Video Motion Tracking has recently become a strong feature in Blender, giving the program the ability to rival other professional programs used to create composite CGI feature films. This feature adds to Blender’s ability to be a one-stop-shop for video creation and editing.

Camera and motion tracking allows you to load video footage of some real-life scene into Blender, track various points in the scene in Blender, then analyze this tracked data to turn the movement into a 3D virtual scene. You can now add your own 3D modeled objects and merge the CGI with the real footage. With practice and patience, you can create scenes that will rival the Hollywood blockbusters!

Setting Up the Tracking Scene

Getting Started:
The first step is to film the scene you wish to use with your 3D models. Obtain the highest quality video possible for the best results. Think ahead and plan for lighting, foreground/background elements, and smooth camera motion. The video will need several high-contrast points (markers) in the scene that will be used to create the Blender camera path. Blender will track these point throughout the video in order to determine the camera’s location, target depth, and zoom. If your scene does not have natural high-contrast points, you may need to add them (small white paper dots on a dark surface, coins, tape, etc). If you know where your 3D objects will be placed, your markers can be placed in those locations and be covered by the 3D objects in the final video.

Blender is able to use many different video formats. Since most phones and digital cameras use the .mp4 format, Blender is able to use videos in this format. Video quality that is too poor or with mismatched frame rates may not work well. It is best to convert the video to match the size and frame rate to what you plan to use for your final composite video output before tracking the video. This can be done through a video converter program or in Blender’s video editor that is discussed in Chapter 24. For our practice video, we will use this simple desk scene.

Adding the Video:
After you have your video, open a new Blender file and change the “3D View” window to the “Movie Clip Editor” window.
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At the bottom of the window you will see an Open button. Open your video. It should now display in the window.

Adjust your End Frame to match the video length. In order to play the video, hit "Alt-A" or the bottom "Play" button. As the movie plays, you will notice a small blue bar at the bottom of the window with a small lighter blue area following the marker. This small area represents cached frames in memory. We need to adjust this so all frames are cached in memory.

In order to adjust the cache, go to the “File” menu and select “User Preferences”. In User Preferences, go to the “System” tab and find the Memory Cache Limit setting under Sequencer at the bottom of the display. The default setting is 1024 Megabytes which only caches about 250-300 frames. You will need to adjust this setting so all frames in the sequence are cached for smooth playback and operation. Try dragging the setting all the way up to the highest limit that your computer will allow. If you find your computer is sluggish, try adjusting the cache down until you have as much as needed or try to exit other programs that may be running on your computer.

By pressing “Alt-A” or the “Play” button at the bottom of the screen should now display the entire bar light blue, indicating that all frames are now cached in memory. It is now time to start the tracking process.
Adding and Adjusting Markers:
Markers are used to track the camera motion and can be difficult to adjust. Here are some of the basics to use when placing markers:

- By clicking the small triangle in the "Tracking Settings" box, you will see a few settings you may need to adjust as you add markers. While most settings should work for most scenes, results can be improved by changing the following:

  - **Pattern and Search Sizes** - The pattern size should be large enough to cover the entire marker you are using, but not too large so that it includes a large area around the object. The search area is where the computer will look for the marker from frame-to-frame. If you lose the marker when you try to create the track, try adjusting these. The quality of the movie, contrast of the marker, and amount of motion will vary for all of these. Larger pattern and search sizes will slow the system.

  - **Match** - Less errors will occur if you change the frame matching from Keyframe to Previous Frame.

  - **Correlation** - Controls how tightly the camera tracks the marker. The default of 0.750 works for most videos, but can be lowered if your video quality is poor and has trouble creating a good track.

  - **Margin** - As some of your marker approach the edge of the frame, they will “float” at the edge. Try setting the margin to 5 to prevent errors.
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The more markers you add, the better your camera will track. Not all marker areas may work well so you will need to experiment with pattern and search sizes for each marker. Depending on your scene, some markers may go off the screen during the video. This is fine and will still help create your camera track. The more markers you can create that remain on the screen during the entire playback, the better. Markers can be moved and scaled with normal Blender commands (“G” and “S”). Remember to use “Alt-A” to show animation.

As you add a marker, press the track selected markers button (triangle) to record the tracking. If it fails, try adjusting the marker, clear the track, and track again. You can clear before or after the current frame. If you have placed several markers and want to track them all at the same time, make sure they are all selected.

RoboDude Says:
Always make sure you are on frame 1 when adjusting markers! You can also add markers quickly by pressing “Ctrl-LMB” in the video window.

Here is our test scene with several markers added and tracked. You will need at least 8 markers for accurate tracking. More is better. If you plan to track an object in the scene to add CGI to it (like a mask or hat on a person), You will need to track that object as
well with at least 8 markers. If you go over to the right side of the screen, you will see an “Object” panel at the top of the menu. By default, you have tracked the camera to determine its motion. Press the “+” button to add an object to track. The Camera tracking markers will disappear so you can start tracking the object.

It is now time to create the camera path to use with our 3D models.

Exporting the Camera Path Data:

After the points have been tracked, it is now time to set up the camera data so the path can be exported to your 3D scene. On the right-hand side of the viewport, you will find the Camera and Lens settings. You may need to do some internet research to find some information about the camera used to create the video. For best results, the Focal Length, Sensor Width, Pixel Aspect, and Optical Center should be set as closely as possible to the camera used. There are also several Camera Presets available to chose from. While Blender attempts to keep the preset list up-to-date, it is usually running a model or two behind the current cell phones on the market.

Another setting that you should adjust at this time is in the Solve panel on the left side of the viewport, second tab down. Find the two blocks that deal with Keyframe A and Keyframe B. These setting are used to tell Blender where there is significant forward movement in the video. For example, if between frames 65 and 86 the camera operator took 2 steps forward. This should be set as Keyframes A and B in this panel. This will help Blender calculate camera position. Scroll through your video to determine any forward movement. If the camera was used on a tripod with no forward motion, select that option.

You are now finally ready to press the “Solve Object Motion” button (also in the Solve panel) to calculate the camera path. You will see a percentage bar at the bottom of the viewport as Blender processes the path. After the path is processed, you will notice a Solve Error message at the bottom right side of the viewport. You goal is to have a number as low as possible for a high quality motion path. Anything less than 1.00 is considered excellent while anything less than 3.00 is considered good. This scene shows an error of 0.7547 which should be good. If the error is very high (3-40 or more), you may need to check your camera data settings (focal length and sensor width) or redo your markers. It is a process that gets easier over time and use.
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Using the Camera Path in the 3D Scene:
Now that you have calculated your camera motion, it is time to switch back to the 3D View window and apply these settings to the camera.

Select the Camera, go to the Constraints panel, and then add a Camera Solver constraint. You will immediately see points (represented by empties) on the screen that represent your markers (depends on your Blender version. If not, we will fix that in the next step) and when playing the animation, your camera will move as the actual camera did when filming the video. It is now time to refine your scene so it will be easier to work with 3D elements.

Go back to the Movie Clip Editor window (or split your screen so you can have a 3D View window and a Movie Clip Editor window open together). Find the panel on the left called “Scene Setup”. By clicking the button “Set as Background”, your 3D View window will now display the video in camera view (0 on number pad). If you do not see your points in the 3D View, click “Setup Tracking Scene”. This should display your points and may also give you a floor plane. By pressing play, the points should align with where your markers were located in 3D space.

Aligning the Scene:
You now have a camera path and points, but you will notice that they are not aligned with the grid and a few points may be higher or lower than the others. To correct this problem, we need to move the entire scene to the grid level and align it correctly.
To align the points (floor) to the grid, you will need to make some more adjustments in the Movie Clip Editor panel. In the left panel, close to the Scene Setup options, you will find a panel called “Orientation”. We can use these options to align various points in your 3D scene and also set scale.

Select 3 markers in your scene to use as a floor reference. Select points that have some distance between them. With those 3 points selected, press the Floor button in the left side panel. This will move the points onto the grid in the 3D View window. You can also select a marker and set as Origin to center the scene. Points can also be selected and set as Wall. Scale can also be set by selecting 2 points, changing the “Distance” and pressing the “Set Scale” button.

RoboDude Says:
It may take a little trial and error to get your scene set up and tracking well. Experiment using different marker points and scales. Try also setting an origin.

Setting Up Objects for Your Scene:
You are now ready to start adding your 3D objects. If you did not press “Setup Tracking Scene” in the previous steps, do so now. By pressing this button, your 3D View window will now get a plane and cube set along the floor line. These objects will be placed in a different layer, set as a mask. Basically, objects in this layer do not render, but will display shadows cast upon them. This is how your 3D modeled objects look like they belong in the actual scene. Masks and material settings will be discussed in the next section. You are now ready to begin creating 3D objects in your scene. Some may be set to render and some may mask objects so it looks like your 3D objects go behind objects in the video.
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Using Masks and Materials

When you added the tracking scene, Blender placed the plane into the bottom layer. It did this because Bender set that layer up as a masking layer and also considers it a Background layer in node rendering. Basically, anything placed into that layer will not render. You can see this by going into the Render Layers properties panel.

Creating masking objects that receive shadows using the internal render engine materials is a simple process. For the example below, in the tracking plane that was added as our floor, I create a hole by subdividing the plane, deleting some vertices, then reshaping the hole to look more jagged. A material was added to the plane. In the material “Shadow” panel near the bottom, The only items needing checked are “Receive” to receive shadows from other objects, and “Shadows Only” so the only thing the plan displays in the rendered view are those shadows it has received.

You will notice that a model of the milk carton and other objects were created to match the items in the video as closely as possible. These objects are being used as masks so if the monkey head passes behind one of them, it blends perfectly with the scene, making it difficult to tell what is real and what is CGI, as displayed to the left.
Scenario:
You have been hired to work on a soft drink commercial requiring a CGI video using a real desk scene. Your goal is to create a 300 frame movie (10 seconds @ 30 fps) using camera motion tracking.

For this project, create a Blender file called “Motion Tracking”, using your standard video default settings. Your steps are:

- Create a 10 second video of a desk scene, or use an instructor provided video.
- Convert the video to match your final output settings.
- Create your tracking scene in Blender. Research your camera’s settings for accuracy.
- Develop your 3D models, materials, lighting, and appropriate masks for your video.
- Save a 10 second video of your final work.

** Call the instructor when finished**
Chapter 21 Reflection

Is it real or is it CGI?

Adding realistic-looking 3D elements to a real video is common place in movies, TV shows and advertisements these days. So much so, that it is becoming impossible to tell the difference. Many of the car commercials you see today use 3D models of cars instead of the real thing, but you can't tell the difference. Please take a few minutes to reflect on your experiences with motion tracking.

1. After creating a simple motion tracking scene, what were your biggest challenges and how did you overcome them? Explain.

2. What did you find to be the most interesting aspects of this project and why? Explain.

3. Research the internet to find some examples of motion tracking. What would you like to attempt to do with motion tracking in a possible future project? Why?

4. Find the Blender Open Movie “Tears of Steel” on the internet. “Tears of Steel” was developed by the Blender foundation to highlight development of the motion tracking tools. Which features of the movie did you find to be the most interesting and realistic? Which ones seemed like a low-budget sci-fi movie effect (cheesy or not very realistic)? Explain your answers.