## Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>OmniCal Camera setup</td>
<td>3</td>
</tr>
<tr>
<td>Workflow</td>
<td>3</td>
</tr>
<tr>
<td>OmniCal MV system</td>
<td>3</td>
</tr>
<tr>
<td>OmniCal Capture</td>
<td>12</td>
</tr>
<tr>
<td>Overview</td>
<td>12</td>
</tr>
<tr>
<td>Workflow</td>
<td>12</td>
</tr>
<tr>
<td>Example</td>
<td>12</td>
</tr>
<tr>
<td>OmniCal Multi-pose alignment</td>
<td>18</td>
</tr>
<tr>
<td>Overview</td>
<td>18</td>
</tr>
<tr>
<td>Limitations</td>
<td>18</td>
</tr>
<tr>
<td>Workflow</td>
<td>19</td>
</tr>
<tr>
<td>Example</td>
<td>19</td>
</tr>
<tr>
<td>OmniCal Rig-check</td>
<td></td>
</tr>
<tr>
<td>Overview</td>
<td>22</td>
</tr>
<tr>
<td>Workflow</td>
<td>22</td>
</tr>
<tr>
<td>Example</td>
<td>24</td>
</tr>
</tbody>
</table>

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**OmniCal**

**Last updated 04 May 2022**
OmniCal Camera setup

This camera setup must be done before you run the disguise software.

⚠️ Warning: OmniCal camera networks must use a separate network adapter to all other network traffic.

Workflow

1. Install Vimba Viewer to configure the cameras
2. Network setup
3. Verify camera connections
4. Adjust exposure & focal length

OmniCal MV system

Network setup

⚠️ Warning: OmniCal MV system cameras use all the available network bandwidth, so they must always remain on a dedicated network, away from any other traffic.
Please note: When Camera Discovery is enabled, machine vision cameras continuously capture images and send them to master. This only affects the camera network and not disguise directly, however it consumes CPU time processing these packets.

Please note: Camera Discovery can be disabled explicitly in the OmniCal Calibrator window and is also turned off automatically when the OmniCalCalibrator and Plan windows are not open.

Network infrastructure:

The OmniCal MV system is based on the GigE Vision (R) standard and requires a bandwidth of 1 Gb/s or higher. For example, on 10 Gb/s setups the discovery of disguise MV cameras and the transmission of captured images will be faster.

The disguise MV cameras are powered via PoE, which needs to be provided either by the network switch or a PoE injector. The power requirement over PoE is quite low at 2.8W.

Make sure that all parts of the network infrastructure (switches, cables...) match the desired bandwidth and power specifications.

In case of wired cables (as opposed to fibre), we recommend using at least Cat6 cables, because they are more reliable than Cat5e over longer distances or in the presence of electromagnetic interference (EMI).

**Network Adapter Setup**

You may need to update to the latest drivers to see some of these advanced options.

- Enable jumbo frames with size (MTU) 8228 or larger

- Interrupt Moderation Rate: Extreme

- Transmit buffers: 256 bytes

- Receive buffers: Max setting available

- See here for further explanation.
Please note: A 1 Gb port should work fine but we normally use a 10 Gb port when available as the max receive buffer size is larger. Some network adapters may show some of the above settings under an Advanced button. Others may not provide some at all. E.g. the external Promise SANLink3 adapter only offers the Jumbo Frames setting.

Switch Setup

1. Connect a PoE network switch with bandwidth 1 Gb/s or higher.

2. Enable jumbo frames/packets by setting the max packet size to the highest it will go (usually around 9k).

OmniCal MV system setup (in windows)

The Vimba software installs camera drivers, SDK and the Vimba Viewer application used for testing and trouble shooting.

1. Install Vimba for windows SDK from here.

Please note: We recommend Vimba Viewer v2.1.3

1. In the Vimba installer, select Application Development.

2. Keep install drivers checked and complete the installation as normal.

3. Hit Start.
   
   Open Vimba Viewer

4. Plug your cameras in if they are not already.
a. They will show up in the Detected Cameras list in Vimba, in white.

b. These may have a red lock icon on them if the disguise software is running. Camera access is exclusive to each application. I.e. if you have a camera capturing in the disguise software you will not be able to view it in Vimba and vice versa.

**Verify camera communication**

1. Open Vimba and select a camera.

2. Press play button and verify images are streaming

---

**Please note:** In case camera connections are lost, and replugged, the software should detect them again, but in case they don’t you can press the refresh button in the top left corner.

---

**Troubleshooting**

- No image is displayed in Vimba Viewer: try disabling jumbo frames on the network adapter. We’ve seen this can be an issue on 4x4s. When using jumbo frames over 2034 bytes we aren’t able to get complete images from the cameras (due to packet loss). The other workaround is to limit the packet size on the switch. Use Vimba Viewer to verify the GVSP packet size setting is 2034 or below. This is negotiated automatically so you don’t set this directly.

- Network adapter becomes disabled after applying the above settings: try reverting the interrupt moderation rate to the default.

- Capturing images is very slow / cameras become unresponsive: try reverting the interrupt moderation rate to the default.

---

**Configuring cameras in Vimba**

You can right-click or double-click on the cameras to see and adjust metadata of the camera.
This window also shows the Play button in the top left hand corner, on pressing this the camera image should appear in this window, this can be zoomed using the mouse scroll button.

**Focus, aperture and focal length**

Align the cameras to look at the object that is to be projected onto. Adjust focus as needed. We recommend that you open the aperture as far as it can go, so you can use the exposure time to control the amount of light that comes in. Make note of the focal lengths used by the cameras, you will need these later.

**The Brightness Tab**

**Exposure time**

Exposure time will heavily depend on the light levels in the calibration environment. On the right hand side you will see a value in milliseconds that allows you to calculate roughly the FPS the camera is producing. High exposure time will make it slow.

The other parameter we will not touch. The only other tab we’ll interface with is the All tab.

**All**

Here we can type in a filter pattern and search through settings. We might need to change the DeviceUserID here. Just type it in and click search. The ID will be visible inside disguise.

**Connecting to cameras in the disguise software**

Part of the disguise software is a separate program called VimbaCamServer.exe which is used to discover and connect to one or more OmniCal MV system cameras on a network.

- In the disguise software the **OmniCal Calibration editor** configures and enables camera discovery on the network.

- Usually, the VimbaCamServer is launched automatically from within disguise, as soon as the Discovery Adapter is set to the localhost Loopback adapter. In that case, the network switch with the cameras needs to be connected directly to a separate network adapter on the disguise
The VimbaCamServer can also be run separately, e.g. on a standalone computer. In that case the Discovery Adapter inside disguise needs to be selected as the network port with which the disguise server machine is connected to this other computer. The disguise server then does not need a direct connection to the OmniCal MV system cameras or the network switch they are on.

In other words, the Discovery Adapter needs to be set to the network adapter that the camera server app is on. For an OmniCal MV system the VimbaCamServer can be anywhere as long as it can somehow see and connect to the cameras.

The Mobile Cameras button opens a list of cameras that are currently connected to disguise. If you have many MV cameras on a network (especially if it is only 1Gb/s), then the cameras may appear one by one over the course of several seconds.

Renaming cameras in Vimba Viewer

It is recommended to add unique names for each camera for easier identification within the disguise software. Follow these steps to set this up:

- Open Vimba Viewer
- Locate the setting "DeviceUserID" (not to be confused with a similar setting labelled "DeviceID" which can not be changed)
Rename the camera as desired
Controller for Mako G-507C (169.254.152.156)-50-0536902991

Filter pattern: Example: Gain|Width

<table>
<thead>
<tr>
<th>Feature</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controls</td>
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<tr>
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</tr>
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</tr>
<tr>
<td>Stream Information</td>
<td></td>
</tr>
</tbody>
</table>

DESCRIPTION:
User-programmable Device Identifier.

FEATURE NAME: DeviceUserID
Press Enter and close this window. Note that Vimba must be closed in order for the re-name to be visible.
OmniCal Capture

Capture is the process of projecting structured light patterns and taking images of these to later use in the calibration process.

Overview

OmniCal Capture is the process of projecting structured light patterns, taking images of these and detecting blobs within these images.

Workflow

1. Define the position & properties of cameras and projectors.
2. Setup the Capture.
3. Perform the Capture.

Example

Defining cameras & projectors

1. Left click the OmniCal calibration editor from the stage editor to open it.
2. Create a new Capture Plan by right clicking the capture plan to open the capture plan manager, entering a name in the new plan field and clicking OK.
3. Right click the newly created capture plan.

4. At this point, if you wish to do a simulated capture, set **Use simulated cameras** to Yes.

5. Click the + icon to add each of your cameras to the plan.

6. Right click on each of the plan cameras. This will open up the Camera plan editor.
   
   a. Left click Mobile Camera and select the required camera from the list of available cameras.
   
   b. If you are doing a simulation, you can choose your virtual camera settings here.

7. Click the + icon to add your projectors to the plan.

**Setup capture**

1. Left click **Setup Capture** to open the Capture editor

2. Set the blob size and the grid size.
   
   a. The blob is the size of the blobs we are projecting in pixels.
   
   b. The grid size is the number of blobs projected horizontally.

   **Please note:** Generally speaking, blobs should be as small as possible whilst still remaining detected by all cameras. More blobs does not necessarily mean better calibration, but will increase calibration time. 32 blobs across should be sufficient for most use cases. More blobs can be useful in a scenario where mesh deform needs to be used.

3. Left click **Grid** to see how many blobs are projected, and how well they cover the surfaces you are calibrating.
4. Left click on **Blobs**. A test blob detection will be performed highlighted in the camera views. The colour coding of the blobs is based on the colour of the projector wireframe. The blobs should be made as small as possible, whilst still being detected in this view.

   a. At this stage, you may need to adjust camera exposure for better blob detection.

   b. To adjust exposure, left click on the camera name and adjust exposure time in the camera plan editor.

   **Please note:** A good way of getting setting a suitable exposure time, is turning continuous capture on, selecting grid mode and adjusting the exposure time and turning continuous capture off when you are happy the blob levels are clearly visible.

5. Ensure your **Alignment level** in the Capture setup is at a level where you can see the detail on your models clearly, as this image is the one that will be shown in Alignment.

### Performing a capture

**Warning:** The stage should be clear.

**Warning:** No changing light levels.

**Warning:** No people walking across stage.

1. Click **Capture** from the OmniCal plan editor

2. The system will perform a capture, the time taken will depend on number of projectors & cameras and whether projectors are converging or not. For example, 4 cameras & 4 projectors non converging takes roughly a minute.

3. Verify the results of the capture by clicking **View Capture**.
4. Left click **Blobs** from the **View Capture Editor**.

5. Verify the blob detection results are as expected. These results should be consistent with what you saw in the capture setup. If something went wrong with the capture (change in light levels, people walking across stage), then perform the Capture process again.

**Camera Diagnostics**

![Camera Diagnostics](image)

Available in the camera collapsible widget.

1. This will only be enabled if there is a plan and there are plan cameras mapped to MV cameras.

   The following is shown for info:

   ![Camera Diagnostics](image)

2. Right click header to show columns:
3. This displays camera stats and feedback of settings (such as IP, name). The disguise software only displays plan cameras.

4. Click **Start Per Cam** to enable stats feedback.

   Visit this link for additional information about each of the specific stats.

**Column descriptions**

- **Frames incomplete** is the only one measured by disguise and provides some feedback to the user as to the stability of the cameras in vimbacamserver.

  This setting indicates that the disguise software failed to validate the frame data or there may have been an exception when handling frame data from vimba api.

- **Green** means cameras are ok and receiving data from vimbacamserver (with respect to the stats measuring incomplete frames between each receipt of stats).

- **Red** means there have been incomplete frames between the last read and the current read.

  The count of incomplete frames will continue to increase.

  The red colour will reset if there have been no incomplete frames between each read of the stats.

- Grey indicates the camera has been disabled.

- **Brown** indicates the camera is disconnected/ offline.
Change mv camera BW to adjust bw per camera. This is split between cameras.

The graph button will show the stats in graph format.

Bandwidth allocation can be adjusted while diagnostics are running.

Dropped packets means you need to lower the bandwidth settings or there is a physical problem like a bad cable.
OmniCal Multi-pose alignment

Multi-pose alignment improves the way OmniCal works with objects controlled by automation.

Overview

OmniCal QuickAlign currently positions secondary (non-master) objects. Multi-pose adds the ability to do this in multiple positions, or “poses”. The automation system can then be given information about these poses and interpolate between them when moving objects.

Currently only movement along a linear path is supported, which requires 2 poses per object.

Prerequisites

- A master screen is required as well as the objects that are moving. The master screen must be stationary.

- Accurate Meshes: Multi-pose is designed to interpolate between object poses. These poses are determined by reference points, therefore an accurate model is required.

- It is recommended that the master screen matches the scale in the real world as this will define the scale for the whole calibration. If your master screen scale is incorrect, you may have to adjust the scale of all secondary screens.

Limitations

- Only supports linear paths, with a single input value from the automation system.

- Does not support calculating rotation pivot points. If an object rotates between poses, the system will simply linearly interpolate between these rotations, which may not be what is desired.

- Multi-pose alignment only uses a single calibration (it is not multi-pose calibration like QuickCal). Therefore there are some important requirements for projector calibration:

  Projectors need to be calibrated with depth using the DLT algorithm. Blobs cannot be on a single plane.
Projection will only be accurate within the calibrated "space", ie around same place where blobs land. Surface movement should be limited to this area.

- No mesh interpolation is done
- Mult-pose alignment is not supported by the Rig Check workflow. It shouldn’t normally be necessary to use multipose on a regular basis. It should only be necessary to redo it when there are changes to the automation system causing screens to move along a different path.

Workflow

1. Extract good Meshes
2. Setup automation axes for all moving screens
3. Perform a capture and calibration
4. Align master screen and all static screens in base pose
5. Create 2 poses for each moving screen

Example

Extract Good Meshes

The multi-pose workflow requires that you have accurate meshes. You can skip this step if you already have these or if you are in a simulation

Please see “Extracting a mesh using OmniCal” for further information

Setup automation axes for all moving screens

1. Create an automation device and driver using the regular workflow. For information on creating automation devices, visit this link.
   - Create 6 axes all with the same input ID from automation, for XYZ position and XYZ rotation of the object as follows.
Warning: Note that all 6 axes are required even if the object is moving in a single dimension and no rotation is expected. This is because QuickAlign will calculate a composite rotation and translation of the surface. Ignoring rotation will mean the translation will not be correct. This will become especially apparent when local origin of the mesh is far way from its centroid.

Perform a capture and calibration

Follow the regular OmniCal workflow capture and calibrate.

Open the Quick Align editor.

Align master screen and all static screens in base pose

1. Align the Master screen.
   a. Make sure the Current Pose is set to base, the Master Screen and Current Screen are set to the actual master screen object in the visualiser.
   b. Perform an alignment.
   c. Repeat for all static screens
      i. You can only use reshape tools in the base pose. In min and max poses, the current mesh is being moved, but no reshaping is supported. Note that the UI does not yet prevent you from turning alignment points into reshape points.
      ii. If you need to reshape a mesh for which you need to use the Multi-Pose workflow, then you can either do this by aligning and reshaping in the base pose, or doing it in a separate step, and export+re-import the mesh (probably preferred).

Create poses for each moving screen

1. With the Quick Align editor open, ask automation to move the moving piece to its minimum position.
2. Create min pose
   a. Click Create Pose
   b. This will take a capture and present the camera images for the user to align to. It will also take a snapshot of the current automation input values.
   c. Select the Current Screen as the object which has just been moved by automation to be aligned.
   d. Perform an alignment of the screen at the minimum position.
   e. Each pose can contain multiple screens so you can repeat this for each screen that is visible. Alternatively you could create a separate pose per screen.
   f. Click the Set Min Range in the automation section of the Quick Align editor.
   g. The minimum pose has now been set.
   h. You can right click on a pose to view the screens and automation data contained within it.

3. Keeping the Quick Align editor open, ask automation to move the moving piece to its maximum position.

4. Create max Pose
   a. Repeat the same pose creation steps and instead select Set Max Range in the automation section of the Quick Align editor.

5. Click Normalise Rotation (always required unless a rotation of >= 180 degrees is required between the poses)
   a. For example, after a multi-pose alignment, if you get -0.2deg as the min output and 359.7deg as the max output, then the min output should be set to 359.7 or the max output should be set to -0.3deg. This is because the direction of rotation is ambiguous.

6. Close the Quick Align editor and ensure automation is engaged.
OmniCal Rig-check

Overview

Rig check is the tool for quickly re-calibrating without advanced knowledge of the rest of the OmniCal system. It is primarily used by touring operators to re-calibrate shows moving into new venues.

Workflow

The Rig Check workflow is used after a full OmniCal calibration & alignment has been completed. The plan is used as a template to repeat the calibration with the same settings. The plan is not modified in this workflow.

1. Ensure that you have a plan already calibrated by a Trained user. It should be selected in the OmniCal Calibrator editor.

2. Left click Check Cameras in the OmniCal Calibrator editor.

3. Verify there are no errors when the Check Cameras window opens. Errors can include the following:
   a. Cameras are unavailable
   b. Camera names have been modified in the plan. The plan capture is used as a reference for Rig Check. Any changes to cameras names after the plan capture was done will invalidate it.

4. The Check Cameras window will open which shows camera pairs consisting of the original plan capture and a snapshot capture of the current stage. You can take a new snapshot using the Refresh Camera Views button.

5. Ensure that the camera views match:
   a. They don't need to be identical, but the coverage of projection surfaces should match and they should be in approximately the same positions.
b. The brightness of the images should also match. The exact camera settings specified in the plan (like exposure time) will be used here, so any differences would be either due to the physical aperture or focus of the camera lens (for machine vision cameras) or the lighting environment. It is therefore recommended that the focus and aperture of machine vision cameras be locked in place for repeatability.

6. Once you are happy with the camera views, close the **Check Cameras** window.

7. Left click Execute Plan. This will perform a capture, calibration, alignment and optionally a mesh deform if it was configured to run automatically in the plan's deform settings. A new Result object is created which contains the capture and calibration.

8. Ensure that the correct Plan and Result are selected in the OmniCal Calibrator editor.

9. Left click **Check Result** in the OmniCal Calibrator editor. Note that this will apply the result's alignment to the stage (if it hasn't been applied already). This will update both projectors and projection surfaces if they have alignment points. If **Check Result** is greyed out a tool tip should tell you the reason, which can include the following:

   a. The Plan has no capture or calibration
   
   b. The Result has no capture or calibration

10. Verify there are no errors when the Check Result window opens. Errors can include the following:

   a. The camera names in the Plan and Result don't match. The Plan may have been modified since the Result was created.

11. The **Check Result** window will open which shows camera pairs consisting of the original Plan capture and the Result capture that was taken.

12. Left click on a camera image to open the Result Aligner window. If an Mesh Deforms have been applied these will be undone in order for alignment points to be editable.

13. On the left hand side is the camera view from the original Plan (read only) and on the right the Result. You can then update the alignment points on the right to match the left. This will update the alignment on the stage as you do it. The controls are identical to Quick Align.

14. Select the next screen by pressing the button at the bottom of the camera views or selecting it from the surfaces drop down and repeat the process of checking and adjusting alignment points.

15. Repeat this for all cameras. You could in theory only check cameras or projection surfaces which you know to have moved.
16. Close the Check Result window. You will be asked if you'd like to re-apply the mesh deform

**Warning:** The stage should be clear

**Warning:** No changing light levels

**Warning:** No people walking across stage

Example

**Accessing rig-check**

1. Open the stage editor by right clicking **Stage** from the dashboard or by right clicking the **floor** in the visualiser.

2. Left click **OmniCal Calibration** to open the OmniCal editor.

3. Ensure that you have a plan already calibrated by a Trained user.

4. Left click **Check cameras**.

**Using rig-check**

1. Ensure that you have a plan already calibrated by a Trained user. It should be selected in the OmniCal Calibrator editor.

2. Left click Check Cameras in the OmniCal Calibrator editor.

3. Verify there are no errors when the rig-check editor opens.
   
   Errors can include the following:
Cameras are unavailable

Camera names have been modified in the plan. The plan capture is used as a reference for Rig Check. Any changes to cameras names after the plan capture was done will invalidate it.

4. The **Check Cameras** window will open which shows camera pairs consisting of the original plan capture and a snapshot capture of the current stage. You can take a new snapshot using the Refresh Camera Views button.

5. Ensure that the camera views match:
   
   a. They don't need to be identical, but the coverage of projection surfaces should match and they should be in approximately the same positions.
   
   b. The brightness of the images should also match. The exact camera settings specified in the plan (like exposure time) will be used here, so any differences would be either due to the physical aperture or focus of the camera lens (for machine vision cameras) or the lighting environment. It is therefore recommended that the focus and aperture of machine vision cameras be locked in place for repeatability.

6. Once you are happy with the camera views, close the Check Cameras window.

7. Left click **Execute Plan**. This will perform a capture, calibration, alignment and optionally a mesh deform if it was configured to run automatically in the plan's deform settings. A new Result object is created which contains the capture and calibration.

8. Ensure that the correct Plan and Result are selected in the OmniCal Calibrator editor.

9. Left click **Check Result** in the OmniCal Calibrator editor. Note that this will apply the Result’s alignment to the stage (if it hasn't been applied already). This will update both projectors and projection surfaces if they have alignment points. If Check Result is greyed out a tool tip should tell you the reason, which can include the following:

   a. The Plan has no capture or calibration

   b. The Result has no capture or calibration
10. Verify there are no errors when the Check Result window opens. Errors can include the following:

   a. The camera names in the Plan and Result don’t match. The Plan may have been modified since the Result was created.

11. The Check Result window will open which shows camera pairs consisting of the original Plan capture and the Result capture that was taken.

12. Left click on a camera image to open the Result Aligner window. If an Mesh Deforms have been applied these will be undone in order for alignment points to be editable.

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14. Select the next screen by pressing the button at the bottom of the camera views or selecting it from the surfaces drop down and repeat the process of checking and adjusting alignment points.

15. Repeat this for all cameras. You could in theory only check cameras or projection surfaces which you know to have moved.

16. Close the Check Result window. You will be asked if you’d like to re-apply the mesh deform.

**Warning:** The stage should be clear

**Warning:** No changing light levels

**Warning:** No people walking across stage