

Tracker revisited

The free, open-source Tracker software package, written by Doug Brown of Cabrillo College, has been a favourite of ours at SSERC for over a decade. Indeed, we first wrote about it in 2008 [1]. Tracker is many-faceted, but at its core is the ability to analyse video and still images. Students working at home could perform meaningful practical work using the application.

In this article we will cover the following:

- Uses of Tracker.
- How to run Tracker in a browser (including on a Chromebook).
- Alternatives to Tracker.
- Learning more about Tracker.

What we will not be doing is guiding you step-by-step through the package. We have material available online for that purpose. You can even take part in self-study professional learning on the topic.

Uses of Tracker

Linear motion analysis

Create motion graphs by following a moving object from frame to frame in a video (Figures 1a/b).

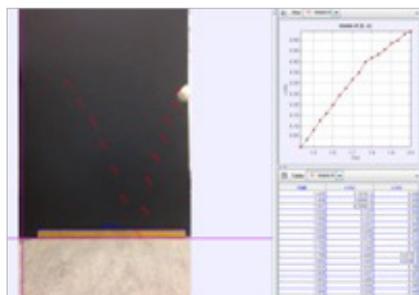


Figure 1a

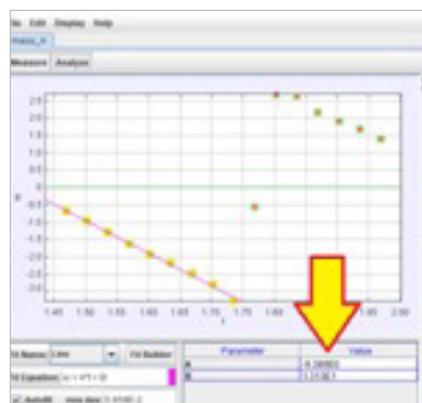


Figure 1b

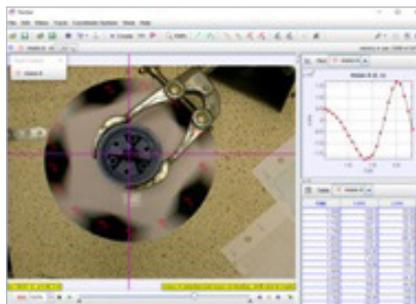


Figure 2a

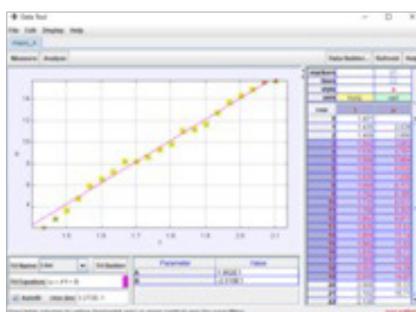


Figure 2b

You can replay the video and see the corresponding point on a graph highlight as the object moves.

Best fit lines can be plotted and gradients calculated.

Tracking can be performed automatically if the moving object is well-defined against the background (though where's the fun in that?).

Rotational motion analysis

Rotational motion can also be analysed. The experiment shown involves plotting angular velocity

against time and subsequently finding the angular acceleration when various constant torques are applied (Figures 2a/b).

Line profiling

Here we have taken a still image of a double slit interference pattern and used Tracker's line profiling tool to scan the pixel intensity across the photograph. We see that the intensity of the light and dark bands is modulated by the envelope of a single slit diffraction pattern (Figures 3a/b).

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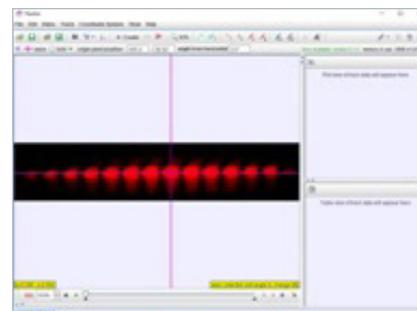


Figure 3a

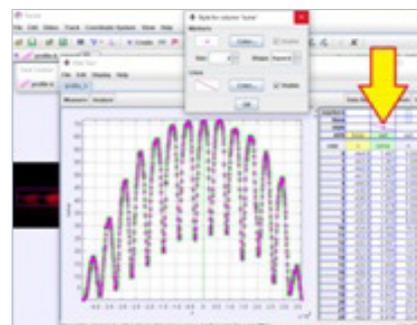


Figure 3b

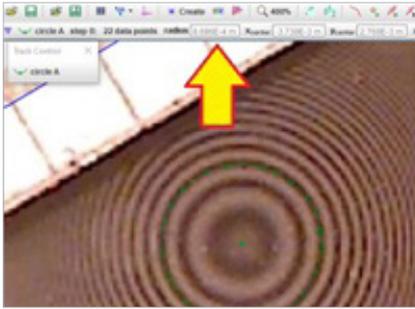


Figure 4a



Figure 4b

Radius of curvature

This is a Newton's Rings pattern photographed using a digital microscope. If we click on various points on a ring, tracker can fit a circle to it and work out the radius of curvature. We have also used it to work out the radius of curvature of the lens in the Newton's Rings apparatus (Figures 4a/b).



Figure 5a

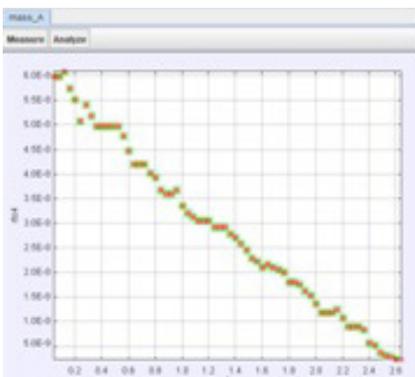


Figure 5b

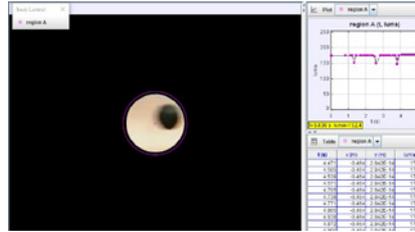


Figure 6a

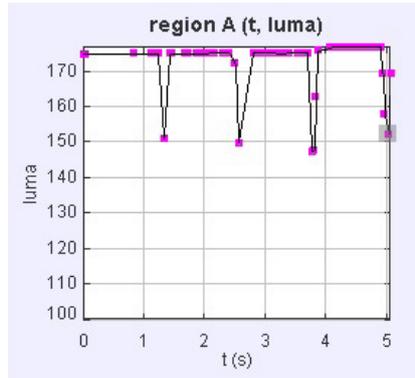


Figure 6b

Define your own variables

When a soap bubble deflates through a capillary tube, a graph of radius to the power 4 versus time should be a straight line (Figures 5a/b).

Tracker lets you define new variables such as 'rt04' in terms of existing quantities.

(This experiment can be used to determine the viscosity of air)

Modelling exoplanet detection

Here we have filmed the bob of a conical pendulum passing in front of a lamp (Figures 6a/b). When we analyse the variation of the brightness of a group of pixels with time we get a graph just like that obtained by the transit method of exoplanet detection [2].

How to run Tracker in a browser

There are versions of Tracker for Windows, OSX (Mac) and Linux [3]. At this point, we can almost feel the frustration emanating from some of you. We know that getting software installed on school computers can be difficult. We are aware of one department that took pendrives home and installed Tracker directly

on to them. Tracker could then be run from the pendrives when they were inserted into school machines. This does not work for every school. Furthermore, many schools have now moved to Chromebooks (Figure 7).

The following solution may work for schools where either Chromebooks are in use or installing software on laptops and desktops is not possible. It has its limitations but we have had some success with it.

Visit the Rollapp website [4]. Rollapp allows certain applications to run in a browser, including Tracker and another physics education favourite, Audacity. If you opt for the free Rollapp service you will encounter the following limitations:

- You cannot save your work (surprisingly not such a big deal as far as Tracker is concerned, in our experience).
- Uploading files to analyse is a bit of a pain.

When you go to the Rollapp Tracker page you will see a button marked Launch Online (Figure 8).

You will now be taken to a screen that gives you the option of signing up or logging in. If you haven't signed up beforehand, you'll have to do that now. >>

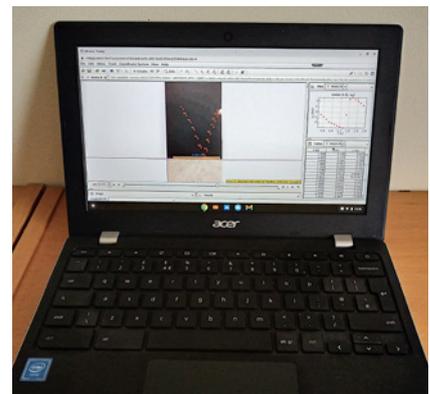


Figure 7 - Tracker on a Chromebook.



Figure 8 - Launch Online.

Once you have signed up and logged in you may be met with a screen that entices you to upgrade to a less limited version of Tracker. Ignore this and click on Launch Tracker with limited capabilities.

Normally, to analyse a video or image in Tracker you would go to the menu Video and select Import (Figure 9)

You would then navigate to that file on your computer. With Rollapp, you need to upload the file first. When you select Import... you should see a pop-up (Figure 10).

Look for the wee dots (see the arrow in Figure 10) and hover your mouse pointer over them (Figure 11).

Select the icon indicated by the arrow in Figure 11.

You will then be able to navigate to the file on your computer that you would like to upload. Once uploaded, it is placed in the LocalSync folder. If it's an image rather than a video file, you may have to use the drop down arrow to the right of Files of Type: Video Files to see it. You can also link cloud storage such as Onedrive or Google Drive to your Rollapp account. We did so with Google Drive, but set up a bespoke account solely for use

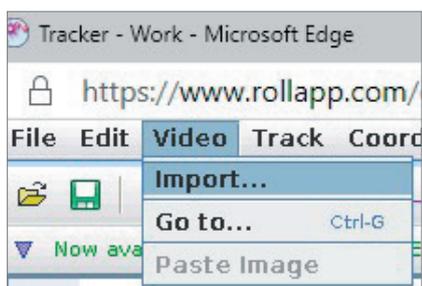


Figure 9 - Go to menu Video and select Import.

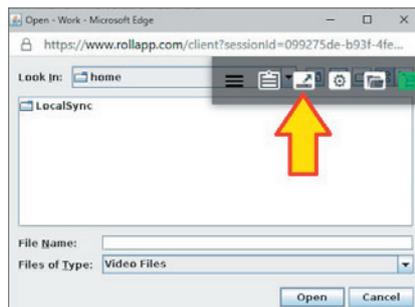


Figure 10 - Select Import to see the pop-up.

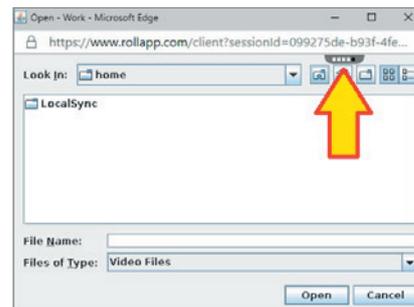


Figure 11 - Select the icon indicated by arrow.

with Rollapp as the permissions the platform was asking for made us emit an abrupt squeak.

At the end of this article we will tell you how to find out more about using Tracker.

Alternatives to Tracker

If you have an Android tablet or phone, or can run Android apps on your Chromebook, you might like to check out a motion analysis app called Vidanalysis. It is not as sophisticated as Tracker but is still useful, especially if you can use a mouse or trackpad rather than a touch screen with your device.

For iPad users, there is Vernier Video Physics. This is a paid-for app that is reasonably slick. You can find out more in our apps guide [5] or by signing up to our Mobile Devices self-study course [6].

Learning more about Tracker

You can find out how to carry out many different activities by working through the documents on our Tracker section of the SSERC website [7] or you can sign up for a self-study course [8]. Feel free to share the materials with your students. Both the webpage and the course include sample videos and images. <<<

References

- [1] <https://www.sserc.org.uk/wp-content/uploads/2020/08/225-Tracker.pdf>.
- [2] https://en.wikipedia.org/wiki/Methods_of_detecting_exoplanets#Transit_photometry (accessed November 2020).
- [3] <https://physlets.org/tracker/> (accessed November 2020).
- [4] <https://www.rollapp.com/app/tracker> (accessed November 2020).
- [5] https://www.sserc.org.uk/wp-content/uploads/2013/07/All_apps_iOS_Droid.doc (accessed November 2020). Some of the apps, including the SSERC speed camera app, mentioned in this document are no longer on the Play Store. We may be able to help you obtain them. Please get in touch.
- [6] <https://www.sserc.org.uk/professional-learning/secondary-clpl/physics-clpl/mobile-devices-self-study/> (accessed November 2020).
- [7] <https://www.sserc.org.uk/subject-areas/physics/physics-higher/tracker-easy-motion-analysis-and-more/>.
- [8] <https://www.sserc.org.uk/professional-learning/secondary-clpl/physics-clpl/tracker-self-study>.