Developing A Laser Diode Control System

CURE Program Summer 2010

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Abstract:

Measuring magnetic field in space is a major component of many NASA mission. JPL has produced magnetometers for many previous missions and is in the process of developing a new type of magnetometer, which requires a stabilized laser diode operating at 1083nm, corresponding to an optical line in the Helium atom. While laser diodes are extremely useful and versatile, they are not intrinsically stable. For our application, we need to have the diode operate at close to the center of the 1083nm transition of Helium, and so we need a method of stabilizing the diode. As part of this process during summer, we are developing a controller program to read data from a photodiode illuminated by the laser and to use this data to correct any change on the laser's wavelength. This involves programming a high speed data acquisition system in LabView that will be used to both obtain data from the photodiode and provide control signals for the laser.

Introduction:

LabView is a high level computer programming language that will be used in operating and regulating the temperature and wavelength systems of a laser diode attached to a vector helium magnetometer. LabView uses object-oriented methods to construct complicated programming in a basic and easy-to-use fashion. It has built in sub programs called virtual instruments to accomplish various tasks. These virtual instruments may be user-generated, program-generated, or altered depending on the necessity.

A USB device, the USB 2527 model, will transfer input and output signals from a LabView software program to the diode laser. This laser magnetometer replaces the traditional lamp light assembly with a laser to maintain a relatively stable wavelength around 1083nm, which is an absorption transition wavelength for helium. This project will simulate a prototype

of a new genre of vector helium magnetometers that will process large amounts of data on magnetic fields from special objects, namely the sun.

Goals:

The LabView control program is intended to support the laser diode functions and maintain stability for inner stellar analysis. The background sub programs built into LabView which are time efficient and less demanding on memory are also purposeful in gathering continuous and extensively more data than the previous magnetometer models. The goal is to gather more reliable and precise data than before under less time intervals.

Progress:

During the summer of 2010, the USB 2527 was tested for malfunctions by inputting and outputting analog and digital signals through external channels on the device. Once testing was completed, the usage of LabView software began with foreground input and output and then redesigned for background input and output programming. After separate programs were developed, a composition of all programs was generated for simultaneous input signals and output signals through the USB 2527 to simulate the throughput that it would do when tested with a laser diode.

The testing process was basic and initially began with the output of a sine wave created by a function generator to the USB 2527 analog input channel which was read by an already prepared oscilloscope virtual instrument program in LabView. After the analog input channels were checked, the analog output channels were tested using a created program to output a sine waveform sample from LabView to the USB 2527 device and attach an external oscilloscope to an output channel to view the results. After the analog I/O channels were confirmed to be working properly the programming began.

Foreground VIs were practice programs to make sure that the USB 2527 could read the software since it is not a specifically designed data acquisition device for LabView. Since LabView is effectively compatible with other data acquisition devices and not with this USB 2527 device, creativity was required to use the basic functions of LabView that are compatible with the USB 2527 to transmit analog signals to and from the device. Once the programs

worked successfully, background VI's were imbedded and configured to work with the USB device.

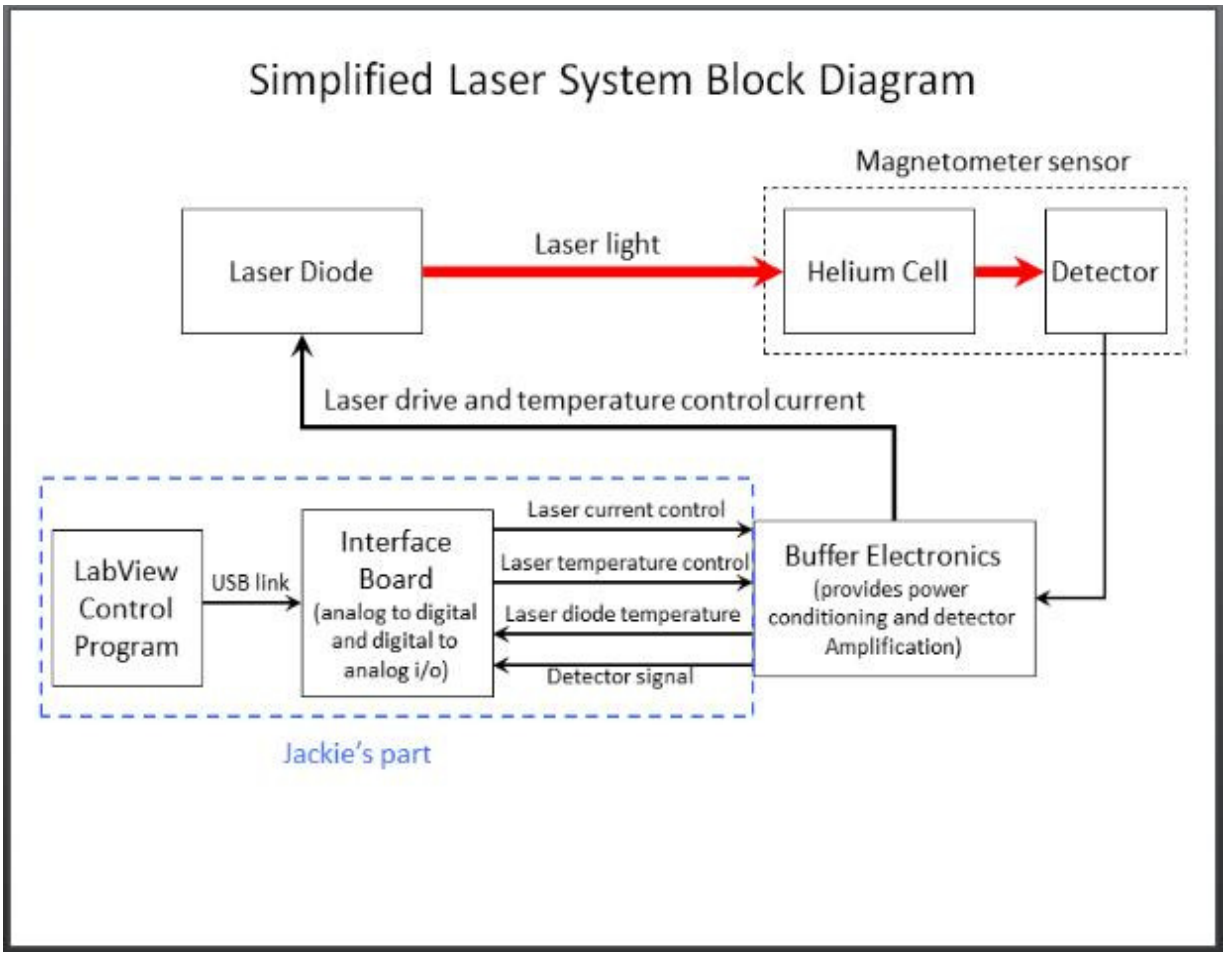
Results:

Finally, the individual programs for background input and background output analog signals were composed to generate a LabView program to input signals into the board and out from the board. Conversions to frequency and bit compatibility were made so that if a given frequency is input to the sine waveform in the software, it will output the same frequency on an external oscilloscope. The conversions are still being perfected and the full process of two signals being simultaneously input and output is still in construction.

Future Plans:

In offing, the LabView programs are intended to drive the controls of a diode laser in a vector helium magnetometer. This program will use two digital signals and output them into the USB 2527 device which uses built in analog-to-digital converters to convert the digital signals to analog signals. One digital signal is an output current signal to regulate the wavelength of the laser light. The second digital signal will be to monitor and control the temperature of the laser diode so that it does not overheat. The image below shows the components involved with and influenced by the software programming.

Once the USB 2527 converts the digital signals into analog signals they are read by the buffer and fed into the laser diode. The laser diode transmits the temperature it is at simultaneously. After the laser light travels through the helium cell, it is detected and the detector signal can be used to measure the variations from the initial wavelength emitted by the laser diode to the final wavelength detected. From this, the diode may be monitored for fluctuations in the laser wavelength and can be corrected.



During this summer, the LabView software appears to have potential in gathering large amounts of data at a faster rate and with more accuracy and options to the user. The LabView software generates digital waveforms that have a limited sample count range which interferes in frequency measurements on external devices at given intervals. However, overall the program is very malleable and versatile with what the project is requiring and looks highly prospective in future uses, namely controlling a laser diode.

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