Multiple Particle Tracker

January, 2009

This is a beta release of version 1.7 of the particle tracker. Any issue, bug report or suggestions may be made on the forum address: http://ecovision.mit.edu/~ecovision/forum/viewtopic.php?f=6&t=7.

There is no absolute or implied warranty with the software. Please feel free to share it widely and critique it generously. Your feedback and suggestions will help us improve this software enormously.

The particle tracker (*ptrack v1.7b*) is designed to track multiple particles in stark contrast against a background. The particles may be brighter or darker than the background. The tracker can track up to 30 particles and be aware of up to 40 detected segments in the image. In release 2.0, these numbers may be revised up after incorporating the feedback you give us as you test and use the software.

The tracker can detect segments in an image by looking for contrast and motion. In this beta version, motion cues have been turned off so that we can test performance over a wide range of velocity scales without worrying about sampling issues.

Required Hardware

You will need

(i) A PC running XP or windows Vista, with at least 1GB RAM and 1GHz 32-bit or faster processor

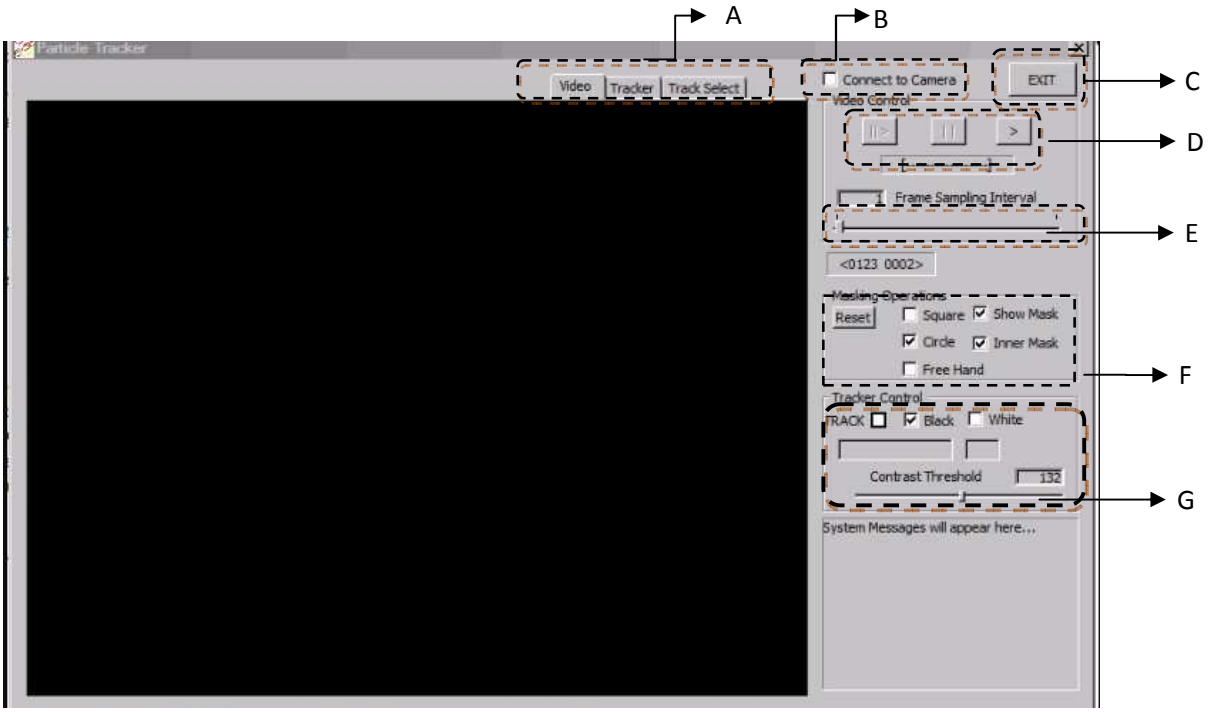
(ii) A video acquisition device (also known as *framegrabber*), which may be connected to one of the interface ports of the computer including USB, Firewire or PC-CARD slot (and its variants). The framegrabber must support a video-for-windows mode.

How to install the Software

You can download the particle tracker from the web page http://ravela.net/particletracker.html as an executable. It is self extracting and will by default create a folder called *ptrackv1p7b*, in which there are two program icons of interest. The first icon is *vfw* and the second is *ptrack*. You will need both to setup and run the tracker, as we now describe.

How to run the Software

1. Launch the icon *vfw* (or shortcut to *vfw*) and use it to connect to the camera. Please ensure that your camera connection is set to **no compression, 24-bit color scale, with 640x480 or 320x240 image resolution (the former is preferred)**. Once you are able to preview the video in *vfw* in this mode, you can be confident that the camera will interface with *ptrack*. This configuration step is typically necessary once per installation of your *framegrabber* (such as a USB device, once per slot).
2. Quit vfw and launch *ptrack*. You should see a screen that is similar to the image below.



3. The following guide explains the options available to you:

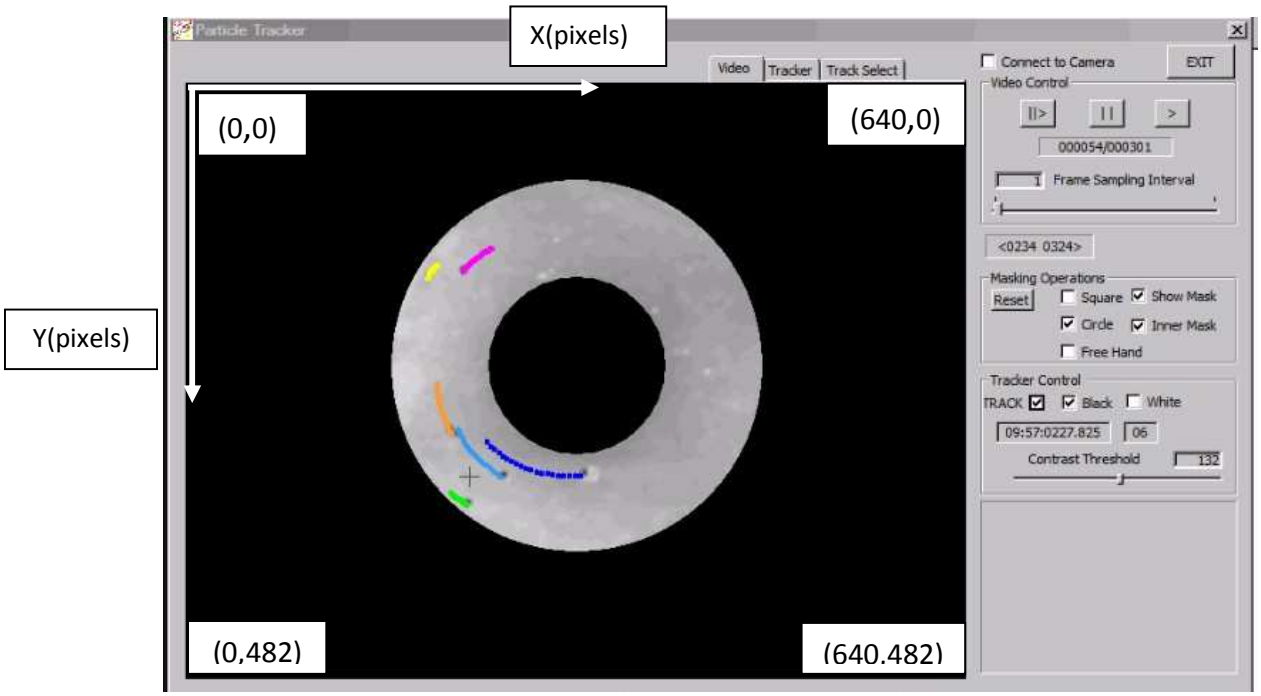
   A. The *Video/Tracker/Select Track* tabs allow you one of three views. These are: a look at the raw *Video* with track overlays, a *Tracker* view depicting detected segments and tracks (when the tracker is turned on), and a *Track Select* view, which depicts the track selected for saving in a file.
   B. *Connect to Camera*: This option allows you to connect to an available acquisition device (video) and uses the video for windows (*vfw*) interface to do it. If you've successfully connected, the main pane in Video tab (now black) will show a live video.
   C. *Exit* the application any time using this button (duh)!

D. When unconnected to the camera, you can use the *play* (>, right) button to play an avi file. The avi file must be uncompressed, 24-bit, 640x480. The *pause* (||, middle) button can be used to pause the video and the *step* (||>, left) button can be used to step one frame at a time, which is a useful feature to step through the tracker and understand how it works (or fails).
E. The *Frame Sampling Interval* option determines the number of frames that the tracker skips, which is useful for very slowly moving particles when the motion cues are turned on. You can ignore this feature in this beta version.
F. The *Masking Operations* section of the tracker allows you to create masks. By selecting an appropriate check-box, you can create square masks or circular ones and paint a free hand mask if you wish. By checking the inner mask check box, you can create an annulus that masks out regions outside it. This is useful for certain experiments. The left mouse button allows you to reposition the centers of the square or circular masks.
G. The *Tracker Control* section allows you to run the tracker. By selecting the *TRACK* checkbox detected particles are tracked over successive frames. If you are using the offline mode by running the tracker on an AVI file, then you may step through individual frames if you wish (see step D). The *Black* or *White* checkboxes allow you to specify whether the particle is darker or brighter than the background and the *Contrast Threshold* slider allows you to set a relative threshold for classifying a pixel as black or white. It is best to adjust the tracker in the *TRACK* mode (i.e. while tracking particles) whilst looking at it in the *Tracker* view (A).

Mouse Moves

1. Left mouse button (click and drag): This can be used to adjust the radii of the inner and outer masks.
2. Left mouse button (double-click): By double clicking the left mouse button, you re-center the square or circular mask to the clicked position.
3. Right mouse button (single-click): Clicking the right mouse button provides several options, including:
   - Selecting a track for saving to file.
   - Clearing the logs and reinitializing the tracker.
   - Exporting a picture of the current tracker state to the clipboard.
   - Setting up the path to the directory where the data file is saved.

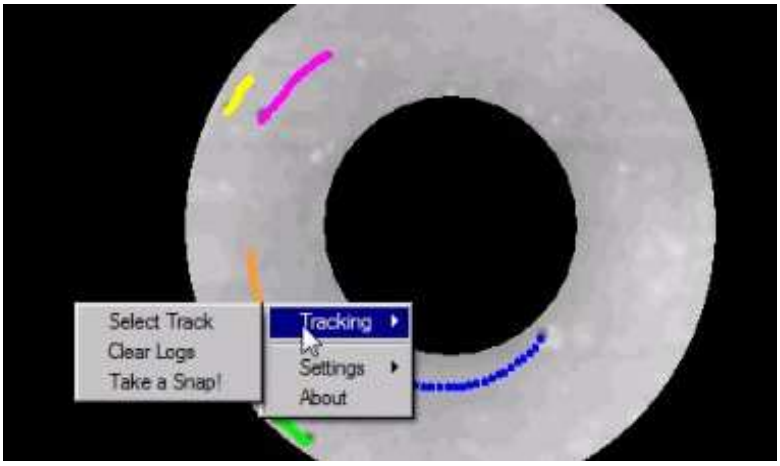
These are discussed next.



The above figure shows the state of the tracker as it runs a video file (a simple test file is provided with the software). Notice it is at frame 54 out of 301 frames in the video. The contrast is at the default value of 132, by selecting an inner mask, we choose an annular workspace. Black particles are being tracked and in this frame *ptrack* shows having detected 06 particles in the video tab-view.

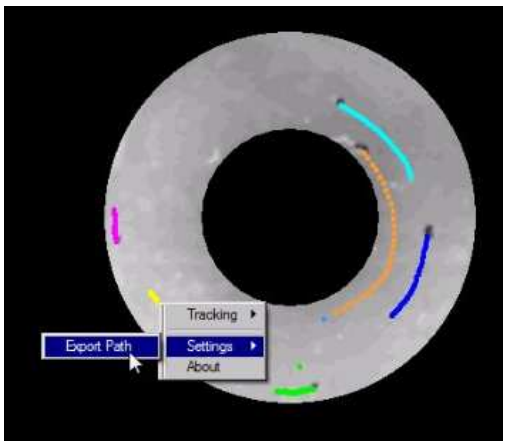
Also shown are the (X,Y) coordinates in pixel units with, by convention, X increasing to the right from 0 to 640, Y increasing down from 0 to 482. The tracker yields the coordinates of points in (X,Y) pixel space – see below.

Conversion to physical units can readily be made in post-processing by noting the physical dimension of the field of view and its corresponding pixel dimension and calculating the conversion factor.



Shown here are the menu options obtained by selecting the right mouse buttons and the sub-options for the tracking items. The *Select Track* option selects the track on which the mouse was clicked. The *Clear Logs* option clears the tracker state (it assigns colors afresh). This option is useful when the tracker becomes cluttered with particles either due to false detections or having too many of them. The *Take a Snap* option

allows you to copy a picture of the current state on to the clipboard, which can be pasted into a word-like document.



Under the S*ettings* option, the *Export Path* sub-option allows you to set the directory where the tracker saves its tracks when you use the *Select Track* option, as shown above. The default is the '*My Documents*' directory. Here, the tracker saves a file with a name that looks like:

The name includes the date, hour and second when you launched the current *ptrack* session. Within this file, you will find tracks listed as follows:

$NEW TRACK *This indicates the start of a new track.*

HR	MIN	SEC	MSEC	X(px)	Y(px)	*Time (hh mm ss mmmm) and Position (x, y in pixels)*
09	57	21	0432	0209	0247	
09	57	21	0772	0208	0244	
09	57	22	0103	0208	0242	
09	57	22	0314	0208	0239	
09	57	22	0541	0208	0236	
09	57	22	0797	0208	0234	
09	57	23	0028	0208	0232	
09	57	23	0266	0208	0229	
09	57	23	0508	0208	0227	
09	57	23	0754	0209	0225	
09	57	23	0992	0208	0223	
09	57	24	0285	0209	0221	
09	57	24	0488	0209	0219	
09	57	24	0720	0210	0217	
09	57	24	0939	0210	0215	
09	57	25	0249	0211	0212	

$$END TRACK *This is the end of a track*

If you select multiple tracks, one after the other, they are simply appended. The individual fields are tab separated and records are delimited by a newline/carriage return, so you can read this into most data processing programs (such as MATLAB or EXCEL).