Title: LIDAR System

Abstract:

We will be building a laser-based 1D distance imager, and characterizing and optimizing its performance. The goal is to surpass the range and accuracy of the current market time-of-flight LED imager (Bluetechnix Argos3D P100), which sits at approximately 5m and delivers distance reports with a 1-40% range of error depending on the reflecting surface. After the 1D distance imager is completed we can propose ways to assemble them into a coherent array of individual imagers, which can then be applied as a 3D imager.

**Research Plan**

Objective: We will be building a laser-based 1D distance imager, and characterizing and optimizing its performance. The goal is to surpass the range and accuracy of the current market time-of-flight LED imager (Bluetechnix Argos3D P100), which sits at approximately 5m and delivers distance reports with a 1-40% range of error depending on the reflecting surface. After the 1D distance imager is completed we can propose ways to assemble them into a coherent array of individual imagers, which can then be applied as a 3D imager.

Methods: 1.     Paperwork; introduction to lasers, E &M, and ranging systems; in-depth tours of lab setups, seeing and probing VCSELs on chips; start of independent review of non-technical literature on ranging systems towards making overview; safety quizzes

2.     GPIB control and data acquisition programming with oscilloscopes, function generators, keithleys, and Arroyo T-O can controllers in Matlab; show generating, capturing, plotting various signals; continue literature review, making notes along the way

3.     Aligning freespace optics for LIDAR setup; continue literature review, focusing on key figures of merit across different disciplines (OCT, LIDAR, commercial 3-D cameras)

4.     see signal through existing LIDAR setup with packaged laser; expand literature review into peer-reviewed literature

5.     Making first distance measurement with AMCW LIDAR, making testbench that qualifies accuracy versus known standards (micrometer movement, samples with known height features); making standard tests of resolution, range, other FOMs

6.     Upon return of SS-OCT laser, reintegrating SS-OCT system; comparative theory of AMCW, FMCW, SS-OCT; continue polishing LIDAR system

7.     Introduction to theory signal processing techniques beyond simple time of flight AMCW LIDAR: codes, modulation formats; rebuild standard SS-OCT system, learning LabVIEW and replacing or cleaning data acquisition and display code

8.     Integrating signal processing techniques for AMCW LIDAR and SS-OCT, showing improvement over naive methods (need not compete with state of art FOM's in any way, just show variety of techniques and evaluate improvement or decrease in FOMs);

9.     Continue designing, testing and evaluating signal processing techniques in AMCW and SS-OCT

10. Wrapup, documentation, plans for work after summer if wishing to continue; educating rest of group on the landscape of 3-d imaging techniques and comparisons of figures of merit and limits

Required Skills: Oscilloscope usage

MATLAB

3D camera operation

LASER/LIDAR operation

custom software usage

Required Knowledge: LASER/LIDAR mechanics

the various forms of LIDAR distance imaging

error analysis

Needed Skills: Physics (optics, electromagnetism)

electrical engineering for voltage testing and oscilloscope handling

effects of mirrors, glass, and various surfaces on error detection