Name: Alan Kilian Fall 2009 PIL 3251 – Project Registration

Title: Design and Construct a Phase Difference LASER Range Sensor.

Description:

This project will produce a Phase Difference LASER Rangefinder capable of determining the distance to an object by using a beam of light and measuring the light reflected off the object. This project will demonstrate proficiency using the knowledge and tools required to design, build and test a Phase Difference LASER Range Sensor. A 5-7 page paper will be written addressing the process used to design build and test the Phase Difference LASER Range Sensor.

Background and Rationale:

The successful completion of an Individualized Degree in Mechatronics requires an understanding of mechanical, electrical and computer systems as well as the tools used to design and implement each of these systems to produce a machine capable of performing a specific task. This project will allow me to learn these tools through self-paced experiential learning, the learning method which is most successful for me.

In this project I will design and build a Phase Difference LASER Range Sensor to measure the distance to an object.

- A Range Sensor: A mechanism which uses a method by which the distance between two objects can be determined. This may be a simple tool like a wooden stick with markings precisely applied placed between the two objects or a device which uses other physical phenomena to measure the distance between the two objects. This project intends to build a sensor capable of measuring the distance from the front of a garage to the front of an automobile as the automobile is driven into the garage. Such a sensor can aid the driver in parking far enough into the garage so that the garage door does not hit the back of the car when it is closed.

- LASER: A device that emits a narrow beam of bright light which can be made to change in brightness with an electronic signal.

- Phase: A measurement of the angle of an oscillating system. For example, the position of a child on a playground swing can be described by stating the phase of the swing where the phase changes from minimum when the child is as far back in the swing cycle as possible to maximum when the child is as far forward in the

swing cycle as possible. When the child is at the bottom of the swing the phase of the swing will be ½ the maximum phase.

- Phase Difference: The mathematical difference between two oscillating systems' phase. If two children swing on adjacent swings, they could be described as having a phase difference of zero when they are at the same position in their swing at the same time, or could be described as having a large phase difference if one child is at the maximum forward position when the other child is at the maximum rearward position.

A Phase Difference LASER Range Sensor uses a LASER to produce a bright beam of light. This beam of light is made to change its brightness by an electronic signal. This beam of light travels from the LASER through space at the speed of light and reflects off the object of which the distance is being measured and returns to a light detector located next to the LASER. By measuring the difference in phase between the outgoing light and the reflected light and knowing the speed of light in air, the distance to the object can be determined.

Objectives:

- To understand the design principles and mechanics of a Phase Difference LASER Range Sensor.
- To determine a measuring system that allows the Phase Difference LASER Range Sensor to measure the distance to an object.
- Design and construct a Phase Difference LASER Range Sensor.
- To test the Phase Difference LASER Range Sensor's measurement accuracy.
- To discuss the Phase Difference LASER Range Sensor's accuracy in relation to its ability to allow the driver of a car to position a car in a garage.

Methods:

- I will research possible measuring systems that will allow the sensor to measure the distance to an object.
- I will select a sensor system design.
- I will acquire or build the required parts.
- I will assemble and test the sensor system.
- I will write a 5-7 page project report discussing my results.

Results:

- The project will result in a Phase Difference LASER Range Sensor capable of measuring the distance to an object.
- A 5-7 page paper addressing the theoretical and conceptual framework that I used in the design and development of the sensor.

Schedule:

April 2001 - December 2001	Studied LASER range-finding measurement systems.	120 hours
January 2001 – December 2009	Tested several methods for generating LASER signals and measuring the reflected light.	80-120 Hours
January 2010 – December 2011	Designed and implemented the electronics for the final system.	200-300 Hours
November 2013	Write draft paper	40 Hours
October 2013	Edit final paper	16 Hours
October 2013	Submit paper to evaluator	4 Hours

Evaluator: Dr. Joseph J. Talghader, Department of Electrical and Computer Engineering, University of Minnesota, Minneapolis, Minnesota

Evaluation:

1. Please comment on how well the student understands the design principles and mechanics of a Phase Difference LASER Range Sensor.
2. How well did the student determine a measuring system that allows the Phase Difference LASER Range Sensor to measure the distance to an object?
3. How well did the student select electrical components, fabricate parts and assemble a working Phase Difference LASER Range Sensor?
4. Please comment on how well the student measured the accuracy of the Phase Difference LASER Range Sensor to determine the distance to an object.

5. Please comment on how well the student discussed the ability of the Phase Difference LASER Range Sensor's accuracy as it relates to allowing the driver of a car to position a car in a garage.

6. How does the quality of this project compare to other undergraduate projects of a similar nature?

Bibliography:

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Jain S. (2003) A survey of Laser Range Finding. Retrieved October 2011 from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.130.6167&rep=rep1&type=pdf

Nejad, S., Olyaee, S. (2006) Comparison of TOF, FMCW and Phase-Shift Laser Range-Finding Methods by Simulation and Measurement. *Quarterly Journal of Technology & Education, 1,* 12-18

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Philips Semiconductor (1990). 74HC/HCT7046A [Data sheet]. Retrieved November 10, 2012, from http://www.nxp.com/documents/data_sheet/74HC_HCT7046A_CNV.pdf