Sudan University of Science and Technology

Collage of Graduate Studies

(Institute of laser)

Unidirectional and Bidirectional Synchronization and Control in Chaotic Diode Laser

ألسيطرة والتزامن احادي الاتجاه وثنائي الاتجاه في الليزر الثنائي الفوضوي

A thesis submitted in a fulfillment of the requirements for the Degree of Ph.D. In Laser Physics

by

ALrabab Hassan Eisa Mohamed Ahmed

Supervisor

Prof. Kais. A. Al Naimee

Co-supervisor

Dr.Wafaa. S. Abdulrahman

Declaration

I will gift my effort to my father(Hassan)and my friend(Safaa)

souls

also to my family

then to my son Ahmed and my doughtier Ayah

Acknowledgments

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Abstract

This study aimed to control chaos from Amplitude modulation optoelectronic delayed feedback of diode laser, under 1GHz modulation frequency.

Also to control unidirectional synchronization and bidirectional synchronization by using Amplitude modulation optoelectronic delayed feedback of diode laser. The method which we used is simulation modeling adaptive the configuration of the optoelectronic delayed feedback of diode laser with amplitude modulation by using Berkeley Madonna software and Origin. The results showed the effect of small window modulation amplitude on the output dynamics when all other control parameters are kept constant at the chaotic operating condition. The transition from a chaotic spiking to stationary steady state and eventually periodic self-oscillations when the amplitude of the modulation varied was explained. Instability of the system was achieved. Also we derive and discuss synchronization conditions for (unidirectional, bidirectional) optically coupled lasers. These conditions ensure the existence and stability of a completely synchronized solution, i: e: perfect synchronization of identical lasers. A comparison between unidirectional and mutual coupling, for the identical synchronization case when all the other control parameter are kept constant was demonstrated.

المستخلص

الهدف من هذه الدراسه هوتقديم نموذج يحاكي نموذج التغذيه الخلفيه الراجعه باضافه تعديل السعه ثم التحكم في توليد اشارات فوضويه لجهاز الليزر دايود باستخدام التغذيه الخلفيه الراجعه معدله الاتساع وثبوت تردد التعديل (حوالي 1قيقا هيرز). وايضا دراسه حاله التزامن احادي الاتجاه وثنائي الاتجاه باستخدام نفس نموذج التغذيه الخلفيه الراجعه معدله السعه وثبوت تردد التعديل (صغيرحوالي4 هيرز).

الطريقه التي استخدمت في هذه الدراسه هو انموذج يحاكي نموذج التغذيه الخلفيه الراجعه معدله السعه باستخدام قيمه صغيرة للتردد وثبوت كل المواثرات الاخري لليزر دايود باستخدام برنامج سوفت وبير بريكلي مادونا مع برنامج التحليل اورجن.

والنتائج التي تحصلت عليها تظهر حاله انتقال النظام من حاله الفوضي العاليه الي حاله الاستقرار مرورا بالحاله الموجيه عندما تتغير السعه المعدله قد وضحت وايضا تظهر حاله عدم استقرار النظام بمنحني التفريع.

ومن النتائج الهامه هو دراسه حاله التزامن للمتذبذبين يستخدمان التزامن المثالي ويستخدمان تعديل السعه بطريقتين بطريقه الاتجاه الاحادي والثنائي وقارنا بينهما عند ثبوت التردد.

من خلال المقارنه تبين لنا ان التزامن احادي الاتجاه اكثر حساسيه من التزامن ثنائي الاتجاه في حاله تعديل السعه. وان التزامن ثنائي الاتجاه تدوم فترته الزمنيه اكثر من الاحادي الاتجاه.