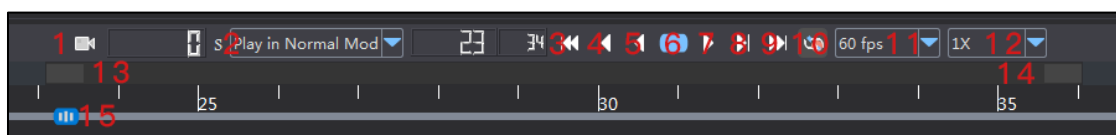
"Real-time mode" and "playback mode" are shown in the following figure. The 3D character in the real-time mode is synchronized with the character performing in real time by wearing the motion capture device. When a recorded data file is opened for playback, it will be in "playback mode". Click here to switch from "playback mode" to "real-time mode".

**Fig.9.3. Play mode**

## 9.3 Other buttons

- (1) Hold and drag mark "4" in fig.9.1 to rotate the scene 360° and view the 3D character model from multiple angles.
- (2) Drag "5" in fig.9.1, then the scene can be dragged by pan in four directions.
- (3) Drag "6" in fig.9.1 to zoom in or out of the scene.
- (4) Click "7" in fig.9.1 is the "character follow" function. Click the button to make the scene follow the movement of 3D characters.
- (5) "8" in fig.9.1 is the name of the current 3D character.(Actor1(Live))

## 10 The timeline

**Fig.10.1. The timeline**

The timeline bar is used to manage the recording, playback, fast and slow playback of real-time data, and modify data with the frame data modification module.

No.	Name	Explain
1	Record button	Click the record button to record the real-time data stream, and the recorded data stream will be displayed in the recording file management module. When recording, the main window will be marked red with a red border.
2	Play mode	There are four play modes: "Normal broadcast"; When "drag by frame" is played as dragging time axis slider, the minimum interval is one frame; "Play by frame" is the minimum interval of one frame when playing; When "play by frame" is played and dragged, the minimum interval is one frame.
3	To start file	Jump directly to the start of the file
4	On a frame	_____

5	Reverse playback	_____
6	Pause	_____
7	Positive play	_____
8	Next frame	_____
9	To end file	Jump directly to the start of the file
10	Loop for	_____
11	Frame rate to choose	_____
12	Play speed selection	_____
13	The left slider	The left and right slider in the middle controls the area of the timeline. You can directly double-click the slider to enter the frame number to achieve a fast jump.
14	The right slider	

Note: during recording, the file cannot be played back at the same time. If you switch to playback mode, the recorded content will be blank. Playback framerate can be changed to preview the actual effect of exporting this framerate to BVH or FBX. Frame rate selection supports multiple frame rates.

## 11 The data file

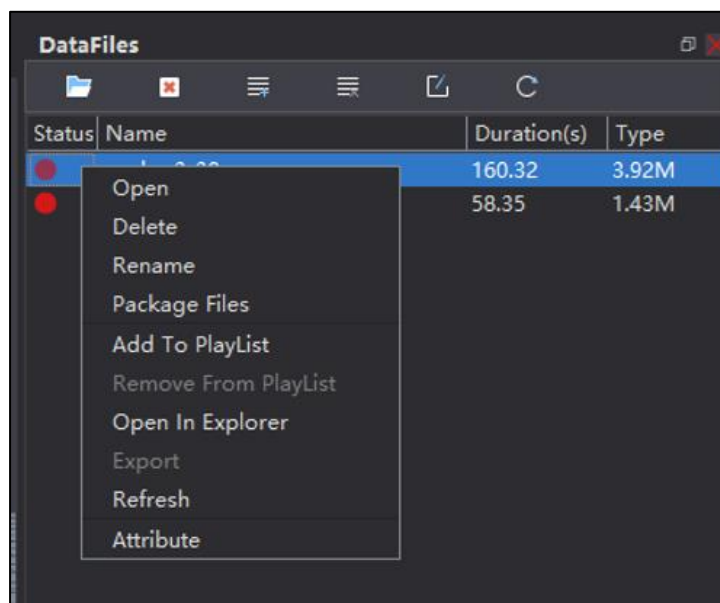


Fig.11.1. The data file

### 11.1 Functions overview

"Data file" module is mainly responsible for: storage, management and playback of recorded motion capture files; Export files to BVH, FBX and other general formats; File naming rules: record date + time + role name. For example, 20170713\_172853\_Actor1(Live), 20170713 represents the recording time on July 13, 2017, \_172853 represents the recording time at 17:28 minutes and 53 seconds, and \_Actor1(Live) represents the role name.

## 11.2 The packaged file

Packaged file in figure 11.1. When you need to move motion capture files from one storage location to another, you can use the built-in file packaging feature in MotionVenus to quickly compress the current file and all its associated files to the specified storage location for ease of operation.

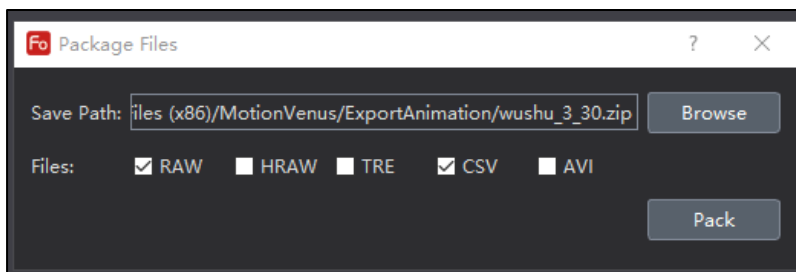


Fig.11.2. The packaged file

RAW file	Motion capture system data raw file.
HRAW	Finger action data raw file (data from data glove).
TRE file	Save the edit information of touchpoint. If you edit touchpoint, please check this box.
CSV file	The original data (quaternion, Euler angle, acceleration, angular velocity, magnetic value) of the Sensor is saved. If the original data export option is turned on in the Settings during recording, this file will be generated.
AVI file	The synchronous video is saved. If the camera capture function is used in the motion capture process, the synchronous video file will be generated.

Generate.zip file with file name after compression. If you need to use the packaged motion capture file, extract it into the root directory in the data folder in MotionVenus.

## 11.3 Export the data within the scope of the timeline

The exported data is the range determined by the two sliders in the middle of the timeline module. The data for this file cannot be exported until the file is opened first. See figure 11.3.

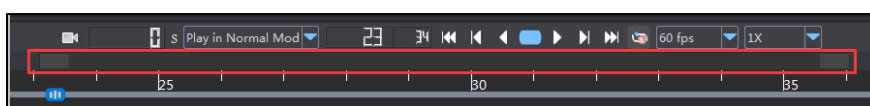


Fig.11.3. Export the data within the scope of the timeline

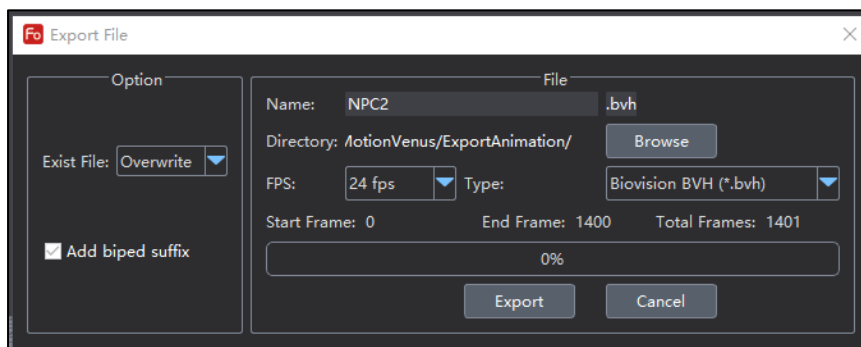


Fig.11.4. Export file

### 11.3.1 Export option

There are three options for handling files with the same name: Automatic renaming: automatically adds the "\_1" suffix after the file with the same name. Overwrite: automatically overwrites duplicate files. Ask: each time a dialog box pops up asking if it is overwritten. When the export file is "3Ds Max Biped BVH", the \_biped suffix is automatically added to the end of the file.

### 11.3.2 Frame rate to choose

Frame rate selection supports a variety of standard frame rates:

PAL	25 fps
NTSC Full	29.97 fps
NTSC Drop	29.97 fps

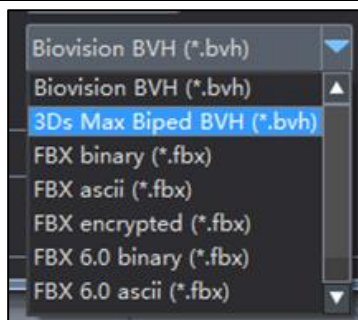


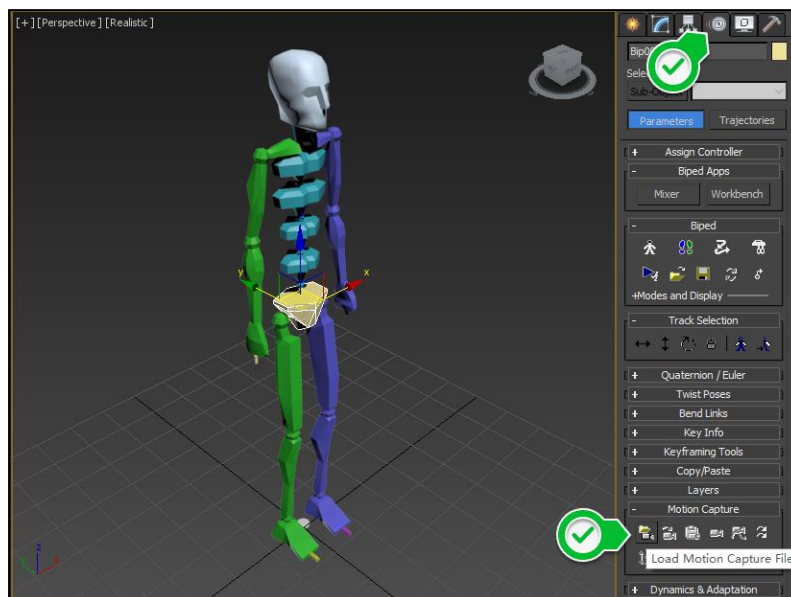
Fig.11.5

### 11.3.3 3D Max Biped BVH

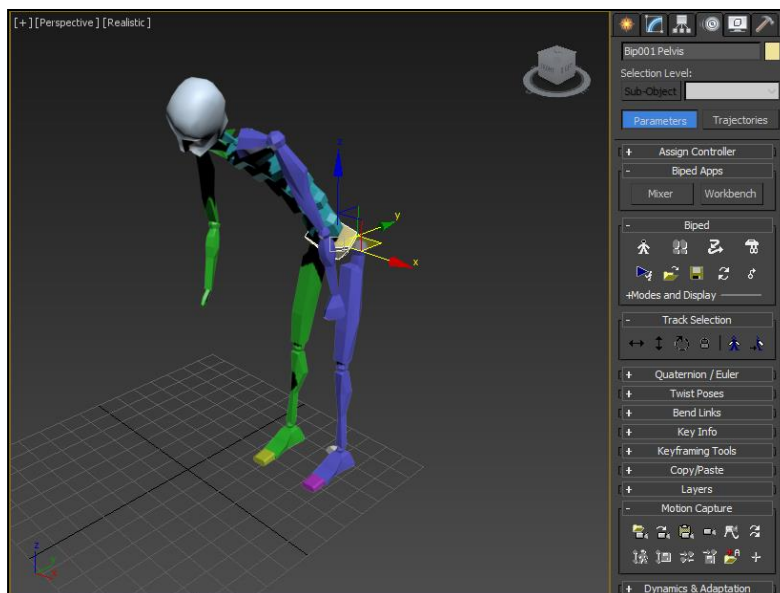
First drag and drop in the scene to create a default Biped model,



Then select Load Motion Capture File,



Select the exported ActorM\_biped. BVH, and the final display is as follows :



### 11.3.4 Other export

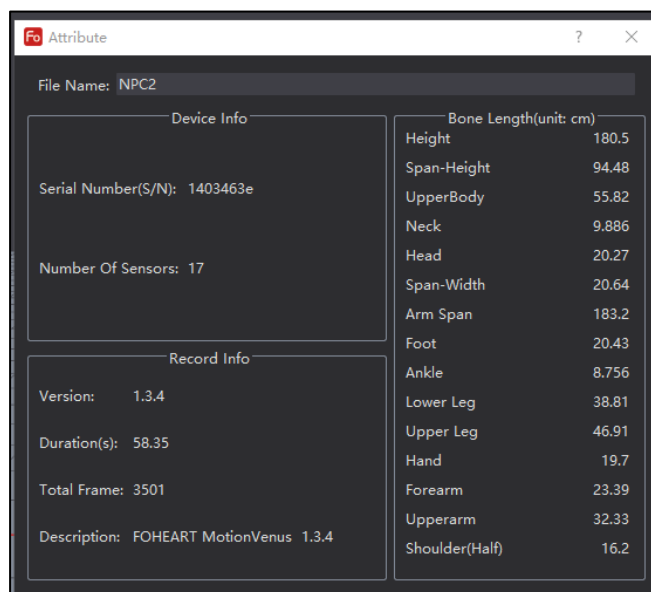
Biovision BVH
FBX binary
FBX ascii
FBX encrypted
FBX 6.0 binary
FBX 6.0 ascii

### 11.4 The playlist

Right click to add to the play queue means to add the current file to the playback stream. All the files in the playlist will forward their data to the network port in the background (for example, to the third party software or Engine such as Unity3D, Unreal Engine 4).



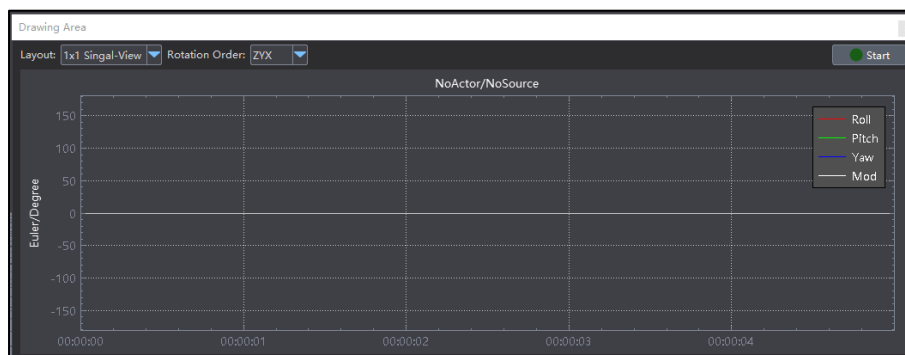
## 11.5 Attribute



**Fig.11.5.1 File attributes**

Right-click on the properties to view the details of the recorded file, including the hardware suite used, total frames, bone length, and so on.

## 12 Graphics area



**Fig.12.1. Graphics area**

Data from the kinematics window euler Angle are displayed in the mapping area below the software, which allows maximum simultaneous monitoring of the Angle changes of four segments of bone or joint.

There are six rotation orders for the angles: XYZ, XZY, YXZ, YZX, ZXY, ZYX, which can be selected from the drop-down box. Select the arrangement of display areas in the drop-down box at the top left of the drawing module. "Stop/play" button. After "stop" drawing, you can drag the data of each drawing area with the mouse to view the historical data, or use the mouse wheel to zoom in and out the displayed data.

### 13 Kinematics

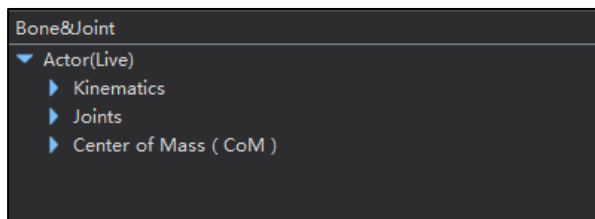


Fig.13.1. kinematics 1

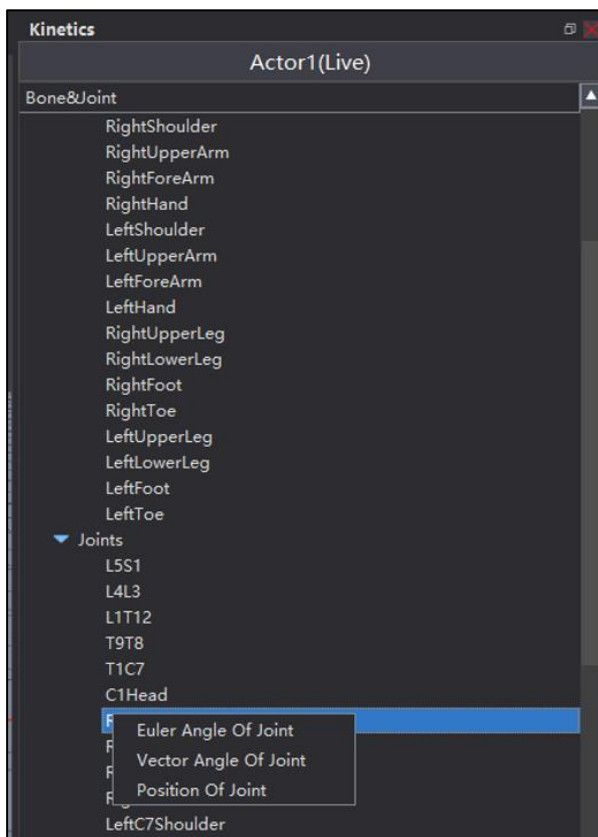


Fig.13.2. kinematics 2

Right click on each bone or joint to view euler Angle data for that bone or joint, such as right shoulder, or directly click on the bone or joint and drag it into the drawing window. Here we can view the Angle change information of the bone or joint we are interested in, and we can monitor the Angle change information of the bone or joint (up to four segments) at the same time.

Kinematics	Bone Euler angle	Global coordinate system, the Global coordinate system indicated by the coordinate system in the lower left corner of the 3D scene.
Joints	Joint Euler angle	The Local coordinate system, the rotation Angle relative to the parent skeleton
	Joint vector Angle	The vector Angle of the direction vector represented by the current rotation of the skeleton relative to the direction vector represented by the rotation of the parent skeleton.
	Joint displacement	Global coordinate system, the Global coordinate system indicated by the coordinate system in the

		lower left corner of the 3D scene.
Center of Mass	Center of gravity displacement	Global coordinate system, the Global coordinate system indicated by the coordinate system in the lower left corner of the 3D scene.

## 14 The menu bar - Set up -Option

### 14.1 Shortcuts

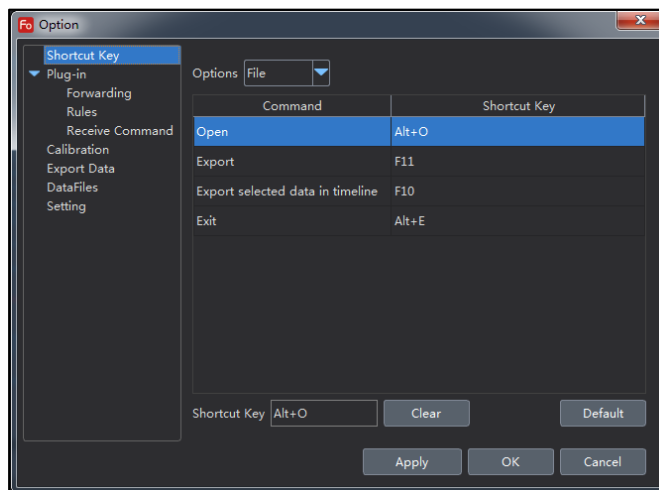


Fig.14.1. shortcuts

### 14.2 The plug-in

#### 14.2.1 Data forwarding

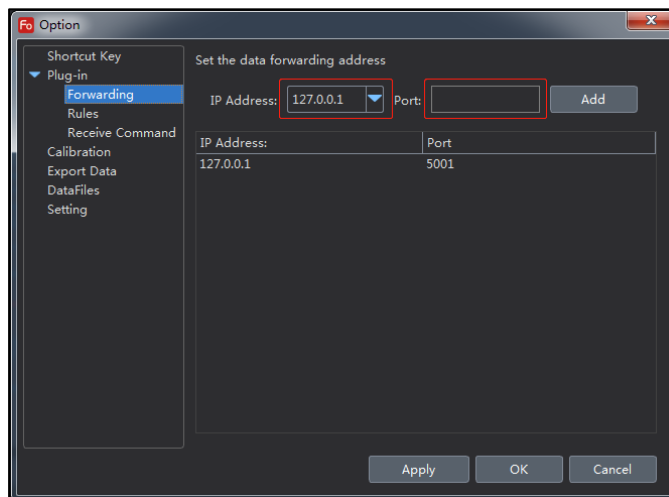


Fig.14.2.1. Data forwarding

In the same LAN, you can set the IP address and port number of the target host, and the data can be automatically forwarded to the target host you set.

### 14.2.2 Forwarding rules

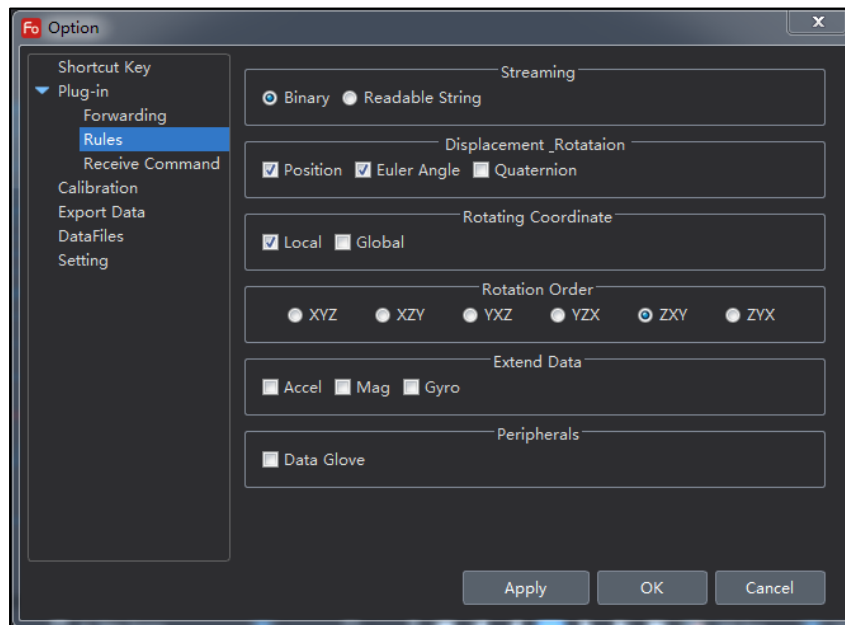


Fig.14.2.2. Forwarding rules

### 14.2.3 Receiving Command

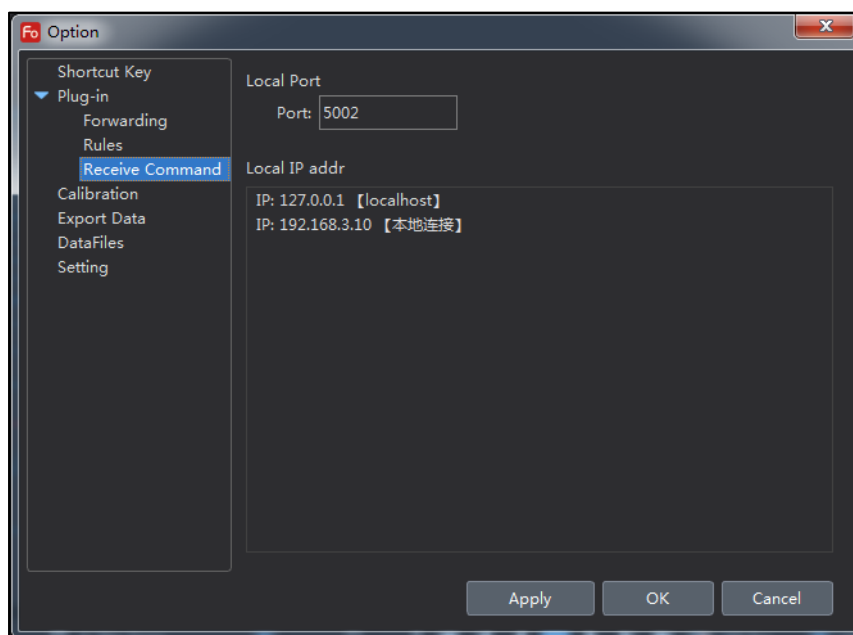


Fig.14.2.3. Receiving Command

## 14.3 Posture calibration

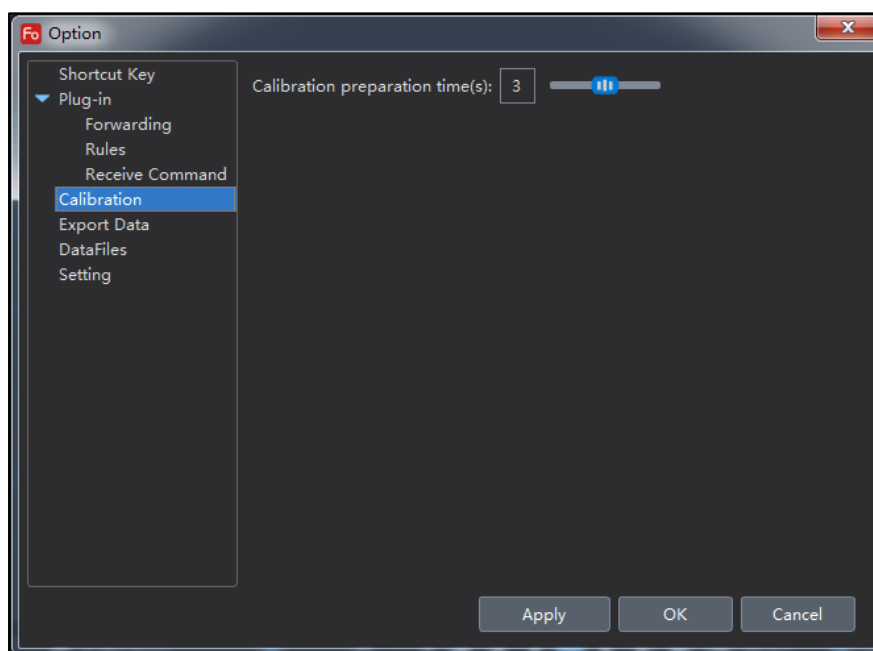


Fig.14.3. Posture calibration

You can customize the waiting time from the completion of each calibration to the next one. The default time is 3 seconds.

## 14.4 Export data

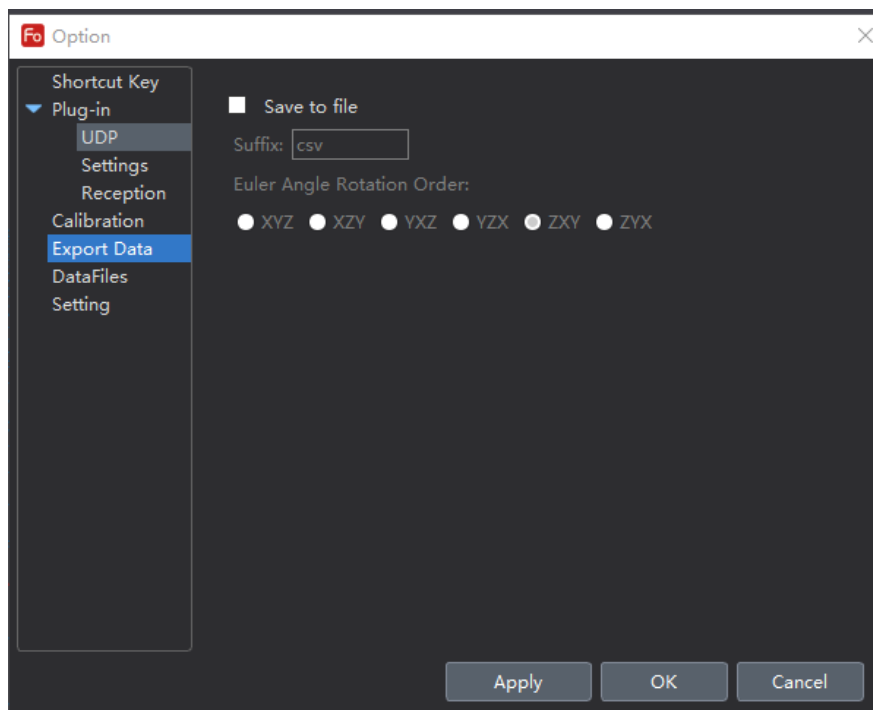


Fig.14.4 Export data

Please check "export raw data and skeleton solution data".

Note: the data export function only saves the data when the action is recorded, so it is necessary to record the action when using this function.

## 14.5 The data file

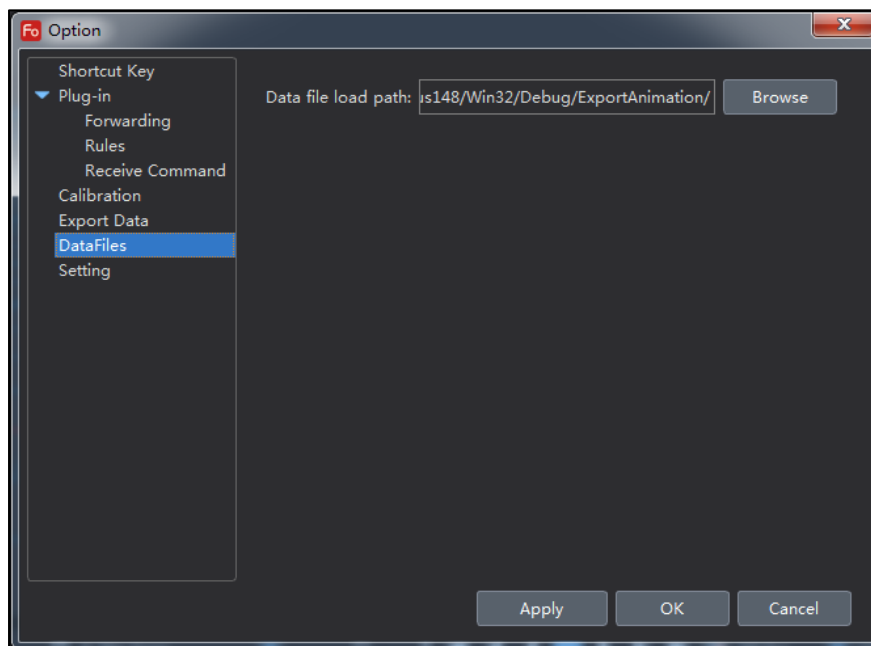


Fig.14.5. The data file

Here you can set your own data saving location.

## 14.6 The software Settings

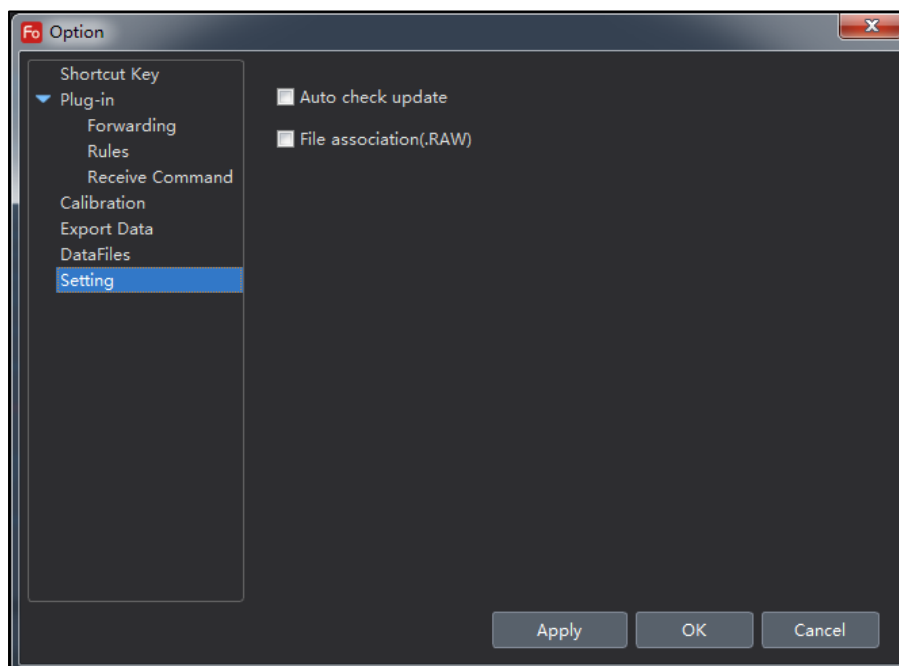


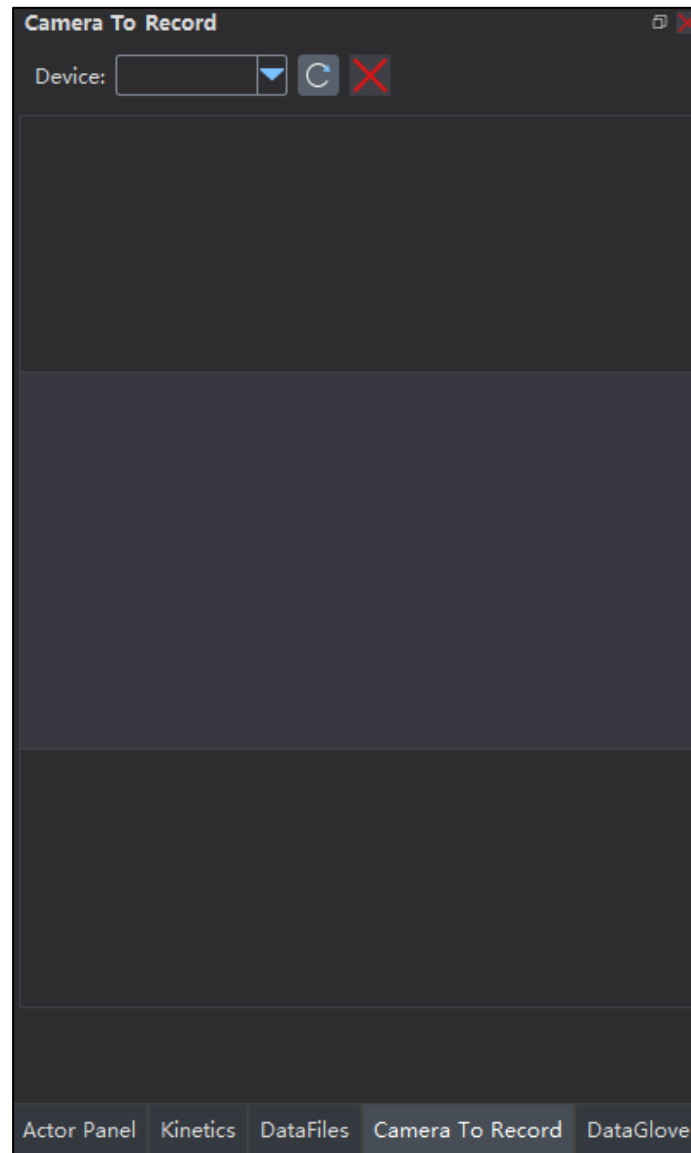
Fig.14.6 The software Settings

- (1) **Automatic check update:** when checked, the software will automatically check whether the version of the software is the latest version.
- (2) **File association:** When checked, the software automatically checks if RAW is associated with the software.

## 15 The camera to record

MotionVenus can record video with the camera.

### 15.1 Used to prepare



**Fig.15.1. Used to prepare**

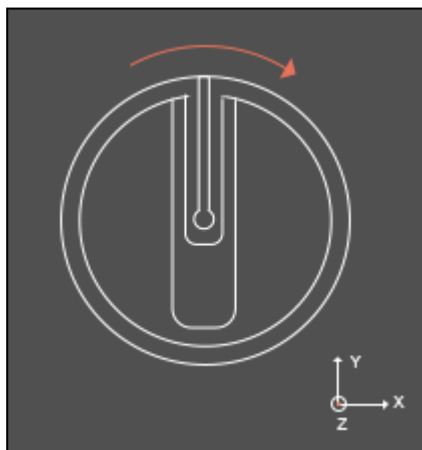
(1) cameras that are compatible with the system.(2) ensure that the camera driver has been properly installed. As shown in figure 15.1, in the right dock bar of MotionVenus, select "camera record" and click the "refresh" button to get the connected camera. If there are multiple cameras in the system, you can select the camera device you want to use from the drop-down list. If there is an open USB camera device, the background will record the video stream from the camera synchronously by default when clicking to record the active capture file. After the recording, video will be saved as the same name video file with suffix.avi. When video is played back, if a video file with the same name exists, the video file is automatically played back synchronously in the video window.

## 15.2 Video recording parameters

<b>Resolution</b>	640 x 480px
<b>Frame rate</b>	30fps
<b>Number of video recorded at the same time</b>	1

## 16 Definition of coordinate system

### 16.1 Sensor coordinate system definition



The light guide column points to the Y axis, the right axis points to the X axis, and the Z axis points directly above the sensor. It conforms to the output value of the coordinate system: acceleration value of the sensor, angular velocity value.

### 16.2 Quaternion and euler Angle coordinate system definition

Corresponds to the definition of east (X) north (Y) day (Z) coordinate system. Match the output value of this coordinate system: directly drag a sensor in the device list to the charting area window to display the real-time curve value.

### 16.3 Definition of skeletal coordinate system

Right hand coordinate system definition.



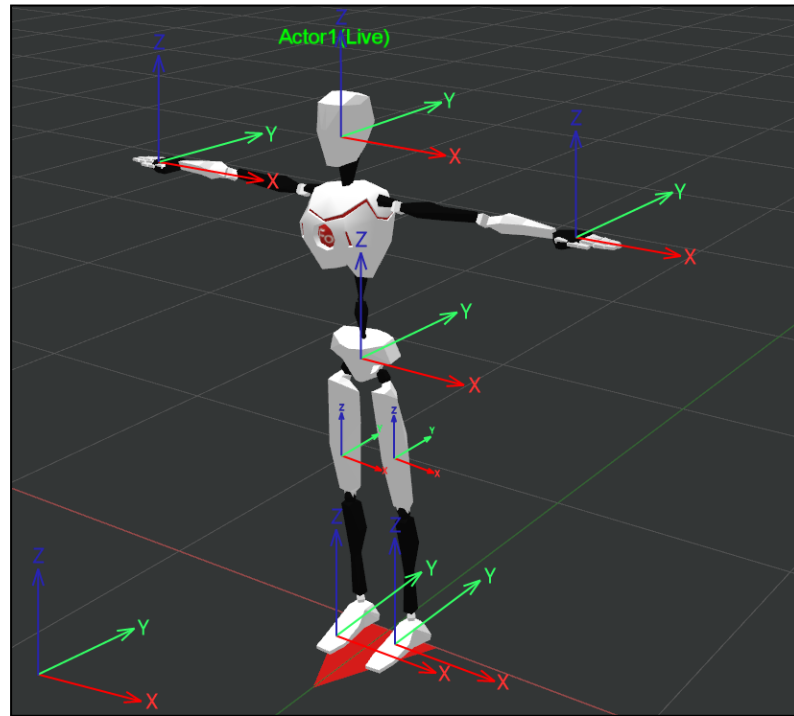
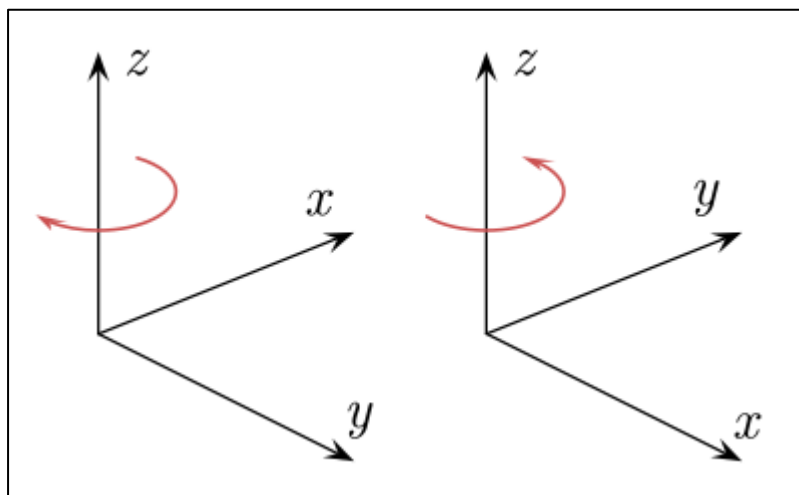
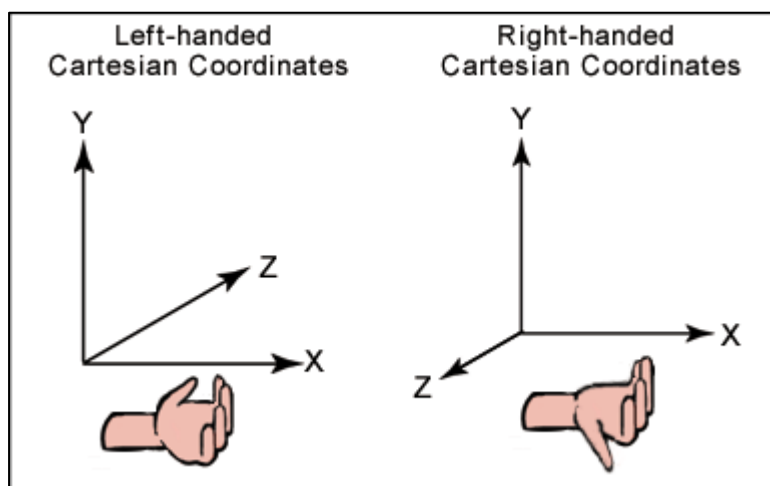


Fig.16.3. Skeletal coordinate system

As shown in the figure above, the world coordinate system is the right-handed coordinate system. When t-pose, the local and global coordinate systems of each segment of skeleton are also right-handed coordinate systems. The Angle of each skeleton in t-pose is defined as (0,0,0). Local or Global rotation values can be output for each bone segment. According to the output value of the coordinate system: rotation Angle of 23 segments of skeleton and rotation Angle of 22 joints.

#### 16.4 Unity3D Coordinate system





3D coordinate system is the basic concept of 3D game development. General 3D software USES cartesian coordinate system to describe the coordinate information of the object. Cartesian coordinate system is divided into left hand coordinate system and right hand coordinate system: The left-hand coordinate system is the Y-axis pointing upwards, the X-axis pointing to the right, and the z-axis pointing forward. The right-hand coordinate system is the Y-axis pointing up, the X-axis pointing to the right, and the z-axis pointing back. The left hand coordinate system is used in Unity3D, where X axis represents horizontal direction, Y axis represents vertical direction, and Z axis represents depth. In MotionVenus, a right-handed coordinate system is used, where the X-axis represents the horizontal direction, the z-axis represents the vertical direction, and the Y-axis represents the depth.

## 17 Common problems

**Q: why can't the animation recording function be used?**

**A: if the installation directory of MotionVenus is on system disk C, it should be run in administrator mode. Otherwise, the operation of data recording cannot be performed. Software installed on a non-system disk does not have this problem.**

**Q: why can only one device display motion animations when multiple devices are used simultaneously?**

**A: when multiple sets of equipment are used at the same time, each set of equipment should be calibrated separately. Click to select the device root sensor in the list on the left, and click the calibration button on the right to carry out n-pose, t-pose and other calibration processes.**

**Q: can the calibration of a single sensor be performed in the game engine?**

**A: no. At this stage in the game engine support only human level initial action calibration.**

**Q: if the game engine is used to control character alignment, can MotionVenus not be run?**

**A: no. MotionVenus needs to run.**

**Q: why does MotionVenus fail to respond after clicking calibration in Unity?**

**A: please check if the name of the character in Unity is correct. Verify that UDP\_Target\_IP and UDP\_Target\_Port are filled correctly in the Unity terminal.**

## 18 Equipment use problem

**Q: magnetic interference and how to avoid it?**

If there is a problem with the Angle display of the sensor, or the magnetic interference is still displayed not close to the interference source, please calibrate the sensor according to this manual.

**A: keep away from magnetic interference when the sensor is calibrated and used, for example:**

- (1) mobile phones, watches and other electronic devices and key COINS;
- (2) iron, cobalt and nickel, as well as their alloys and other magnets;
- (3) high power substation, wireless base station, air conditioner cabinet, or high power motor are within a few meters around when working; For the above mentioned (1) (2) type interference, the distance shall be more than 20cm, and for (3) type interference, the distance shall be at least 1m.

**Q: how many sets of devices can FOHEART X/C1 support at the same time?**

**A: it can support four devices in one software.**

**Q: foot shaking during use?**

**A: keep away from serious magnetic interference; Adjust the "body tilt Angle value" at the bottom of the calibration column (gradually increase from the default value of 6°), gradually increase or decrease to find the right Angle for you.(because the leg Angle of different human body is not the same, so it is best to adjust manually)**

**Q: when the software is used, all the sensors suddenly drop the line?**

**A: replace the PC with another USB port. Replace the USB cable. In addition, USB hub may be used, and the device is dropped due to insufficient power supply of USB hub. Please make sure that the USB hub you use can provide at least 350mA power supply current, or use a USB hub with independent power supply.**

**Q: how will magnetic interference affect motion capture?**

**A: magnetic interference shielding algorithm is built into the sensor of FOHEART motion capture system, which can shield sudden magnetic interference, such as suddenly holding A mobile phone.The shielding process lasts for 30 seconds at most. If the magnetic interference cannot be separated within 30 seconds, the final effect will be significantly worse.**

**Q: how fast do sensors upload data?**

**A: 24~96fps, 96fps by default.**

**Q: what is the data rate of MotionVenus forwarding data to Unity3D or Unreal Engine?**

**A: 60 FPS.**

**Q: what data does the MotionVenus data stream contain?**

**A: euler Angle of the 23 bones; Quaternion of 23 bones; Local coordinates of 23 bones; The Gobar coordinates of the 23 segments of the skeleton;**

**Original accelerometer value of 17 sensors; Original gyroscope value of 17 sensors; Original magnetometer value of 17 sensors;(original value factory setting does not output)**

**Q: what format is optional for forwarding data stream in MotionVenus?**

**A: binary stream (the smallest packet in this way);Readable string; Json format;**

## 19 Matters needing attention

- do not use or store motion capture sensors near a heat source (such as a fire or heater);
- please use the original charging plug bank for charging;-- do not put the sensor in water or wet it;
- do not heat the sensor;
- do not hit, throw or subject motion-capture sensors to mechanical vibration;
- do not hammer or pedal sensors;-- disassembling the sensor in any way is prohibited;
- do not charge the sensor under fire or extreme heat; Please use the original adaptor to power the charging plug. Poor quality adaptor may cause damage to the sensor battery.

## PART III SDK and Plug-in

### 1 MotionVenus SDK

#### 1.1 Brief introduction

- (1) the download address: <https://github.com/FOHEART/MotionVenusSDK>
- (2) source code is provided for all parts of SDK and Demo program.
- (3) part of the SDK is developed in C language, and the Demo program is developed in C++.
- (4) package the project with Visual Studio 2013.

#### 1.2 Method of use

- (1) extract or clone to any location on the local hard disk.
- (2) set the MotionVenusSDK\_Test project as the startup program.
- (3) compile and run.

#### 1.3 Functional description

- (1) receive real-time data streams from one or more MotionVenus clients via UDP.
- (2) real-time spatial position and rotation of 23 human bones.
- (3) the SDK has been packaged as a DLL library, supporting multithreading.
- (4) equipped with DEMO program.

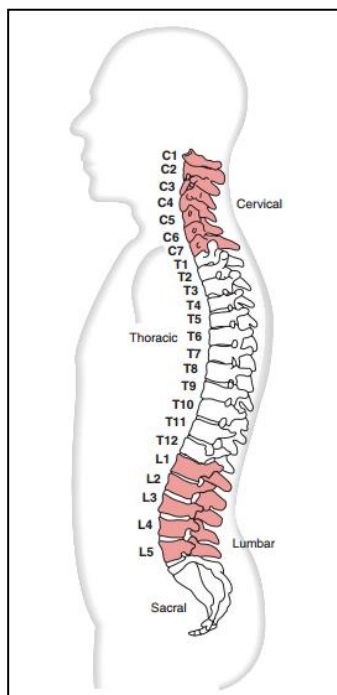
#### 1.4 Data type in units

Name	unit
location	meter
Euler Angle	angle (Angle system)

#### 1.5 Skeletal correspondence

No.	Name	Note	No.	Name	Note
-----	------	------	-----	------	------

0	Spine Or Hips	The root sensor of the humanoid model controls the displacement of the whole human body and the rotation of the root sensor	12	LeftUpperArm	
1	Spine1	L3~L5 segment of human skeleton	13	LeftForearm	
2	Spine2	T12~L2 segment of human skeleton	14	LeftHand	
3	Spine3	T8~T11 segment of human skeleton	15	RightUpperLeg	
4	Spine4	T1-t7 segment of human skeleton	16	LeftUpperLeg	
5	Neck		17	RightFoot	
6	Head		18	RightToeBase	
7	RightShoulder		19	LeftLowerLeg	
8	RightUpperArm		20	RightLowerLeg	
9	RightForearm		21	LeftFoot	
10	RightHand		22	LeftToeBase	
11	LeftShoulder				



## 1.6 Usage scenarios

This SDK provides a 23-segment skeleton model based on human dynamics, and also gives the rotation and spatial position of each segment of skeleton, which can be used for example: Medical applications, such as elbow and shoulder motion analysis, spine curvature analysis, lower limb dynamics analysis and so on. Sports analysis, such as hand, forearm and forearm linkage analysis in throwing movement; Analysis of impact force of feet, thighs and calves during landing [note 1], etc. Props mapping, such as the hand sensor can be fixed to the gun props, the props have space 360° rotation and displacement information; Or the sensor can be placed on any object that needs to measure rotation information, and the real-time rotation information of the object can be obtained. Third party software integration, the SDK can be used to integrate with any third party software to quickly obtain standard human dynamics data.

## 2 Unity real-time plug-in

### 2.1 Download plug-in package

- (1) <http://www.foheart.com/resource.html> Download Unity3D plug-in.
- (2) <https://github.com/foheart> Git clone library to any location on the hard disk.

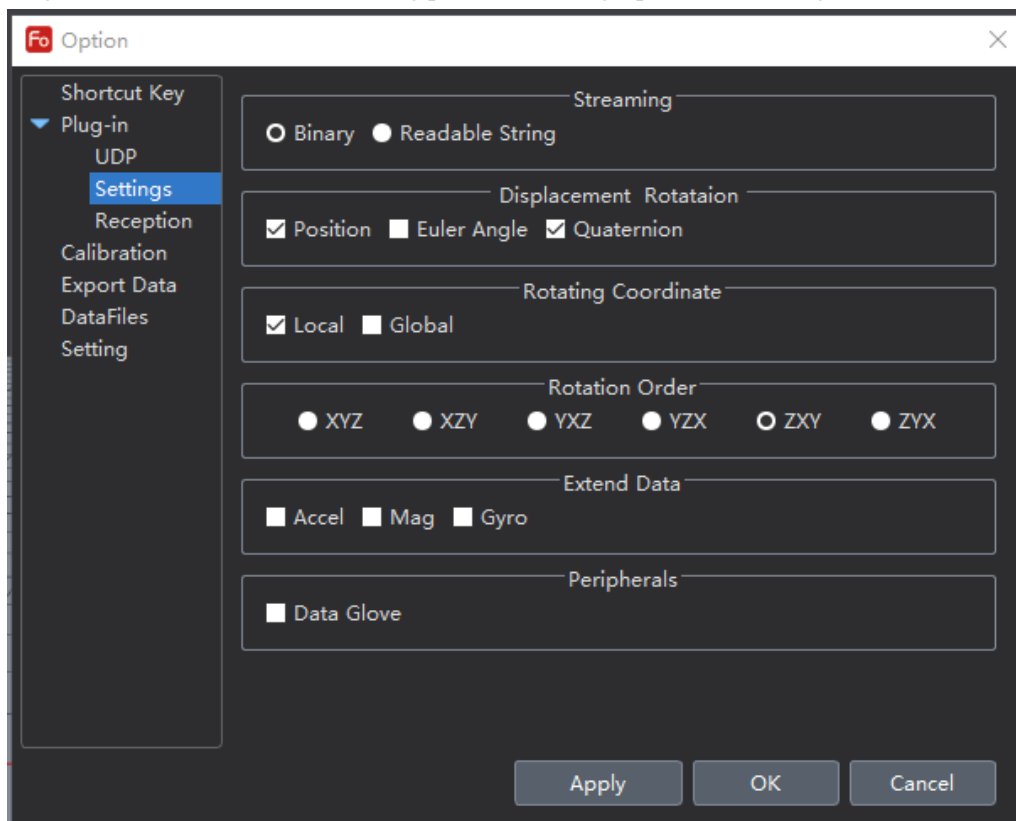
### 2.2 Modeling recommendations

When modeling and exporting FBX, adjust the model to t-pose. In MotionVenus, rotation starting with model t-pose outputs the Local rotation value of each skeleton relative to the parent skeleton or the Global rotation value relative to world coordinates. Therefore, when modeling and binding the skin, it is recommended to use t-pose for modeling, to ensure that the model shoulder does not rise or pull when t-pose. Why t-pose? T-pose can eliminate the uncertainty of the Angle between shoulder bone and upper arm in a-pose caused by the working habits of different companies. In a-pose, it is difficult

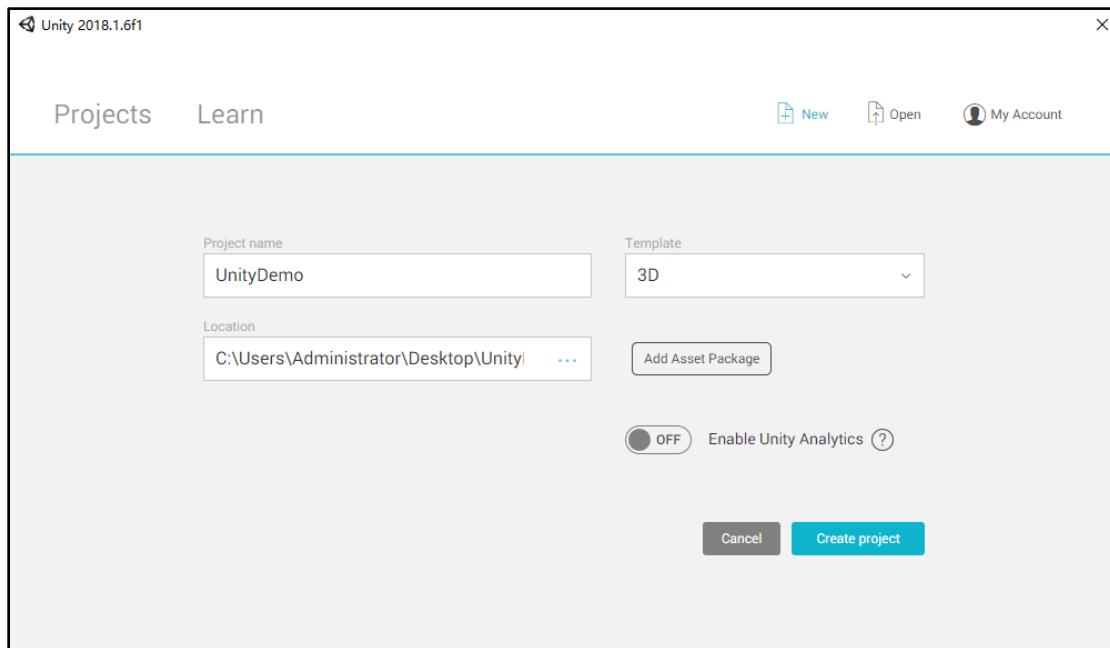
to determine the Angle between the shoulder and the big arm, which is very important for the upper arm movement. FK is used in the calculation of the upper arm movement chain, and the movement closer to the root sensor in FK will cause A lot of errors in the position of the final sensor.If this error is too large, the IK operation of the whole upper limb will not work, so it is very important to determine the initial Angle between the shoulder and the upper arm.In reality, it is difficult to perform A standard a-pose calibration action.The initial orientation of each segment of t-pose skeleton is clearly defined, which provides accurate initial reference for dynamic capture calibration and calculation.

## 2.3 Plug-in usage process

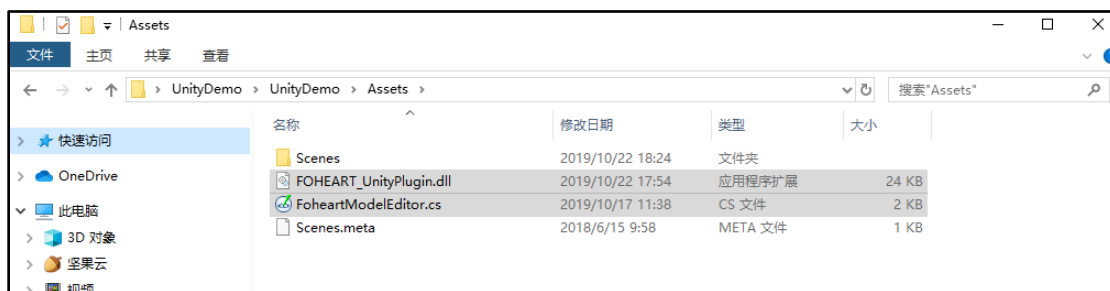
(1) configure the MotionVenus forwarding protocol [setting-option-forwarding rules] as shown below:



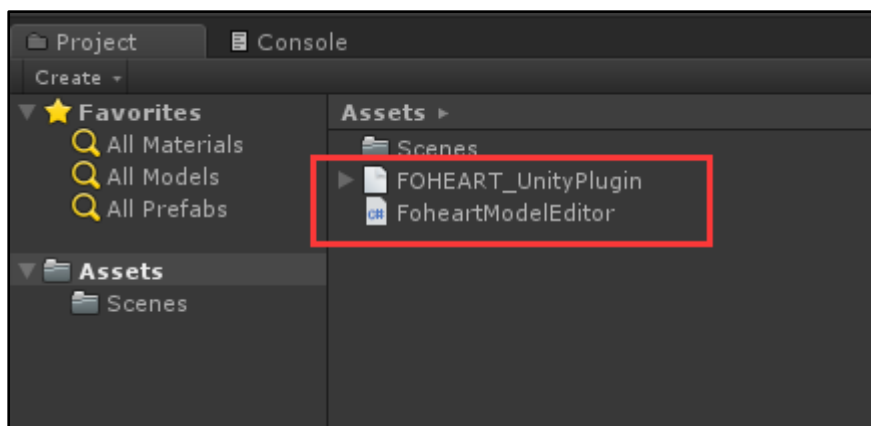
(2) Open unity and create a new project:



(3) Locate the Assets folder in the project creation directory and copy the FOHEART unity plug-in into this folder:



Plug-in and script appear under Unity3D Project:

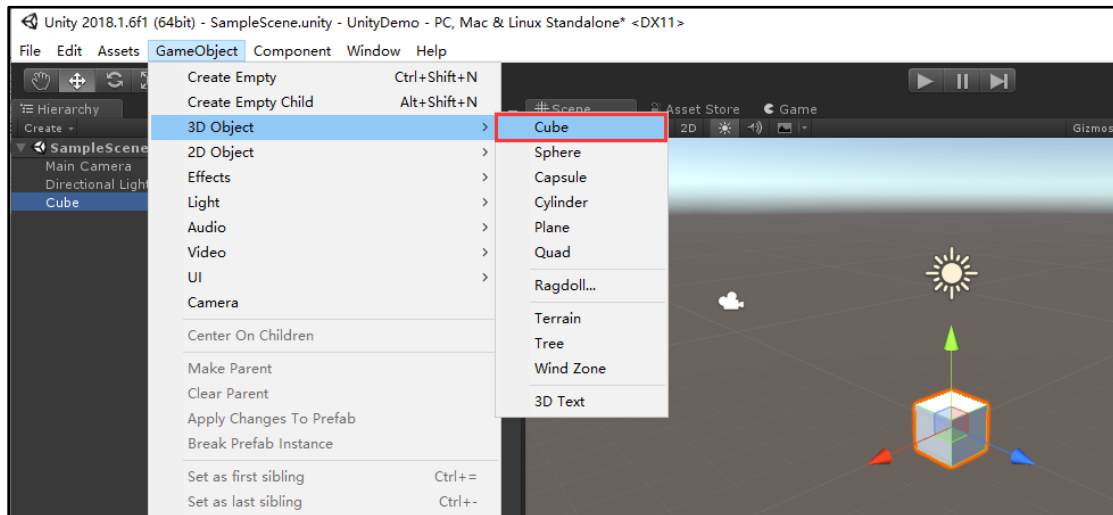


Create a new Model folder under Assets folder and put the Model to be bound (.fbx format) :

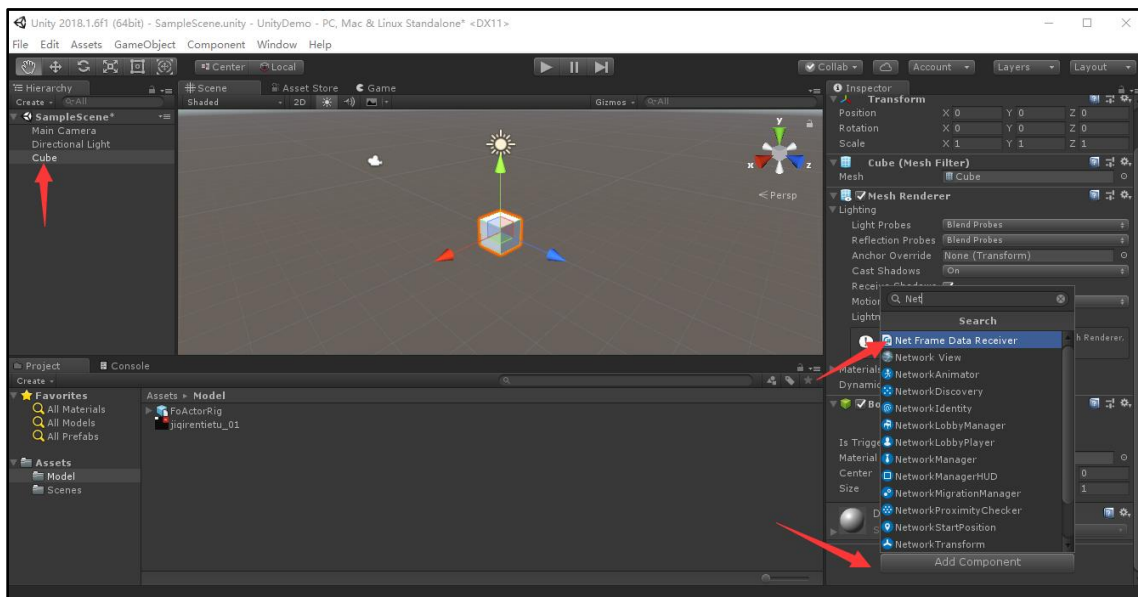


Return Unity3D interface. Create any object in the scene. Here, create a Cube:

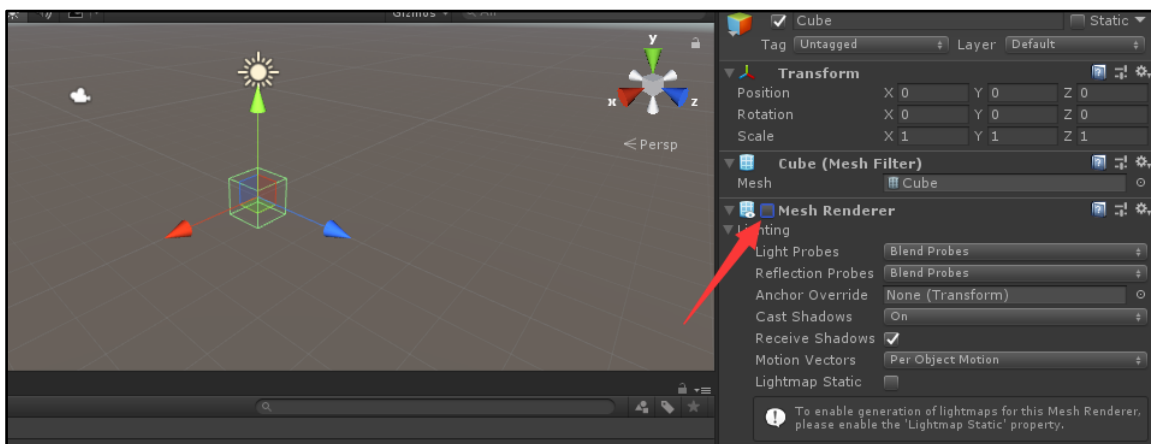




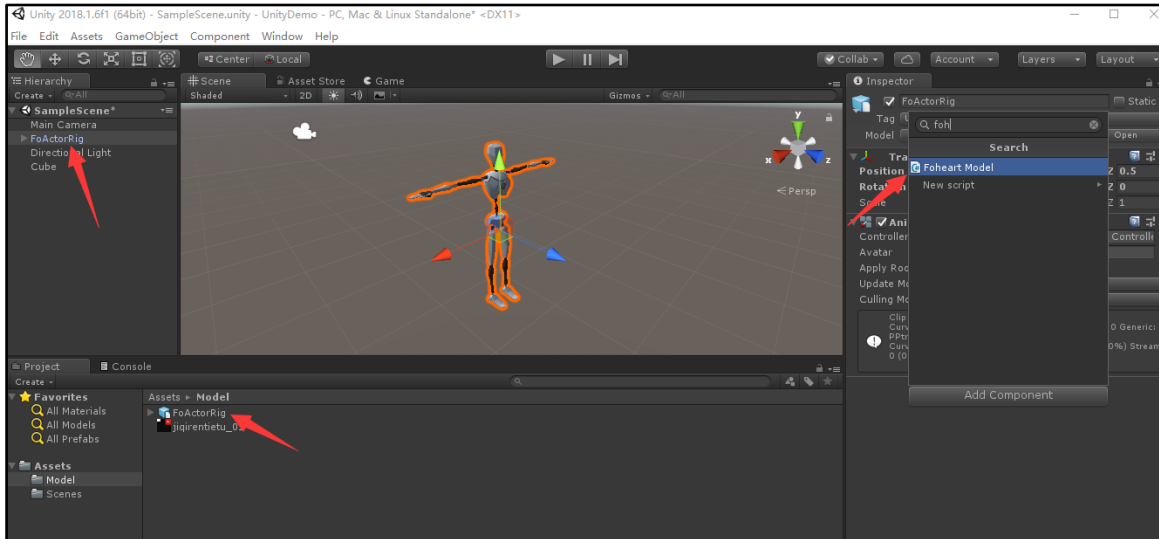
Click Add Component on the right Inspector to Add the netframe receiver script:



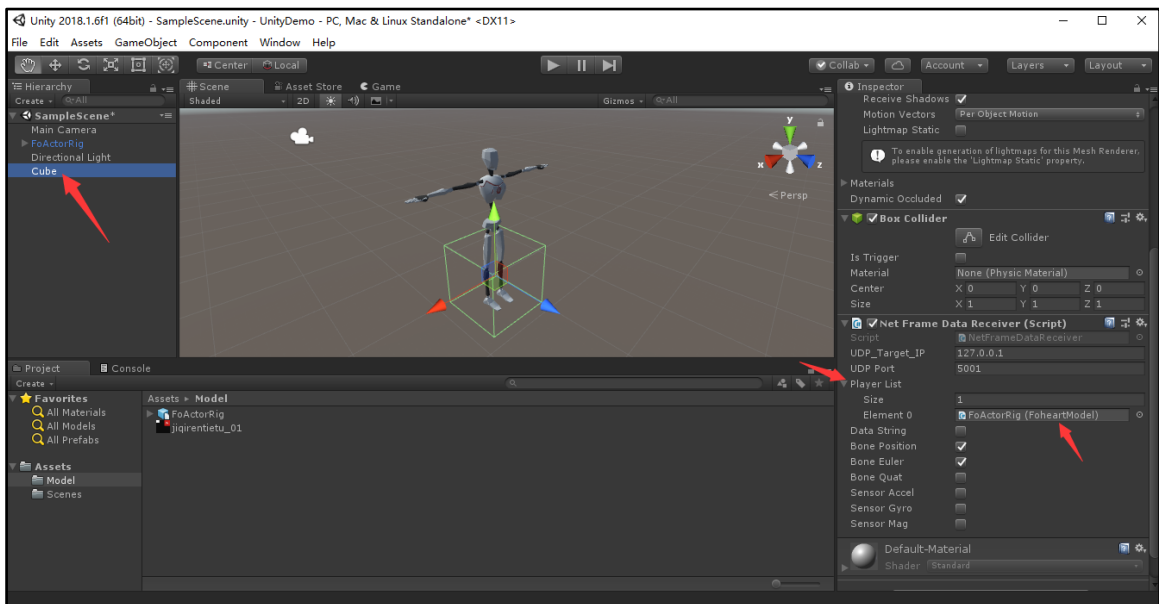
Remove the Mesh Renderer option of Cube to hide Cube:



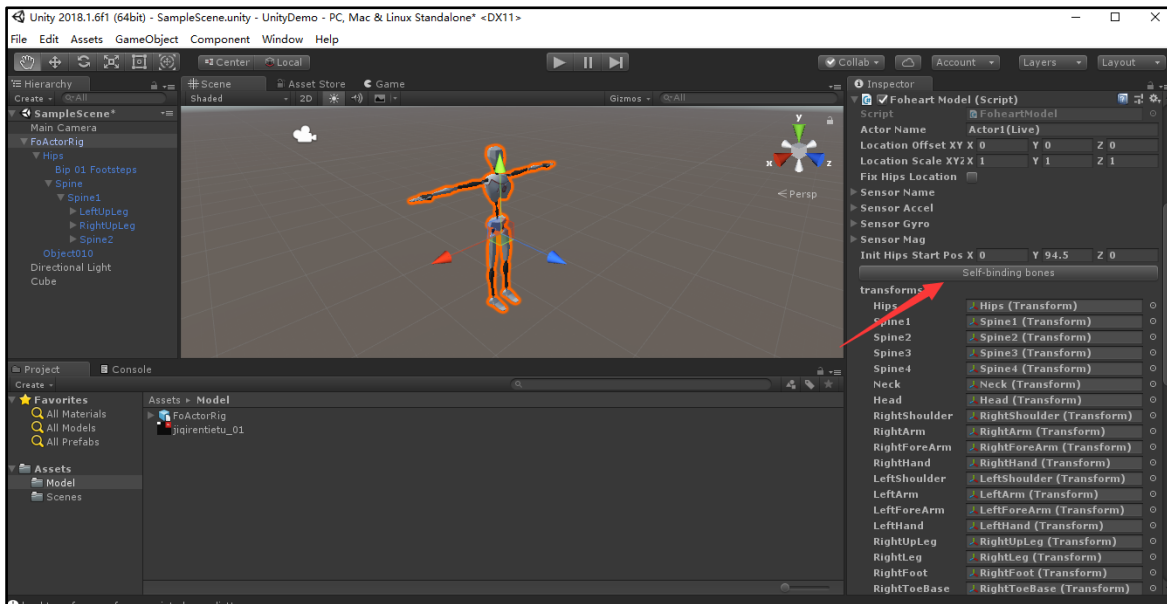
(4) drag the model into the scene and click Add Component on the right Inspector to Add the foheartmodel.cs script:



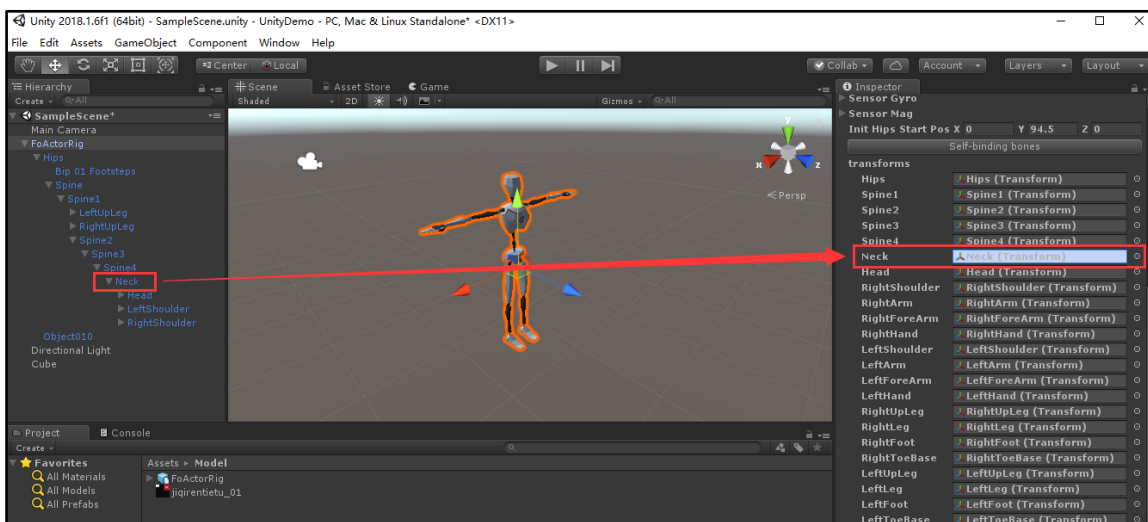
Expand the PlayerList in the script of Cube, fill in Size 1, and then drag the model in Element 0:



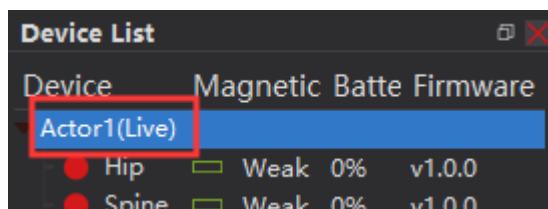
(5) click the self-binding bones button in the model script, and the script will automatically fill in bones with similar names:

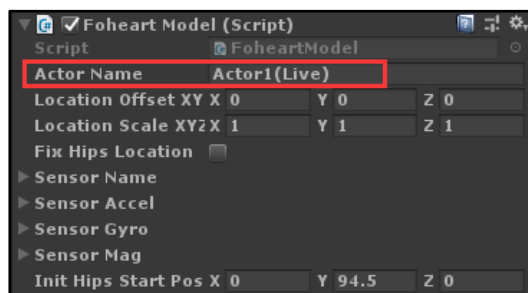


Otherwise, it is necessary to drag the unrecognized bone on the left side to the corresponding part on the right side. Assuming that the Neck is not recognized, the left Neck should be dragged into the column of the right Neck:

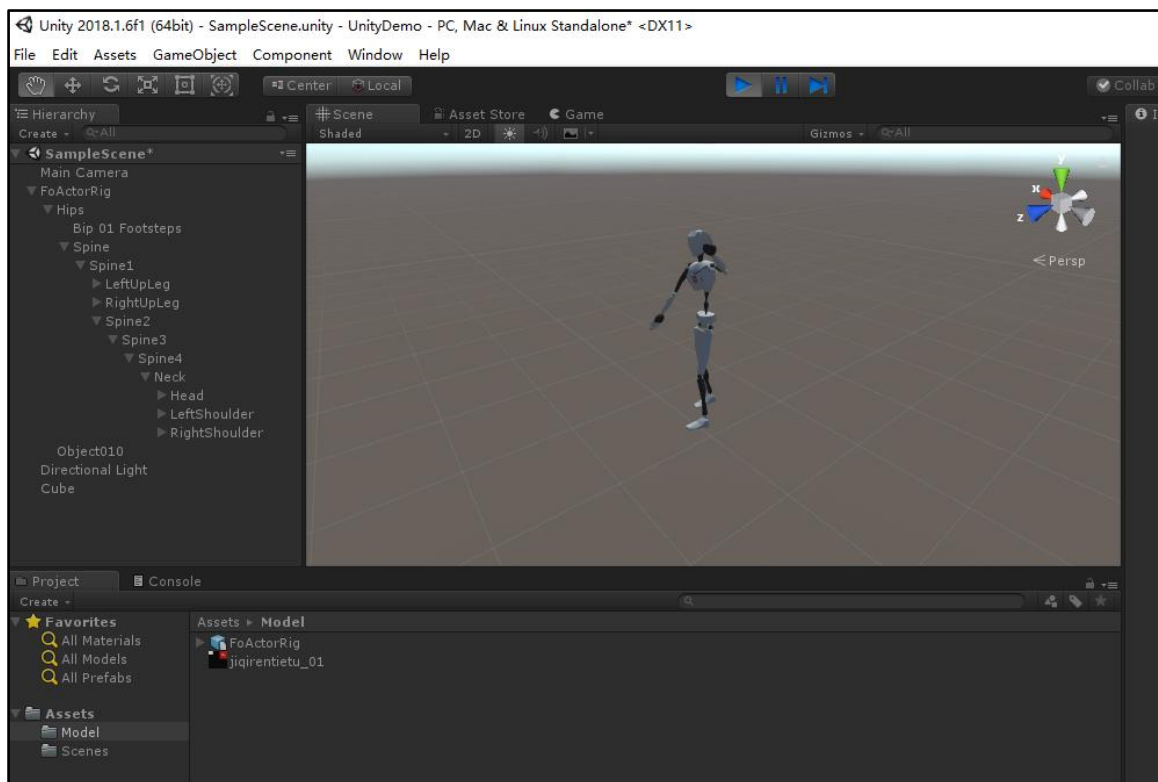


Other unidentified bones performed the same procedure. The suit name in the list on the left of MotionVenus in the ActorName:





Save and run the project:



## 2.4 Demo

Download the plug-in package has Demo project, use Unity5.6.0 above version to open and run.

## 2.5 how to solve the problems of model sliding/floating or feet under the ground after binding?

### (1) Problem analysis

In MotionVenus, according to the strict procedure, the length of each human skeleton needs to be measured in detail and accurately, and the parameters of [skeleton] are filled in before motion capture. However, for convenience, we only use the built-in template in most cases, but even if we choose a size template that doesn't exactly match our own, MotionVenus can calculate the position information without drift or slide by algorithm. However, as the size and proportion of the binding model in Unity3D are inconsistent with the model of output displacement data in MotionVenus, the waist displacement will be consistent. However, if the foot is suspended or extended below the ground, it is normal. We need to take measures to repair it. For example, in unity3D, a dwarf model with a height of only half a meter is bound. When running, the feet of the dwarf model will be lifted because

the normal waist position is 0.95m.

### (2) Determine bone length

Real-time mode: in real-time mode, set or view the currently used bone length through the character bar -> bone length setting. Please refer to the body bone length setting for setting method.

Playback mode: use the right-right-> property to open the property window on the file that has been recorded, as shown below:

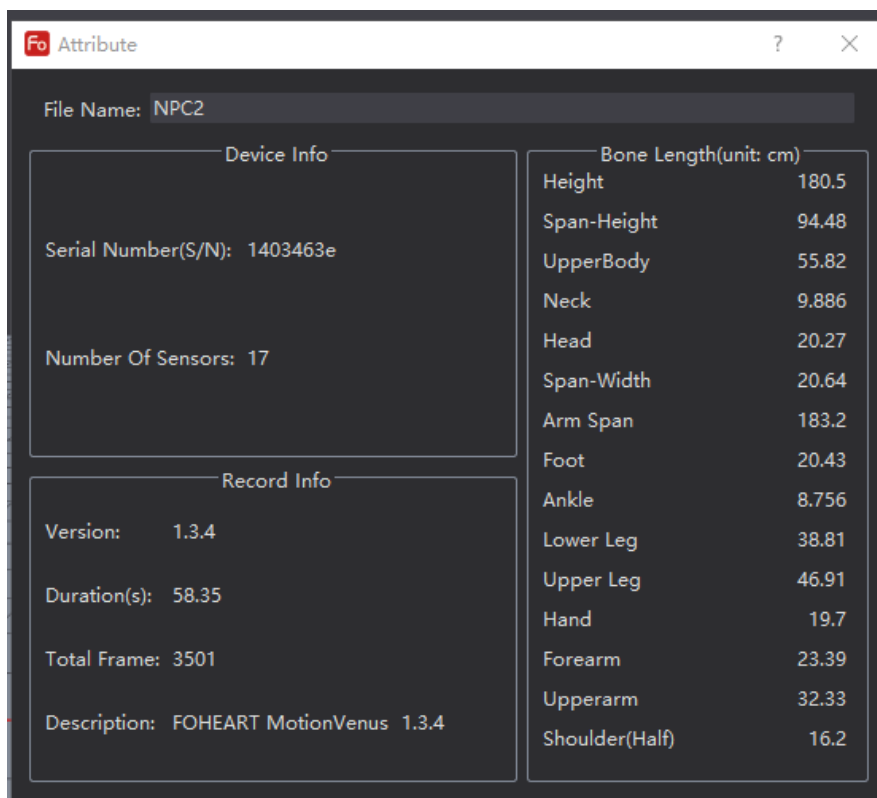


Figure 2.11.2 file properties

Figure 2.11.2 bone information is the bone length information used in recording the file.

### (3) Determine the root bone position

The first step is to determine in MotionVenus Hips, which is the initial height of the root bone, i.e. hip height, and set it H1. If the crotch height of the model bound in Unity3D is less than H1 (the distance from the crotch to the heel, excluding the thickness of the sole), the foot will be lifted during the movement of the model; if the crotch is larger than H1, the foot will step below the ground. (3) set the crotch height deviation. Suppose you want the model at some height above the ground, or at some height below the ground, or in any region. The whole model needs to be shifted by a displacement, which is set in Location Offset XYZ. Select the bound model and set Location Offset XYZ on the right side: determine the Offset of the model and fill in XYZ.



#### (4) Set the XYZ axis multiplier value

The binding model, on the right to set the Location Scale XYZ: hip is high after the completion of the set, only determine the overall space position of the model, but if less than the H1 H2 (short legs), and the model of movement, there will be a walk too fast, if H2 is greater than the H1 model movement will appear too slowly, then need to zoom ratio of H2 / H1 XYZ axis movement.

#### (5) Only applicable to bone models of similar proportions

The above mentioned method is only applicable to the case that the ratio of leg/leg/foot length in U3D model is the same or nearly the same as that in MotionVenus. Most of the classification of human model or normal human model thigh: calf: foot length basically conforms to 1:0.70:0.5, if the model conforms to this ratio, then the binding effect can achieve the ideal effect. For example, in MotionVenus, the 175cm template for male is 44.34cm long for the thigh, 36.74cm long for the calf and 24.99cm long for the foot, with a ratio of 1:0.83:0.56. Then, the lower body of the model in Unity3D should be in line with or close to this ratio. After the steps in section 5, the foot can be close to the ground without sliding step, sunken ground and flying air.

#### (6) How to deal with abnormal proportion bone model

If used in Unity3D model changes, has completed the inconvenience or proportions of the bones need to an exaggerated Settings, then you must before the hunt began to set in advance in the MotionVenus exaggerated or percentage, the length of the specific methods can be implemented as follows: in the "body bone length" setting form, detailed Settings thighs, legs, feet long, with Unity3D need binding model in the keep the same length, or proportion, then wear hunt to perform real-time capture, or capture data after the completion of the playback.

## 2.6 points for attention

When using plug-ins, you should pay attention to the following:

- (1) the model should be adjusted to the standard T posture, and the character should face the positive direction of the Z axis of Unity3D.
- (2) MotionVenus cannot be minimized in the process of using Unity3D.

## 3 UE4 real-time plug-in

### 3.1 Introduction

(1) The download address: <http://www.foheart.com/resource.html> or <https://github.com/foheart>

### 3.2 Application method

(1) Download and open the project

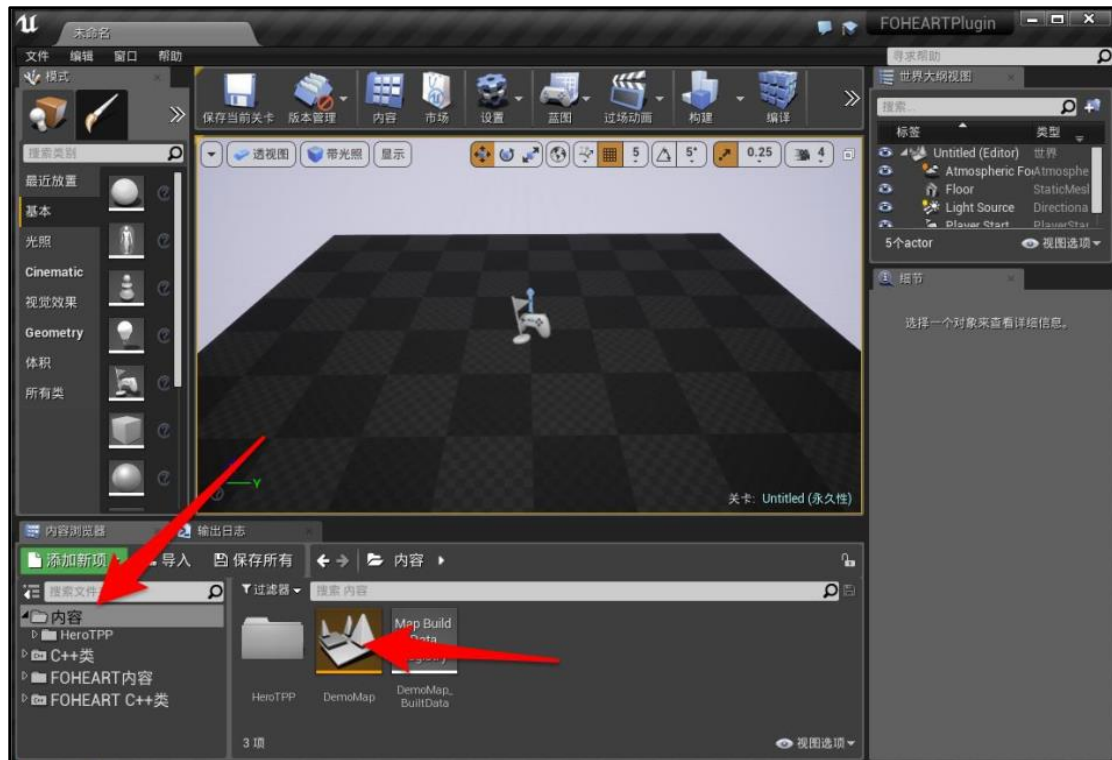


Figure 3.2.1

(2) select DemoMap in the content folder, double-click and open it.

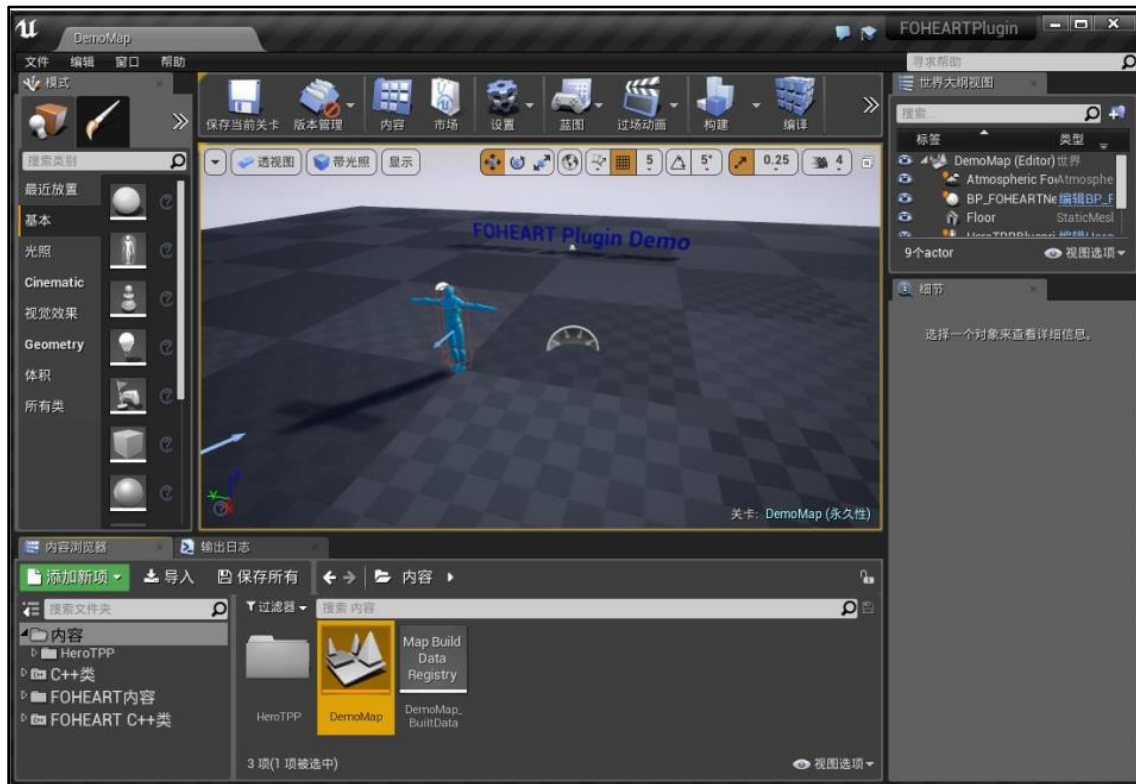


Figure 3.2.2

### (3) Configuration

Click BP\_FOHEART Network Manager in the view to see the Host Name, Port, and so on Whether the setting is consistent with that in MotionVenus.





Figure 3.2.3

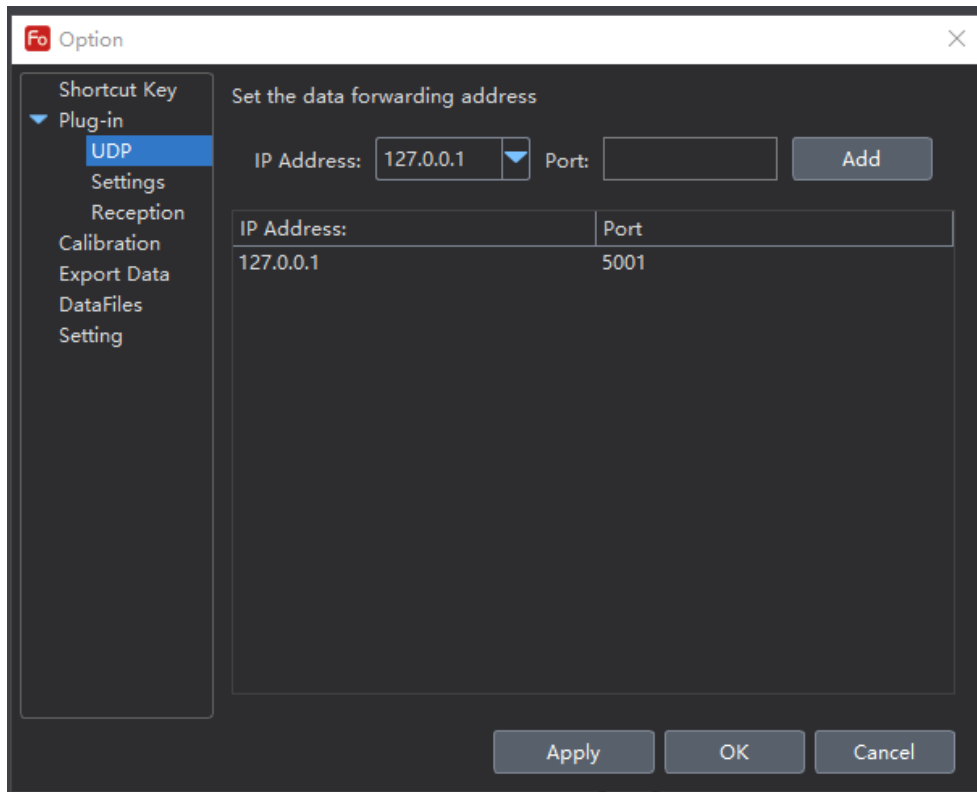


Figure 3.2.4

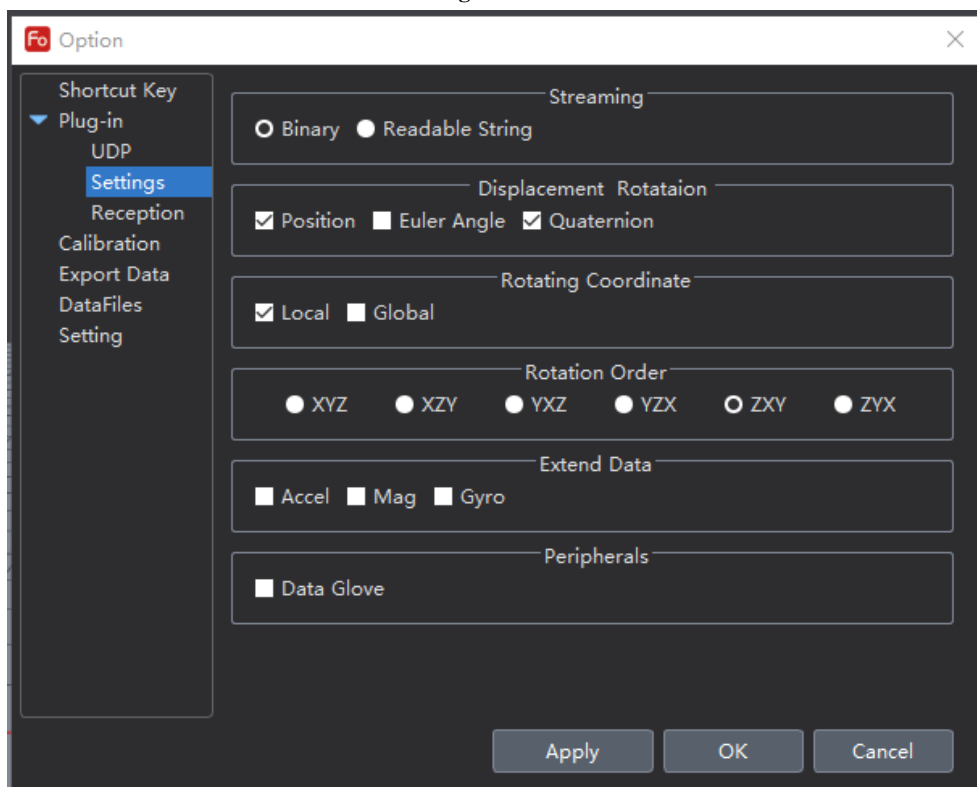


Figure 3.2.5

Click HeroTPPBlueprint2 in the view to see if its ActorName is consistent with that in MotionVenus.

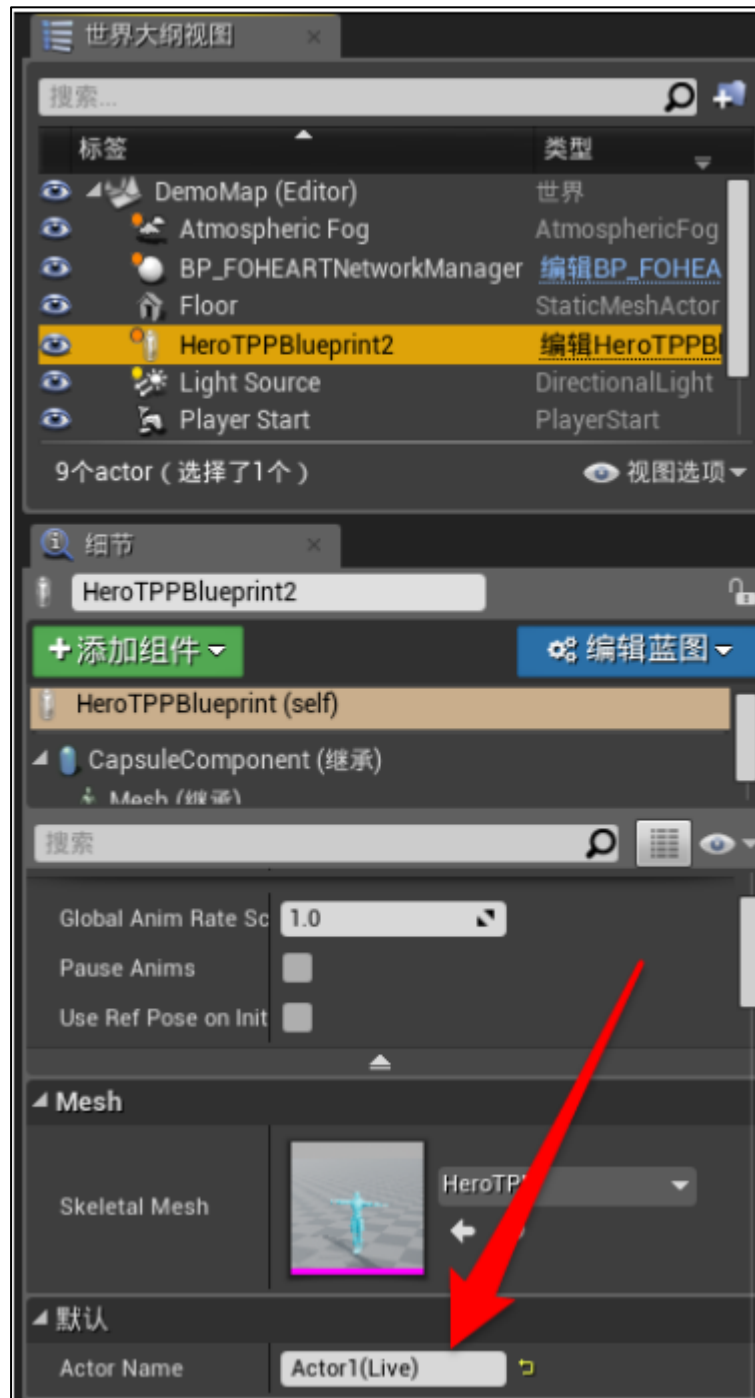


Figure 3.2.6

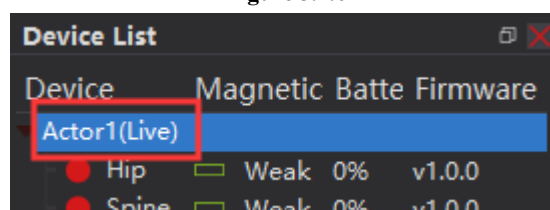


Figure 3.2.7

**(4) Finish**

Click start to see the movement of the character in the scene in line with that of the character in MotionVenus.

## 4 MotionBuilder real-time plugin

### 4.1 Introduction

- (1) the download address: <http://www.foheart.com/resource.html> or <https://github.com/foheart>
- (2) the plug-in provides installation package and supports MotionBuilder versions 2014, 2016 and 2018.
- (3) plug-in supports data glove data docking.
- (4) support simultaneous action binding of 4 models.

### 4.2 Usage method

- (1) install MotionBuilder software (2014/2016/2018).
- (2) download the plug-in and install it into the default directory. The installation program will automatically obtain the corresponding plug-in of MotionBuilder version.
- (3) open MotionBuilder, click the foheart directory in the AssetBrowser TAB in the Resources window, and drag Foheart4Chars into the scene, as shown below:

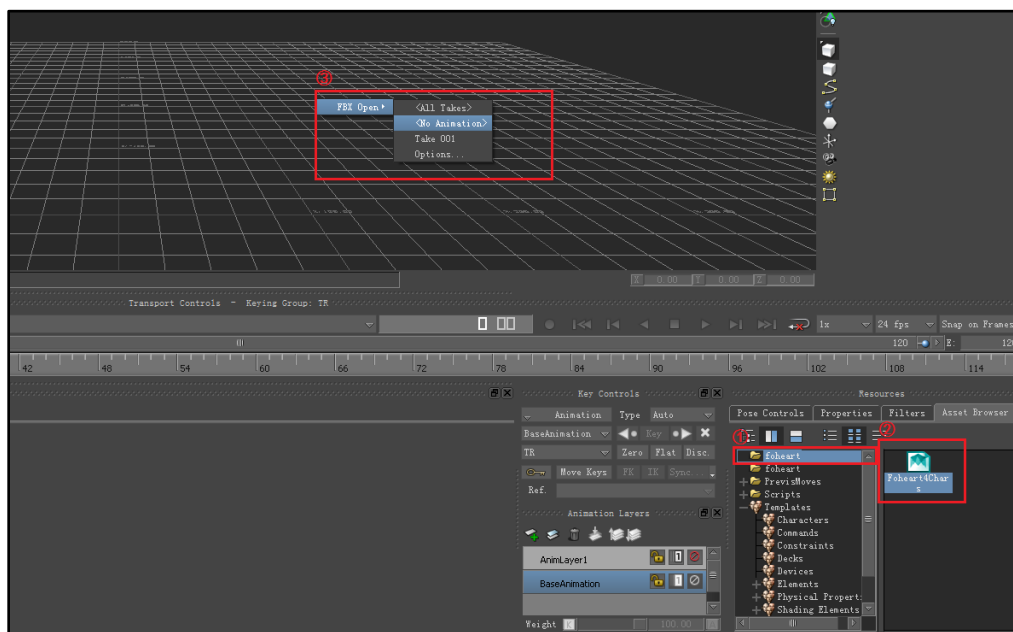
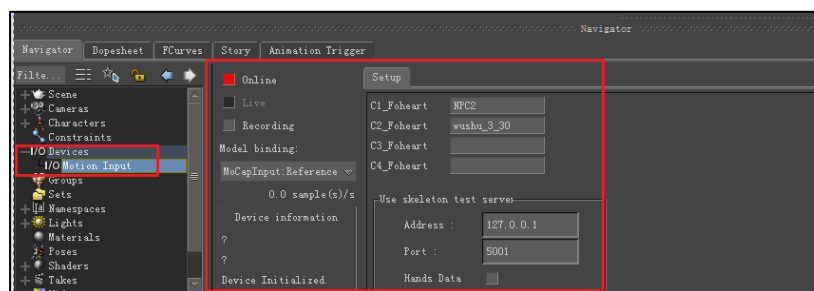


Figure 4.2.1

- (4) after opening, Motion Input item will be automatically created under I/O Devices in the Navigator TAB in the Navigator window and double-click to open it, as shown below:



- (5) import the model and configure the data source and model binding. Next, using the build model in

MotionBuilder, click on the Tutorials directory in the Asset Browser TAB in the Resources window to select the build model, as shown below:

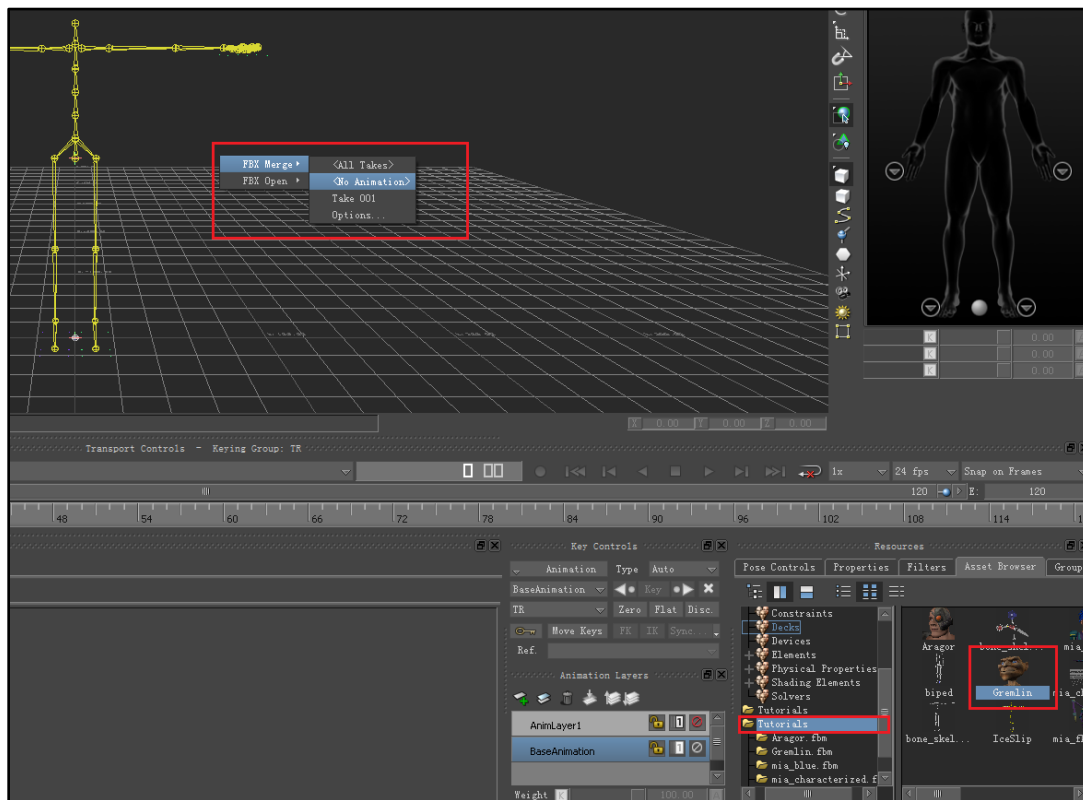


Figure 4.2.3

Add the model to the scene and configure the data source and driven model, as shown below:

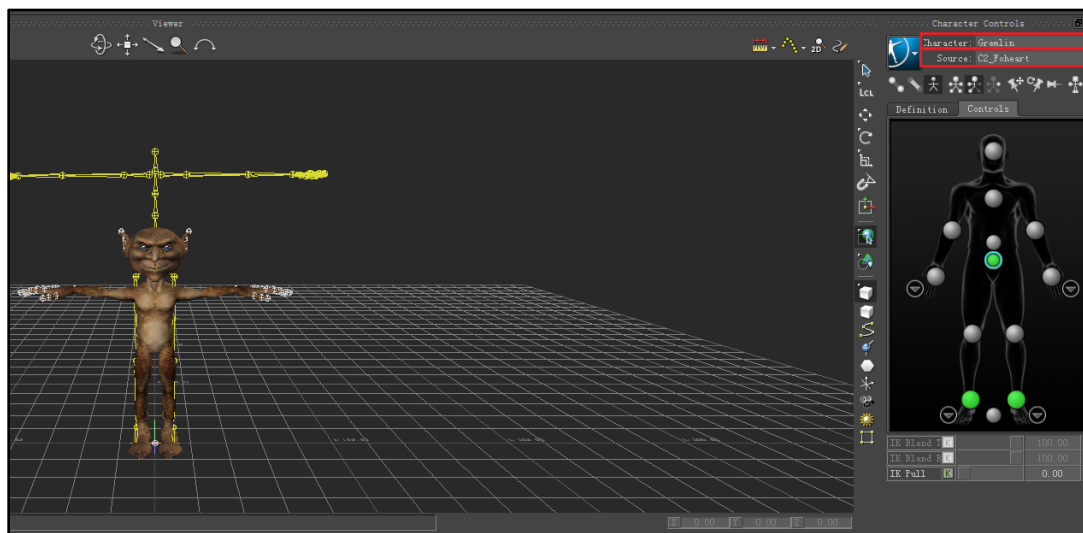
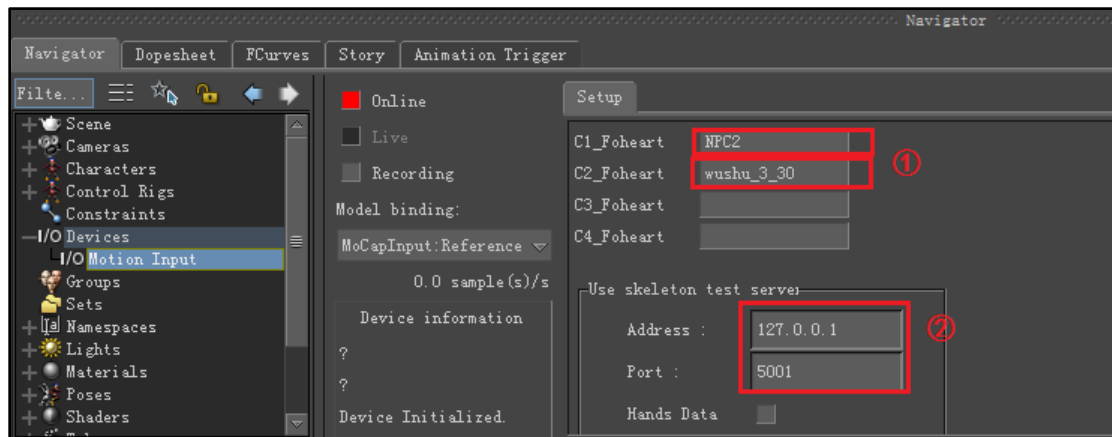
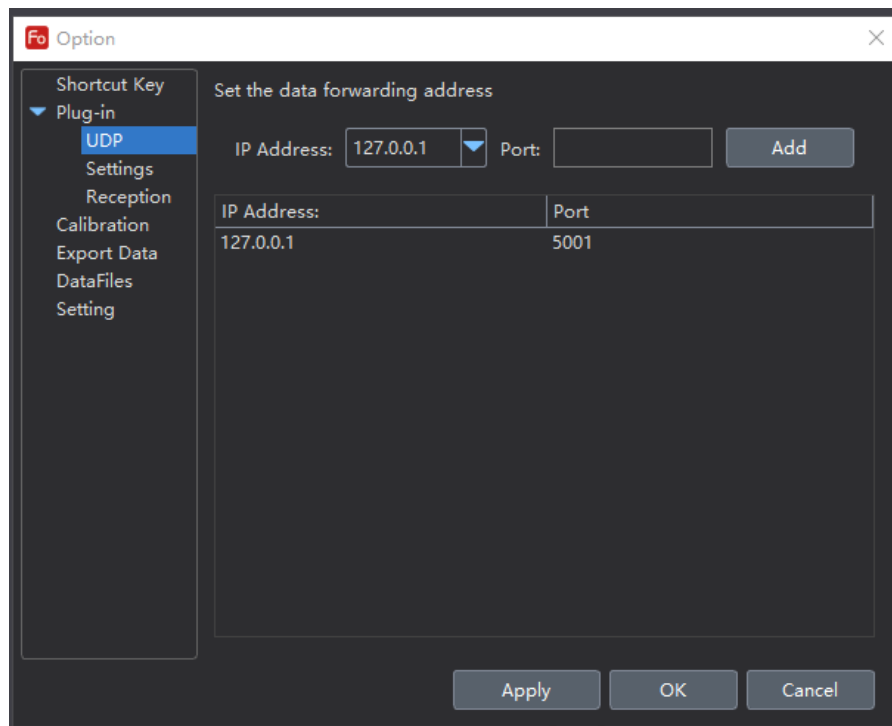


Figure 4.2.4

The above figure is configured with C2\_Foheart as the data source and drives the model Gremlin.  
 (6) binding model name and destination IP and port number, as well as configuration data format. Connect with the data source by binding with the meaning of the model name currently being recorded or played back in real time in MotionVenus, as shown below:

**Figure 4.2.5**

Up to 4 model names can be configured as data sources in the plug-in. Currently, only the playback data model names NPC2 and wushu\_3\_30 are entered. For real-time motion capture, Actor1(Live) is required. Fill in the IP address of the machine running MotionVenus and the set communication port number, as shown below:

**Figure 4.2.6**

Configure the data forwarding rules, as shown below:

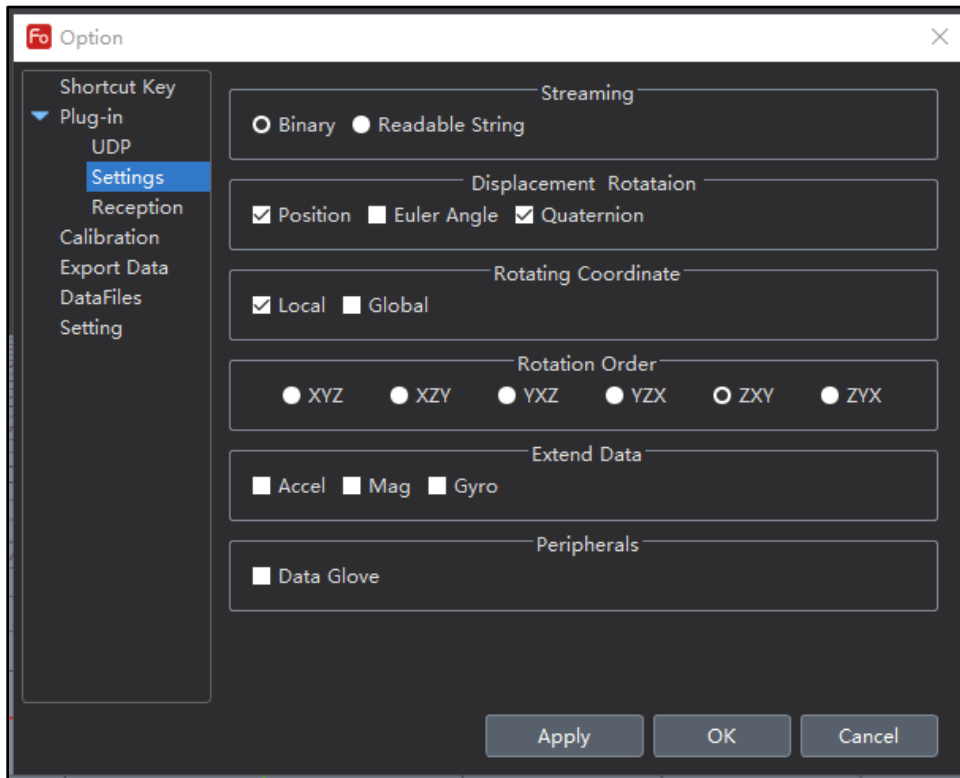


Figure 4.2.7

At this point we play wushu\_3\_30 data file in MotionVenus and keep the MotionVenus software window unminimized. (7) go back to the MotionBuilder and MotionInput plug-in Settings, and check the Online button to complete the configuration, as shown below:

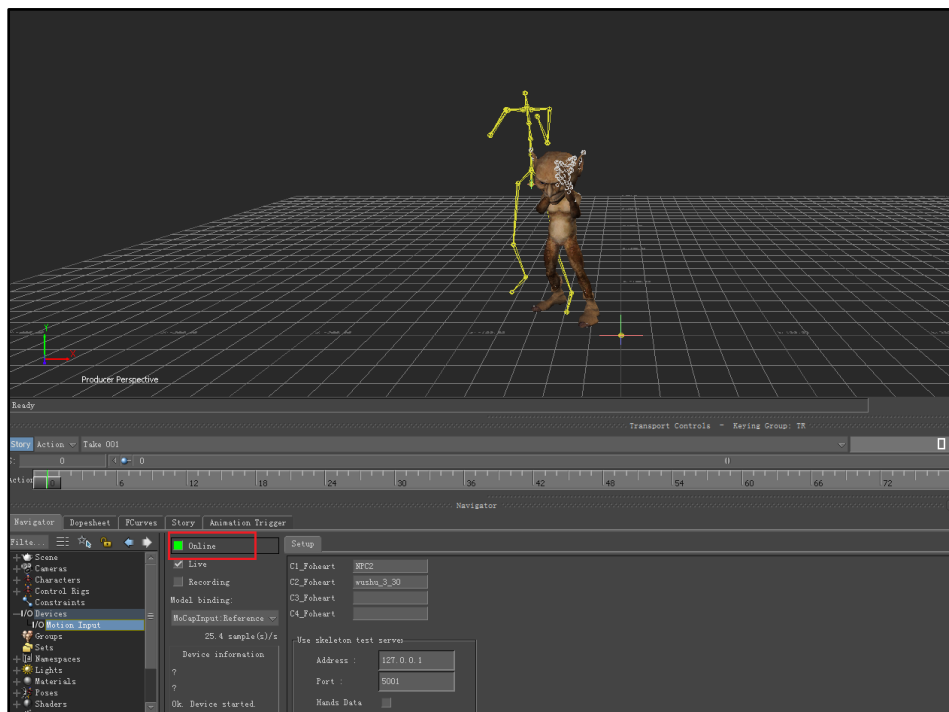


Figure 4.2.8

### 4.3 Function and problem description

- (1) the MotionBuilder plug-in receives real-time data streams from one or more MotionVenus clients through UDP.
- (2) the plug-in supports at most four models for data binding at the same time.
- (3) if the relevant file provided by foheart is not found after installing the plug-in, please go to the installation directory and copy the DLL plug-in file corresponding to MotionBuilder version to the plugins directory of MotionBuilder version (such as: C:\Program Files\Autodesk\MotionBuilder 2014\bin\x64\plugins), then Open the MotionBuilder software again, then Open the foheart4chars.fbx File in the plug-in installation directory through the file-open menu in MotionBuild, and then follow the above steps.



## Contact Us

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