Interfacing Pasco Sensors with the LabJack U3-HV

Timothy Niiler, Ph.D. tan13@psu.edu
Malick Fofana
Department of Physics, Penn State Brandywine,

Abstract

With recent budget cuts due to the economic situation, it has become increasingly difficult to maintain or replace failing electronics equipment in the physics lab. Other than computers, the most expensive equipment many labs maintain are their DAQ devices such as the Pasco Science Workshop 750. We demonstrate our successful integration of a lower cost alternative, the LabJack U3-HV, with our existent Pasco sensors. Our results include both easy to use open source data acquisition software for many out-of-the box labs as well as schematics for creating the requisite wiring harnesses needed for the Pasco-LabJack interface. Data collection is shown to be easier than with the DataStudio interface and extensible with modest scripting experience.

Introduction

The Pasco Science Workshop 750 (SW750) is, perhaps, the most commonly used data acquisition device in undergraduate physics labs. Despite this, it is an aging interface which has a significant number of downsides. For example, the serial to USB converter limits data collection rate to 4000 Hz, frequent disconnects between the device and computer cost students time, and finally failing current sensors limit its usage in certain labs. Additionally, the SW750 is expensive ($679 per unit) and funding is not available for repair or replacement. Due to this situation, we have decided to investigate the use of a low cost alternative to the Pasco SW750. The LabJack U3-HV is an excellent substitute because it accomplishes a variety of tasks more efficiently and at a lower price tag. For example, the LabJack U3-HV has more input/output channels, timers, and counters than the SW750 meaning that a greater number of sensors can be used concurrently. It also supports a number of communications protocols and its input stream rate ranges from 2.5 to 50 kHz making it much faster than the SW750. Furthermore, the LabJack U3-HV is one-seventh the price of the SW750 and can be accessed using Free/Libre and Open Source Software (FLOSS). The primary purpose of our research was to create hardware and software that enabled the use of the LabJack U3-HV with the existent Pasco sensors. To this end, we tested and built both digital and analog interfaces to connect the sensors to the LabJack U3-HV. Using the programming language Python and its modules labjackpython and matplotlib, we developed graphical user interfaces for the Pasco voltage sensor, photogate, photogate and picket fence, and force sensor.

Hardware and Software

This project involved building and testing hardware to interface with Pasco sensors as well as writing and testing some basic data acquisition code to acquire data.

Hardware
The hardware used in this project included the LabJack U3-HV and various Pasco sensors (Photogate, Picket Fence, Force Sensor, and Voltage Sensor).

- LabJack U3-HV
  USB/Ethernet based measurement and automation device

- Photogate
  Photogates allow for extremely accurate timing of events within physics experiments.

- Picket Fence
  A "Picket Fence" is a piece of clear plastic striped with black bars. The Picket Fence is dropped between a photogate.

- Force Sensor
  The Force Sensor is designed to measure both “pulling” and “pushing” forces.

- Voltage Sensor
  The Voltage Sensor provides a simple connection between an interface and an electronic circuit.

- Custom built analog and digital wire harnesses for interfacing with Pasco products

• Digital Wiring Harness

• Analog Harness

Pin	Signal
1)	ANA In (+) ± 10 V Max
2)	ANA In (-)± 10 V Max
3)	N/C
4)	+5 V, 100 mA
5)	Power Ground
6)	+12 V Power 50 mA total
7)	-12 V Power 50 mA total
8)	ANA Out

Software
The software used consisted of the LabJack drivers (UD driver for Windows and Exodriver for Linux) and Python and its modules LabJackPython and Matplotlib.

- Python Programming Language
  Python is a general-purpose, high-level programming language whose design philosophy emphasizes code readability.

- LabJackPython
  LabJackPython is a cross-platform Python module for communicating with LabJack devices.

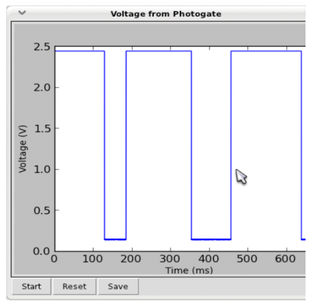
- Matplotlib
  Matplotlib is a python 2D plotting library which produces publication quality figures in a variety of hardcopy formats and interactive environments across platforms.

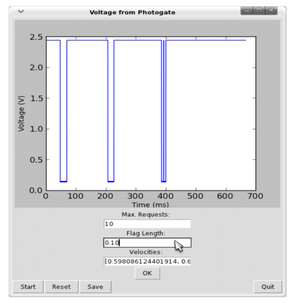
Current State of Work

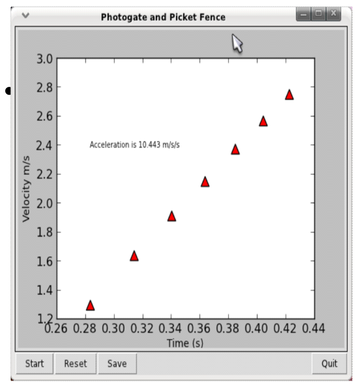
We have successfully created graphical user interfaces for the Pasco voltage sensor, photogate, photogate and picket fence, and force sensor.

- Photogate

A user can use basic acquisition to process data by hand or specify flag length to determine velocities in software.





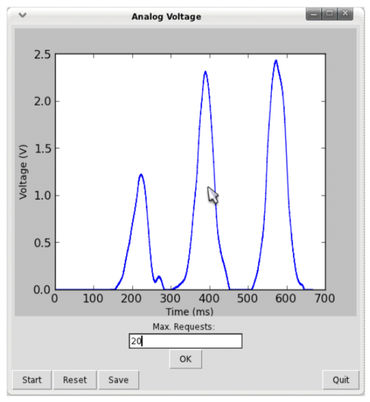


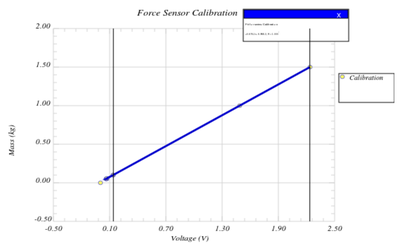
• Photogate and Picket Fence

Software automatically calculates velocities as each band passes through the photogate. A linear regression is done to determine the acceleration. Inaccuracy of internal clock (about 2.5% at 10,000 Hz, can lead to over estimation of g. This can be adjusted for programmatically.

• Voltage Sensor

This is the most trivial of the sensors as the LabJack basically **is** a voltage sensor. If, for some reason, one wishes to use the Pasco voltage probes, our wiring harness works.





• Force Sensor

Calibration to voltage level is required as with DataStudio. Calibration is stable and does not tend to drift from day to day.

Discussion

Although, the Pasco SW750 is more commonly used and can be easily adapted by less experienced instructors, it is more expensive than the LabJack interface. The current software we have developed for the interaction of the LabJack U3 with the Pasco sensors is alpha-quality: it is sufficient for testing and development or for more advanced physics students. With some additional time and external interest, we feel that it will be possible to develop a worthwhile and robust graphical user interface to the LabJack that spans a much larger number of Pasco sensors and laboratory exercises.

References

Pasco SW750: http://www.pasco.com/prodCatalog/CI/CI-7650_750-interface-usb/index.cfm
LabJack U3-LV: http://labjack.com/u3
Photogate: http://www.vernier.com/products/sensors/vpg-btd/
Picket Fence: https://wiki.brown.edu/confluence/display/PhysicsLabs/Picket+Fence
Force Sensor: http://www.pasco.com/prodCatalog/CI/CI-6537_force-sensor/
Voltage Sensor: http://www.pasco.com/prodCatalog/CI/CI-6503_voltage-sensor/
Python: http://www.python.org/
LabJackPython: http://labjack.com/support/labjackpython
Matplotlib:http://matplotlib.sourceforge.net/