ACTIVE OPTICAL SYSTEMS

AN034

AOS Adaptive Optics Software Speed Characterization

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Abstract

The speed of the AOS software depends on a wide variety of factors including the AO hardware, the computer speed, and the amount of available light. In this application note we report some of the results of testing we performed using AOS hardware and software.

Experimental Setup

For this experimentation we reflected a 532nm laser from a 5-actuator plate-type deformable mirror which was driven by a set of AOS Ethernet drive electronics and then illuminated an AOS Marlin F131B wavefront sensor constructed using a 150-micron pitch 6.7 mm focal length lens array. We did this testing with version 2.0 of the AOS software with the process priority set to high in the Windows 7 task manager. In all of these tests we used an NI 6269 card to trigger the Marlin wavefront sensor via the camera's external Hirose connector.

Speed Testing Results

We began with the wavefront sensor in Mode 7 set for 128x128 pixel resolution. At this resolution we were illuminating a 5x5 grid of sub-apertures. We tested the software's acquisition rate using the "Speed Test" button in the camera tab and obtained 292Hz frame rate. Then we tested the AOS AO software with no wavefront reconstruction and standard centroiding and obtained a 240Hz frame rate. We then measured a poke matrix, created a control matrix and performed AO control. The DM controller window was set to stop the user interface updates to minimize the drawing time. In this configuration we measured an average of 5.71 ms per iteration over 100 AO iterations for an average sample rate of 175Hz.

We then reduced the frame to 64x64 pixels which corresponded to 3x3 sub-apertures. At this resolution we were able to obtain frames at 440Hz. When processing to slopes we obtained a 420Hz frame rate. When performing 100 frames of AO, we measured an average period of 3.5ms (285Hz).

Pixel Resolution	Maximum Acquisition Rate (Hz)	Rate of Acquisition and Processing to Slopes (Hz)	Matrix Adaptive Sample Rate (Hz)
128x128	292	240	175
64x64	440	420	285

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When performing the AO testing, we sampled the camera trigger signal and one of the DM voltage channels on a high speed digital oscilloscope. Figure 1 shows results from the 64x64 pixel frame rate adaptive optics testing. The time from the trigger signal to the first write to the DM is 3.32ms. Because the DM drive electronics was sufficiently powerful, the analog signal was converged by the time the next frame acquisition was triggered.

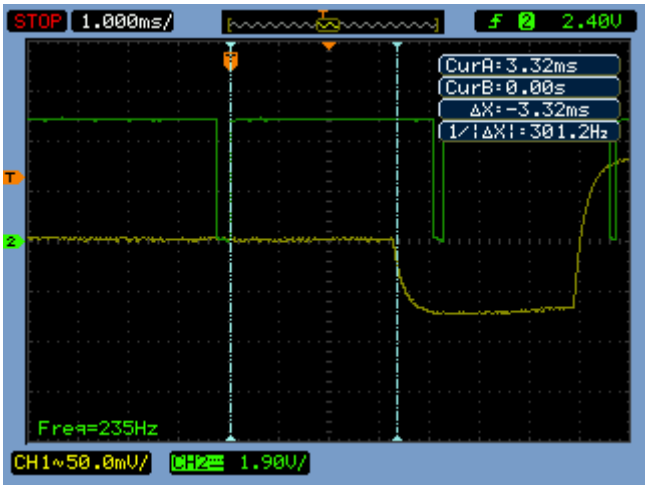

Figure 1 - Timing Results from the 64x64 pixel AO testing

Figure 2 shows a longer trace of the results from the 64x64 pixel AO testing when compensating a tilt term that was applied to the wavefront sensor after it was calibrated. The AO system converged in about 12 iterations. Based on this data, we can estimate a 27 Hz closed-loop bandwidth.

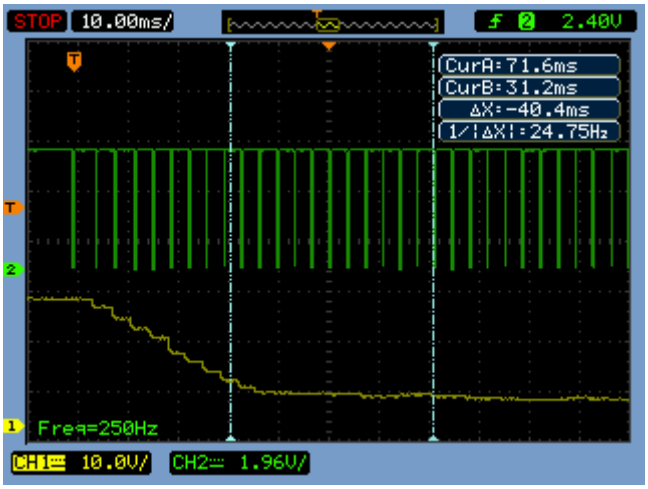

Figure 2 - Timing Results from the 64x64 pixel AO testing when compensating tilt

Conclusions

In this testing we found that we can achieve a reasonably fast frame rate even with performing slope processing and adaptive optics. With a small frame, we were able to achieve adaptive optics system sample rates of around 285 Hz.

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