correlated
SOLUTIONS

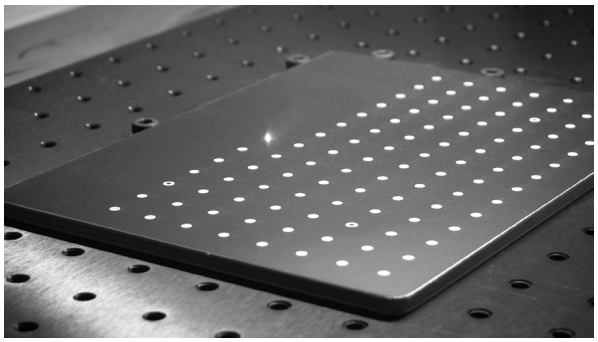
Application Note

External Orientation Calibration

VIC-3D 11

2026

External Orientation Calibration in VIC-3D



Introduction

Calibration in VIC-3D serves to establish two distinct sets of parameters.

- Intrinsic parameters: These parameters are specific to each camera. We calculate focal length, aspect ratio, and sensor center (the point on the sensor that corresponds to the center of the lens). These parameters will change if you move the lens or change the aperture or focus.
- Extrinsic parameters: The parameters define the relationship between the two cameras in the stereo system. We calculate X, Y, and Z displacements between the cameras, and 3 angles between the cameras (alpha, beta, gamma). These parameters will change if the cameras are moved or tilted.

Typically, we calibrate extrinsic and intrinsic parameters at the same time, with a stereo calibration. However, in some cases, it's advantageous to calibrate the extrinsic parameters separately, or to refine them using a speckle image.

Examples of cases where separate calibration is required:

- Cameras cannot be synchronized
- Large measurement fields for which a large enough grid is not practical

For these cases, use Procedure 1.

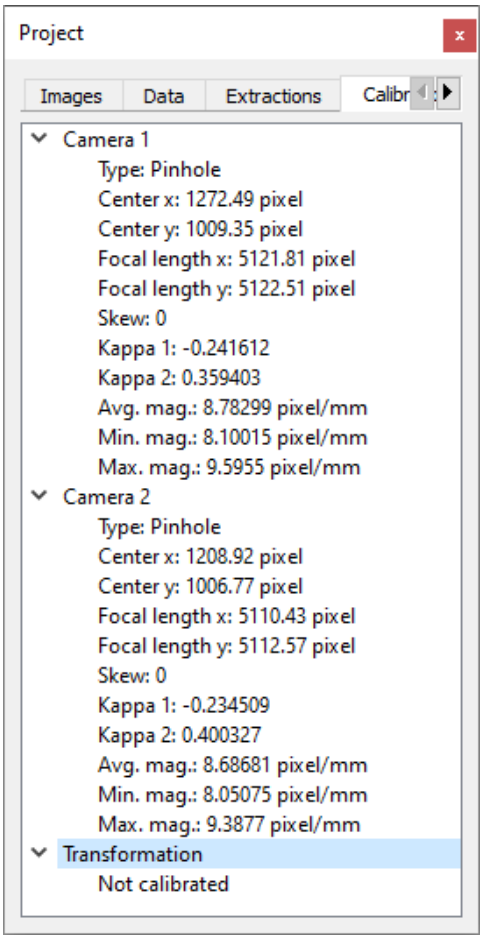
Examples of cases where stereo calibration may be refined by external calibration:

- The cameras have been moved or bumped since calibration. In general, any time you run a correlation and see a higher-than-expected projection error, you can try running the external orientation calibration to improve your results.
- Test setups that include nonstandard distortions, such as from a glass pane.

For these cases, use Procedure 2.

Procedure 1: Calibrating Separately

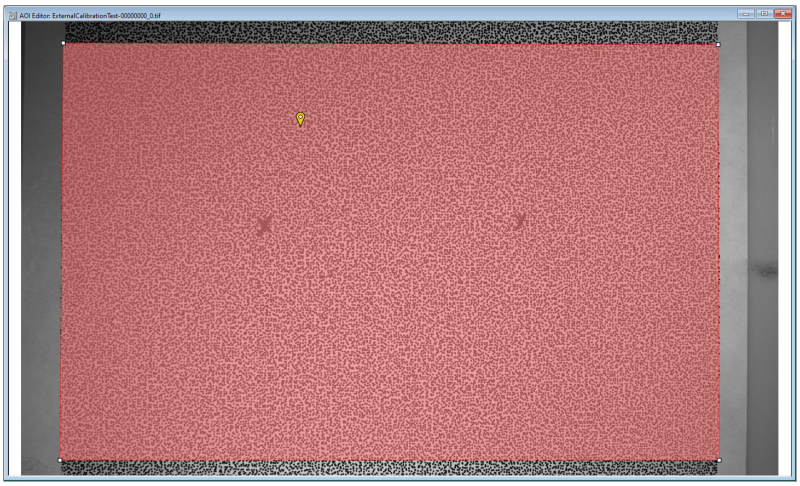
Select *Data… Calibration… Calibrate Camera 1* from the menu bar. Proceed as with stereo calibration; repeat for *Camera 2*. At this point, you may check the Calibration tab at the left side of the main window and confirm that both cameras are calibrated but the Transformation section shows “Not calibrated”.



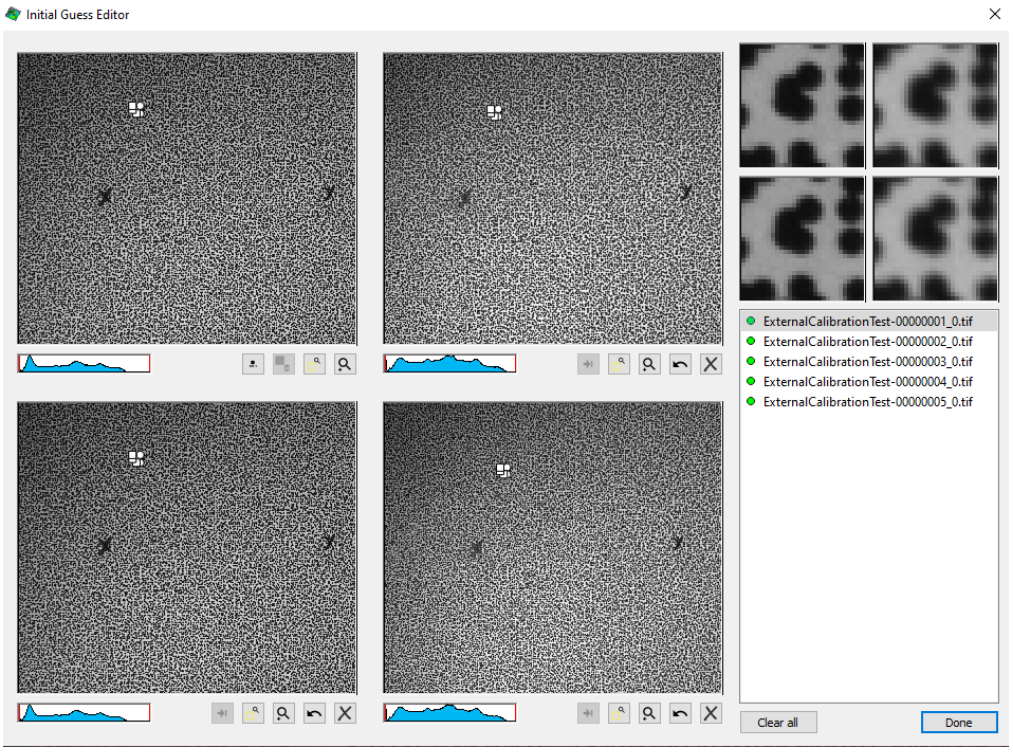
Next, you will need a single image of a speckled target to complete the orientation calibration. Any shape may be used for this, but the target must contain a known distance marked off with two recognizable end points. This will be necessary to establish scale later in the process. Typically, this can be accomplished by simply making two small black “X” marks on the specimen and carefully measuring the distance between them. These points should be relatively far apart for best accuracy.

Note: external orientation eliminates the need for the grid calibration images to be synchronized, since they will be considered separately. However, for the speckle image, your cameras must either be synchronized, or the target must be immobile.

Load this image pair as the Reference image, as normal. Define an area of interest that contains the two measurement marks, and encompasses as much of the shape as possible. Using a patch that is too narrow or small may result in erroneous results. Our two “X” marks are visible about halfway down the image.

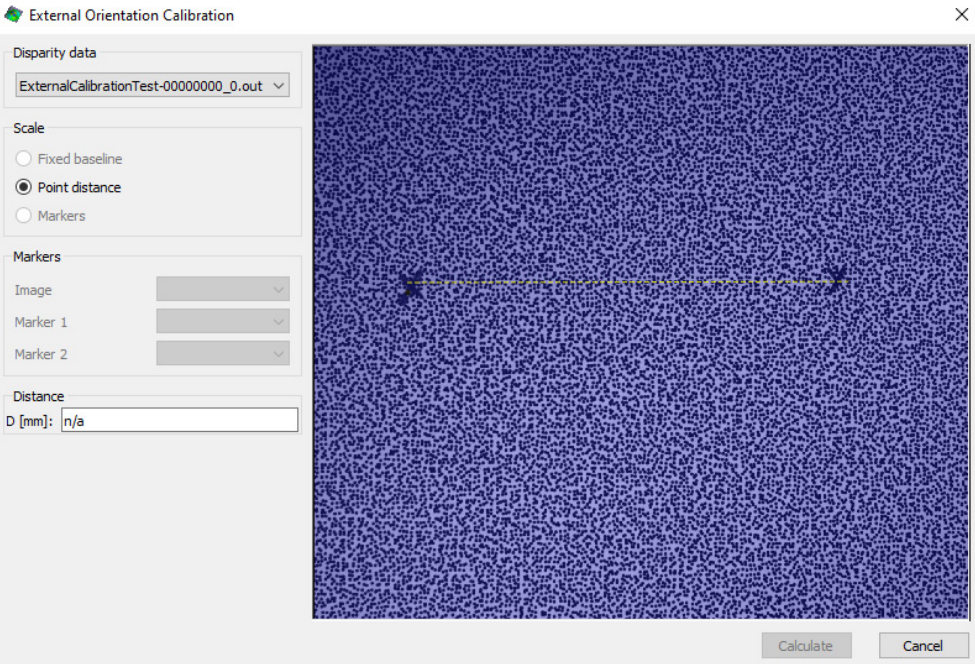


Next, double click the icon to check the initial guess. Confirm that a green bubble appears next to the data file; if a red bubble appears, complete a manual initial guess, or select a new seed point and try again.

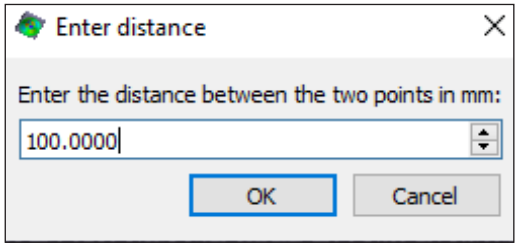


Since no Transformation calibration is present, you will be prompted to run a disparity analysis for calibration. Click Yes; this sets all the appropriate options for this type of calibration. Click *Run* to continue, then Close when correlation is complete. Projection error will be reported as 0, and no 3D plot will be shown; this is because VIC-3D has no geometry information with which to triangulate a shape. However, we've just calculated the raw disparities, which can now be used to determine the camera orientation.

Click *Calibration… Calibrate camera orientation* on the menu bar.

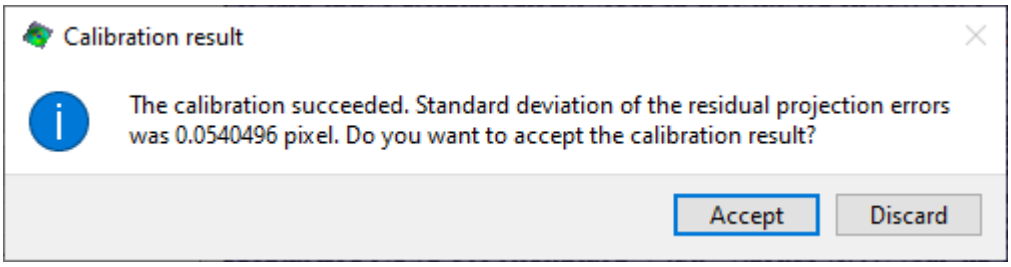


You will see your reference image; where data is present, the image is overlaid with blue. Click on one of your measurement marks, and then the other. You will be asked to enter the distance between these points to establish scale:



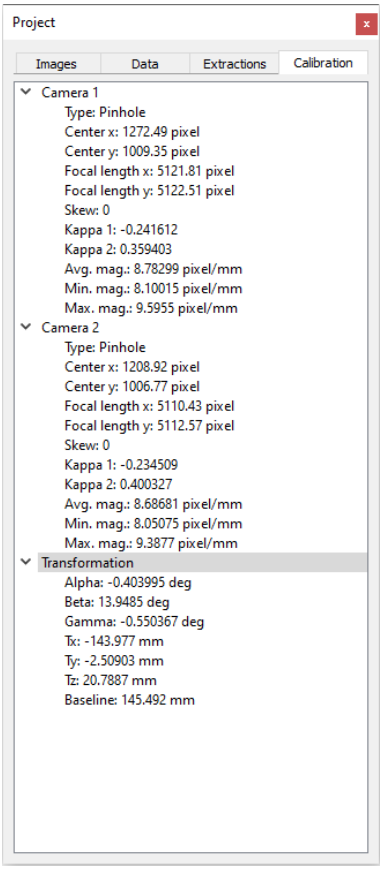
Enter the previously measured distance. If an incorrect distance is entered, the calibration will succeed, and measurements will be successful; however, the scale of all your future results will be off by a constant factor.

Click *Calculate*, and a score will be displayed.



If the score is acceptably low (i.e., less than 0.05 pixels), click *Accept* to finish. If the score is high, there is a problem with the source data; check your area of interest and initial guess, and check the *sigma* variable in the output data to eliminate any problem areas.

The calibration is now complete. If desired, you may note the figures in the Transformation section of the Calibration tab, and confirm that they are as expected. Alpha, Beta, and Gamma are the three angles between the cameras; Tx, Ty, and Tz are the displacements; and baseline is the total distance between the two sensors.



At this point you may also re-run the correlation; this time, a shape will be calculated, you can confirm that the profile returned is as expected with regards to shape and scale.

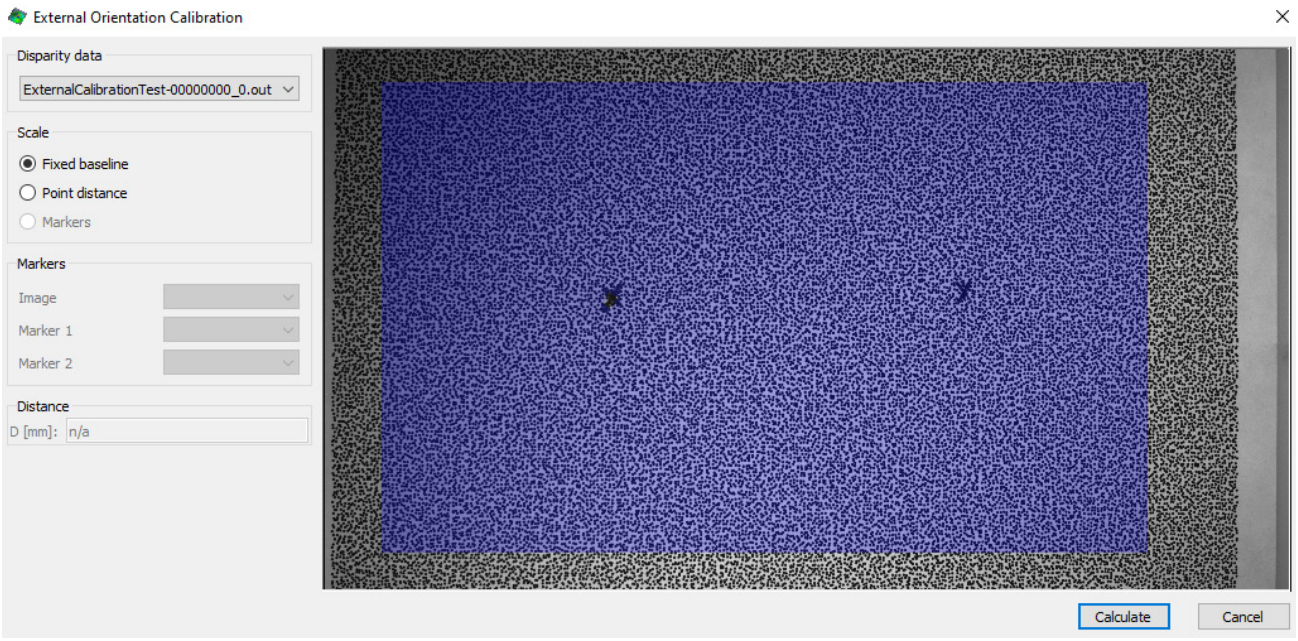
Procedure 2: Calibrating Together

To calibrate as a system and then refine the calibration with External Orientation Calibration, begin by calibrating as normal (*Data… Calibrate… Calibrate Stereo System*).

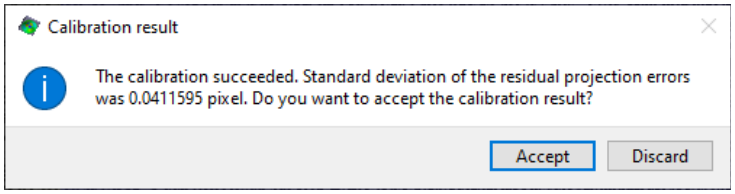
Load a reference image, and select an AOI that covers as much of your specimen as possible. If desired, check the initial guess.

Click the  icon on the toolbar to run the analysis. Click *Run* to run the calibration, and *Close* when it has completed. Confirm that your shape looks good with no erroneous data.

Click *Calibration… Calibrate camera orientation* on the menu bar.



You will see your reference image; where data is present, the image is overlaid with blue. Leave the Scale selection set to Fixed baseline; click *Calculate*. An error score will be displayed:



The score should be very low; if not, check the source data and make any necessary changes, then repeat. The calibration is now complete.

Note: The **Fixed baseline method** *works by assuming that the distance between camera sensors has not changed. This is a good approximation when the cameras are in a typical mounting configuration where they may be able to rotate but not translate. If the cameras have moved in a different way where the baseline changes significantly, this procedure can cause scale errors in your results. You may also correct a calibration using the Point distance option, if a known distance is present on your specimen as in Procedure 1.*

Support

If you have any questions about this document or any other questions, comments, or concerns about our software, please contact us at support@correlatedsolutions.com, or visit our website at correlatedsolutions.com/support.