Vicon How To Guide

This guide will take you through the basic steps of connecting and calibrating the Vicon system, as well as tracking simple objects. We'll be using Vicon's *Tracker* software.

Contents

Connecting the System

Cabling

The Vicon system consists of two Giganet routers. Each router can connect to up to ten cameras.

Illustration 1: Giganet Routers

Figure 2 shows how the routers are wired together. The cameras are attached with a variant of standard Ethernet cables that have more robust connectors. The Interconnect is a short Ethernet cable that connects the two routers. The computer is attached through the blue Ethernet cable at the bottom.

It's possible to separate the routers to use them independently. We would have two sets of cameras tracking two different volumes; one for each router. Each router would connect to its own computer running the Vicon Tracker software.
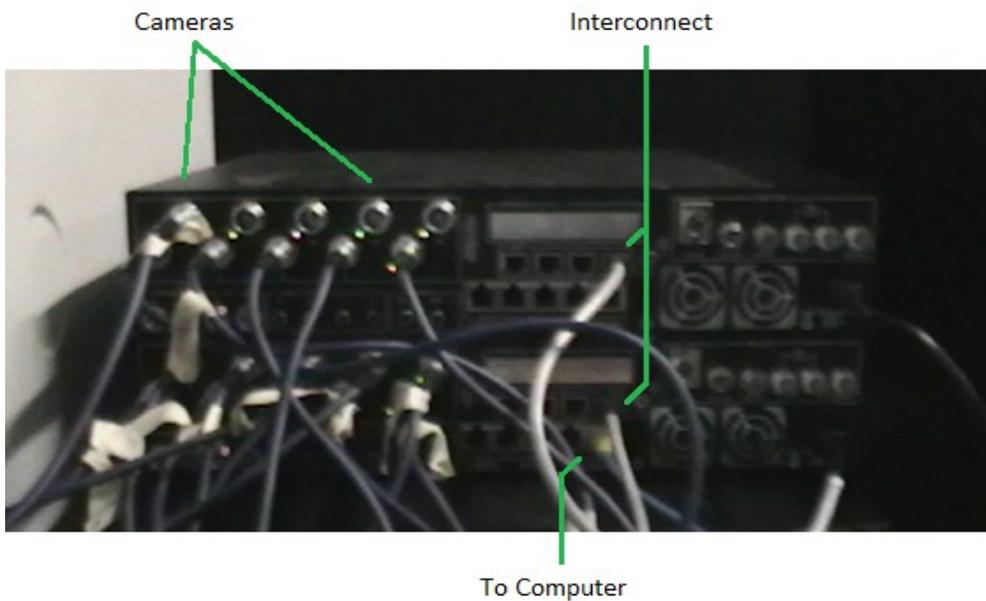

Illustration 2: Giganet Routers, Rear View

Networking

The Giganet routers have no way to provide an internet connection to the connected computer. Ideally, the connected computer should have two ethernet adapters, one for the Giganet routers, and one for its internet connection.

The adapter for the Giganet routers should be configured to have a static IP address. As of Windows 7, this can be configured with the following steps:

1) Navigate to Start->Control Panel->Network and Internet->Network and Sharing Center

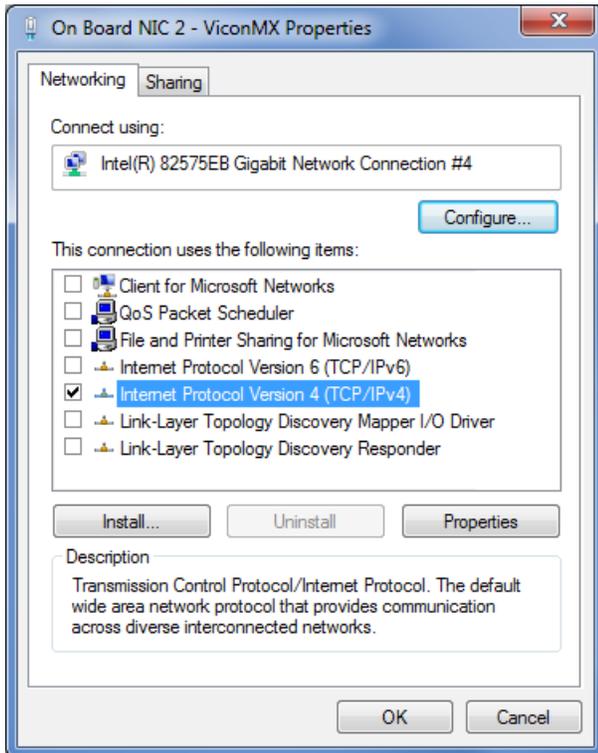2) You should see a list of the ethernet adapters connected to the computer.
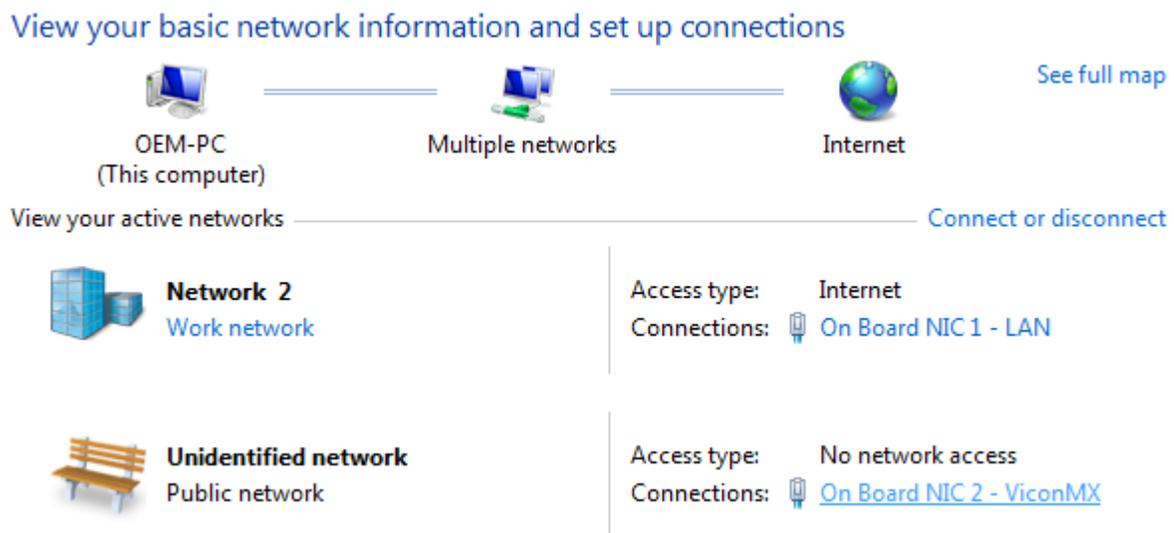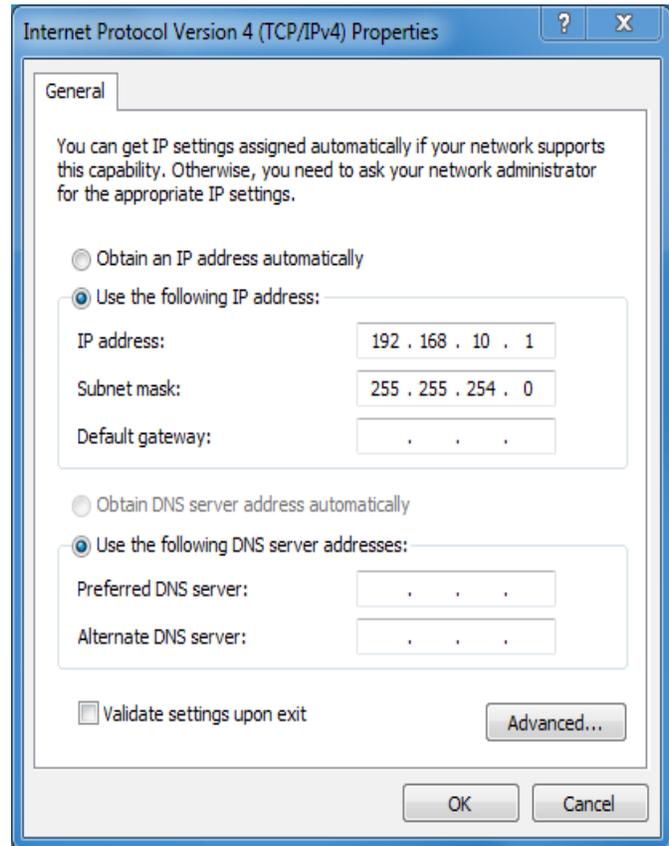

Illustration 3: Network Interfaces

Click on the link next to "Connections:" for the adapter you wish to configure.

3) A status window should appear for that adapter. Click on the "Properties" button.

4) As in Figure 4, select Internet Protocol Version 4 (TCP/IPv4) and click on the Properties button.

Illustration 4: Adapter Properties

Illustration 5: Internet Properties

5) Click on the button next to "Use the following IP address:". Set the IP address to 192.168.10.1, and the Subnet mask to 255.255.254.0
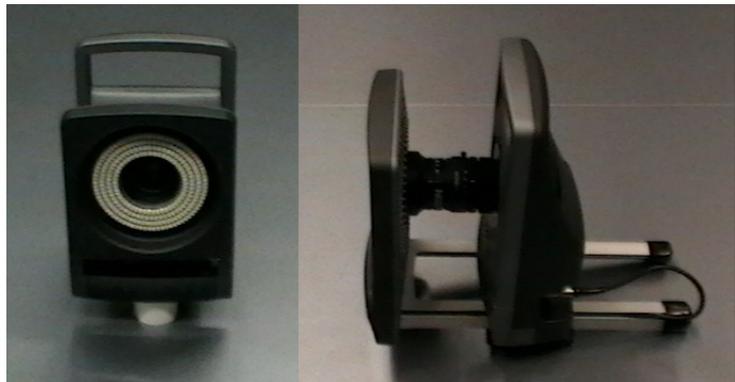
You should be finished!

Camera Setup

Infrared Cameras

Illustration 6: Infrared Reflector

Illustration 7: Vicon Camera

The Vicon cameras work in the infrared, or IR, spectrum. They have infrared emitters that illuminate a cone-shaped area. They come with special infrared reflectors that bounce the IR light back towards the camera. These reflectors are the only things the cameras can see – most other objects do not reflect enough IR to trigger a reading on the camera. It's not possible to obtain a standard video feed from the cameras.

The IR emitters on each camera are fairly powerful, and should not be looked at continuously, or from short distances, as this can cause damage to the eyes.

Camera Settings

Open the Vicon Tracker software. On the left side of the application, you should see an item called "Vicon Cameras" under the System Tab. Click on the black arrow to reveal the currently connected cameras.

Connected and functional cameras have green 'play' icons next to them. If the cameras have a red X, or if some cameras are not present, Tracker encountered problems connecting to them.

Right-clicking on a camera and selecting 'Reboot' may fix the problem. Sometimes the Giganet routers need to be rebooted. Otherwise, see the Vicon documentation for troubleshooting.

You can select multiple cameras with the shift key. Select them all now – we'll adjust their settings to ensure that they can detect IR reflectors. Once they're selected, look at the 'Properties' section in the lower left corner of the screen.
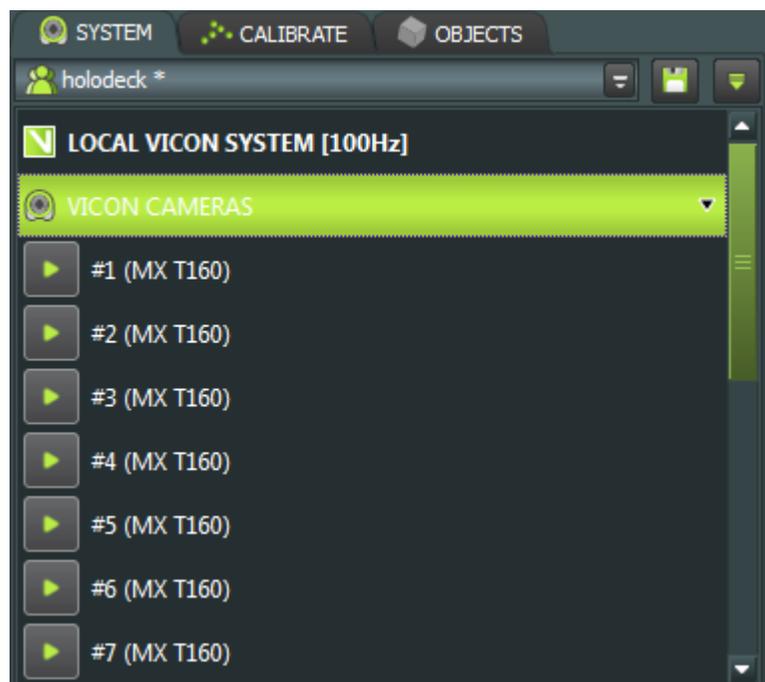
Illustration 8: Vicon Camera List

The **Strobe Intensity** is the amount of infrared light each camera emits. The cameras can only see reflectors that are bathed in IR light, so this should generally be kept fairly high.

High levels of IR light make reflectors appear larger in the camera view – lower the Strobe Intensity to more easily distinguish between small markers that are placed close together. Higher levels of IR can make these markers appear to merge together.

The **Grayscale Mode** determines how reflectors are presented in Tracker. Normally the default of Auto is fine, but we'll switch it to Edges to show the relative size of each marker. This will help when focusing the cameras.
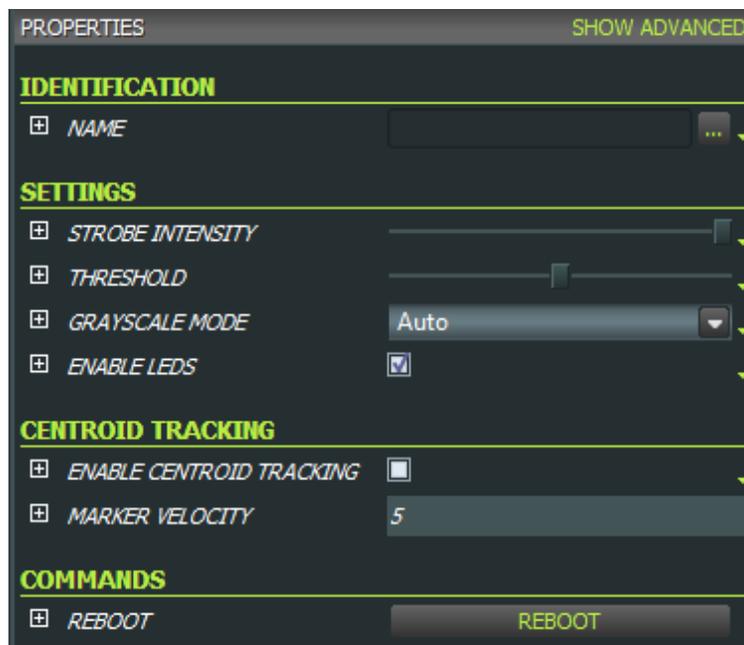
Illustration 9: Camera Properties

The **Threshold** can be decreased to increase the sensitivity of the camera. It's the minimum threshold of received light that must be met before a marker is detected. Lower values allow detection of fainter markers, but add noise.

System Settings

Select the Local Vicon System item. It's the left side of the screen, under the System tab.

Now, examine the properties section at the lower left-corner of the screen, seen in Figure 11. The only setting we're interested in is the **Minimum Cameras Per Marker**. This is the minimum number of cameras that must see a reflective marker for it to be reported by the system.
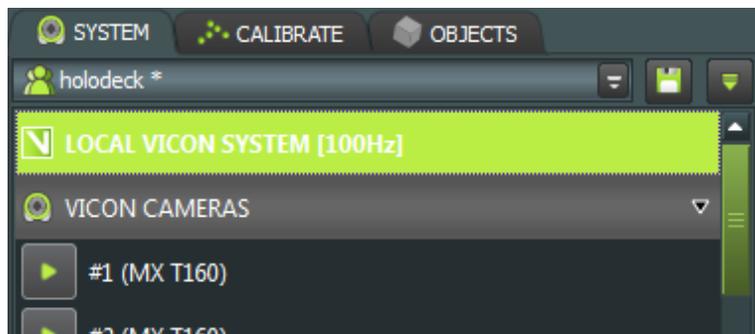
Illustration 10: Vicon Local System

Three cameras are necessary to triangulate the object's x, y and z coordinates. It can be increased to four cameras to remove noise and false positives. If noise is not a problem, I would recommend leaving it at three.
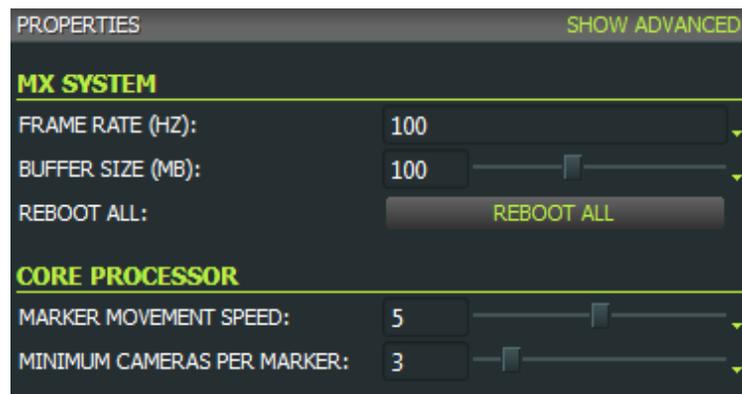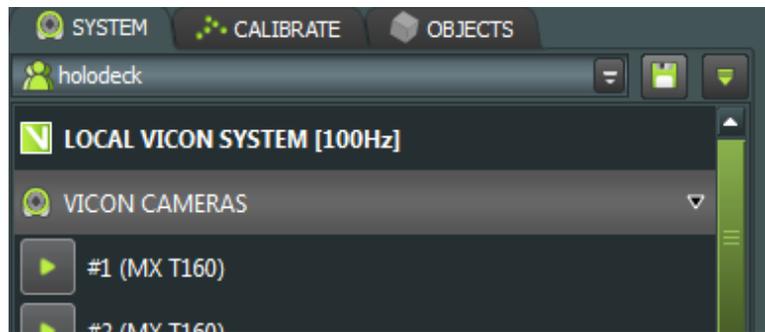
Illustration 11: System Settings

When you're finished making changes, you can save them by clicking on the Save button above the left pane.

Illustration 12: Save Button (Upper Right Corner)

Aiming the Cameras

Tracked Volume

The tracked volume is a 3D region in space where reflectors' positions can be tracked. At least three cameras are needed to triangulate the position, so the tracked volume extends to wherever at least three camera viewpoints overlap.

Vicon cameras are fairly wide-angle, but should ideally be placed a few meters from the tracked volume to cover as much of it as possible. The cameras are very high resolution, and can track markers as small as 4 mm across from several meters distance.

The cameras should be very stable, as even small vibrations from the camera mount can interfere with tracking.

To aim the cameras, we'll need to place IR reflectors around the edges of the tracked volume. These markers are the only things the cameras can see, and will be needed to ensure the camera is properly aimed. The markers should be placed along the x, y and z axes to ensure that the top, bottom and sides of the volume are visible.

Camera View

To view what each camera sees, select Camera mode from the main window's drop-down menu.
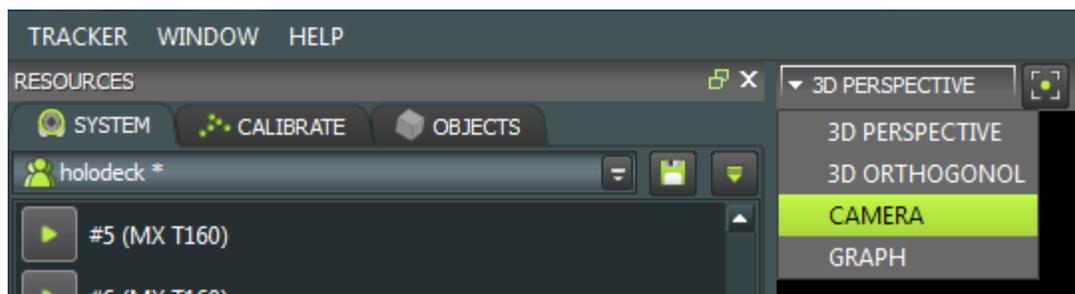

Illustration 13: 3D Perspective Mode

Now, select one or more cameras. The camera view should appear in the main window.

Because we previously selected Edges as the Grayscale mode, each reflector has a different size based on the amount of light it reflects.

Note: if there are no reflectors in the camera's view, the display will be solid black!

Each camera should be adjusted so that the markers outlining the tracked volume are visible. At least three cameras must be able to see each part of the volume to track markers there.
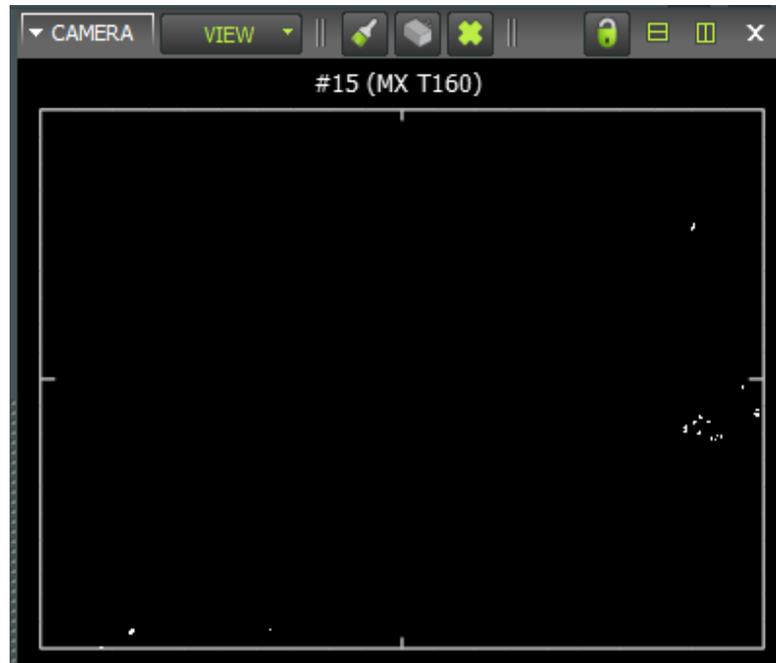
Illustration 14: Reflector View

If possible, try to avoid having the cameras see each other as much as possible. If one camera can see another, the camera's infrared emissions will create a small dead zone where reflective markers cannot be detected. (This will not damage the camera.)

Focusing the Cameras

Once the Vicon cameras are properly positioned and aimed, they must be manually focused. Each camera has a back and front focus. We'll use only the back focus, as per the instructions given by the Vicon salesperson.

There's a small bolt which must be loosened from the rear focus before it can be adjusted. (See Figure 15) The adjustment is made by rotating the lens around the camera shaft.

Use the reflector view in Figure 14 to check the focus. The markers outlining the volume should be made as large as possible. Verify that both nearby and distant markers in the volume can be seen. It's often not possible to focus on all markers equally well, but try to achieve a good compromise.

Illustration 15: Camera Focus

Calibrating the Cameras

After the cameras are aimed and focused, they must be calibrated before use.

Masking

1) Open Tracker, and select all cameras.

2) Select Camera mode from the main window's drop-down menu. (See "Aiming the Cameras – Camera View")

3) You should see each camera's input in the main screen. Remove any visible IR reflectors from the tracked volume.

4) If any cameras detect IR emissions, either from another camera or other IR source that cannot be removed, that source needs to be masked. First, select a single camera that detects interference.

5) Now, select the Mask tool. It's a small button with a paintbrush icon above the main window.

6) Draw over the areas to be masked. They should be highlighted blue.

7) Repeat this procedure for all other cameras.

Illustration 16: Mask Tool

Calibration

1) To begin calibrating, select the Calibrate tab from the left pane.

2) Select 5 Marker Wand & L-Frame for both the Wand and L-Frame.

Illustration 17: Calibrate Pane

3) Remove all IR reflectors from the tracked volume, and click on 'Start' in the Create Camera Masks section. This performs additional background subtraction.
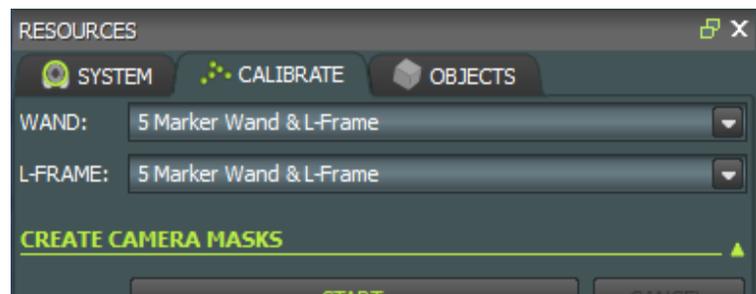
4) Wait for a few seconds, then click Stop.

5) Click on 'Show Parameters' in the Calibrate Cameras section. Ensure that the **Calibration Type** is Full Calibration, and that the **Cameras To Calibrate** are All MX Cameras.
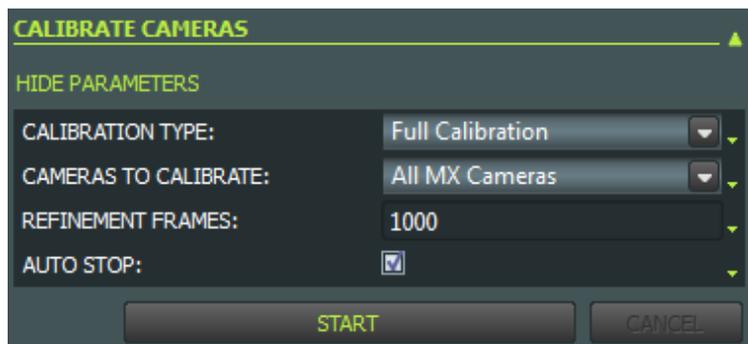

Illustration 18: Calibrate Cameras

6) Set the **Refinement Frames** to 1000, and check the **Auto Stop** checkbox.

7) Obtain the five-marker calibration wand and click the Start button in the Calibrate Cameras section.

8) Move the wand through the tracked volume. Try to cover as much of the volume as possible. You can monitor the calibration by selecting the cameras and using Camera Mode from the 3D Perspective drop-down menu.


Illustration 19: Five Marker Calibration Wand

The wand will leave a rainbow trail across the camera's field of view. If the camera can see the wand, but no rainbow trail is left, then there are not enough other cameras to triangulate the wand's position.

The camera LEDs will blink blue until enough data points have been read. When all LEDs have stopped blinking, calibration is complete.

9) You can view a report of the calibration accuracy in the Camera Calibration Feedback section. If you are happy with the results, click on "Save..." in the Manage Camera Calibration section. This will also save any masks you have drawn.
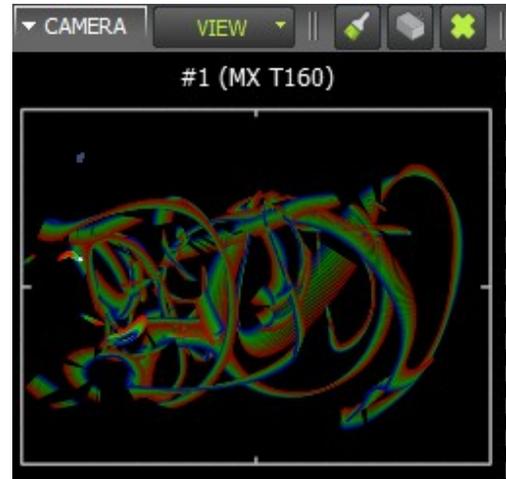
Illustration 20: Calibration Trail

Set the Origin

The 5-marker wand is used to set the scene orientation and position. The IR marker at the intersection of the two bars on the wand will be the scene's origin. The wand should be placed as in Figure 19. There are adjustments on the wand to make it perfectly horizontal, and levels to check the tilt amount. Once the wand is properly placed, select "Start" from the Set Volume Origin section.

Again, use "Save..." in the Manage Camera Calibration section to save your changes.

Tracking Objects

Constellations

Tracker can detect the position and orientation of objects using constellations. These are arrangements of three or more IR markers that define an object. Tracker uses the exact distance between markers to identify different objects, so they must be placed on a rigid surface.

While only three markers are needed, I recommend using four or five. This will allow the system to continue tracking the object even if a marker is hidden. Constellations work best when the markers are arranged in an asymetrical pattern.
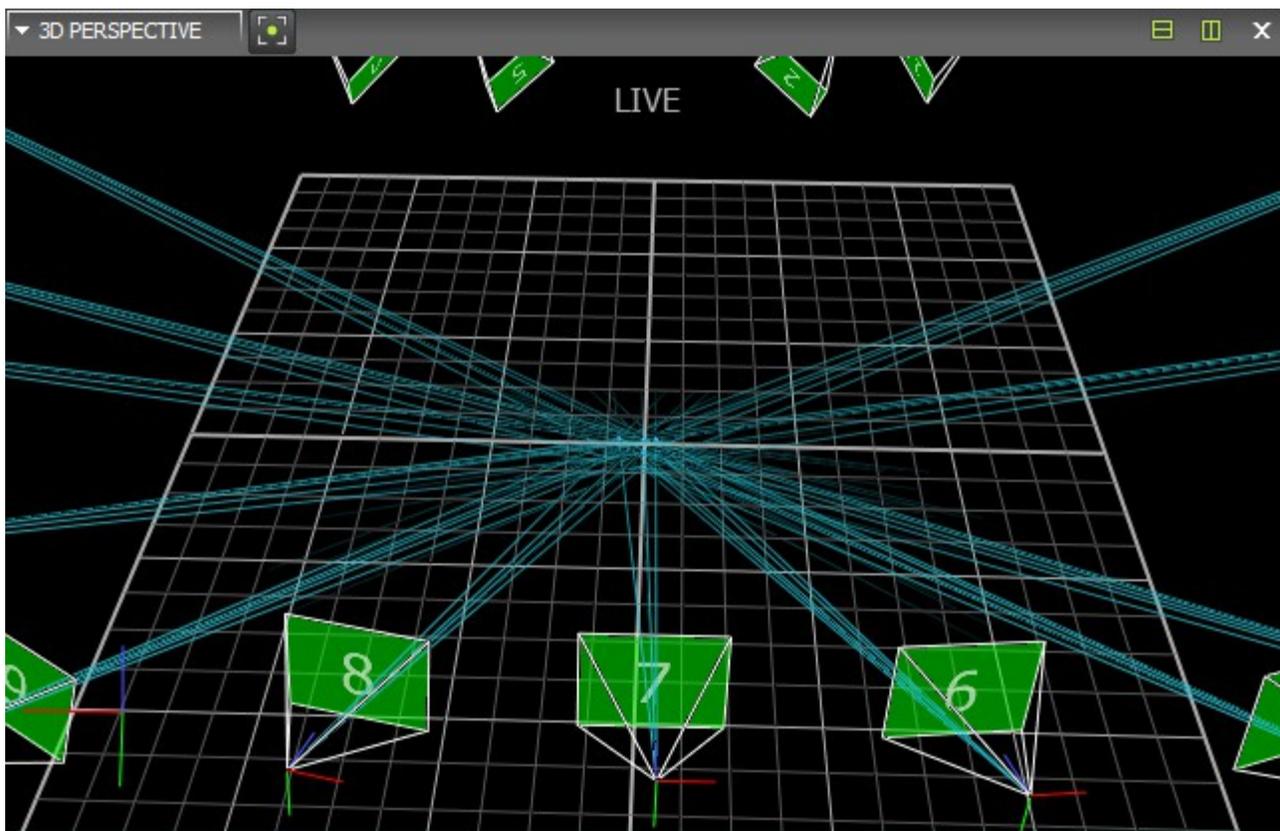
Define an Object

Once an object has been marked with a constellation, switch to "3D Perspective" mode from the main window's drop-down menu.

You can change the scene viewpoint by clicking and dragging in the main window.
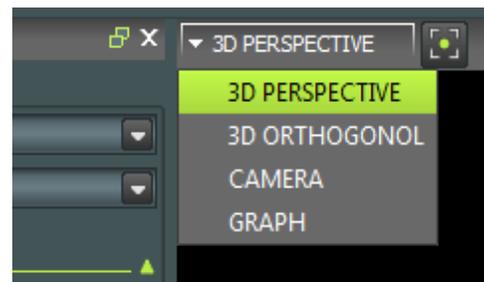

Illustration 21: Perspective Mode

Illustration 22: Object Tracking

When the object to be tracked is visible, hold down the Alt key to highlight its markers. If some markers are not visible, re-position the object so that at least three cameras can see them.

Once all markers are selected, open the Objects tab in the left pane. At the bottom of the pane is a field called **Create Object**. Type in a descriptive name for the object and click the create button. The object's position and orientation will now be tracked!

You can control which objects to track with the checkboxes next to the object names.

You will be prompted to save the object settings when the program exits.
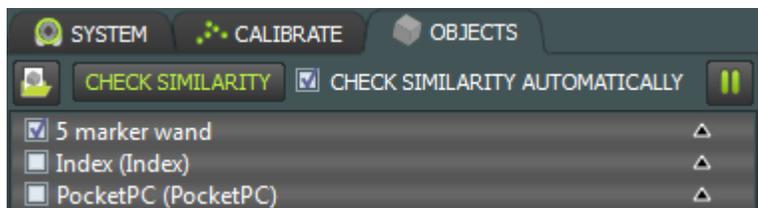
Illustration 22: Tracked Objects