Processing images using AutoStakkert! 2

AS!2 is a powerful application designed to produce stacks of images, such as lunar, planetary and solar recordings. Specific information on features is described on the astrophotography website of Emil Kraaikamp. On this page I will give some global instructions on how to process images using AutoStakkert!2, in a simple walkthrough. In this tutorial, both a solar and planetary recording will be demonstrated. For this tutorial AutoStakkert! 2.1.0.5 was used.

AS!2 can be downloaded from the authors website or directly from autostakkert.com. Optionally, you may want to use Castrator for some images, in particular images with relatively much black space around the object. It could be used to reduce the size of a recording if you want to retain the original recording to save on disk space, or if you want to reduce the size of a video recording prior to processing with AutoStakkert to improve the processing time.

The user interface of AS!2:

1. Open the recording.

You can simply open one recording, but with AutoStakkert it is also very easy to run a batch and process many images automatically. All you have to do is select the files that you want to process and configure all required settings necessary for processing once for the first recording. Please notice that the Image Stabilization anchor, which is placed automatically (but can also be placed manually with CTRL+click), is not hold to the configured position in a batch. You may want to account for this, because it means that if you want the anchor to be positioned at the lower right for example or somewhere off center, it will not be placed there in a batch even if you manually configure so at the first recording. In that case, the stabilization anchor will always be placed at the center of the image. You could however change the size of the image stabilization anchor by using the 1-9 keys where 1 will give you the smallest possible anchor and 9 the largest. A larger anchor could potentially include the area of the image you want your anchor to stabilize on, but is too far off center to fit in a small anchor. The first thing to do after opening the recording with AutoStakkert, is to set the Image Stabilization option. By setting the Image Stabilization, AS!2 will be able to properly align all frames relative to each other. The two options for Image Stabilization are:
Surface: Use this option for surface images, such as lunar and solar images.

Planet (Center of Gravity): Use this option for planetary images.

After configuring this option, you can notice how the recording aligns itself in the Frame Window of ASI2. Precise alignment of the individual frames is done at a later stage. The next step in ASI2 will be to align the features in the frames to about the same place. The option between Expand and Crop allows to set the final image size to your preference, where Expand will show as much as possible (including less sharp edges) and Crop only the sharpest part of the image. For Surface images you can also manually create a coarse alignment window in the Frame Window by holding the CTRL button and clicking 1 time at the preferred location. The place where you click will be the center of the alignment window. It is recommended to place this alignment window at a prominent feature that is apparent in ALL frames (for example a sunspot, or a particular crater on the moon).

After setting the Coarse alignment, set the Quality Estimator value depending on the quality of the images. While a value of 2 should be good for high quality data and 6 for dim/noisy data, a value of 3 usually works well for most images. You can always try to experiment with this setting and see what works well for your images.

SOLAR/LUNAR: At the Quality Estimator, Edge is greyed out because that option is suited for planetary recordings where it uses the edge of a planet to estimate the quality of the frames.

PLANETARY: With planetary images, you have the choice to choose Edge as Quality Estimator. This method of quality estimation can be useful for recordings of for example Venus, where you only want ASI2 to estimate quality of frames based on certain parts of a planet. It may work well on Venus images, where you could have a sharp edge and a shading terminator and only want AS to estimate frame quality on the sharp edge rather than the terminator.

2. Analyze the recording.

After clicking the Analyze button and ASI2 finishes that step, surface features have been aligned to appear at about the same place. In the steps ahead we will add alignment points to properly align features and prepare the frames for stacking. While the amount of frames used for the reference frame can be set, it is a good practice to leave this option to Auto size (quality based). To manually set the amount of frames for the reference, uncheck the Auto size option and set the slider. ASI2 will use the resulting stack as reference.

Now go to the Frame Window of ASI2, containing a display of a frame of the recording.

SOLAR/LUNAR: The automatically placed red rectangle indicates the region in which ASI2 will be able to place alignment points. After analyzing, ASI2 knows which region of the recording is for certain on every frame and can have an alignment point. This region will in any way be the sharpest
part of the recording. Outside of the rectangle, AS!2 is not able to automatically place APs (alignment points) and it is also not recommend to manually place them there.

PLANETARY: In case of a planetary image, AS!2 will have aligned the frames to about the same place after which you can place alignment points.

In the left part of the Frame window, the alignment point setting must be made. It is highly recommended to use Multiple (MAP) as it will produce a better result. It is a good option to have the alignment points be placed automatically for some images, but if you want you can also place them manually. To place them manually, tick the Manual Draw box and make alignment regions by drawing them (the place you initiate a click will be the upper left part of the alignment region).

PLANETARY: It is a good idea to manually place alignment points for a recording of Saturn. You should in this case create a number of alignment points that should have significant overlap. It is recommended to place these alignments on prominent features, rather than on a dim part of the image at which AS!2 may have difficulties to properly keep its alignment box locked on the same feature in every frame.

SOLAR/LUNAR: It is a good option to automatically place alignment boxes, this will create a grid over the whole image.

The difference for a solar image:
In this instruction, Multiple (MAP) is used and APs are placed automatically in case of the solar image, because it gives the best result. After setting the alignment point setting to Multiple, the AP size needs to be set. The AP size is the size of each individual alignment box that will be placed on the image. The size of the AP you should choose depends on the quality and resolution of the image. For high resolution, you want to use a small AP size versus a larger AP size with lower resolution images. In this case I choose for a size of 40. Eventually, the minimal brightness of the APs can be set when choosing to automatically place the APs. It indicates the minimal brightness of the background the automatically placed APs must have at least. After setting that, click Place APs in Grid to have AS!2 place the APs on the image.

To clear APs, click the Clear button next to the AP count below Multiple (MAP).

Now, return to the main window of AS!2 and set the Output options in the right pane of the window. I usually choose TIF as output file format for the final stack(s), but you may want to choose for PNG. The Stack at frame number option allows to stack at a certain frame number, and the percentage option to stack (for example) the best 10% of all frames. It is possible to let AS!2 also include sharpened images by checking the appropriate box. This option exists to give an impression of the sharpness of a stack, rather than being a "final" image. By checking Save in Folders AS!2 saves the stacks in folders. In this case AS!2 will make only one folder for the 10% stacks. Using Single alignment point, it is possible to fill in more percentages/frame numbers and have AS!2 stack at all of those values. AS!2 will make more folders in that situation. In case of checking Sharpened images, a secondary folder will be created containing the convolved images. It is recommended to keep HQ Refine on, as it will ensure a more precise alignment of the frames. You are now ready to stack!

When you have "Save in Folders" selected, the images are saved to separate folders (depending on the settings), ALWAYS at the location of the image/video files you are loading. For example, given that the recording EXAMPLE.avi is located at C:\Users\User\Documents then the folders are created in that same folder, and could have the following path: C:\Users\User\Documents\AS_p50_Multi.

3. Stack the images.

The stacking process can take a while depending on the amount of frames, size and amount of APs and the available memory on the computer. The process of the steps AS!2 performs can be nicely followed.
First of all...

Jerry Lodrigus gave me permission to use this chapter on AutoStakkert!2 from his latest book A Guide to DSLR Planetary Imaging. The contents has been slightly modified by me.

This chapter only covers planetary imaging. In the future I will expand this to also include imaging of the Sun and Moon. In the meantime, I suggest you have a look at this excellent guide on Solar Image processing using AutoStakkert!2 written by Dennis Put. The same techniques discussed in that guide can be applied to Lunar image processing.

Emil Kraaikamp - October 5, 2012

AutoStakkert!2 - Planetary Imaging

**AutoStakkert!** by Emil Kraaikamp is a great freeware program for grading, aligning, and stacking planetary images. It will work with uncompressed AVI or SER videos, MJPEG AVI videos, or with a series of FIT, BMP, TIFF, PNG, or JPEG still frames. It supports both color and gray scale recordings. The program does not do any (wavelet) sharpening however, so to sharpen your stacks - and you likely have to perform this step - additional software is required.

AutoStakkert! currently lacks the ability to process most compressed movie formats. To convert compressed movie formats, one can use the freeware program **VirtualDub**. But if possible it is best to avoid using lossy compressed formats altogether, as the image quality likely will suffer from compression effects.

![AutoStakkert!2's Interface.](http://www.astrokraai.nl/software/manual/as2_planet.html)

Overview

- **AutoStakkert!** goes through a video, and analyzes each frame. It grades and sorts them based on a quality estimate that you specify - either edge sharpness or gradient sharpness.

- A reference frame is then created behind the scenes that is used as a template for alignment and stacking.

- You then select alignment points. You can use a single alignment point, but multiple alignment points usually work much better. You can do this manually, or let AutoStakkert! do it automatically.

- **AutoStakkert!** then aligns these points to the reference frame that was previously created and stacks the number of frames that you specify.

- A final aligned and stacked image is produced. A sharpened version of the aligned and stacked image can also be created at the same time, and can be used to preview the results.

**MOV files in AutoStakkert! ?**

If we shoot video in a DSLR camera, it is often saved in a MOV file format that must be converted to an AVI format for **AutoStakkert!** to work with. Some programs that record Live View will record directly in AVI format.
Unfortunately, there are lots of different flavors of AVI. Some will open directly in AutoStakkert! and some need to be opened and re-saved as an AVI in VirtualDub. Here is a list of those that will open directly:

- AVI converted from MOV in VirtualDub - opens without problems in AutoStakkert!
- AVI from EOS Camera Movie Record - needs to be converted in VirtualDub
- AVI from Backyard EOS - opens without problems in AutoStakkert!

Help! AutoStakkert! can't open my file!

If you find a file that you think should work in AutoStakkert!, please let me know!

Compressed AVI formats other than MJPEG will likely NOT be supported anytime soon.

1. Open the Video or Image Files

First click the large button on the top left of the operations screen labeled 1) Open. You can also click, drag and drop a file onto AutoStakkert!’s operation window. If you want to load a series of still images you have to click and drag and drop them.

If you hover your mouse cursor over an item, more information about it is usually revealed.

- **Image Stabilization Panel**
  - Select the type of image stabilization based on the type of image you are working with.
  - Select Planet (COG) for a planet like Jupiter. (COG) means "center of gravity".
    - Check Dynamic Background
  - Select Surface for lunar or solar surface detail such as craters and sunspots.
    - Expand - uses the maximum image size possible, but edges might not look good.
- **Crop** - crops to a smaller image where the alignment points are located, produces sharper edges.

- **Quality Estimator Panel**

  - Select **Gradient** for larger planets such as Saturn, Jupiter or Mars when it is larger than about 15 arc seconds. Each alignment point will use its own set of frames to stack, except when force global quality is selected.

  - Select **Edge** for smaller bright planets such as Venus, Mercury or Mars when it is smaller than about 15 arc seconds. All alignment points use the same frames to stack.

  - Set **Noise Robust** based on the amount of detail and noise in the video. If it contains very fine details and was taken in excellent seeing, use a lower number. If there is a lot of noise use a higher number.

  - Only check **Force Global Quality** if you use multiple alignment points and the stacked image shows seams. This will force AutoStakkert! to use the same subset of frames for stacking and should prevent seams from occurring.

For a planet with one sharp sunlit side, and the other side with a diffuse edge from a shadow terminator, such as this example of Venus as a crescent, use **Planet (COG)** as the Image Stabilization type, and select **Edge** as the Quality Estimator, and uncheck the boxes on the shadow side of the planet on the Quality Estimator.

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2. **Analyse the Images**

Before analyzing the image, take a look at the image display window. If the image of a planet is small in the frame, click and drag the **Set Size** sliders. You are **not required** to change the size, but I highly recommend it for planetary recordings. Cropping the image will significantly speed up the processing, and will also enable AutoStakkert! to filter out frames with missing information because the planet moved to the edge of the screen for example. If you change the size after analysis, it will be forced to run the analysis again when you stack.

Click on the large button at the bottom of the left hand column labeled **2) Analyse**.
AutoStakkert! will now examine and analyse each individual frame in the video and create a stack that will be used as a reference frame. This is a carefully created stack onto which all the alignment points for all frames will be aligned.

As AutoStakkert! analyzes the frames you will see a progress bar move across the bottom of the second column where information about the processes being conducted is displayed.

After the analysis is finished, AutoStakkert! will display a quality graph at the bottom of the information column. Two plots are superimposed on each other. The jagged up-and-down plot shows the frame quality in the order that the frames were shot - it shows the varying quality of the frames based on the seeing. The green line is a plot of the quality of the frames sorted by best quality first, then dropping off to lesser quality on the right.

- **Reference Frame Panel**
  
  The Reference Frame Panel specifies how the reference stack is created.

  - Last Stack is Reference - AutoStakkert! will use the last stack that was created if a set of images have been run through previously.

  - Auto Size (Quality Based) - The reference frame is created from the best set of frames automatically. This should be chosen the first time you work on a set of images. If you want a bit more control, you can uncheck this box, and manually select the amount of frames to use for the reference frame. Using more frames will result in a slightly better representation of the true form of the imaging target, but it also leads to a blurred reference frame that is more difficult to align on.

### 3. Set the Image Alignment Points

Now we will go to the image display box and set the image alignment points.
After the Analyse step that we performed above, the images are sorted by quality. By clicking and dragging the slider at the top of the image display box we can scroll through this sort.

If you click on the word **Frames** next to the slider, you can change the sort order to numerical. Clicking again changes the sort order back to quality.

You can also click and drag the **Set Size** sliders if the object of interest is small in the frame and crop down to it. This will increase the speed of the aligning and stacking, and allow for filtering of bad frames containing missing information. If you set these sliders now, it will also force the program to perform buffering and analysis again. So next time, it might be better to start cropping before analysis.

**Alignment Points**

- **Select a single** alignment point or **Multiple (MAP)** alignment points.
- The number of alignment points is displayed and there is a **Clear** button to remove all of the alignment points.
- **Manual Draw** - checking this allows you to manually draw an alignment point - click in the image to set an alignment point.
- **AP Size** (Alignment Point Size) - Use the up and down arrows to change the size of the alignment point boxes. Use smaller sizes for fine high-quality details. Use larger boxes for noisy images and/or those taken under poor seeing conditions.
- **Min Brightness** - Sets the minimum brightness of a feature in the image that can be used as an alignment point.
- **Place APs in Grid** click this button at the bottom of the left-hand column for **AutoStakkert!** to automatically place a series of alignment points in a grid.

**AutoStakkert!'s image display screen**
You can manually add alignment points in automatic multiple alignment mode by left clicking in the image. Right click to remove an alignment point. Use the mouse wheel to change the size of the alignment point. For planets I recommend the manual placement of alignment points. Make sure to not use APs that are too small, as the program will fail to align properly and you'll end up with a result that could have been much sharper if you used properly sized alignment points.

The results of manually placing APs on a slightly cropped image is shown below. It is often best to avoid placing APs near the edge of planets.

![AutoStakkert!'s image display screen with manually placed alignment points](image)

4. Stack the Images

Now we go back to the operations screen and work in the "Stack Options" column at right.

- **Stack Options Panel**
  - Select the file type you would like the stack to be saved in - TIFF or PNG. Both formats contain the exact same data, but the PNG images will be compressed (lossless, so no image is lost).
  - Select either the number of frames to stack, or a percentage of frames to be stacked. Here I have selected 10 percent of the 10,013 total frames to be stacked. You can also select multiple percentages and/or frame numbers if you want to find out which stack produces the best results for your images.
  - Check "Normalize Stack". This is useful if you have brightness variations from frame to frame due to things such as passing clouds or varying transparency. It will also make it easier to fine tune the color balance after processing multiple recordings, as each stack is forced to have the same final brightness.
  - Check "Sharpen Images" if you would like AutoStakkert! to apply a default sharpening to the image. If this is checked, AutoStakkert! will save two copies of the stack, one unsharpened and one sharpened.


- "Blend in Raw" allows you to specify a percentage of the original unsharpened raw file to be blended into the sharpened image.

- Check "Save in Folders" and add a prefix to the image file name if you would like.

**Advanced Settings Panel**

- Check "HQ Refine" (high quality) on unless you have an ancient computer or really know what you are doing. I recommend to ALWAYS leave this setting on, in fact, it will be hidden in a next release.

- Check drizzle if the images are undersampled or if you want a slightly larger image scale. Drizzling will increase the stacking time significantly, and most of the time it is not needed.

Finally, click the 3) Stack button at the bottom right-hand corner.

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*AutoStakkert! will now go through all of the images and align and stack them precisely. As it does this, you will see the progress indicators at the bottom of the middle column move, and a checklist in the center of this column get checked as each task is completed.*

The final stacked image, as well as a sharpened version, will be saved in a special folder in the directory with the original AVI file.
Hold your mouse cursor over the Jupiter image to see a comparison of the stacked image to the sharpened image. The image stack is from the best 10 percent of 10,013 total frames in 3 minutes of video of Jupiter shot with a C11 Edge at f/20 with 2x Televue Powermate Barlow in average seeing conditions using a Canon T2i (550D) and 640x480 Movie Crop Mode at 60fps shot at 1/60th of a second exposure at ISO 400.

Above we can see the potential of the data in the raw stack with AutoStakkert!'s default sharpening applied to it. There are more adjustments and enhancements that we can perform on the image that are covered in other sections of the book A Guide to DSLR Planetary Imaging by Jerry Lodriguss.

AutoStakkert!2 Tips from Emil

- It is best to stack only the frames with good quality. Don’t stack a lot of frames just to have a large stack. A stack with a smaller number of frames will be more noisy however. This gets back to the quality of the seeing. If you don’t have decent seeing for at least some moments while recording, you are not going to get very good results, no matter how many or how few frames you stack.

- For some objects, you will get better results by manually setting multiple alignments points.

- Add a bit of overlap to manually placed alignment points.

- Keep alignment points away from the edge of a planet.

- Alignment Point Size - Smaller alignment points are generally less stable than big ones. It is easy to lose track on a small part of an image, especially if it is very noisy or a dim feature, and if the seeing is poor. But potentially, smaller alignment points can track finer movements and provide better quality. That is an important trade-off here. It is actually possible to mix multiple alignment point sizes. If for example there is a small moon in front of Jupiter, add a small alignment point around it (and the shadow), and you’ll see the stacking improves quite a bit around the moon and shadow.

- For large planets like Jupiter and Saturn, with good detail in them and a large image scale, use around 30 alignment points with a size of about 75 to 125. This one is a bit tricky, as the size of the alignment points depends a lot on the imaging scale.

- For smaller details, such as the polar cap on Mars, or moon shadows on Jupiter, use extra alignment points with smaller sizes for those features, in addition to the existing alignment points with normal sizes.

- When planets are small, such as with Uranus or Neptune, use a single alignment point with a large area around the entire planet.
• For the Sun, always use the gradient quality estimator. Solar images that are correctly exposed usually have little noise. If the seeing is good and the detail is fine, use a smaller value of 2 for Noise Robust under the Quality Estimator.

• For images that have small fine detail, use smaller alignment points.

• For Saturn, use manual alignment point placement. Diagonal lines on the rings are not good places for alignment points. Place the alignment point on the rings to include a perpendicular feature like the edge of the planet, or the black space at the tips of the rings.

• Good alignment points can track a feature in two perpendicular directions. This is why alignment points placed near the limb of a planet don't work so well.

• For small bright objects like Venus and Mars, the edge quality estimator may work better than the gradient quality estimator.

• If you have problems with seams in the stacked image that are caused by poor transparency, use Forced Global Quality under the Quality Estimator panel. If the seams are caused by the alignment points being too small, use larger alignment points and re-stack the image.

This tutorial was done with AutoStakkert! version 2.1.0.5.