*M. T. Hussein et al., Iraqi J. Laser A 3, 19-22 (2004)*

Iraqi J. Laser, Part A, Vol. 3, pp. 19- 22 (2004)

**IRAQI JOURNAL OF LASER**

# Design and Construction of Semiconductor Laser Range Finder for Target Designation

**M. T. Hussein** **Z. A. Hafidh** and **B. R. Ali**

*Department of Physics, College of Science, Al-Mustansiriya University, Baghdad, IRAQ*

(Received 2 February 2003; accepted 7 February 2004)

**Abstract:** The aim of this research is to design and construct a semiconductor laser range finder operating in the near infrared range for ranging and designation. The main part of the range finder is the transmitter which is a semiconductor laser type GaAs of 0.904 μm wavelength with a beam expander, and the receiver with its collecting optics. The characteristics of transmitter pulse width were 200ns and threshold current 10 Amp. and maximum operating current 38 Amp. The repetition rate was set at 660 Hz and maximum output power about 1 watt. The divergence of the beam was $0.268^o$. A special computer code was used for optimum optical design and laser spot size analysis and for calculation of atmosphere attenuation.

## Introduction

A variety of techniques have been developed to achieve a laser range finder. Recently GaAs semiconductor laser of 0.904 μm was extensively used due to its compatibility in many applications for ranging measurement and designating of different target [1-3].

## Experimental

The present system consists of two parts; the transmitter (Fig. 1) which contains charging and discharging circuits as well as a fast switching trigger circuit (thyrestor). The main job of the trigger circuit is to operate the laser diode with a suitable pulse frequency limited by the value $f=1/R_1C_4$. The charging circuit provides a suitable pulse width and the output laser beam of the transmitter device passes through a beam expander of focal length (6.8 cm) with a lens diameter (3.2 cm). The beam trace was obtained by ZEMAX–EE 2000 Code as shown in Fig. (2) to achieve a small spot size and parallel beam with minimum divergence. The second part is the receiver (Fig. 3) which receives the collimated reflected beam by a Dume lens (as a fish eye) with focal length of 1.5 cm and lens diameter of 4.14 cm made of BK-7 type glass for optical transmission. The receiver circuit is triggered by the beam transmitted and, the reflected beam automatically records time duration.

## Results and Discussion

The transmission and reflection of the laser pulse were observed and detected by a night vision monitor. The laser spot size was systematically analyzed by MATLAB computer code. The analysis showed a uniformity of the intensity distribution as different color regions as shown in Figs. 4 and 5. The laser spot size showed broadening of over 10 times as photographed as indicated in these figures which compare the transmitted and reflected laser pulses.

The severe broadening of the reflected beam weakens the detected signal, which imperatively reflects the improvement of the sensitivity of the detected circuitry.

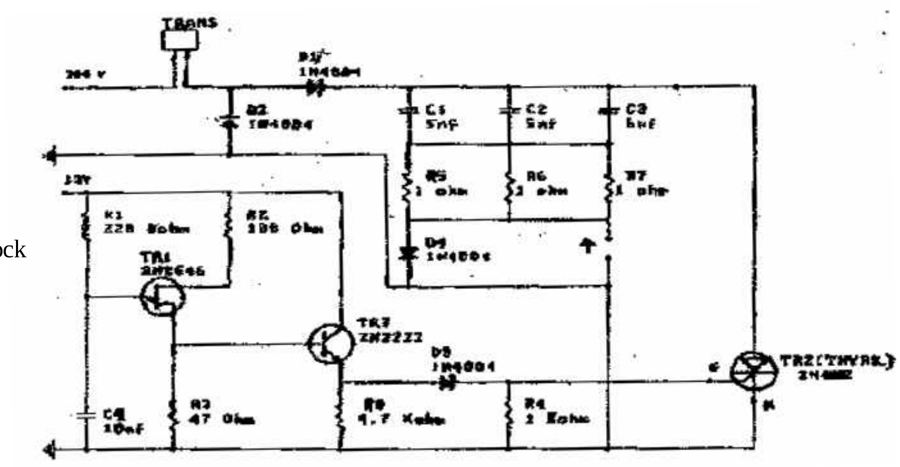

**Fig. (1):** Transmitter circuit block diagram of laser range finder

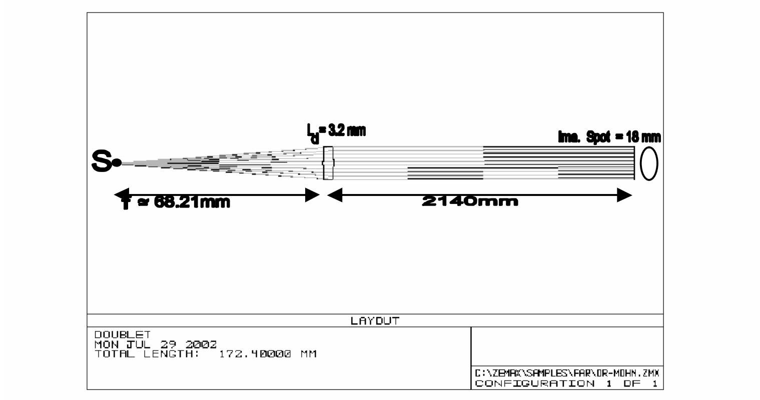


**Fig. (2):** Beam trace of output semiconductor laser range finder

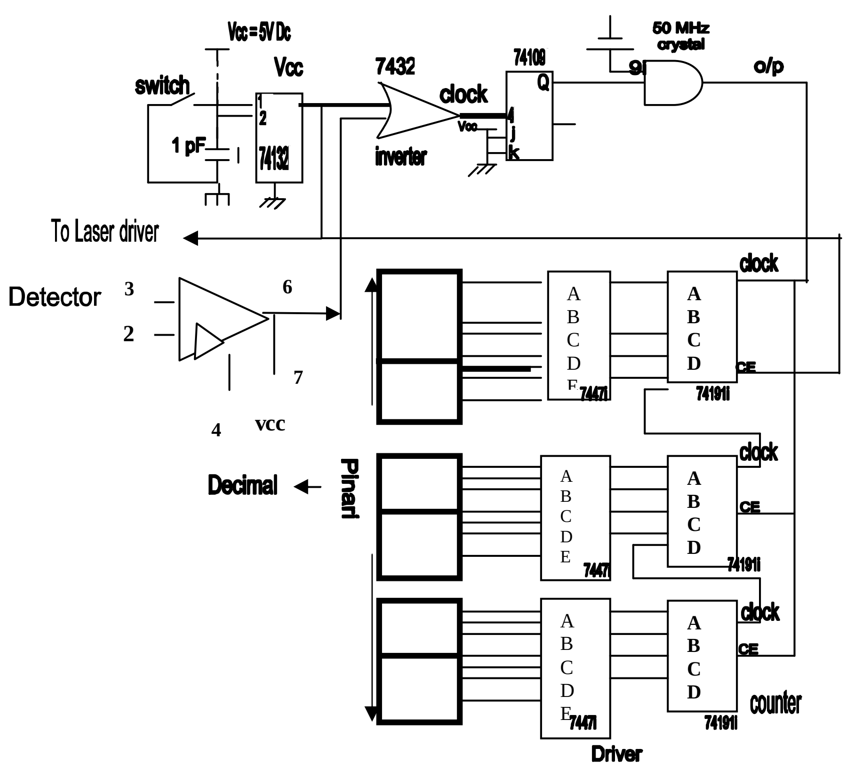


**Fig. 3:** Receiver circuit block diagram of laser range finder

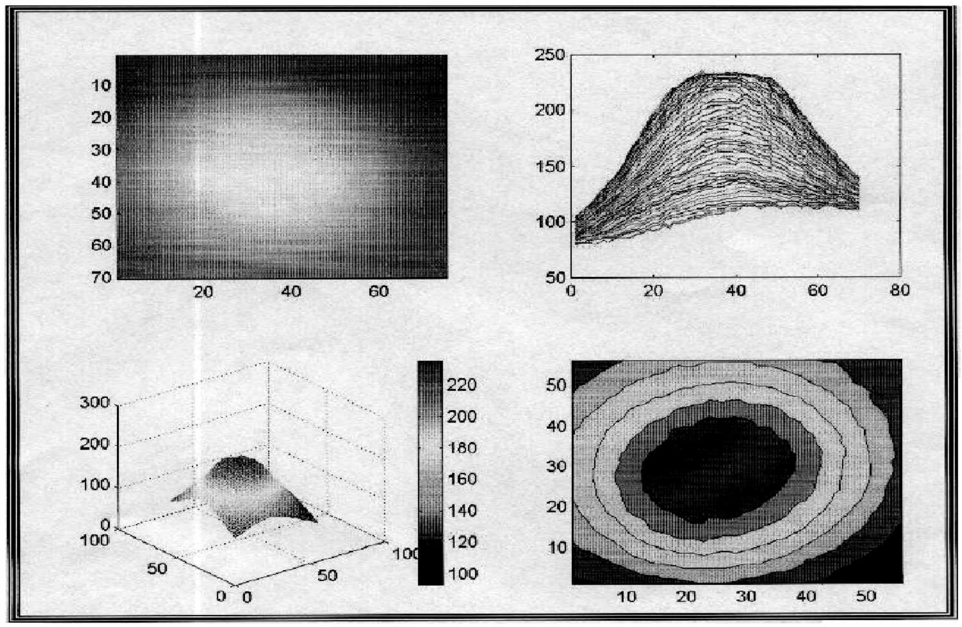

**Fig. 4:** Analysis of the transmitted laser pulse.

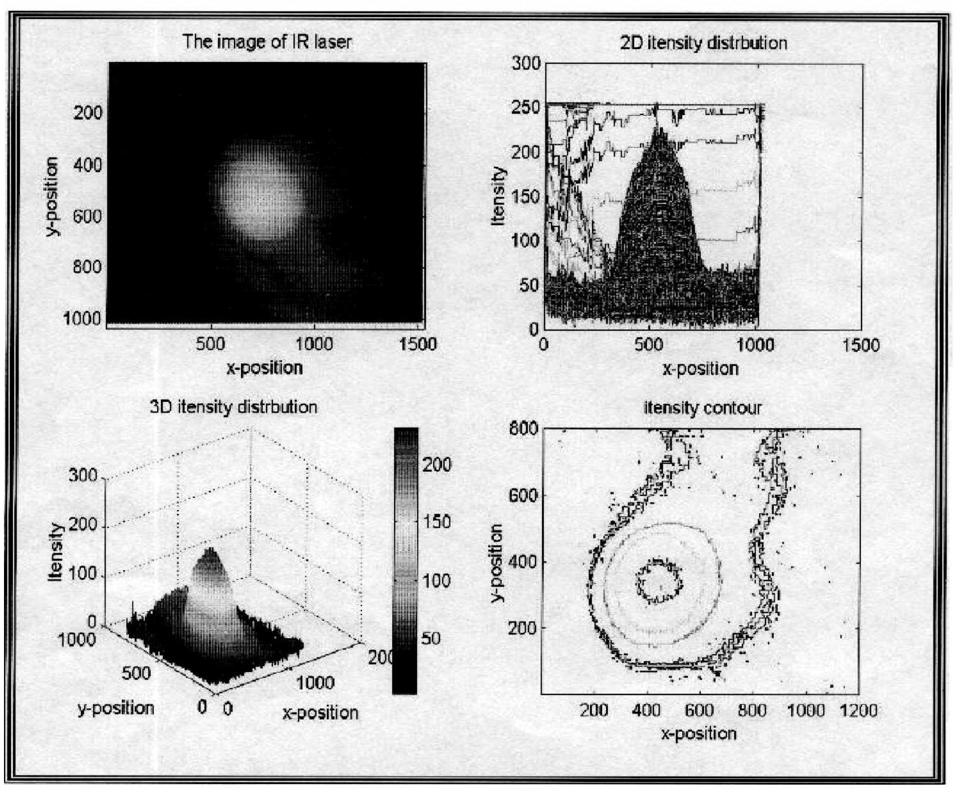


**Fig. 5:** Analysis of the reflected laser pulse

The results obtained of LOWTRAN-6 code indicate further expected attenuation of the transmitted laser pulse which further limits the range finder identification [4, 5]. The results of LOWTRAN-6 code are shown in Table 1 as transmission and absorption of particles in atmosphere while Fig. (6) shows the average transmittance of the laser pulse as a function of the atmospheric range .

Table 1: Results obtained from LOWTRAN-6 code

| Range (km) | Transmission of atmospheric suspended particles | Absorption of atmospheric suspended particles |
|---|---|---|
| 2 | 0.4173 | 0.6510 |
| 3 | 0.2696 | 0.0961 |
| 4 | 0.1739 | 0.1260 |
| 10 | 0.1260 | 0.2858 |
| 20 | 0.0002 | 0.4900 |

## Conclusion

The divergence of the diode laser limits its target selective identification which correspondingly affects the useful recorded distance as range finder. This high divergence limits the collimated effective spot for range finder as compared with minimum divergence type solid state laser which ranges to several kilometers.

The codes used proved its reliability in assessing the relevant optical geometry for minimum beam divergence which relatively confirms the beam attenuation of the order of 0.1 mW/m which was verified experimentally. The quality switching of the laser diode was imperative to increase the laser peak transmitted power to further extend the effective ranging.

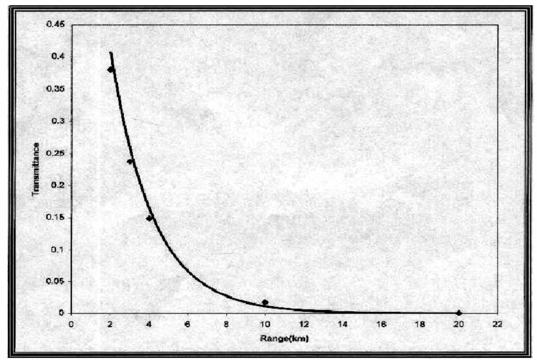


**Fig. 6:** Average transmittance vs. range

## References

[1] A. Korotkov, *A lidar system* (2003). Retrieved 15 Dec. 2003 from www. Ee.ucr.edu/dgiles/sendesign03/lider\

[2] TELEFUNKEN, *Lidar semiconductor* (1996). Retrieved 15 Dec. 2003 from www. chipdocs.com/ manufactores/TFUNK.html.

[3] M. E. Zucker, *Calibration of optical levers* (1999) Retrieved 21 Jan 2002 from www.Ligo.caltech.edu/docs/T/T990026-00

[4] P. A. Forrester and K.F. Hulme, Optical and Quant. Electr. ***13***, 259 (1981).

[5] V. F. Corcoran, SPIE ***227***, 54 (1980).

# تصميم وتصنيع مقدرة مدى لأشباه الموصلات الليزرية لتشخيص الاهداف

**محمد تقي حسين          زيدون أحمد حافظ          بان رشيد علي**

قسم الفيزياء ، كلية العلوم ، الجامعة المستنصرية ، بغداد ، العراق

**الخلاصة**

يهدف البحث الى تصميم وتصنيع مقدرة مدى لاشباه الموصلات الليزرية والعاملة بالاشعة تحت الحمراء القريبة لتحديد موقع وكشف الاهداف المختلفة . حيث تم تصميم وتصنيع العناصر الرئيسية لمقدرة المدى الليزرية والتي تتضمن المرسلة الليزرية حيث تم استخدام ليزر GaAs ذو الطول الموجي 0.904 مايكرومتر مع الاجزاء البصرية الخاصة به ( موسع الحزمة ) والمستقبلة والجزء البصري الخاص بها . وتم قياس مواصفات المرسلة حيث كان عرض النبضة 200 نانوثانية وتيار العتبة 10 امبير واعلى تيار للتشغيل 38 امبير وتردد 660 هيرتز والقدرة الخارجة بحدود 1 واط . تم قياس انفراجية الليزر وكانت بحدود 0.268 درجة . كما تم الاستعانة ببعض البرامج لاختيار التصميم البصري المناسب وكذلك لتحليل البقعة الخارجة والمنعكسة من السطوح المختلفة وكذلك حساب معامل التوهين الجوي .