

Pursuit Tracking and Analysis

TrackAnalyze version 5 William T. Powers

With this program you conduct a pursuit-tracking experiment and then manually or automatically adjust the parameters of a control-system model for best fit.

TrackAnalyze5 is a program for carrying out pursuit tracking experiments and analyzing the results by matching a model to the data. The matching can be done by manual adjustment of the model parameters, or by letting an automatic procedure find the best match. The automatic matching method has been checked against the Powell optimizing process in the Ventana Systems program Vensim, by Robert Eberlein, and gives very nearly identical results.,

On starting the program, the window in Figure 1 appears (only a portion of the window is shown):

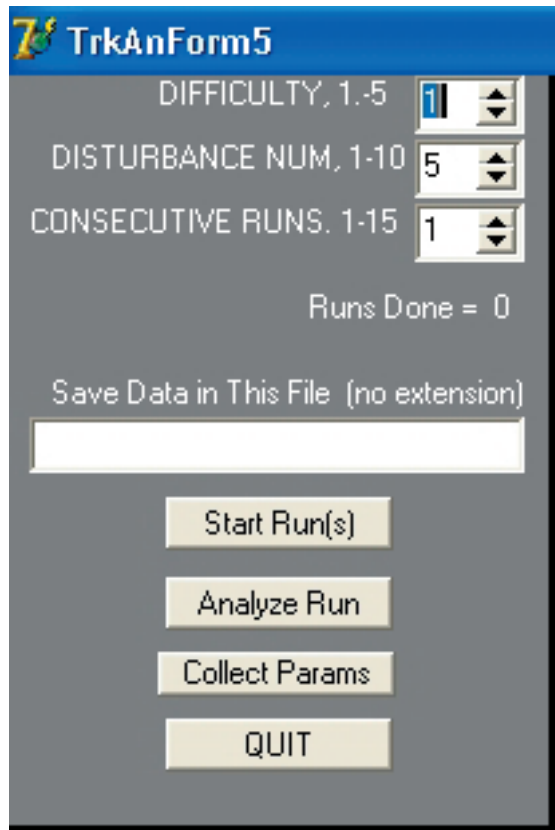


Figure 1: Starting TrackAnalyze

The first time this program is started, a set of disturbance tables is created, stored as the file “distable.” It contains 50 sets, 10 patterns at each of 5 difficulty levels. The disturbance and difficulty level can be selected in the gray window shown above.

If a new run is to be done, the root name of the file where the data are to be stored should be entered in the white rectangle (click on the rectangle, then type it in). Do not add any file extension; if you add one it will be ignored and removed. Leaving the rectangle blank will cause a file named “default” to be created just as if it had been typed in. Any number of runs can be saved in the file default, but if any other file name is used more than once, a window will appear asking for a different name to be entered. If you really want to replace the data in a file with an existing name, manually delete that file.

A set of consecutive runs with the same root name can be specified by setting the number in the “consecutive runs” box. If the root name is “bill”, the file name used will be bill_a.txt, bill_b.txt, and so on for the number of runs specified..

Clicking on “Start Run(s)” will cause a tracking run to start. The first three seconds are ignored, then a 60-second data recording begins. A pair of red lines appears on the screen, moving up and down, and a green line moved by the mouse (forward-back direction only) is to be kept exactly between the red lines. The appearance with a fairly large tracking error is shown below, Figure 2:



Figure 2: Large tracking error

When only one consecutive run is scheduled, at the end of the run the screen returns to its initial appearance. If multiple runs are to be done, the gray window looks like this, Figure 3:

If you click on “Next Run”, the next run will begin immediately with all the same settings. However, you can change the difficulty factor or the disturbance pattern, so consecutive runs can be done under changed conditions.

The model used is shown below in Figure 4:

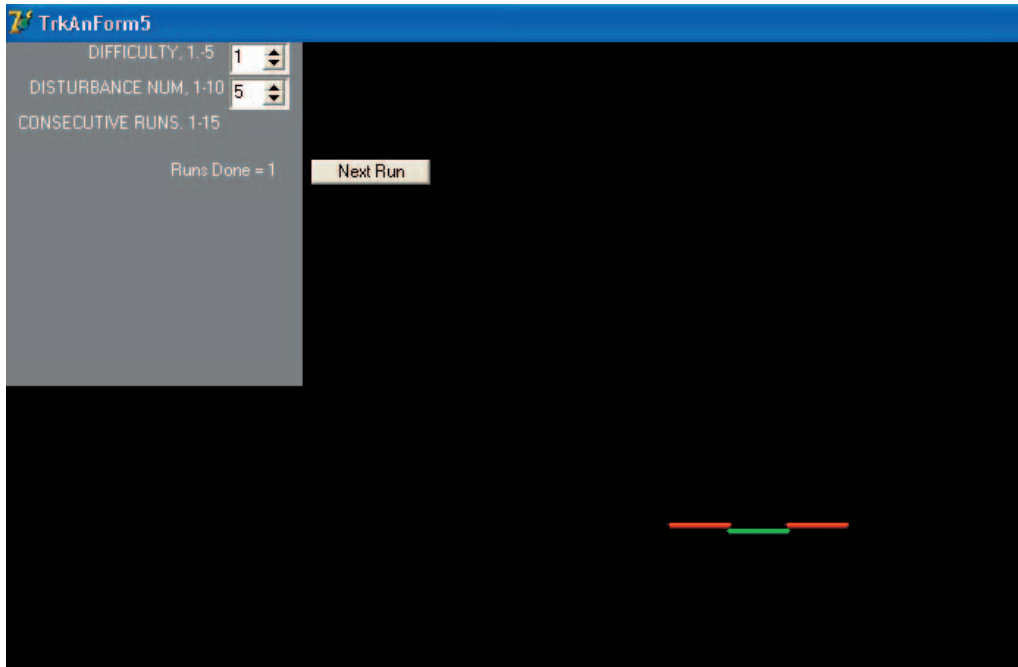


Figure 3: Ready for the next of X multiple runs

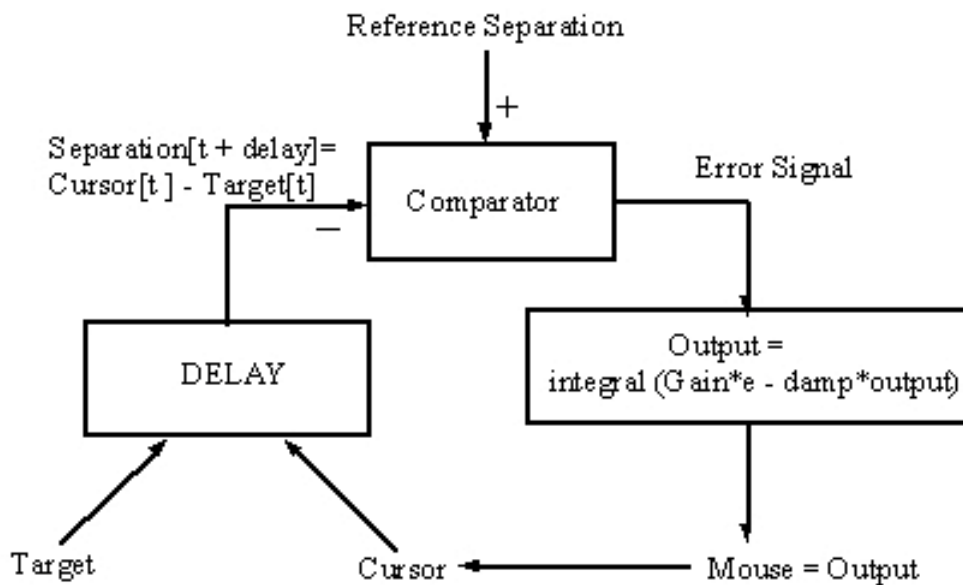


Figure 4: Model used in TrackAnalyze

The adjustable parameters are the delay, the reference signal, the output integrator gain, and the damping factor. The damping factor is the “leak” in the integrator. The output of the integrator loses some fraction of its value on every iteration, the fraction being any number from 0 to 1. This way of constructing a leaky integrator seems to permit better matching of parameters; there is less interaction between parameters than when using the more standard (for PCT) gain and slowing factor. The underlying form of the output function is the same.

When the last run of a series (1 or more runs) is done, the original screen reappears. You can now analyze the run to determine best values of the parameters. To start matching, click on “Analyze Run”. The result will be the file management screen as shown in Figure 5:

Click on the data file to be analyzed (default_a.txt if you didn’t enter a file name) and click on Open (or double-click the file name), to get the screen shown in Figure 6:

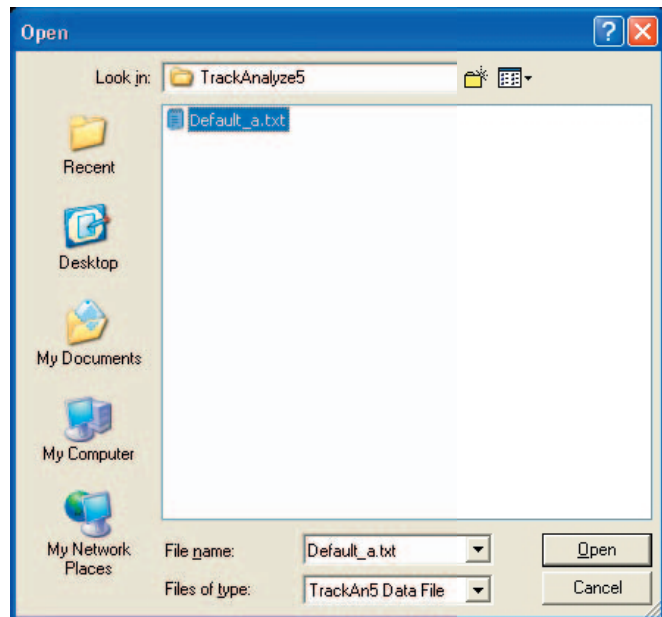


Figure 5: File management screen

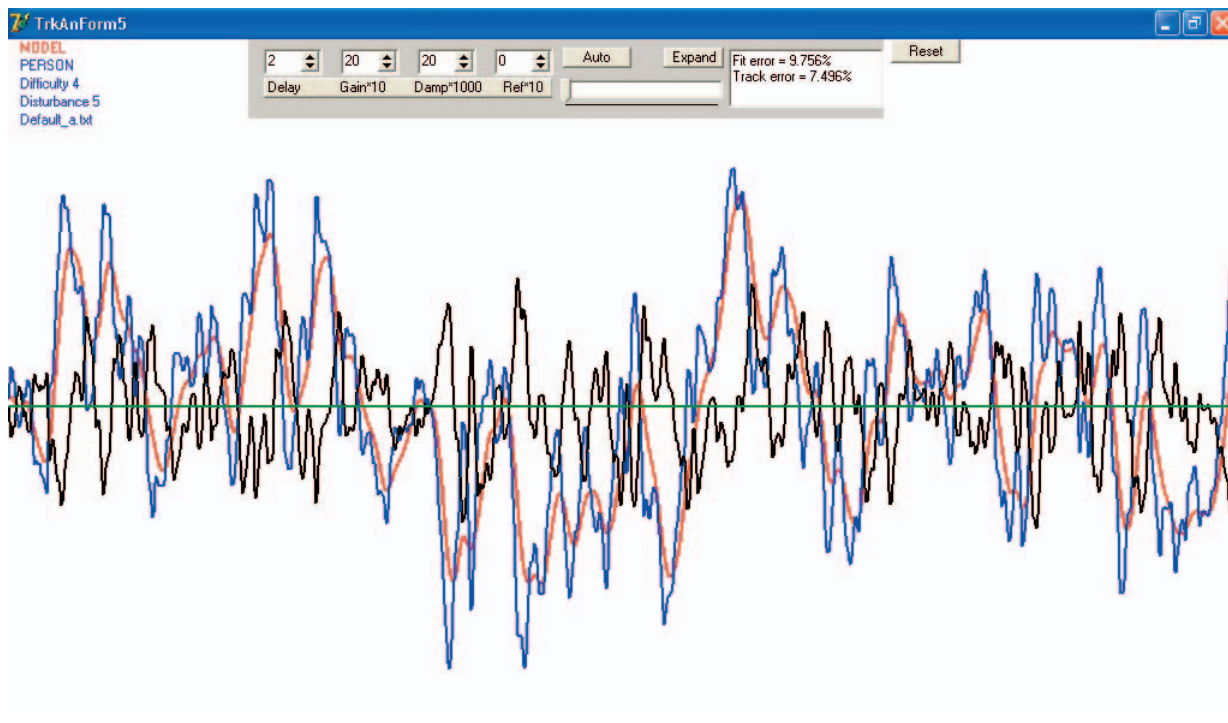


Figure 6: Record of mouse movements and model movements with default parameterse

Figure 6 shows the behavior of the mouse for the human controller (Blue) and for the model (Red) with a default set of parameters. You can adjust the parameters individually to get the best fit error (shown in a box to the right), or by clicking “Auto” you can

have the program find the best fit (recommended). The Expand button expands the trace to one pixel per 60th of a second, and the slider then moves the trace left and right.

The result of the analysis will be similar to the result shown in Figure 7:

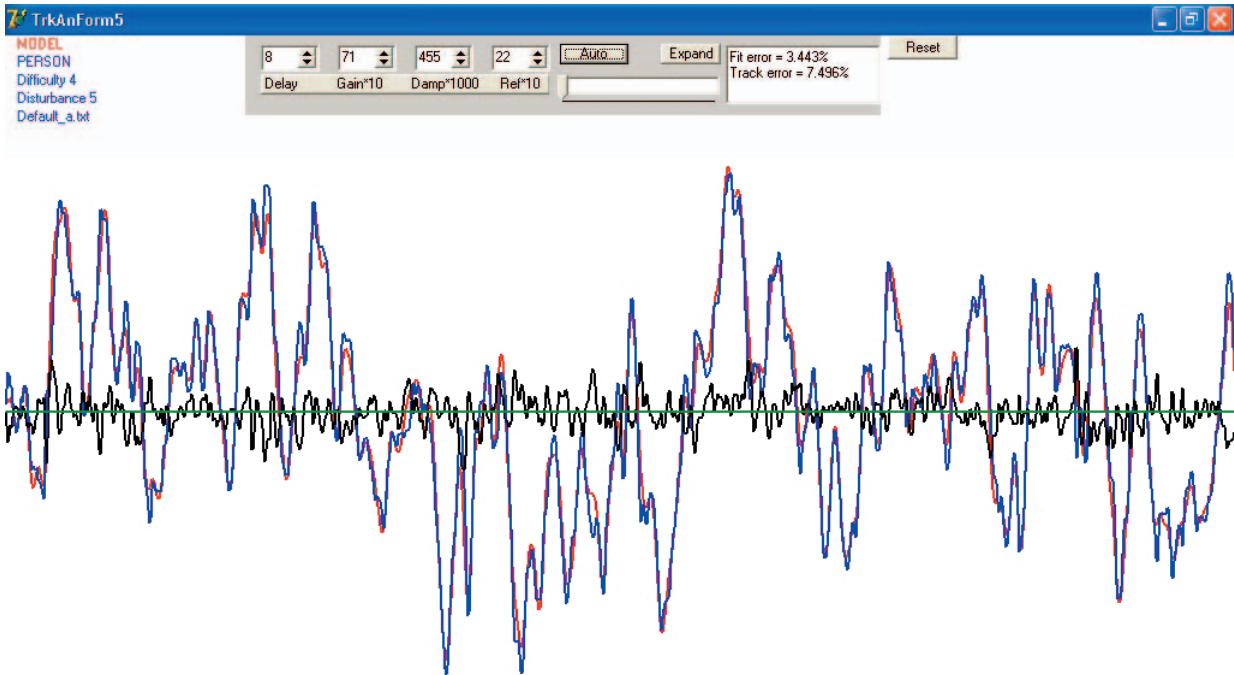


Figure 7: Result of parameter analysis: mouse movements and improved model movements

Notice that the model's mouse position very closely follows the human controller's mouse position. The black trace shows the difference. The "track error" is the RMS difference between cursor and target positions during the experimental run. The "Fit Error" shows how closely the model's mouse follows the real mouse. Both numbers are a percentage of the peak-to-peak range of real mouse movements.

Clicking "Reset" returns the original screen. Click on "Analyze Data" again and select the next data file to be analyzed, and repeat until all files have been analyzed.

Finally, clicking on "Save Params" will allow you to select a series of runs (click on any file name within the set). As soon as you click, all the parameter data

will be collected into a single text file with the root name and an extension of ".par" for parameters. For the series with "Bill1" as the root name (two runs, a and b), the data file "Bill1.par" looks like this:

```
bill1_a.txt, 5, 4, 7, 7.1, 0.488, 1.1, 3.392, 7.404
bill1_b.txt, 5, 4, 8, 7.0, 0.390, 2.2, 3.092, 7.255
```

The order is Name, Disturbance Number, Difficulty, frames of delay (at 1/60 sec each), Integrator Gain, Integrator Damping, Reference Level (in pixels relative to screen center), Fit Error, and Tracking Error (the last two as a percent of the peak-to-peak range).

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To standardize the experiment, two adjustments to your computer should be made. First, make sure the screen resolution is set to 800 x 600 pixels. This is done by selecting resolution as follows:

Setup in Windows XP:

Start | Control Panel | Display | Settings

Setup in previous versions of Windows:

Start | Settings | Control Panel | Display | Settings

Second, use Control Panel | Mouse to find the mouse speed adjustment. Set it so that moving the mouse pointer from bottom to top of the screen requires a mouse movement of 4 to 6 inches. This is an approximate setting; get as close as you can. It is annoyingly slow for normal use, as you will find when you finish with this program and have to restore the old mouse speed.