A Study of Kiwi Timestamps with the PC164C Video Camera
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Abstract

Kiwi timestamps provide millisecond readings of the start and end of the video sync signals corresponding to each video field. Although the true video exposure interval may differ slightly from this interval, the timestamps are assumed to be a good indication of the times of this video sync signal rounded down to the nearest millisecond. If the video camera is free-running, driven by its own oscillator, the sync signals should come out at regular intervals, with errors only due to the effect of rounding. In this report I use two independent methods to measure the error of the true time from the timestamp, and I find periodic departures of one and two milliseconds that are not consistent with rounding. Although this has little impact on occultation timing, it may impact other detailed timing studies that assume 1 ms accuracy of the timestamps.

Determining the error of Kiwi timestamps is difficult because it requires checking the timestamp value on each video frame and comparing it to a known reference. Although spot checks can be done manually by visually reading the timestamp from a few frames, a thorough study requires automatically reading all timestamps in a long series, and without error. The separate issue of a true time reference can be provided in two ways: Comparing the timestamps to a linear fit of their own values, and comparing them to a fit based on an accurately pulsing light.

If the fields are coming out at regular intervals in lock-step with a local oscillator on the video camera, then the error between the true time and the timestamp time should like like Figure 1:
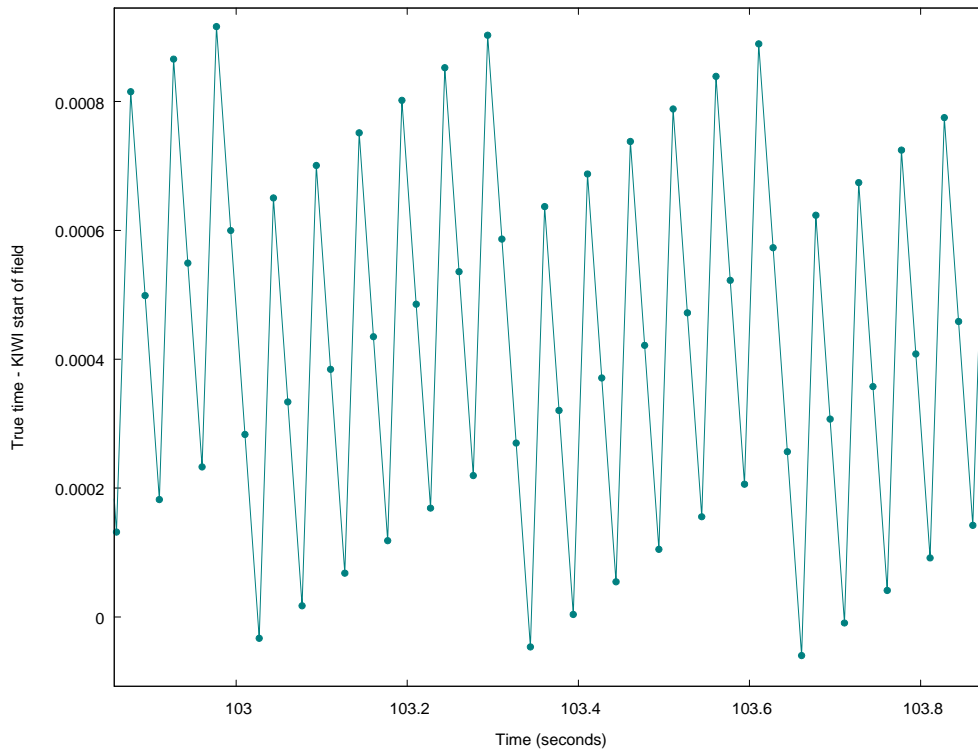

Figure 1. Expected error between true time and timestamp time caused by rounding down to nearest millisecond. The drift is caused by aliasing of the 59.94 fps NTSC frame rate.

Although locally the timestamps lag the true time, they should never lag by more than 1 ms due to rounding. A long recording of timestamps can then be fit to a line based on this model, and the error should show the behavior in Figure 1 over an arbitrarily long time period.

To test this, I wrote code to read the timestamp digits in each field since LiMovie could not parse them in my recordings. I also needed high confidence in each frame reading, so the error rate needed to be low. I recorded video direct to disk via a Dazzle usb capture device into Virtualdub. Note that testing the timestamps against a fit of themselves requires no video content at all since only the timestamps are used, and no reference blinking light. Also note that Virtualdub cannot introduce delays or alter the timestamps in any way since the timestamps are read directly from the video, and have been stamped prior to receipt by Virtualdub.

There have been several tests of timestamps to detect slight anomalies in their relation to the true exposure window, but to my knowledge this is the first study based on checking every time in a long series and comparing it to a reference. The result is shown in Figure 2:
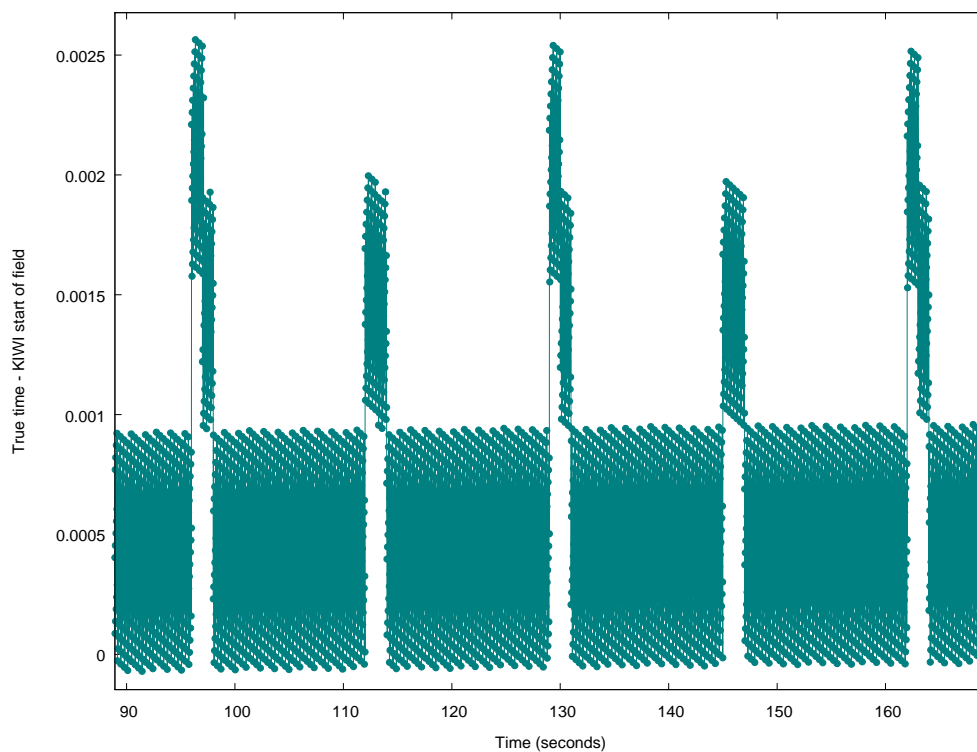

Figure 2. Actual result comparing timestamps to a linear fit of their values. The dominant range between 0 and 1 ms is expected, as shown in Figure 1, but the periodic errors of 1 and 2 ms are not.

Figure 2 shows that most timestamps are behaving as expected, but every 16.4 seconds there is a sudden error of 1 and/or 2 ms, which itself shows periodic behavior. Since the timestamp is expected to track the vertical sync signal, which itself should be very regular, this result is surprising. In a long series, occasionally this 16.4 s error does not occur.

I then did a separate check to a true reference time by fitting a pulsing light to a linear timebase, including sub-frame interpolation of the time to the millisecond level. I found the same periodic errors, suggesting this was a true error in the timestamp and not a periodic delay in the vertical sync signal. Note that the errors are periodic, but rare compared to the large number of times that behave as expected. This suggests the error may be common but not noticed yet since it would have evaded

spot checks. This may also be unique to NTSC cameras and not show at all with PAL cameras, or perhaps the time between errors is much larger with PAL because its frame rate more evenly fits an integer number of frames per second.

Although this issue should have no impact on normal occultation timing measurements, for which noise limits the accuracy to much greater than one millisecond, it does suggest an increased level of uncertainty in the time, beyond the presumed one millisecond.

Note that this error is not consistent with an error in reading the timestamps, because it is persistent over many frames, meaning the small digit of each timestamp has to be read off by one or two, which is an unlikely mode of error.

Despite this possible error in the timestamps, the fact that linear fits to the times agree with fits to a pulsing light suggests that the linear fit does give a good time reference at the millisecond level. Thus, although this issue may be present, it does not prevent sub-frame and even sub-millisecond measurements from being performed with video as long as appropriate steps are taken to reconstruct the true reference time.