Re: A beginner question

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- *Date*: Mon, 11 Jun 2007 21:06:25 +1000

"Chris L Peterson" <clp@xxxxxxxxxxxxxxxxxx> wrote in message
news:u01p63leoukjm0m7rsmdq6fb051md0fb5n@xxxxxxxxxx

> On Mon, 11 Jun 2007 01:13:18 +1000, "Peter Webb"
> <webbfamily@xxxxxxxxxxxxxxxxxxxxxxxxxx> wrote:
>
>> Whilst I have not taken astronomical photographs, I have a pretty good understanding of optics. So I was surprised to find that I could find no way of calculating exposure times of astronomical objects (other than the moon) by comparison to terrestrial ISOs, f−stops etc. I note above that this is not the route you took to your solution. Can it be done that way?
>
> For the most part, no. The ISO setting on a digital camera is at best loosely related to the concept of film ISO values. In fact, using high ISO values with dim astronomical targets is rarely advantageous. That's because the important components of noise are amplified at the same rate as the signal.

Essentially then digital ISOs are analogous to push−processing on film. To somewhat extend the analogy, its like a "digital zoom" − no extra information is actually added.

> There can be some advantage to shooting at high ISO if
> you save to JPEG, but if you save to RAW (which you should always do with astronomical objects if your camera supports it) there is almost no difference between high and low ISO settings. Or to put it a little differently, you can shoot at low ISO and multiply all the pixel values by 2, 4, 8 etc in your image processing program, and get the same result as if you had shot at high ISO. That's _not_ the case with film.
>
> You can consider the effect of f−stops to be quite similar to ordinary terrestrial photography or imaging (assuming you are using the camera's lens). Each stop doubles the time required to get the same amount of signal, and more than doubles the time required to get the same S/N.

Sure. My issue was that I had two different "scales" in use in my head, and now way to calibrate between them. I know its much the same principles for astro and terrestrial photography (of course, no depth of field issues, point sources only, some others), but I had no way "in my head" of equating the two scales. When I looked at the question concerning a magnitude 5.8 object on a terrestrial camera, I had no scale to equate this to daytime photography. Unlike, for example, photographing the moon which is directly illuminated by the Sun. I don't even know how to work out the exposure etc for photographing the Sun directly (and nor would I try!); if I did, I could pull out an inverse square law and work out what would be needed for the Sun as a distant point source to be "resolved".

> > Anyway, that's a useful computation, and I now know that a 3mm aperture aperture will see the same objects as a human observer with a 2 second exposure. Did you assume an equivalent ISO rating for the CCD, or are you just assuming it is cranked up to the maximum in the calculation?
>
> As noted, the ISO is pretty meaningless. The basic S/N is determined by the number of photons collected, and that's the same regardless of how much amplification is applied between the sensor and the A/D (which is what the ISO setting controls). A few cameras apply the gain inside the sensor, which means you do get a slight edge on readout noise (which in that case is constant regardless of ISO setting). But usually, for longer exposures, readout noise isn't the major noise source.
>
> The situation is further confused by the sort of image processing that goes on inside the camera. Nearly all cameras (all Canon's for sure) subtract a computed dark frame, really a scaled bias, from the image. They do this even when shooting in raw mode. That changes the noise characteristics. Also, many cameras (but not Canon's in raw mode) apply filters to the data to make noise less visible, even though doing this also reduces the resolution of the image.

Presumably the camera optics are not much better than are needed to resolve to physical pixel size on the CCD array (what would be the point)? So presumably also the point source can easily spill over into adjacent pixels. Most digital cameras will let you reduce resolution − I wonder whether this improves sensitivity (as it does for film grain size). This is presumably whether they sum the baseline data from adjacent pixels to produce the lower resolution image. If they do, halving the total image size should provide a massive 1.5 dB gain.

Of course, this can as easily be done in post−processing, I guess?

Finally, and thankyou for your answers so far, a somewhat more technical one.

I am something of an expert on digital imaging as applied to business documents. I therefore know that JPEG compression produces bad artefacts on sharp edges ("ringing", effectively the digital equivalent of diffraction lines). Not a good look.

Is the intent to capture in each JPEG frame the "dark background" in sufficient resolution to add multiple images and decrease noise by summing? So is the JPEG really better considered as a map of the background noise rather than the foreground point sources, and the digital artefacts don't matter as much?

And if the JPEG contains the data to exactly reconstruct the original bitmap, then its hard to see how it could be much smaller than the bitmap. You have got to be chucking information away somewhere.

I assume that RAW is just that, the pixel values. Every camera I have owned in the last five years has it, wouldn't that be heaps better? (Although I have never used it, and until recently was prohibitively expensive in storage).

Finally, and again, thanks for your input thus far. This is a fascinating area − the interplay between optics and information theory.

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