Princes Risborough U3A Photography Group - Photographing Star Tracks

Introduction

The objective of photographing star tracks is to record the stars in the rotating night sky such that the stars are recorded as circular arcs, as in this image:

Fig. 1

Back in the olden days

If we go back to the days of film-based photography, there was really only one way to try to do this – pointing the camera at the sky and holding the shutter open for a suitably long time.

This could certainly give interesting results, as this next image, an exposure of about 45 minutes taken in the Arizona desert in 1980, shows:

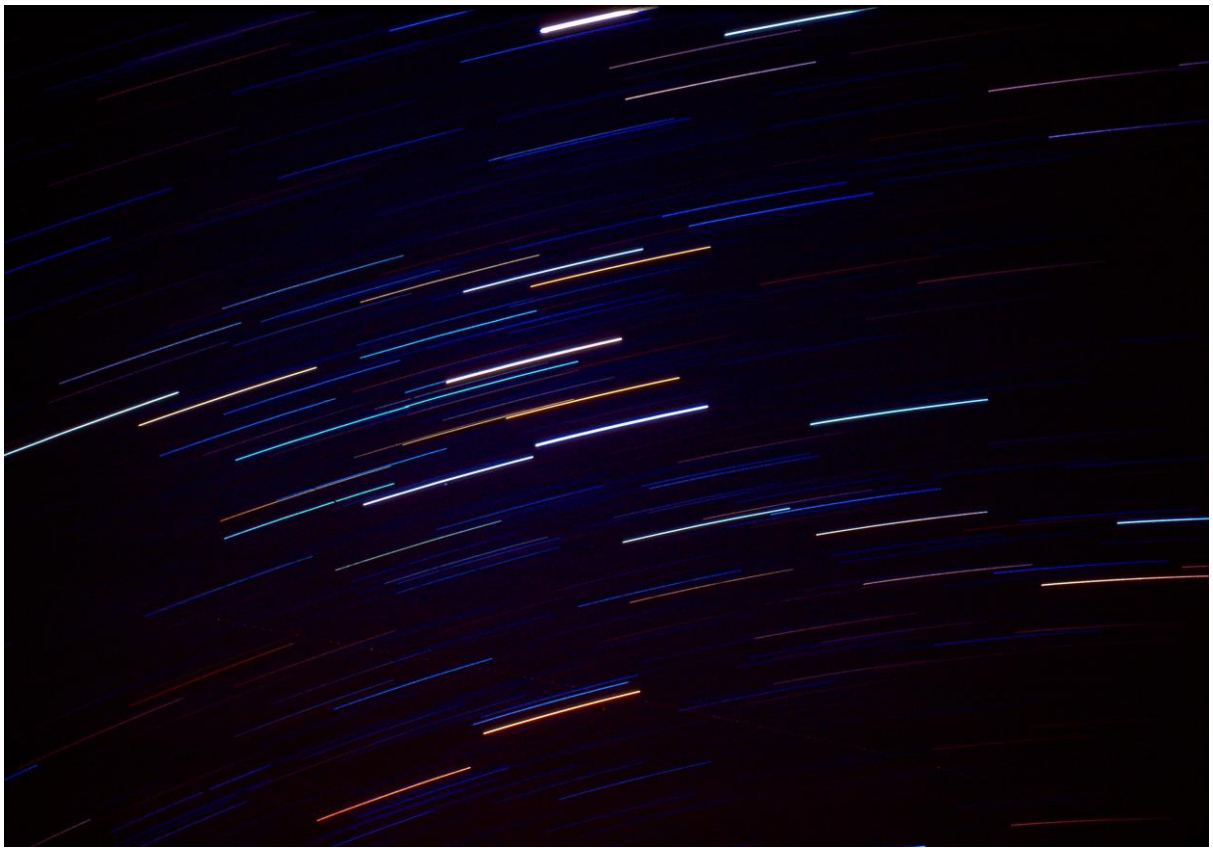

Fig. 2

However, this technique is limited. Although you can get away with it when you are far away from civilisation and have a clear, moonless night, if the moon is shining or you are somewhere like the southern UK then the light pollution will wash out the image before you can make a long enough exposure.

So to record star tracks around our area, you need to take a more sophisticated approach. The image in Fig. 1 was taken from the outskirts of High Wycombe, where there is plenty of light pollution from the town's lighting, close-by street lights, car headlights, etc., and the stars are hardly visible to the naked eye.

Outline of the technique

The technique that needs to be used is essentially to take a large number of exposures which are short enough to prevent light pollution from washing the image out. These photographs, and there may be hundreds of them, are then overlaid using a readily-available software package to provide a single image with the star tracks.

Equipment

To take the photographs you should ideally use a camera with a B (or Bulb) setting, which allows the shutter to be held open as long as you want. You should also be able to use a camera without a B setting if it offers long exposure times, such as 30 seconds.

It is not reallistic to expect the photographer to sit outside for perhaps 6 hours on a clear night to to tend the camera and make hundreds of exposures, one after the other. So an essential piece of equipment is a programmable timer, such as this one:

Fig. 3

There are quite a few of these available on Amazon, for example. Some of them have a cable connection to the camera, but I recommend one that uses a wireless connection because this also makes it a useful remote control for other purposes.

The significance of these timers is that you can easily programme them to take several hundred shots of a specified exposure time, so that once you have set this up you can go off to bed.

Unfortunately not all cameras can be used with these devices, so you need to check. The camera needs to have a socket that this timer can plus into – and you need to make sure that you buy a timer with the appropriate plug: you can see in Fig. 3 that this model has options for Canon and Nikon cameras.

You will also need a means of holding the camera rock-steady during the hours you are doing this over – such as a sturdy tripod.

Exposure Settings

You need to consider the exposure against two criteria:

1. recording the star tracks clearly

2. preventing light pollution from washing out the sky or making surrounding trees, buildings, etc. too bright.

Exposing for the star tracks

My advice is to get the star exposure right using a combination of aperture and ISO setting. You should experiment to find the best combination that appeals to you. For my shots in High Wycombe I have been using an aperture of f/2.8 (the maximum provided by the lenses I have been using) and an ISO setting of 200 (which provides optimum quality).

The length of exposure is essentially irrelevant to the exposure of the stars: because the stars are moving across the sky, after a few seconds they have moved to a different position on the sensor and so the exposure at the previous sensor location is no longer being increased.

Exposing for the background

Use the exposure time to adjust the darkness of the sky and the brightness of any trees, buildings, etc. that you include in your photograph. For my photographs at High Wycombe, I use exposure times of 30 or 60 seconds. If your exposure time is too long, you will get results like this:

Fig. 4

If you are well away from a built-up area you could use longer exposure times. Longer exposure times are useful because it means you have fewer gaps in the star tracks (i.e. the short period between exposures) and you can cover a longer period of

time – the timer shown above at Fig. 3 can be programmed for a maximum of 399 photographs, which means you are limited to about 3 hours if you are using 30-second exposures. (Mind you, your camera battery might run out before then, anyway!)

Other camera settings

Turn off the noise reduction settings – especially noise reduction for long exposures. Use of these features means that the camera has to process the images between exposures and so there will be a delay between exposures resulting in gaps in your star tracks.

Set the ISO to your chosen value – do not leave it on Auto.

If your camera has a B(ulb) setting, select that. If you are using a fixed shutter speed (say 30 seconds), then make sure your camera is set to Manual exposure.

Set focussing to manual.

Lenses

If you have a choice of lenses, then using a lens with a larger aperture will allow you to set lower ISO to maintain image quality.

The choice of focal length (or zoom setting) will depend on what you are trying to achieve. Fig. 1 was made using an ultra-wide angle 14mm lens on a full-frame camera (equivalent to about 9mm on a camera with a smaller APS-C sensor). This is great where you want to capture a wide area of sky plus some of your surroundings. Fig. 2 was taken using an f/1.4 50mm lens (equivalent to about 30mm on an APS-C sensor). On the other hand, the following image was made using a 200mm lens (equivalent to about 125mm on an APS-C sensor):

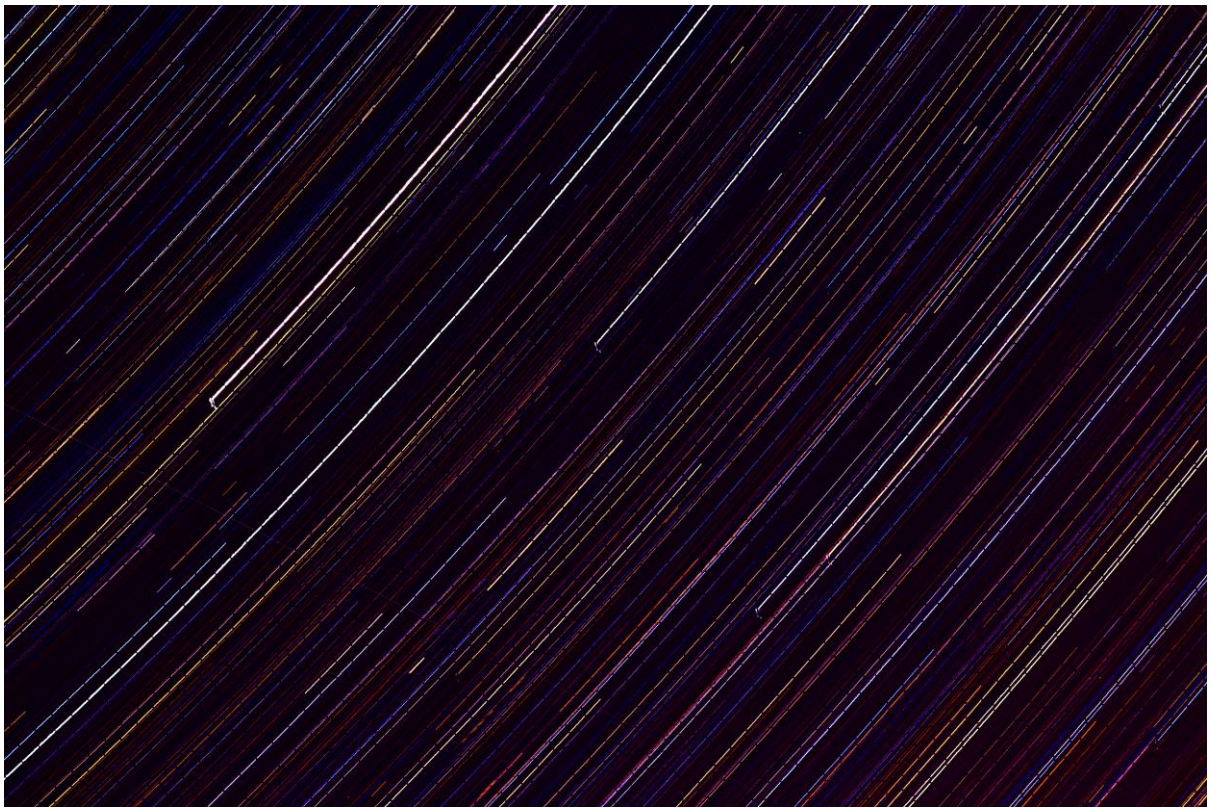

Fig. 5

This is better if you are just interested in the stars themselves, and shows the different colours well. But the gaps (between exposures) in the star tracks is more evident.

Focussing

The camera will not be able to manually focus on the stars. So you need to switch your camera/lens to manual focussing, and find a distant object (lights across town, or the moon) to focus on manually.

Composition

Decide what you want to include in your image and select the appropriate focal length of lens or the appropriate zoom setting. You may find it quite hard to see what you are taking through the viewfinder or on the LiveView screen.

Make sure that any bright light sources such as street lamps are out of view, and preferably position the camera in the shade of any such light sources.

If you want to get the centre of the stars' rotation (as in Fig. 1) you need to point the camera towards the north and include the Pole Star (Polaris). As I am astronomically-challenged, I had to find its location through trial and error.

Processing your results

In the morning you will hopefully find several hundred photographs in your camera, and you need to "stack" these to get your single composite image. You can stack images using

general purpose photo-processing software such as GIMP or Photoshop (Elements), but these are only practical for small numbers of images.

For star tracks, I use StarStax, which is free software available from http://www.markus-enzweiler.de/StarStaX/StarStaX.html . It does only one thing, stacking star track images – and it does it very well. It is very easy to use – you just drag your images into the StarStax window, and tell it to process them. It can take quite a few minutes, depending on how many images you have.

StarStax has two important features you may wish to use:

- Gap Gilling – to fill the gaps in the Star tracks caused by the intervals between exposures.
- Noise reduction by using "dark images". Random noise will appear in photographs taken with long shutter openings. This noise becomes worse as the exposure time increases and with cameras with smaller sensors. So the idea of this noise reduction function is that you take a number (say 10 or 20) of dark images – i.e. completely black images, typically by leaving the lens cap on the lens – with the same exposure time and ISO setting as your star images. You then load these dark images into StarStax, and the software subtracts the typical noise pattern it sees in these dark images from the star image. To be honest, with 60-second exposures on a full-frame sensor I don't see any benefit from this. But if you are using longer exposures and a camera with a smaller sensor then it might be worthwhile.

I generally process the image that StarStax provides in GIMP. I will generally increase the saturation to try to bring out the colours of the stars, darken the sky, and perhaps suppress the surroundings. In the images below, the original unprocessed result is at the top, and the final processed result is below:

Fig. 6

"Scratch Lines"

You may get what look like scratch marks on your results. You can see a couple going left-right in Fig. 4 and one going top-bottom towards the left of Fig. 6. These will almost certainly be tracks of aircraft crossing your field of view – if you look at them closely you will often see they are accompanied by spaced out dots, which are the flashing beacons on the aircraft. But if you are really lucky, you might have caught a meteor or meteorite!

Track gaps

If you have regularly spaced small gaps in your star tracks this is probably caused by the interval between exposures. There is probably at least a second between the shutter closing at the end of one exposure and opening again for the next exposure. And if you have noise reduction set on in the camera then the delay will be greater. (*Using the feature to reduce noise for long exposures is especially bad, because to do this the camera makes a second "dark" exposure (i.e. with no light reaching the sensor) of the same duration as the image-forming exposure.*)

Larger, irregular gaps in your star tracks are probably caused by clouds drifting across the sky during your sequence of exposures.

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