Revision date 2016 January 22

- - - - - - -

T P O I N T

- - - - - - -

Telescope Pointing Analysis Program

TPOINT (sometimes known as Pro TPOINT) is an interactive telescope pointing analysis system which runs on PCs under Microsoft Windows or Linux, and on other Unix platforms, including Mac OS X.

It allows data from pointing tests to be input and fitted to various models. The residuals from the fits can be displayed in a variety of graphical formats. If systematic errors are visible, the pointing model can be adjusted by adding and removing terms.

Patrick Wallace

ptw@tpsoft.demon.co.uk

+44-1235-531198

INSTALLING TPOINT ON A WINDOWS COMPUTER

The standard TPOINT Windows distribution comprises a .msi installation file plus a User Manual as a PDF file, supplied as a Zip file through web download. Execute the .msi file and copy the PDF file to a convenient place.

The application can be run via the desktop shortcut. But it is more convenient and flexible to add the distribution folder to the PATH environment variable, enabling the application to be run from any folder. This is accomplished as follows:

1. Start Control Panel and then double-click on System.

2. In the System Properties window, click the Advanced tab then the Environment Variables button.

3. Double-click the Path variable in the System Variables list.

4. In the Variable text box, at the end of the existing path, add the text:

```
C:\Program Files (x86)\Tpoint Software\TPOINT
```

(n.b. This is the default installation folder. If you installed TPOINT somewhere else, substitute the path you actually used.)

5. Click OK to save the updated PATH.

6. Click OK twice more and exit from Control Panel.

These settings will take effect when a new command window is started.

INSTALLING TPOINT ON A UNIX COMPUTER

The standard TPOINT Unix distribution comprises a compressed tar file, supplied through web download, that includes a makefile and all the files necessary to build an executable system.

The only pre-requisites are the Unix (or OS X) operating system itself and the Tcl/Tk package, which is used for graphics. To install the application:

1) Extract the contents of the compressed tar file to a scratch directory on the hard disk, and cd to the latter.

2) Invoke make. By default, the makefile will copy files to the directories $HOME/bin and $HOME/etc/tpoint, creating them if they do not already exist. If these destinations are not suitable, either edit the makefile, or alternatively use “make INSTALL_DIR=” to override the $HOME default.

3) Make sure the script tpoint and the executable tpt are in your path. (The makefile puts them in $HOME/bin by default.)

Should de-installation become necessary, type “make deinstall”.

TO RUN TPOINT

Go to the directory you wish to work from and type "tpoint". The system will start, and, over the next few moments, read in various script and catalog files. The appearance of the * prompt indicates that the program is ready to accept commands. To exit, type "end".

If the application fails to start, or if error messages appear during the start-up phase, or if the graphics commands fail to work, the things to check first are (a) paths, (b) the location and contents of the tpoint.ini and tpg.ini configuration files and, in the case of the Unix platforms, the existence location and version of the Tcl/Tk software.

As a simple demonstration:

1) Type "tpoint" to start the system. Wait for the * prompt.

2) Type "indat aat15" to read a sample data file (that contains authentic and unedited AAT data).

3) Type ".aat" to fit the standard AAT model.

4) Type ".e9" to plot nine assorted graphs of the residuals.

5) Type further TPOINT commands (for example "help"), or "end".

A MORE COMPLETE DEMONSTRATION

Start the package by typing "tpoint". The announcements refer to the internal star catalog (there to simplify the format of input data) and a procedure library. It is easy to have your own versions of these files, either read in automatically at startup time, or on demand during the run. Then type "help" to enter the hierarchical help system. Type "commands" to list all the commands that are available. Pursue any further paths through the help library that you wish, ultimately escaping by pressing return enough times (or CTRL/Z then return for a quicker exit).

The object of the exercise is to build a pointing model for the UK Schmidt Telescope at Siding Spring, NSW, Australia. The UKST is a 1.2m aperture wide field camera on a fork mount, designed for accurate autoguided tracking rather than blind pointing. Read in the pointing test data by typing "indat ukst". Each observation listed on the screen is the star name (in the catalog) and the RA,Dec synchro readouts.

Type “gscat” to show the uncorrected pointing on a plot like a "rifle target" where we want all the marks to be as close to the middle as possible. Type “gsmap” to show the individual pointing errors as a function of position on the sky. These are only two of the many ways of displaying the pointing residuals, many of which offer considerably greater diagnostic insights. A good selection can be obtained by typing “.e9”, which runs a preprogrammed procedure.

The basic model for an equatorial consists of six terms - two encoder zeroes (IH and ID), the displacement of the polar axis up/down and left/right (ME and MA), and the nonperpendicularities between the HA and Dec axes (NP) and the telescope and Dec axis (CH). Type “.equat” to select these six terms and “clist” to show that they start out zero before typing “fit” to obtain the optimum values. The RMS error is about 13 arcsec, already quite good.

Type “g x h” to show the east-west errors against HA. Note the indications of a systematic error - a steady slope. Shall we try to model it? Not yet - let's have a better look at the residuals. Type “.e9”, and see how the graph plotting Dec errors against HA shows where the trouble really lies. The strong systematic effect is due to fork flexure: the weight of the telescope makes the fork sag. We expect maximum sag to be on the meridian, affecting Dec only but to be the same for all Decs, while there should be no sag at HA 6 hours because the fork will distort in a parallelogram way. Hence we expect corrections of the form dDec = k*cos(HA) to be helpful. Such a term can be added to the model by typing “use fo” and then “fit”.

Note the dramatically reduced RMS, down to less than half its previous value. Look for further systematic errors by typing “.e9” again; there aren't any, so we have a final model - just seven terms.

In fact this manual modeling is seldom the first step as TPOINT contains an automatic modeling capability which often does better than manual fitting. Try typing “lose” to discard the current model, then “fauto”. The resulting model reduces the RMS still further, though at the expense of using a much more complicated model.

Data files from other telescopes are provided. Examine the pointing of the 3.9 metre AAT by typing “indat aat15”, “.aat”, “gscat”. The outer circle of the plot is 10 arcsec in diameter, less than a quarter the diameter of Jupiter's disc. The inner circle (marking the RMS value) is only about twice the diameter of the Galilean satellites.