Re: Smear

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- *From*: Phil Hobbs <pcdh@xxxxxxxxxxxxxxxxxxxxxxxxxxxxx>
- *Date*: Thu, 18 Oct 2007 20:51:13 −0400

Alan Hall wrote:

> In message <47179456.1080104@xxxxxxxxxxxxxxxxxxxxxxxxxxxx>, Phil Hobbs <pcdh@xxxxxxxxxxxxxxxxxxxxxxxxxxxx> writes
>
> > Manuel Kroehl wrote:
> >
> > > Alan Hall <usenet7@xxxxxxxxxxxxxx> wrote:
> > >
> > > > I agree this is not obvious at first. As you know, the smear that you are expecting to see occurs because the filled charge buckets, containing the exposed image, pass by pixel(s) which, for various reasons associated with the intense light exposure, cause leakage of extra charge into the passing charge buckets, increasing the exposure and causing the vertical smear.
> > > >
> > > > The smear in the opposite direction, which you are not expecting to see, happens for a similar reason. But in this case, the leakage is into the passing EMPTY charge buckets, which will later be used to transport the NEXT image. So in this case the unwanted leakage occurs FIRST and the image charge is added LATER. Does that make sense, it's a bit tricky to describe without waving my arms around?
> >
> > Thanks! It totally makes sense now. So the unexpected smear could be avoided
> > by "blanking" the buckets before the next charge? And on a single picture
> > there should be only the "expected" smear. You are good at explaining, even without arms.

> Regards
> Manuel

> In theory yes, but in my very limited experience (mainly Kodak CCDs) most CCDs don't allow you to do this. The "buckets" we are talking about are the charge readout shift register, not the photosensitive capture cells. There usually isn't any way to directly dump the charge in the shift register cells, only in the charge capture cells.
>
> However it may be possible to indirectly flush them by doing a special "dummy" readout. You run the readout shift register at high speed, without clocking out each line from the horizontal shift register. This is sometimes called "Fast Dump" mode. Of course you will still get some unwanted pre−charging of the cells, but since you are clocking the register perhaps hundreds of times faster than normal (because you are not waiting to shift the data our horizontally) the effect is a lot less than normal.
>
> You still get the smear opposite to the readout direction, so it may not be worth the trouble, depending on your application. I'm sure there are many weird and wonderful tricks in this area, the good ones probably quite secret.

I realize that it's a bit of a moot point, since you can't actually do what Manuel was talking about. The thermodynamics of CCD transfer are pretty interesting, and everyone should know about correlated double sampling and how it works...it's just too pretty to miss. It isn't quite something for nothing, but it's about as close as you can get.

> > You really really don't want to dump the bucket on each stage. The resulting uncorrelated kTC noise would destroy your low light level performance. It would be better to use a CMOS sensor or a CID, both of which are more bloom−resistant than a CCD.
> >
> > Cheers,
> >
> > Phil Hobbs
>
> For the avoidance of doubt, as I understand it (far from perfectly no doubt as this is not at all my speciality!) blooming is a different phenomenon to smearing. I understand blooming to be spillover from overloaded capture cells to adjacent capture cells during the exposure period. Hence it is unrelated to the readout shift register which now correctly carries the resulting erroneous charge from these neighbouring cells. Blooming can affect neighbouring cells in either axis, though it tends to follow the vertical structures in the silicon, leading to vertically−oriented elliptical artefacts.
>
> Smearing is specifically to do with leakage into the readout shift register, as previously described.
>
> All IMHO, as I say this is only a little bit of my day job!

Kind regards,

There's a bit of a terminological thicket here...AIUI, 'smear' is a specific, unidirectional problem caused by trap states freezing out in cooled CCDs. It leads to trailing streaks along the transfer direction. I understand the term 'bloom' to be charge leaking into adjacent pixels or transfer cells, more or less regardless of how it happens. I'm not really a CCD expert either, so probably we'd both better go look it up in Jim Janesick's magisterial book on the subject (which is at work).

Cheers,

Phil Hobbs
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