

Undergraduate Research Project: Red Pitaya Instrumentation for Optics Research

JJ Modig

Abstract:

This semester, I was tasked with developing instrumentation for optical research in K-State's UNFO (Ultrafast Nonlinear Fiber Optics) laboratory led by Dr. Brian Washburn. The primary objective of research at UNFO is to use ultrafast laser pulses for gas spectroscopy. The device I worked with was a Red Pitaya. The Red Pitaya is an inexpensive, widely available and wallet-sized system-on-chip computer that has hardware suitable for scientific measurements. The end goal of this project is to use the Red Pitaya as an optical frequency comb phase stabilizer. That kind of device will be necessary for the future of the research in Dr. Washburn's lab. Analog methods of phase-locking an optical frequency comb require bulky and expensive hardware. More streamlined digital methods have been developed in recent years, but the hardware package is practically unobtainable. The Red Pitaya has the capabilities to act as one of these devices with some modifications. The first step towards this goal was to use the Red Pitaya to control one of the less complicated devices in the lab – in particular, our monochromator (a device that diffracts a beam of incident light and directs a tunable frequency component of that light onto a sensor). This is one step in the process of streamlining our means of running experiments in the lab. By documenting my progress on this project, I'm providing the lab with infrastructure to continue development with these devices.

I accomplished or made significant progress on these goals. I successfully developed and tested an independent control / data acquisition program for our monochromator on the Red Pitaya. Through that development process, I acquired skills that I may not learn in any of my classes. I am now competent with programming in a Linux environment, writing C programs for control and data acquisition, using various forms of serial communication between devices, and the basics of nonlinear fiber optics. I have also taken steps towards our final goal of using the Red Pitaya as an optical frequency comb phase stabilizer, but this was not completed. Instead, I have documented the steps that need to be taken so that this project can be continued any time.