

Sudan University of Science and Technology

College of graduate studies

Study of Nd:YAG Laser rangefinder design

**A thesis submitted to the Institute of laser as a partial
fulfillment of requirement for the degree of master in laser
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بسم الله الرحمن الرحيم

: قال تعالى

الذي عنده علم من الكتاب أنا آتيك به قبل أن ((يرتد إليك طرفك

الله العظيم

سورة النمل

الاية رقم 40

Dedication

To the my prophet Mohmmmed who brought us out from darkness of ignore to the light of Islam.

To my father Abd Alrahman my mother Mahasen and my brothers and sisters Maha, Sayed , Manal ,Ahmed,Osama and the youngest Aseel.

To my uncle Galal and his wife Enayaan .To all whom participated positively in my life.

Acknowledgement

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I thank my family without their encouragement and patience, I would never complete this research.

Thank you all

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Abstract

A laser range finder design was studied and the parameters affected the laser transmission in the atmosphere was presented.

Nd :YAG laser source $1.06\mu\text{m}$, 3300KW which, pumped by krypton arc lamp was selected to this work . The krypton arc lamp supplied from power supply circuit with a capacitor of $40\mu\text{f}$ and voltage of 1000V.

A computer program was built and run in order to investigate the atmospheric attenuation for laser beam.

InGaAs Avalanche photodiode has been selected as detector with responsivity of $(1.5-10.5)\text{Amp/W}$ for wavelengths $(.92-1.7)\mu\text{m}$. The optical receiving antenna was

designed and then all detector performing characteristics were calculated.

Another computer program was operated in order to investigate the amount of power received by the detector.

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الخلاصة

اختص هنا البحث بدراسة منظومة قياس المسافات بالليزر و العوامل المؤثرة علي الشعاع الليزري المرسل و تأثير طبقات الغلاف الجوي علي الشعاع.

اختير النيدنيوم ياق كمصدر ليزري ذي الطول الموجي 1.06 مايكرون و بقدرة 3300 كيلوواط. يضح المصدر الليزري بواسطة لمبة الكريتون التي تغذى من دائرة مصدر الامداد والتي تغذى من مكثف 40 ميكروفاراد وفرق جهد 1000 فولت.

انشأ برنامج كمبيوتر لدراسة التوهين الناتج من تأثير الغلاف الجوي للشعاع الليزري.

اختير الثنائي الضوئي المضاعف (انديوم-جاليوم-سيليكون) ككاشف ضوئي للمدى (0.92-1.7) ميكرون من الاطوال الموجية، و تم تصميم نظام الاستقبال البصري كما تم حساب خصائص العمل الظاهرية للكاشف.

انشأ برنامج اخر كمبيوتر لحساب الطاقة المستلمة بواسطة الكاشف.

References

- (1) Siham Kandela, laser in medicine, academic press, 1990
- (2) William T. Silfvast, laser fundamental, academic press, Cambridge university, 1996.
- (3) K.F. Hulme, P.A. Forrester, optical and quantum electronic, academic press, UK 1999.
- (4) Theodor Tamir, solid-state laser engineering, academic press, department of electrical engineering, university of Stanford, USA.
- (5) <http://cord.org/cm/leot/course/course01/mod01.01.htm>.
- (6) Svelto, principle of lasers, academic, press Plenum, New York, 1989

- (7) Ready, John ,industrial application of laser, academic press,department of electrical engineering, university of Polytechnic, USA,1997
- (8) Luxmoore.A.R, applied science ,academic press, New York, London, 1983.
- (9)Royal.S.R.S ,laser rangefinders, company press, 1981 April U K.
- (10) Harry, John E , industrial laser and their application, book company UK 1974.
- (11) Weast, Robert, hand book of lasers, company press, 1978._
- (12)Lee.T.P and T.L.Li, optical fiber telecommunication, academic press,1979.
- (13)A.Z AND E. Hench, optic, academic press, London, 1973.
- (14) Leher.G.G, laser tracking system, academic press, New York 1974
- (15) Sawsan, design and construction for laser tracking system, master research bagdad 2001.
- (16) M.R. Holter ,W.L. Wolf and G.J Zissis, Fundamental of infrared technology, academic press, New York 1962.
- (17) K.T.V Craitan and B.T.Eggit, optical fiber sensor technology, academicpress, 2000.
- (18) PH.D Gerd keise, optical fiber communication, academic press, university of Wisconsin, Boston,2000.
- (19)A. Rogalshi, infrared detector, academic press, university of technology, Warso.

(20) Budde. W, physical detector of optical radiation, academic press New York,1983

(21)Christopher C. Davis, laser and electro-optics and engineering, academic press,1990 .

(22)W.G. Driscoll, W. Vaughan, hand book of optic, academic press, optical society of America, 2000.

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