Motion Analysis Using Tracker.jar

Recently, we have been looking at analysing motion using video clips from digital cameras. *Tracker.jar* is a free motion analysis application written by Doug Brown of Cabrillo College, California. It can be downloaded here:

http://www.cabrillo.edu/~dbrown/tracker/

This site also has links to two other free applications that you may need to download in order for *tracker.jar* to run, namely *Quicktime 7* and *Java 1.5* (or later). Many computers have these installed as a matter of course. Doug Brown's site also has downloadable sample videos.

Tracker.jar cannot presently read the video files created by the camcorders we have been giving away at SSERC courses. It requires video clips in the *avi, mov* or *mp4* format. The simple test is that if the video can be played with *Quicktime*, it can be analysed with *tracker.jar*. Fortunately, even if your camera produces videos that do not run in *Quicktime*, you can download a free, easy to use converter from www.stoik.com. Its use is described in a separate handout available from our website [1].

In a nutshell, *tracker.jar* allows you to import a video of a moving object and to track the motion of a point or points on the object, frame by frame. The software can graph displacement, velocity, acceleration and more. Think of it as a 21st Century version of strobe photography. Whilst you would be unlikely to use *tracker.jar* to work out the value of *g* to 3 decimal places, it is superb for teaching velocity/time graphs and for analysing motion in two dimensions. There is far more to this resource than we will cover here. If you do use some of its other features, please feed back your experiences to SSERC (gregor.steele@sserc.org.uk).

Starting Tracker

When you start *tracker.jar* you will see the following screen:

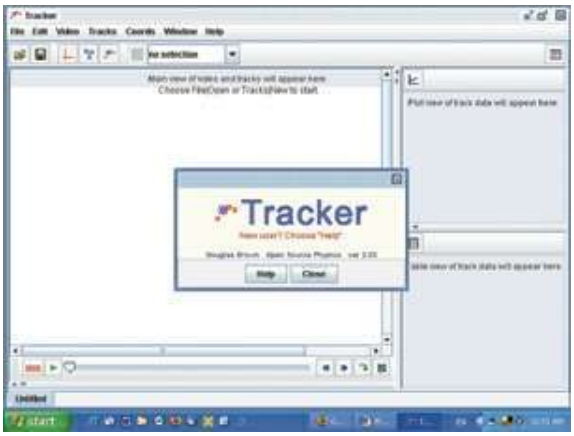

figure 1: tracker main screen

Click ***Close***, which closes the window that offers help, not the application. The first thing you must do is to import a video into *tracker.jar*. Choose ***Import***... from the ***Video*** menu.

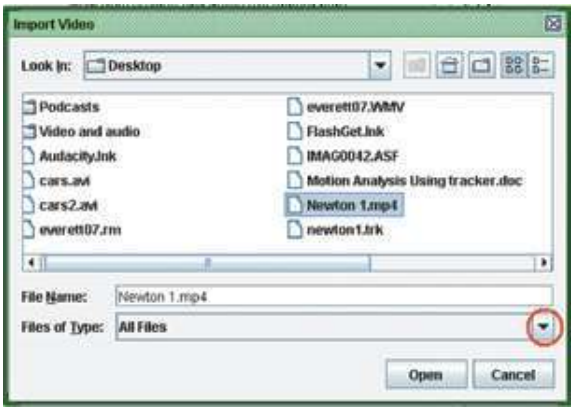

Figure 2: importing a video clip

For some files, you may have to use the arrow on the ***Files of Type*** box (circled in red above) to select ***All Files***.

Click the name of the file, e.g. Newton 1.mp4 you want to import, then click ***Open***.

Your video will then be loaded into *tracker.jar*.

Figure 3: video loaded into tracker.*jar*

The clip can be played, paused and so forth using the standard controls at the bottom of the screen.

The forward and rewind buttons advance the movie one frame at a time.

Important Note on Saving

Saving a file using ***File. Save As.*** produces a file with the *.trk* file extension. Two important points are:

Double clicking this file does not open up *tracker.jar.* These files can only be opened via *tracker.jar*.

.trk files are useless without the original video file.

[1] Stoik help sheet –
http://www.sserc.org.uk/members/SafetyNet/bulls/225/video_conversion.doc

Before analysing the video, we need to be familiar with certain controls:

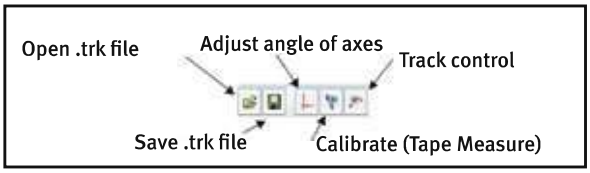

figure 4: tracker controls

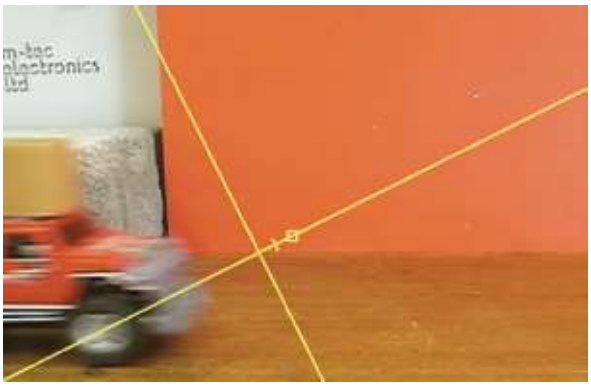

Figure 5: adjusting the axes

The ***axes button*** allows you to position the origin and to adjust the angle of the axes, very useful if you are dealing with motion down a slope.

Figure 6: the tape measure

Clicking the ***tape measure button*** (Fig. 6) reveals a double-headed arrow. This can be positioned alongside an object of known length on the screen, for example a ruler. The ends of the tape measure can be dragged to the ends of the ruler. The number (in scientific notation) alongside the tape measure can then be edited. For example, the tape measure could be placed alongside a 15 cm ruler in the video. Note that when the number alongside the measure is edited, 15 will be displayed as 1.500E1.

If all you are interested in is the shape of motion graphs, there is no need to use the tape measure.

Clicking the track control button produces this window:

Figure 7: tracker controls

To track: Click ***New***.
From the menu that appears, choose ***Point Mass***.

You will then see a message telling you to use Shift + Click to mark the mass. You may have to use your video controls to move through the video to the point where you want to start marking.

We made our own NCAP-style stickers to give us handy reference points.

Shift-click on a point on the moving object. The video will then move to the next frame. ***Shift-click*** on the same point. As you mark, a displacement/time graph appears on the right.

figure 8: tracking a point

Double click the graph to make it larger.

Left click the quantity on an axis to change it, *e.g.* to graph velocity instead of displacement.

Right click a quantity to change the scale. This is quite important: *Tracker.jar* autoscales, so a velocity/time graph will default to displaying between a maximum and minimum value. A fairly constant velocity could thus appear to be wildly varying.

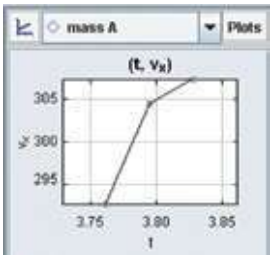

Figure 9: An autoscaled graph

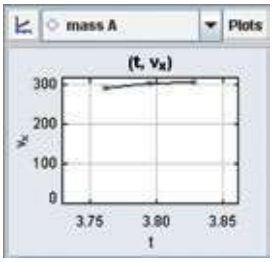

Figure 10: Same graph but with velocity origin set to zero

Top Tips

- Use as plain a background as possible
- Use an object that contrasts well with the background
- Use a tripod
- Fast moving objects in video frames are blurred. try to track the same spot on the blurred object in each frame
- Put a sticker on the moving object to help with tracking •

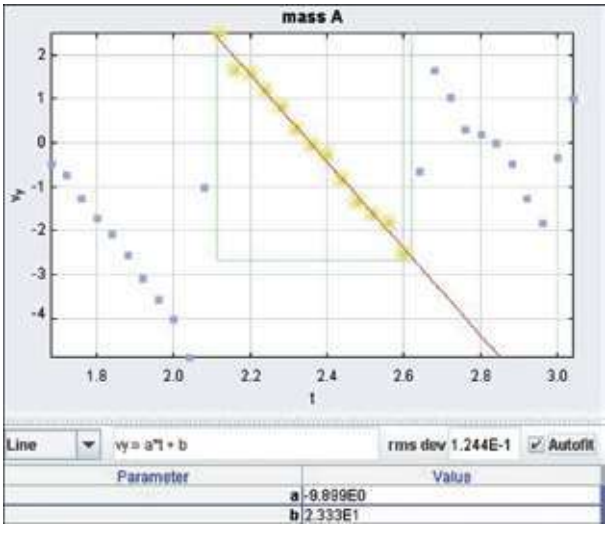

Figure 11: Vertical velocity of a bouncing ball