Weekly Report

John Anglo

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1 Tracking a star's brightness over time

Stars are expected to maintain constant brightness throughout their transit across the field of view of an imager, provided that the view is reasonably clear. I decided to test this, first by using existing methods and data to track the star.

I selected a track having a radius measured from last week, and found the star in every frame by selecting the local maximum pixel in the image. The first test involved simply plotting this pixel value over time. The results show that for a portion of the time that the star is visible, the pixel value is an average of 7337 ± 856.

Next, a small circle or square (I tried both) would then be drawn centred around the pixel in every frame, hopefully so that none of the star is left out. The average brightness of the contained area is recorded for each frame, and the time sequence is plotted. Here the average was 5008 ± 122, which suggests that too much of the background is incorporated into the average when the star is picked out this way, and that the background is more uniform than the maximum pixel value. I think it may be a matter of whether or not the star falls onto the CCD properly centered on any particular pixel. If so, the star would be represented well by the brightest pixel and possibly the eight pixels adjacent to it. If not, other selections would be necessary, such as a square of four if the star is captured at or near the point shared by four adjacent pixels.

When a star lands centered on a single pixel that pixel should be significantly brighter than any of its neighbors; if it lands close to the point shared by four pixels as mentioned before the four pixels should be close to uniformly bright, and less so than if a single pixel received most of that light. This may account for the apparent oscillation of the maximum pixel value in the first plot, since as the star moves across pixels it would alternate between being close to the center of a pixel and being close to the boundary between two pixels.

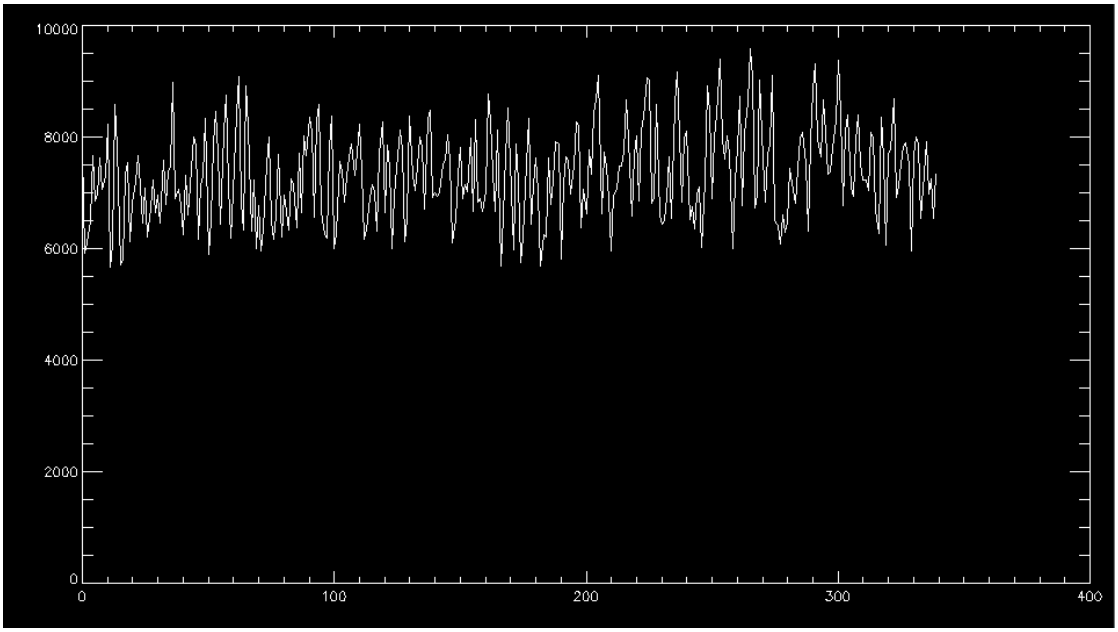

Figure 1: Maximum pixel value over time for a single selected star.

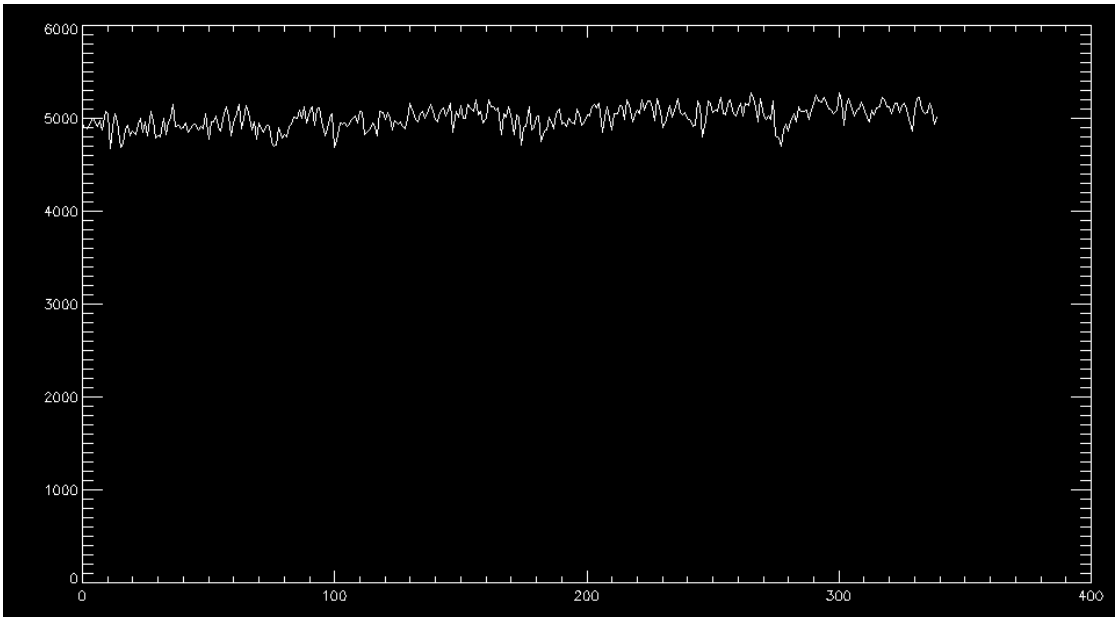

Figure 2: Average value of the maximum pixel and the four adjacent pixels. The average appears to be diluted greatly by the background compared to the maximum as shown in Figure 1.

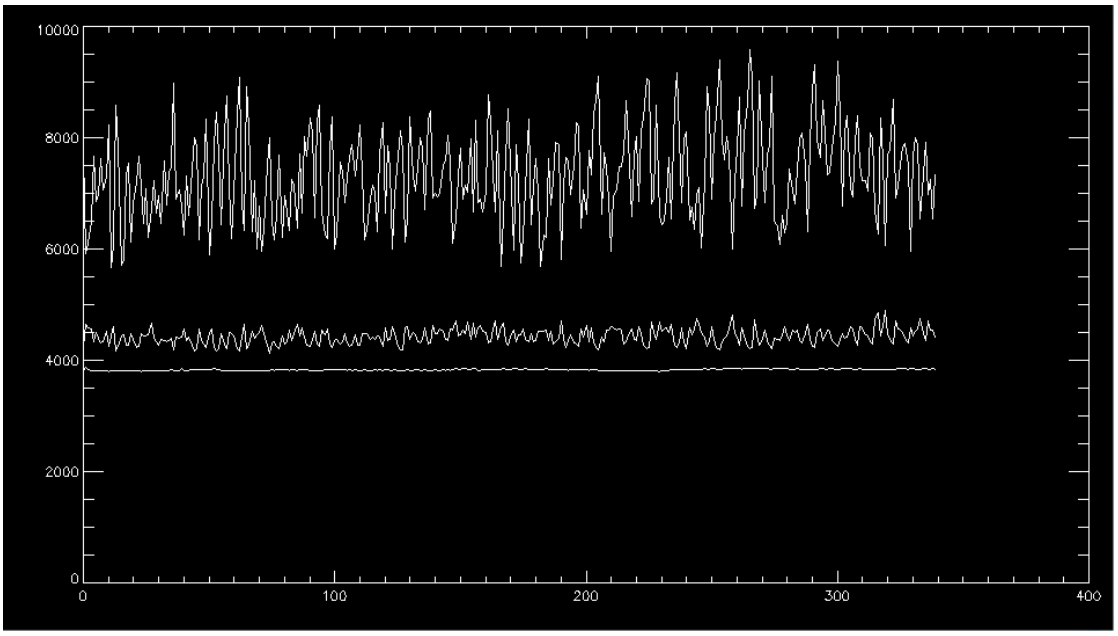

Figure 3: The plot in figure 1 (highest line), combined with a plot average of the four adjacent pixels without the maximum (middle line), and a plot of background values, taken as the pixel value of a point six pixels away from the star (lowest line). On average, the adjacent pixels seem to be closer in value to the background than to the maximum.