VICON

boujou.

Tutorials

Revision 3.1

---

boujou 5.0

The first choice for professional matchmovers

Vicon Motion Systems
UK registered no. 1801446
Email: boujousupport@vicon.com

www.vicon.com

Vicon – Oxford
14 Minns Business Park
West Way
Oxford
OX2 0JB
UK
T: +44 (0) 1865 261 800
F: +44 (0) 1865 240 527

Vicon – Denver
7388 S.Revere Parkway Suite 901
Centennial
CO 80112
USA
T: +1 303.799.8686
F: +1 303.799.8690

Vicon – Los Angeles
5419 McConnell Avenue
Los Angeles
CA 90066
USA
T: +1 310.306.6131
F: +1 310.437.4229

Vicon – Singapore
8 Cross Street # 11-00
PWC Building
Singapore 048424
T: +65 6400 3500

Vicon, builds cameras with custom high-resolution, high-speed sensors and embedded multiprocessing.

Vicon (www.vicon.com) is a subsidiary of OMG plc (www.omg3d.com).

Contents

Preface

The *boujou Tutorials* provide step-by-step instructions on how to use the key features and functionality in boujou. These tutorials build on the fundamental workflow explained in the basic tracking tutorial in the *boujou Getting Started* book.

Audience

This book is intended for users who are new to boujou or for previous users who want to learn how to use new features in the latest release of boujou.

boujou camera tracking and calibration data is used by professional matchmovers in the following types of applications:

- **Post Production** for film and TV visual effects solutions.
- **Industrial Design** for architecture, manufacturing, prototyping, forensic, and other industrial applications.
- **Education** for training and research programs.

This book does not assume any previous experience with boujou. If you have used a previous release, you will notice some differences in the user interface and some functionality.

Structure

This section describes how the information in this book is organized.

The first chapter provides an overview of this book:

Chapter 1 **Introduction** describes the design of the tutorials and identifies where to obtain the sample files you need to work through them.

Each of the following chapters show you how to use the key features and functionality in boujou:

Chapter 2 **Tracking Nodal Pan Shots** shows you how to work with nodal pan shots, where the camera can only rotate and there is no 3D depth information from the scene.

Chapter 3 **Correcting Lens Distortion and Adding Locators** shows you how to reduce the effect of lens distortion on the quality of camera tracking in boujou and to improve the quality of a scene's 3D structure by adding locators.

Chapter 4 **Using Masks** shows you how to combine moving objects and a background in a scene by identifying which elements to track and which to ignore.

Chapter 5 **Using Target Tracks** shows you how to manually create tracks for features that would normally not be found by the automatic tracker.

Chapter 6 **Using Non-Consecutive Feature Tracking** shows you how to match features in two images that are separated by more than one frame.

Chapter 7 **Using Focal Length Constraints** shows you how to improve the accuracy of the camera solving solution by supplying information about the focal length of the camera used in shooting the scene.

Chapter 8 **Using Models** shows you how to set up approximate camera positions using a 3D model to help boujou to solve difficult shots. It also

shows you how to use a 3D model as survey data to improve the accuracy of boujou's 3D structure.

Chapter 9 **Using Face-based Tracking** shows you how to link 2D features and the faces of a polygon mesh to track an object through a shot.

Chapter 10 **Using the Sequential Solver** shows you how to generate a small 'seed' solve from which you can quickly camera solve an entire sequence.

Chapter 11 **Using Reference Frames** shows you how to supply additional images or sequences to improve the accuracy of the solve.

Each of the appendices provide additional information that can help you make the most of using boujou:

Appendix A **Support Resources** describes the support resources available to boujou users.

Appendix B **Documentation Feedback** describes how to supply feedback on the boujou documentation.

Appendix C **Customer Satisfaction Survey** requests your feedback on our products and services to help us improve future offerings.

Conventions

This table illustrates the typographical conventions used in this book.

Convention	Description
This type	Menus, commands, buttons, and options displayed in boujou. Terms in a definition list or emphasis for important introductory words in a paragraph.
`This type`	Text displayed by the system or extracts of program code.
This type	Path names, file names, and extensions. Commands or text you enter in files or dialog boxes.
This type	Cross-references to related information in another section or document.
This type	A URL for a site on the World Wide Web.
Caution	A caution alerting you to actions that could result in the loss of data.
Important	Information that emphasizes or supplements important points in the text or information that may apply only in special cases.
Tip	A tip helping you to apply the techniques and procedures in the text to your specific use or to suggest an alternative method.

Related Documentation

This *Tutorials* book is designed to be used in conjunction with the additional documentation for this release of boujou shown in the following table.

Document	Description
Books	All of the boujou books are installed in PDF format (requires Adobe Reader version 5.0 or later, which you can download free from the Adobe Web site at *www.adobe.com*).
Getting Started	This book provides details on installing and getting started with the current software release. This book is also provided in printed form in your boujou product box.
Reference Guide	This book describes the features and functionality available in boujou 4.1. Much of this information applies to the current release of boujou. However, there are some differences in the interface and functionality. Where there are differences, please see the relevant documentation.
Vicon Web site	The Vicon online support system, found at *www.vicon.com*, provides a library of information that you can use to help answer your questions.

Introduction 1

This book contains the following tutorials to help you learn to use the advanced features in boujou:

- *Chapter 2 Tracking Nodal Pan Shots*
- *Chapter 3 Correcting Lens Distortion and Adding Locators*
- *Chapter 4 Using Masks*
- *Chapter 5 Using Target Tracks*
- *Chapter 6 Using Non-Consecutive Feature Tracking*
- *Chapter 7 Using Focal Length Constraints*
- *Chapter 8 Using Models*
- *Chapter 9 Using Face-based Tracking*
- *Chapter 10 Using the Sequential Solver*
- *Chapter 11 Using Reference Frames*

Tip

For an introductory tutorial showing the basic tracking workflow in boujou, see the chapter *Getting Started with boujou* in the *boujou Getting Started* book.

Important

Apple users: Where these tutorials reference the CTRL key for selecting multiple items or for modifying key functions, use the Command (or Apple) key on the Apple Mac keyboard instead.

Required Shortcut Buttons for Tutorials

You will need to have the following shortcut buttons in your Toolbox to work through the tutorials:

To add a shortcut button to the Toolbox:

1. Right-click in an empty area of the **Toolbox** and from the displayed list of available shortcuts click a shortcut name.
2. Repeat this until you have added all of the required shortcuts to the **Toolbox**.

For information on the **Toolbox** and shortcuts, see the chapter *User Interface* in the *boujou Reference Guide*.

Importing Sequences

boujou 5.0 enables you to import more than one image sequence into a single project. For all operations that apply to sequences, for example, feature tracking, camera solving, and exporting, you can select the sequence name from a drop-down list in the relevant dialog boxes.

Important
Always make sure the required sequence is selected before proceeding with the rest of the tutorial.

Sample Data for Tutorials

The sample image sequences and saved project files for these tutorials are stored in the *Tutorials* directory on the boujou DVD. They are also available for download from the boujou Web site www.vicon.com/support. Example export files for each tutorial are also provided in case you are using the demo version of boujou.

You must copy the sample files onto your hard disk drive where you can access them while working through the tutorials. Each tutorial tells you which files you will need for that lesson.

Table 1-1 describes the naming convention for the supplied boujou project files.

Table 1-1: Naming convention for sample files

File Name Suffix	Description
-0	The project has not been tracked.
-f	The project has been feature tracked.
-c	The project has been camera solved.
-l	Locators have been added to the project.
-g	Scene Geometry has been set up.

Tracking Nodal Pan Shots 2

This tutorial demonstrates how to work with nodal pan shots.

With nodal pan shots, the camera movement is pure rotation. Because of this, foreground objects do not appear to move relative to background objects, and the sequence contains no parallax that boujou can use to calculate the positions of objects in 3D space.

When boujou tracks a nodal pan shot, it assumes that all 3D points are an equal distance from the camera's center of rotation.

Adding CG objects to a nodal pan is more like 2D compositing than 3D animation, since the perspective will have to be matched by eye, and the distance of a CG object from the camera is not significant.

The lessons in this tutorial describe the stages in creating a nodal pan track:

This tutorial uses the following sample sequence of JPEG image files:

- *tutorial2_car_pan.[###].jpg*.

Important

Before starting this tutorial, you must have already added the required shortcut buttons to your **Toolbox** and copied the sample tutorial files to your hard disk drive where you can access them while working through the tutorial. For details, see *Chapter 1 Introduction*.

Creating the Nodal Pan Track

In this stage of the tutorial, you create a nodal pan track and save the project file to disk.

To create a nodal pan track:

1. In the **Toolbox**, click the **Import Sequence** button.

2. In the **Import Sequence** dialog box, browse for the image sequence *tutorial2_car_pan.[000-240].jpg*, click the file name of the first image in the sequence, and then click the **Open** button.
3. In the **Image Sequence** dialog box:
   a. Use the **Movie Type** pull-down list to change the **Move Type** setting to **Nodal Pan**.
   b. Leave all of the other settings at their default values and click **OK**.

   The sequence loads.
4. In the **Toolbox**, click the **Track Features** button.

   The **Feature Tracking Properties** dialog box is displayed.
5. Note that **Sequence 1** is selected in the **Sequence** drop-down list. Leave all the settings at their default values and click **Start**.

   As soon as feature tracking begins, select the **Camera solve on completion** check box to have camera solving start as soon as feature tracking is complete.

Tip

The **Camera solve on completion** check box is located on the **Status bar**, just below the main Image window.

If the **Camera solve on completion** check box was not selected, when feature tracking is complete, you can start camera solving by selecting the **Solve Camera** option on the **3D Tasks** menu, and clicking **Start** in the **Advanced Camera Solve Properties** dialog box.

When camera solving is complete, a cloud of yellow and cyan dots appear on the displayed image. These are the 3D prediction points.

6. Click different points in the **Timeline** to display the images at those points. Check the images to ensure that the prediction dots stick to the background. You can also use the mouse to drag the blue vertical bar on the **Timeline** and view the sequence.
7. On the Toolbar, click the **3D view** button.

The 3D structure is displayed as shown in Figure 2-1.

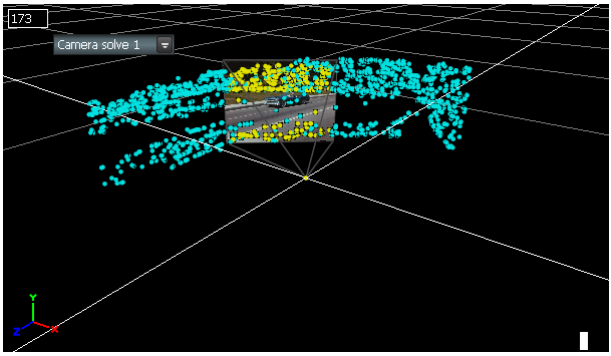


Figure 2-1: 3D structure of scene

Tip

If you want your 3D view to be identical to the one in Figure 2-1, in the **Overlays** pane select **Image** and make sure the **Error Scale** is set to 1.

8. Use the **Timeline** to select different points and note how the highlighted area changes. Use SHIFT+RMB and SHIFT+LMB to zoom and dolly around the 3D structure.

   Because there is no depth information in the scene, all of the 3D predictions have been placed at an equal distance from the camera. This results in the point cloud appearing as the surface of a sphere with the camera at the center.

9. From the **File** menu, click **Save As** to save the project file.

Use Scene Geometry to Calculate an Eye-Level Plane

In this stage of the tutorial, you set up some approximate scene geometry in the form of an eye-level plane, so that boujou can calculate 3D data for a scene.

If you are starting the tutorial at this stage, you can use the *tutorial2_car_pan-c_step1.bpj* project file This project file uses the same image sequence as in the previous exercise: *tutorial2_car_pan.[###].jpg*.

In a nodal pan shot, because the only camera movement is panning, there is no parallax between objects in the sequence. With panning, boujou cannot calculate:

- The plane for the ground
- The 3D positions of the features in the scene.

So that boujou can calculate these, you can define some approximate scene geometry using the position of the camera. boujou then uses the geometry you create to determine the ground plane.

Setting up scene geometry involves identifying three prediction points in the sequence that are the same height above the ground as the camera.

To calculate an eye-level plane:

1. On the Toolbar, click the **2D** button to display the image.
2. If you cannot see the yellow and cyan dots that are the prediction points, display the **Overlays** pane by clicking on the **Overlays** tab (to the right of the Image window in the default layout).

   In the **Overlays** area, select **Predictions** to display the prediction points.

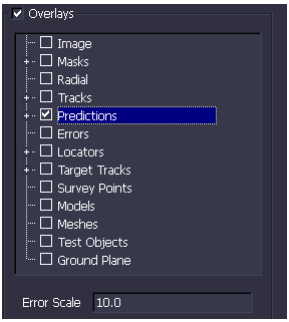


Figure 2-2: Displaying prediction points

3. From the **Edit** menu, select **Clear selections** to clear any existing prediction point selections.
4. Using the **Timeline**, navigate to Frame 0.

Tip
Frame numbers are displayed at the top left of the Image window.

5. Select a prediction point on the top right of the roof of the parked car, as shown by the green arrow in Figure 2-3. The prediction point turns green when you select it.

Figure 2-3: Choose first camera-height prediction

6. Using the **Timeline**, navigate to Frame 120.
7. Hold down the CTRL key and select a camera-height prediction point as shown by the green arrow in Figure 2-4. Holding down the CTRL key enables you to select multiple points. The prediction point turns green when you select it.

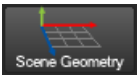
Figure 2-4: Choose second camera-height prediction

8. Again using the **Timeline**, navigate to Frame 240.

9. Hold down the CTRL key and select a camera-height prediction point as shown by the green arrow in Figure 2-5. The prediction point turns green when you select it.

Figure 2-5: Choose third camera-height prediction

10. In the **Toolbox, c**lick the **Scene Geometry** button.



11. In the **Scene Geometry** dialog box, click the **Add Coord Frm Hint** button to create a new geometric feature. With the three points that you selected, the settings are:
    - The **Type** is set to **Origin (hint)**
    - The **Name** is set to **Geometric feature 1**.
    - In the **Coordinate Frame Hint Properties** area, the text to the left of the **Connect to Selected** button reads:

      0 currently connected. 3 currently selected. 1 required

This indicates that boujou has recognized the three points that you selected. If it does not display this text, check you have selected the points as described in steps 4. to 8.

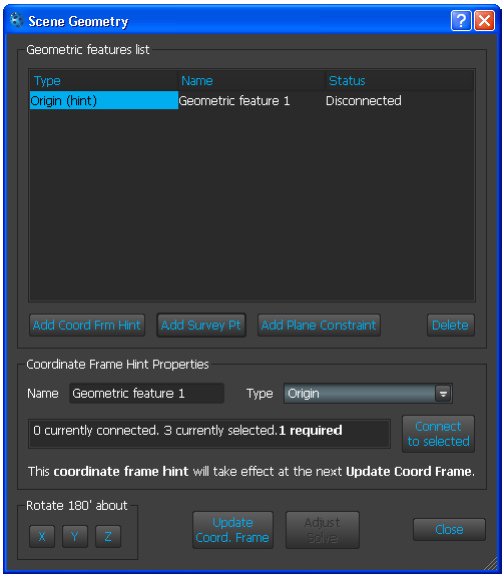


Figure 2-6: Scene Geometry dialog box

12. In the **Scene Geometry** dialog box:

    - In the **Coordinate Frame Hint properties** area, click the **Type** pull-down list and scroll down to select **Plane parallel to z-x plane**.

      This is the plane of the ground. If you were working with the z axis pointing up then you would use **Plane parallel to x-y plane** instead.

    - Click the **Connect to selected** button and then click the **Update Coord Frame** button to apply it to the scene. Click the **Close** button.

13. On the Toolbar, click the **3D** button to display the 3D view. Your 3D structure should now look like Figure 2-7. Note that the plane is set at camera height.

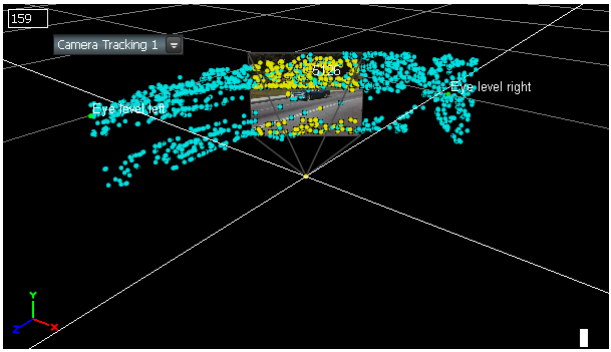


Figure 2-7: 3D structure with parallel plane set to camera height

Move the Horizontal Plane to Ground Level, and Add a Test Object

In this stage, you move the eye level plane that you created to the ground height, and add a test object to the sequence.

As part of this exercise, you select a point on the ground as close to the camera as possible, and set this point as the point of origin.

1. On the Toolbar, click the **2D** button to return to the image view, and navigate to frame 0.
2. From the **Edit** menu, click **Clear Selections** to clear your previously selected points.

   Check that your previous selection on the roof of the parked car has been cleared. The selected point should have changed from green back to yellow and the label disappears.
3. Navigate to Frame 240 and select a 3D prediction point on the ground as close to the base of the camera tripod as possible (shown by the arrow below).

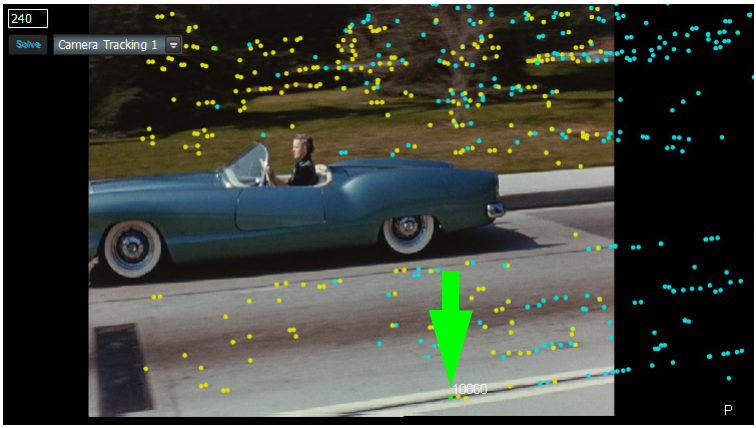


Figure 2-8: Choose 3D predictions at tripod base

4. Click the **Scene Geometry** button in the **Toolbox**, and in the **Scene Geometry** dialog box:
   a. Click **Add Coord Frm Hint**.
   b. In the **Coordinate Frame Hint Properties** area, scroll in the **Type** pull-down list to select **Origin**.
   c. Click the **Connect to Selected** button.
   d. Click the **Update Coord Frame** button to apply it to the scene.
   e. Click the **Close** button to close the dialog box. Your 3D structure should now look like Figure 2-9.

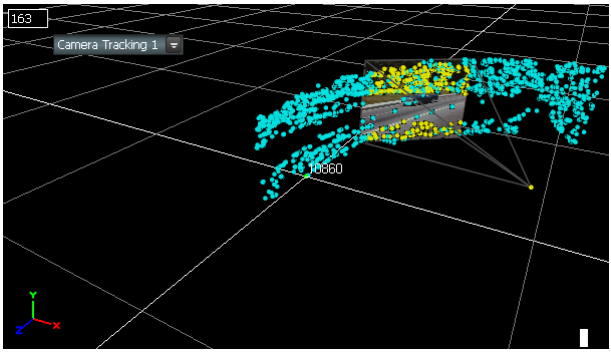


Figure 2-9: 3D structure with updated coordinate frame

5. Click the **Add Test Objects** button in the **Toolbox**. a **Ladybird** object appears in the 3D view and the **Test Objects** dialog box is displayed. Click **Close** to keep the test object defaults.

   The default test object that you created is located at the origin, on the ground plane.

6. Click the **2D** button on the Toolbar to display the image in the 2D view.

7. On the Toolbar, click the **Scale** button, select the test object, and use the mouse to drag the test object and change its size.

8. Click the **Translate** button, select the test object, and use the mouse to change the position of the test object.

9. On the **Timebar** or **Timeline**, drag the vertical bar to view the sequence. Check that your test object behaves correctly as if it was a part of the sequence.

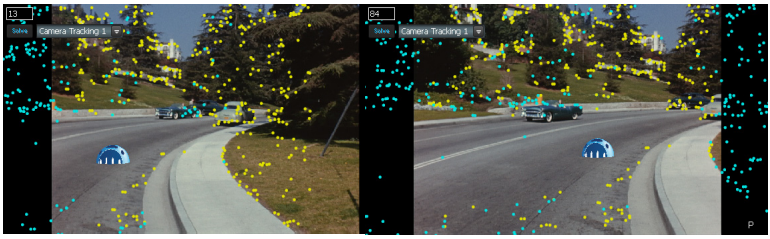


Figure 2-10: Test object added to scene

Correcting Lens Distortion and Adding Locators 3

This tutorial shows you how to:

- Reduce the effect of lens distortion on the quality of camera solving
- Improve the quality of a scene's 3D structure by adding locators

Lens distortion can have a significant effect on the quality of your camera solving. To assess the level of radial distortion in an image, you can draw a calibration line from within boujou onto any feature that you know should really be straight.

You can then undistort the image until the feature that should be straight lines up with the calibration line. Lines that pass through the center of the image will not appear to be distorted. The further from the center a line is, the more distorted it will be.

You can also assess radial lens distortion automatically.

The lessons in this tutorial describe the stages in correcting lens distortion and adding locators:

For this tutorial, you use the following sample image sequence:

- *tutorial3_chapel.[###].jpg*

Important

Before starting this tutorial, you must have already added the required shortcut buttons to your **Toolbox** and copied the sample tutorial files to your hard disk drive where you can access them while working through the tutorial. For details, see *Chapter 1 Introduction*.

Manually Assessing Lens Distortion

boujou has a tool for automatically assessing the amount of radial lens distortion. However this tutorial begins by describing the manual method of assessing lens distortion.

To manually assess the level of lens distortion:

1. In the **Toolbox**, click the **Import Sequence** button and import *tutorial3_chapel.[000-100].jpg.*

2. Press the F9 key to open the **Feature Tracking Properties** dialog box.
3. Note that **Sequence 1** is selected in the **Sequence** drop-down list. Click the **Start** button. As soon as feature tracking begins, select the **Camera solve on completion** check box to have camera solving start as soon as feature tracking is complete.

Tip

The **Camera solve on completion** check box is located on the **Status bar**, just below the main Image window.

If the **Camera solve on completion** check box was not selected, when feature tracking is complete, you can start camera solving by selecting the **Solve Camera** option on the **3D Tasks** menu, and clicking **Start** in the **Advanced Camera Solve Properties** dialog box.

4. Go to the **3D view** by pressing the F3 key and look at the 3D structure that boujou has calculated.

   As you can see in Figure 3-1, the predictions are concentrated on the corner of the building nearest the camera and there are none at all in the background. This is typical of shots with lens distortion. Features near the edges of the frame are too inconsistent to be used in the camera solution. If you look at

the camera path, you will see that it is noisy, suggesting that the camera solving is not accurate for this shot.

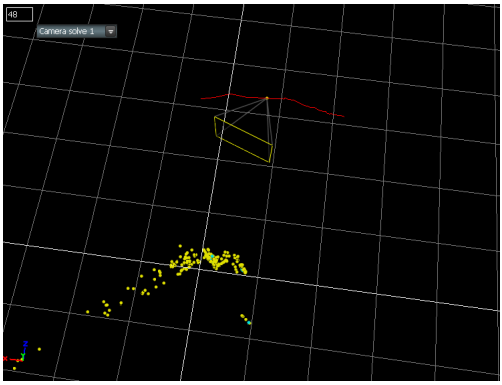


Figure 3-1: Calculated 3D structure with lens distortion

Correcting for Lens Distortion

The lens distortion must be corrected before boujou can calculate an accurate and usable camera solve for this shot. This would be especially important if you wanted to do any set-extension work on the shot.

To correct for lens distortion:

1. Open a new boujou project and import *tutorial3_chapel.[000-100].jpg* as before.
2. Click the **Assess Distortion** button in the **Toolbox**.

Alternatively, from the menu bar, click **Setup** and then click **Assess Lens Distortion (manual)**. The **Assess Lens**

Distortion dialog box, shown in Figure 3-2, is displayed with Camera 1 selected.

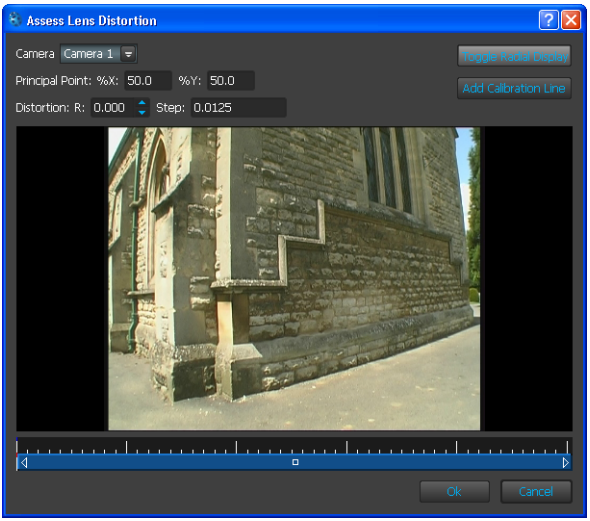


Figure 3-2: Assess Lens Distortion dialog box

3. Click the **Add Calibration Line** button and click and drag on the image in the **Assess Lens Distortion** dialog box to draw a yellow calibration line along the nearest corner of the building, making sure that the end points are positioned on the corner. You can use the usual navigation controls to pan and dolly in this window. When you click away from the calibration line, it will turn cyan. If you click the line, it will turn green, and a white editing box is displayed at each end. This enables you to adjust the position the ends of the line more precisely.
4. Adjust the distortion factor, R, by clicking the up and down arrows next to the **R** field. Keep adjusting the value of R until the corner of the building (the feature that should be straight) lines up with the calibration line (always straight), as shown in Figure 3-3. The distortion effect will be greatest in the

middle of the line, so it is best to zoom in on this region when adjusting R. A value of 0.30 is about right.

Tip

If in a future project you already know the value of R, you can enter this value in the **Radial** field of the **Advanced** area of the **Camera Properties** dialog box. In this case, if you have any default camera views or an existing solve in the project, a warning dialog is displayed to alert you to the fact that the camera views or solve are no longer valid for the undistorted images. For further details, see the *Assessing Lens Distortion* section in the *Advanced Functions* chapter in the *boujou Reference Guide*.

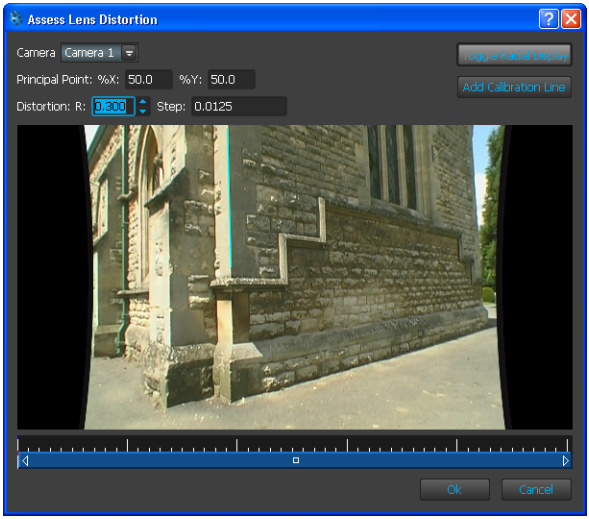


Figure 3-3: Distortion factor adjusted

5. Click **OK** to apply your changes and close the dialog box.
6. To ensure the Image window is in 2D view, click the **2D** button on the Toolbar, then click the **Overlays** tab to display the **Overlays** pane.
7. In the **Overlays** tree, select the **Radial** check box. This displays the corrected (undistorted) images in the Image window. If the corrected image is larger than the original PAL image, press the F5 key to fit it to the current window size.

8. In the **Toolbox**, click the **Track Features** button. The **Feature Tracking Properties** dialog box is displayed.
9. Leave all of the defaults unchanged and click the **Start** button. As soon as feature tracking begins, select the **Camera solve on completion** check box to have camera solving start as soon as feature tracking is complete.

If the **Camera solve on completion** check box was not selected, when feature tracking is complete, you can start camera solving by selecting the **Solve Camera** option on the **3D Tasks** menu, and clicking **Start** in the **Advanced Camera Solve Properties** dialog box.

10. Change to 3D view and look at the structure that boujou has calculated. There are many more predictions and they are distributed throughout the scene (not just concentrated in a small area). The camera path looks smoother, which suggests a more accurate camera solution.

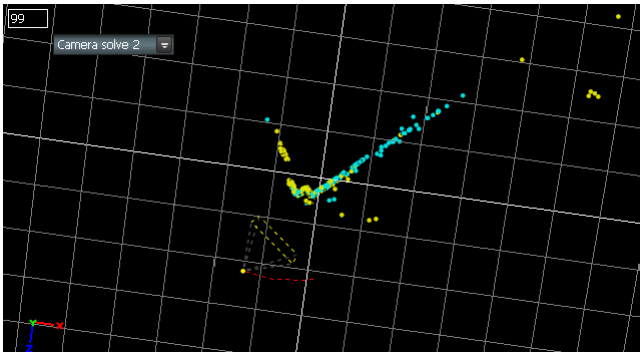


Figure 3-4: Calculated 3D structure with corrected lens distortion

Adding Locators

You can make further improvements to the 3D structure of this scene by adding locators and using **Solve Adjust**.

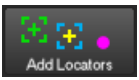
When you add information about the position of locators in the 2D view, keyframes are created. If you have tracked the camera, you need a minimum of two keyframes for boujou to be able to calculate the locator's position in 3D space.

There are not many predictions on the left of the front wall of the building so adding locators around the window to the left of the image should improve the structure in this area. The suggested positions of these locators is shown in Figure 3-5.

Figure 3-5: Suggested locator positions

To add locators to the scene:

1. In 2D view, go to frame 1. You may find it easier to work with the uncorrected image, so on the **Overlays** tab, clear the **Radial** check box.
2. In the **Toolbox**, click the **Add Locators** button or use the keyboard shortcut CTRL+Q.



The cursor changes to a cross hair and the **Zoom** pane is displayed (unless the **Zoom** pane has been hidden). The text

in the Status bar under the Image window indicates that you are adding a locator and boujou switches to Edit mode.

Important

Edit mode is indicated by the **Toggle Edit Mode** button on the **Status Bar** appearing pressed. In Edit mode, you can only edit the currently selected locator or add a new one: you cannot select other artifacts. If you want to select a different locator, you must leave Edit mode by clicking the **Toggle Edit Mode** button, or by right-clicking in the Image window and selecting **Toggle Edit Mode** from the menu.

3. In the Image window, click at the apex of the window arch to add Locator 1 in its start position. This also creates the first keyframe.
4. Zoom in on the locator in the Image window to position it more accurately. You can zoom in several ways:
   - Press the z key. A zoomed-in image is displayed in the Image window, as shown in Figure 3-6. A green box shows the locator position. The zoomed-in region covers the area shown by the yellow box in the **Zoom** pane.

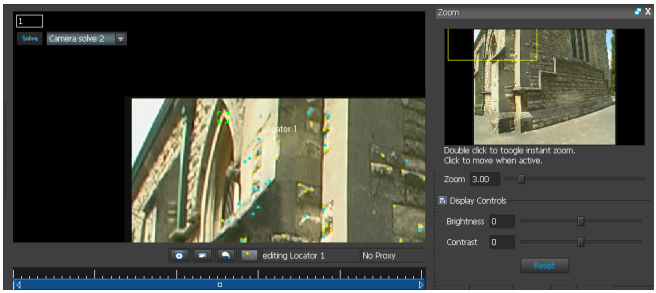


Figure 3-6: Locator in zoomed-in view

   - Use SHIFT+LMB+RMB (or SHIFT+MMB if you have the preference set in **Edit > Preferences > Miscellaneous**) in the Image window. You can change the amount of zoom by using SHIFT+RMB or adjusting the **Zoom** value in the

Zoom pane. Notice how the yellow box in the **Zoom** pane changes size as you zoom in and out in the Image window.

Tip

You can use CTRL+SHIFT+ARROW to position locators precisely.

5. In the **Timeline** pane, expand the **Locators** branch of the artifact tree.

   A locator line has been added, labeled **Locator 1**, representing the locator that you have just added. The diamond shape represents the keyframe that was created when you added the locator at its first position, as shown in Figure 3-7.

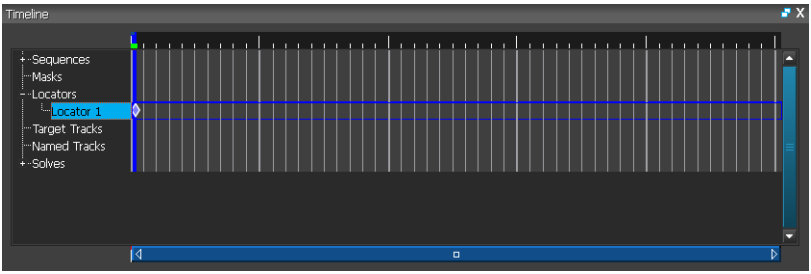


Figure 3-7: Locator and first keyframe in the Timeline

6. Scrub forward to frame 20. Do this in one of the following ways:

   - SHIFT+LMB in the main window

   or

   - Click and drag in the Timebar or **Timeline**

   or

   - Type 20 in the frame counter at the top left of the Image window.

   or

   - Press the PAGE UP key twice to advance 20 frames.

7. Click in the Image window and adjust the position of Locator 1.

boujou now has enough information to start calculating the position of Locator 1 in 3D space. Note that in the **Timeline**, another diamond has appeared at frame 20, representing the keyframe you have just added by adjusting the position of Locator 1.

8. Scrub forward to frame 35. The Image window now shows the predicted position of Locator 1 on this frame. Adjust the position of the locator and note that a keyframe is added on this frame.
9. Scrub forward to frame 55 and add another keyframe by adjusting the position of Locator 1.
10. To stop editing Locator 1 and to add a second locator, click on the **Add Locator** button in the **Toolbox**. Repeat the procedure that you followed for adding Locator 1, but create the keyframes for Locator 2 on frames 20, 55, 75, and 90.
11. Add the third and final locator in the same way, also creating the keyframes on frames 20, 55, 75, and 90.

    In the **Timeline**, three locator lines are now displayed. These represent the locators that you have just added, and the diamonds represent the keyframes, as shown in Figure 3-8.

Important

You can see that the keyframes for the locators are grouped together on the same frame whenever possible. It was not essential to do this for this shot, but it is a very good idea to get into the habit of grouping your locator keyframes for more complex camera moves, or for when you use survey points.

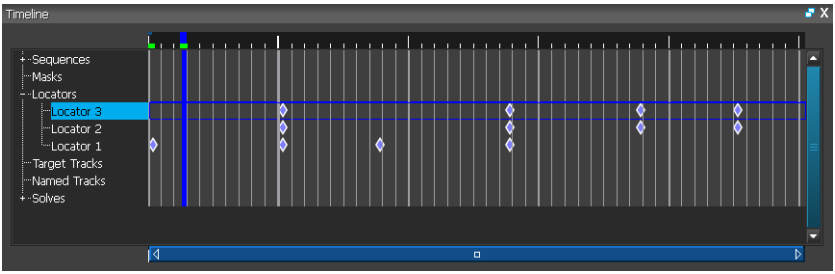


Figure 3-8: Locators and keyframes in the Timeline

12. Leave Edit mode by clicking on the **Toggle Edit Mode** button on the Status bar just below the Image window.

13. If you need to make any changes to any of the locators, select it in the 2D view and either drag it to a new position or use the zoom options described in step 4. to make more precise adjustments.
14. Go to the 3D view. The locators that you have just added are displayed as purple dots. They are now valid 3D points which will be exported with the automatically generated predictions.
15. On the menu bar, click **3D Tasks** and then click **Solve Adjust**. The **Solve Adjust** dialog box, shown in Figure 3-9, is displayed.
16. Select **Smoothing** and then click the **Start** button.

    As the solve progresses, the adjustments are listed in the dialog box. The **Solve Adjust** is much faster than the complete solve because it is only making refinements to an existing camera solution.

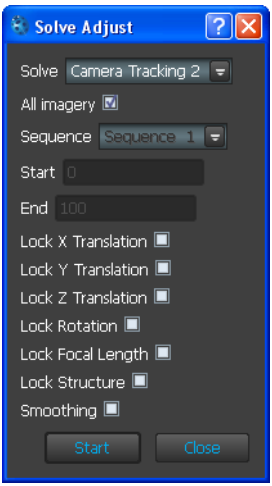


Figure 3-9: Solve Adjust dialog box

17. When complete, you will see that more predictions have been created along the walls of the building and around the window, as shown in Figure 3-10. Press F3 to switch between 2D and 3D view, noting the improved 3D structure.

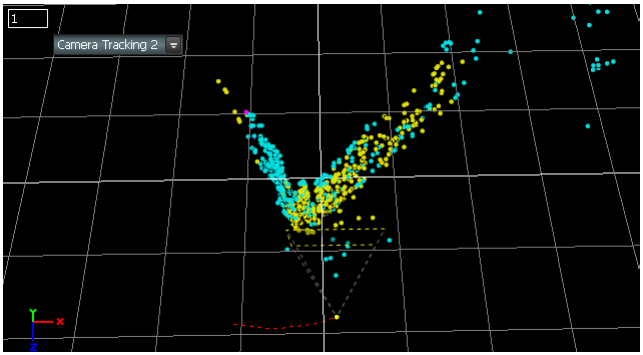


Figure 3-10: Predictions created based on locators

Automatically Assessing Lens Distortion

boujou also enables you to assess the lens distortion automatically.

To automatically assess lens distortion:

1. Note that Camera Tracking 2 is displayed in the Image Window, showing that it is the active solve. From the menu bar, click **3D Tasks** and then click **Assess Lens Distortion (automatic)**.

   boujou automatically calculates the optimum value of lens distortion for the current camera solve. The Status bar displays a message indicating that lens distortion is being automatically assessed and shows the progress of the operation.

To see the calculated value of lens distortion:

1. In the **Taskview** pane, expand **Cameras** and double-click **Camera 1**.

   The **Camera Properties** dialog box is displayed.

2. Select the **Advanced** check box.

   In the **Lens Distortion** area, the **Radial** field displays the calculated value, which should be about 0.35.

3. Click **Close** to close the dialog box.

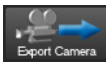
There is not a big difference between the manual and automatic methods for assessing lens distortion in either the quality of the camera solve or the 3D structure, confirming that are both methods are valid.

If this shot had no straight lines in it and you had not shot a lens grid with your camera, you would have to rely on the automatic method to assess the distortion.

Adjusting the Pipeline for Lens Distortion Corrections

Correcting for lens distortion means that your VFX pipeline becomes more complicated. The camera that boujou calculates is based on the undistorted images and so it has a different resolution to the camera that shot the original footage. In this case the PAL camera (720x576) that was set up when you first imported the image sequence becomes a custom type with a resolution of 834x668 when you export it to your animation software. Consequently you will have to export the undistorted images to use as background images in your 3D animation software, and re-distort your CG images to match the original sequence.

To adjust the lens distortion pipeline:

1		D1 PAL 720x576		Import the image sequence that you want to track into boujou. The original, distorted images are D1 PAL resolution (720x576).
2		Custom 834x668		Correct the images for lens distortion. A radial distortion value of 0.30 gives a custom camera with an image size of 834x668.
3		Custom 834x668	 	Export the camera to your 3D animation package. Also export the undistorted images to act as the background sequence in your 3D software. Add your CG elements and render them with an alpha channel at the same resolution as the undistorted images exported from boujou (in this example 834x668). Do not render the background image.

4		D1 PAL 720x576		Use boujou to redistort the rendered sequence so that it matches the original footage. This can be done using the **Lens-Adjust External Sequence** tool. After the rendered images have been re-distorted they should be in the same resolution as the original footage.
5		D1 PAL 720x576		Composite the distorted CG frames on top of the original background plates. The distortion that you have added to the CG elements will match the distortion in the original images.

Using Masks 4

This tutorial shows you how to combine moving objects and a background in a scene.

The shot in the sample tutorial file was taken with a hand-held digital video camera, and the move type is effectively a Nodal Pan because there is almost no parallax. However, the moving van has parallax and would have to be tracked as a Free Move.

Tip

Although this tutorial describes how to create two separate projects: one for the moving van and one for the background, which can then be combined in your 3D animation software, you could instead import the sequence twice into a single project, once as a Nodal Pan, and the second time as a Free Move.

The van is quite large in the image and boujou would have difficulty deciding which set of feature tracks represents the dominant motion of the scene. A simple polygon mask will enable you to tell boujou exactly which elements of the scene you want it to track and which ones to ignore.

The lessons in this tutorial describe the stages in using masks to combine moving objects and a background in a scene:

For this tutorial, you need the following sample image sequence:

- *tutorial4_van.[###].jpg*.

Important

Before starting this tutorial, you must have already added the required shortcut buttons to your **Toolbox** and copied the sample tutorial files to your hard disk drive where you can access them while working through the tutorial. For details, see *Chapter 1 Introduction*.

Creating a Polygon Mask

In this lesson, you will learn how to create a polygon mask. A polygon mask in boujou is a shape defined by straight lines as well as vertices that can be animated. The fill area can be either inside or outside the outline and defines the regions in which you do not want boujou to find 2D features.

To create a polygon mask:

1. Click the **Import Sequence** button in the **Toolbox**, then browse for the image sequence *tutorial4_van.[000-071].jpg*.

2. In the **Image Sequence** dialog box, change the **Move Type** to **Nodal Pan** and click **OK**.
3. Go to frame 1 and click the **Add Poly Masks** button in the **Toolbox**.

Move the cursor over the image and click to create the first keypoint of the mask outline.

4. Move the cursor and click again. A second keypoint will appear, connected to the first by a straight line. Add more keypoints around the outline of the van and click the first keypoint to close the outline (the cursor will change to a hand to show you that you are about to close it).

A polygon mask is created immediately and is displayed in the main window, as shown in Figure 4-1. A keyframe has been set at frame 0.

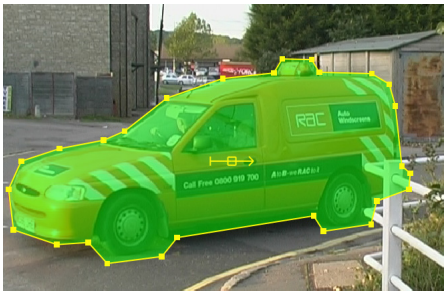


Figure 4-1: Polygon mask created

5. In the **Timeline** pane, expand the **Masks** branch of the artifact tree.

   A bar is displayed, representing the mask that you have just added. The diamond shape represents the keyframe that was created when you added the mask, as shown in Figure 4-2.

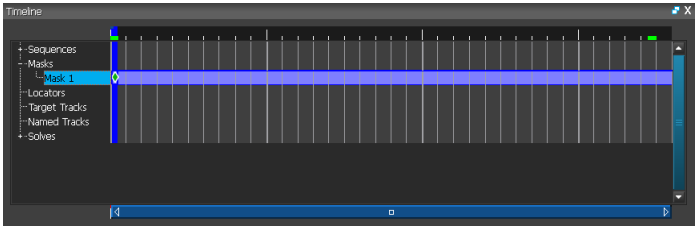


Figure 4-2: Mask and first keyframe in the Timeline

6. To animate the mask so that it covers the van for the whole sequence you must add more keyframes. Go to the last frame of the sequence and edit the shape of the mask.

A keyframe will be set whenever you make any changes to the mask:

- To add a keypoint, right-click on a line and click **Add keypoint**.
- To delete a keypoint, CTRL+click to select one or more keypoints, then right-click and click **Delete selected keypoints**.
- To move a keypoint, click it and drag. It will turn red when you are editing it.
- To move a line, click it and drag. It will turn red when you are editing it.
- To move the whole mask, click and drag the center of the **Mask Manipulator** tool.
- To rotate the whole mask, click and drag the arrow on the right of the **Mask Manipulator** tool.
- To scale the whole mask, click and drag on the T-bar to the left of the **Mask Manipulator** tool.

7. Keep editing the mask and adding keyframes until it covers the moving van for the entire sequence. View your keyframes in the **Masks** branch of the **Timeline**, as shown in Figure 4-3.

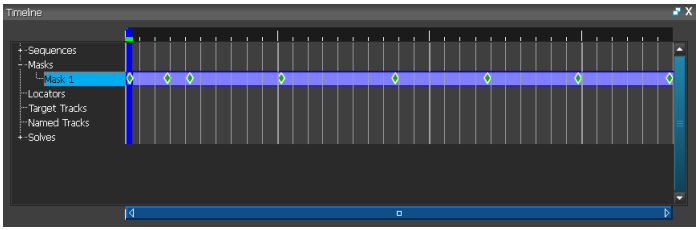


Figure 4-3: Masks branch in Timeline

8. Save the project. Call it *tutorial4_van_background-0.bpj.*

Tracking the Background

In this lesson, you learn to track the background behind the mask you created in the previous lesson. Now that you have hidden the

moving van in the previous lesson, you can track the shot normally to find out how the camera moved.

To track the background:

1. Click the **Track Features** button in the **Toolbox**.

The **Feature Tracking Properties** dialog box is displayed. Note that **Sequence 1** is selected in the **Sequence** drop-down list and leave all of the settings at their default values.

2. Click the **Start** button. As soon as feature tracking begins, select the **Camera solve on completion** check box to have camera solving start as soon as feature tracking is complete.

Tip

The **Camera solve on completion** check box is located on the **Status bar**, just below the main Image window.

If the **Camera solve on completion** check box was not selected, when feature tracking is complete, you can start camera solving by selecting the **Solve Camera** option on the **3D Tasks** menu, and clicking **Start** in the **Advanced Camera Solve Properties** dialog box.

3. When camera solving is complete, in the **Taskview**, expand **Camera Solves** and double-click **Camera Solve 1**, as shown in Figure 4-5.

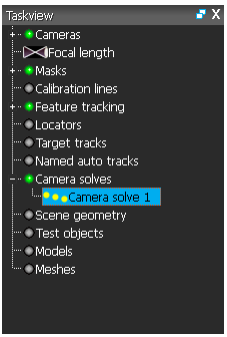


Figure 4-4: Camera Solve 1 artifact in Taskview

The **Camera Solve 1 Information** dialog box, as shown in Figure 4-5, is displayed.

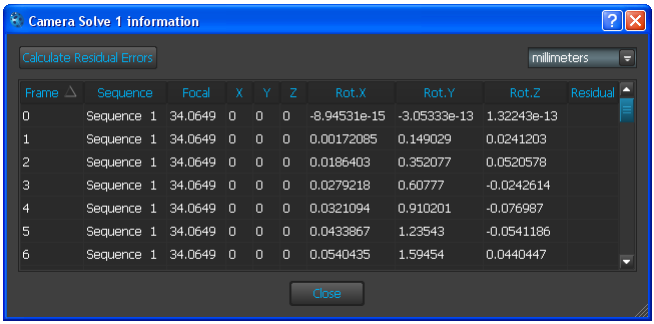


Figure 4-5: Camera Solve 1 Information dialog box

This window displays the calculated animation data for the camera solution. Notice that the X, Y, and Z translation values for a **Nodal Pan** camera move are all zero (a Nodal Pan move is rotation only). Make a note of the calculated value of focal length (in our example the value is 34.0649 mm, but your value may be slightly different) and click **Close**.

Tip

To see the focal length measurements in pixels or FoV (degrees), click the drop-down list at the top right of the dialog box, which by default displays **millimeters** and select your preferred units of measurement.

4. Click the **Export Camera** button in the **Toolbox**.

The **Export Camera** dialog box is displayed.

5. Set the **Move Type** to **Moving Camera, Static Scene** and export the camera solving results in your preferred format.
6. Save the project with a different file name. Call it *tutorial4_van_background-c.bpj.*

Tracking the Moving Object

In this lesson, you learn to track the movement of the object for which you created a mask in the first lesson across the background you tracked in the second lesson. If you invert your animated polygonal mask, you will be able to hide the background and track the moving object. boujou does not understand that the object is moving—it will solve the camera as if the object were stationary. All of the motion will be applied to the camera.

To track the moving object:

1. Either reopen your original project file (*tutorial4_van_background-0.bpj*) or undo the camera solving and feature tracking from the **History** pane. If you double-click **Feature Tracking** near the top of the **History** stack, you will undo feature tracking and everything above it. A red cross will appear next to all actions that have been undone. If you cannot see your mask, turn on the **Masks** overlay in the **Overlays** pane.
2. From the **Setup** menu, click **Edit Sequence** to open the **Image Sequence** dialog box.
3. Change the **Move Type** to **Free Move** and click **OK**.
4. On the **Overlays** pane, make sure the **Masks** check box is selected.
5. In the Image window, click the mask to select it. Right-click in the fill region and select **Invert Mask**. The green fill area will now be outside the mask outline, hiding the background and revealing the van.
6. Click the **Focal Constraint** button in the **Toolbox**.

The **Focal Length** dialog box, shown in Figure 4-6, is displayed.

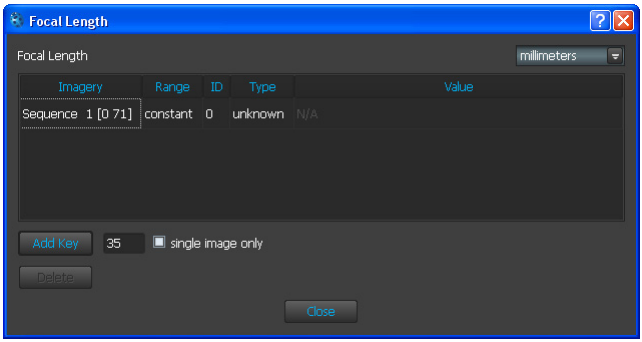


Figure 4-6: Focal Length dialog box

7. In the Focal Length dialog box:
   a. Make sure the **Range** is set to **constant**.
   b. In the **Type** field, double-click **unknown**, click on the downward arrow and select **fixed to value**.
   c. In the **Value** field, enter the value that boujou calculated when you tracked the background as a Nodal Pan (in this example, 34.0649 mm) and close the dialog box.
8. Click the **Track Features** button in the **Toolbox**. When the **Feature Tracking Properties** dialog box appears, keep all of the default values.
9. Click the **Start** button. As soon as feature tracking begins, select the **Camera solve on completion** check box to have camera solving start as soon as feature tracking is complete.
10. When tracking is complete, go to the **3D view** and look at the 3D structure. The 3D predictions form the shape of the side of the van and the motion of the van has been added to the motion of the camera. boujou does not know that the van is moving and so it assumes that the van was stationary and the camera was moving. If you add a test object to the scene, it will look as if it is moving with the van even though it is not animated.

11. Click the **Export Camera** button in the **Toolbox**. The **Export Camera** dialog box is displayed.
12. Set the **Move Type** to **Static Camera, Moving Scene** and export the camera solve results in your preferred format.
13. Save the project with a different file name. Call it *tutorial4_van_object-c.bpj.*

Combining exported sequences in a 3D Animation Package

After completing the previous lessons, you should now have two exports:

- Moving camera: a static scene export for the background.
- Static camera: a moving scene export for the moving object.

Both cameras will have the same focal length. The simplest way of combining these two camera tracks is to add your CG elements to each one separately and then composite the rendered images in a 2D compositing package. However, if you want, you can combine them in the same 3D scene.

To combine the moving and static camera tracks into the same 3D scene:

1. Load both exports into your 3D animation package. Make sure you are at the first frame of the sequence and line up the camera for the moving object with the camera for the background. To do this make sure that the top node of the moving object hierarchy has the same pivot point as the camera below it.
2. Constrain the top node of the moving object hierarchy to the position and orientation of the camera for the background.
3. Remove the constraints and make the top node of the moving object hierarchy the child of the camera for the background.

Now if you look through either one of the two cameras you should see the points for both the background and the moving object overlaid onto the image sequence.

Using Target Tracks 5

This tutorial shows how to use the target tracker to create 2D tracks for features that may not be found by the automatic tracker.

A good example of such features might be circular bluescreen or greenscreen markers. Because the target tracker relies on pattern matching rather than corner detection, it can track such shapes reliably. However, it is not restricted to circular shapes, and can be used on a wide variety of features.

To begin using the target tracker, you tell it what features to follow on a single frame. It will then try to follow these features through the sequence.

You can track multiple features with a single click of the tracking buttons (see page 5-25).

If necessary, you can refine and adjust the accuracy of the target tracker by:

- Adding additional keyframes on a per track basis
- Refining settings such as the search region to help it track a particular feature

Although target tracking is often used to give boujou additional help with its automated feature tracking or solving process, you can track an entire sequence using target tracks alone, as shown in this tutorial.

There are many ways to work with the target tracker. This tutorial is designed to cover some of the tools and techniques and to help you understand how the target tracker works. However, every shot is different and the workflow in this tutorial may not be the best way to work with every shot.

The lessons in this tutorial describe the stages in target tracking:

- *Target Tracking* on page 5-15
- *Refining Target Tracking* on page 5-16
- *Solving the Camera* on page 5-21
- *Adding a Test Object* on page 5-22

For this tutorial, you need the following sample image sequence and project file:

- *tutorial5_target_tracks.[###].jpg*
- *tutorial5_target_tracks_0.bpj*

Important
Before starting this tutorial, you must have already added the required shortcut buttons to your **Toolbox** and copied the sample tutorial files to your hard disk drive where you can access them while working through the tutorial. For details, see *Chapter 1 Introduction*.

After the end of the lessons, additional features of the target tracker that are not covered in the tutorial are described, together with tools that are useful when target tracking:

- *Additional Target Tracker Features* on page 5-24
- *Using Tools for Target Tracking* on page 5-32

Placing Target Tracks

In this lesson, you learn how to define the patterns you want to track. Target tracking in boujou is a two-stage process. First you identify, on a single keyframe, the region of the image that you want to track, and then you track the pattern defined by this region. If necessary, you can then refine the tracking, using additional keyframes.

To place the first track:

1. Open the project file in one of the following ways:

   - On the menu bar, click **File** and then click **Open**.

   or

   - On the **Toolbar** click the **Open** button.

   The **Open Project** dialog box is displayed.

2. Browse for the boujou project file named *tutorial5_target_tracks_0.bpj*.

   When the project opens, a **Relocate Files** dialog box, similar to that shown in Figure 5-1, will probably also be displayed. This indicates that boujou cannot find the required image sequence and needs you to specify where to find it.

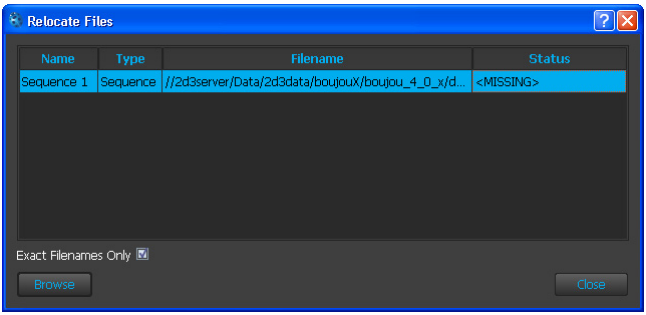


Figure 5-1: Relocate Files dialog box

3. In the file **Name** list, note that **Sequence 1** is selected and then click **Browse**.

   The file browser is displayed.

4. In the file browser, locate and select the image sequence named *tutorial5_target_tracks.001.jpg* from the *tutorial_05\tutorial_5_source_images* folder and then in the **Relocate Files** dialog box, click **Close**.

5. Using the Timebar or the **Timeline**, go to frame 50.

   Tip
   In this tutorial, you will be tracking both in a forward direction and backward. You will therefore place your first track in the middle of the sequence. You could place a track at the beginning of the sequence and track just forward, or at the end and track backward. Choosing the middle frame of the sequence allows you to track in both directions from this position. This minimizes slippage from the pattern you want to track.

6. In the **Toolbox**, click the **Add Target Tracks** button, or use the keyboard shortcut CTRL+W.

   The cursor changes to a cross hair.

   Important
   
   When you click the **Add Target Track** button, you go into **Edit mode**. This is shown by the **Toggle Edit Mode** button on the **Status Bar** appearing pressed in. You will only be able to edit the currently selected target track or add a new one when you are in Edit mode. If you want to select a different target track, you must leave Edit mode by clicking on the **Toggle Edit Mode** button, or by right-clicking in the main window and selecting **Toggle Edit Mode** from the menu.

7. To place your first target track, click in the center of the bottom leftmost white circular marker in the image sequence,

as shown in Figure 5-2. The placement does not have to be accurate at this time as you will edit it later.

Figure 5-2: Creating the first target track

Two concentric squares appear over the marker: a blue search region border and a green pattern border, as shown in Figure 5-2 above.

As soon as you click the **Add Target Tracks** button, the **Zoom** pane is displayed (unless it has been hidden), as shown in Figure 5-3.

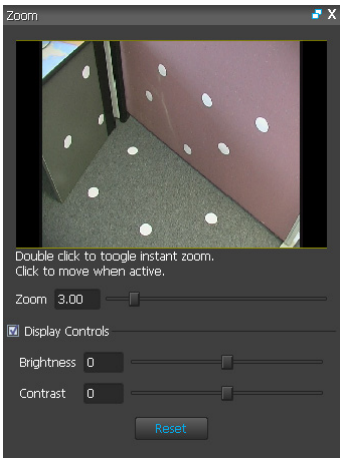


Figure 5-3: Target track in Zoom Tool pane

If it is not displayed, click on the **Zoom** tab in the right sidebar. If it is hidden, on the **View** menu point to **Panes** and then click **Zoom**. For more information on the Zoom pane, see *Zoom Tool* on page 5-32.

8. Click the **Add Target Tracks** button again, or use the keyboard shortcut CTRL+W and then click in the center of the next marker to the left and above the first in the 2D Image window, as shown in Figure 5-4.

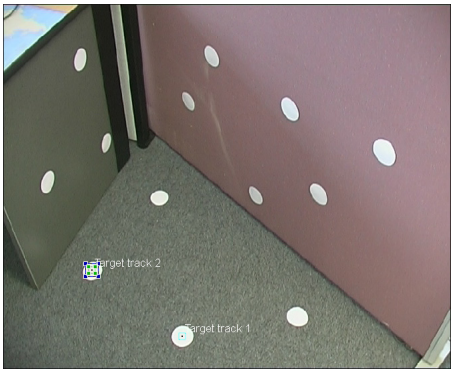


Figure 5-4: Creating the second target track

Again, concentric squares appear where you clicked on the marker. The first track you placed is now displayed as a cyan square with a black dot at its center.

9. Repeat step 8. for all the markers in the image at frame 50. Add them in the order shown in Figure 5-5.

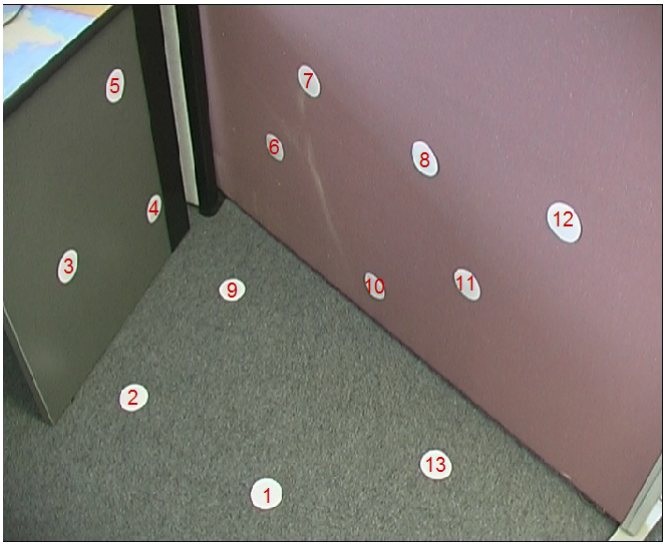


Figure 5-5: Adding the remaining target tracks

Important
Make sure you click the **Add Target Tracks** button or CTRL+W each time you place a new track. This ensures you create a new track. If you do not do this, you will remain in Edit mode for the original track and will simply move your last placed track when you click on the next marker.

10. When you have placed your last track (13), click the **Toggle Edit Mode** button in the status bar to exit Edit mode, and then click somewhere in the image (not on a target track) to deselect all tracks.

The Image window should now look similar to that shown in Figure 5-6.

Figure 5-6: All tracks placed

11. Position your mouse pointer over Target track 1 in the Image window, and then press the z key.

    Your view in the Image window is zoomed in by the factor specified in the **Zoom** field of the **Zoom** pane.

    The zoomed region is indicated in the **Zoom** pane overview by a movable yellow border, as shown in Figure 5-7.

For more information on using the Zoom tool, see *Zoom Tool* on page 5-32.

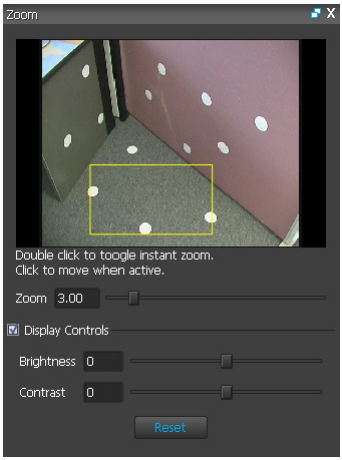


Figure 5-7: Overview in the Zoom Tool pane

12. To select Target track 1, in the Image window, click on the cyan square.

    Tip
    You can also select the track in the **Timeline** by expanding **Target Tracks** and clicking on the **Target track 1** label.

13. To center the view on Target track 1, on the **View** menu click **Center selection**, or press the **F** key.

    The Image window is centered on the selected marker.

    You are now ready to edit the position of the tracks and the size of the comparison and search regions.

Editing Target Tracks

In this lesson, you learn how to edit the position of the tracks you placed in the previous lesson, and to change their comparison and search regions.

To edit target tracks:

1. Move the center position of Target track 1 by clicking and dragging the black center point in the middle of the small green square, or by clicking in a new center position.

   Tip
   You can also move the target track in small increments by selecting it and pressing CTRL+SHIFT+ARROW.

   Two concentric squares surround the center of a target track:

   - The inner, dotted green square is the **comparison** or **pattern region**. This defines the pattern that you want to track
   - The outer, blue square is the **search region**. This shows how far the tracker will look to find this pattern in the next frame.

2. Make the comparison region (the dotted green square) slightly larger than the circular marker. To edit the size of the comparison region, click and drag on its corners.
3. Make the search region (the blue square) just large enough to find the center of the pattern in the next frame. To edit the size of the search region, click and drag on its corners.

   Tip
   The search region will vary according to the speed of the camera motion. If you make it too big, it can adversely affect tracking speed and you increase the chance of it finding mismatches. If you make it too small, the pattern may not be found in the next frame.

Figure 5-8 shows the center, comparison, and search region for the first target track.

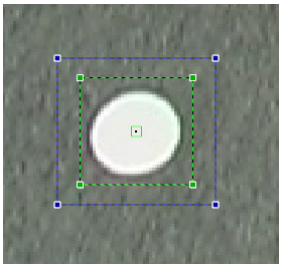


Figure 5-8: Center, comparison, and search regions

4. When you are happy with the center position and regions of the first target track, in the **Timeline** expand the **Target Tracks** branch. You may have to enlarge or even undock the **Timeline** pane to see all of your target track entries.

   Tip
   To rename or delete a track, or to open its **Properties** dialog box, right-click its label in the **Timeline** tree and then select an option from the menu that is displayed.

   The red diamond on frame 50 of each **Target Track** indicates where a **Target Track** keyframe has been added, as shown in Figure 5-9.

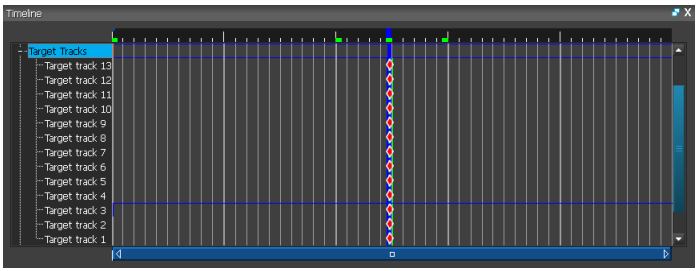


Figure 5-9: Target Track keyframes

5. Make sure you are not in Edit mode (see page 5-4), then, in the **Timeline** tree, click the label of **Target track 2**.

6. Press the **F** key to center the view on your selection. Go into Edit mode (see page 5-4) and edit the center and the comparison and search regions of this track in the same way as you did with the first. Click the **Toggle Edit Mode** button to leave Edit mode.
7. In the **Timeline** tree, click the label of **Target track 3** and center on the selection to edit it as before. Continue in this way for each of the target tracks until you have edited them all on frame 50.

Setting Up Target Tracking

In this lesson, you will prepare boujou to follow the tracks you placed and edited in the previous lessons.

To set up target tracking:

1. To display the Target Tracker (**TT**) pane, click on the **TT** tab in the right sidebar in default layout. If it is hidden:
   - From the **View** menu, point to **Panes**, then click **TT**.

   or

   - Right-click on any pane's title bar and make sure **TT** is selected.

   The TT pane is displayed in the right sidebar as shown in Figure 5-10.

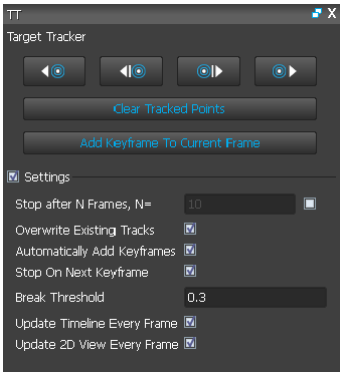


Figure 5-10: TT pane in the right sidebar

2. In the **TT** pane, make sure both the following are selected:
   - **Overwrite Existing Track**
   - **Stop On Next Keyframe**
3. Set the **Break Threshold** to 0.7. This is a fairly high value, so tracks will fail even if they quite accurate.

   Important
   Target tracking will stop for a given track if its health is below a certain threshold. You can alter this threshold by changing the **Break Threshold** parameter in the **TT** pane. The value of this parameter is between 0 and 1. Lower values allow tracking to continue even when the track's score is relatively low; higher values will cause tracking to stop even with relatively high scores. For more information about the **Break Threshold** parameter, see page 5-26.
4. For target tracking to take place, the active frame must contain some tracking data. This means that a keyframe has been created or the frame has already been tracked.

To make sure frame 50 is the active frame:

- Using the Timebar or **Timeline**, go to frame 50.

or

- In the frame number field at the top left of the Image window, type 50.

Important
Target tracking will also only take place if there is at least one track selected. It takes place for each selected track simultaneously.

5. To make sure the Image window is in default view, in the **Overlays** pane, click the **Default View** button, or use the keyboard shortcut F5.
6. In the Image window, select all of the target tracks. Do this in either of the following ways:

   - Click and drag around the tracks. This is the default selection mode and enables you to select a rectangular area.

   or

   - On the status bar, click the **Lasso Selection Mode** button:

     This enables you to select an area by dragging the mouse pointer. Click and drag to select the target tracks.

   The target tracks are selected in the Image window and all the **Target track** artifacts are highlighted in the **Timeline**.

   For more information on selection modes, see the boujou *Reference Guide*.

Target Tracking

In the previous lessons, you learned how to place target tracks, and how to edit their positions and their comparison and search regions. You also learned how to give boujou information about the tracking you want to carry out. You have now completed all the set up steps and are ready to begin target tracking.

To run target tracking:

1. In the **TT** pane, click the **Track Forward** button.

   Tracking begins on all the selected tracks.

   As tracking progresses, these tracks are displayed in the Image window as black and yellow dashed lines.

   In the **Timeline**, smoothly varying color shows the health of each track:

   - Green: good
   - Yellow: fair
   - Orange: mediocre
   - Red: poor

   At the point for a given track where its score falls below the **Break Threshold**, tracking stops altogether and nothing is displayed for that track.

   Tip

   To get more detailed information about the health of a selected track, in the **Timeline** right-click on the track's label and then click **Properties**. For more information on target track properties, see *Target Tracks Dialog Box* on page 5-27.

2. When tracking is complete for the selected tracks in the forward direction, return to frame 50 and make sure all tracks are selected.

3. In the **TT** pane, click the **Track Backward** button.

Tracking progresses in the same way as in the forward direction.

4. When the first pass of tracking in both directions is complete, the **Timeline** should look similar to that in Figure 5-11. It may not be exactly the same since the placement of tracks and search and comparison regions will vary.

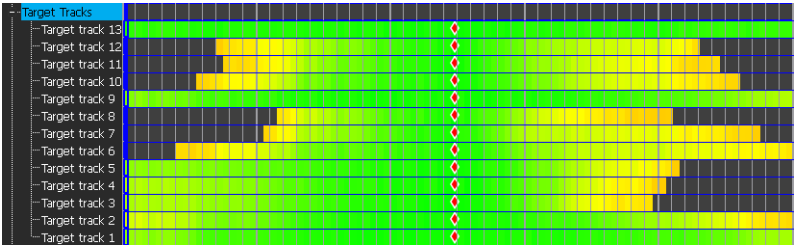


Figure 5-11: Timeline after first pass tracking

Tip

In addition to using **Track Backward** and **Track Forward**, you can specify precisely how many frames to track. For information, see *Specifying the Frames to Track* on page 5-30.

Refining Target Tracking

Target track 13 in Figure 5-11 above looks good, with a single keyframe and a consistently healthy green color. Your project might not be identical in this respect but it should be similar. This is because this marker does not change shape a great deal through the shot and so does not need any additional keyframes to track.

Move the **Timebar** to the frame where **Target track 12** stops on the left side of the **Timeline**. In Figure 5-11, this is frame 15. **Target track 12** stops here because its health is below the **Break Threshold**.

You can now improve tracking by making a few manual adjustments.

To refine target tracking for Target track 12:

1. In the Timeline tree, select **Target track 12**. Press F to center the Image window on this track then with your mouse pointer over the track in the window, press z to zoom in.
2. Make sure you are still at the frame where tracking stops for this target track.

   The track health has deteriorated at this frame because the track center may have drifted or the comparison region no longer encloses the pattern. To correct this, you need to add a new keyframe to adjust the region size and track center.
3. To add a new keyframe for Target track 12 at this frame:

   - In the TT pane, click the **Add Keyframe To Current Frame** button and change the position and search and comparison regions for this track at this frame.

   or

   - Create the keyframe automatically by going into Edit mode (see page page 5-4) and changing the position and search and comparison regions for this track at this frame. As soon as you edit the track a keyframe is created.
4. With **Target track 12** still selected, on the **TT** pane, click the **Track Forward** button.

   The color of the track changes from orange to green as boujou tracks over the existing track and the health of the track improves.

   Because **Overwrite Existing Track** is selected in the **TT** pane, the tracking replaces the existing track data with the new track.

   Because **Stop On Next Keyframe** is selected, the track stops when the original central keyframe is reached.
5. Use the **Timebar** to go to the furthest left keyframe (frame 15 in the example in Figure 5-11) and make sure **Target track 12** is selected.

6. To track backward to the beginning of the sequence, make sure **Stop After N Frames** is not specified and click the **Track Backward** button.

   If the track stops again because the **Break Threshold** has been reached, or if the color of the track becomes orange or red at any point between two keyframes:

   a. Add another keyframe and edit the track center, comparison and search regions as necessary.

   b. Track forward to the next keyframe and backward to the previous one.

   c. Continue until the health of the track is no worse than yellow (preferably green).

7. Continue to add keyframes and track forward and backward in this way until the beginning of the sequence is reached and the health of the track is no worse than yellow at any point. No additional keyframes are required for **Target track 12** in the example shown in Figure 5-11.

8. Use the **Timebar** to go the center keyframe and perform a similar process but this time working forward to the end of the sequence.

   In the example in Figure 5-11, Track 12 stops at around frame 86. Look the marker in the Image window around this frame. You can see that it begins to disappear out of frame immediately after the tracking fails. boujou cannot track a marker after it leaves the frame or if, for example, something passes in front of it (occludes it).

9. Add a new keyframe for **Target track 12** at the frame when tracking fails and edit the track position and comparison and search regions as before.

10. Track backward to the keyframe at frame 50.

11. In the **Timeline**, make sure **Target track 12** is still selected, then right-click in the region after the furthest right keyframe (around frame 86), then click **Set Range Occlusion**.

    Tip

    Setting the occluded range tells boujou that the marker is not trackable for this part of the shot. Since, in this case, this range is at the end of the shot and there are no further keyframes, this step is not strictly necessary.

    If however, the marker became obscured for a number of frames in the middle of the shot, you would set this range as occluded to tell boujou that the marker is only temporarily out of view, and that it can continue to track it from the next keyframe after the occluded range.

To refine target tracking for the rest of the sequence:

1. When you have completed the tracking for **Target track 12**, move down the list of tracks in the Timeline tree and refine each of the other tracks in the same way, adding keyframes and tracking forward and backward.

   When working with target tracks, you may find the following tips help to speed up your workflow:

   - Always ensure the relevant track is selected before you start tracking.
   - Remember to use **Undo** (CTRL+z) or delete steps in the **History** pane to go back if you make a mistake.
   - To navigate between keyframes for selected tracks, use the **Next Key** and **Previous Key** buttons in the Play Controls toolbar, as shown in Figure 5-12. Alternatively, use the keyboard shortcut SHIFT+ARROW.

2. To examine the track center during tracking or playback to see if there is any slippage:

   a. Zoom in and center on the selected target track.

   b. On the Play Controls toolbar, click the **Locked To Point** button, as shown in Figure 5-12.

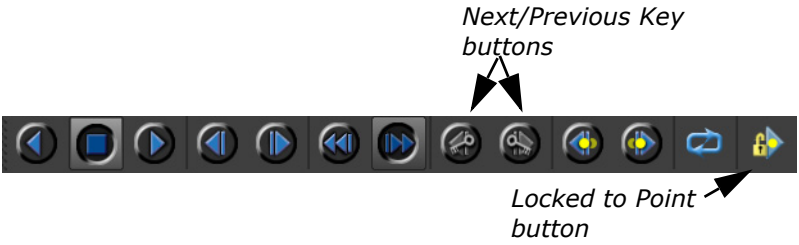


Figure 5-12: Play Controls toolbar

   c. Click the **Play Forward** button.

      The background image moves, but the selected point is static. This lets you see how much the surrounding pixels move relative to the selected point.

Tip
You can lock more than one track by selecting several tracks before clicking **Locked to Point**. During playback, the center of the group of selected tracks remains static.

3. When you have finished tracking all the patterns, the **Timeline** should look similar to that in Figure 5-13, but it will vary according to the positioning of the tracks in your project.

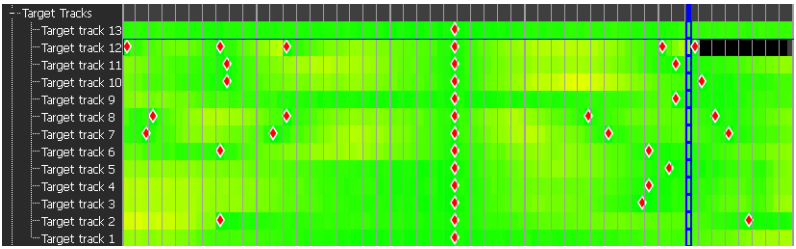


Figure 5-13: Completed tracks in Timeline

Solving the Camera

In this lesson, you learn how to use boujou to calculate the motion of the camera from the tracking information you have supplied in the previous lessons.

To solve the camera:

1. To solve the camera, in the **Toolbox** click the **Camera Solve** button.

   Alternatively use the keyboard shortcut F10. The **Advanced Camera Solve Properties** dialog box is displayed. Keep all of the default options and then click the **Start** button.

   Camera solving should take only a few seconds to complete.

2. When it is finished, go to the 3D view (either click the **3D** button in the Toolbar or press F3). The 3D predictions calculated from the Target Tracks are displayed as red dots.

The 3D structure is good but the camera path (as shown by the red line) is very noisy. You now need to smooth the camera path.

To smooth the camera path:

1. From the menu bar, click **3D Tasks** and then click **Solve Adjust**. Select the **Smoothing** check box, then click **Start**.
2. Go to the 3D view and you will see that the resulting camera path looks perfectly smooth.

You can now add a test object to test the accuracy of the camera solve.

Adding a Test Object

In this lesson, you will learn how to add a test object to the tracked sequence you created in the previous lessons. This lets you test the accuracy of the camera solve that boujou created.

To add a test object:

1. On the status bar, click the **Lasso selection mode** button.

2. In 2d view, select the four target tracks on the floor of the shot then click the **Add Test Objects** button.

   a. In the **Test Objects** dialog box:
   from the **Alignment** drop-down list choose **Orient and Move**.

   b. From the **Align To** list choose **<Plane through selected prediction>**.

   c. Click **OK**.

   The ladybird test object is positioned on the floor of the shot between the markers.

3. Play through the shot to check for slippage.

When your project is complete, it should look similar to that in Figure 5-14 although it may vary depending on your particular target track placement.

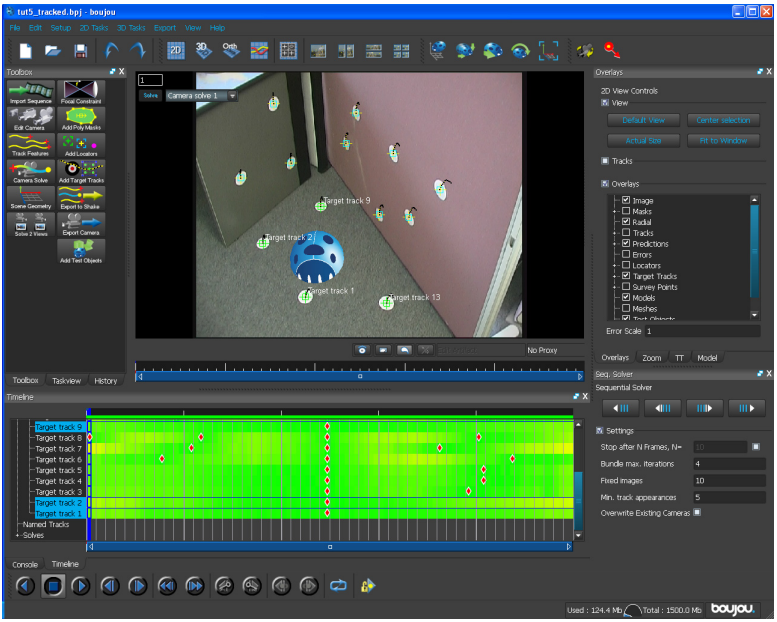


Figure 5-14: The completed target tracking project

4. The solved camera is now ready for export to the animation package of your choice.

Additional Target Tracker Features

This section describes the features and functionality of the target tracker that are not covered elsewhere in this tutorial. The features and functionality described are:

- *The TT (Target Tracking) Pane*
- *Target Tracks Dialog Box* on page 5-27
- *Specifying the Frames to Track* on page 5-30
- *Target Tracking Preferences* on page 5-31

The TT (Target Tracking) Pane

The TT pane, shown in Figure 5-15, enables you to control and modify the way target tracking works.

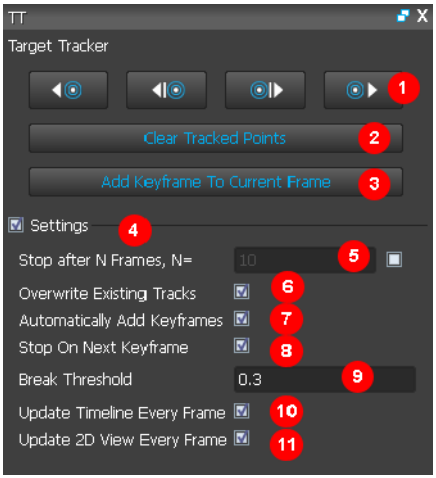


Figure 5-15: Features of the TT pane

1. **Tracking Buttons**

   Perform the actual tracking functions. From left to right these buttons are:

   - **Track backward/Track backward N Frames**

     Functionality depends on whether you select **Stop After N Frames**. If you select it, you can specify a value for **N** in the **Stop After N Frames** field.

   - **Track backward 1 frame**
   - **Track forward 1 frame**
   - **Track forward/Track forward N Frames**

     Functionality depends on whether you select **Stop After N Frames**. If you select it, you can specify a value for **N** in the **Stop After N Frames** field.

   Tracking only takes place when you click these buttons, if:

   - You have selected one or more tracks.
   - The active frame for the selected track(s) contains tracking data. This could mean that a keyframe has been placed, indicated by a diamond shape in the Timeline, or that the frame has already been tracked, indicated by color in the Timeline.

2. **Clear Tracked Points**

   Clears any existing tracking data from any selected tracks or tracks.

3. **Add Keyframe To Current Frame**

   Adds a keyframe at the active frame for the selected target track when there is existing target track data for that frame. It does not add a keyframe if that frame has not been tracked.

4. **Settings**

   When selected, displays in the **TT** pane the advanced feature settings described below.

5. **Stop After N Frames**

   When selected, turns the **Track forward/backward** buttons into **Track N Frames forward/backward** buttons.

N= Defines the number of frames tracked before stopping when the **Track N Frames forward** and the **Track N Frames backward** buttons are clicked for all selected tracks (see 1. and 5., above). You can enter the value for **N**.

6. **Overwrite Existing Tracks**

   When selected, any tracking replaces existing tracking data for all selected tracks.

7. **Automatically Add Keyframes**

   When selected, adds a keyframe automatically when the **Track forward** or **Track backward** buttons are clicked. This is useful during supervised tracking. When a track's health deteriorates during tracking, as shown by its color change, if you stop the tracking a keyframe is added ready for editing as soon as you click the button again.

8. **Stop On Next Keyframe**

   When selected, the target tracker stops when it reaches any keyframe on any selected track during tracking either forward or backward.

9. **Break Threshold**

   The value of this parameter determines the lower limit of a track's health score at which the track fails and the target tracker stops tracking. If, during tracking, a track's score drops below this value, the tracker stops.

   The value is 0–1

   - ~0 = lower scores = Keeps tracking even when the track has low score
   - ~1 = higher scores = Stops tracking even when the track has high score

10. **Update Timeline Every Frame**

    When selected, the **Timeline** updates one frame at a time as the tracker progresses with the health score color for all tracks currently being tracked.

Whether to select this option depends on your requirements:

- Select this option to closely monitor tracking.
- Clear this option to significantly increase tracking speed, particularly when you are tracking a high number of targets simultaneously or you have a lower powered computer. This is because the **Timeline** color is updated only after all tracking is completed and not during tracking.

11. Update 2D View Every Frame

When selected, the 2D view in the Image window is updated on every frame of tracking. This means that every frame of the sequence is displayed or played back as you track.

Whether to select this option depends on your requirements:

- Select this option to closely monitor tracking.
- Clear this option to significantly increase tracking speed.

Target Tracks Dialog Box

The **Target Tracks** dialog box, as shown in Figure 5-16, lets you view and change information relating to individual target tracks.

To open the Target Tracks dialog box:

- In the **Timeline** or the **Taskview** pane, right-click the required target track. In the menu, click **Properties**.

or

- In the **Taskview** pane, double-click the required track.

The **Target Tracks** dialog box is displayed.

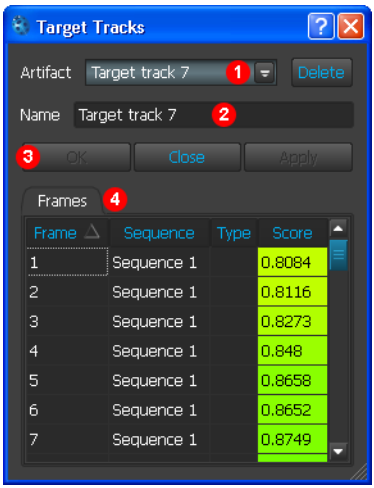


Figure 5-16: Target Tracks dialog box

1. **Artifact**

   Enables you to select any of the available target tracks.

   To the right of this list is the **Delete** button, which lets you delete any selected target track

2. **Name**

   Contains the editable track name or label that is displayed in the **Timeline** and elsewhere. You can type a name for any selected target track.

3. **OK, Close, and Apply buttons**

   - **OK** Accepts any changes made in this dialog box and closes it
   - **Close** Closes the dialog box without accepting any changes
   - **Apply** Accepts any changes made but leaves the dialog box open

4. **Frames**

   Displays information for a track at every frame on which there is tracking data for this track.

   When you select an entry in the **Frames** list, the selected frame becomes active in the Image window and the **Timeline**.

   From left to right the columns are:

   - **Frame** The frame number for this track data
   - **Sequence** The sequence with which this track is associated
   - **Type** Whether or not this frame is a keyframe
   - **Score** The health score for the track:

     0 = worst health

     1 = best health

     The color coding reflects the health of the track against the **Break Threshold**. The **Break Threshold** acts as a scaling factor on the track's score so the color changes as the score and the **Break Threshold** vary. The higher the **Break Threshold** value, the worse the health of a track is for a given score (see *Break Threshold* on page 5-26).

     The colors represent the following states of health for a track:

     - Green = best
     - Yellow = acceptable
     - Red = worst

Specifying the Frames to Track

In addition to using the **Track Backward** and **Track Forward** buttons as described in the steps in this tutorial, you can be more precise about the frames you want boujou to track.

You can change the method of tracking at any point during the tracking process.

To specify the number of frames to track:

1. In the **TT** pane, in the **Stop after N Frames** field, type the number of frames (**N**) you want to track.
2. Click the **Track Forward** or **Track Backward** buttons.

   boujou stops tracking after the number of frames specified in the **N=** field.

To closely supervise tracking:

Click the **Track Forward One Frame** and **Track Backward One Frame** buttons:

 and 

Target Tracking Preferences

Three preference options are available for target tracking.

To access the target tracking preferences:

1. Open the **Preferences** dialog box in either of the following ways:

   - From the **Edit** menu, click **Preferences**.

   or

   - In the **Toolbox**, click the **Preferences** button.

   The **Preferences** dialog box is displayed.

2. If necessary, scroll down to select **Target Tracking**.

   The following controls are available:

   - **Break Threshold** The default value for the Break Threshold parameter. For more information, see *Break Threshold* on page 5-26.
   - **Comparison region size** The default size in pixels for the comparison (pattern) region.
   - **Search window size** The default size for the search region (the area the tracker will search in the next frame to find the tracked pattern).

Using Tools for Target Tracking

Several tools are particularly useful during target tracking. These are mentioned during the tutorial *Using Target Tracks* on page 5-1. These tools are:

- *Zoom Tool*
- *Relocate Files Dialog Box* on page 5-34

Zoom Tool

The **Zoom** tool can help you to place target tracks accurately. Use it to display a close-up view in the Image window of the track, the pattern that you want to select, and the comparison and search regions.

The **Zoom** tool is automatically displayed in the right sidebar in the default layout when you add target tracks and locators (unless it is hidden), as shown in Figure 5-17.

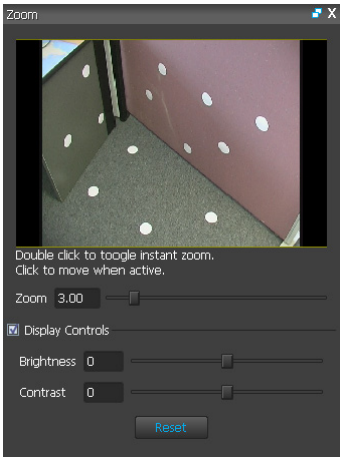


Figure 5-17: Zoom tool

The controls in the Zoom tool are:

- **Zoom** Controls the amount that the image is zoomed in the Image window. Type a value in the field or drag the slider to change the amount of zoom. The default value is 3.0.
- **Display Controls** When selected, the controls for brightness and contrast are displayed in the **Zoom** tool. When cleared, the controls are hidden.
- **Brightness** Controls the brightness of the image in the Image window. The default value is 0.
- **Contrast** Controls the contrast of the image in the Image window. The default value is 0.
- **Reset** When clicked, this button resets the **Brightness** and **Contrast** controls to their default values.

Note that these controls affect the display only, not the end result of the target tracking.

To display the Zoom tool:

- Click on the **Zoom** tab in the right sidebar in the default layout.

> **Tip**
> If you can't see the **Zoom** tab, on the **View** menu point to **Panes** and then click **Zoom**.

To zoom in on a target track:

You can zoom in on a target track in any of the following ways:

- Position your mouse pointer over the target track in the Image window, and then press the z key.

  Your view in the Image window is zoomed in by the factor specified in the **Zoom** field of the **Zoom** tool pane.

or

- Use the **Instant Zoom** button on the status bar.

This either zooms into the center of the 2D view or into an area you specify by double-clicking in the overview in the **Zoom Tool** pane.

or

- Use the standard 2D navigation controls to zoom (SHIFT+RMB).

The zoomed region is indicated in the **Zoom** tool overview by a movable yellow border. You can drag this border or click in the **Zoom** tool overview to navigate around the Image window.

Tip

You can work with the **Zoom Tool** in either of two modes. By default, boujou uses the instant zoom mode, as described in this tutorial. To use a previous version of the **Zoom Tool**, on the **Edit** menu, click **Preferences**, then expand **Miscellaneous**, click **Use Old Zoom Tool** and select **Yes**.

Relocate Files Dialog Box

boujou projects contain references to a number of files. The location of these files is stored in the boujou project file.

When a boujou project is opened, it looks for any files it needs. If it cannot find them in the location specified, perhaps because they or the boujou project file has been moved, the **Relocate Files** dialog box opens, as shown in Figure 5-18.

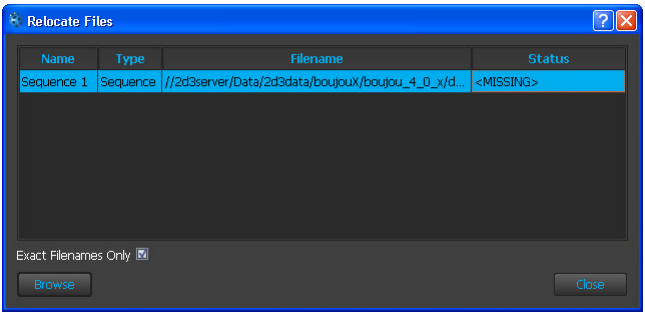


Figure 5-18: Relocate Files dialog box

The four columns in the dialog box are:

- **Name** The name of the boujou artifact that is created using the missing file.
- **Type** The type of artifact that is missing. This can be one of the following types:
  - Sequence
  - Reference Frame
  - Proxy
  - Image Based Mask
- **Filename** The full directory path and filename where boujou is expecting to find these files.
- **Status** Either **<FOUND>** or **<MISSING>**

  If a file is missing, the entry is displayed in red.

To relocate a file:

1. From the list, select the required filename and click **Browse**.

   If **Exact Filenames Only** is selected in the **Relocate Files** dialog box, only the file whose name matches the selected file is displayed in the file browser. If it is cleared, any file can be used to replace a file.
2. In the file browser, locate the file and then click **OK**.
3. In the **Relocate Files** dialog box, a previously missing entry is displayed in white text. Click **Close**.

To open the Relocate Files dialog box at any time:

- From the **Setup** menu, click **Relocate Imagery**.

  The **Relocate Files** dialog box opens, enabling you to specify the new location of the files. This new location will be saved into the boujou project file when you next save it.

6 Using Non-Consecutive Feature Tracking

This tutorial shows you how to match features in two images that are separated by more than one frame.

The **Non-Consecutive Feature Tracker** in boujou can match features in two images that are not next to each other on the **Timeline**. This is very useful if your scene contains an object that goes out of shot and then comes back in later, or if a foreground object moves in front of the lens and cuts all of the background tracks.

For this tutorial, you need the following sample image sequence and project file:

- *tutorial6_elevator.[###].jpg*
- *tutorial6_elevator_split-c.bpj*

Important

Before starting this tutorial, you must have already added the required shortcut buttons to your **Toolbox** and copied the sample tutorial files to your hard disk drive where you can access them while working through the tutorial. For details, see *Chapter 1 Introduction*.

To use non-consecutive feature tracking:

1. From the menu bar, click **File** and then click **Open**, or on the **Toolbar** click the **Open** button.

   The **Open Project** dialog box is displayed. Browse for the project file *tutorial6_elevator_split-c.bpj* and open it.

   When the project opens, a **Relocate Files** dialog box, similar to that shown in Figure 6-1, will probably also be displayed. This indicates that

boujou cannot find the required image sequence and needs you to specify where to find it.

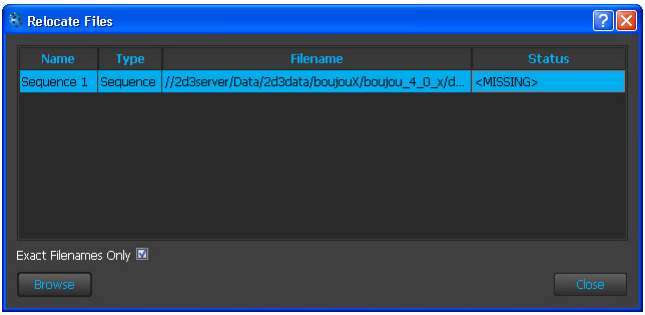


Figure 6-1: Relocate Files dialog box

2. In the file **Name** list, note that **Sequence 1** is selected and then click **Browse**.

   The file browser is displayed.

3. In the file browser, locate and select the image sequence named *tutorial6_elevator.000.jpg* from the *tutorial_06\tutorial_6_source_images* folder and then in the **Relocate Files** dialog box, click **Close**.

4. When the project has loaded, from the **Overlays** pane, select the **Predictions** overlay and play though the sequence.

   A cloud of cyan predictions are floating in the foreground. In 3D view, you can see that the camera path changes direction suddenly and there are two distinctive groups of 3D points.

   The object that moves in front of the camera at around frame 25 has broken the background feature tracks and this has resulted in two separate groups of predictions representing the same features in the scene.

5. Go back to the 2D view, turn the **Predictions** overlay off and the **Tracks** overlay on.

   In the first frame of the sequence select the feature tracks on the group of plants in the background; the features will turn from red to blue when they are selected and by default, their labels are displayed.

6. Scrub forward to the last frame of the sequence using SHIFT+LMB in the Image window.

   The feature tracks on the plants are no longer selected, which means that the original feature tracks were broken and new ones were created. boujou does not know that the two sets of tracks belong to the same objects in the scene, and this is what has caused the broken camera path.

   To fix a problem like this you would usually have to join the broken feature track fragments, one pair at a time, using CTRL+J, but the **Non-Consecutive Feature Tracker** enables you to match between frames on either side of the break automatically.

7. In the **Toolbox,** click the **Non-Consecutive Feature Tracking** button.

   If you don't have this button in your **Toolbox**, add it by right-clicking in an empty slot, pointing to **2D Tasks** and clicking **Non-consecutive Feature Tracking**. Alternatively, from the menu bar, click **2D Tasks**, and then click **Non-consecutive Feature Tracking**.

   Important
   You must have a set of feature tracks in your project file before you can use the Non-consecutive Feature Tracker.

The **Non-consecutive Feature Tracking Properties** dialog box, shown in Figure 6-2, is displayed.

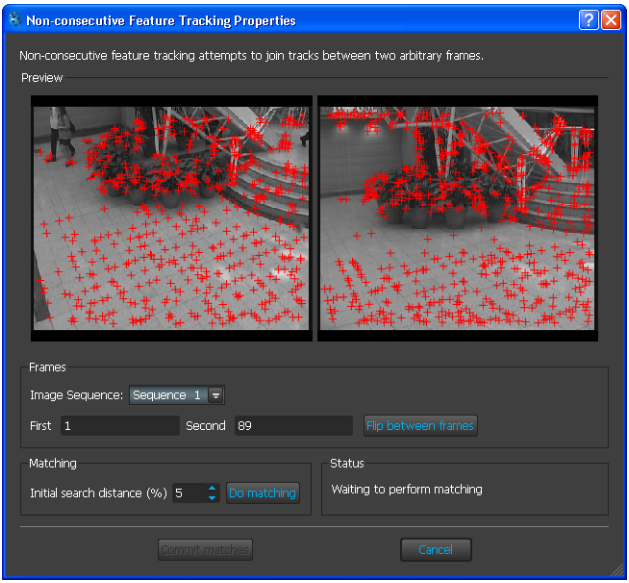


Figure 6-2: Non-consecutive Feature Tracking Properties

Previews of the two frames to be matched are displayed in the dialog box. By default the first and last frames are shown and the features found in each frame are displayed as red crosses. You can navigate in the **Previews** using the normal pan and zoom shortcuts (SHIFT+LMB and SHIFT+RMB respectively).

8. Set the **First** frame to 10 and the **Second** frame to 60.
9. Set the **Initial search distance** to 10% (the difference between the two frames is quite large, so increasing the value of the search distance will help to find more matches, although it also increases the chance of mismatches, so decreases accuracy).

10. Click the **Do Matching** button. Yellow tracks are displayed in the preview windows, and the number of matches found are displayed in the **Status** field, as shown in Figure 6-3.

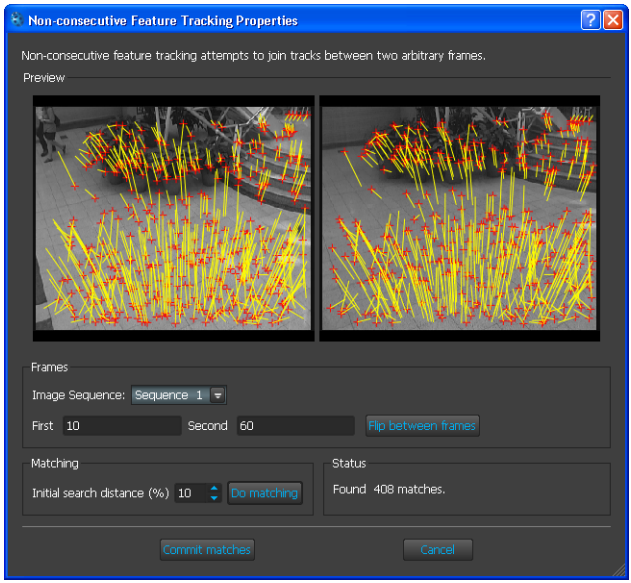


Figure 6-3: Matched features identified

11. You can look more closely at the matches that have been made by zooming in on a feature in one of the previews and then pressing the **Flip between frames** button.

    If matching fails or if you want to increase the number matches that have been made, you can try any of three ways to get a better result:

    - Change the value of **Initial search distance**.
    - Try a different pair of frames.
    - Add a locator in the main boujou workspace with a keyframe on each of the two frames that you are trying to match between.

12. When you have a good set of matches, click the **Commit matches** button.

13. Now track the camera by clicking on the **Camera Solve** button in the **Toolbox**.

    Alternatively use the keyboard shortcut F10.

14. When the **Advanced Camera Solve Properties** dialog box appears, leave all values at their default settings and click the **Start** button.

15. When camera solving is complete, play back through the sequence in the 2D view with the **Predictions** overlay on. There are no more floating predictions. If you check the 3D view, you will see that there is now just one group of predictions representing the scene and the camera path is smooth and continuous.

7 Using Focal Length Constraints

This tutorial shows you how to improve the accuracy of the camera solving solution by supplying information to boujou about the focal length of the camera used in shooting the scene.

The lessons in this tutorial describe the stages in using focal constraints:

For this tutorial, you need the following sample image sequence and project file:

- *tutorial7_taxi.[###].jpg*
- *tutorial7_taxi_mask-0.bpj*

Important

Before starting this tutorial, you must have already added the required shortcut buttons to your **Toolbox** and copied the sample tutorial files to your hard disk drive where you can access them while working through the tutorial. For details, see *Chapter 1 Introduction*.

Adding Focal Length Constraints

In this lesson, you import a sequence and add information about the focal length to it.

To use focal length constraints:

1. From the menu bar, click **File** and then click **Open**, or on the **Toolbar** click the **Open** button.

   The **Open Project** dialog box is displayed. Browse for the project file *tutorial7_taxi_mask-0.bpj* and open it.

   When the project opens, a **Relocate Files** dialog box will probably also be displayed. This indicates that boujou cannot find the required image sequence and needs you to specify where to find it.

2. Click **Browse** and in the file browser, locate and select the image sequence named *tutorial7_taxi.001.jpg* from the *tutorial_07\tutorial_7_source_images* folder and then in the **Relocate Files** dialog box, click **Close**.

   This project file already contains a mask so that boujou tracks only the taxi.

3. Set up some focal length constraints. To do this, click the **Focal Constraint** button on the **Toolbox**.

Important

You can add buttons to the **Toolbox** by right-clicking anywhere in the **Toolbox** and checking the function that you want to add from the list. Once you have added the button, you can move it to a different location within the **Toolbox** by dragging and dropping.

You can also set focal length constraints in several other ways:

- From the menu bar click **Setup** and then click **Edit Focal Constraints**

or

- Use the keyboard shortcut CTRL+F

or

- Double-click the **Focal Length** artifact in the **Taskview**, as shown in Figure 7-1.

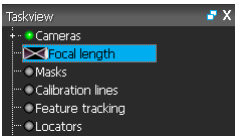


Figure 7-1: Focal Length artifact in Taskview

4. The **Focal Length** dialog box is displayed, as shown in Figure-7-2.

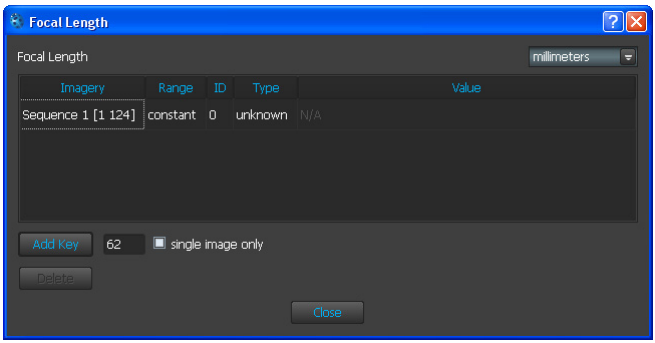


Figure-7-2: Focal Length dialog box

Using the focal length **Range** and **Type** lists, you can select one of the following options:

- **Range: constant Type: unknown**
  There is no zoom and you do not know the focal length.
- **Range: constant Type: init. to value**
  There is no zoom and you have a rough idea of the focal length.
- **Range: constant Type: fixed to value**
  There is no zoom and you know the exact focal length.
- **Range: varying Type: unknown**
  There is zoom in the shot, but you do not know how much.
- **Range: varying Type: init. to value**
  There is zoom in the shot, and you have got a rough idea of the starting focal length.

5. You could track this shot by setting the **Range** of the focal length to **Varying** and the **Type** to **unknown**. However, for this tutorial, we will assume you have more detailed focal length information, which you can enter in the **Value, ID,** and **Add Key** fields.

   The focal length was varying throughout this shot but the value is known at four frames, including the first and the last, as shown in Table 7-1.

Table 7-1: Focal length for sample shot

Frame number	Focal length
Frame 1	23mm
Frame 29	70mm
Frame 62	90mm
Frame 124	23mm

6. As we know values for the focal length at four frames, we can specify these, creating a keyframe for each one:

   a. In the **Focal Length** dialog box, change the value in the **Add Key** field to 2 and click **Add Key**.

      A line beginning **Sequence 1 [1]** appears above the line beginning **Sequence 1 [2 124]**. It contains a single keyframe on frame 1.

   b. In the line beginning **Sequence 1 [1]**:

      - In the **ID** column, leave the ID as **0**.
      - In the **Type** column, double-click and change the type to **Fixed to Value**.
      - In the **Value** column, change the value to **23**.

      Tip

      You may need to widen the columns by dragging the right edges of their headings so that they look similar to those in Figure 7-3.

   c. Click on **Sequence 1 [2 124]**, change the value in the **Add Key** field to 29, select the **single image only** check box and click **Add Key**.

      Two new lines appear:

      - A line beginning **Sequence 1 [2 28]**
      - A line beginning **Sequence 1 [29]**

   d. In the line beginning **Sequence 1 [2 28]**:

      - In the Range column, double-click and change the range to **varying**
      - Leave the **Type** as **unknown**. (The ID is automatically set to N/A.)

   e. In the line beginning **Sequence 1 [29]**:

      - Leave the **ID** as **2**.
      - Change the **Type** to **Fixed to Value**.
      - Change the **Value** to **70**.

f. Click on **Sequence 1 [30 124]**, change the value in the **Add Key** field to 62, make sure the **single image only** check box is selected and click **Add Key**.

   Two new lines appear:

   - A line beginning **Sequence 1 [30 61]**
   - A line beginning **Sequence 1 [62]**

g. In the line beginning **Sequence 1 [30 61]**:

   - Change the **Range** to **varying**
   - Leave the **Type** as **unknown**.

h. In the line beginning **Sequence 1 [62]**:

   - Leave the **ID** as **3**.
   - Change the **Type** to **Fixed to Value**.
   - Change the **Value** to **90**.

i. Click on **Sequence 1 [63 124]**, change the value in the **Add Key** field to **124**, make sure the **single image only** check box is selected and click **Add Key**.

j. In the line beginning **Sequence 1 [63 123]**:

   - Change the **Range** to **varying**
   - Leave the **Type** as **unknown**.

k. In the line beginning **Sequence 1 [124]**:

   - Change the **ID** to **0**.

     This automatically changes the **Type** to **Fixed to Value** and the **Value** to **23**, like the first keyframe.

When you have finished, the **Focal Length Properties** dialog box displays all the constraints at the keyframes you have just added, as shown in Figure 7-3.

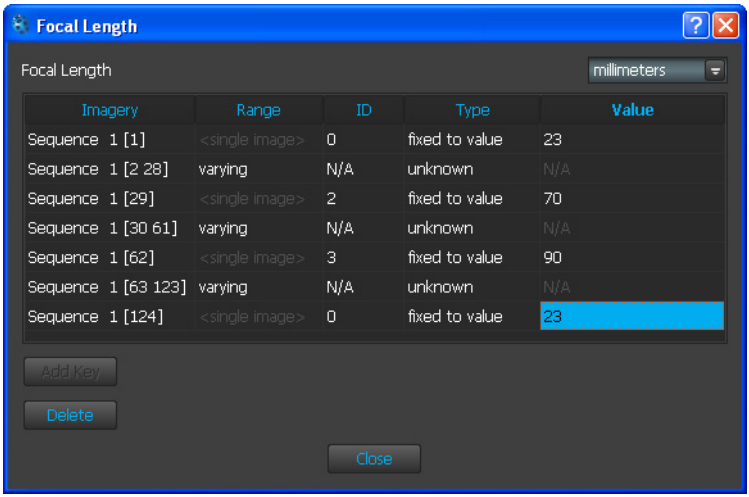


Figure 7-3: Focal length constraints set

If you make any mistakes, you can click on the relevant line in the list in the **Focal Length** dialog box and then click the **Delete** button to remove the keyframe.

7. When you are have correctly added all the keyframes, click **Close**.

Viewing Results

In the previous lesson, you added information about focal length to a sequence.You can now track features and view the results.

To track features and view the results:

1. Click the **Track Features** button in the **Toolbox** or press F9.
2. In the **Feature Tracking Properties** dialog box, click the **Advanced** button to reveal the advanced properties. Leave **Feature Scale** set to **Normal**, but increase the **Sensitivity** to the maximum value and click **Start**.

   This will help to find more feature tracks when the taxi is smallest in the image at the start of the shot. The more automatic feature tracks that boujou can find, the more accurate the camera solve will be.
3. When feature tracking is complete, click the **Camera Solve** button in the **Toolbox** to open the **Advanced Camera Solve Properties** dialog box. In the **Advanced Solve Refinement** area, select **Optimize Camera Path Smoothness** and then click **Start**. This shot normally takes around 10 minutes to camera solve.
4. When camera solving is finished, press the **Graph Editor** button.

The focal length curve, as shown in Figure 7-4, is displayed.

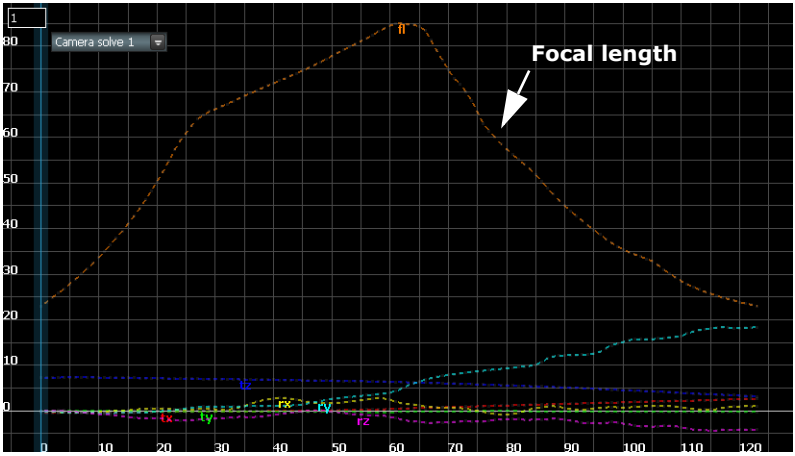


Figure 7-4: Focal length curve in Graph Editor

5. Check the 3D view.

   The 3D structure should be recognizable as the shape of a London taxi, and the camera path should be smooth.

6. Check the 2D view.

   The predictions should appear locked to the moving taxi.

   The shot is now ready for export.

Using Models 8

This tutorial shows you how to solve a shot using a 3D model in two ways:

- Using a 3D model to set up approximate camera positions by eye to help boujou to solve difficult shots.
- Importing your survey data as a 3D model and then connecting locators to model vertices that correspond to features in an image, to improve the accuracy of boujou's 3D structure.

Both methods use the solve key frames that boujou usually calculates before camera solving. Using boujou's **Initialize Key Schedule** option creates a default camera view on each of the solve keyframes, which are linked by a minimum number of feature tracks. If you use these initialized views as a guide to where you should set up your approximate cameras or where to place locators, you will usually have enough tracks to fill in the intermediate frames.

This tutorial describes these two ways of using a 3D model:

- *Using a 3D Model to Set Up Approximate Camera Views* on page 8-2
- *Using a 3D Model As Survey Data* on page 8-8

For this tutorial, you need the following image sequence, project, and model files:

- *tutorial8_using_models.###.jpg*
- *tutorial8_using_models-f.bpj*
- *tutorial8_using_models_initialized-f.bpj*
- *desk.obj*

Important

Before starting this tutorial, you must have already added the required shortcut buttons to your **Toolbox** and copied the sample tutorial files to your hard disk drive where you can access them while working through the tutorial. For details, see *Chapter 1 Introduction*.

Using a 3D Model to Set Up Approximate Camera Views

Setting up approximate camera positions by eye is a very useful way of solving difficult shots. You can manually create a sparse solve (one that only has camera views on the solve key schedule frames) and then fill in the gaps between the views using the feature tracks.

The stages involved in using a 3D model to set up approximate camera views are:

- *Importing the Model and Initializing the Key Schedule*
- *Aligning the Model and Finishing the Solve* on page 8-4

Importing the Model and Initializing the Key Schedule

In this lesson, you import an existing model into a sequence, add focal length information and initialize the solve key schedule. You initialize the solve key schedule to get boujou to find out the best frames on which to set up your approximate cameras.

To import the model and initialize the key schedule:

1. From the menu bar click **File** and then click **Open**, or on the **Toolbar** click the **Open** button.

   The **Open Project** dialog box is displayed. Browse for the feature tracked project file *tutorial8_using_models-f.bpj* and if necessary, use the **Relocate Files** dialog box to locate and select the file *tutorial8_using_models.001.jpg*.

2. Go to the first frame of the sequence and from the menu bar click **3D Tasks** and then click **Import OBJ Model**.

3. In the **Import OBJ Model** dialog box, shown in Figure 8-1, browse for the model *desk.obj*, make sure the **Create User Solve** check box is selected, and click **OK**.

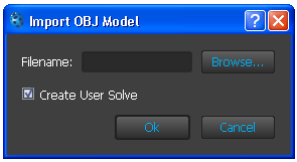


Figure 8-1: Import OBJ Model dialog box

4. In the **Input Focal Length** dialog box, shown in Figure 8-2, set the focal length to 23 mm and click **OK**.

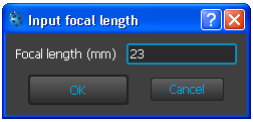


Figure 8-2: Input Focal Length dialog box

5. Once the model has been imported, you can initialize the solve key schedule. This will give you the best set of frames on which to add approximate cameras on based on the number of feature tracks connecting them, and will also create default camera views on these frames.

   To do this, on the menu bar click **3D Tasks** and then click **Initialize Key Schedule**.

   In the **Initialize Key Schedule** dialog box, shown in Figure 8-3, make sure **User Solve** and **Sequence 1** are selected and click **OK**.

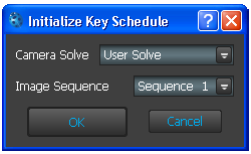


Figure 8-3: Initialize Key Schedule dialog box

6. In the **Timeline**, expand **Solves**. The frames that have been identified in the key schedule are displayed in yellow, as

shown in Figure 8-4. This indicates that a default camera view has been created on these frames.

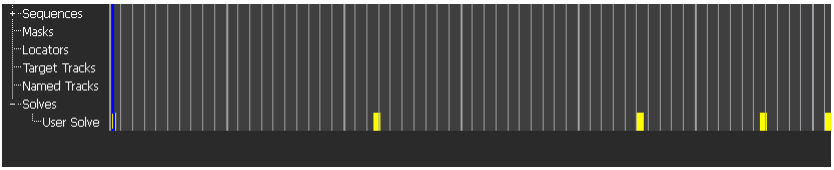


Figure 8-4: Key schedule in Timeline

7. Click the **Next Solved Frame** button on the right of the play controls tool group (or press CTRL+RIGHT ARROW) to go to the next solved keyframe and check the camera views.

Aligning the Model and Finishing the Solve

In the previous lesson, you imported a model into a sequence and initialized the key schedule to find out which frames would be best for aligning the camera. In this lesson, you align the model to create approximate camera positions on the solved frames and use them to obtain a solve for the whole sequence.

To align the model and finalize the solve:

1. Go to the first solved frame (this should be on the first frame of the sequence).
2. To make it easier to see the image and the model:
   a. In the **Overlays** list on the **Overlays** pane, clear the **Tracks** check box.
   b. On the **Taskview** pane, expand **Models** and double-click **Model 1**.

c. In the **Model** dialog box:

- Select **Remove Hidden**.
- Clear **Draw Shaded**.
- Make sure **Draw All Points** and **Draw Wireframe** are selected and click **OK**.

3. Align the model so that it matches the corresponding features in the sequence as closely as possible.

   To do this, you can use several different tools:

- Click the **Fly align** button on the model toolbar.

  When you are in fly align mode, you can align the model in the following ways:

  - Rotate – SHIFT+LMB
  - Dolly – SHIFT+RMB
  - Translate – SHIFT+LMB+RMB or SHIFT+MMB (if **Middle Mouse button for navigation** is set in **Preferences**)

  To quit fly align mode, click the **Fly Align** button again.

- Click one of the vertices of the model and then on the Transformations toolbar, click the **Edit coordinate system or test object button** so that it is selected and the ladybird changes color.

  Use the **Translate** and **Rotate** manipulators.

- Click the **Vertex align** button on the model toolbar.

  When you are in this mode, you can click a vertex and drag the cursor to the point that you want it aligned to.

This will create a 'spring', represented by a red line, as shown in Figure 8-5.

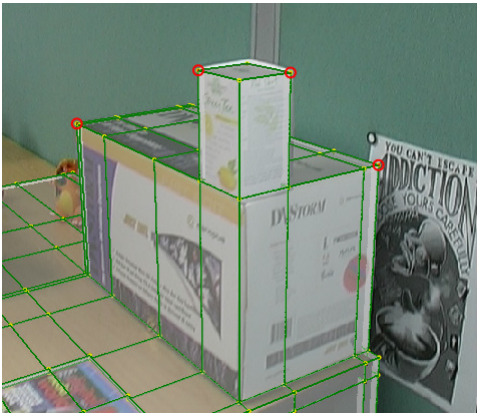


Figure 8-5: Adding springs in vertex align mode

Tip

Drag the spring anchor point to the center of the locator—don't drag past the locator to try to get the vertex on top of it.

When you add a second spring to another vertex, the model will start to rotate in the 2D view. Four or five springs should be enough to specify the camera position, but add more if you think that the model is not yet in the correct position.

Important

Springs are not used in the camera solve. They are used just to aid model alignment.

4. You can delete springs using the **Model** pane in the right sidebar, or from the menu bar by clicking **3D Tasks** and then pointing to **Model Tools** and clicking **Delete All Springs**.

   Tip
   If you have **Optimize Focal Length** selected in the **Model** pane, boujou will adjust the focal length value as you add springs.

   When you have finished aligning the model, it should look similar to Figure 8-6.

Figure 8-6: Object being aligned with Fly align tool

5. To get a better starting point for aligning the model in the next solved keyframe, you can copy the camera position (remember that you are actually moving the camera around the stationary model) from the current keyframe. To do this, use the keyboard shortcut CTRL+C.

6. Jump to next solve keyframe by clicking on the **Next Solved Frame** button or use the keyboard shortcut CTRL+RIGHT ARROW.

7. Use the keyboard shortcut CTRL+V to paste the camera position from the previous solved keyframe. Fine-tune the alignment as before.
8. Repeat this process until you have 'eyeballed' an approximate camera position (view) on all of the frames of the key schedule.
9. On the menu bar, click **3D Tasks** and then click **Solve from Existing Cameras.** This will fill in the gaps between the views and optimize the solve.

   Once the camera has been solved, the model appears in a random position in the scene and is not aligned with the features in the image.
10. The camera path is basically good but very spiky. On the menu bar, click **3D Tasks** and then click **Solve Adjust**. In the **Solve Adjust** dialog box, select **Smoothing** and then click **Start**.
11. You can now align the model with the predictions and use it as a test object.

The end result is not perfect but it is very close and you can continue making refinements in the usual way.

Using a 3D Model As Survey Data

Using boujou, you can import your survey data as a 3D model and then use the solve key schedule to tell you the best frames for adding locator keyframes on, which takes a lot of the guesswork out of using survey data.

You then align the model with the corresponding features in the sequence and connect the vertices of the model to the locators to create survey points. The connections that you make in one frame can be used to automatically generate views in other frames.

The stages involved in this way of using a 3D model are:

- *Adding Locators and Aligning the Model* on page 8-9
- *Creating Survey Points* on page 8-10
- *Finalizing the Solve* on page 8-11

Adding Locators and Aligning the Model

In this lesson, you learn how to add locators to an image and how to use them to align the model to features in the image.

To add locators and align the model:

1. From the menu bar click **File** and then click **Open**, or on the **Toolbar** click the **Open** button.

   The **Open Project** dialog box is displayed. Browse for the project file *tutorial8_using_models_initialized-f.bpj* and if necessary, use the **Relocate Files** dialog box to locate and select the file *tutorial8_using_models.001.jpg*. The project file contains feature-tracking information, the imported model, and default cameras on the solve key schedule.

2. To make it easier to see the image, on the **Overlays** pane clear the **Tracks** check box. You can also modify the **Model** properties as required (see page 8-4).

   Tip
   Hide the model when you add the locators—it will make the workspace less cluttered.

3. Start adding locators to the features in the image that correspond to vertices on the model—try to add around 20 locators.

   Make sure that your locator keyframes are on the same frames as the default camera views. The easiest way to do this is to use the **Next Solved Frame** and **Previous Solved Frame** buttons in the playback controls or the keyboard shortcuts CTRL+LEFT or RIGHT ARROW.

4. When you have finished adding locators, scrub to the first frame and display the model again.

5. Roughly align it using the **Fly align** button on the model toolbar.

6. Finish aligning it using the vertex align mode. To do this, click the **Vertex align** button on the model toolbar.

When you are in this mode, you can click a vertex and drag the cursor to the point that you want it aligned to. For more information on using Vertex align, see page 8-5 to page 8-8.

Creating Survey Points

In the previous lessons, you added locators to the image and aligned the model to features in the image.

When you are happy with the model alignment, you can start connecting the vertices to the locators as survey points (the alignment doesn't have to be perfect to do this).

To create survey points:

1. Click the vertex (the whole mesh will turn green, as well as the selected vertex), then CTRL+click the locator (it will also turn green).
2. Right-click and select **Connect Survey Point**. The model vertex will change color to orange when it is connected and deselected.
3. Repeat steps 1. and 2. for all visible vertices with a corresponding locator.
4. Click the **Solve View from Known 3D** button in the **Model** pane.

5. Click the **Next Solved Frame** button on the right of the play controls, or use the keyboard shortcut CTRL+RIGHT ARROW to go to the next solved keyframe.

6. Click the **Solve View from Known 3D** button in the **Model** pane. This will align the model based on the survey point connections that you have already made, saving you the job of doing it yourself.
7. Connect any unconnected vertices to the corresponding locators in the current frame (you only need to connect each vertex once), and click the **Solve View from Known 3D** button.
8. Go to the next solve keyframe and repeat the process until you reach the end of the sequence.

   You now have a sparse solve with camera positions on each of the solve keyframes.

Finalizing the Solve

Having imported a model and used it to create survey points, you can fill in the gaps between the keyframes and improve the solve.

To finalize the solve:

1. On the menu bar click **3D Tasks** and then click **Solve from Existing Cameras**. When boujou calculated the key schedule, it made sure that there would be enough feature tracks linking each pair of keyframes to enable it to work out how the camera moved between them.

   The model still appears to be in the right position because you connected the vertices of the model to the locators and the model is now always linked to the 3D predictions by the locators.
2. This shot has a significant amount of lens distortion, so the final stage is to correct for it. On the menu bar, click **3D Tasks** and then click **Assess Lens Distortion (automatic)**.
3. When this has finished, on the toolbar, click **3D Tasks** and then click **Solve Adjust**.

The **Solve Adjust** dialog box, shown in Figure 8-7, is displayed.

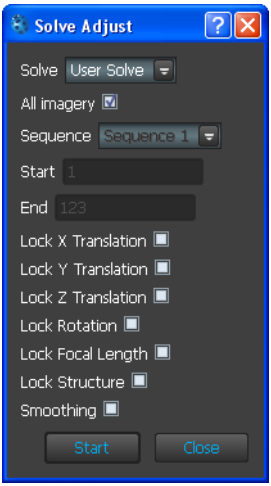


Figure 8-7: Solve Adjust dialog box

4. Select the **Smoothing** check box and click **Start** to run the Solve Adjust.
5. Go to 2D view and on the **Overlays** pane, make sure that the **Radial** check box is selected.
6. In 2D view, scrub through the sequence and check that the model is correctly aligned with the footage. If you want to check the quality of the solve, add a test object to the sequence and play it through. For more information, see *Adding a Test Object* on page 5-22.

Using Face-based Tracking 9

This tutorial shows you how to link 2D features and the faces of a polygon mesh to track a model through a shot.

Face-based tracking works by linking 2D features and the faces of a polygon mesh to track the model through the shot. Drift will often be a problem with this tracking method, so you should look on it as a way of getting an approximate camera path that you can subsequently optimize.

The lessons in this tutorial describes the stages in using face-based tracking:

For this tutorial, you need the following image sequence and model files:

- *tutorial9_face-based.[###].jpg*
- *tutorial9_face-based-m.bpj*
- *phone_simple.obj*
- *phone_curved.obj*

Important

Before starting this tutorial, you must have already added the required shortcut buttons to your **Toolbox** and copied the sample tutorial files to your hard disk drive where you can access them while working through the tutorial. For details, see *Chapter 1 Introduction*.

Importing a Model and Aligning it to the Image

In this lesson, you learn how to import a simple model, change the focal length, and align the model to features in the image.

To import the model and align it to the image:

1. On the menu bar, click **File** and then click **Open**, or on the **Toolbar** click the **Open** button.

   The **Open Project** dialog box is displayed. Browse for the project file *tutorial9_face-based-m.bpj* and open it.

   In the **Relocate Files** dialog box, in the file **Name** list, note that **Sequence 1** is selected and then click **Browse**.

   The file browser is displayed.

2. In the file browser, locate and select the image sequence named *tutorial9_face-based.[001-155].jpg* from the *tutorial_9\tutorial9_source_images* folder and then in the **Relocate Files** dialog box, click **Close**.

3. In the **Toolbox**, click the **Track Features** button and track features using the default settings.

4. Go to a frame where there are the most feature tracks visible on as many surfaces of the phone as possible (around frame 122). This will give you the best lock between the model faces and the 2D tracks.

   Tip

   To find the frame with the highest number of feature tracks, on the **Taskview** pane, expand **Feature tracking** and double-click the **Feature Tracking** artifact. In the **Tracks per frame (ranked)** area, click the **Tracks** heading to order the frames by the number of tracks they contain. The frame with the highest number of tracks is at the top of the column.

5. On the menu bar, click **3D Tasks** and then click **Import OBJ Model**.

6. In the **Import OBJ Model** dialog box, shown in Figure 9-1, browse for *phone_simple.obj,* make sure the **Create User Solve** check box is selected, and click **OK**. Even a very simple model can be used for face-based tracking. boujou is linking the features found in the image with the faces of the model and so the number and shape of the faces does not matter.

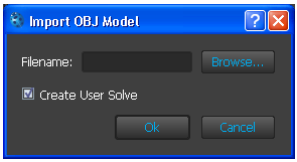


Figure 9-1: Import OBJ Model dialog box

7. In the **Input Focal Length** dialog box, shown in Figure 9-2, set the **focal length** to **25** mm (default 30 mm) and click **OK**.

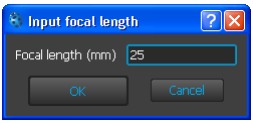


Figure 9-2: Input Focal Length dialog box

8. Align the model to the phone in the image. To do this, click the **Fly align** button on the model toolbar.

When you are in fly align mode, you can hold the SHIFT key and use the mouse to fly the camera around in the 2D view.

Alternatively, click one of the vertices of the model and then use the **Translate** and **Rotate** manipulators from the Translations toolbar, as shown in Figure 9-3.

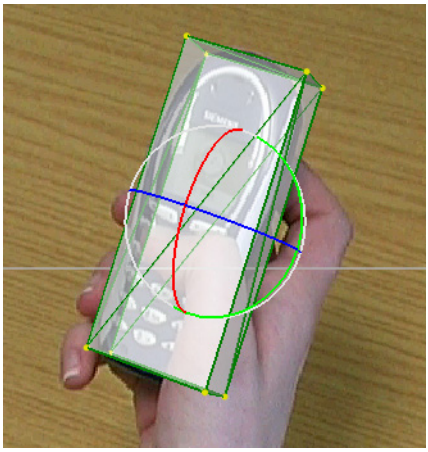


Figure 9-3: Align object using manipulators

Tracking the Model

In this lesson, you track the model that you imported and aligned in the previous lesson.

To track the model through the sequence:

1. Go to the **Model** pane, shown in Figure 9-4, and click the **Track Forward** button.

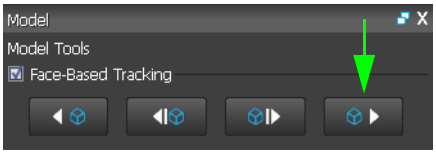


Figure 9-4: Model Tools pane

You should be able to see the object tracking all the way to the end of the shot. Watch the model during the tracking to check for drift.

If the model starts to drift, stop the tracking by clicking on the **Cancel** button in the status bar below the main Image window.

Correct the alignment of the model and then continue the tracking.

2. Go back to the frame where you first aligned the model. The easiest way to do this is to go to the last frame and then click the **Next Solved Frame** button on the right of the play controls tool group.

3. Click the **Track Backward** button in the **Model** pane. This will track the object all the way to the start.

4. If you play through the shot now, you should see the object moving as though it is locked to the phone.
5. Try repeating the whole process but with the more detailed model, *phone_curved.obj*, instead.

Tip

To make it easier to work with this more complex model, on the **Taskview** pane, expand **Models** and double-click **Model 2**, and in the **Model** dialog box, select **Remove Hidden**, **Draw All Points** and **Draw Wireframe** and clear **Draw Shaded**.

6. If you go to the 3D view, you'll see the model and the camera path, but no 3D predictions. If you export the camera at this stage, it will line up with the OBJ in your 3D animation software.

Generating 3D Structure and Optimizing the Solve

In the previous lessons in this tutorial, you aligned a model to features in an image and tracked it through the entire sequence. In this lesson, you learn how to generate 3D structure and optimize the solve.

The camera path produced from face-based tracking may not be perfect, but it can be used as a starting point.

To generate 3D structure and optimize the solve:

From the menu bar, click **3D Tasks** and then click **Solve from Existing Camera**. This takes the existing camera path, generates some 3D structure, and optimizes the result.

It's a good idea to run **Solve from Existing Camera** after the tracking, especially if you made a lot of corrections when tracking the object.

These corrections will appear as spikes in the camera motion and will make the model appear to jump when you play through the shot. **Solve from Existing Camera** will take this camera path as a starting point and then refine it.

7. When the camera solving is complete, the model will no longer be aligned to the solve. You can now use the model as a test object.
8. In 3D view, click one of the model vertices to select it and then use the **Translate** and **Rotate** manipulators to align it with the predictions.
9. To finely adjust the position of the model, go to 2D view and continue using **Translate** and **Rotate** until you are happy with its position.
10. You can now scrub through the sequence using the model as a test object.

Using the Sequential Solver 10

This tutorial shows you how to use boujou's sequential solver to solve an entire sequence from a small 'seed' solve: a solve that is based on sections of the sequence (seeds) in which the feature tracks are most likely to produce an accurate result.

The sequential solver solves a shot one frame at a time either forward or backward, using a small number of adjacent frames to provide a fast, accurate solution. This makes it particularly useful for solving long, complex shots in the minimum of time.

The lessons in this tutorial describe the stages in using the sequential solver:

For this tutorial, you need the following image sequence and model files:

- *tutorial10_seq_solver.[###].jpg*
- *tutorial10_seq_solver-f.bpj*

Important

Before starting this tutorial, you must have already added the required shortcut buttons to your **Toolbox** and copied the sample tutorial files to your hard disk drive where you can access them while working through the tutorial. For details, see *Chapter 1 Introduction*.

After the end of the lessons, the sequential solver settings are described in detail, together with further information about using the Graph Editor:

- *Sequential Solver Settings* on page 10-15
- *Using the Graph Editor* on page 10-17

Creating the Seed Solve

In this lesson, you learn how to generate the seed solve that you can use to solve the entire sequence.

To create the seed solve:

1. On the **Toolbar** click the **Open** button.

   The **Open Project** dialog box is displayed.

2. Browse for the boujou project file named *tutorial10_seq_solver-f.bpj*.

   When the project opens, if the **Relocate Files** dialog box is displayed, click **Browse**.

   The file browser is displayed.

3. In the file browser, locate and select the image named *tutorial10_seq_solver.[000].jpg* from the *tutorial_10\tutorial10_source_images* folder and then in the **Relocate Files** dialog box, click **Close**.

   Note that, as the project has already been feature-tracked, the Image window contains tracking information.

   Tip
   If you can't see the feature tracks, in the **Overlays** pane, select **Tracks**.

4. In the **Toolbox**, click the **Generate Seeds** button.

   Alternatively, from the **3D Tasks** menu, click **Solve Seeds**.

A dialog box is displayed, as shown in Figure 10-1.

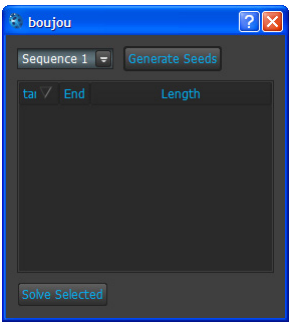


Figure 10-1: Sequential Solver dialog box

5. Note that **Sequence 1** is selected in the pull-down list and click **Generate Seeds**.

   boujou generates a number of 'seeds' based on the feature tracks present. The seeds are the parts of the sequence most likely to produce accurate solves.

   The seeds are listed in the dialog box in reverse start order, by default.

   Tip
   The seeds can also be listed in start order and by length (the longest first or last). To change their ordering, click the column heads.

6. If necessary, expand the left column head by dragging its right edge so that you can see that it reads **Start**. Click on **Start** to list the seeds in start order.
7. To choose the seed frames to solve, note the frame numbers of the seeds and scrub through these frames in the sequence to find the seed that has the best feature tracks and the most parallax. In this case, a suitable seed is located at frames 121–171.
8. Click the seed **121–171**, and then click **Solve Selected** and close the dialog box.

   The Status bar displays a message informing you that the seed solve is being generated.

9. To view the seed solve in the **Timeline**, expand the **Solves** branch of the artifact tree on the left of the **Timeline**.

   The seed solve you just generated is indicated by the label **Seed Solve 121 171**, and by a green bar in the Timeline, as shown in Figure 10-2.

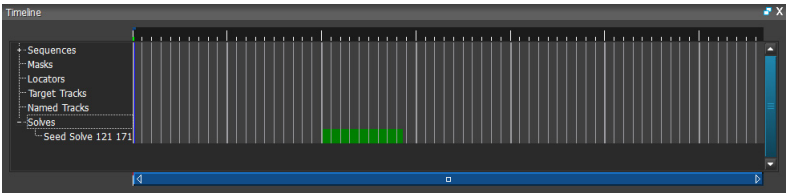


Figure 10-2: Seed solve in the Timeline

Reviewing the Seed Solve

In this lesson, you learn how to examine the structure of the seed solve you created previously and how to make the camera path approximately level with the ground plane.

To review the seed solve:

1. To view the structure of the seed solve, on the **Overlays** pane clear the **Tracks** check box and make sure the **Predictions** check box is selected.
2. In the **Timeline**, drag the vertical bar to move through frames 121–171, noting the positioning of the prediction points in relation to each other and to the ground.
3. In the Toolbar, click the **3D view** button, then in the **Timeline**, drag the vertical bar to move through frames 121–171, and again note the structure that has been created.

   At present, the camera path has no relationship with the ground plane. You can manually adjust the position of the predictions in relation to the ground to supply the missing information.

4. In 3D view, navigate to frame 121 and in the Toolbar, click the **Edit coordinate system** button.

The axes are colored and the ladybird turns gray to indicate you are in Edit mode.

5. Click the **Translate** and **Rotate** buttons to the right of the **Edit Coordinate System** button on the Toolbar and drag in 3D view to align the predictions with the ground plane.

Tip

Use SHIFT+LMB and SHIFT+RMB to dolly and zoom in the 3D view and use **Translate** and **Rotate** buttons until you are satisfied your predictions are correctly placed.

6. When you have finished repositioning, click the **Edit coordinate system** button again to leave Edit mode.

7. Your 3D structure should now look like Figure 10-3.

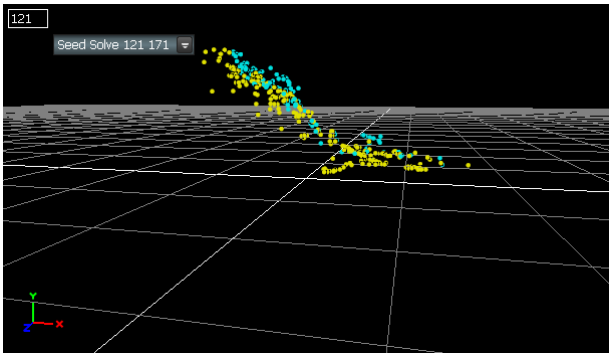


Figure 10-3: Camera aligned with ground plane

Solving Forward from the Seed Solve

In this lesson, you learn how to use the seed solve you generated and reviewed in the previous lessons to continue solving forward through the sequence.

To solve forward from the seed solve:

1. Navigate to any frame within the seed solve (between frame numbers 121–171).
2. In the right sidebar in the default layout, click the **Seq. Solver** tab to make it active.

   Tip
   If you cannot see the **Seq. Solver** tab, from the **View** menu point to **Panes** and then select **Seq. Solver**.

3. In the **Sequential Solver** pane, click the **Solve Forward** button.

   Solving starts from the last frame of the seed solve (frame 171). This is always the case unless you have selected **Overwrite Existing Cameras** in the **Sequential Solver** pane.
4. On the Toolbar, click the **3D** button to display the 3D view.

   As the solve progresses, notice that the cloud of prediction points generated is rather dense and that the solve is quite slow. To correct these problems, you need to make some adjustments to the settings.
5. To do this, stop the solve at frame 190 by clicking the **Solve Forward** button again.

Optimizing the Solve

In the earlier lessons in this tutorial, you generated and reviewed a seed solve and used it to solve forward in the sequence. In this lesson, you learn how to change the relevant boujou settings to improve the efficiency and accuracy of the solve.

To optimize the solve:

1. From the **3D Tasks** menu, point to **Solve Tools**, and click **Filter Structure**.
2. In the **Filter Structure** dialog box, make sure the **%** is set to 25.

   This reduces the number of prediction points by removing the least accurate ones, improving the solve speed.
3. In the **Sequential Solver** pane, in the **Minimum track appearances** box, change the value to 50.

   Increasing this value produces fewer, but better quality predictions (for more information, see page 10-16).

   You are now ready to try out your modified settings by continuing the solve.
4. To continue solving, click the **Solve Forward** button.

   Notice that, although fewer predictions are generated and the accuracy has improved, the solve is still rather slow.
5. To stop the solve, at frame 250, click the **Solve Forward** button again.
6. In the **Sequential Solver** pane, in the **Bundle max. iterations** field, change the value to 1.

   Reducing this value speeds up the solve at the cost of a slight reduction in the quality of the predictions (for more information, see page 10-16). As boujou has created plenty of feature tracks for this part of the sequence, this will not cause any problems.
7. To continue solving, click the **Solve Forward** button.

   Notice that the solve now progress more quickly. You can change another setting to improve the quality of the solve.

8. Stop the solve before frame 264 by clicking the **Solve Forward** button again. You can use the **Solve Forward** 1 frame button to reach frame 263 exactly. If you overshoot, just Undo and try again.
9. In the **Sequential Solver** pane, in the **Fixed images** field, change the value to 5.

   Reducing this value decreases the rigidity of the frames that are already solved, giving a more accurate solve (for more information, see page 10-16).
10. To continue solving, click the **Solve Forward** button.

    The solve stops at frame 268. This is because, with the current settings, boujou cannot find any 2D tracks that will have 3D prediction points in the next frame.

Correcting for Insufficient Data

In previous lessons, you learnt how to generate and use a seed solve and how to improve the efficiency and accuracy of the solve. In this lesson, you learn how to get boujou to generate more camera positioning information, so that it can finish solving the sequence.

Frames 268 to 340 contain fewer long feature tracks than those in the rest of the sequence, so you need to adjust the sequential solver settings to handle this.

To generate more camera positioning information:

1. In the **Sequential Solver** pane, select the **Overwrite Existing Cameras** check box.

   This enables boujou to create new information about the position of the cameras in the sequence.
2. In the **Sequential Solver** pane, in the **Minimum track appearances** field, reduce the value to 20.

   Decreasing this value produces more 3D prediction points, as it allows boujou to use the shorter feature tracks that are available in this part of the sequence. However, the quality of the predictions is also reduced.

3. To compensate for this loss of quality, in the **Bundle max. iterations** field, increase the value to 4.
4. At frame 264, start the solve again by clicking the **Solve Forward** button.

   From frame 340, more feature tracks are available so you can afford to be more selective about the tracks that the solver uses.
5. At frame 340, click the **Solve Forward** button to stop the solve.
6. In the **Sequential Solver** pane, in the **Minimum track appearances** field, increase the value to 30.

   This produces fewer, but better quality predictions.
7. Similarly, at frame 355, as more feature tracks are available in this part of the sequence, increase the value of **Minimum track appearances** to 50.
8. Continue solving forward to the end of the sequence.

Using the Graph Editor to Improve the Solve

In this lesson you learn how to identify and correct problems with the solve you generated in the previous lessons of this tutorial. You also finish solving the whole sequence.

To identify and correct problems with the camera path:

1. If you are not already in 3D view, on the Toolbar, click the **3D view** button.
2. Navigate to frame 260 and slowly drag the vertical line in the Timebar or **Timeline** to frame 323. Note that the camera path

is uneven in this section of the sequence, as shown in Figure 10-4.

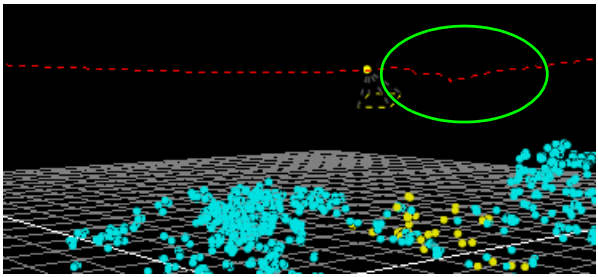


Figure 10-4: Uneven section of camera path

3. To finish solving the rest of the sequence, in the **Sequential Solver** pane:
   a. In the **Bundle max. iterations** field, reduce the value to 1.
   b. In the **Minimum track appearances** field, increase the value to 70.
   c. Clear the **Overwrite Existing Cameras** check box.
4. Click the **Solve Backward** button.

   boujou solves the sequence through to the start (frame 1).
5. On the Toolbar, click the **Graph Editor** button.

The **Graph Editor Controls** are displayed on the **Overlays** tab and the uneven section of the camera path is clearly displayed in the Graph Editor as shown in Figure 10-5.

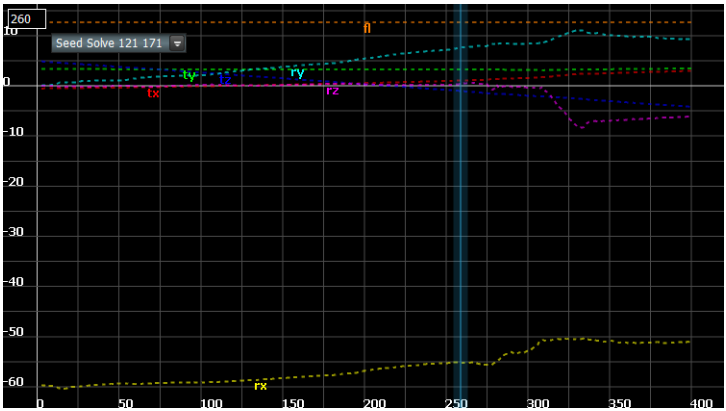


Figure 10-5: Uneven camera path in Graph Editor

6. Use the **Graph Editor Controls** to make the channels for frames 255–323 smoother and more even. To do this, note the following points:

   a. To make changes to the channels, in the **Edit Options** area, click the **Create Editable Solve Channels** button (or right-click in the Graph Editor and select **Create Editable Solve Channels**).

   b. To enable you to focus on the channels you want to edit, in the **Overlays** area of the **Graph Editor Controls**:

      - Expand **Camera types** and select **Editable**.
      - Select only the relevant options from the rest of the tree.

   c. You can pan and zoom by dragging, using the normal shortcuts (SHIFT+MMB and SHIFT+RMB respectively). For more information, see *Navigating in the Graph Editor* on page 10-21.

   d. To zoom in to the part of the channel you want to edit, press ALT+SHIFT and drag to select the relevant area**.**

e. To make channels smoother, drag to select the section of the channel you want to edit, including at least 5 keys, and then right-click and select **Smooth Channel**.

f. To give smoother interpolation by deleting keys, drag to select the required keys, right-click and click **Remove Keys**.

g. To manually adjust the channels, you can copy, cut, and paste individual keys, using the right-click menu or its shortcuts, which are displayed when you open the right-click menu.

   When you delete or cut a key, control handles appear on the two adjacent keys to enable you to edit the shape of the channel.

h. To flatten a channel from a selected key, making all values from that key constant, right-click the key and select **Reset Gradient**.

i. For more information on using the **Graph Editor Controls**, see *Using the Graph Editor* on page 10-17.

Using the above techniques, edit the three **Rotation** channels to make them relatively smooth. In this sequence, the easiest way to do this is to delete the keys to the end of the solve and adjust the control handles to make the channels more even.

7. After you have finished editing the channels, the Graph Editor should look similar to Figure 10-6.

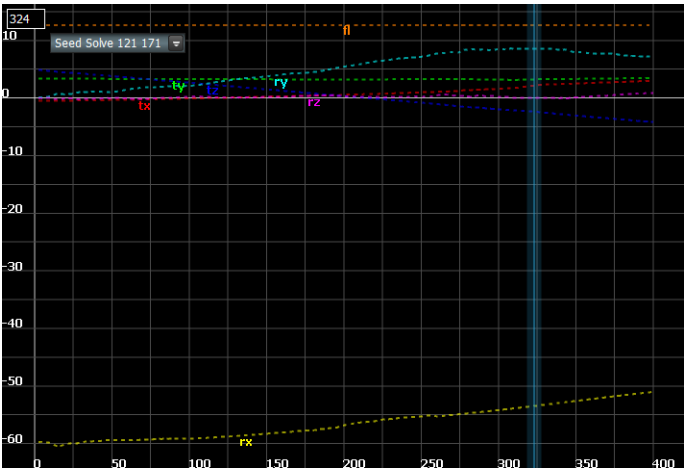


Figure 10-6: Edited channels in Graph Editor

8. When you are happy with your editing, on the **Overlays** pane, click the **Commit All Channels to Solve** button.

Using Solve Adjust to Finalize the Solve

In this final lesson you learn how to use the **Solve Adjust** option to improve the camera positions and the existing 3D structure, and optimize the part of the solve you changed in the previous lesson.

To use Solve Adjust:

1. From the **3D Tasks** menu, click **Solve Adjust.**
2. In the **Solve Adjust** dialog box:
   a. Clear the **All Imagery** check box.
   b. Change the **Start** frame to 255.
   c. Select the **Lock Focal Length** check box to prevent the camera from jumping at the start of the section of the path you adjusted.

d. Select the **Smoothing** check box to give the most even result.

e. Click **Start**.

In the **Solve Adjust** dialog box, the error values are displayed, reducing over time.

Tip

If the **Solve Adjust** error values become negligible at any stage, click **Stop**. This stops the adjustment process without losing any of the displayed adjustments.

When the solve has finished, your camera path should appear fairly smooth in the 3D view, as shown in Figure 10-7.

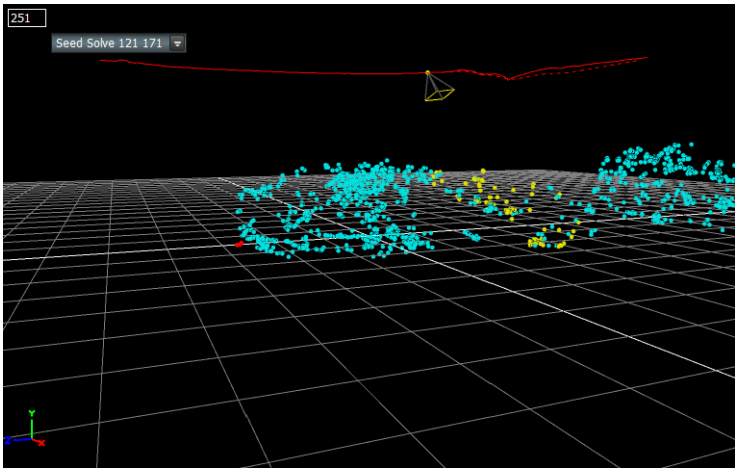


Figure 10-7: Finished sequential solve

3. If you want to check the quality of the solve before you export it to your animation package, add a test object to the sequence and play it through. For more information, see *Adding a Test Object* on page 5-22.

Sequential Solver Settings

You access the Sequential Solver settings in the **Seq. Solver** pane. In the default layout, this is located in the right sidebar.

Tip

If you cannot see the **Seq. Solver** pane, from the **View** menu point to **Panes** and then select **Seq. Solver**.

The **Sequential Solver** pane, shown in Figure 10-8, enables you to control the speed and accuracy of the solve, as well as to specify the number of frames to solve.

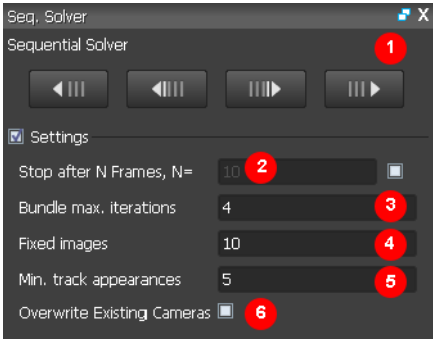


Figure 10-8: Sequential Solver pane

1. **Sequential Solver buttons**

   Run the sequential solve. From left to right the buttons are:

   - **Solve backward/Solve backward N Frames**

     Functionality depends on whether you select **Stop After N Frames**. If you select it, you can specify a value for **N** in the **Stop After N Frames** field.

   - **Solve backward 1 frame**
   - **Solve forward 1 frame**
   - **Solve forward/Solve forward N Frames**

     Functionality depends on whether you select **Stop After N Frames**. If you select it, you can specify a value for **N** in the **Stop After N Frames** field.

2. **Stop After N Frames**

   When selected, turns the **Solve forward/backward** buttons into **Solve N Frames forward/backward** buttons.

   N= Defines the number of frames tracked before stopping when the **Solve N Frames forward** and the **Solve N Frames backward** buttons are clicked for all selected tracks (see 1. above). You can enter the value for **N**.

3. **Bundle max. iterations**

   Specifies the greatest number of times per frame that information about the camera position and 3D structure can be adjusted to minimize errors. A lower value gives a faster solve but may also produce less accurate results.

4. **Fixed images**

   Specifies the number of frames prior to the frame currently being solved in which cameras are static. A lower value increases the number of camera positions that can be adjusted in the previous frames.

5. **Min. track appearances**

   Specifies the lowest number of frames in which a 2D feature track has to appear in the sequence before a 3D prediction point is generated.

6. **Overwrite Existing Cameras**

   When checked, overwrites the information about the position of the cameras with new information, using the current settings.

Using the Graph Editor

The Graph Editor provides a graphical representation of the camera positioning information generated by boujou. It enables you to easily identify problems with the solve and to manually adjust the channels to produce smoother results.

As you adjust the channels, the original path is preserved as a dashed line, while your changes are represented by a solid line.

This section describes the features and functionality of the Graph Editor. The features and functionality described are:

The Graph Editor Controls

The **Graph Editor Controls**, available on the **Overlays** pane and shown in Figure 10-9, enable you to change your view of the graphical information displayed in the Graph Editor, edit channels, and save your changes to the solve or revert back to the unedited version of the solve.

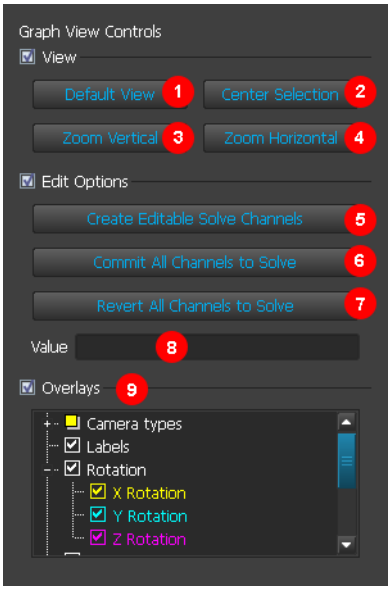


Figure 10-9: Graph Editor Controls

The **View** controls are:

1. **Default View**

   Reverts the Graph Editor to its default state, with everything that is selected in the **Overlays** area visible.

2. **Center Selection**

   Centers the selected keys in the Graph Editor.

3. **Zoom Vertical**

   Displays everything selected in the **Overlays** area in as large an area as possible while fitting into the Graph Editor vertically.

4. **Zoom Horizontal**

   Displays everything selected in the **Overlays** area in as large an area as possible while fitting into the Graph Editor horizontally.

The **Edit** controls are:

5. **Create Editable Solve Channels**

   Copies solve channel data, which you can then use the Graph Editor to change and to apply to the solve.

   Important
   You must click this button before you can edit channels in the Graph Editor.

6. **Commit All Channels to Solve**

   Saves all the changes you have made to the channels in the Graph Editor into the current camera solve.

7. **Revert All Channels to Solve**

   Changes all the channels back to their state before you began editing. Note that you can only use this option before you have clicked **Commit All Channels to Solve**. If you want to undo your changes after you have committed them, use CTRL+Z or delete them on the **History** pane.

8. **Value**

   Enables you to type a value for the selected key or keys, corresponding to the value on the left axis in the Graph Editor.

The **Overlays** controls are:

9. Overlays area

In the **Overlays** area, you can select or clear check boxes to enable you to focus on the channels you want to edit. The options you select here affect the way the **View** controls work. The options are:

- **Camera types**

  When expanded, enables you to view or hide **Solved**, **Editable**, or **Both** cameras in the Graph Editor.

- **Labels**

  Enables you to view or hide labels on all channels in the Graph Editor.

- **Rotation channels**

  Enables you to view or hide **X**, **Y**, and **Z Rotation** channels in the Graph Editor.

- **Translation channels**

  Enables you to view or hide **X**, **Y**, and **Z Translation** channels in the Graph Editor.

- **Focal length**

  Enables you to view or hide the Focal length channel. When expanded, you can select units of measurement: either FOV (degrees), millimeters, or pixels.

Navigating in the Graph Editor

Table 10-1 describes the main options for navigating in the Graph Editor, in addition to the View and Overlays controls.

Table 10-1: Graph Editor navigation options

Option	Controls
Pan view	SHIFT+LMB+RMB or SHIFT+MMB (if **Middle Mouse button for navigation** is set in **Preferences**)
Zoom	SHIFT+RMB
Zoom on selection	ALT+SHIFT+drag
Select active frame	Double-click in Graph Editor

Graph Editor Right-Click Menu

When you select a key or multiple keys and right-click on a key, a menu appears containing the relevant Graph Editor options. These are:

- **Center Selection** Centers the selected keys in the Graph Editor.
- **Interpolate Between Keys** With 2 adjacent keys selected, interpolates the camera position between them.
- **Extrapolate From Key** When you delete keys at the end of a channel, with the final key selected, extrapolates the camera position from its last known position (the end keyframe).
- **Reset Gradient** Flattens a channel from the selected key, making all values from that key constant.
- **Smooth Channel** When at least 5 keys are selected, smooths the channel between the selected keys.
- **Create Key** When you delete a key and then select the 2 keys on either side, adds a key between the 2 selected keys.

- **Insert Key(s**) When you delete 3 or more keys and then select the 2 keys on either side, inserts keys at every frame between the two selected keys.
- **Remove Key(s)** Deletes selected key(s).

  When you delete a key, control handles appear on the two adjacent keys to enable you to edit the shape of the channel.
- **Cut Key(s)** Removes selected key(s) and copies the selection to the pasteboard.

  When you delete a key, control handles appear on the two adjacent keys to enable you to edit the shape of the channel.
- **Copy Key(s)** Copies the selection to the pasteboard.
- **Paste Key(s)** Pastes the cut or copied selection to the channel, at the selected key or keys. You can paste one key to multiple selected keys, or multiple keys to the same number of selected keys.
- **Commit Channel to Solve** Saves the changes you have made to the selected channel(s) to the current solve.
- **Revert Channel to Solve** Changes the selected channel(s) back to their state before you began editing.

Reviewing Graph Editor Changes in the Image Window

With boujou, you can view reprojection errors in the Image window to check whether the changes you have made in the Graph Editor have improved the solve.

To do this:

1. Make your changes to the channels in the Graph Editor.
2. Click to go to the start of your changed section(s).
3. Go to 2D view.
4. In the **Overlays** pane, select the following options and expand them to set the specified sub options:
   - **Track**: Clear the **All** sub option
   - **Predictions**: Clear the **All** sub option
   - **Errors**
5. At the top left of the Image window, click the blue text that reads **Solve** under the frame counter to change it to **Editable**.
6. In the **Timeline** or Timebar, scrub forward and backward through the relevant frames to see whether your changes have improved the solve.

   Reprojection errors are represented by purple lines – the longer they are, the less accurate the camera solve is.

For more information, see *Visualizing Reprojection Errors* in the *boujou Reference Manual*.

Tip

You may find it easier to make changes and view errors if you click the **Horizontal Split** button or **Vertical Split** button on the Toolbar and view the Image window in one half and the Graph Editor in the other.

Using Reference Frames 11

This tutorial shows you how to provide additional parallax information to a sequence by importing an additional image, known as a reference frame, into your project.

The lessons in this tutorial describe the stages in using reference frames:

For this tutorial, you need the following sample image sequences and project file:

- *tutorial11_reference_frames-0.bpj*
- *tutorial11_reference_frames.[###].jpg*
- *tutorial11_reference_frames_suppl-01.jpg*
- *tutorial11_reference_frames-f-l.bpj*

Important

Before starting this tutorial, you must have already added the required shortcut buttons to your **Toolbox** and copied the sample tutorial files to your hard disk drive where you can access them while working through the tutorial. For details, see *Chapter 1 Introduction*.

Importing a Reference Frame

In the other tutorials in this book, you import only a single image sequence into your boujou projects. In this lesson, you learn how to import a second image, called a reference frame, to add camera information to the shot.

To import a reference frame into a project:

1. Open the project file in one of the following ways:
   - On the menu bar, click **File** and then click **Open**.

   or

   - On the **Toolbar** click the **Open** button.

   The **Open Project** dialog box is displayed.
2. Browse for the boujou project file named *tutorial11_reference_frames-0.bpj*.

   In the **Relocate Files** dialog box, in the file **Name** list, note that **Sequence 1** is selected and then click **Browse**.

   The file browser is displayed.
3. In the file browser, locate and select the image sequence named *tutorial11_reference_frames.[001-197].jpg* from the *tutorial_11\tutorial11_source_images* folder and then in the **Relocate Files** dialog box, click **Close**.
4. On the Toolbar, click **Setup** and then click **Import Reference Frames**. Locate and select the file *tutorial11_reference_frames_suppl-01.jpg*.

Creating Camera Views and Adding Locators

In the previous lesson, you learned how to import a reference frame into your project. You are now ready to track features and use the resulting tracking information to initialize the key schedule.

When boujou initializes the key schedule, it indicates the frames on which you should add locators, and also creates default camera views on these frames.

To create camera views and add locators:

1. In the **Toolbox**, click the **Track Features** button and in the **Feature Tracking Properties** dialog box track features using the default settings.

2. On the Toolbar, click **3D Tasks** and then click **Initialize Key Schedule**.
3. In the **Initialize Key Schedule** dialog box, note that Sequence 1 is selected and click **OK**.
4. In the **Input Focal Length** dialog box, leave the focal length at its default size (30 mm) and click **OK**.
5. In the **Timeline**, expand **Solves** and note where the default camera views have been placed, as shown in Figure 11-1.

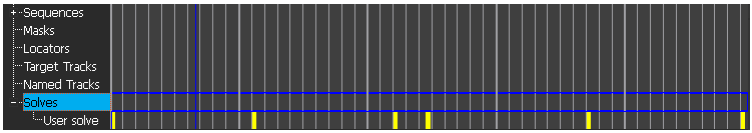


Figure 11-1: Default camera views in Timeline

6. To make it easier to see where to place locators in the Image window, on the **Overlays** pane, clear the **Tracks** check box.
7. Scrub to the reference frame at the end of the **Timeline** (after frame 197).
8. In the **Toolbox,** click the **Add Locators** button, then in the Image window click on the bottom left of the T in the sign for The Fishes, as shown in Figure 11-2.

Tip

To help you place the locator accurately, use the Instant Zoom button to zoom in and if necessary, zoom in further using SHIFT+RMB.

Figure 11-2: Placement of the first locator

9. To go to the next camera view:
   - In the **Timeline** or Timebar, press CTRL+right arrow key.

   or

   - In the Play controls, click the **Next Solved Frame** button.

10. On this frame (frame 1), click to add Locator 1 at the same point on the sign.
11. Repeat until you have placed Locator 1 on as many of the frames that have camera views as possible (four frames).
12. Repeat steps 7. to 11. for at least seven more features.

Tip

To save time, before starting the next lesson, you can instead open the project file *tutorial11_reference_frames_f-l.bpj*, in which the locators have already placed. When the Relocate Files dialog box appears, click Browse, locate and select the image sequence named *tutorial11_reference_frames.001.jpg* and click **Close**.

Adding 3D Structure to the Sequence

In the previous lesson, you added locators to the default camera views in both the sequence and the reference frame you imported. In this lesson, you learn how to use information from the sequence and the reference frame to add 3D structure to the shot.

To add 3D structure to the sequence:

1. Either use the file to which you added locators in the previous lesson, or open the project file *tutorial11_reference_frames_f-l.bpj*, in which the locators have already placed. When the **Relocate Files** dialog box appears, click **Browse**, locate and select the image sequence named *tutorial11_reference_frames.001.jpg* and click **Close**.
2. In the **Toolbox**, click the **Solve Two Views** button.

   The **Solve Two Views** dialog box is displayed.

   Figure 11-3: Solve Two Views dialog box

3. In the **Solve Two Views** dialog box:
   a. Change the **2nd Image** to *tutorial_11_suppl-01.jpg.*

      The values in the middle text boxes specify which frames to solve. For this lesson, leave these as they are.

   b. Change the **Focal** value to 17.5 mm. This is an initialized value and will be adjusted by the solver.

   c. Click Solve.

4. In the **Timeline**, expand **Solves**. The camera views at the beginning and end of **Camera solve 1** are shown in green, indicating that solves have been created for these frames.

   In this example, solves were created at the beginning and end of the **Timeline** because in the **Solve Two Views** dialog box, you specified frame 1 for the **1st Image** (the sequence) and specified the reference frame as the **2nd Image**, which is automatically added at the end of the first sequence.

5. On the Toolbar, click **3D Tasks**, point to **Solve Tools** and then click **Regenerate Unsolved Views**. This uses the 2D locators that have predictions on the remaining unsolved camera views to generate camera views on as many unsolved frames as possible (that is, the unsolved frames that have locator keyframes).

6. In the **Timeline**, expand **Locators** as well as **Solves**. Note that camera views appear wherever locators have been placed and keyframes created, as shown in Figure 11-4.

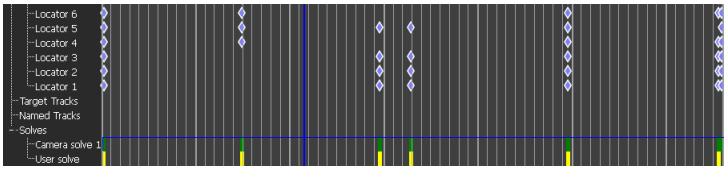


Figure 11-4: Keyframes and locators

7. On the Toolbar, click **3D Tasks**, point to **Solve Tools** and then click **Regenerate Structure**. 3D information for all the automatic feature tracks is generated and the predictions are displayed in the Image window.

8. To see the prediction points clearly, in the **Overlays** pane, clear the **Tracks** check box and make sure the **Predictions** check box is selected.

Completing the Camera Positioning Information

In previous lessons, you learnt how to generate prediction points using information from both the image sequence and the reference frame you imported. In this lesson you learn how to improve the 3D structure and generate complete camera positioning information for the sequence.

To complete the 3D structure:

1. Scrub to the first frame in the sequence, then on the Toolbar click **3D Tasks** and click **Solve Adjust**. In the **Solve Adjust** dialog box, leave all the settings at their default values and click **Start**.

   Using **Solve Adjust** improves both the camera positions and the existing 3D structure.

2. When the Solve Adjust has finished, on the Toolbar click **3D Tasks** and then click **Solve From Existing Cameras**.

   This option generates 3D structure from the existing camera path, and fills in the gaps between the camera views. It also optimizes the camera solve.

   The Status bar shows the progress of the solve and when it has finished, **Camera solve 1** is displayed in the **Timeline** as a solid green bar.

   On the Toolbar, click **3D Tasks**, point to **Solve Tools** and then click **Regenerate Structure**. 3D information for as many automatic feature tracks as possible, based on the whole camera path, is generated and prediction points for the solve are displayed in the Image window.

3. To optimize the result and give the smoothest possible camera path, scrub to the first frame in the sequence, then on the Toolbar click **3D Tasks** and click **Solve Adjust**.

4. In the **Solve Adjust** dialog box, select the **Smoothing** check box, leave all the other settings at their default values and click **Start**.

Adding a Test Object

In the previous lesson, you learnt how to complete the 3D structure of the sequence. In this lesson, you learn how to add a test object and adjust it to check the camera path you have produced.

To add a test object:

1. In the **Overlays** pane, clear the **Predictions** check box.
2. Scrub to the reference frame at the end of the **Timeline** (after frame 197).
3. In the Image window, drag to select the three locators over the sign for The Fishes, as shown in Figure 11-5.

Figure 11-5: Three locators selected

4. On the Toolbar, click the **Add Test Objects** button.

5. In the **Test Objects** dialog box:
   a. Change the **Type** to **Plane**.
   b. Change **Alignment** to **Orient and Move**.
   c. In the **Align To** box, select **<Plane through selected predictions>**.
   d. Click **OK**.

6. On the Toolbar, click the **Scale**, **Translate**, and **Rotate** buttons and use the manipulators that appear in the Image window to line up the test object.

Note that as the test object is already locked to the three locators on the wall, you do not need to rotate it backward or forward, but use the manipulators to move and scale it so that it just covers the sign for The Fishes, as shown in Figure 11-6.

Figure 11-6: Test object aligned

7. Use the play controls to play through and check the sequence.

Support Resources A

This appendix describes the resources available to you to obtain support for your use of boujou.

If you have a technical support query, go to the **Support** page on the Vicon Web site:

www.vicon.com/support

In the **Find Solution** section, you can search through an extensive list of FAQs, or you can go to the **Log a Case** section to submit support requests to our team based in the UK. All users with an up-to-date support contract will have a log-in name and password for full access to the Web site. If you have not yet received your log-in details, please contact us at *boujousupport@vicon.com*.

When reporting a bug, please try to supply as much of the following information as possible:

- Company name
- A description of the bug with steps to reproduce the problem
- boujou software version number
- Operating system
- Image size, format, and number of frames
- Example images or screen grabs

If you need help with a difficult shot, contact boujou Support, who can provide you with a link to our FTP site, where you can upload the files.

Documentation Feedback B

At Vicon, we are working to develop comprehensive and easy-to-use documentation to support your use of our products. We welcome your comments or suggestions on how we can continue to improve our product documentation.

Please provide your documentation feedback using our online support system, at *www.vicon.com/support*. For details, see *Appendix A Support Resources*.

Please include "Documentation Feedback" in the Summary line and provide the following details in the body of your message:

- **Product details**
  - Product name, version number, and build number
- **Document details**
  - Document title and revision number or copyright date
  - Document type and content location:

Book	Chapter title, section title, and page number
Help	Topic title and section title

- **Problem description**
  - Brief description of current content, identifying your concerns (e.g. specify any factual inaccuracies, errors, or omissions; grammatical errors; navigation or information location problems)
- **Feedback details**
  - Your suggestions for correcting or improving the documentation

Customer Satisfaction Survey C

Please help us to improve our services by printing this page and sending your completed survey by fax or post to the Vicon office. See the inside cover of this book for our contact details.

We value your honest opinion on the service you have received so far. We take your feedback into consideration when providing products and services in the future. If you have any questions or comments about this survey, please contact our Sales and Support Manager.

Contact Name _____ **Title** _____

Organization _____ **Date** _____

For each question, check the box that most closely describes your opinion. Leave any that are not applicable blank.

How satisfied are you with the quality of your boujou software? (1=Very, 5=Not at all)

❍ 1 ❍ 2 ❍ 3 ❍ 4 ❍ 5

How satisfied are you with the purchase experience of your boujou software? (1=Very, 5=Not at all)

❍ 1 ❍ 2 ❍ 3 ❍ 4 ❍ 5

How satisfied are you with the value of your boujou software? (1=Very, 5=Not at all)

❍ 1 ❍ 2 ❍ 3 ❍ 4 ❍ 5

How satisfied are you with the installation or your first usage of your boujou software? (1=Very, 5=Not at all)

❍ 1 ❍ 2 ❍ 3 ❍ 4 ❍ 5

How often do you use your boujou software? (1=Every day, 2= Every week, 3=Every 2-3 weeks, 4=Every month, 5=Every 2-3 months)

❍ 1 ❍ 2 ❍ 3 ❍ 4 ❍ 5

How satisfied are you with your continuing usage of your boujou software? (1=Very, 5=Not at all)

❍ 1 ❍ 2 ❍ 3 ❍ 4 ❍ 5

How likely are you to buy another Vicon software application in the future? (1=Very, 5=Not at all)

❍ 1 ❍ 2 ❍ 3 ❍ 4 ❍ 5

How likely are you to recommend boujou to others? (1=Very, 5=Not at all)

❍ 1 ❍ 2 ❍ 3 ❍ 4 ❍ 5

How completely were any problems you contacted Vicon customer services about resolved? (1=Fully, 5=Not at all)

❍ 1 ❍ 2 ❍ 3 ❍ 4 ❍ 5

Please provide any additional information or comments

Index

G

H

I

K

L

M

N

O

P

R

S

Z