Model Building utility for 10Micron mounts

Model Maker is a software utility that aids in the building of pointing and tracking models for 10Micron mounts. It has been extensively tested with GM1000HPS and GM2000HPS and should work equally well with the QCI series of mounts and the 4000 models as well as the new kid in the series, the GM3000HPS.

Model Maker repeatedly slews to different Az/Alt coordinates and exposes images at each. Each exposure is saved to a temporary file on your hard disk and is then plate solved by means of PinPoint. The result of the plate solve is then sent to the mount as a sync point.

Using Model Maker, the tedious task of creating a 100-point model for your mount is reduced to a couple of clicks and a warm cup of coffee. Once you start the process, it is fully automatic and will not require any user intervention.

Model requires .NET Framwork 4, MaximDL and PinPoint Astrometric Engine. Please note that the version of PinPoint that comes with MaximDL is not sufficient as it lacks programming interface. PinPoint is obtained DC3 Dreams Software (http://dc3.com).

NOTES!
Model Maker assumes and requires your mount set to use the J2000 coordinate system. My ASCOM driver supports using J2000 with on-the-fly conversion, even though the mount itself only knows JNow. The driver supplied by 10Micron will not work with Model Maker! Both drivers can co-exist without problem and have simultaneous connections to the mount.

Until a firmware release will correct a slight error in handling of Alt/Az coordinates, please refrain from using alignment points with Az of exactly 0° and 180°!

Features

Model Maker has evolved over a period of 15 months from a simple quick-and-dirty application to a full-fledged and robust application with good graphics. Models and terrain masks can be clicked into existence very quickly and the user interface is easy to use.

When Model Maker does its thing, the user interface is continually updated with progress information and details on the pointing errors that it corrects.
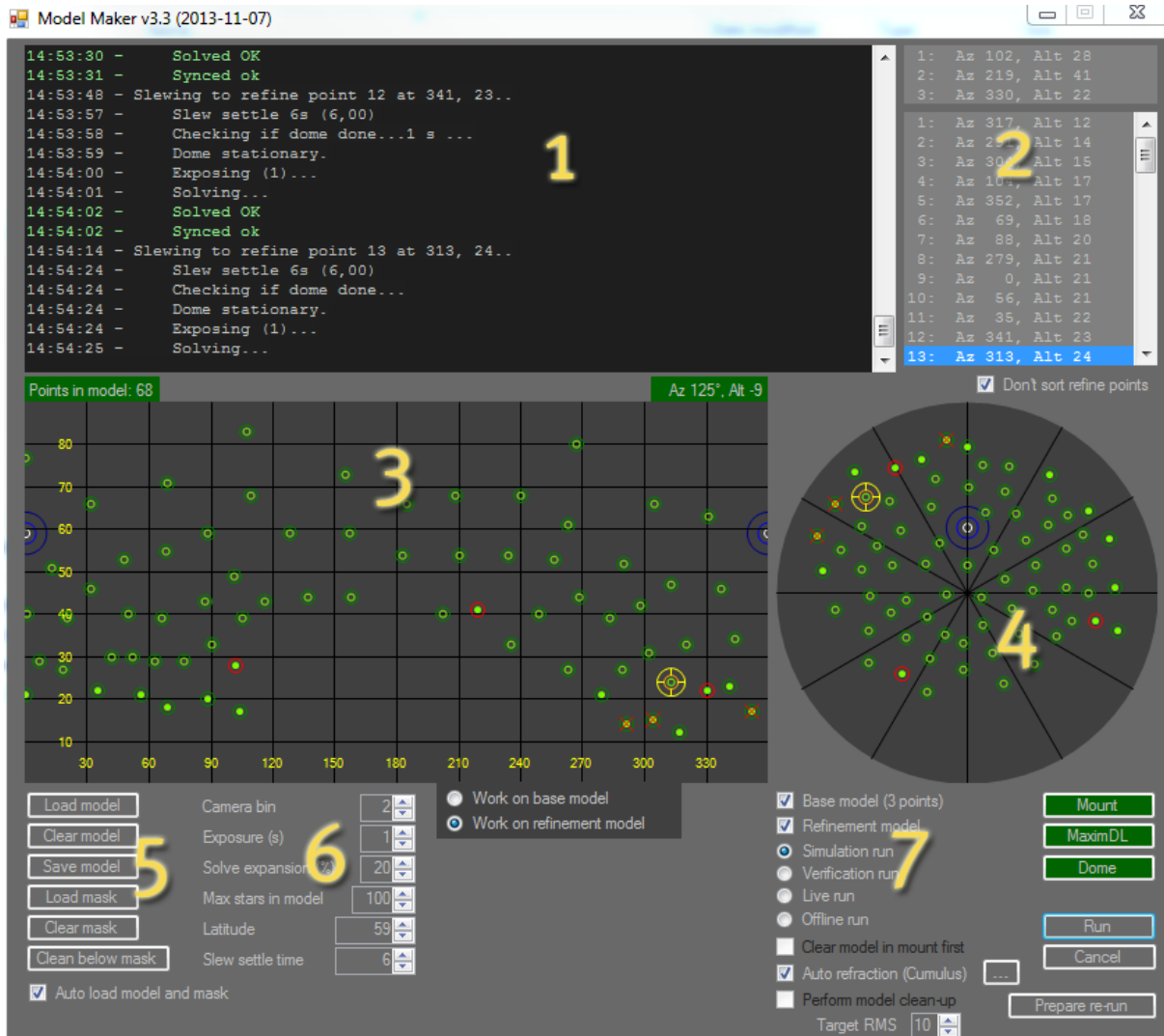
In addition to clicking models into existence, Model Maker also lets you save the points of the model to disk files so that you can have different scenarios available for quick implementation.

If you feel that you want to be thorough in your modelling, Model Maker also supports terrain masks that you create in order to not accidently create pointing coordinates that, for instance, points into your neighbour's bedroom window or a house wall.

The 10Micron mount firmware fully supports atmospheric refraction compensation, and Model Maker lets you update the parameters for the refraction calculations automatically from a standard weather station file if you have one. That way, your models are always correctly created.

The sync points are divided into two sets; one for three base points and one for the refinement points. The reason for the division is to force out three evenly spaced points initially and the let the rest of them be refinement points. This is in accordance with how the firmware works.

User Interface

1 – Log Window

The log window will list everything that happens after you start the application. Each entry is time-stamped to the second and is displayed in different colours depending of the severity of the entry.

Context (right-click) menu

Right-clicking in the log windows gives you the options of:

- Clearing the log window
- Saving the log contents to a text file
- Requesting a model report from the mount
- Removing the single mount point with the worst error value
- Graphing the model

- Recursive model optimization
- Force a non-default reference star catalogue path (GSC 1.1)

Mount model report

The model report from the mount includes all current model points and will be reported with Az/Alt and error. It takes a while to read and convert the model so be patient. Also the whole model is processed before anything is sent to the log window.

Removing worst point

This function will read the mount model from the mount and then delete the point with the highest error. A note of caution is appropriate here... After the deletion, the model is re-calculated in the mount, a procedure that changes the errors of all the points to new values. Therefore, it is possible that your expected RMS error will actually increase after the deletion. If your mount firmware is prior to the 2.10 series, a firmware bug will cause the mount to not re-calculate the model immediately. The best way to force a full re-calculation is, as of firmware 2.9.16, to enter the alignment info menu in the handset. After you have done that Model Maker will report the same RMS error as the handset. If your mount firmware is 2.10 or later, the model is correctly updated in the mount and Model Maker will show the same figures as the mount.

Graphing the mount model (Open Model Graph Window)

The mount model can be visualized in a polar graph with error colour coding. Note that the colour coding is from worst to best, so even a model with a very low RMS error will display red points. They are simply the worst points of that model, even if they happen to have an individual RMS error of just a few arc-seconds.

PinPoint reference catalogue

In previous versions of Model Maker, the GSC 1.1 reference catalogue was assumed to reside either in the default location (C:\GSC11) or in E:\GSC11. From version 1.9.1 and on, you can change the path. Make sure you point it to a location that corresponds to the required file structure and at the right level, or solves will fail.

Currently, only GSC 1.1 is supported, but I am working on allowing any PinPoint-supported catalogue to be used.

Log colors

Generally, non-essential information is displayed in a discrete grey tone. Yellow is used when the information is slightly more important. Green signifies successful events that are important to the operation, such as plate solves and syncs. Orange signifies errors that will affect the result of the run but are in no way a show stoppers. This includes missed solves and syncs. If the error is more hardware related it will be displayed in red. No errors will halt the program (as far as I know).

2 – Point list

The lists of points for both the base and refinement models are listed in these boxes. If you click a point in the list, the corresponding point will be highlighted in both maps. Correspondingly, if you hover over a point in one of the maps, the list item that represents that point will be highlighted.

3 – Orthogonal map

The map represents an orthogonal view of the sky with South in the middle. Base points are red and refine points green. As you run your model the points will change appearance according to the results. Hovering over the map will display the Az and Alt coordinates of the mouse pointer. Clicking in the map adds or deletes points. More about that later. The terrain mask is displayed in dark green and anything below it is in a no-no area. When your scope is connected, it will be displayed in the map.

4 – Polar map

The Polar map represents a better view of the sky if your aim is to understand where the points really are and how tightly together they lie. The functionality is the same as the orthogonal map.

5 – Model and mask handling

Several buttons control the model points and the terrain mask. Load Model will load a complete set of points from a disk file. Clear Model will clear the current model content, and Save Model will save the current model to a disk file. This way you can have several alternative point lists readily available.

The terrain mask can be loaded with the Load Mask button. Clear mask will simply remove the current terrain mask.

Clean below mask will remove all loaded points that are below the terrain mask. This is useful if you load a model and want to make sure that nothing falls below your mask, or if you change your terrain and want to clean up your model.

6 – Run parameters

Camera Bin

You can choose to expose your plates with the binning you think is appropriate. PinPoint will solve very accurately even with higher binning, so using bin 2x2 and getting better download times and shorter exposures is a good idea.

Exposure

Every plate is exposed with the same exposure time, entered here in whole seconds. A setting of 2-4 seconds works well with most systems. Shorter exposure, of course, means shorter run time, so experimenting is a good idea.

Solve Expansion

PinPoint wants to know how far outside of the field of view it is allowed to search for stars. If you are really bad off in your basic mechanical alignment, a higher setting may be required, for instance when you are shooting your first model for polar alignment purposes. 20 per cent normally does the job very well, but if you encounter repeated solve failures you should look at your exposure time and solve expansion. PinPoint accepts values up to 80 per cent. If your first points do not solve, you may have to look at your mechanical alignment a bit in order to create better initial pointing.

Max stars in model

The 10Micron mounts have support for 100 stars in the model from firmware 2.9.16. There isn't a hard limit to the number of points (except your RAM) and the setting is used to help you create

models that can be fitted to the mount, basically by not letting you create more points than the setting.

Latitude

This setting is only used for the display of a North Celestial Pole indicator on the maps. Set to your latitude in whole degrees.

Slew settle time

It may be a good idea to add some settle time to all slews, especially if you run your mount at higher slew rates. A setting of one to two seconds is usually adequate, but heavily loaded mounts may get better results with 4 seconds. This setting is important for dome handling (see more in the dome section).

7 – Run behaviour

Model Maker needs to know how it should handle a run. Several yes/no parameters control this and should be carefully selected.

Base Model (3 points)

When this checkbox is ticked, the run will start with the base model points. If you are creating a new model these should always be included. If it is unchecked, the run will skip the base points.

Refinement Model

All points in excess of the base points are considered refinement points. When the checkbox is ticked, the refinement points will be run after the base points. If the base points are not selected, the run will start with the refinement points.

Simulation Run

The simulation mode is a valuable feature when you want to test your mount. When in simulation mode, MaximDL and PinPoint are not required and all exposures, solves and syncs are simulated. All simulated operation items will fail in about 10% of the cases. Simulation runs do not send any sync information to the mount, do not delete the model in the mount and thus only moves the mount around.

Verification run

This mode will run through your alignment points, expose each one and report how much off your mount is. It does not send any sync commands to your mount.

Live run

This is the normal mode for Model Maker, and the mode that will build or refine your model.

Offline run

The possibility of first exposing all your points and then sending them to the mount in one batch, or stored in a file for later transfer to the mount is currently under development and slated for release as version 4.0.

Clear model in mount first

If you want to do a full model you may want to check this box. It will zap the model from the mount and let you start from scratch. If you want to save the result from a previous run you have to use the

handset and tell your mount so save the current pointing model in one of the storage slots in the mount.

Running without this is basically only useful if you are starting from a mechanically poorly aligned mount, for instance when you just put it on the pedestal or tripod and want to get a reasonable polar alignment quickly. You would then start with the box ticked and run just the base points, after which you turn the knobs according to the instructions in the handset. When you have done that you do it again. Should you choose not to adjust because it turned out fine, you can save time by not clearing the model, then running just the refinement points.

Auto refraction
Refraction calculations in the mount need access to the altitude you are at, the ambient air pressure and the ambient temperature. If you happen to own a weather station that can produce a Cumulus-compatible real-time weather file, Model Maker can read that file and update the parameters upon run. You choose the file location with the browse button next to the checkmark that enables the feature.

Perform model clean-up
If this option is selected, Model Maker will end the session by repeatedly removing the worst point from the model until the model's expected RMS error is below the threshold. Better to do this manually…

Final things

Auto load model and mask
With this checkbox checked, Model Maker will load the last used model and mask from disk files upon start-up. Note that this requires you to save the model to a file first. The setting used for storing the last used model is updated on model save and model load.

Work on base model and work on refinement model
With these two radio buttons you control which type of point is created in the maps.

Don't sort refine points
All refinement points are normally subject to sorting by altitude. Model Maker does this in order to spread the points evenly in Az, something that you thus can control by hand editing your points file and making slight adjustments to altitude values in order to force them to a specific order.

If you check the don't sort box, Model Maker will refrain from all sorting. Just remember that if you have a model loaded, you will have first click the don't sort and the reload the model as it is sorted upon load or any change.

Parameters and settings

All checkboxes and settings are preserved between runs. The next time you fire up Model Maker, all settings will be just as they were the last time you used it, including the points and the mask (the latter two if you have autoload enabled). This way, re-running a model between sessions, for whatever reason, is just a process of a few clicks.

Re-running missed points

Points that do not expose, solve or sync during the run will be crossed out in the display. If, at the end of a run, any points are crossed out, a button will appear in the right section of the display: "Prepare re-run". If you click this button, all points that were run OK in the last run will be deleted leaving only the missed points left in the model. You can then click "Run" again and have it run just the missed points.

Dome support

From version 3.3, Model Maker supports the handling of a dome and will wait for it to finish its slew before exposing the plates. This feature requires MaximDL to handle the dome, and MaximDL you already have or you wouldn't be using Model Maker.

IMPORTANT: Specific setup instructions
MaximDL needs to be handling the dome slaving for you, and Model Maker needs to be connected to the same dome at the same time. Do this with the ASCOM Generic Hub. You connect MaximDL's dome to the generic hub and configure the generic hub to use your dome driver. Then, simply connect Model Maker to the generic hub. You can leave the dome in MaximDL connected to the generic hub even after the model is done as this does not impair functionality.

MaximDL also needs to be connected to your scope. As 10Micron mounts can handle several connections (from firmware 2.9.16, two before that, one to 3490 and one to 3492), this does not require a hub.

Model Maker's slew settle time needs to be <u>longer</u> than MaximDL's dome slaving rate. The standard dome slaving rate is five seconds, so set your slew settle to six seconds and you're good to go. The reason for this is that MaximDL will not start slewing the dome until the scope has stopped slewing. Model Maker will use its own slew settle setting and wait that long before asking the dome if it is still moving.

If he slew settle time in Model Maker is shorter than the slave polling rate of MaximDL, then the dome will not yet have started moving, and Model Maker will thus believe that the dome is done. **Using a slew settle time longer than slave polling rate ensures that this will not happen.**

Workflow

Using Model Maker is very simple.

Make the model

You start by making or loading a model. Clicking it into place is a breeze and shouldn't take you more than a few seconds. The base model should be evenly spread out in Az. The model supplied with the application is a good starting example that was tailored to my balcony setup. Save your points; you may want to run them again, for instance if you are portable or have changed OTA or something in the rig.

A click in a map will create a point at the mouse position, a right-click on or very close to a point will delete it. Simple as that.

Mask or not?

You do not need to use a terrain mask, but it is a nice feature. Included is my balcony mask for reference. There is no user interface for creating a mask, but you can create model that corresponds to your mask, save it and the load it as a mask, perhaps after some hand editing. The file format is the same for the two.

Connect to Mount

Connect to your mount with the mount button. Choose my ASCOM driver, set the normal parameters and connect it. The button turns green upon successful connect. Model Maker will, theoretically, work with other drivers if they can use J2000, but this has never been tested.

Connect to MaximDL

Model Maker will start MaximDL if it is not already started. You will have to connect your camera in MaximDL and set the desired download speed if your camera supports it. The button will turn green if MaximDL is successfully connected.

I usually start MaximDL manually, set up the camera properly and then connect the camera. After that I let Model Maker connect to MaximDL. A future release of Model Maker will include functionality to connect the camera and set up everything for you.

Connect to Dome

If you intend to have Model Maker wait for the dome to slew the slit to your telescope, connect the dome.

Select your parameters

Select camera binning, exposure time, solve expansion and whether you want to clear model etc.
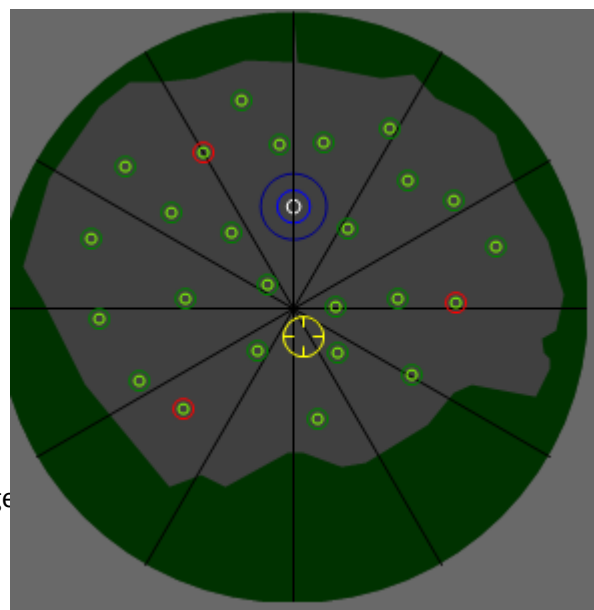
Run

When you click run your coffee break starts...

A run can be aborted at any time by clicking the cancel button. Please note that a cancel may not be immediately recognized and may have to be repeated. The reason is that plate solves and MaximDL exposures are handled by the Model Maker's process and both MaximDL and PinPoint lock up the calling thread. A cancel during slew will be immediately recognized but the slew will complete.

A good model

What constitutes a good model? Well, it is a tricky question to answer. I have managed one

hour unguided subs with my GM2000HPS at a focal length of 1000mm. The model used did not cover the entire sky as my balcony has a substantial mask. One of my first attempts with the GM2000 was made with a 7-star model and that yielded 20-minute unguided subs.

The maths behind the model is fairly advanced and it is difficult to predict. The model shown here usually gets me the unguided performance that I want, but your mileage may vary.

I suggest that the base points be spread out evenly, just like in the image here.
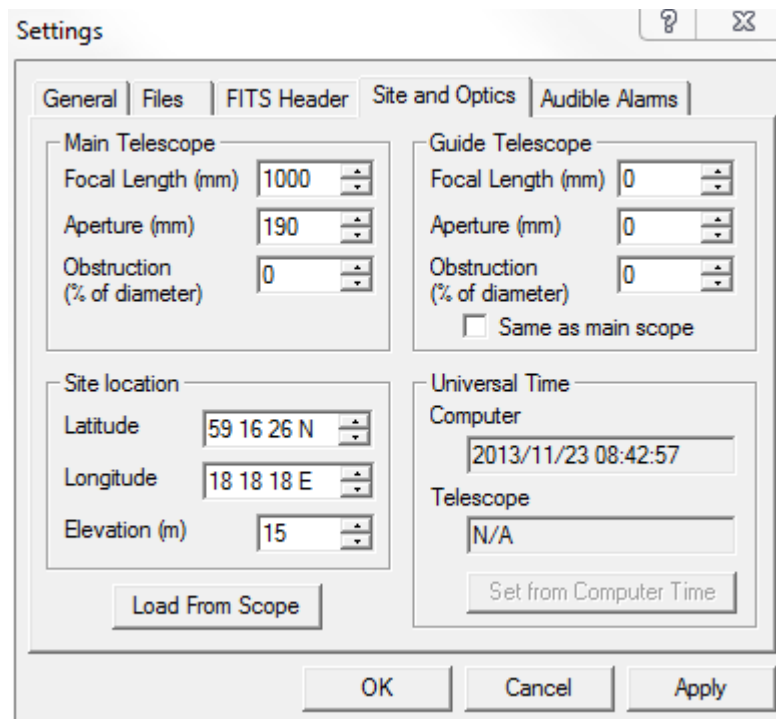
Indicators of good models

The first and foremost indicator is the expected RMS pointing accuracy that the mount will report in the alignment info section in the handset. When you start hitting single digit number there you're in for some phenomenal unguided performance.

Plate solving

PinPoint is a good plate solving software with high repeatability and accuracy. In order to work it needs to use J2000 coordinates and three headers available in the image:

- XPIXSZ
- YPIXSZ
- FOCALLEN

These values are set by MaximDL and are taken from your camera and site and optics preference tab. Hence, you need to set the focal length of your telescope in MaximDL (File/Settings):

Questions and reports

The Model Maker is donor-ware and there are no guarantees whatsoever. You use it at your own risk and your results may vary.

Updated versions will show up on my web-site, and all that choose to pay a small amount for the software will get e-mail notifications when new versions are available. On the other hand, if you choose not to pay, which is OK by me, you will have to scout around my web-site in order to find new versions.

Any reports of ill-behaviour or requests for new features can be addressed to ascom@frejvall.se.

Clear skies!

Per Frejvall