

OpsAG – CCDOps Autonomous Guider

January 3, 2005

Introduction

Several customers have asked us to implement background guiding in **CCDOps** whereby you could start the Autoguider, put it in the background and then go about imaging. With the Autoguider running in the background for example, taking a sequence of images with the **AutoGrab** command would result in a set of perfectly guided and co-aligned images. Third party programs like *CCDSOFT* and *MaximDL* have implemented this feature and everybody likes it.

With the pending release of our low cost ST-402, which will make an outstanding computer-controlled Autoguider (as opposed to a stand-alone Autoguider like the ST-4 or STV), we are releasing a new program called **OpsAG**, which is short for *CCDOps Autonomous Guider*. These days almost everybody has abandoned film (or never even tried) and adopted digital astrophotography. In that case two things apply:

1. You are using a computer at the telescope for imaging.
2. You need an Autoguider and because of #1 it needn't be stand-alone.

OpsAG fits the bill perfectly and has the following features:

- **OpsAG** integrates seamlessly with **CCDOps**, a program you are already familiar with.
- **OpsAG** operates autonomously, autoguiding in the background with any SBIG USB or Parallel port based camera. Once started you're free to use **CCDOps** or any other program without worrying about the autoguider.
- **OpsAG** offers the most complete control and innovative feedback of any autoguiding program or system available.
- **OpsAG's** only limitation is that it requires complete and individual control of the autoguider. This means that unfortunately you cannot use it to autoguide with the *Tracking CCD* while using **CCDOps** to image with the same camera's *Imaging CCD*. The Autoguider must be a separate camera.

How do you use OpsAG?

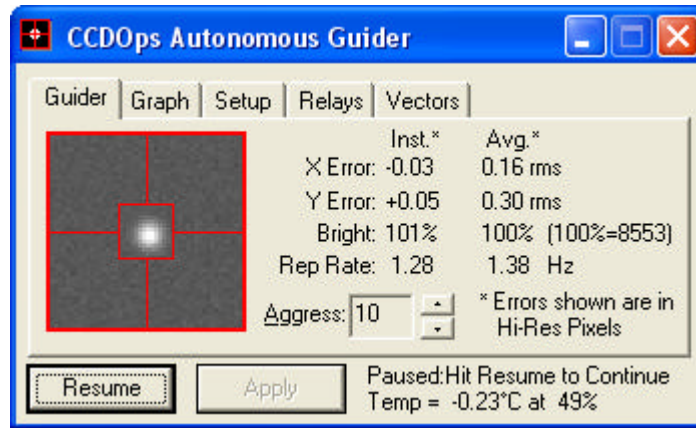
If you know how to autoguide with **CCDOps** then using **OpsAG** is very easy! Running **CCDOps** you prepare for autoguiding just as if you were going to autoguide with **CCDOps** by the following:

1. Establish a link to the autoguider camera and select the desired CCD (*Imaging, Tracking* or *External Tracking* in the case of the STL), resolution mode, operating temperature, etc. in the **Setup** command in the *Camera* menu.
2. Find and focus on the desired guide star using the **Focus** command.
3. If you haven't done so already, calibrate the autoguider using the **Calibrate** command in the *Track* menu.

4. Start autoguiding using the **Autoguide** command in the *Track* menu but now you have a new choice: by selecting the *Yes* option in the *Autonomous Guider* pop-up you're telling **CCDOps** to want to hand off the guiding to **OpsAG**.
5. Finally, select the guide star in the image that pops up then hit the *Resume* button in the *Tracking* dialog. **CCDOps** then terminates its link to the autoguider and passes the autoguiding off onto **OpsAG**.

OpsAG User Interface

OpsAG uses a relatively small window with multiple tabbed pages to present control and feedback information as shown in the figure below. At the bottom of window, below the tab pages you'll find the following controls/information:



Pause/Resume Clicking this button alternately pauses then resumes the autoguider.

Apply Click this button to apply changes you have made to any of the items on the various pages. Not all items require hitting Apply to take effect, and this button will be grayed-out until you change one of the settings that does.

Status Shown to the right of the Apply button, the status shows the current status of the autoguider.

Temp This shows the CCD temperature and percent TE power of the Autoguider.

To show any of the other pages simply click the named tab at the top of the window. Each page is described individually below.

Guider Page

The Guider page shows the image of the guide star and the tracking performance. The data presented here is the same as is shown in the *Tracking* dialog in **CCDOps** and includes the following:

X and Y Error These two rows show the X and Y guide star error in units of high-resolution pixels. The *Inst* column shows the instantaneous error and the *Avg* column shows the average error over the last 16 cycles.

Bright This row shows the instantaneous and average integrated brightness of the guide star in percent and actual ADU units. If the instantaneous

brightness drops too low **OpsAG** will continue to cycle but won't make telescope corrections.

Rep Rate

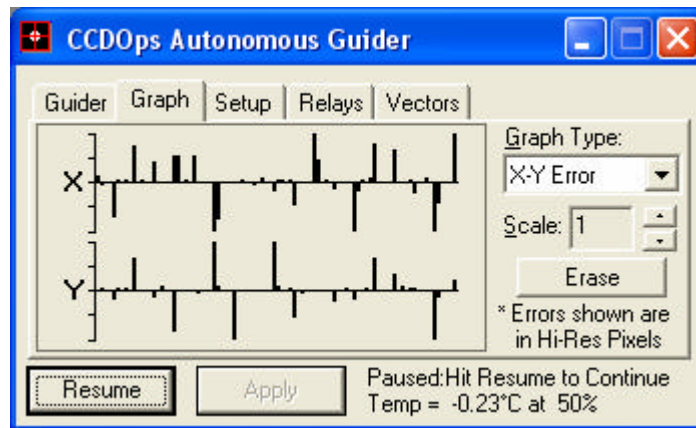
This row shows the repetition rate or frequency of the autoguider. The resulting rep rate will depend on the Exposure time and how often and how long **OpsAG** spends correcting the Telescope with the relays.

Aggress

Use this to control the aggressiveness of the autoguider whereby the "gain" of the autoguider is the Aggressiveness/10. A setting of 10 is normal, where the autoguider applies the exact calculated correction. Values lower than 10 apply fractional corrections and tend to dampen the autoguider. Values higher than 10 cause over correction and can lead to oscillation.

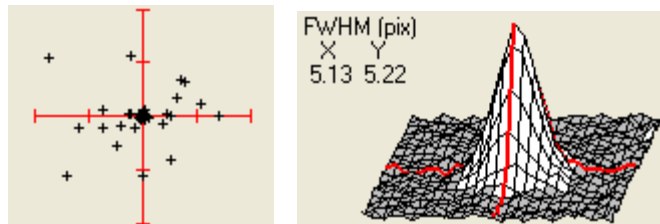
Graph Page

The Graph Page displays graphs of the autoguiding performance and is shown and described below:



Graph Type

Select from one of the five graph types available. The *X-Y Error* graph shows a bar graph of the guide star error over recent time as shown above. The *Scatter* graph shows a cross at the position of the guide star for the last 100 or so cycles as shown below. The *Accumulation* graph shows an image that is the accumulation of all the individual images and should give a fair representation of what your final image will look like. Finally the *Profile-Wire* and *Profile-Solid* show three-dimensional views of the guide star along with a measure of the star's Full-Width at Half-Maximum (FWHM) as shown below.



Scale

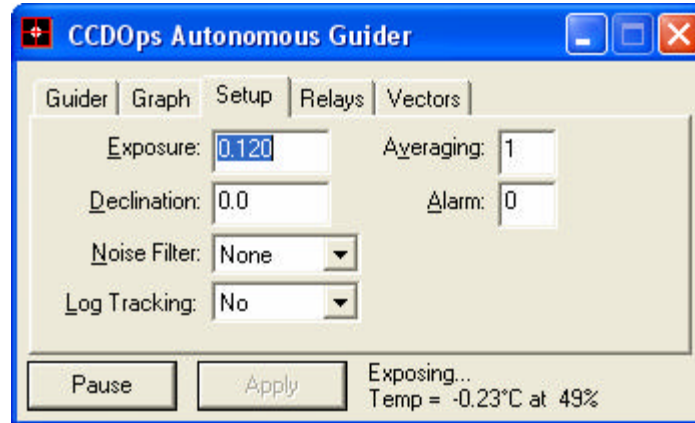
This controls the full-scale of the *X-Y Error* and *Scatter* graphs.

Erase

Click this button to erase the *X-Y Error*, *Scatter* or *Accumulation* graphs and start over with the data collection.

Setup Page

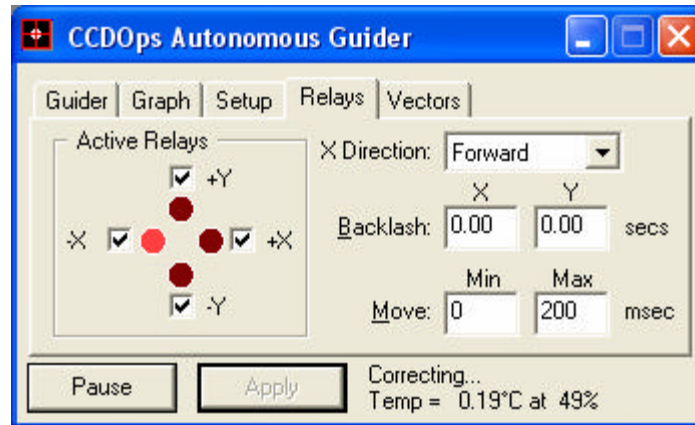
The Setup Page controls many aspects of the **OpsAG** autoguiding and is shown and described below. These controls work the same way here they do in **CCDOps** except that after changing any of these items you need to click the **Apply** button to have it take affect:



- Exposure** This is the exposure time used in acquiring the images. It is initially set by **CCDOps** when **OpsAG** starts but you can change it at any time by entering a new value and then clicking the **Apply** button. Longer exposures will allow you to autoguide on dimmer stars but will also slow down the rep-rate and could allow some streaking in your autoguided images.
- Declination** Set this roughly to the declination of the guide star and **OpsAG** will adjust the RA corrections (X Relays) for the loss of movement in RA associated with increasing Declination. This assumes you entered the correct declination of the calibration star when you ran the **Calibrate** command in **CCDOps**. If you didn't then just leave this set.
- Noise Filter** OpsAG can filter the autoguiding images using either a Low Pass (smoothing) or Median filter. This can reduce the effects of noise and hot pixels in images when guiding on dim guide stars that can lead to autoguiding errors.
- Log Tracking** Setting this item to *Yes* causes **OpsAG** to create a *Track Log File* that you can then convert into a mosaic image and spreadsheet using the **Convert Track Log File** command in **CCDOps**. This can be invaluable for troubleshooting autoguiding.
- Averaging** Set this to values greater than 1 to have **OpsAG** average the error in that number of images before making a telescope correction. This is handy for reducing the autoguider activity on very stable mounts.
- Alarm** When the integrated star brightness drops below 25% **OpsAG** will continue to cycle but it won't make telescope corrections. This parameter sets the number of sequential images below 25% brightness before **OpsAG** will alarm you by beeping. Generally this indicates the presence of high clouds or telescope dew and is something you'll want to know about. Finally, set this to zero to disable the alarm feature.

Relays Page

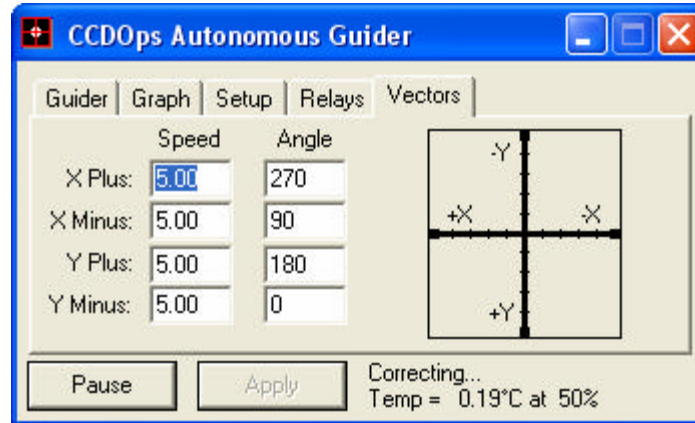
The Relays page controls the autoguiding relays aspect of the **OpsAG** autoguider and is shown and described below. Changes to the **Active Relays** and **X Direction** items apply immediately whereas changes to the **Backlash** or **Move** items require hitting the **Apply** button before they take effect.



- Active Relays** This section provides both control and feedback of the relay activity of **OpsAG**. The Red LEDs will illuminate (brighten) as **OpsAG** is making relay corrections to the telescope. To disable any or all of the Relays uncheck the checkbox adjacent to the Red LED.
- X Direction** Users with German Equatorial mounts can reverse the X Relays with this item as is required when autoguiding an object that required flipping the mount from the position where you had calibrated the autoguider.
- Backlash** You can add backlash compensation to **OpsAG** by setting these items to non-zero values. For example, setting the Y Backlash to 0.5 causes **OpsAG** to add 0.5 seconds to any Y (or Declination) relay move that is in the opposite direction of the previous move in Y.
We recommend a five pronged approach to handling the backlash found in many a mount's Declination axis: First, second and third do everything you can do to reduce the mechanical backlash at the gearbox and to stop it from happening at all. This is so important that we dedicate three of the five steps to the elimination of backlash! Fourth, program your mount to internally remove as much of the backlash as you can without causing the mount to jump when making reversing Dec corrections. Fifth and finally and only as a last resort, use these settings to have **OpsAG** compensate for the backlash.
- Moves** These items allow you to limit the relay corrections **OpsAG** will make. Raising the *Min Move* will cause **OpsAG** to skip any move shorter than that duration and can help to reduce over-aggressive guiding. Lowering the *Max Move* can stop **OpsAG** from making giant moves should a hot pixel or noise cause an autoguiding error.
Again, caution is called for when setting these items. For example the typical mount moves at $\pm 1/2$ sidereal rate or roughly 8 arc-seconds per second. Setting the *Min Move* to 50ms causes **OpsAG** to not make any corrections unless the error is greater than $8 * 0.05$ or 0.4 arc-seconds, something that may affect your autoguided images.

Vectors Page



The Vectors page of **OpsAG** allows you to display and modify the Calibration results. Typically you won't need to modify these as the **Calibrate** command in **CCDOps** measures them for you. This page and its controls are shown and described below:



- Speed** This is the correction speed of the Telescope in response to relay moves in units of high-resolution pixels per second.
- Angle** This is the angle in degrees of the correction vector clockwise from North (0°).

Miscellaneous

This section contains miscellaneous information about OpsAG and its interactions with CCDOps.

- If you want to restart guiding with a different guide star simply quit **OpsAG** by clicking the Close-box  then reestablish a link to the camera with **CCDOps** and start over.
- If you make changes to the settings in **OpsAG** they will be reflected back in **CCDOps** the next time you use them.
- Once **CCDOps** has terminated the link with the autoguider and **OpsAG** has taken over autoguiding with it make sure you select a different camera with **CCDOps** to start imaging. This could involve using the **Graphics/Comm Setup** command in the **Misc** menu to select a different port or in the case of multiple USB cameras selecting a different camera when you establish the link.
- If you want to know which version of OpsAG you have installed, click the mouse on the  icon and then select the *About OpsAG...* item.