User Manual

Broadcast

October 2014 v1.1

Contents

Introduction

About this guide

This document is composed of an initial Quick Start Guide, with more in-depth coverage in later sections. The Quick Start Guide should be used in conjunction with an already calibrated system. This guide will introduce terminology, as well as the basic procedure required to initialise the camera tracking and set a datum, as well as some recommendations regarding the operational use of Ncam Reality. The latter half of the manual deals with more in-depth details on the calibration elements of the system, as well as a full breakdown of the user interface of the Ncam Reality software.

Terms for the user

Bold – indicates a command, such as **Left** click

Italics – indicates a location, *Top menu bar* or *preferences,* for examples

Initialising

Starting the server

- Ensure all the components of the system and server are connected and powered.
- Power up the server by pressing the power button on the front panel of the server.
- Once the server has booted and the user is presented with the server desktop, **double-click left** on the *Ncam* directory on the desktop.
- Inside this directory, **double-click left** on the *Ncam Reality* icon.
- The server and software will now be running.

Bringing the hardware online

- **Left click** the *start tracking* button in the *top menu bar*.
- In the *top menu bar* select *Devices > At Sensor > Reset*

Ensure that the camera bar is completely stationary while the At Sensor is reset. It does not need to be level however

Selecting camera and lens from database

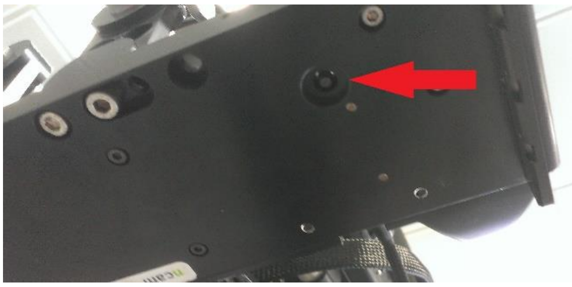
- On the *right sidebar* choose the *Film Camera Details* tab
- Select the correct make, model, and id number for both the main camera and lens being used from the relevant drop down menus.
- Ensure that the default boxes for camera and lens are checked.

If either the lens or main camera is not contained in the database, then refer to the full manual. Adding these is not covered in this Quick Start Guide.

Homing the encoders

Homing the encoders is required to set the range of movement within the software.

- On the underside of the camera bar, to the rear of the left witness, is a small button. **Press** once. This will put the system into *homing* mode.
- The two LEDs on the front of the camera bar will change from a constant green to a flashing red. This is a visual indication that the system is in *homing* mode.
- **Move** the each ring on the lens through its full range of motion from minimum to maximum and back several times.



- **Press** the underside *homing* button on the sensor bar to complete and exit homing mode. The front facing LEDs should return to a constant lit green to reflect this change.

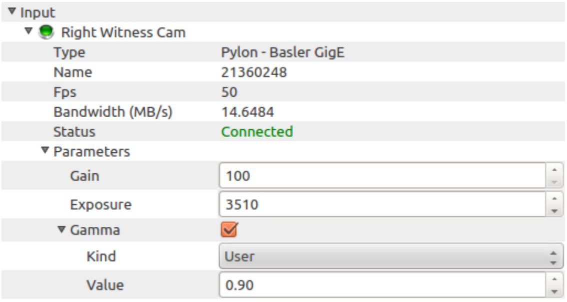
Note on LEDs

From the front of the camera bar, the left LED represents focus and the right LED represents the zoom position of the lens. During the homing process, the rate of flashing changes for each LED: fast flashing indicates the lens position is at infinity focus or tight zoom; slow flashing indicates closest focus or widest zoom. If the flash rate of the LEDs does not match with the actual position of the lens, then the particular range will have to be inverted in the software. Consult full manual for information on this.

- This concludes the homing process. It is vital that this step is completed.

Setting the witness camera parameters

- The manual apertures of the witness cameras should be set to the correct F-stop for the current lighting conditions.
- F-16 is recommended for full sunshine, F-8 for bright but overcast conditions, and F-1.4 for indoor, studio or darker environments.
- The user will ultimately have to judge this themselves. To aid this the user can **Left click** the *Start tracking* button, this will display the view from the witness cameras in the *main area.*
- The exposure, gamma and gain of the witness cameras can be altered in the software. This allows the user to fine tune the witness cameras to ensure optimum point tracking. It is however, only recommended to alter the gain value as a last resort, as it can add noise to the images.
- To alter these settings, in the *system status* tab in the *right side bar*, **expand** the *right witness camera* drop down list (found under *inputs*). Then **expand** the *parameters* drop down.



- The user can then select a variable and **scroll** using the mouse wheel, to gradually change the values. If the tracking view window is open the user can see in real time the effect these changes have.
- Gamma is altered by **checking** the tick box, selecting *User* from the drop down menu, and **scrolling** with the mouse wheel.

Changes in light conditions will require these settings to be modified. And in extreme cases the manual F-stop will need altering too. Unless in a consistently lit environment, the user is advised to consider the lighting conditions at all times.

It is also vital that the left and right witnesses are equally balanced for aperture. Differences in exposure will cause the system to fail to detect tracking points between the two witnesses in stereo, and impact negatively on the quality of tracking.

Tracking

Initialise the track

- If not already done, **left click** the *Start Tracking* button.
- The display will show the contrast points being detected by the system. This is a good view in which to adjust the witness camera parameters to ensure optimum conditions.
- When the witness parameters have been set to optimum, **left click** the *Initialize Tracking* button.

- This generates the initial point cloud. The *Tracking View* window will change to display the points that have been selected for the point cloud.

> *The colour of the dots indicates the magnitude of the feature detected.*
>
> *Purple is the largest, then blue, followed by green and finally yellow being the smallest.*

Selecting a datum - manual

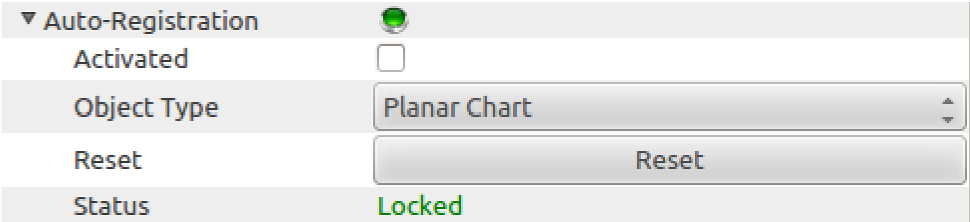
A datum is required to align the virtual assets with the real world. It is suggested to use a prominent point that is easy to select and to find on repeated initialisations.

- On the *left sidebar* change to the *image modelling tab.*
- At the lower edge of the screen will be a pair of images. These are referred to as *Key Positions*. As the camera is moved, more *Key positions* will be generated. They will be added chronologically to the timeline at the bottom, with most recent ones to the right and older ones to the left. Images are always added as a left and right camera view pair.
- The first two key position images are automatically displayed, if a different view is required, then from the timeline, **Click and drag** one image to the *left pane* of the main window, and one image to the *right pane*. Ideally, select the images from the same image pair, as to select a datum it is necessary to see the relevant contrast point in both images. If significantly different images are chosen then the user will be substantially limiting the amount of points that can be used as a datum.
- **Left click** whichever point has been decided on as a suitable datum point. **Press** *space* on the keyboard to select the point as the datum. Instead of pressing the *space* key, the user can also **left click** the *Set WorldRref* button on the interface.
- The user may wish to re-orientate the axes, this can be done by **Holding** the *shift key* and **holding left click and dragging** around the Y axis in either the left or right pane of the main window.
- The red axis represents X (horizontal); the green axis is Y (vertical); and blue axis is Z (depth).

Selecting a datum – Auto-Registration

The auto-registration technique of selecting a datum involves the use of a specific chart that the system will lock the datum to automatically, once it has been detected by the system. The benefits of using auto-registration are that it allows for a very quick, accurate, and easily reproducible datum to be selected. The technique is described below:

- Place the *Registration Object* (RO) chart on the floor in a position that allows it to be easily viewed by the Ncam camera bar.
- In the *right side bar* swap to the *System Status tab*, **expand** the *Auto-Registration* drop down (found under the tracking tree)



- **Tick** the *activated* checkbox and ensure *planar chart* is selected in the *object type* drop down
- **Left click** the *initialize tracking* button on the *top menu bar*
- Move/orientate the camera so that the RO chart is clearly visible in the witness camera view. When detected *"Locked and Updated"* and then *"Locked"* will be displayed in the auto-registration area of the *system status* tab.

To allow the system to reliably detect the Registration Object, it is important for the chart to be well lit and not occluded in any way. Ideally, it should also be within 2 metres of the camera bar.

Selecting a Datum – Planar Fitting

The planar fitting (PF) method of choosing a datum should be chosen only when the camera cannot be kept stationary during point cloud initialization. If the camera is moving during creating the point cloud the vertical axis can become misaligned, the PF tool therefore detects the vertical orientation of the world by estimating it from the tracking points.

Planar fitting is enabled/disabled under the *Registration Object* tab in the *Preferences* window.

With PF enabled, when the point cloud is initialized (by pressing the green tick icon in the *top menu bar*) the software will automatically pick a datum on what it considers to be the ground plane. There are two factors that affect this:

Max gravity to plane normal angle – This variable alters the amount the ground plane is allowed to differ from the camera bars reported vertical axis. Values are in degrees with the maximum value being 90.

Max plane to point distance – Changes the tolerance of points used to detect the ground plane, smaller values will only use closer points.

Operationally, the user can manually select which points are used to estimate the ground plane by switching view to the *image modelling tab* and then dragging a selection box around the points wanting to be used. A selection box is created by holding **left** mouse button in combination with the **meta** key (see hotkey sheet)

The user can swap between how the vertical axis is determined by pressing either the **F9** or **F12** key. **F9** will tell the system to define the vertical axis using the camera bars on-board sensors (not reliable if camera moving), **F12** will use the planar fitting algorithm.

Operational considerations

There are several factors to bear in mind while operating Ncam, these are:

1. The size and quality of the point cloud
2. The lighting conditions
3. The amount of filtering
4. Tracking FPS

Information regarding each variable is provided below.

Pointcloud

The user is able to adjust 3 variables that directly affect the amount of tracking points detected by the system. The variables are *Samples, Grid Side* and *Max Score*. They are located in the *Features* drop down of the tracking tree in the *System Status* window.

Increasing any of the 3 values will increase the number of points detected. It is suggested that the user experiment with the values when testing the system in a new environment. There is often a "sweet spot" beyond which additional tracking points may cause the system to slow down.

Lighting

Depending on the environment Ncam is being used in, lighting can either be extremely easy or more challenging to cope with. An indoor, consistently lit environment, will not require any user involvement once the system has been initialised. Outdoors or in a dynamically lit environment, on the other hand, will require constant monitoring by the user.

The user should initially adjust the manual irises of the witness cameras. Knowing the duration of the session will assist in selecting the correct aperture. For example, transitioning from afternoon light to early evening, the aperture would be set wider than for daylight, to allow accommodation for the failing evening light.

Once the irises have been set, unless there is a small break in broadcasting, the user should make all further adjustments within the Ncam Reality software.

Lighting controls are found in the *System Status* tab under *Input > Right Witness Cam > Parameters*.

Exposure is the main variable to handle lighting changes. Aim to have start with a median value to allow for increases and decreases in illumination. For bright sunlight, the *Gamma* is best left to 1.0, but can be useful to bring texture out of the shadows in flat and failing light. *Gain*, should be used sparingly as although it’s useful in low light conditions, above values of 500, it can introduce noise into the images.

Filtering

Filtering is important variable to be aware of, although the user will not need to modify it after initially testing the system. It is essentially the amount of time the system will use to smooth the tracking data before exporting it. Values below 1.0 hold the data for less time than the delay inherent in the Ncam/Broadcast pipeline, values above 1.0 will cause the tracking data to be held longer and could cause delays.

As a rough rule of thumb, the lower the delay value in the system, the closer to 1 the filtering factors can be set. Too much filtering however can cause a sense of “rubberyness” in the augmented reality graphics, so testing should be done and a suitable filter value found, prior to broadcasting. Too little filtering could lead to some apparent jitter.

Tracking FPS

The final concern relates to the ability of the system to sufficiently handle the computation of all the data. The size of the point cloud as well as the amount of time the system has been running can affect this, as well as the frame rate of the main camera and delay time.

If the system is unable to keep up, a warning dialog will be displayed in the *System Status* tab, if the user has the *Log* window open they are likely to see messages regarding *dropped frames* and *duplicated packets.*

The chief ways to manage this issue are:

- Ensure that whenever broadcasting the *On Air* mode is activated. This is done by **left clicking** the *On Air* button in the *top menu bar*. *On Air* mode, disables all unnecessary operations on the Ncam server.

- Manage the point cloud, adjust the point cloud features (as described above) to prevent the point cloud becoming larger than required.

- Ultimately, resetting the point cloud, will restart the tracking system, it will mean the user will have to reset the datum, so is not something that should be done while broadcasting, but wait until there is a pause. This can be done very quickly. To reset the point cloud **press** the trash icon in the top menu bar, shown here.  Upon pressing the button, a dialog will appear to confirm this action with the user. If the point cloud has grown large, there may be a short delay in deleting the point cloud.

Calibrations and User interface details

This section is intended to expand upon the user interface and the calibration details of the Ncam Reality software. Chiefly, it intends to explain the initial calibrations that are required in setting up a system, as well as how to add new cameras and lenses to the system database.

While the accompanying Quick Start Guide provides a basic checklist of steps required to operate the system, this document will expand on these details by explaining some of the more advanced software features and settings.

When to calibrate

The table below explains when and under what circumstances each element of the system needs calibrating

COMPONENT	
WITNESS CAMERAS	Initial Set up or whenever a different camera bar is used on the Ncam server.
WITNESS CAMERA STEREO LINEUP	- as above -
MAIN LENS CALIBRATION	Only when a new lens is added to the system.
LINEUP	Whenever the camera bar is re-positioned.
ENCODERS	Need homing when the system is powered up.
DELAY	Initial set up, or whenever a new main camera is used or witness camera frequency is changed

N.B. Sometimes a dynamic change in the infrastructure fabric may also require a change in delay – for example where a fibre ring system is employed and default routing changes.

Homing

The homing procedure is done to correlate the range of the movement of the lens barrel with the movement of the encoder system being used. Whether external encoders are being used or if the data is being taken directly from the lens, the procedure is the same.

Homing should be done each time the system is powered up.

The method of homing is as follows:

- Ensure the camera bar is powered and that the system has been "powered on" and the software has been started.
- On the underside of the camera bar, to the rear of the left witness, is a small button (Fig 1). **Press** once. This will put the system into *homing* mode (pictured)
- The two LEDs on the front of the camera bar will change from a constant green to a flashing red. This is a visual indication that the system is in *homing* mode.
- Move the zoom and focus rings of the lens through their full ranges of motion from minimum to maximum and back again several times.
- **Press** the underside *homing* button on the sensor bar to complete and exit homing mode. The front facing LED's should return to a constant lit green to reflect this change

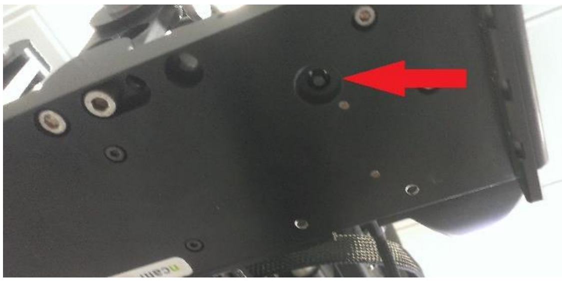


Figure 1

Note on LEDs

From the front of the camera bar, the left LED represents focus and the right LED represents the zoom position of the lens. During the homing process, the rate of flashing changes for each LED: fast flashing indicates the lens position is at infinity focus or tight zoom; slow flashing indicates closest focus or widest zoom. If the flash rate of the LEDs does not match with the actual position of the lens, then the particular range will have to be inverted in the software.

It is important to check that the reported encoder values in Ncam reality relate correctly to the actual positions of the lens barrels. The best method for doing this is as follows:

- Move the lens rings to their minimum positions (wide zoom, close focus).
- In the *System Status* tab, under the *Input* dropdown, open the *Lens Encoder* dropdown.
- This will display the encoder values, check that they are all at 0 (or close to).

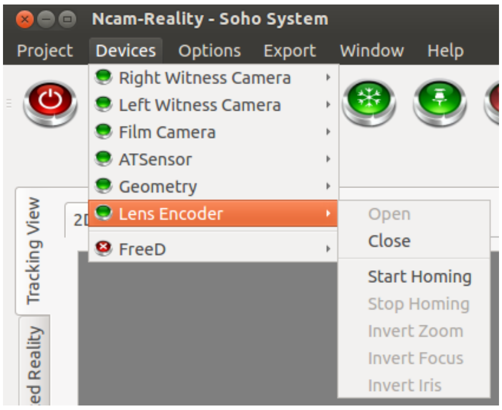


Figure 2

- Move the lens rings to their maximum positions.
- Check in the software that the encoder values are 1 (or close to).
- If any of the values are reversed, for example, at minimum lens position there is a reported encoder value of 1, then the relevant range for that ring should be inverted, this is done in the software by selecting *Devices > Lens Encoder > Invert Zoom | Focus | Iris* (Fig 2)

The Camera/Lens Database

Ncam Reality stores a database of all the lenses and cameras that have been used with the particular system. Whenever a different camera or lens is used, it first needs to be added to the database. Due to the nature of calibration, lenses are stored in relation to the particular camera they were calibrated on, and not globally for all cameras stored in the database.

Adding new cameras and lenses, as well as swapping between existing ones, is handled in the *Film Camera Details* tab, Fig 3.

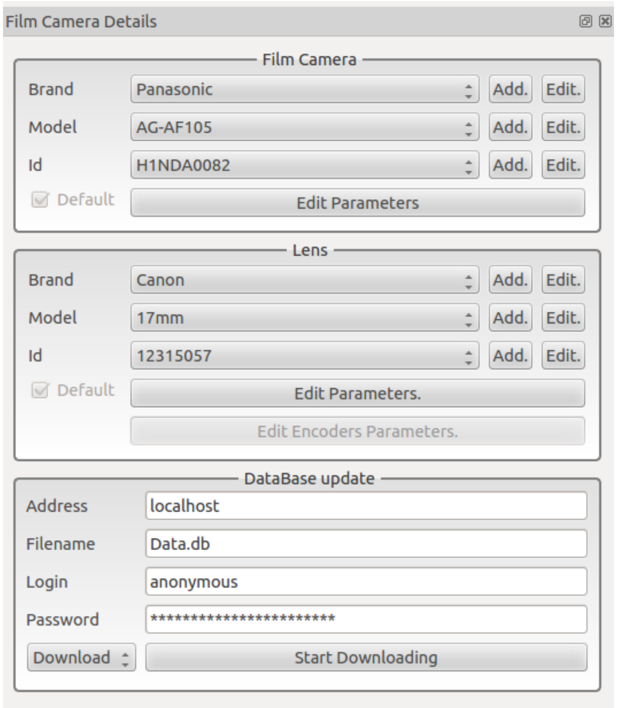


Figure 3

Adding a camera to the database

To add a camera to the database, switch to the *Film Camera Details* tab on the right sidebar (Fig 3).

Add brand, model and unique ID information into the relevant fields using the *Add* buttons.

The *Default* checkbox can be ticked if the user wishes for the selected camera being to be automatically loaded on system start up.

The sensor size of the camera is integral to the successful calibration of the system, this information is entered into the system in the *Parameters* dialog that is opened by selecting *Edit Parameters*.

The exact horizontal and vertical dimensions of the sensor should be entered into the relevant fields. An appendices regarding sensor size is contained at the rear of this manual

Frameline

The Frameline fields refer to a customisable cropping of the rendered image and are not relevant in a broadcast environment. The user should enter the same values as the sensor size.

Adding a lens to the database

Similar to adding a camera, when a new lens is being added to the system the user must first enter brand, model and ID information into the particular fields using the *add* buttons

Again the *Default* box should be used if this lens is to be the preferred one.

Further details are added next in the *Film Camera Lens Parameters* dialog box by selecting *Edit Parameters.*

This dialog is shown in Fig 4.

Firstly in the *lens Kind* dropdown menu the user should select the appropriate lens type. Typically *Simple Spherical* should be used.

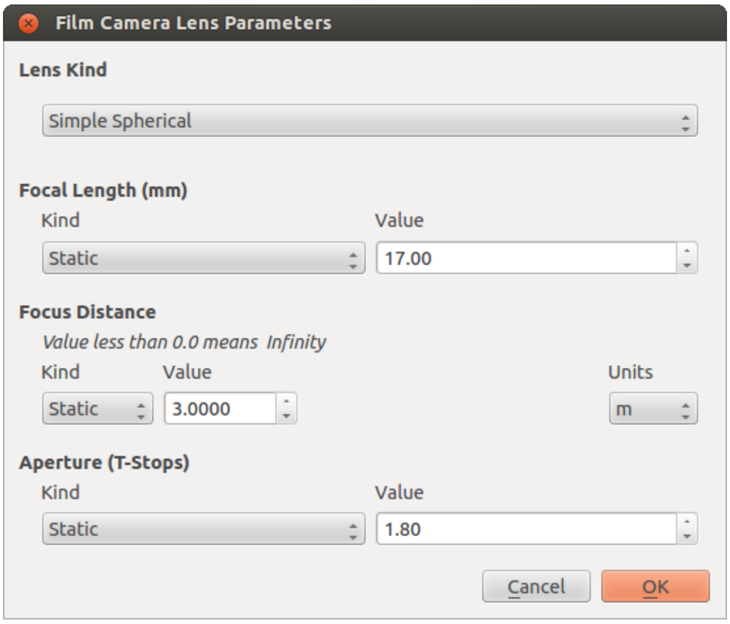


Figure 4

In the *Focal Length* field the range of the lens' zoom should be entered. Almost invariably a varifocal ENG lens will be used in which case the *Kind* dropdown should be changed to *Dynamic*. This will change the interface to allow the user to enter minimum and maximum values for the *Focal Length*. These can be read directly off the lens barrel and should be entered in millimetres.

Prime lenses

Unlikely in a broadcast scenario, but if a prime lens is being added, then the Kind field should be set to ***Static*** *and the single focal length value added to the single available slot.*

This applies to the focus distance field for fixed focal focus lenses also.

Next, the user repeats this process for the *Focus Distance* section, adding the minimum and maximum focus (See *Infinity* note) values as shown on the lens barrel. Values can be added in either metric or imperial, the measurement units selected via the *Units* dropdown.

Aperture data can be added finally, this is done in a similar fashion to the other fields and is therefore not repeated here again.

N.B. In most cases, aperture data is not captured or required, and so this field can usually be left as *Static*.

Infinity

Most lenses use infinity, instead of a defined number, as their maximum on their barrels. It isn't possible to add infinity into the parameters; instead a number twice the value of the previous "focus tick" should be used.

For instance if the penultimate focus distance on the lens is 10m, then the user should add a value of 20m in as the ***maximum*** *parameter.*

Mapping the encoder values

As lens values do not progress in a linear fashion, it is necessary to map the encoder values to specific points on the lens. This will allow the system to interpolate values for zoom and focus at all positions of the lens.

Open the dialog box by pressing the *Edit Encoders Parameters* button, Fig 5. The dialog box has three tabs representing the focus, iris and zoom rings of the lens.

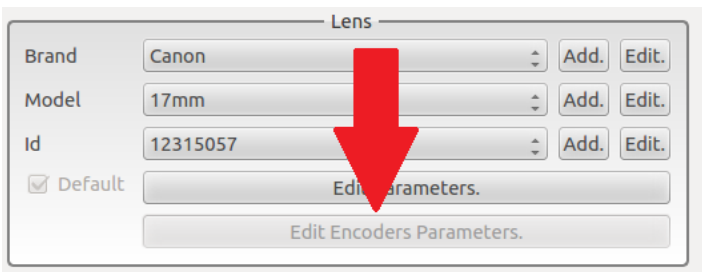


Figure 5

Ensure the encoders have been ***homed*** *prior to this step. See the homing section for detailed instructions on this.*

The process for all three rings is identical and is outlined below:

- Physically move the lens ring to its minimum tick mark.
- Cross check that the reported encoder value is at (or near to) zero.
- Into the field, enter the numerical value for that particular tick and press the *Add* button. Importantly, ensure that the lens position isn't changed until the value has been added to the table.
- Move to the next tick mark on the lens barrel and enter that value.
- Repeat this process for all remaining tick marks.
- On the focus ring for the final "infinity" tick mark, use a numerical value twice the previous tick.
- Finally, double check several of the values to see if the *Interpolated* value corresponds to the lens ring position.

Once all three lens rings have been mapped, the process of adding a lens to the database is complete. The lens will still need to be calibrated however. This procedure is described in the lens calibration section.

Lens calibration

Ncam Reality uses a pattern-based calibration system to map the behaviour and distortions of the main camera lens. A calibrated lens is a requirement to be able to calculate the offset between the Ncam camera bar and the broadcast camera. This is essential for providing accurate tracking data.

Starting lens calibration

To open up the main lens calibration screen select *Calibrate Lens* from the *Devices > Film Camera* drop down in the *top menu bar.*

Calibration suggestions

- *A spacious, consistently lit environment.*
- *A robust stand for firmly holding calibration charts.*
- *Additional, moveable lighting.*
- *Setting the Ncam server adjacent to the camera.*
- *The camera is set to a progressive video mode.*

The lens calibration screen (Figure 6) is made up of several elements, these are:

- The video image from the main camera on the left hand side.
- A 3D plot of the lens calibration on the right hand side.
- A table showing data values for all computed points shown on the bottom of the screen.
- Settings and acquisition controls on the right hand screen edge.

The basic principle of a lens calibration is to create calibrated points, or "nodes", at different combinations of zoom and focus. The number of nodes that will need creating will depend on the type of lens. As a bare minimum, 9 nodes are suggested (all the combinations of minimum, medium and maximum zoom and focus positions), but generally an ENG zoom lens may require between 18 and 27 nodes. The software will interpolate between these nodes, however as lenses do not proceed in a linear fashion additional nodes will probably have to be added to aid in interpolation. The user will have to use their own judgement, as each model of lens is different.

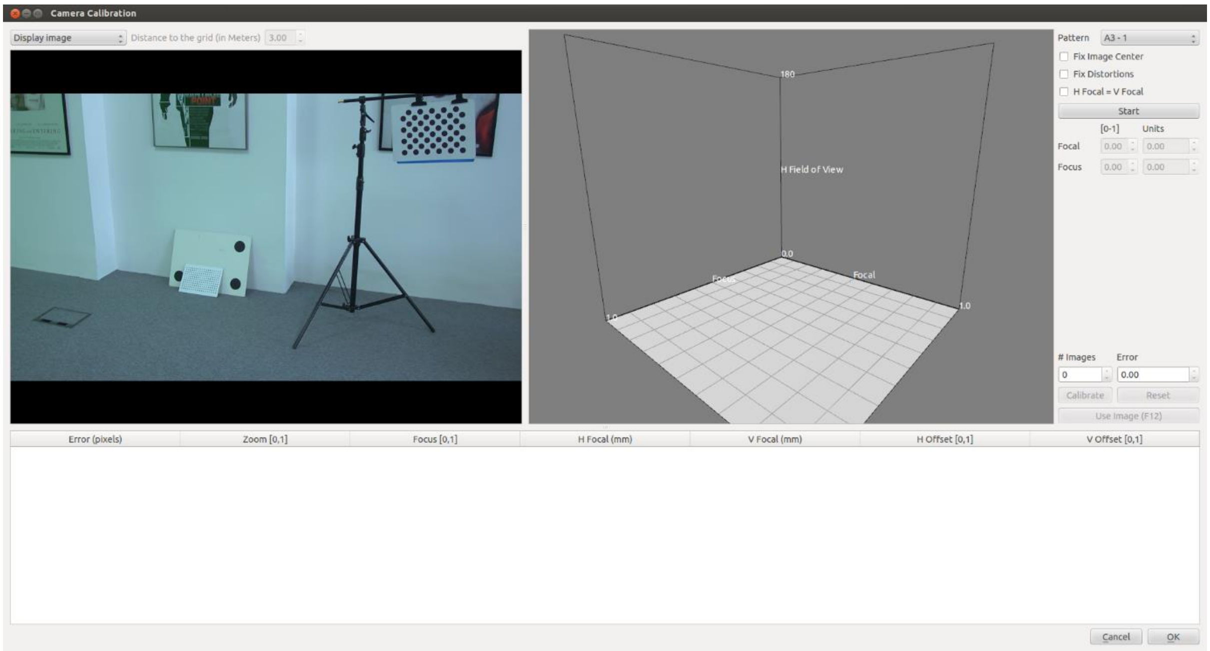


Figure 6

Creating a node

The basic process for creating a node is outlined here. The user will then be required to repeat these steps to create sufficient nodes for an adequate calibration. Before starting this process ensure that the encoders have been homed and that the software ranges are correct.

Nodes are created at the intersection of the black axes shown in the 3D plot, the user is recommended to use the 3D plot as a tool to see where to position nodes, and to use the zoom and focal length displayed values to ensure nodes are positioned on a rigid grid pattern wherever possible.

- From the right hand bar, select the chart type being used from the dropdown *Pattern*.
- Press *Start* (Figure 7)
- Position the chart so that it is fully seen in the video image and that it is in sharp focus, this will enable the chart to be recognized by the system and is indicated by a coloured overlay being displayed over the chart, Figure 8
- Additionally, twist the chart so that it is at an angle to the line of sight of the camera.

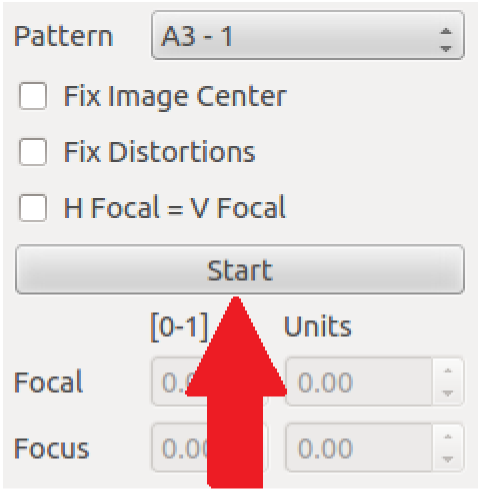


Figure 7

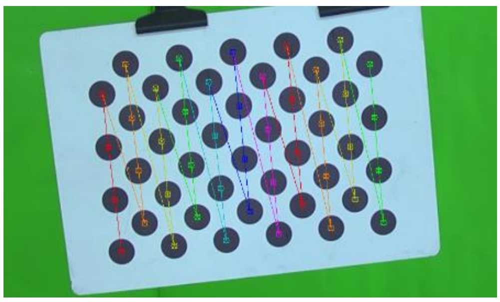


Figure 8

Additionally, in the upper left side of the video feed screen a coloured dot will be displayed (Figure 9), this will alternate between green, yellow, and red.

It represents how well the system is detecting the orientation of the chart. Ideally this will show green, but may turn yellow or red at times. Green is the desirable setting, but good calibrations can be achieved with a mixture of snapshots.

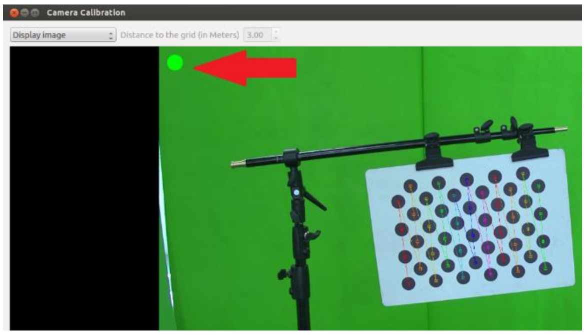


Figure 9

- Aim the camera so that the chart is aligned into a corner of the frame, in the user interface press *Use Image* or instead press the *F12* key on the keyboard (Figure 10). This will take a snapshot of the chart pattern in that position of the frame, the user will notice a green overlay of small dots left in the position of that snapshot on the screen. As the camera is moved and more snapshots are taken, the screen will become covered with the green dots,

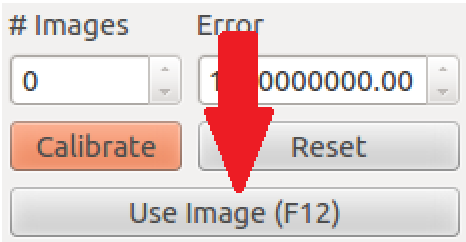


Figure 10

  indicating where the snapshots have been taken. The aim is to cover the whole frame by these green dots.
- Ideally, if the camera is set to a progressive mode, the user can slowly pan and tilt the camera while simultaneously pressing *F12* to cover the whole frame. Depending on the scale of the chart, the number of required snapshots to achieve this will vary, as a rough rule of thumb, around 100 images should be sufficient.
- Having covered the screen from one position, move the chart forward or back slightly, and change the twist, and repeat to grab yet more snapshots.
- Figure 11 indicates a suitably filled frame.

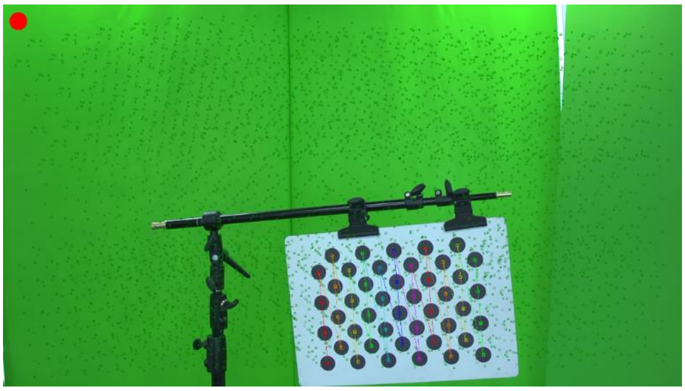


Figure 11

- After filling the frame and two passes there is probably around 200 snapshots, press the *Calibrate* button on the right hand side bar. The system will then compute the node values from the snapshots gathered. The time taken for node creation will depend on the number of snapshots taken – more than 400 snapshots could significantly increase calculation time for the node. Importantly the lens barrel rings should not be altered until the software has finished calculating the node, and the values have been added into the node list.
- When the calculation is complete a node will be created, this is represented by an entry in the data table on the bottom edge of the screen, as well as visually by a new point in the 3D plot.
- The user should then adjust the zoom/focus positions to the next area judged to require a node and then repeat this process again.

Chart selection

Depending on the zoom/focus position of the lens, different charts will have to be used. In some cases however no chart will be able to be suitably framed in the camera. In this case, the user can select a "partial" chart from the chart selection drop down menu. This will allow the system to recognize a partially framed chart, care should be used when taking snapshots in this mode, as it isn't the preferred method of operation.

It is suggested that the sequence for creating the first 9 nodes is:-

Node	Focus	Zoom
1	0.0	0.0
2	0.5	0.0
3	1.0	0.0
4	0.0	0.5
5	0.5	0.5
6	1.0	0.5
7	0.0	1.0
8	0.5	1.0
9	1.0	1.0

Saving

Throughout the calibration process the user is advised to occasionally select *Stop* and *OK* from the bottom right hand of the screen (Figure 12). This will close the calibration screen, but in doing so it saves the current nodes to the database. This prevents the loss of data due to power loss or user error. Following this, the user can reopen the lens calibration screen as normal and continue the calibration.

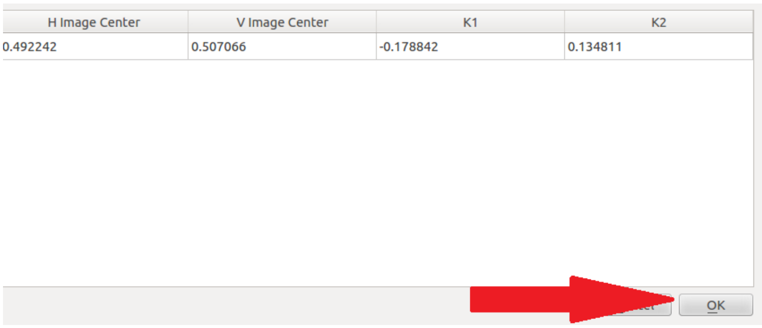


Figure 12

Checking the calibration

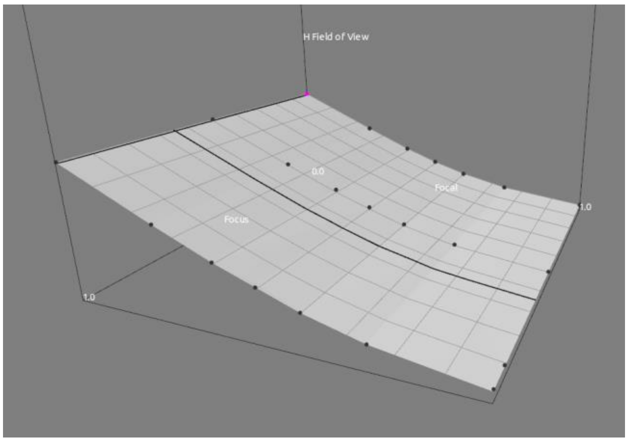


Figure 13

Figure 13 shows a completed 3D plot, it is apparent where additional nodes have been created to aid interpolation between the 9 fundamental nodes (Min zoom – Min focus, Min zoom – Med focus etc.)

Prior to this completed stage however the user is recommended to check the quality of the calibration by using the *grid overlay*. Chiefly, this will indicate to the user where additional nodes are needed, and it also acts as a final check and proof at the end of the calibration process.

Using the grid overlay

The basic premise of the grid is that it displays over the main camera image a computed generated grid pattern calculated from the measured distortions of the main lens. If the lens has been calibrated well, then as the zoom and focus of the lens is slowly racked, the grid overlay should distort in the same fashion as the camera image behind it. The primary technique for using this is to align grid intersections over prominent features of the environment shown in the video feed, then to slowly traverse the zoom or focus of the lens, the grid line or intersection should stay “locked” to the real feature behind it.

N.B. It is necessary for the camera to be on a head and tripod, and for the pan and tilt to be locked off when performing these checks.

To bring the grid up, select *Display 3D Grid* from the drop down menu in the top left of the calibration screen (Figure 14). The user can also adjust the scale of the grid using the dialog box next to this as an aid in helping line up the grid with features in the video feed.

It is suggested to check the horizontal match of the lens primarily, and to correct this using H focal.

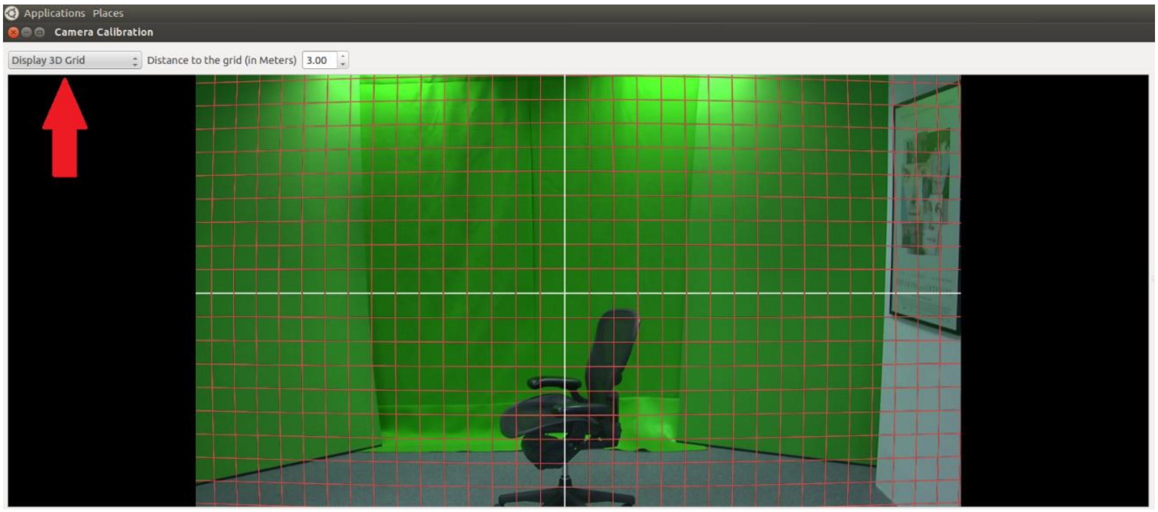


Figure 14

Refining data values

Depending on the results of using the grid overlay the user may have to modify some of the node values. This is done using a combination of the 3D plot view and the node data table on the bottom edge of the screen.

Error (pixels)	Zoom [0,1]	Focus [0,1]	H Focal (mm)	V Focal (mm)	H Image Center	V Image Center	K1	K2
0.0497826	0.000482461	0.000373539	9.08564	9.08564	0.510394	0.50514	-0.131995	0.433547
0.0475732	0.000482461	0.499496	8.55767	8.47212	0.510394	0.504271	-0.172291	0.2534
0.0519353	0.000844306	0.998095	8.11416	8.11416	0.510394	0.508552	-0.212584	0.157379
0.0527312	0.250317	0.501718	13.4896	13.4896	0.510394	0.501993	0.161522	0.858001
0.0470365	0.250317	0.999626	12.5942	12.5838	0.510394	0.500861	0.0617428	0.542263
0.0724328	0.250417	0	14.4947	14.4947	0.510394	0.500861	0.287539	1.29313
0.0900977	0.395851	0.00102643	20.7808	20.7808	0.510394	0.500861	0.781305	-0.137309
0.031911	0.396173	0.49274	18.9579	18.9579	0.510394	0.500861	0.608999	0.703289
0.0245107	0.399208	0.999981	17.4172	18.1021	0.510394	0.500861	0.410978	0.672825

Figure 15

The different groups of the node data table (Figure 15) are explained here

- Error – refers to the quality of the calibration of that node, a lower number is preferred, ideally below 0.1

- Zoom – the zoom encoder value for that node
- Focus – the focus encoder value for that node.
- H Focal – The calculated horizontal focal length of the lens at that encoder position.
- V Focal – the calculated vertical focal length of the lens at that encoder position, for a spherical lens this should be a similar value to the corresponding H Focal entry.
- H Image Centre – the horizontal calculated position of the optical centre of the lens.
- V Image Centre – the vertical calculated position of the optical centre of the lens.
- K1 – A distortion value for the node.
- K2 – A distortion value for the node.

N.B. Only the values for H Focal, V Focal, H Image Centre, V Image Centre, K1 and K2 are user editable. Error is a calculated value, and Zoom and Focus are read from the encoders as the node is added.

Values that may need changing in the table are the H and V focal fields and the H and V image centres. If when using the grid overlay, the user noticed the white centre axis of the grid drifting from the feature they were locked on, then it is the *image centre* values that will need modifying. If the red grid intersections away from the centre were seen to distort differently, then it is the H and V focal values that will need adjusting.

When selecting a data value in the table, the corresponding node will be coloured purple in the 3D plot view. The user should ensure the correct node is selected before adjusting values, they should then make small adjustments while moving the zoom/focus between two points to see the effect the alterations are making to the grid in real time

It should be noted that this is an involved and iterative process and hence is beyond the scope of this manual to explain fully.

Converting Lens files between Progressive and Interlaced

Due to the nature of how video frames are generated between progressive and interlaced video modes, it is much quicker to calibrate the lens in a progressive mode. If however the broadcast camera typically operates in an interlaced mode, our lens calibration file will need to be converted to an interlaced format. The only way to do this is by manually opening up the calibrations database and editing the lens details in there. A description of how to do this is provided within the appendices at the end of this document.

Exporting the lens calibration

It is important to understand, that while the lens is calibrated within the Ncam system, it is the graphics partner that uses the Ncam tracking data who ultimately requires the lens calibration information. To facilitate this, there are options within Ncam Reality that allows the user to export the lens data in a variety of file formats that can then be passed on to the graphics partner. The basic steps for creating a lens file are listed below. Details relating to specific graphics partners are also provided

The steps for exporting the lens file are:

- In the Film Camera tab, select the lens that you wish to export.
- Select *Export* from the top menu bar.
- From the drop down menu, open *Camera Parameters* (Figure 16)
- Choose the file type to save to, this depends on the graphics partner being used.
- Save the file to the server hard drive, with a meaningful name.
- Copy the lens file to a USB memory stick or similar and pass this over to the graphics partner operator.

Figure 16

VizRT

Typically the lens file calibrated within Ncam simply needs passing over to the VizRT operator via a memory stick. However a few extra details of how it is applied within the VizRT environment are provided below.

VizRT utilize more than one type of file format for their lens calibrations. The type that *Ncam Reality* exports is only compatible with the *Viz Engine.* There is no GUI to apply the lens directly to the engine however, so to achieve this the Ncam lens file needs to be renamed to **camera1.lcb** and placed inside the directory containing the *Viz engine .exe file.* This will cause the lens file to load up automatically upon starting the engine.

Beyond this, it is important for the lens limits (similar to Ncam's homing procedure) and centre shift to be set up within the *studio setup* environment of *VizRT*. This is beyond the scope of an Ncam operator but is mentioned here so that a rough idea of the steps required to correctly apply Ncam lens files is described fully.

Lineup

About

The lineup refers to the calibration of the offset of the camera bar to the image sensor of the main camera. It is an absolutely critical factor for producing satisfactory tracking. It can only be done once the camera bar and the main camera lens have been calibrated.

Technique

To start the lineup, select *Lineup* from the *Devices > Film Camera* drop down menu in the top menu bar. This will display the lineup screen (Figure 17), which contains the right witness camera view on the left and the main camera video feed on the right, as well as acquisition controls in the top right.

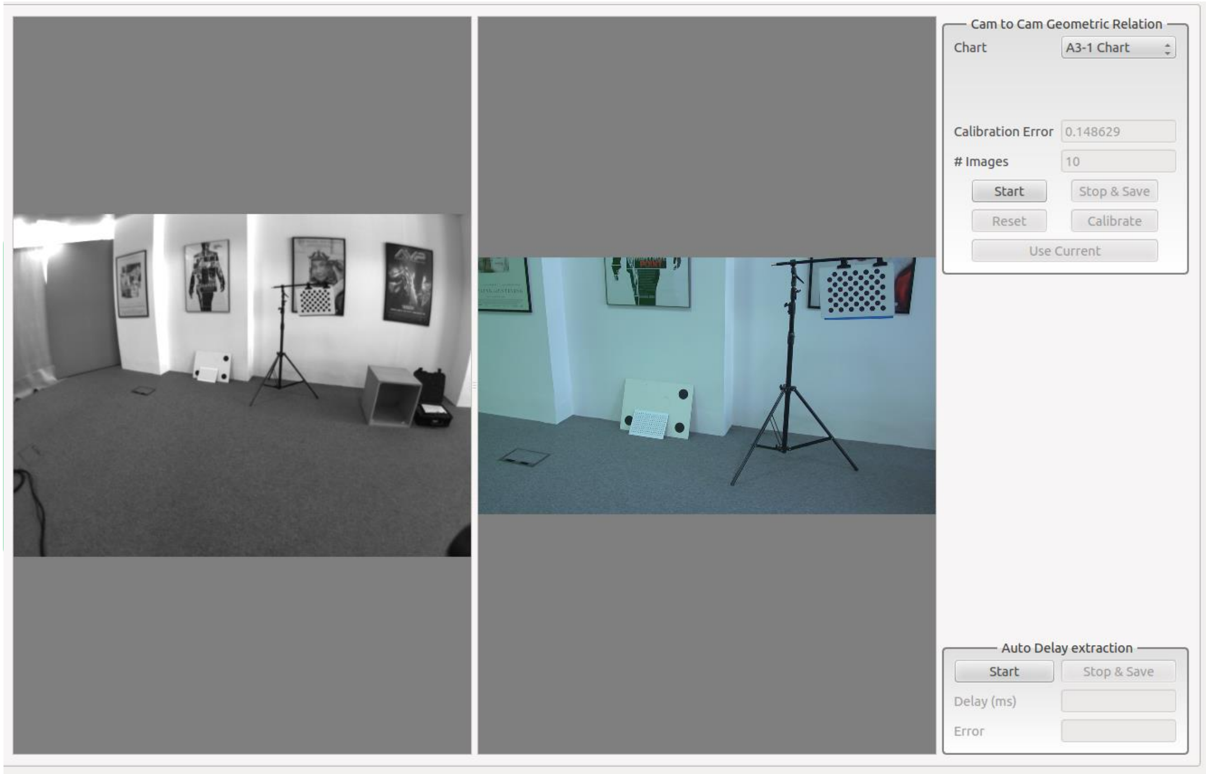


Figure 17

A step by step process for calculating the lineup is described below:

- Set the main lens to be at closest focus and widest zoom.
- Position the chart so that it is fully visible in both frames, typically this will involve bringing the chart quite close to the camera due to the fixed focus of the Ncam camera bar.
- Select the correct *Chart* from the drop down menu in the top right – typically this will be the A3-1 chart.
- Select *Start* from the same menu.
- Ensure that a coloured overlay is visible over the chart in both frames. It may be necessary to adjust the exposure controls of the witness cameras and/or the iris of the main camera.
- Once the chart is seen and here is a stable coloured overlay, press *Use Current* to take a snapshot. Press *Use Current* more than 8 times (10 is usually sufficient) to add a number of snapshots.
- Then press *Calibrate*. The system will compute its position and produce an error value. If this value is below 0.1 then press *Stop and Save*. If it is greater than 0.1 then it is recommended to press *Reset* and repeat the process until a lower value is obtained.

Calculating the delay

One final calibration that is required is to ascertain the timing between the main camera video feed and the data from the Ncam camera bar. This value varies depending on the model of camera being used as well as the video path into the Ncam system. The delay time plays an important role in the tracking quality of Ncam with regard to filtering, and this aspect will be explained further.

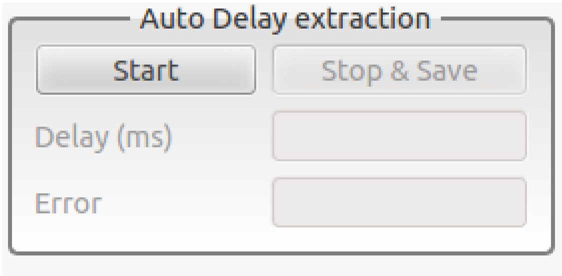


Figure 18

To calculate the delay a slow flashing light is used, this is registered in the right witness camera and the main camera. The controls for calibrating the delay are found in the lower right hand side of the *lineup* screen. The process is described below

- Position a flashing light in front of the camera bar and main camera, a stand is helpful for this, typically a flashlight app for a smartphone is used to produce a flashing light. (Typically, Flashlight by GreenGar is used for IOS devices, with a strobe value of 0.3)
- Make sure there is no other movement in the frame of the two video feeds, and that no-one walks through the shot while calibrating, otherwise the process will need to be restarted.
- Press *Start* (Figure 18)
- A delay value and error value will display in real time, these will gradually improve in accuracy over time, when the error value is below 1 the user can press *Stop and Save.*
- It may be necessary to restart this procedure several times to get an accurate value.
- The user can also manually adjust the delay value in the *system status* tree under *Witness-Film Relation > Delay* (Figure 19)

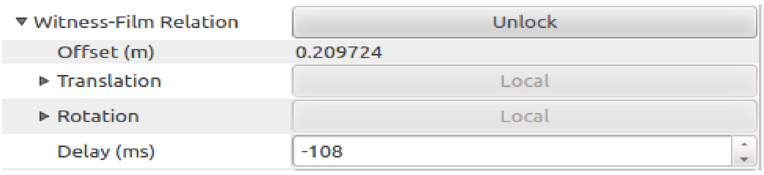


Figure 19

Significance of the delay value

The larger the value of the delay, the greater the time that Ncam Reality has to filter the tracking data, and therefore produce a smoother result. Having a larger delay will give the system more time to process tracking data, thereby reducing the chance of system slow down when large point clouds are present.

A value of around 50ms is considered an adequate delay. The delay in Ncam can be increased from the calculated value to around 50msec, as long as the timing can be adjusted in the graphics engine downstream and the graphics made to synchronise with the video feed.

ncam®

Witness camera calibration

The witness cameras should only need calibrating during the initial set up of a system, the calibration of the witness cameras is saved to the Ncam server, so if a different camera bar is used on that server, or the camera bar is moved to a different Ncam server, then the witness cameras will need calibrating again. Also, if the frequency of the witness is changed, from 50 Hz to 60 Hz for instance, then the delay will need re-calibrating.

There are two calibrations required for the witness cameras, these are:

1. A lens calibration for each witness camera, the technique for this is similar to the calibration of the main lens.
2. A stereo calibration to determine the offset between the two witness cameras, similar in fashion to the lineup calibration.

Error Values

When calibrating the left and right witness cameras, the user should try to achieve an error value below 0.04 for each lens.

For the stereo calibration, the user will not be able to achieve an error value lower than that achieved for the calibration of either the left or right witness cameras.

Witness lens calibration

The technique for calibrating the witness lenses is identical to the main lens calibration. However as the witness cameras are fixed zoom and focus, it is greatly simplified. A basic step by step is listed below, for a more detailed explanation, the user is invited to read the main lens calibration section as this provides more thorough instruction.

- Open the lens calibration screen by selecting *Devices > Right Witness Camera > Calibrate Lens*. (To calibrate the left witness camera, select *Left Witness Camera* from the Devices menu).
- Select the chart type being used (typically A3-1) from the *Pattern* dropdown in the top right.
- Press *Start* (Figure 20).
- Position the calibration chart so that it is clearly visible and the coloured overlay is displayed in the system

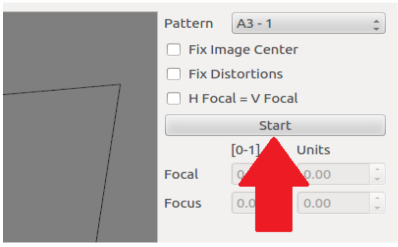


Figure 20

- Press F12 (or *Use Image* button on the interface, Figure) repeatedly while panning and tilting the camera so that multiple snapshots are taken of the chart in all positions of the frame.

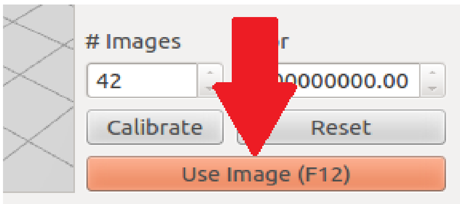


Figure 21

- Press *Calibrate* (Figure 22)

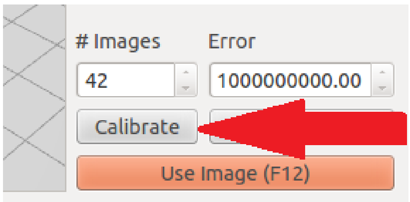


Figure 22

- When the system has finished creating the mode, press *Stop* and *OK* to save and exit, (Figure 21)

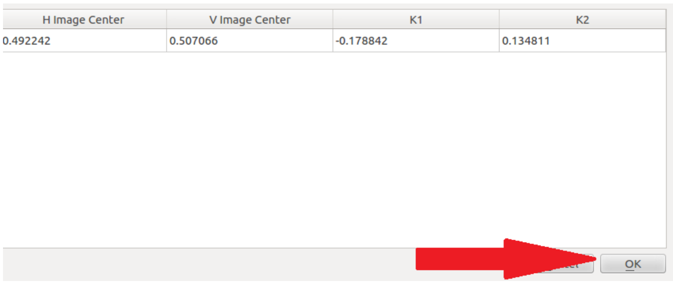


Figure 21

Witness stereo calibration

Stereo calibration will again only need to be done on an initial set up or when a new camera bar/server combination is used. The principle is the same as for the lineup calibration between the camera bar and the main camera. The steps for it are as follows:

- Enter the stereo calibration screen by selecting *Devices > Right Witness Camera > Calibrate Stereo* (can also be reached through *Left Witness Camera* drop down).

- Select the *Chart* type being used (typically A3-1) and press *Start* (Figure 22)

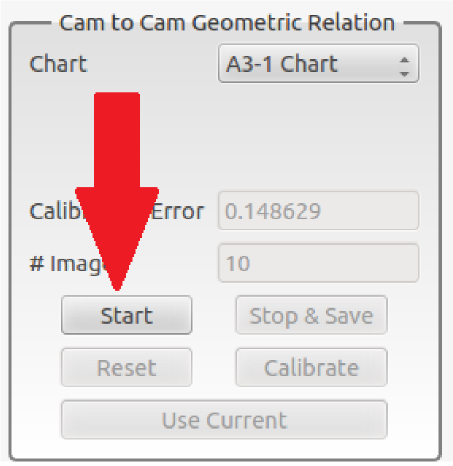


Figure 22

- Position the chart in front of the witness cameras, and within the software check to see that the coloured overlay is displayed over the chart in both the left and right camera feeds.
- Press *Use Current* to take an snapshot (Figure 23)

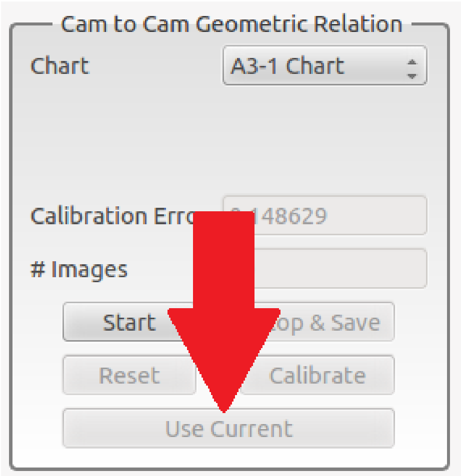


Figure 23

- Move the camera bar position and repeat this until around 10 to 20 snapshots have been taken.
- Press *Calibrate* (Figure 24), and an error value will be calculated and displayed. Check that the value is below 0.1.

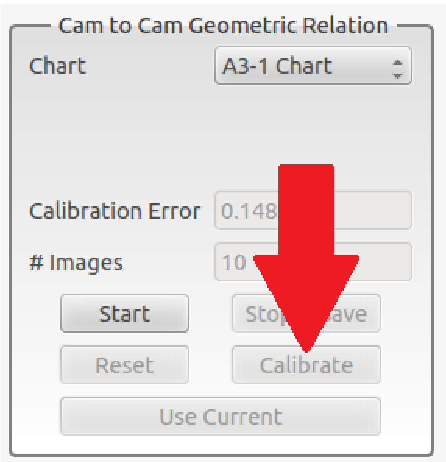


Figure 24

- Press *Stop and Save* (Figure 25)

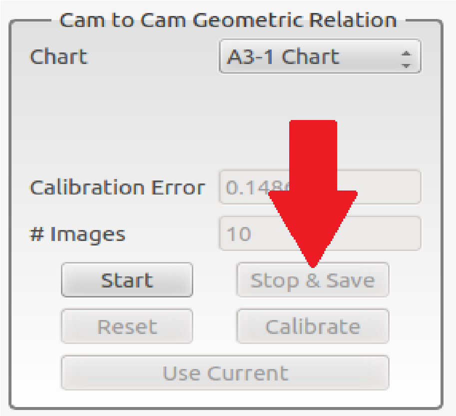


Figure 25

Ncam Reality, UI and preferences

About

This section is intended to explain the main areas of the GUI as well as features and variables the user can adjust within the Reality software. Provided at the rear are diagrams illustrating Hotkeys.

User interface

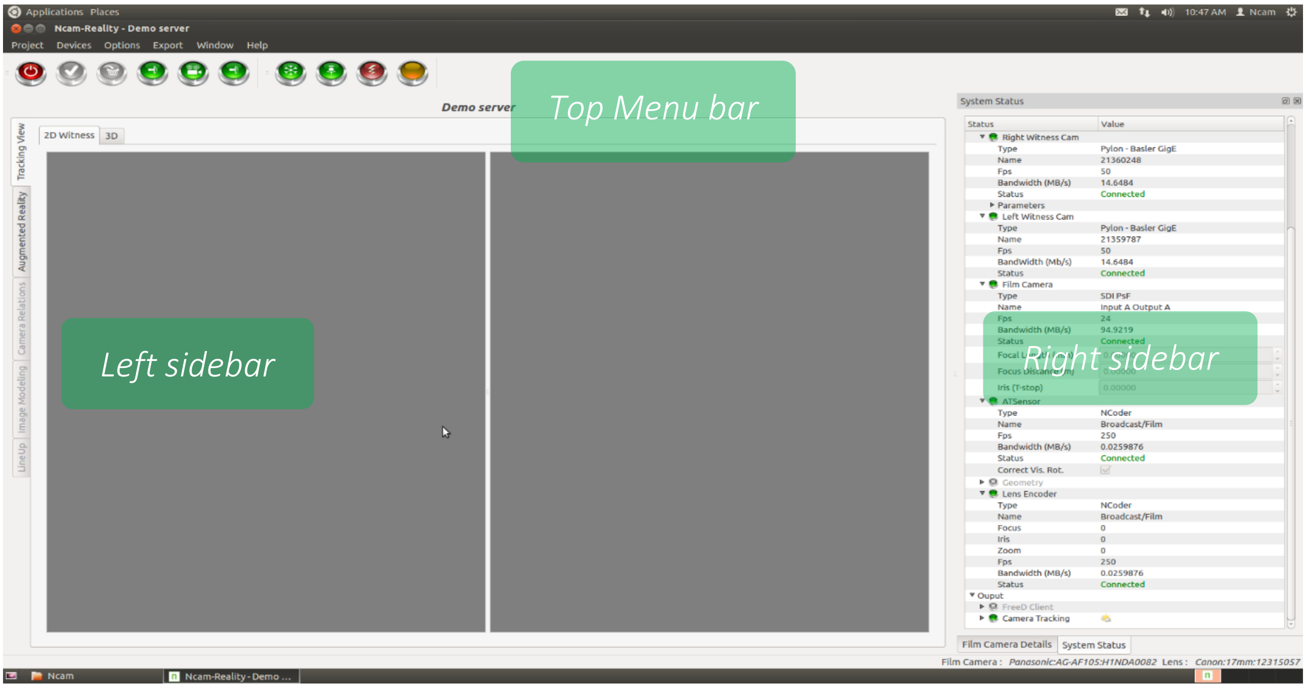


Figure 26 The main gui window with the terminology used for each area

Top menu bar

Project – Save/load controls and Quit command for exiting software.

Devices – Shortcuts to Open/Close each system component, as well as to calibrate them.

Options – Displays the system preferences.

Export – Used to export the current lens file.

Window – Allows the user to select additional windows to display in the gui.

Help - Displays the current software version.

Left Sidebar

This area provides tabs allowing the user to swap between the different windows of the user interface. Of primary importance are the Tracking View tab and the Image Modelling tab. These will be used most frequently by the user to monitor the tracking and for selecting a datum respectively.

Right Sidebar

The right hand side bar features tabs at the lower edge to swap between different windows. The most important tabs are the *Film Camera Details* tab, and the *System Status* tab.

The Film Camera Details tab is used to initially select the model of camera and lens being used.

The System Status tab should be displayed during operation, as it provides feedback on the quality of tracking as well as allowing the user to modify certain variables.

Software directory structure

The Ncam Reality application is contained within the Ncam directory displayed on the main desktop of the server.

Within this directory is the executable for the reality software and a Calibrations folder. The calibrations folder contains a master database file named – CameraAndLensV2.db3 – that contains all the settings for the Ncam Reality software. **The user is recommended to keep a backup of this file**. The .pfs files contain the calibrations for all the camera bar witness cameras that have been connected to that server.

Preferences

The preference dialog window allows the user to adjust system settings, it also contains presets that allow the user to swap between pre-defined modes.

The preference window is opened up by using *Options-preferences* from the top menu bar, Figure 27

Figure 27

The preference window is composed of 6 tabs along the left hand side and a row of preset selections .along the upper edge, Figure 28.

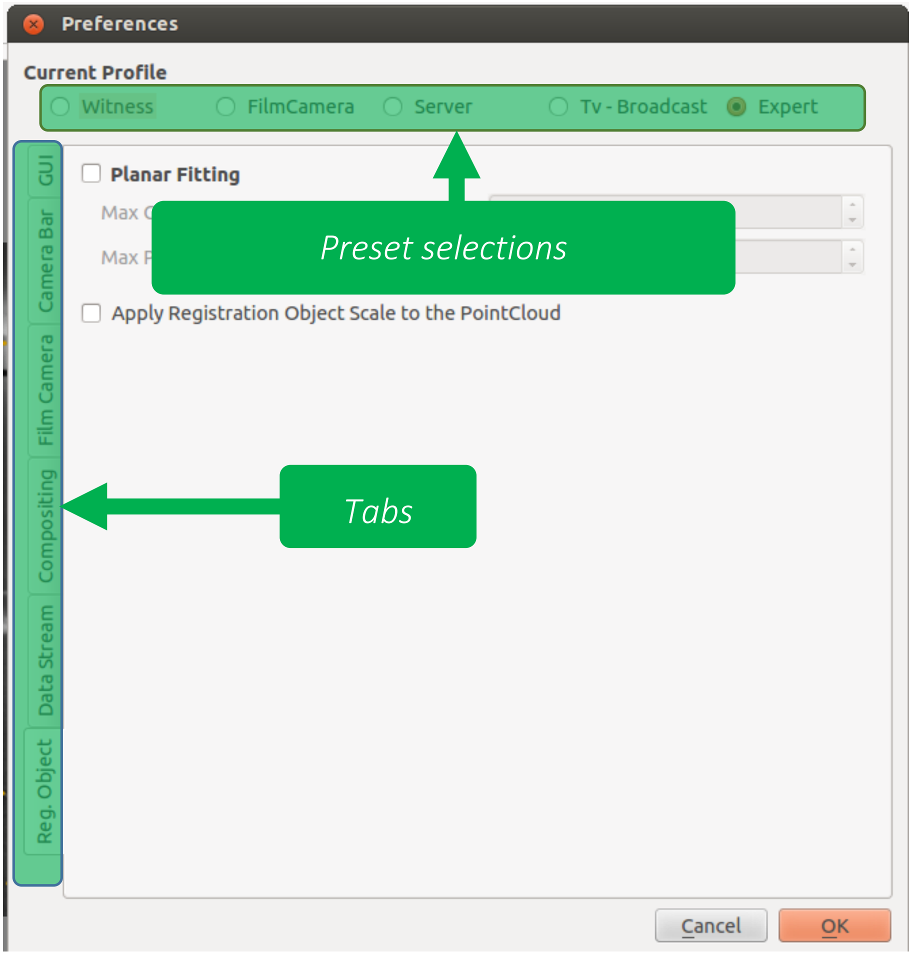


Figure 28

The presets swap the Preference Settings to enable/disable certain features. If the *Expert* preset is selected then it allows all options to be modified. It is suggested that the user selects the **TV-Broadcast** preset, this will ensure the appropriate preferences are always enabled, but to change values, *Expert* will need to be selected.

A brief description of the tabs and preferences that relate to the broadcast environment are listed below

GUI Tab

The GUI tab (Figure 29) contains the *system name* dialog which allows the user to rename the system name (this is displayed on the main desktop screen). The *Auto open devices on startup* tickbox, when enabled, automatically powers up the system upon starting up the Ncam Reality software (providing all the elements are connected and powered). Having this activated streamlines the startup procedure greatly.

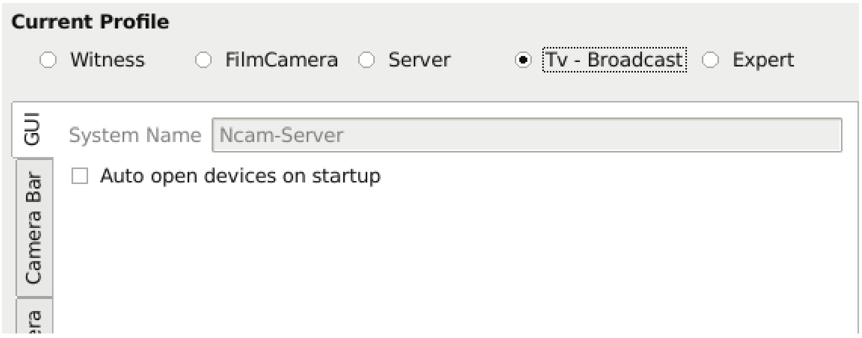


Figure 29

Camera Bar tab (Figure 30)

Camera bar version – Tells the system the model of camera bar being used. "Broadcast/Film (Optical Fiber or 1 x Cat6" Should be typically selected as the other options are legacy options for previous hardware revisions.

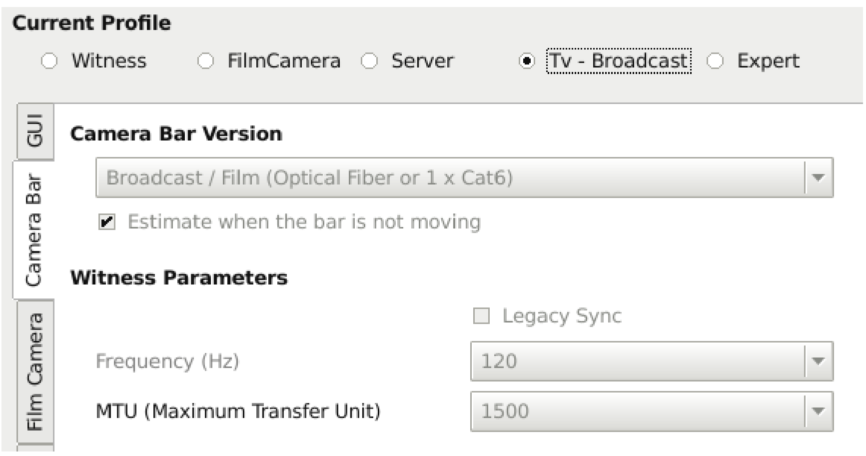


Figure 30

Estimate when the bar is not moving – When enabled the system makes an estimation on whether there is any movement of the camera, depending on how the system is mounted it may help produce better results.

Legacy Sync – A legacy setting for an older version of the camera bar. Should not be activated unless specifically advised by an Ncam technician.

Frequency – Sets the frequency of the witness cameras, it is useful to be able to adjust this to reduce a strobing effect from artificial lighting. However changing to a different frequency may result in having to recalibrate the witness/Film delay.

MTU – Sets the packet size of the data transmitted from the bar, the larger 8192 size is more efficient and should be used as default. (This is a jumbo frame size, and may not pass through some network switches).

Film Camera Tab (Figure 31)

This tab deals with parameters relating to the main camera. **They are typically not relevant in a broadcast environment**

Use Film video feed – With this unchecked allows Ncam to operate without a video input from the main camera. This can be useful for making basic tracking tests in a scenario where a camera is not immediately available.

Use Psf signal as P – When active tells the system to handle Progressive segmented frame (Psf) feeds as Progressive (P) instead.

Display logo when not ready – When checked, an Ncam logo will be displayed on Ncam's video output when the system is not tracking.

Input is LogC – When activated, it tells the system that the main camera feed is operating in the Arri LogC colourspace, this is not relevant to broadcast.

Auto Gen Anc Data – If enabled, it will generate a timecode and other metadata on the output video if none is supplied on the input video signal.

Start Geometry Streamer – Turns on and off the streaming of assets **into** the Ncam system, it is not relevant in the broadcast scenario

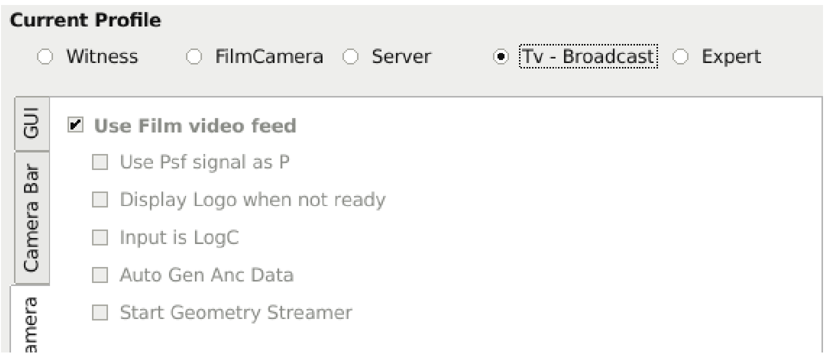


Figure 31

Compositing (Figure 32)

The compositing tab is completely redundant in a broadcast setting, the settings within it refer to assets streaming into Ncam and with how shaders are handled in the Ncam renderer.

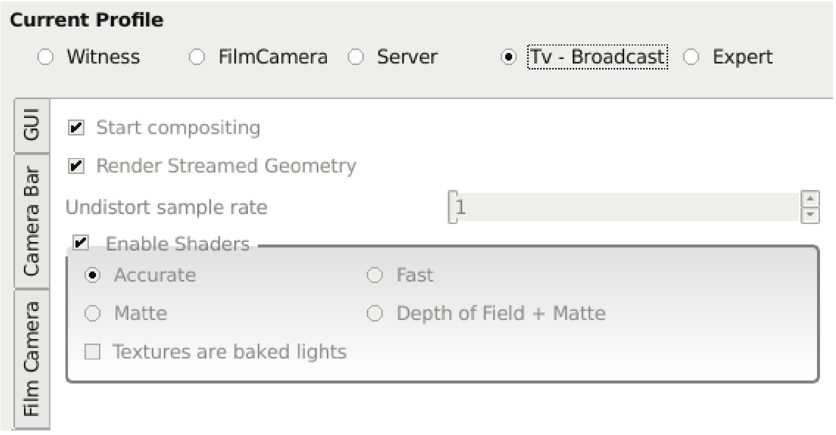


Figure 32

Datastream Tab (Figure 33)

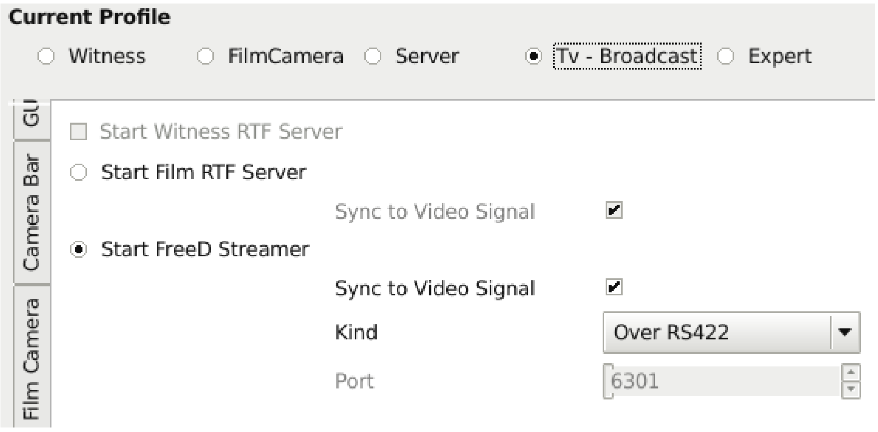


Figure 33

This tab contains the parameters for handling the output of tracking data from Ncam. The user can select between different output options, these are:

Start Film RTF Server – The system will stream tracking data through the network to the rendering engine.

Start FreeD Streamer – This option tells the system to use the FreeD format to stream data, the *Kind* field selects to send this over a RS422 serial or UDP network connection.

Sync to video signal – This synchronizes the tracking data to the video signal and should be selected.

Registration Object tab (Figure 34)

Planar Fitting – When planar fitting is activated the system will automatically try to detect the ground plane, it can be useful to use when the camera cannot be kept stationary while tracking is initialized. Usually this is disabled.

Max gravity to plane normal angle – This variable alters the amount the ground plane is allowed to differ from the system's computed vertical axis. Values are in degrees with the maximum value being 90.

Max plane to point distance – Changes the tolerance of points used to detect the ground plane, smaller values will only use closer points.

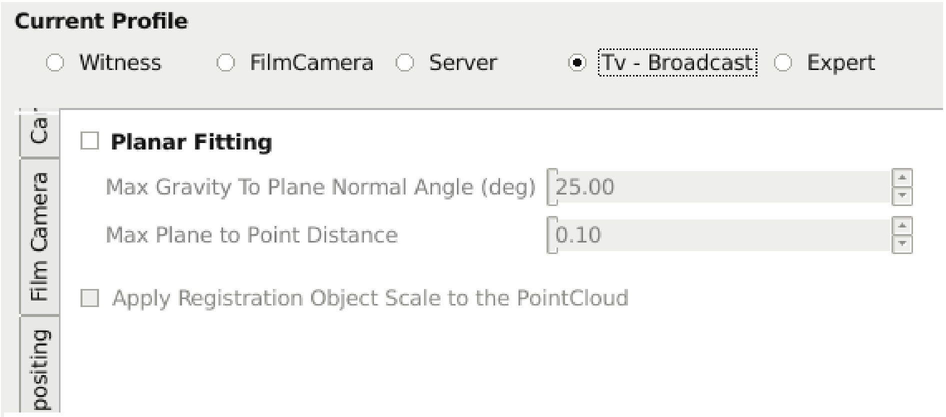


Figure 34

Data log window

The data log window is accessed via *Window > Log*. When selected it will display a log window along the bottom edge of the interface (Figure 35).

The log will display operational information about the system as well as any error messages. It can be a useful diagnostic tool and is useful to have displayed during operation.

Log data can be saved in a HTML format, this is done by pressing *Save Log* in the lower right hand of the log window.

Figure 35

System Status Tray

The right hand sidebar contains the system status tray. The tray contains an overview of the system, showing information regarding the status of all the components, as well as point cloud data and options, lens encoder data, and output details.

Tracking preferences (Figure 36)

Visual Tracking Tick box - activates/deactivates the visual tracking component of the Ncam sensor bar

Pixel Error - Displays a numerical value for the amount of error in the tracking system

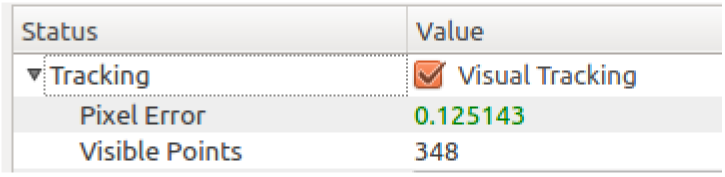


Figure 36

Pixel error

*Upon initially tracking, a well calibrated system should have a pixel error in the region of 0.4 and below. Higher values **may** indicate that elements of the calibration need improving.*

During use the pixel error will increase, this is perfectly normal, values higher than 1 can indicate poor tracking, the colour will change to yellow, and ultimately red, to reflect this

Visible Points – Total number of points currently seen by the system.

Features (Figure 37) – User can select between *High precision* and *High speed*. It alters the way the system registers points, high precision is preferred and high speed should only be used in very specific environments. *Samples, Grid Side* and *MaxScore* allows the user to modify the selection parameters of points for the point cloud. Changing these

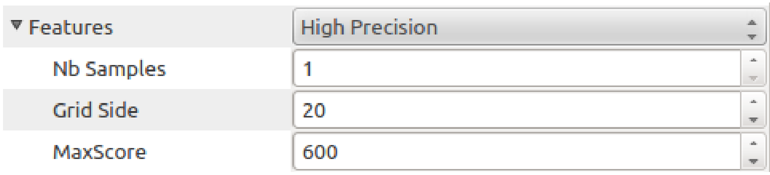


Figure 37

***Grid side** – Default value is 20, increasing the grid side will produce more points. When increasing the value it is suggested to go from 20 straight to 32.*

***Samples** – Default value is 1, higher values will produce more points, however it is not recommended to increase higher than 2, or possibly 3 at a maximum.*

***MaxScore** – It is not recommended to change this value from the default value of 600.*

factors can increase/decrease the points detected. It is recommend the user adjusts the *Samples* and *Grid Side* variables only, details on these are provided in the note.

Used points (Figure 38) – The number of points currently being used for tracking, ideally during operation this should stay above 200. However the environment Ncam is being used in is a big factor in the amount of used points needed. The *max* and *min* boxes describe an upper and lower limit for the number of points to be used for tracking.

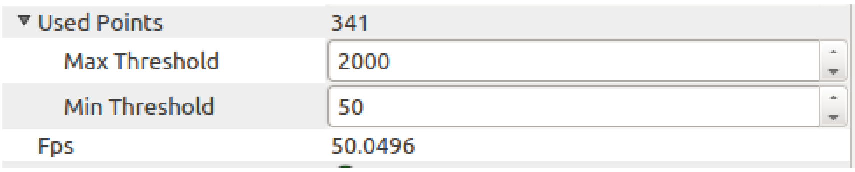


Figure 38

FPS – Current framerate of the tracking system – this varies during operation.

Auto Registration (Figure 39)

Tickbox – Activates the Auto-Registration feature. Prompts the system to start searching for a specific registration object. Can be very useful in environments with limited points or where the user wants a reliable, repeatable datum point every time.

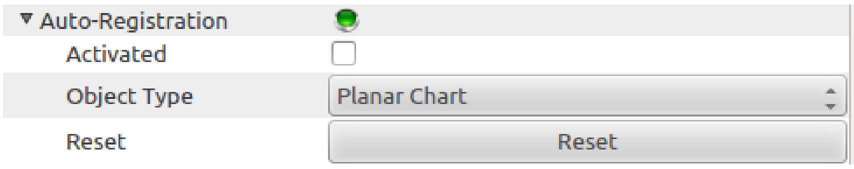


Figure 39

Object type – Selects the object being used for registration. The *planar* chart should be selected.

Status – Indicates the condition of the Auto-Registration, *Locked* is displayed when the system has detected the registration object.

Point Cloud (Figure 40)

Learn new points – This tickbox tells the system whether to continue/stop collecting extra points from the environment for use in the point cloud.

Points – Number of points currently stored in the point cloud.

Min. Depth – Sets the lower limit distance for points, units in metres. Points closer than this will not be added to the point cloud, should be left at the default of 1m.

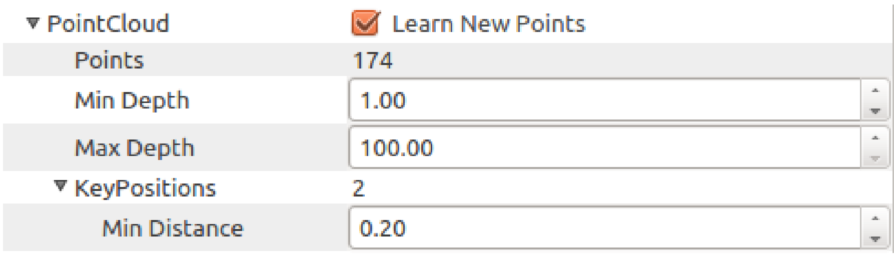


Figure 40

Max Depth – Applies an upper limit, again in metres, to the range at which new points will be added to the cloud. Certain environments will require a larger distance here, stadiums for example, 150m for example.

Key positions – These are the key frame positions that the Ncam camera bar recognizes it has been in. They can be seen in the *3D Tracking View* as grey Cartesian axis. They also relate to the snapshots that the system records in the image modelling and lineup tabs.

Min. Distance - This is the minimum distance the system will have to move before it creates a new key position. If the camera is moving a large distance, for example on a jib crane, it is suggested to raise this a little but no higher than 0.4.

Witness relation preferences (Figure 41)

Witness-Film relation – It is not recommended to unlock this feature, but essentially allows the user to manually modify the offset of the sensor bar to the film camera that has been computed in the lineup process.

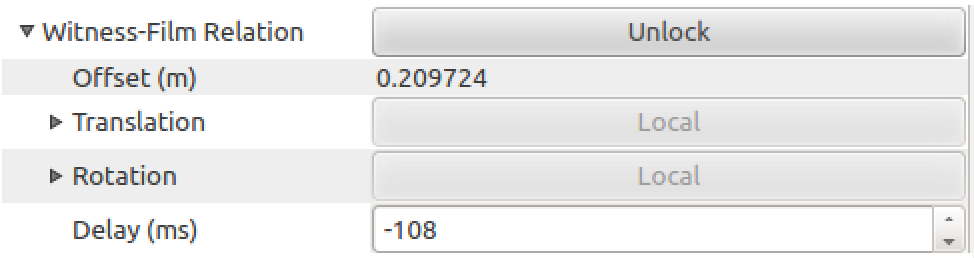


Figure 41

Delay – The time, in milliseconds, between the witness cameras and the film camera, this number should always be a negative value. An incorrect value here will cause issues with the quality of the augmented reality tracking, or with delays between video stream and the augmented reality graphic elements.

Witness AtSensor relation (Figure 42) – Sets the delay between the witness cameras and the other sensors contained in the sensor bar. **This value should not be altered**. The user can also choose how the system handles the data between *soft fusion* and *hard fusion*.

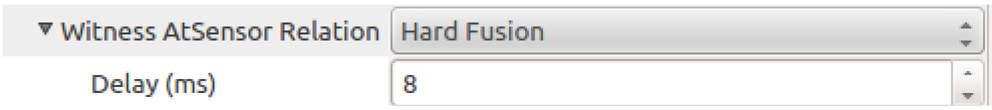


Figure 42

Witness LensEncoder Rel. (Figure 43)

This field allows the user to alter the delay value between the data received from the lens encoder and the other tracking data received from the bar. It can be used to correct a delay in the lens movements (zoom/focus) when the positional movements of the camera are correct. It should be left at the default of 7 unless a specific discrepancy between the two is noticed

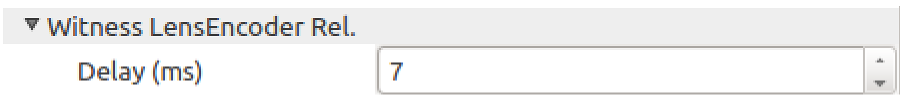


Figure 43

Right witness (Figure 44)

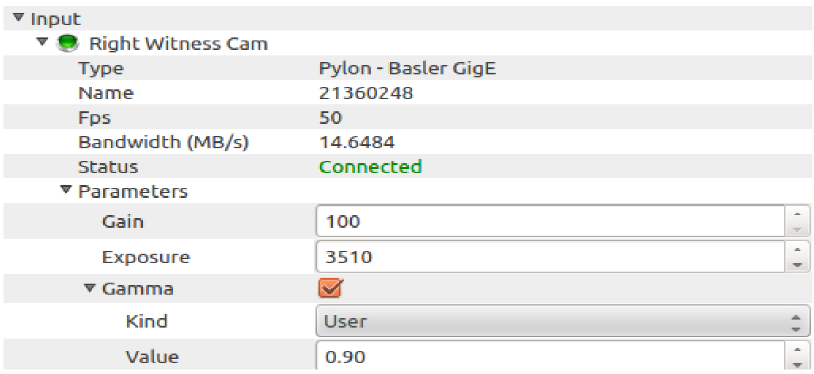


Figure 44

Displays the input type and status of the right witness camera. Also shows the framerate and the bandwidth of data being received. The parameters drop down allows the user to modify the gain, exposure and gamma of the camera. These may need to be altered depending on the environment the system is being used in

Left witness (Figure 45)

Same as the above, except detailing the left witness.

N.B. there are no controls for exposure, gain or gamma for the left witness camera – it is automatically updated with the values from the right witness camera, so that the cameras are kept locked together.

Left Witness Cam	
Type	Pylon - Basler GigE
Name	21359787
Fps	50
BandWidth (Mb/s)	14.6484
Status	Connected

Figure 45

Film Camera (Figure 46)

Provides information regarding the type of input being received from the film camera, the frame rate, bandwidth, and focus/zoom/iris information

Film Camera	
Type	SDI PsF
Name	Input A Output A
Fps	24
Bandwidth (MB/s)	94.9219
Status	Connected
Focal Length (mm)	0.00558
Focus Distance (m)	0.65212
Iris (T-stop)	0.25968

Figure 46

AtSensor (Figure 47)

The status of the AtSensor is displayed here

ATSensor	
Type	NCoder
Name	Broadcast/Film
Fps	250
Bandwidth (MB/s)	0.0271797
Status	Connected
Correct Vis. Rot.	☑

Figure 47

Geometry

Shows the details of any geometry being streamed into the system. When assets are actively being streamed in, the bandwidth should increase and also a frame rate should be displayed. If problems are encountered with asset streaming, checking these details can be a useful first step in trouble-shooting. This is not relevant for Broadcast scenarios.

Lens Encoder (Figure 48)

This area provides the user with information from the lens encoders, either external ones, or direct from the lens using a smart cable. The focus and zoom values here are useful to correlate against the real world zoom/focus (for instance, when near maximum zoom or focus the value displayed should

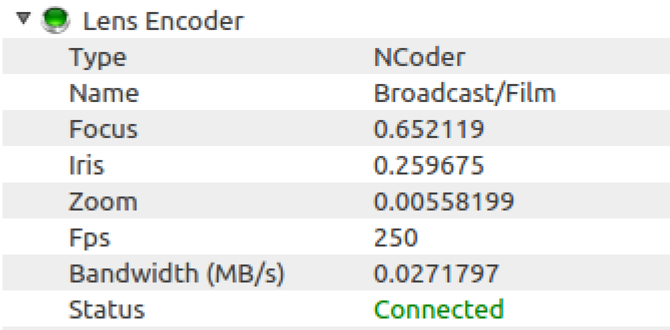


Figure 48

be close to 1, and when at minimum zoom/focus the value should be at or close to 0).

Output (Figure 49)

The output dropdown contains two submenus, *FreeD* and *Camera Tracking*.

The FreeD provides basic information about the tracking data being sent by the Ncam system, importantly it displays the FPS which should not drop below the FPS of the main camera.

The Camera Tracking drop down displays the FPS of the main camera, it also contains the *Filtering* sub menu.

Filtering should be activated by making sure the tickbox is checked. The user can then select numerical values to apply filtering to translation and rotation movements. The filtering values correspond to the amount of delay that is present in the system, essentially a value of 1 will use the whole delay time to filter, while a value of 0.5 will only use half the delay time. As a rule of thumb the lower the amount of delay, the closer to one the filter values should be set. Importantly, **values over 1 will introduce extra delay into the system.**

Near plane and *Far plane* refer to the clipping distance of objects rendered in Ncam, they are not used in a broadcast scenario and can be ignored.

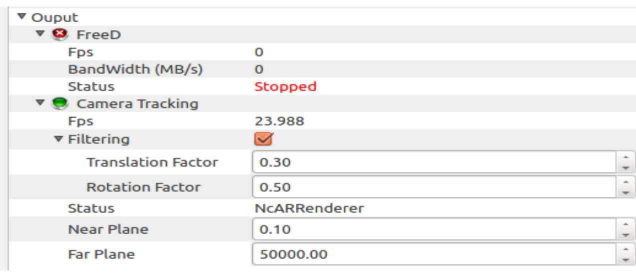


Figure 49

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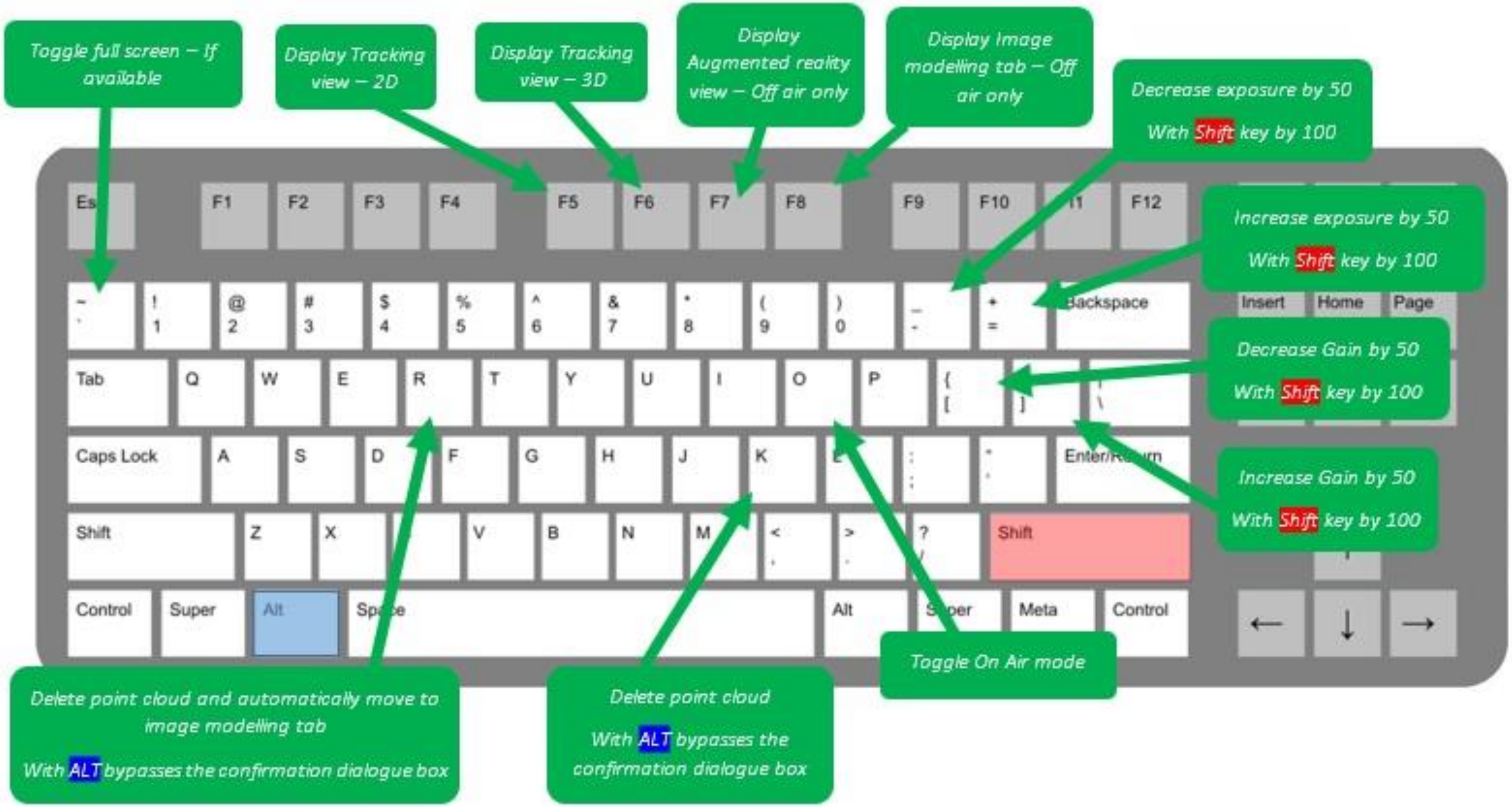
Ncam Hotkey's



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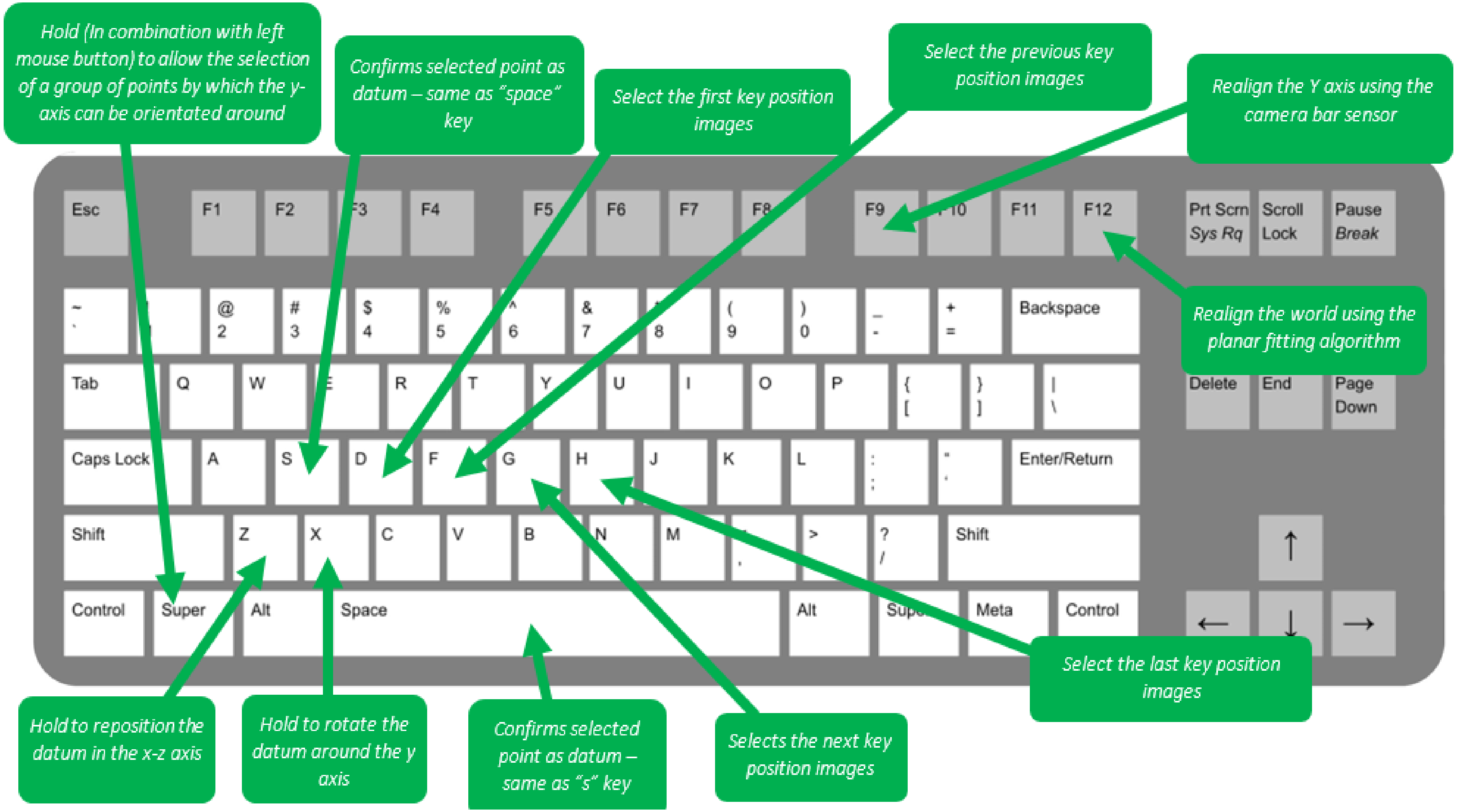

Hold (In combination with left mouse button) to allow the selection of a group of points by which the y-axis can be orientated around
Confirms selected point as datum – same as "space" key
Select the first key position images
Select the previous key position images
Realign the Y axis using the camera bar sensor
Realign the world using the planar fitting algorithm
Select the last key position images
Hold to reposition the datum in the x-z axis
Hold to rotate the datum around the y axis
Confirms selected point as datum – same as "s" key
Selects the next key position images

Appendices

This sections contains some ancillary details as well as a troubleshooting guide

Sensor Sizes

When adding a new camera to the *Ncam Reality* software it is important to know the exact sensor size of the camera, or more specifically the exact sensor size of the camera in the format that the camera will be used in (See **Text Box**). An incorrect value will present as abnormalities in the virtual graphics as well as producing incorrect interpolated values for *H focal* and *V focal* fields in the lens calibration setting

It is vital to understand that the recording format of the camera can alter the amount of the sensor being used. For instance there is a distinct difference between 4:3 and 16:9 aspect ratios. Of upmost importance then is to confirm the mode the camera will be used in, the correct sensor size is used for this mode, and also that the lens is calibrated in this mode as the calibration will only apply to this setting specifically

Documentation often refers to the sensor size as a ratio, 2/3", 1/2" etc. It is important to understand that these ratios act as a rough classification of the sensor and can't be used as a way for determining the exact sensor size. For instance the absolute dimensions of a 2/3" camera sensor will differ between camera brands, even though they both have 2/3" sensors.

Camera documentation should provide exact dimensions of the sensor size, however for convenience a list of camera models and sensor sizes are provided below.

Sony Camera's in 16:9 aspect ratio

Sensor size format	Horizontal (mm)	Vertical (mm)
2/3"	9.59	5.39
1/2"	6.97	3.29

Sony Camera's in 4:3 aspect ratio

Sensor size format	Horizontal (mm)	Vertical (mm)
2/3"	8.8	6.6
1/2"	6.4	4.8

Grass valley Camera's

Camera	Horizontal (mm)	Vertical (mm)
LDK 6000	8.8	4.95
LDK 8000	8.8	4.95

Ikegami Camera's

Camera	Horizontal (mm)	Vertical (mm)
HDK-55	9.59	5.39

Converting Lens files

If a lens was calibrated on a camera set in a progressive mode, yet will ultimately be used interlaced, then it is important for the lens data to be converted within our database.

Before proceeding it is recommended to make a backup copy of the *CameraAndLensV2.db3* file. This is also useful if the user wishes to swap back to a progressive format later on, as the earlier pre-converted, database file can be swapped back.

- Within the *Ncam* directory of the server desktop, open up the *calibrations* directory. Inside this will be the *CameraAndLensV2.db3* file. **Double left click** to open
- On the left had pane, **double left click** the *lensintrinsic* entry.
- This will display in the lower centre pane, all the data for all the lenses that have been calibrated on this system
- Identify the fields that relate to the lens that need converting. Typically the easiest way of doing this is to scroll right to the bottom, as the entries are sorted chronologically, with the most recent lenses being listed at the end
- If in a progressive mode the values *1280* and *720* will need changing to *1920* and *1080* respectively
- Manually input these values into each row relating to that lens. The number of rows depends on the number of nodes that were calibrated for that lens. For instance if 20 nodes were created during lens calibration, then there will be 20 rows that need converting in this stage.
- After all fields have been converted, save by **pressing** the *push to database* button

Now that this has been saved, it is important to make sure that upon restarting the *Reality* software, the camera is now set to its interlaced mode. If it is still in a progressive mode then the system will display an error message stating that it cannot find a lens calibration file. The lens data is still present within the system, however it is now looking to associate it with an interlaced camera. If the camera is switched to interlaced then the lens data will associate correctly to the camera

Troubleshooting

Not receiving any lens data via the encoders

Initially check the connections of the smart cable into the bar and also into the virtual port of the lens. It is possible to connect the 20 pin hirose into one of the other ports on the lens so it is important to check that the correct one is being used

When using a canon lens it is possible for the output of data from the virtual port to be switched off, it is also known that the lens can switch back to this off setting during a power cycle of the main camera. To check the status of the encoder data follow the following steps on the lens interface directly

1. **Press** *display*
2. **Select** *menu*
3. **Press** right 6 times
4. **Select** *encoder* to on
5. **Select** *initialize*
6. **Check** *zoom* and *focus* are both switched on

Additionally, check that the lens encoder is activated under the *devices* drop down in the *top menu bar*

Stuttering visible in graphic

If a small stuttering effect is apparent either under zoom or physical movement of the camera, then ensure that *Ncam Reality* has been switched to *on air* mode.

Check the *status tree* on the *right hand sidebar*, make sure the *freed fps* under the output section is not below the framerate of the camera (typically 50 or 60). If the *freed* framerate is lower than that of the camera then it is recommended to *reset the pointcloud* and then reinitialize it

Within the *Datastream* tab of the *Preferences window* make sure *sync to video signal* is **enabled**

If stuttering is still present after these steps have been taken, then it is very unlikely for it to be being caused within Ncam

Jittering visible in graphic

A jittering/vibrating type movement of the graphic typically indicates that the system is not detecting very good tracking within the environment. There are several things the Ncam operator can do to improve upon this, these are:

- Increase the *grid side* or *samples* within the *features* drop down of the tracking tree in the *system status tree*. A *grid side* of 32 is suggested if the default of 20 is not suitable, ideally the system should be using between 200-400 points (this is displayed in the *used points* field of the *system status tree*). Larger values are fine but excessively high numbers can cause a drop in the tracking fps
- Place markers in the environment. Banners or other trackable objects can ideally be placed close to the camera bar to provide better tracking
- Perform a *reset* of the pointcloud. Typically the system will perform best following a fresh initialization of the datum, so this may prove helpful, particularly if the system has been tracking for some time
- Ensure that an adequate delay/filtering time is present in the system. Delay values approaching 0 will not allow for sufficient time to filter tracking data, ideally a delay value in the region of -50 is achieved, the introduction of video delay within the pipeline may be necessary to achieve this. In an environment with incredibly poor tracking, it may be required to increase the filtering value significantly higher than 1
- Resetting the At sensor (make sure the camera is completely stationary while doing this), and very occasionally switching to *Soft Fusion* under *witness At relationship* in the *system status tree* can reduce jittering in certain circumstances

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Very few tracking points detected

The amount of tracking points detected depends entirely on the environment the camera is set up in. Some universal steps that can help though are listed below:

- Check that the witness cameras are not over/under exposed, control this through a combination of the manual irises on the witness cameras and through the use of the *exposure, gain* and *gamma* controls found on the *system status tree*
- Ensure that the images produced by the left and right witnesses are exposed exactly the same, if one is lighter or darker than the other then this is typically due to the manual irises not being set exactly correctly. Tracking points can only be used if they are visible in both witnesses, this is why it is so important to make sure the images between each camera are as similar as possible
- Adjust the *Features* fields in the *system status tree* to increase the amount of points used
- Add markers to the environment to introduce more tracking points to the environment
- Make sure the left and right witnesses are focussed the same. The only reason this would need any adjustment would be if the camera bar suffers a significant impact or if someone manually changes the focus of the witness cameras from their stock setting
- Check that the camera bar is well calibrated, the witness cameras should have a calibration error of ideally below 0.04 and the stereo calibration should be as close as possible to this value. For the best results it is often worth redoing the stereo calibration following transport of the camera bar or any impacts to it

No tracking data received by graphics engine

- Check connections
- Ensure the correct serial adaptors are being used, A in ncam, B in 3rd party
- Bluestorm cards are being used and the connecting cable is coming out of the lower port
- Check that the FreeD stream is activated in the datastream tab of the preferences window

Left witness disconnected

This is caused when the *exposure* setting of the witness cameras is set below 50. Simply increase the exposure value to correct this. It is advised to “stop in” the manual irises of the witnesses instead of trying to operate the system with exposure values below 500.