



Astrel Instruments

AST-8300-A
AUTOGUIDER MANUAL
rev A

Description

Lin_guider is a simple autoguider program for Linux operating system. It is designed to help you get quality astroimages with long exposure. Once connected to your astro hardware and properly configured, Lin_guider will compensate for the periodic tracking errors of your telescope mount during the exposure time. This will help get images without blurred stars. In addition, the program allows for the examination of the periodic error of your mount due to the ability to write deviational plots. If you like taking planetary images, Lin_guider can record video without compression in the AVI format.

Supported Hardware

The video capture equipment and the link to your telescope mount are needed for the operation of the autoguider. The autoguider ST-4 port is used for the connection to the telescope mount.

Supported video hardware:

- QHY5 / 5II / 5LII
- QHY6
- Starlight Express (Lodestar, ...)
- ZWO ASI
- Generic ATIK
- DSI2PRO
- UVC compatible cams
- Philips webcams (PWC)

Supported webcam colour video formats:

- YVU420, YUV420, JPEG, MJPEG, YUYV.

Webcams, that do not support any of these formats, are not yet supported.

Supported actuators (ST-4):

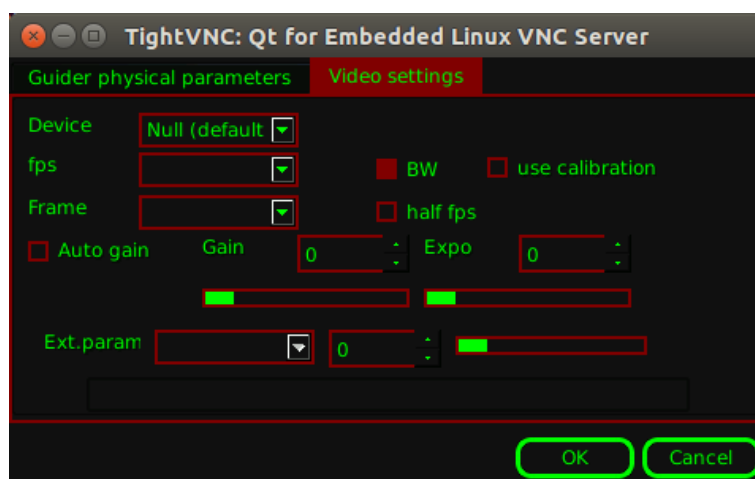
- QHY5 / 5II / 5LII
- QHY6
- Starlight Express (Lodestar, ...)
- ZWO ASI
- Generic Atik
- FTDI compatible
- GPIO interface
- GPUSB
- LPT interface
- NEXSTAR compatible

SETTING UP THE HARDWARE

Before starting to work with the program, make sure your videoequipment and the mount actuator are properly identified and operational.

Video hardware setup

From the menu, select 'Setup' -> 'Guider setup' and choose the 'Video Settings' tab.



It is necessary to specify the guider device you will work with. To do this, you should choose it from the 'Device' list. Every time you change guider it is necessary to restart the program for the connection to the specified device to occur.

The image from the video device must appear after the restart.

You could also need to specify the required frequency of frames per second (FPS) and the size of the captured image. You should know that the exposure time of one frame is calculated as $1/\text{fps}$, i.e. if fps is set to 5 ($\text{fps} = 5$), the exposure time of one frame will be $1/5 = 200$ milliseconds. This time doesn't account for the time required for the data transfer and its post-processing. That's why real FPS is somewhat smaller, than the chosen one. This difference doesn't influence substantially the guiding quality. You should test such parameters, as 'Autogain', 'Gain', 'Expo' (if they are available), on the image and watch how it will change.

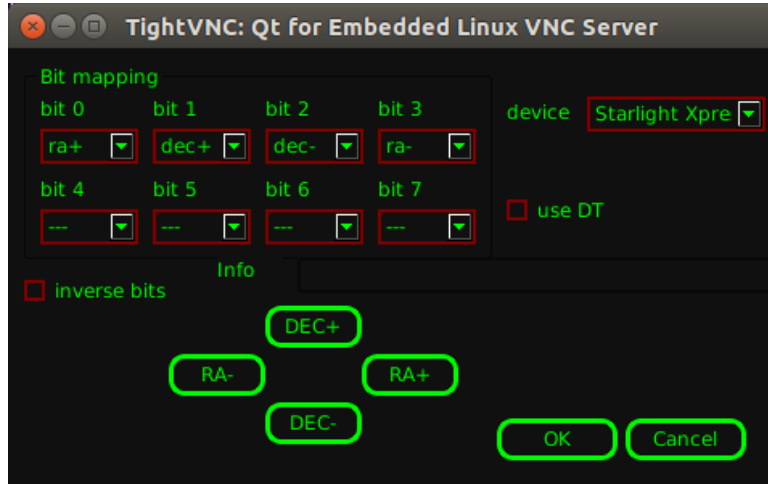
The 'BW' parameter makes the screen layout monochromatic for several graphics formats, thus slightly decreasing the CPU usage.

The 'half fps' parameter makes the screen layout of every second frame. It affects only the screen layout and decreases the CPU usage, all frames are objectively captured and processed by the autoguider.

You can switch the 'use calibration' parameter on, if you are planning to calibrate the camera with a dark frame.

Actuator setup

Open 'Setup' -> 'Driver setup' in the menu.



You should choose the device to work with from the 'device' dropdown list in the first place.

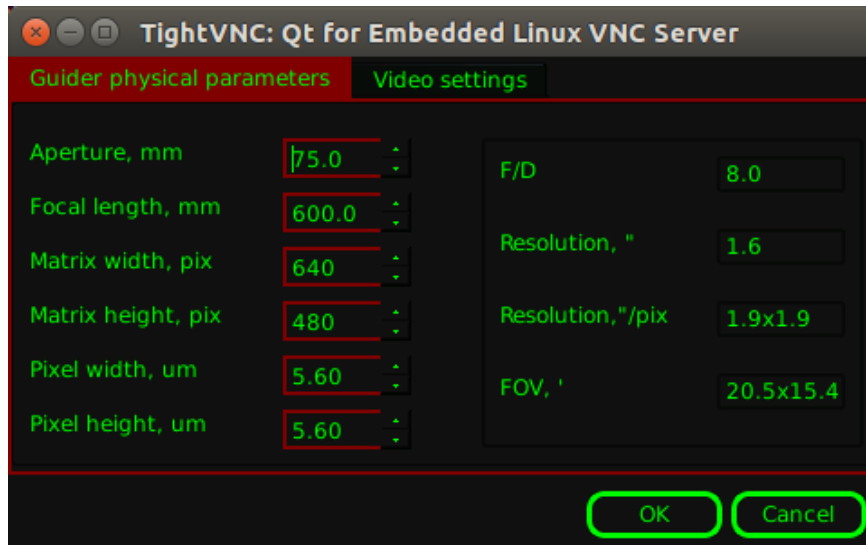
It is necessary to restart the program for the connection to the specified device to occur. If all went right, the program would start without pulse driver error messages.

If the launch is successful, connect the device to the autoguider port and check that the guiding device functions properly.

That's all that is needed for autoguiders with the ST-4 output connector, while the other parameters are used for interfacing directly to the mount (send an email to info@astrel-instruments.com for support)

SETTING UP THE PHYSICAL PARAMETERS OF THE GUIDER

From the menu, select 'Setup' -> 'Guider setup' and choose the 'Guider physical parameters' tab.



When the video device and the telescope mount control device are connected and working in the program, you must specify several parameters before the guiding can be started:

1. Aperture - the diameter of the guide objective, mm.
2. Focal length - the focal length of your guide, mm.
3. Matrix width - the amount of matrix pixels in horizontal direction, pixs.
4. Matrix height - the amount of matrix pixels in vertical direction, pixs.
5. Pixel width - the width of a pixel, um.
6. Pixel height - the height of a pixel, um.

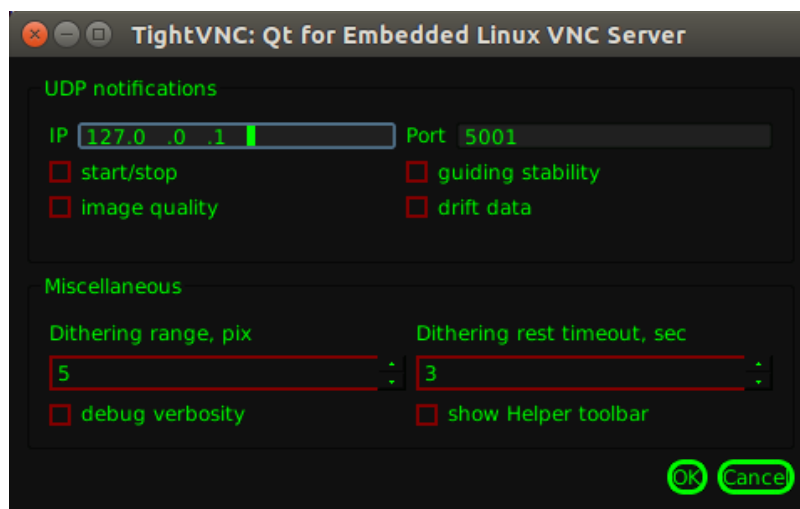
!!! WARNING !!!

Some camera types, including webcams, allow for more than one resolution, for example 320x240 and 640x480. In this case you should set up the pixel size very attentively. For example, let's consider Philips SPC 900 NC camera, that has matrix with 640x480 pixels,

their size being 5.6x5.6 um. If we choose the default camera resolution of 640x480 in the list of available resolutions, the pixel size will be defined as 5.6x5.6 um, just as in the camera specification. If we choose the resolution 320x240, the pixel size must be defined as 11.2x11.2 um otherwise, the scale of all displayed and calculated values will be wrong.

SETTING UP DITHERING AND REMOTE SERVER INFO

From the menu, select 'Setup' -> 'Settings'.



The application has an internal UDP server which can send guiding information to a remote server. The IP and port can be specified along with the kind of data transmitted.

Moreover here you can insert the 'Dithering range' in pixels. The software calculates the time needed to get to the dithered position automatically but you can also add an extra time using the 'Dithering rest timeout' in seconds. Dithering is automatically added by the camera exposure scheduler at the end of every exposure.

'debug verbosity' and 'show Helper toolbar' are not implemented.

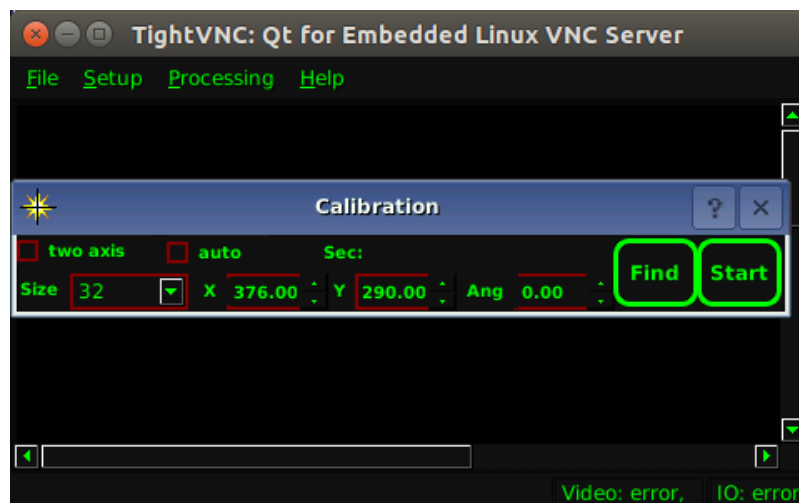
CALIBRATION

It is necessary to calibrate the autoguide before the start of the guiding. To do this you have to complete at least one procedure - determination of the orientation of the celestial reference frame in the image, taken from the camera. In addition, it is advisable to perform camera calibration with the dark frame.

Determination of the orientation of the celestial reference frame

Direct your guide to the star you'd like to use for guiding. Make sure that the star isn't near the image edge. Focus the image. Make sure that all mountings are tightened and the wires do not hang freely.

Open 'Processing' -> 'Calibration' from the main menu. The Calibration window is opened and can be moved if needed for monitoring the guide star.



Use the 'two axes' parameter to choose the two-axes or one-axis calibration. If the polar axis is aligned, it is recommended to use the automatic mode of calibration - parameter 'auto mode'.

Automatic calibration

Set time in seconds during which the drift along axes will be performed, making sure it is long enough that the star moves but always remains in the field. Use 'Find' to let the software automatically choose a suitable star in the field or grab the green square and drag it over the guiding star you prefer. Make sure that the square follows the star. Press the button 'Start'. The program will start to shift the star along one or two axes afterwards. The result will be shown at the end of calibration. 'Status: DONE' will be shown in the case of successful termination and the axes of reference will take the new position. In case of an error, the window with an error message will be shown. If the polar axis is poorly aligned, the automatic calibration may be terminated with an error. In this case, it is not recommended to perform the photographic surveying. Try to align the polar axis more precisely.

Manual calibration

If the automatic calibration doesn't suit for any reason or terminates with an error, you can perform manual calibration. To do this, grab the green square by the mouse pointer and drag it over the guiding star. Make sure that the square follows the star. Press the button 'Start'. Next use the mount control panel to shift the star position in RA+ direction and press 'Stop'. If the two-axes mode is engaged, use the control panel to shift the star in the DEC+ direction and press 'Stop' right after the end of the drift along RA. It is important to understand that the longer the shift vector is, the more precise the determination of the celestial coordinates' axes will be.

!!! WARNING !!!

It is recommended, that the square, following the star, doesn't touch the image edges during the calibration.

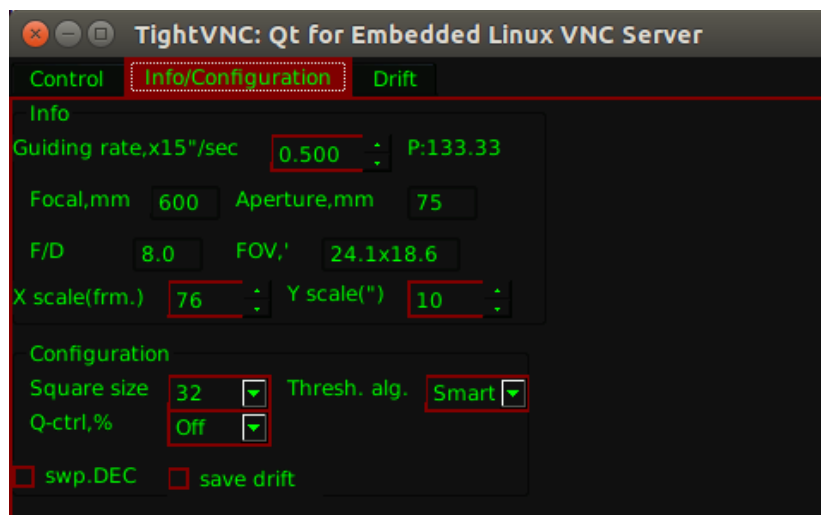
Calibration with the dark frame

In order to calibrate the camera with a dark frame, define the amount of frames to accumulate in the field 'Frame count'. Cover the guide objective to prevent light from penetrating the camera and press the 'Start' button. At the end of the process the dark frame will be formed, that will be subtracted from every new frame, taken from the camera, if the 'use calibration' parameter is chosen in the dialogue box of the guide setup.

GUIDING

You can start guiding after the celestial reference frame is determined.

Open 'Processing' -> 'Guiding' from the main menu and choose the 'Info/Configuration' tab.



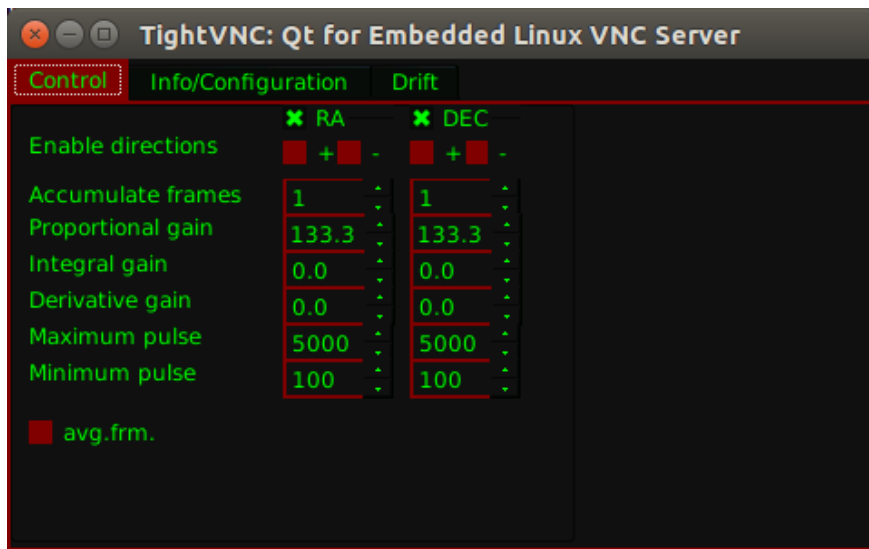
Set the appropriate size of the square, following the star - 'Square size'. The square area shouldn't be too small or too large, compared to the visible size of the star.

Choose the threshold algorithm, used to calculate the star position, 'Threshold alg.' The value 'Smart' is the more precise dynamic threshold calculation, compared to 'Auto'. The value 'Auto' is the dynamic threshold calculation. The value 'No thresh.' - threshold calculation is disabled.

You can also save guiding logs in text files. To do this, you have to set the checkbox 'save

drift' to checked and specify the file name in the 'Configuration block'. The file format is a plain text with two columns with numbers - deviations along RA and DEC.

Next you have to specify parameters in the 'Control' tab. All parameters are defined separately for each axis RA and DEC.



These parameters are:

1. Enable directions - enables or disables the use of calculated axis corrections. All is enabled by default.
2. Accumulate frames - enables the averaging of the coordinate values, using N frames, and the transfer of corrections at the end of the averaging. Set to 1 by default, could be changed when using very long guiding focal lengths.
3. Proportional gain - is the coefficient of the proportional term in the PID control. May be precalculated in the 'Info' block by default.
4. Integral gain - is the coefficient of the integral term in the PID control. Set to 0 by default.
5. Derivative gain - is the coefficient of the differential term in the PID control. Set to 0 by default. Disabled in this version.
6. Maximum pulse - the maximum duration of the correction pulse. Limited by the specific type of the actuator. Set to 5000 ms by default.
7. Minimum pulse - the minimum duration of the correction pulse. Set to 100 ms by default.
8. Avg.frm. - disabled.

PID control coefficients adjustment should be performed empirically, using the specific equipment and with full load. The idea of the adjustment is to find coefficients that don't lead to 'under-guiding' (corrections are too slow) or 'over-guiding' (sinusoidal oscillations with increasing amplitude).

It is recommended to choose the range of values from 10 to slightly more than the recommended value during the selection of the proportional coefficient (see 'Info' block) and move through this region with the step of 10, looking attentively, how the result of the guiding will change.

The selection of the integral coefficient is recommended to perform, if there is constant impact in one direction. This coefficient will allow for the faster correction of the impact, because it takes into account the previous guiding history.

The differential coefficient, as has been said above, is disabled at the moment.

!!! WARNING !!!

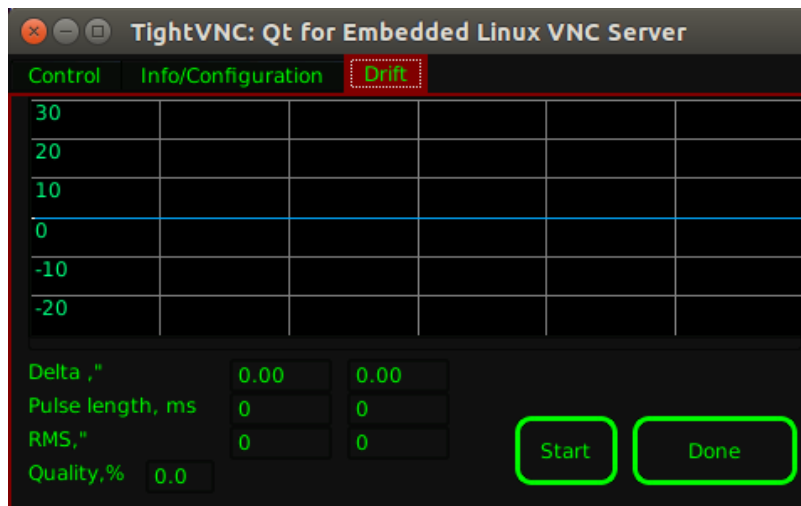
You should bear in mind during the selection of the coefficients, that their values may vary for different axes.

If the polar axis is well aligned, then the guiding along the DEC axis can be performed more rarely, every 2-4 frames. This will allow to avoid excessive activity along the axis and unnecessary vibrations. In addition, it is recommended to induce small imbalance (overweight) against the diurnal motion for the RA axis in order to move with constant tension and remove the play. It is recommended to induce a small shift of the polar axis (for details see the drift method) from the ideal position for the DEC axis in order to make a constant shift in one side and the guiding go in only one direction. This will allow to reduce turbulence in the region of 0.

The value of 'Maximum pulse' is usually chosen more or less equal to the period of the working cycle (time between two successive camera data captures). Usually there is no

need to change this value. The 'Minimum pulse' value is of more importance. This parameter defines the threshold of the correction duration. If the calculated correction is more or equal to 'Minimum pulse', it is transferred to the mount, otherwise the correction is discarded. If the threshold is too large, then the non-adjustable band of deviations around the zero value will be too wide and the quality of guiding will be too low. If the threshold is too small, then the amount of corrections around the zero value will be very large, leading to constant axis twitching in opposite directions and, as a consequence, badly controlled antidamping. This fact is particularly important for high load setups with low mechanical stiffness.

To start guiding and monitor guiding drift graph and statistics, select the 'Drift' tab.



Press 'Start' to begin guiding. The drift graph, current values of corrections and statistics are updated at every new image from the guider. When ready, you can close the guiding application by pressing 'Done'. Of course guiding will continue in background and you can get back to the 'Drift' tab by simply clicking on the autoguider icon on the camera desktop.

When guiding is no more required, press the 'Stop' button, the 'Drift' tab will be closed and the main lin_guider window is showed.

GENERAL RECOMMENDATIONS

1. Everything on the photographic setup should be tightened: focusers, camera mounts, mounting of the optical tubes to each other and to the telescope mount, mounting of the mount head to the tripod/column, etc. The camera wires shouldn't dangle. The floppy cable parts should be as short as possible.
2. It is recommended to induce small imbalance along RA in the direction opposite to the diurnal rotation.
3. If the guiding star is too bright, It is recommended to adjust camera (if the hardware allows) to eliminate overluminance.
4. The change in camera parameters (Gain, FPS, etc.) requires the obligatory recalibration of the camera with the dark frame, if it is used.
5. It is recommended to use the two-axes calibration method in the near-polar regions, where the drift along RA is very short during the calibration.

AUTHOR

Andrew Stepanenko (Galaxy Master) <galaxy_master@mail.ru>

AST8300 CCD camera version porting: Andrea Ricciardi <info@astrel-instruments.com>

PROJECT PAGE

<http://sourceforge.net/projects/linguider/>

SUPPORT

<info@astrel-instruments.com>