Re: How many pixels?

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- *From*: Gary G <see.signature@bottom>
- *Date*: Thu, 20 Apr 2006 20:44:21 −0700

On Thu, 20 Apr 2006 15:38:59 GMT, "NoSpam" <NoSpam@xxxxxxxxxxx> wrote:

> "Gary G" <see.signature@bottom> wrote in message
> news:sq3e429itnv0erudkpelhrno9jjjpohik0@xxxxxxxxxx
>
> > On Thu, 20 Apr 2006 02:26:31 GMT, "NoSpam" <NoSpam@xxxxxxxxxxx>
> > wrote:
> >
> > > > What about final magnification at the
> > > > camera sensor? I.e., if the
> > > > oculars are 10X and the objective is 100X,
> > > > the final mag is 1,000X.
> > > > This assumes that the camera is parfocal
> > > > with the oculars (which can
> > > > be done).
> > > >
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>
> No, I am afraid a 10 times factor between the intermediate
> image and that at the CCD may only serve to adjust the size
> of the resolved elements in the image plane to the pixel size
> on the CCD. It will not increase the number of resolved elements
> on the object. This number is fixed once and for all by the
> objective lens(and its illumination).
>
> If the image formed by the objective consisting for example of

1000x1000 elements or pixels is accurately imaged onto a CCD of say 1000x1000 elements then you have a perfect match.

If you enlarge the 1000x1000 elements in the exit pupil of the objective so that they will cover an area 4 times larger than the 1000x1000CCD array, then each element resolved by the objective will cast\ its light upon 2 CCD elements. 75 % of the image will be lost. The remaining resolved elements will illuminate about 2 pixels with reduced energy flux but with the same color. This will not enhance or diminish the resolution of the device but decrease the portion of the object which is imaged. This portion will then appear enlarged but will not be better resolved. This is the case of empty magnification.

If the exit pupil is imaged upon a smaller number of pixels than the 1000x1000 array covers, then one of these pixels will receive more than one resolved element and the resolution achieved for this arrangement will be decreased. All of the imaged area is imaged, but at decreased resolution. In this case more magnifi−cation will give a better resolved picture.

Now the question will arise: why should it be that a microscope camera does not need all the many pixels which an ordinary digital camera may offer? The reason is that the objective in the ordinary digital camera has a linear resolution determined by the same formula as the objective lens in a microscope (lambda/2xNA). The linear size of the resolved element in the detector plane is therefore the same for all cameras with a lens of the same f−number. If the size of the detector array is larger, as it is for lenses of longer focal length, then there are more resolved elements in the image plane. An image of the same scene will be rendered at higher resolution in the camera with the larger array or longer focal length. (This of course supposes that the technology of the CCD array is comparable for the cameras being compared.) There is no intermediate image and no second magnification involved here.

One could enhance the number of useful pixels for a micros−cope in a similar fashion. One could possibly construct objective lenses at any of the current NAs with longer focal lengths. All of these objectives will resolve at identical linear distance. But the ones with the longer focal lengths will have larger intermediate images and at the same linear resolution would allow the use of CCDs with an increasing number of useable pixels. The disadvante is that for quadrupling the number of resolved pixels one would have to build micros−copes twice the size of the present scopes and about four times their weight.

That is great to know. so the final mag at the CCD makes no difference. Cool. So, can I use your analysis to help users select cameras and adapters? This would give them a great reference point.

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