

Motion Capture & Motion Tracking

MoCap, short for **motion capture**, is a technique used to digitally record movement. In art, it's a powerful tool that allows creators to translate physical gestures into digital data that can be used across many digital art forms. Mocap can be recorded or used in realtime in contemporary art, performance, and installation work.

Motion Tracking is used to follow the movement of a specific object, body part, or point — often in real time — but not necessarily capturing full-body motion or saving a performance.

In short:

MoCap is about **capturing a performance**.

Motion tracking is about **responding to movement**.

- [Which Mocap/Tracking do I choose for what?](#)
- [Various types of Motion Tracking, a comparison](#)
- [Various types of MoCap, a comparison](#)
- [Using Motive and GazeboOSC for realtime OSC messages](#)
- [Rokoko](#)
 - [How to Rokoko](#)
- [Vive Tracking](#)
 - [Vive Trackers](#)
 - [Vive Ultimate Trackers](#)
- [Optitrack Motion capture](#)
- [Motion capture & Unity](#)

Which Mocap/Tracking do I choose for what?

Optical	Inertial	AI/Camera-based	Kinect	Vive Trackers	Vive Ultimate
Capture & Tracking	Capture & Tracking	Tracking	Tracking	Tracking	Tracking
Optical; multicam & markers	Inertial, IMUs (gyros + accelerometers)	Markerless, AI + RGB/depth cameras or webcam	RGB + depth sensor	Hybrid with external IR	Hybrid inside-out tracking
Film, dance, precise animation	Performance capture	Web/mobile art, interaction, low-budget, prototyping	Installations, skeleton-based interaction	Room-scale performance, VR puppetry (objects)	Vr Avatar Puppetry, Untethered mocap, portable installations

Various types of Motion Tracking, a comparison

Kinect & depth camera's	Vive Ultimate	AI-based Motion Capture
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Depth-sensing / markerless camera-based mocap

How it works:

- RGB camera, infrared depth sensor
- Tracks body skeletons in 3D space without any wearables.

Strengths:

- All-in-one: depth + skeleton tracking
- Works out-of-the-box with good body tracking
- Widely used in interactive installations and prototyping

Limitations:

- Limited range and lighting conditions
- Skeleton tracking is less robust than pro systems
- Requires a (windows) PC and specific SDKs

In art, Kinect is great for:

- Interactive performances
- Visuals that respond to body movement
- Multi-user installations

[See more info on 3d Depth camera's here](#)

Inside-out inertial tracking with onboard cameras and IMUs (think of it as a hybrid between inertial and AI/vision-based tracking)

How it works:

- Unlike earlier Vive Trackers that rely on external Lighthouse base stations, the Ultimate Trackers use two onboard cameras and IMUs to track their position in space independently.
- They perform inside-out tracking, meaning they see the environment rather than relying on it.
- Designed to work with Vive XR systems, but are also being adopted for standalone tracking in XR, motion capture, and performance.

Strengths:

- No need for external base stations (fully wireless)
- Much more portable and scalable
- Accurate enough for many art/performance uses
- Easier multi-tracker setups

Limitations:

- Still relatively new — fewer integrations than legacy trackers
- Limited support in open-source or non-Vive environments (for now)
- Needs line of sight and light for the onboard cameras to function optimally

In art, Vive Ultimate is great for:

- Untethered performer tracking
- Object tracking in environments where base stations are impractical
- Mobile or temporary installations where quick setup is needed

How it works:

- Uses a single camera (or a small number of cameras) and AI algorithms to detect and track body, face, and hand movement.
- Examples include:
 - MediaPipe (Google): Real-time pose estimation in 2D or 3D
 - OpenPose : Widely used for body landmark detection
 - Move.ai: Advanced multi-camera AI mocap, often used with smartphones
 - DepthAI / OAK-D/ Zedi: Cameras with built-in AI processors that provide depth and pose data

Pros:

- No suits or markers needed — just a (web)camera
- Low cost, often free or open-source
- Quick to set up, highly accessible for artists and educators
- Can be embedded into web or mobile apps
- Good for gesture-based interaction, web-based artworks, or low-budget capture

Cons:

- Generally less accurate than optical or inertial systems
- Often limited to 2D or rough 3D estimation
- Struggles with occlusion, fast movement, or unusual poses
- Limited support for fine detail (like fingers or subtle facial expressions)

Various types of MoCap, a comparison

MoCap, short for **motion capture**, is a technique used to digitally record movement. In art, it's a tool that allows creators to translate physical gestures into digital data that can be used to generate or manipulate digital work.

What is MoCap?

Motion capture often involves placing **sensors or markers** on a person's body (or using camera-based systems) to track movement in 3D space. This data is then sent to software that interprets the motion and applies it to a **digital avatar, 3D model, or visual system**.

Examples of use:

- **Live performance & dance:** people wearing mocap suits can control visuals, sound or avatars in real time, turning their movement into an interactive experience.
- **Digital puppetry:** Use MoCap to animate virtual characters that mirror their movements, creating storytelling pieces or interactive experiences.
- **Film & animation:** MoCap can be used to create detailed, lifelike animation without manual keyframing.
- **Interactive installations:** Viewers' movements can be captured and visualized, making them part of the artwork.
- **Experimental art & research:** MoCap enables artists to explore themes like embodiment, identity, or data aesthetics by abstracting or transforming movement.

Why artists use it

- **Expressiveness:** It captures the nuance of real human motion.
- **Efficiency:** Complex animations can be recorded rather than animated by hand.
- **Interactivity:** MoCap allows for responsive, **real-time** work—art that moves because you move.
- **Hybrid creation:** It bridges physical and digital realms, letting artists craft performances or immersive visuals that live in both.

There are various types of Mocap:

Optical Motion Capture	Inertial Motion Capture
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How it works:

- Uses cameras (usually infrared) to track reflective markers or colored dots placed on the performer.
- Multiple cameras triangulate the position of each marker in 3D space.

Variants:

- Passive optical (uses reflective markers + infrared light, e.g., Vicon or OptiTrack)
- Active optical (uses LED markers that emit their own light)

Pros:

- Very accurate spatial tracking
- Excellent for large-scale and high-precision capture (e.g., dance, film, games)
- Good for multiple actors and full-body motion

Cons:

- Requires a studio setup with multiple calibrated cameras
- Sensitive to occlusion (when a marker is hidden from view)
- Expensive

How it works:

- Uses IMUs (Inertial Measurement Units), which are small sensors containing gyroscopes and accelerometers.
- Sensors are worn in a suit (e.g., Rokoko, Xsens) and measure rotation and acceleration to calculate joint angles and movement.

Variants:

- Can be combined with Optical Mocap for precision.

Pros:

- Portable: Can be used anywhere, indoors or outdoors
- Not affected by lighting or line-of-sight
- Great for live performance, field work, and small studios

Cons:

- Less accurate in tracking absolute position (especially in large spaces)
- Susceptible to drift over time (though software can correct this)
- Locomotion is harder to grasp, like jumping, climbing etc.
- Rokoko: frustrating glitches & subscription needed for realtime.

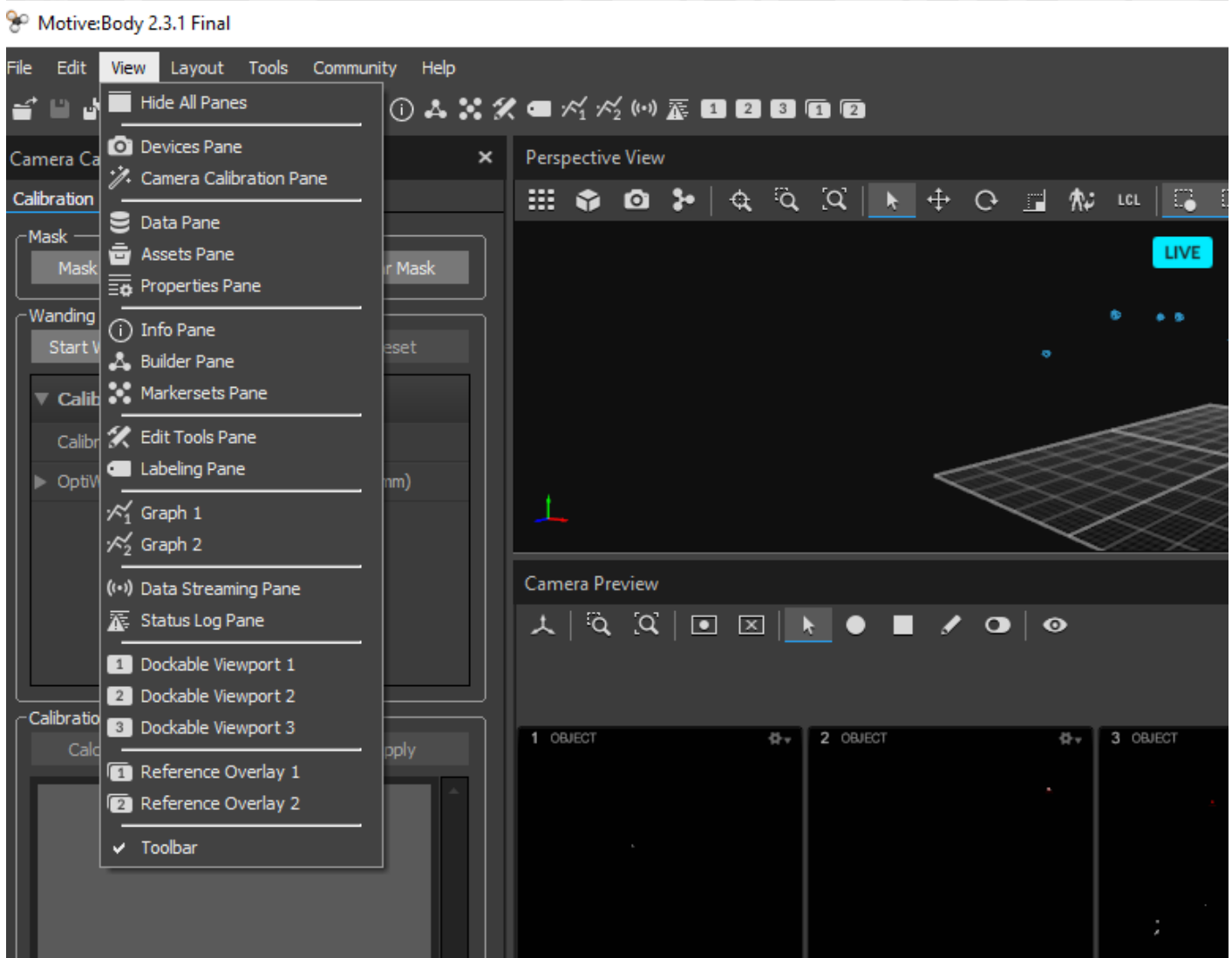
Some systems **combine optical + inertial** tracking (e.g., combining Xsens suit with camera tracking or facial capture or Rokoko, iPhone & Coil), giving the best of both worlds—especially for virtual production and advanced installations.

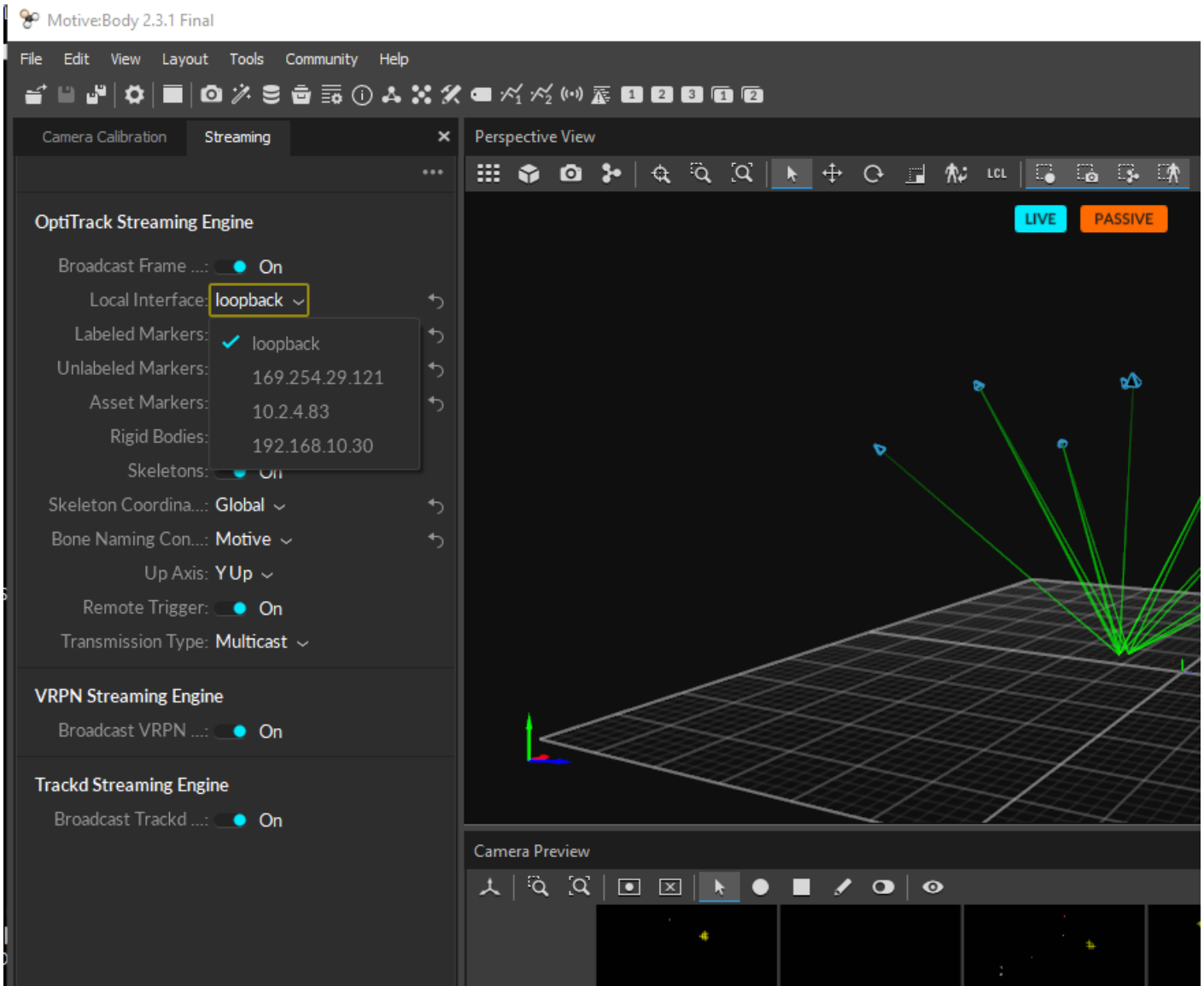
Using Motive and GazeboOSC for realtime OSC messages

The following tutorial explains the use of [Motive](#) with [Gazebo](#) for sending real-time Mocap data to other applications.

1. Preparing Motive

To prepare Motive for sending internal NatNet data to Gazebo, go to the 'data streaming' pane in Motive and set the streaming destination to "Loopback" for streaming data wireless through '[Streaming Vlan](#)' (ask your nearest blackbox manager for more info) or select a network switch for wired connection (The switch in the blackbox workshop at location Oudenoord is by default set to 192.168.10.30). The NatNet data can now be received in GazeboOSC (see pictures below)

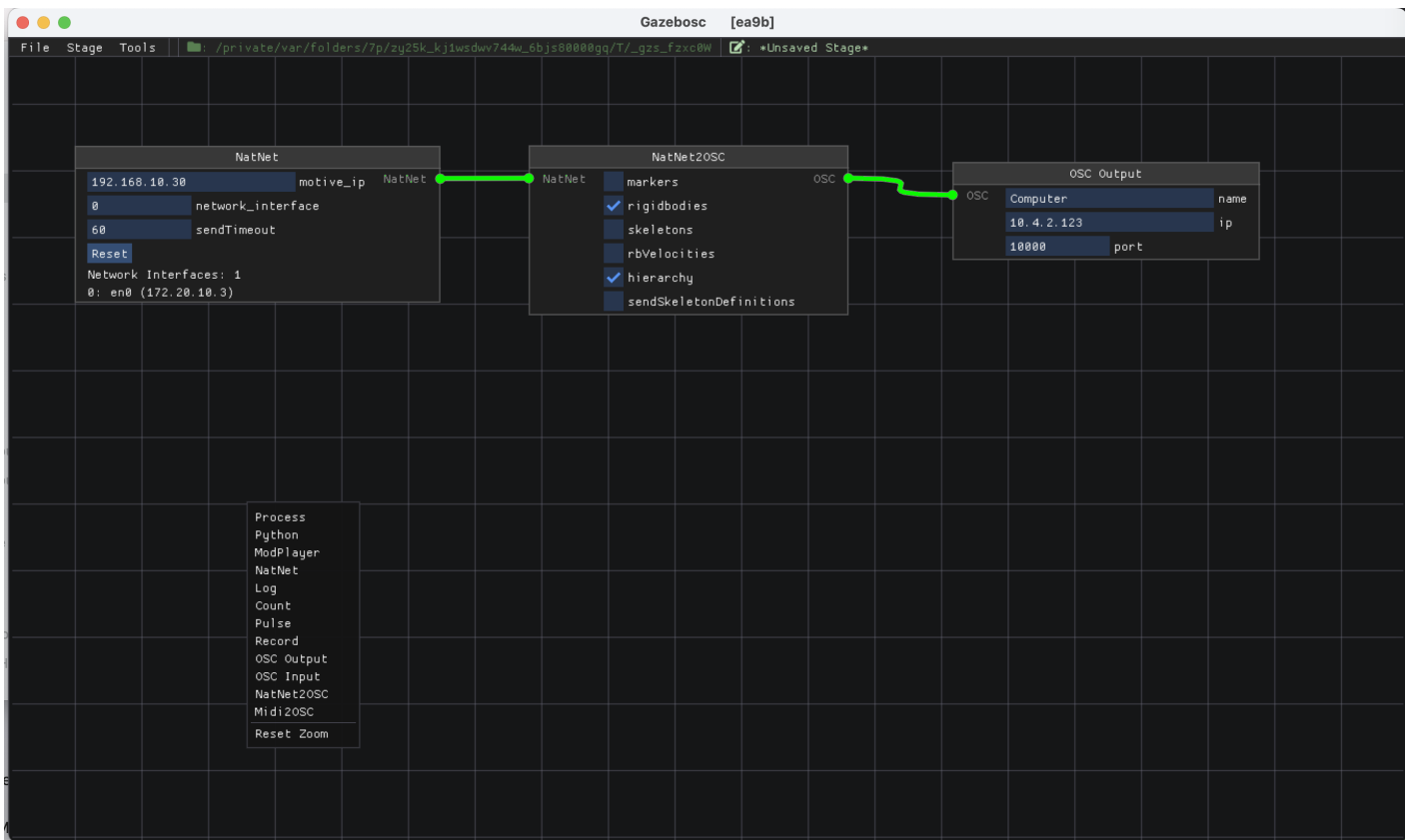




2. Setting-up Gazebo

In Gazebo you need to build a patch to convert Natnet data to OSC (see picture). Use the following actors by right clicking in the Gazebo workspace;

- NatNet: this actor reads the NatNet data which is streamed from Motive. **Fill in the IP adres with the corresponding network interface number** and **push reset**
- NatNet2OSC: this converts the NatNet data stream from Motive to OSC data.
- OSC Output: this actor sends out the OSC data to its destination. Fill in the destination IP adres and port number determined by the software who receives the OSC data.



Once the correct connection is established between Motive and Gazebo the patch cords connecting the actors should colour green, an indication that data is streaming through Gazebo. To monitor the OSC data from GazeboOSC, or other OSC, data you can download the free OSC and MIDI monitoring application [Protokol](#).

The following example shows GazeboOSC distributing OSC data from [ZigSim](#) to different destinations.

<https://www.youtube.com/embed/-fbrncBbujk>

A further explanation about Gazebo and it's use can be found at:

<https://bookstack.hku.nl/books/gazebosc>

Rokoko

What is the Rokoko Suit?

The **Rokoko SmartSuit Pro** is a **wireless motion capture suit** that tracks full-body movement in real time. It's made up of sensors placed around the body, allowing you to **capture the motion of a performer** and translate it into digital animations.

What Can You Use It For?

The suit is designed for both **recording** and **live-streaming** motion data. This makes it ideal for:

- **Animation** - drive 3D characters in games, films, or visual effects
- **Performance** - use live body movement to control digital avatars or visuals (real-time)
- **Virtual production** - blend real-time motion with virtual environments
- **Research & art** - explore movement, embodiment, choreography, or interaction in new ways

It connects to the **Rokoko Studio software**, where you can see the motion data live, record takes, and export it to tools like **Blender, Unity, Unreal Engine, or TouchDesigner**.

How to Rokoko

important: NEVER firmware-update any part of the suit without prior contact with the Blackbox!



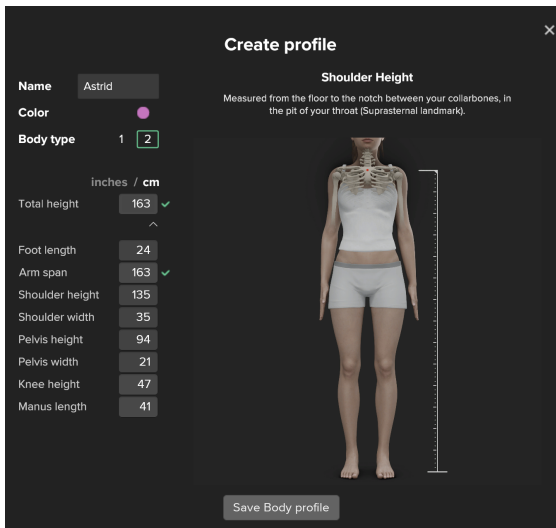
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What do you need to use it?

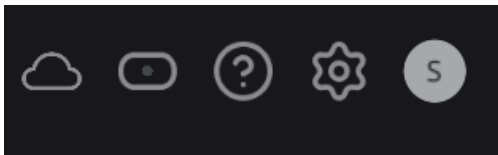
- Rokoko suit (textile & sensors, check the Blackbox)
- powerbank
- advised: standalone router (remember: in HKU you can never plug a router into the LAN network, standalone use only!!!)
- computer (preferably with utp to the router & wifi for internet*)
- optional: Rokoko Gloves
- Rokoko studio software (windows & mac):

<https://www.rokoko.com/products/studio/download>

How to setup (steps)



1. Open Rokoko studio
2. Create a Rokoko ID (in the studio, but directs you to the browser)
3. Create a Project & Scene
4. Create an Avatar, with your sizes (rough estimates can work measuring is better)
5. Connect the Smartsuit to the computer. Use the provided USB-C cable & connect to the sensor on the back of the suit.



6. Select the second icon to connect to your device (smartsuit)
(If the suit does not appear, [check](#) your firewalls)

7. Setup the [wifi](#) (preferably for the dedicated Router Specs**.)
Use the 5ghz option if available.
8. Connect the powerbank & disconnect the Usb-pc cable
9. Connect the actor profile to the device
10. Wear the smartsuit (this step can be done earlier if you are working together)
11. When using the gloves follow steps 5-9 again for each glove. Although the powerbanks we use has 3 outputs, it is preferred to use separate powerbanks for the gloves.

How to record mocap (steps)

1. Callibrate
2. Record
3. Clean data
4. Export

How to live streaming

For real-time data streaming you need a license/paid seat.

Info & prices: <https://www.rokoko.com/pricing> (set it to per month instead of anual> 28,- euro per month)

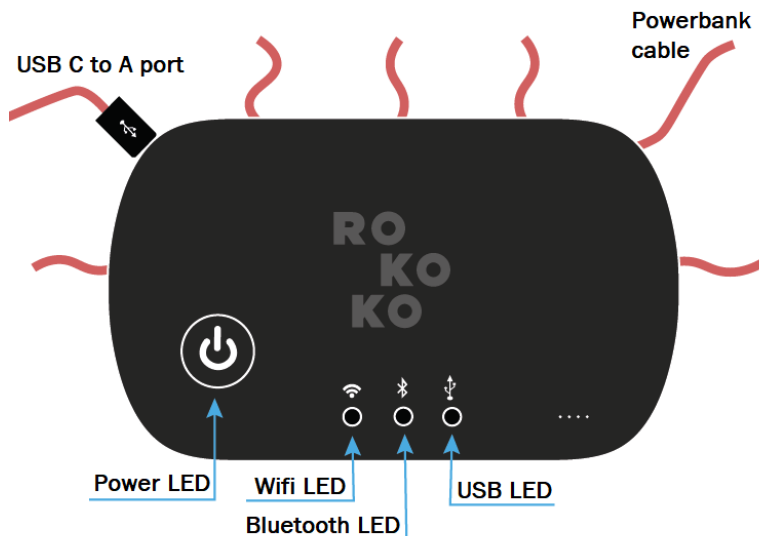
Loophole: Try it out for free: <https://support.rokoko.com/hc/en-us/articles/4410424273169-How-can-I-access-the-free-7-day-trial-of-Studio-Plus-or-Pro>

For this you need to set up a team (<https://support.rokoko.com/hc/en-us/articles/4410409137297-Creating-a-Rokoko-Team-and-Selecting-a-Subscription-Plan>)

** The HKU Rokoko's MacAdress has been added to streaming Vlan so the suit also works in all of HKU & connects to your computer if you place it in streaming Vlan too. Connect with your local Blackbox Employee for help with this ;)

HubLights:

The sensors light up blue/green before turning off. When your Smartsuit Pro II sensors are in a normal state they will not be lit when powered on. The only lights that will be on during use will be that of the HUB.



Power LED	What does it mean?
RED	There is a problem communicating with some of the sensors(possibly a broken wire or sensor)
YELLOW	Failed Redpine initialization
GREEN	The power is on! The Smartsuit Pro should be detected in Rokoko Studio in the Device Manager

Power LED	What does it mean?
OFF	Smartsuit is not connected to a battery

WIFI LED	What does it mean?
RED	A failure has occurred while trying to connect to the network. Please double check your WiFi settings(network/password/IP/Firewall etc) and reach out to support@rokoko.com if further assistance is required. This colour is normal if you have changed computer or network or if this is the first time connecting your Smartsuit Pro to your network
BLINKING GREEN	The Smartsuit Pro's Wifi function initializes. The Smartsuit Pro is also searching for WiFi
GREEN	The system is working properly and connected to an access point in the 5GHz band
BLUE	The system is working properly and connected to an access point in the 2.4GHz band
YELLOW	The system is working properly and connected to an access point in the Dual band mode
BLINKING PURPLE	The Smartsuit Pro's Hotspot is being initialized
PURPLE	The device is being connected to the PC via the Hub Hotspot

Issues & Troubleshooting

- **Suit not appearing in manager?**
 - [check](#) your firewalls
 - disableantivirus software
- **No legs?**
 - If part of the sensors stop working: Disconnect Battery pack, wait 30 secs & reconnect to wifi
- **Hub light off or red?**
 - Check the **charging cable and port.**
 - If the hub still doesn't respond, try a **hard reset** by holding the power button for 10+ seconds.
- **Magnet interference?**
 - Avoid standing near **large metal objects** or **electronics** during calibration. (see if the sensors are green in the software)

useful links:

- video tutorials Rokoko: <https://www.youtube.com/@RokokoMotion/playlists> &

<https://www.rokoko.com/academy/tutorials>

- compatible software & plugins for realtime intergration:

<https://www.rokoko.com/integrations>

- * <https://support.apple.com/en-gb/guide/mac-help/mchlp2711/mac> prioritise the order of connection-service on mac

Vive Tracking

Vive Trackers are small motion-tracking devices designed to bring real-world objects into virtual environments. While they are commonly used in VR setups to track body movements or props, they can also function as standalone tracking devices in software like TouchDesigner. Each tracker sends precise position and rotation data, making them useful for interactive installations, motion capture, and experimental media projects. By integrating them into creative software, we can map real-world movement onto digital visuals, audio, or other interactive elements.

Vive Trackers



What Are Vive Trackers?

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Setting Up Vive Trackers with a Vive Pro & SteamVR

To use Vive Trackers standalone (without VR controllers), follow these steps:

1. Hardware Setup

A. Prepare Your Equipment

- **Vive Pro Headset** (even if unused, SteamVR requires it to be connected)
- **Vive Trackers** (paired via dongles or directly with the headset)
- **Base Stations** (for tracking)
- **USB Dongles** (when using multiple trackers)

B. Position the Base Stations

- Mount **at least two** base stations (2.0 recommended) **above head height** at opposite corners of your space, at a maximum of 5 meters apart.
 - Ensure they are powered and have a **clear view** of the area.
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2. Install & Launch SteamVR

- Install **Steam** and **SteamVR** if not already installed.
 - Connect the **Vive Pro headset** to ensure SteamVR initializes correctly.
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3. Pair the Vive Trackers

1. **Turn on each tracker** by pressing the power button until the light turns **blue**.
 2. Open **SteamVR** and go to **Devices > Pair Controller** (works for Trackers too).
 3. Select "**Vive Tracker**" and follow the instructions.
 4. If using a **USB dongle**, plug it into your PC and ensure the tracker is paired to it. Place the extension cradles at 45 cm from the computer for stable tracking.
 5. Once paired, the tracker's LED will turn **green**.
-

4. Configure the Trackers in SteamVR

- Open **SteamVR > Devices > Manage Vive Trackers**
 - Set each tracker's **role** (e.g., "Held in Hand" or "Disabled" if using it just for positional data).
 - If needed, attach them to an object or a strap (e.g., for body tracking). This can be done with a camera-mount, ¼-inch screw size.
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5. Use in TouchDesigner

- Open [TouchDesigner](#) and use the **OpenVR CHOP** and set it to 'trackers' to read positional and rotational data.
- Trackers send **position (XYZ)** and **rotation (quaternion or Euler angles)**.
- You can map this data to visuals, interactive elements, or other media.

6. Use in other software

- Use [GazeboOsc](#) to pick up the Tracker signals & send them to other software (e.g. Isadora) that can handle OSC.

Troubleshooting

- Check if the tracker has a **uninterrupted line of vision** with the base stations & headset.
- If a tracker is **not detected**, reset it by **holding the power button for 10 seconds**.
- Ensure **no reflective surfaces** interfere with the base stations.
- Restart **SteamVR** if tracking is unstable.

Vive Ultimate Trackers



What Are Vive Ultimate Trackers?

The **Vive Ultimate Tracker** is HTC's next-generation tracking device designed to improve motion tracking in VR and standalone applications. Unlike the **regular Vive Tracker**, which relies on external **base stations**, the **Ultimate Tracker** features **inside-out tracking**, meaning it uses **built-in cameras** to track its position without needing external sensors.

This makes the **Ultimate Tracker** more portable and flexible, as it doesn't require a dedicated tracking area or base stations.

Comparison: Ultimate Tracker vs. Regular Vive Tracker

Feature	Vive Ultimate Tracker	Vive Tracker
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Tracking Method	Inside-out (built-in cameras)	Outside-in (Base Stations), infrared.
Base Stations Needed	<input type="checkbox"/> No	<input type="checkbox"/> Yes (Lighthouse)
Connection Type	Wi-Fi 6E / USB-C Dongle	USB dongle (2.4 GHz)
Battery Life	~7 hours	~7 hours
Size & Weight	Slightly smaller & standalone	Various sizes depending on the. model (1,2,3) & requires base station setup
Latency	Slightly higher due to processing	Lower latency with base stations
Connection	Built-In camera's, do not cover. Sometimes loses connection. Calibrates through mapping setup at startup. When connection is lost, move back to the centre point of callibration	Base stations, do not cover the tracker for line of sight connection, then stable. Zero point connected to headset initial calibration placement. This can be updated it TD
Best Use Case	Portable, flexible tracking without a defined play area	High-precision tracking in controlled spaces

When to Use Each?

- **Use the Vive Ultimate Tracker if:**
 - You need **standalone, flexible tracking** without base stations & headset.
 - You're working in **large or dynamic spaces** where base stations aren't practical.
 - In a well-lit environment (but not too much direct sunlight)
- **Use the Vive Tracker if:**
 - You need **high-precision tracking** with minimal latency.
 - You're working in a **controlled space with base stations**.
 - You need compatibility with **existing VR setups** (e.g., Vive Pro).
 - When working in low-lit spaces.

1. Hardware Setup

A. What You Need

- **Vive Ultimate Tracker(s), preferably with straps**
- **Usb -c Hub & extension cradle**

- **PC (windows only) with Vive software installed**
- **USB-C Cable** (for wired mode, firmware updates & charging)

B. Charging & Powering On

- Charge the **Ultimate Tracker** via **USB-C** before first use.
 - Press the **power button** until the LED lights up Blue.
-

2. Connect to Vive Wireless Hub

1. Install & Open the Vive Wireless Hub Software

- Download & install [Vive Hub](#) from HTC's official site.
- Launch **Vive Hub** on your Windows PC.

2. [Pair the Ultimate Tracker](#) (link for steps on the Vive website, link)

- Connect the USB Dongle to your computer at least 45 cm away for decent tracking.
- Open **Vive Hub** and go to the **settings**, choose Vive Ultimate Trackers
- Check for **firmware update** & do them if necessary (app explains the steps) .
- **Pair New**: Follow the on screen instructions to pair each Ultimate Tracker.

3. Tracker Mapping

- click on Tracker setup & follow the **steps** on screen>

<https://www.youtube.com/embed/D53DEBVqvUY>

3. Open SteamVR

- Once trackers are **mapped in Vive Hub**, launch **SteamVR**.
 - SteamVR should now detect the **Ultimate Trackers** automatically.
 - You can check and adjust tracking roles under **Devices > Manage Vive Trackers** in SteamVR.
-

4. Use in TouchDesigner

- Open **TouchDesigner** and use the **OpenVrChop** & set it to **Trackers** to receive position & rotation data.
- Map the data to visuals, interactions, or animations as needed.

5. Use in other software

- Use [GazeboOsc](#) to pick up the Tracker signals & send them to other software (e.g. Isadora) that can handle OSC.
-

Troubleshooting

- If SteamVR doesn't detect trackers, temporarily **turn on the headset** or **restart SteamVR** and **Vive Hub**.
- Ensure the tracker is **properly mapped in Vive Hub** before launching SteamVR.
- Reset a tracker by holding the **power button for 10 seconds**.
- When tracking is lost, return it to the **zero point** of the calibration
- Since the **Ultimate Tracker uses inside-out tracking**, ensure there are **enough visual markers** and **light** in the environment for stable tracking. Dark furniture may cause tracking issues.
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Optitrack Motion capture

General Info

- Optitrack main site: <https://optitrack.com/>
- Optitrack wiki: <https://docs.optitrack.com/>

Example projects

- [What Is? - Motion Capture](#)
- [I Learned Hollywood Motion Capture](#)
- Roger Gihlemon: [4 year old in MOCAP suit](#) / [MOCAP Reel](#) / [3 year old in mocap suit](#)
- [Forms](#) Memo AKten 2011 vimoe movie: [here](#)

Motion capture & Unity

The OptiTrack Unity3D Plugin allows you to stream real-time Rigid Body, Skeleton, and HMD tracking data from Motive into Unity. Using the streamed data, objects and characters in the scene can be animated.

All the information and plugins you need can be found here:

<https://docs.optitrack.com/plugins/optitrack-unity-plugin>

Mind also these settings which are not so clear through the website stated above:

Settings for Motive & Unity

Connect both pc's with HKU network Wifi or ethernet

Put mocap & Unity pc in SVlan: ask blackbox employe to help, Restart connectios to make sure.

Ip range should be 10.3.4.xx (not 10.3.**40**.xx) (3rd number is location based, 4 = IBB)

Disconnect all firewalls on both pc's! (Mocap pc is already disconnected)

Motive > view > Datastreaming Pane > Local interface: ip adres from wifi or ethernet verbinding
Transmission type: Unicast

Open Unity file

client optitrack (asset/game obj) connection settings:

Server adress: adres from mocap pc

local address: Unity pc

In Unity adjust Rigid Body ID, > Motive:

Assets > properties > Streaming ID