

Starpilot V. 1.2

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Overview:

Starpilot is a windows application for the control of a go-to telescope and a digital camera (monochrome CCD or CMOS, no DSLR). Automatic sequences of moving the telescope to specified objects and subsequent imaging can be performed in an easy way. All telescopes, cameras, filter wheels and focusers with ASCOM support can be used. Dark frame and flat frame corrections can be applied on each image. All sequences can be saved as text files. Objects can be selected from the NGC/IC/Messier number or by typing the J2000 coordinates (RA/DEC). Images are stored in the FITS format with all available informations, e.g. object, observer, telescope, camera, exposure, camera temperature, date/time, pixel size, object position and many more.

Installation:

If not yet installed, install the ASCOM platform 6 (<https://ascom-standards.org/Downloads/Index.htm>).

For each device (telescope, camera,...) the ASCOM driver must be installed.

Create a new folder (e.g. c:\starpilot) and extract the content of starpilot1.zip into this folder, then start the application starpilot1.exe.

Setup:

Click on the setup button (top right). The setup window is divided in several tabs:

Local coordinates/ Fits header

Longitude and latitude of the telescope must be inserted in decimal degrees, eg.:

Longitude -8.24889 (for 8° 14' 56" east) east longitudes negative

Latitude 49.91806 (for 49° 55' 5" north) south latitudes negative

Optional:

The path of a horizon file (text file with azimuth/altitude data for horizon) can be inserted.

Fits-header: tags for observer and telescope

Telescope control

Click on "Telescope chooser" and select your telescope with the ASCOM chooser

Optional:

If your telescope can be parked, insert the park position (azimuth and altitude, pierside). The "park" command can be performed by the telescope itself or by starpilot (using the coordinates provided). This can be set in the field "Park method".

If your telescope has a home position, insert its position.

Guiding: If your telescope can pulse guiding, insert the guiding speed in arcseconds/s and the tracking range; tracking is stopped, if the movement of the telescope drive (measured in camera pixels) exceeds this range.

Camera

Click on "Chooser" and select your camera with the ASCOM chooser.

Important note: Only cameras with a monochrome sensor are supported. Cameras with a color sensor can be selected, but the color information is not used when taking the picture.

The resolution of the camera/telescope in arcsec/pixel must be inserted (for tracking and positioning)

The rotation of the camera image relative to the east-west line should be given in the field Rotation (for tracking and positioning)

The acquired images may be rotated by 180° according to the pier side (on German equatorial mounts); specify in the section "180° Rotation" for which pier side (or none)

Readtime full (s): time to read a full image in sec

Series pause (s): time between two images in a series (default=0)

Timeout (s): at this time after end of exposure an error message occurs, if no image is received.

Sync binning: Binning used for centering a bright star

Set cooler temp: Default cooler temperature

DSLR: There are some fields for DSLR, these can be ignored (DSLR is not really supported)

Observatory

The control of observatory components (dome, environment and so on) is not yet ASCOM compatible, it can be used only with a special interface (documentation not yet available).

Focus

If a focuser with ASCOM interface is available, click on “focuser chooser” and select your focuser.

In the table “Focus positions” several positions can be inserted.

Autofocus: Here the data for automatic focusing must be inserted; the method is based on a paper of Larry Weber and Steve Brady, it can be loaded here: <https://www.ccdware.com/Files/ITS%20Paper.pdf>

Filter wheel

If a filter wheel with ASCOM interface is available, click on “Filter wheel chooser” and select your filter wheel. In most cases filter names and focus offset can be loaded from the ASCOM interface; otherwise the names and offsets can be inserted in the table on this page, in this case select “Filter data from file” click on “Save filter table”, if the table is complete.

Profile

A profile name can be inserted in the field “profile name”. Under this name the whole setup can be saved. The profile will be saved as text file with the file name filename.ssf in the program folder.

A previously saved profile can be loaded by selecting it in the select box above the button “load profile” and then clicking this button.

Working

Connecting to the equipment

Click on “**Connect all**”, if all devices of the selected profile are available, otherwise:

Telescope: Click on the “Connect” button in the “Telescope” section at left

Camera/ filter wheel: Click on the “Connect” button in the “Camera/Filter wheel” section. Then first the camera is connected, then the filter wheel, if it is available.

Focuser: Click on the “Focuser” button

Telescope mount functions (“Telescope” section)

The position of the mount is shown as right ascension (RA), declination (DEC) and altitude (ALT). Also shown is airmass and side of pier.

Warning: Before using the following functions the coordinates of the mount must be calibrated in some way (e.g. synchronized to a star), otherwise a damage of the telescope could occur!

Object: An object of the NGC/IC/Messier object can be selected by typing it in the “Object” field (e.g. “M13”) and click on “find”, then the RA/DEC coordinates are inserted. After clicking on “Slew” the mount slews to this object.

Park: The telescope is slewed to the park position.

Home calib.: The telescope is slewed to the home position and the “find home” procedure is started (ASCOM find home).

Scan horizon: With this function the visible local horizon can be scanned manually. The telescope must be moved manually to a series of positions at (or closely above) the horizon. The positions (azimuth, altitude) are stored in a text file.

Camera/ filter wheel functions

Set cooler temp: Here the temperature of the CCD cooler can be specified. The cooler must be activated by checking “Cooler on”. The temperature is changed, if the “Set” button is pressed. The actual temperature is shown in the field “T(°C)”.

Expose: This starts a single exposure with the specified time (0.001-990s) in the field “sec”; if “Repeat” is checked, the exposure is repeated until this field is unchecked.

Filter: The filter number (if a filter wheel is connected) can be selected here

Binning: The camera binning can be selected (1..3)

Zoom: Here a centered zoom (ROI) can be selected from 1 to 5; the field size is changed from xsize x ysize to xsize/zoom x ysize/zoom, the center position remains unchanged.

On the right side a small preview of the camera image is shown.

Below the image an info field shows the position of the brightest star (if one found) or the name of the object (in autopilot mode). The field “Max” shows the maximum ADU of the image, the field “Mean” shows the mean ADU.

Viewer: This starts a separate window with an enlarged image (see under “image viewer”).

Center: If a bright star is found, the telescope can be moved by clicking on “Center”, so that the star is centered on the CCD.

Crosshair: This activates a crosshair at the center of the image.

Image path: By clicking on “..” the path for saving images with the autopilot can be selected in this field.

Autopilot

With the autopilot a series of commands for positioning objects and taking pictures can be prepared and executed. The commands are written in the table in the lower part of the window.

Each line can contain several commands for time, position and camera parameters:

UT(h), UT(m), UT(s): execution of the line is started not earlier than at this UT time (h m s); if these fields are empty, execution starts immediately

Object name: Name of object, this is transferred into the Fits header of the image; can be empty

RA(h), RA(m), RA(s): Right ascension (h m s) of the object (J2000 coordinates)

DEC(°), DEC('), DEC("): Declination (° ' ") of the object (J2000 coordinates)

If in the field “object name” an object of the NGC/IC/Messier catalog is inserted (e.g. “M1”) the coordinates are inserted automatically with clicking on “**insert RA/DEC**”. In this case the name of the object is inserted also as filename.

If an object from an external database is used, the coordinates can be copied from an external application (e.g. cartes du ciel) into the windows clipboard and then inserted into the table by clicking “Paste”.

exp(s): In this field the exposure time in sec is inserted, e.g. “15” for 15 sec

Live stacking: n images can be stacked together, only the resulting stacked image is saved; in this case insert: n*exposure, e.g. “10*0.1” for a stack of 10 images with 0.1 sec exposure.

bin/zoom: in this field the binning and (optional) the zoom factor for centered zoom are inserted, e.g.:

1 = 1xbinning, full frame

1/ 2 = 1xbinning, half size

2/ 3 = 2xbinning, one third of full size

filter: In this field the number of the filter in the filter wheel is inserted (1..9). If a series of filters is used for each image, the numbers of the filters are set in consecutive order, eg.:
245 = filter 2, then filter 4, then filter 5
Up to 5 filters can be selected
If live stacking is used, only 1 filter can be selected.

number: In this field the number of images in a series is inserted

filename: In this field the first part of the filename of the images is inserted. The resulting filename is then:
<filename>-<filtername><filenumber>.fit, e.g. for inserting "M42":
M42-R001.fit

Pause(s): In this field a pause time in sec between each frame of the series can be inserted (optional).

Additional commands:

If the following commands are inserted in field "RA(h)" or "exp", then special commands are performed; no images are stored.

in field RA(h):

CC: switch on camera cooler
CD: make darkframe
P0: go to park position
H0: go to home position, do home calibration
ZA: go to park position and open roof
Z0: go to park position and close roof
ZZ: disconnect all, windows shutdown

in field exp(s):

AF: Autofocus
FS: Focus shift (.. steps in "number")
The focus is shifted by the given steps (can be used for defocusing)
SY: center brightest star, sync to position of star
The position of a bright star (next to the following object) must be inserted in the RA and DEC fields; the telescope is moved then to this star, the star is centered and the position of the telescope is synced to the given coordinates, if the star is centered (within the given SY range in arc sec).
SY x.xxx exposure x.xxx seconds (default:0.1s)

Storage and editing

Save table: The table data is saved as a .csv file. The file can be edited as a text file, e.g. with Notepad, or imported into a spreadsheet.

Additional functions

Extra viewer: If activated, a separate window with the camera image is shown

Star guiding: If activated, one star of the camera image is used automatically for tracking and guiding the telescope. This function works only, if the telescope mount is capable of pulse guiding.

Stacking: If activated, the images of a series are stacked (added) together; the resulting image can be viewed in the extra viewer, the final result is stored under filename+_stack

Corrections: If this function is activated, a separate window is shown with the correction files and

parameters (see under “image correction”); all images of the autopilot sequences are then corrected according to these parameters.

Web monitor: If activated, each image during a recording series is saved under the (network) path specified in the setup in the "Observatory" section and with the specified file name. The write rights for this path must be guaranteed. This function can only be activated together with the "Extra Viewer" function.

Flow control

The sequence is started by clicking the "Start" button. The processing can be interrupted by clicking the "Pause" button (next to the start button). However, this cannot interrupt an ongoing image acquisition; the processing is only stopped after the image has been saved. After clicking the "Play" button (to the right) the process continues. The processing can be ended immediately with the "Stop" button. In this case, a running image acquisition is also aborted.

Image processing

The images can be processed immediately (on the fly) after acquisition with these functions:

Dark-, bias-, flat-correction; hotpixel corrections.

To configure the filenames for the corrections, click on “**Corrections**”.

Master dark and bias files:

For dark and bias files the file path must be given for all used binning modes. To select an image from filemanager, click on the “.” buttons.

To activate the dark correction, the check box “**dark correction**” must be checked.

Bias constant:

If no bias files are selected, the bias level is assumed constant with the given value.

Masterflat files:

For each color filter and each binning mode an individual masterflat can be selected (up to 9 files).

To insert a masterflat file, click on “**Select master flat**” and select a file from the file manager. The file path is then inserted in the table within the activated (blue) line.

The flat file must be assigned to a specific filter number and binning mode by inserting the ID of the flat file into a field on the right side of the table, which defines the filter number (from 1 to 9) and the binning (1,2,4).

Example:

Master flats for Clear (filter 1), R(filter 2), G(filter 3) and B(filter 4); binning modes 1 and 2 are used:

Flat ID	filename	filter	Bin1	Bin2	Bin4
1	C:\flat\flat-clear1bin.fit	1	1	2	
2	C:\flat\flat-clear2bin.fit	2	3	4	
3	C:\flat\flat-R1bin.fit	3	5	6	
4	C:\flat\flat-R2bin.fit	4	7	8	
5	C:\flat\flat-G1bin.fit	5			
6	C:\flat\flat-G2bin.fit	6			
7	C:\flat\flat-B1bin.fit	7			
8	C:\flat\flat-B2bin.fit	8			
9		9			

To activate the flat correction, the check box “**flat correction**” must be checked.

Hotpixel corrections:

If the checkbox “**Hotpixel correction**” is checked, hot pixels are removed and replaced by a mean value of nearby pixels. The strength of the algorithm can be adapted by the **sigma value** (4-6). For low sigma, more pixels are assumed “hot” than for high sigma. Sigma=5 seems to be a good compromise.