

# COM-MOTION TRACKING

Motion Tracking is used in many ways in special effects and post production. Once "tracked," motion from a clip, or motion of an object from a clip, can be used for composites, mattes, to stabilize plates, or to add additional effects.

This paper is meant to be a supplement to the Commotion 1.5 and higher manuals. Please read the Reference Guide in the manual for a complete overview of all motion tracking features.

## Definitions:

### **Motion Tracking:**

Process of having the computer follow an object or area of a moving image. This information can then be used to add an image later that follows this same motion or can be used to stabilize the image.

### **Stabilize:**

Takes moving footage of a scene with slight camera motion or jitter and makes it locked (removes motion). Useful for doing certain types of special effects where the background can't be moving.

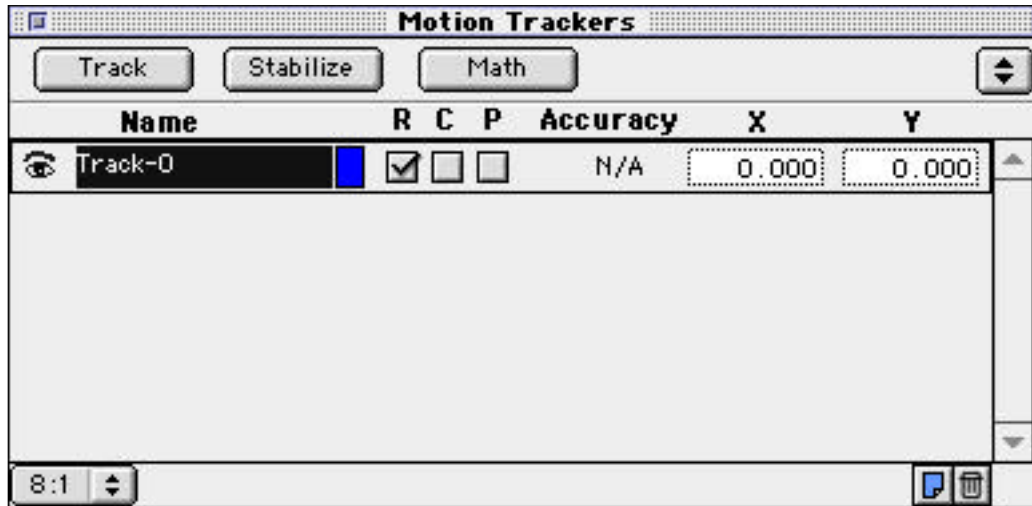
## Motion Tracking Basics:

Motion tracking is usually done one of a few different ways:

- One-point tracking can be used for stabilizing a shot or compositing a foreground element. This method can also be done with multiple points that can then be averaged together into one data set. A point is tracked, then that data can be applied to another layer to follow the tracked point. For example, track someone's hand, then apply the data to an apple and the apple will appear to be in the person's hand.
- Two-point tracking is generally used to obtain either scaling or rotation data (or both) from two tracked points. This is useful when tracking something that is rotating or changing size. The translation between the two points is what the scale and/or rotation data is derived from.
- Four-point tracking is typically used for corner pinning. For example, lets say you need to composite a TV image (video) into a panning shot where a television set was shot, but had no image in it. By first tracking the four corners of the television set's screen, you would then be able to apply that data in a program (like After Effects) to essentially "map" your video image onto the TV screen. It would scale and move in proportion to the movement of the television set in the moving shot.
- Commotion's Motion Tracker provides an unlimited number of trackers to the user. This differs from other trackers as it provides more flexibility for what the user can do with their tracked data. It is a "data generator" in that its sole function is to produce motion or tracked data that the operator can then use in a number of different ways.

# Let's Get Tracking ...

## Motion Tracking Palette:



There are no hard and fast rules to motion tracking settings, so you may need to try a few different settings if you have problems with the defaults.

To bring up the Motion Tracker Palette, double-click the Motion Tracker icon in the Tool Palette:



New trackers are created by hitting the new tracker button.

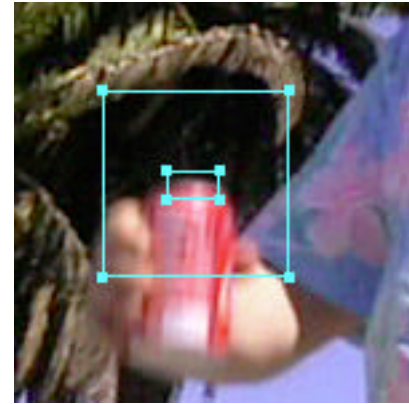


You can delete a tracker or multiple trackers by selecting them and clicking on the garbage can button.



### Setting up the Rectangle:

Select a small point or area that is high in contrast or color difference. If you find it hard to follow frame by frame, the computer will probably have problems also. This can be an isolated object, the corner of a building, or the high contrast edge of a soda can - anything that's obvious.



Set your tracker's inside rectangle to cover this. This area is called the *track target*. Using the zoom tool built into the tracker can help isolate an area to track. Keeping this area small will make tracking faster. The outside rectangle should be adjusted to accommodate the largest change in position in one frame. If your object moves a half inch on the screen, then set the outside rectangle to cover this. Note that if the movement of the object is always moving left to right, with little up and down, you could adjust the left and top and bottom of the outside box to be minimal. This will make tracking faster and will minimize it finding something else.

Within Commotion, you can have as many trackers as you like, so you can use different reference points for different purposes. For instance, you may need to track one point to determine position, and another point to determine scale or rotation. You may want to track multiple points along the same shape and apply them to separate points of a rotospline to automate the rotoscoping process. You can even track multiple points and then apply math functions such as Average Position or Velocity to derive more accurate data. The wide range of possibilities is designed to support a wide range of effects projects.



### To change the name of a Tracker:

- Double-click on the name of the Tracker and enter the new name in the Edit Tracker Name dialog.

### To change the color of a Tracker (3 options):

- Mouse down on the color popup next to the tracker name to select a color preset.
- Option-click on the color popup to use an eyedropper to select a color from your clip
- Command-click to bring up the Macintosh color wheel to choose a custom color.

### Rectangles, Crosshairs, Paths

R, C, P checkboxes control the display of the tracker data within the clip window.

(R) is the Rectangle which allows you to set the track pattern and track region.

(C) is the Crosshair indicator, which appears during or after a track has occurred. When a crosshair is present on a frame, that indicates that valid data has been returned by the tracker.

NOTE: The tracker will search for the region of the inner box each frame. The crosshair is the center of that region, and is what the data is based on.

(P) is the Path, which shows the tracker points and path over time. You can modify tracked data points by interacting with them in the clip window just as you would with a rotospline. You can move individual points or multiple points with the mouse or by nudging them with the arrow keys on the keyboard.

### Working with Multiple Trackers

You can select the tracker to work with by either clicking on its name in the tracker floater or by clicking on it in the clip window. Shift-click to select multiple trackers.

### Magnification

At the bottom of the motion tracker palette window is a magnification popup menu. This allows you to magnify the inner rectangle so it can be set precisely but allow you to see the entire frame. Keyboard shortcuts for this are “1”, “2”, “3” and “4” while in the Motion Tracker.

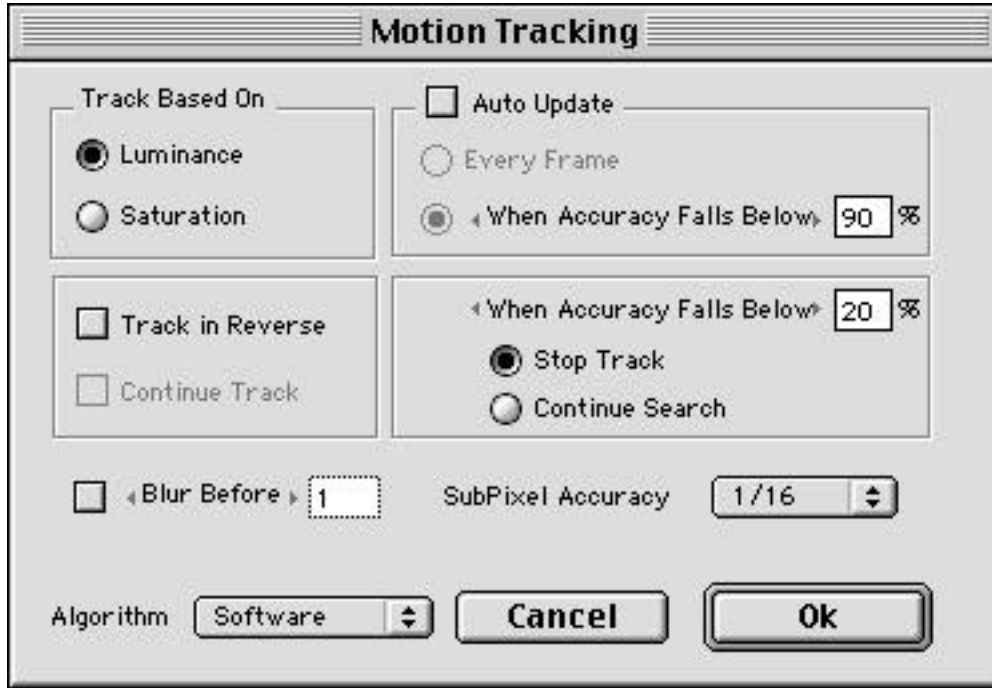
How it works / a brief background:



The image area within the inner rectangle becomes the “track target”. The area in the outside rectangle becomes the search area or “Track Region”. This area is scanned for something that matches what was in the inner rectangle. The closest match is what the tracker returns. This is done through sophisticated cross-correlation computations, not pixel by pixel. This is what provides the subpixel accuracy, among other things. It also provides the accuracy readout. The closer to 100% the better. Tracking should be at 90% or better for typical tracking. The crosshair is that is drawn during or after the track is the center of your tracked region.

## Commotion Tracking Options:

Once you've got the rectangles set up, its time to start the track. Clicking the "Track" button brings up the following dialogue:



### Track Based On: Luminance or Saturation

Commotion can track by luminance (contrast change). This is what most motion trackers do. This is fine but there are times where there is a defined colored object that may in fact have the same gray value. In this case try using the saturation setting which uses the color difference.

### Auto Update

By default Commotion uses the first tracking frame image as the target (inner rectangle area) This will typically produce the highest quality track data even if there are minor changes from frame to frame. If however, the image is changing shape (i.e. rotating or scaling) then it may become useful to use Auto Update. This uses the previous frame as the target, updating what it searches for each new frame. This is the process used by some motion tracking systems. Unfortunately this introduces a certain amount of drift and variance over the course of a shot. In Commotion you can set this to only update when the tracking accuracy drops below a certain percentage.

### Track in Reverse

There are times when the end of a shot may provide a better start point for tracking. For example, an object that goes off screen could be tracked from its last frame backwards, or an object getting closer to the screen might be easily tracked at the last frame, where it has more detail.

### Continue Track

Continue Track is useful when making multiple passes with the same tracker. This can happen if the object becomes obscured, or travels off screen. Continue Track merges the data from any subsequent track, with the previous track.

After tracking a first pass, or partial range, reset your selection slider to a new range. Reposition your rectangle. Click "Track" and choose Continue Track in the options dialog. Commotion will now track the new object, but apply the resulting data to the original track path.

When using a "continue track", you need to begin the second portion of the track (or 3rd, or 4th, etc) with a frame that was tracked in the last pass. For example, if you track 1-10 in the first pass, the next pass should be 10-20 (not 11-20).

### When Accuracy Falls Below

Accuracy settings control the behavior of the tracker when accuracy values begin to drop below a threshold. You can choose to have the tracker stop completely, which allows you to reset the track position and begin again or continue tracking, or you can have Commotion continue the search along the path and velocity of motion before the object became obscured. Once an object that is obscured reappears, the tracker will reacquire the pattern and continue tracking.

### Blur Before

The type of motion tracking done in Commotion tends to ignore things like film grain so you usually don't need this. The purpose of this is to minimize small frame to frame deviation in the image itself. The amount set will control how much blurring is done. The lower number you can get away with is better.

### SubPixel Accuracy

How accurate you need to track depends on what you're trying to do and your original image. If you need to stabilize a moving shot that was almost locked off (i.e. tripod at the top of a tower in the wind) then you want to have a very high setting (1/64 or better). Take a look at your moving shot at high magnification in Commotion. If there's just slight pixel brightness variation then this would require a high setting. If you need to stick a logo on a fast moving truck you could get away with 1/16 pixel or less. The higher the setting the longer tracking will take.

## After The Track:

To modify a point or points on a motion tracker path:

- Select individual points and click-drag to adjust their position.

-Select multiple points by shift-clicking or dragging a marquee over the points you wish to select, then click-drag to adjust their position.

-Option- click on any point to automatically select all points of a track.

-Use the arrow keys to nudge points left/right up/down. The nudge keys are scalable, such that at 1:1 each nudge will be 1 pixel, but when you zoom in on the clip at 2:1 each nudge will be 1/2 of a pixel, and so on.

To lock points on a motion tracker path before re-tracking:

1. Select the points you wish to lock.
2. Choose "Lock selected points" from the Motion Tracker dropdown menu.

## Math

The Math dialog allows you to manipulate motion tracked data to create new tracked data.

The result of Tracker Math is a new Tracker:

- Average Positions - creates a new Tracker that is a frame-by-frame average of the x,y coordinates of up to 4 Trackers.

A common use is to track two separate points and then to create an average position or velocity set from the two points. If you have a very shaky plate you are trying to stabilize, try tracking two separate points and then using the Math function to average the two points together—this will yield a higher precision tracker which can be used for the stabilization.

- Average Velocity - creates a new Tracker where the starting point is the first point of Tracker#1, and all points thereafter are a frame-by-frame average of the velocities of up to 4 Trackers.

- Merge - creates a new Tracker that is Tracker#1 through the reference frame, with Tracker#2 after the reference frame, but offset to continue Tracker#1's path. This is necessary to track objects that move off the frame entirely. For instance, if you were tracking a car's headlight that moves out of the frame, but needed tracking data that continued to follow the headlight, you would track something still visible with similar motion, such as the car's taillight or a taxi following behind. You could then merge that Tracker with the headlight Tracker starting at the frame where it first disappears, to get a new Tracker that appears to follow the headlight right out of the frame.

- Scale - creates a new Tracker with a x and/or y scale factor applied.

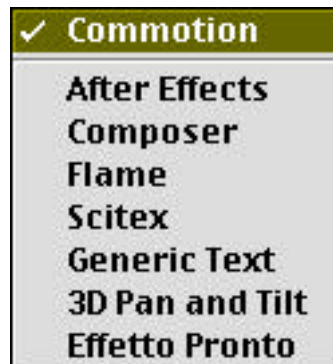
- Smooth - creates a new Tracker that is a frame-by-frame average of the x,y coordinates of the input Tracker. The Smoothing Factor determines how many frames in either direction are averaged together for each point. The greater the amount smoothed, the more your first and last

points will move. These can be easily edited back to their original positions . Unfortunately locking the points down does not currently work (Commotion 1.6).

### Saving and Loading Motion Trackers

Motion Tracking information can be saved in a number of different formats, including those readable by different applications. This gives the user flexibility on where to work with their tracked data.

Save or Load Trackers by selecting the corresponding options in the Motion Tracker dropdown menu. Be sure to save files to a central location so you can easily retrieve them.



### Commotion

Files stored in this format are to be loaded into any clip in Commotion for re-use. If you are working in a scaled down clip or a subwindow, it is important to save your trackers in Commotion format, then reload them back in at full size to ensure the data is correct.

### After Effects (based on After Effects 3.1):

When exporting your tracked data to After Effects, please note when you look at the data (in the clipboard in any word document), your framerate will have been multiplied by 10X. This is to avoid a bug in After Effects where it will sometimes create fractional keyframe data if you have keyframes on every frame. As long as the framerate of your comp matches the framerate you typed into Commotion's export tracker dialogue, the data should paste in properly. (i.e. don't worry if you type in a framerate of 24 and in the clipboard it reads 240).

Also in After Effects, it is important to note After Effects does not recognize clipboard data when it is first launched. This means, that unless you have Commotion and After Effects running simultaneously when you export tracked data to the clipboard, After Effects will not recognize the data. You just need to "copy" the data once After Effects is open to let it see it. You can also do a straight "save" of the tracked data in Commotion to After Effects format. This will automatically create a text document of the data - saving you a step.

When exporting data to After Effects as stabilized data (anchor point keyframes, not position), the frame the stabilization will be locked to the current frame in Commotion, at the time of export.

### Composer

Allows data passable to Alias Composer®

### Flame



Allows data passable to Discreet Logic Flame® or Inferno® systems.

#### Scitex

New with Scitex 2.2, the ability to bring in and apply motion tracked data- and see the results in realtime on the Spherous!

#### Generic Text

This saves out the data as numbers in a generic text form. This makes it easy to load into things like a spreadsheet program or if you have special format needs to write a conversion program.

#### 3D Pan and Tilt

This format is to pass data into Electric Image®. For info on 3D Pan and Tilt, read the "3D Pan and Tilt Read Me" included with Commotion 1.5 and higher Contact us if you do not have this.

#### Effetto Pronto

Saves in a format readable by this powerful hardware, software solution. Very similar to the After Effects format.

## **Applying The Data Inside Commotion:**

In Commotion, tracked data can be applied to rotosplines, SuperClone sources, or AutoPaint strokes. Tracked data can also be used to stabilize shots inside Commotion.

### Rotosplines

After tracking, users can apply the data to a spline or group of splines. This is very useful, for example, if you are rotoscoping something that's overall shape does not change that much - but is still moving in the shot. In the "Boat" tutorial on the Puffin Designs Demo CD there is an example of this. A boat is moving across the frame. A few points are tracked on the boat, and then the tracked data is applied to the spline(s) for the boat. The splines were only drawn on one frame. As soon as the tracked data is applied, the splines move in synch with the boat. Without a motion tracker, the roto artist would have to go in frame-by-frame and alter the spline to match up with the boat. This is one example of how a tracker can save you hours of time.

You could also track multiple points of an object, and apply them to select nodes of a spline for more detailed rotospline/tracking integration.

### SuperClone Sources

By applying tracked data to superclone sources, it is possible to make the superclone source move in position, as well as rotate and/or scale. This feature can be used to track an object wanted to be removed from a shot, and then applying that data to a "clean plate", and then AutoPainting the object out, as it automatically follows your stroke.

### AutoPaint Strokes

Tracked data can be applied to AutoPaint strokes to makes them move in position, rotation and/or scale also. This can be used to create a wide variety of effects.

Be sure to check out the "AutoPaint Tips and Tricks" PDF on our website for more info about AutoPaint, and how you can apply tracked data to your strokes.

### Stabilize

In Commotion, users can also Stabilize their shots after tracking. The Stabilize button is found on the main Motion Tracker palette. Stabilizing a shot applies the inverse data of the motion tracked, and is used to get rid of camera shake and other unwanted motion in a shot.

Another example where one might stabilize an image is when trying to roto or paint an object in a shot where the camera is moving. By stabilizing the shot first, it will become easier to roto or paint out as the object will now be still. Afterwards, the motion can be added back. This process involves exporting the data to After Effects, and rendering the clip there.

## **Tips and Tricks:**

### **Production Tips:**

If planning to do motion tracking in post production, you may consider putting in hi-contrast or color markers in the scene where you want to track. Tennis balls, for example, have been used as markers. Colored tape can also be put on actors clothing or limbs for certain types of tracking.

Avoid obscuring the markers or areas you want to track.

Try to keep these in focus (i.e. anything that can be done to make these stand out and be easily readable will improve your tracking).

These markers can be removed later in Commotion if necessary.

A real scene typically has a lot of depth, so things are moving at different speeds. A wide angle lens will cause distortion, especially toward the edge of frame. This is why it's important to try to track a point near where you want to lock to.

### **Stabilizing:**

If you're stabilizing an image then use a point as far away in the scene as possible (toward the horizon). If you're planning to lock an object to a scene, track at the point you want to lock to or as close as possible to the area.

### **Color Correction:**

When tracking, it is important to remember all you are trying to get is an accurate track of an object or camera move. Often the track can be made much easier if the some basic image adjustments are performed. For example, adding contrast to a washed out shot or altering the color of a shot, may make the track that much easier. When you are done, you can simply reload, or revert, to get back to your uncorrected clip. If you're going into After Effects or another application, you only need to save your tracked data. When you go to the other application, you will just load in your original clip.

### **Tracking on scaled clips or subwindows:**

When tracking in Commotion, you have the option of tracking a clip brought in as a subwindow, or a clip that has been scaled down. The advantage of this being that you can load in more frames in RAM, and get a faster and more accurate track.

After the track, the data can should be saved in "Commotion" format. Load at least one frame of the clip in its original size, and then load in the saved tracker.

Commotion will detect this and give you several options to scale the tracked data to accurately match the clip. When working with subwindows, it is important to choose the first option "keep same size" to make it work properly. When scaling, the options should apply, just as with rotospines.

### **SubPixel Accuracy**

When using the Tracker in Commotion, it is important to understand that although it is capable of tracking pixels at subpixel levels of up to 1/256, you will not be able to see that level of accuracy with the crosshairs when viewing the clip at 1:1, as this view is only capable of showing the crosshairs moving on a single pixel level. Said another way, if you are viewing the image at 100%

(1:1) magnification - you cannot adjust things on a subpixel level because the results cannot be displayed in any resolution above 1 pixel. If you zoom in, the tracker rectangles can in fact be placed on a subpixel level. In all cases internally, the data is subpixel and any rendering will be done at the subpixel level.

#### Tracking Options

And finally, we have said it before but it is worth repeating: make sure to try a few different settings in the tracking options if you are having difficulties tracking an object. Experimentation is often the key to success.

Happy Tracking!

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