UNIVERSITI PUTRA MALAYSIA

IMPROVED RECEIVER SYSTEM FOR LASER RANGE FINDER

SOODEH ZAHAB SANIEI

IMPROVED RECEIVER SYSTEM FOR LASER RANGE FINDER

By

SOODEH ZAHAB SANIEI

Thesis Submitted to the School of Graduate Study, Universiti Putra Malaysia, In Fulfilment of the Requirements of the Degree of Master of Science

May 2010

DEDICATION

To

Presence of Imam zaman and My Beloved Leader
and
My family: Husband, Mother, and Father
For their endless support and love

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement of the degree of Master of Science

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May 2010

Chairman: Dr. Ing. Ahmad Fauzi Abas

Faculty: Engineering

This thesis discusses on the design and development of Laser Range Finder receiver for long range measurement application with concentration on Time of Flight (TOF) concept for range estimation. In TOF method, a laser pulse is emitted from transmitter through the target and the reflected pulse from the target would be detected in pulse detector circuit of the receiver adjacent to the transmitter. By measuring the time of flight of this pulse, the corresponding distance can be obtained.

The designed receiver of this research has two major parts. First is pulse detector circuit that is designed to operate with 50 ns pulse as the input, representing the output of photo diode at receiver that will be provided by pulse generator in this research. For variable sensitivity, which is necessary in long distance range finders, the pulse detector circuit was designed based on variable offset strategy together with variable detecting threshold instead of variable gain, as variable gain is more difficult in control with complex circuitry. For short distance, in which the reflected signal is less attenuated and background noise is stronger, the amount of added DC offset is

higher (so the difference between main signal and threshold increases), and for long distances it reduces gradually to zero. The main signal experiences variable offset before passed to the comparator to be detected. This is a very important part resulting in variable sensitivity in receiver. This signal will be compared to a variable detecting threshold in comparator.

The variable threshold voltage in the comparator consists of three parts. The first part produced by peak detector, is proportional to the amount of noise in the signal to eliminate its effect in detection, which contributes towards more accurate measurement. The second part is the output of low pass filter that acts as an integrator, which is the baseline of the signal. Finally, the third part is a DC voltage for eliminating the undesired voltages, which are the effects of inverter output (when it is saturated) and variable offset, in the output of integrator. Applying this variable threshold for reflected pulse detection results in reducing false detection and noise and eliminate dc effects.

Another part of receiver is counter that is designed and developed using Field-Programmable-Gated-Array (FPGA). FPGA does not only perform high accuracy timing but converts the time to corresponding distance as well. The frequency of operation is adjusted on 200 MHz. It means that the time intervals as short as 5 ns can be measured resulting in a distance accuracy of 0.75 m, which is a good accuracy for long distance measurement. The experimental results from pulse detector circuit show that applying variable offset leads to variable sensitivity and variable detecting threshold can reduce the effects of noise and DC offset in detection process. In

addition, by implementing this method, the circuit will be much more simplified and easy to control in comparison with common methods.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

IMPROVED RECEIVER SYSTEM FOR LASER RANGE FINDER

Oleh

SOODEH ZAHAB SANIEI

May 2010

Pengerusi: Dr. Ing. Ahmad Fauzi Abas.

Fakulti: Kejuruteraan

Penyelidikan ini membincangkan reka bentuk dan perkembangan bagi penerima pencari jarak laser untuk aplikasi pengukuran jarak jauh dengan penekanan konsep perjalanan masa bagi anggaran jarak. Dalam kaedah perjalanan masa, denyut laser dipancarkan daripada penghantar kepada sasaran dan denyut yang dipantulkan daripada sasaran akan dikesan di litar pengesan denyut pada penerima berhampiran penghantar. Jarak yang sama akan diperolehi dengan mengukur perjalanan masa bagi denyut ini.

Bahagian pertama penerima iaitu litar pengesan denyut direka bentuk untuk dikendalikan dengan 50 ns denyut sebagai input mewakili output fotodiod pada penerima yang dibekalkan oleh penghasil denyut. Untuk kepekaan pembolehubah, yang penting dalam pencari jarak yang jauh, direka bentuk berdasarkan strategi ofset pembolehubah selain dari mendapat pembolehubah, kerana mendapat pembolehubah lebih rumit dengan litar kompleks. Untuk jarak dekat, isyarat yang dipantul adalah kurang lemah dan hingar latar belakang lebih kukuh, jumlah DC ofset bertambah adalah lebih tinggi (jadi perbezaan antara isyarat utama dan ambang meningkat), dan

untuk jarak jauh ia berkurang secara beransur-ansur kepada sifar. Jumlah bunyi bising itu dalam isyarat boleh diukur dengan cekap dan kesannya akan dihapuskan, yang menyumbang ke arah pengukuran lebih tepat. Isyarat utama, yang diperkuatkan dan disongsangkan, akan mengalami ofset berubah-ubah sebelum hantar pembanding yang akan dikesan dengan melebihi voltan ambang. Ini merupakan satu bahagian penting memberi hasil dalam kepekaan pembolehubah dalam penerima.

Voltan ambang dalam pembanding terdiri daripada tiga bahagian. Bahagian pertama adalah berkadaran untuk jumlah bunyi bising itu dalam fotodiod output. Selepas menguatkan isyarat penerima daripada fotodiod, pengesan puncak menghasilkan bahagian ini. Bahagian kedua adalah output turas laluan rendah yang berfungsi sebagai pengamir, iaitu DC nilai isyarat selepas diterbalikkan. Akhir sekali, bahagian ketiga adalah satu DC voltan untuk menghapuskan voltan yang tidak diingini, yang merupakan kesan-kesan penyongsang output (apabila tepu) dan ofset pembolehubah, dalam output pengamir. Aplikasi pelbagai ambang untuk pengesan denyut mengurangkan pengesanan yang salah dan hingar, menghapuskan kesan DC dan juga membolehkan ia mengesan dua objek serentak.

Bahagian lain penerima adalah yang direka bentuk dan dibangunkan dengan menggunakan Field-Programmable-Gated-Array (FPGA). FPGA bukan sahaja menjalankan masa kejituan tinggi tetapi (juga menukarkan) masa (kepada jarak tertentu). Frekuensi operasi itu dilaraskan pada 200 MHz. Ia bermakna yang jarak-jarak waktu sependek 5 ns dapat disukat yang menghasilkan satu ketepatan jarak 0.75 m, iaitu ketepatan yang bagus untuk pengukuran jarak panjang.

ACKNOWLEDGEMENTS

First of all, I would like to express my greatest gratitude to ALLAH the almighty, for his help and support during the course of life and moment of truth.

Special thanks to my supervisor, Dr. Ing. Ahmad Fauzi Abas for his advice and guidance. His patience, frankness and encouragement helped me in the finishing this work. Many thanks are also due to my committee member, Prof. Mohd Adzir Mahdi.

In the last but not least, the greatest support came from my family; my husband, Mohsen; my Mother and Father; and my brothers, Ali and Hasan, for their endless love and continuous mental help.

I certify that an Examination Committee met on 13th May 2010 to conduct the final examination of **SOODEH ZAHAB SANIEI** on her master of Science thesis entitled "**DEVELOPMENT OF AN IMPROVED RECEIVER SYSTEM FOR LASER RANGE FINDER"** in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The committee recommends that the candidate be awarded the relevant degree. Members of Committee are as follow:

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This thesis submitted to the Senate of Universiti Putra Malaysia has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory committee were as follows:

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Date: 12 August 2010

DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institutions.

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SOODEH ZAHAB SANIEI

Date:

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