Sudan University of Science and Technology

College of Graduate Studies

Laser chaos generation, modulation and synchronization by electro-optical feedback in communication systems

توليد شواش الليزر وتضمينه وتزامنه بواسطة التغذية الخلفية الضوئية - الكهربائية في نظم الاتصالات

A thesis

Submitted to Sudan University of Science and Technology in fulfillment of the requirements for the degree of Master in laser applications in communications

By

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March 2010 A.C 2nd
Rabee 1430 AH

الاهداء

الى:

جذوري ....العراق
الجبال الشامخة..... ابي و اخواني رحمهم الله
نهر العطاء.....امي اطال الله عمرها
النخلات الباسقات.....اخواتي وفقهن الله
زوجي العزيز.....قيس
زهرات حياتي.....بناتي زينب دانية رحمة

اهديهم جهدي المتواضع هذا

Acknowledgment

At the beginning, I thank GOD for his graces that enable me to continue the requirements of my study and overcome all the difficulties during the studying period.

I would like to express my thanks to my supervisor Prof. Nafie A. Al- Muslet for assisting me through the development of the work, and his guidance and useful comments on the manuscript.

My thanks are extended to the staff of the Iraq telecommunication and post company (ITPC) particularly the formal president Prof. O. Abdulhussien, Prof. W. A. Zainelaabidin, Prof. Ahlam, and Prof. K. A. Kabbani and to the Institute of the Telecommunication and post particularly the formal dean Prof. N. Y. Yakoop, present dean Prof. T. A. Baker, Prof. F. A. Hasson, Prof. S. Faisal, Prof. H. M. Habeeb and Prof. H. K. Ibrahim.

I present my thanks to the Iraqi cultural advisor (Rome) Prof. A. M. Taleb for his kindness' help.

I am very grateful to Prof. F. T. Arecchi, Prof. R. Meucci and Prof. Kais Al -Naimee at the CNR-INOA, Florence - Italy for supporting and helping me during the research period and gave me all scientific advising.

Finally, I would like to present my extreme appreciation to my husband, and daughters for supporting me during the study period.

Abstract

Chaotic dynamics are at the center of multiple studies to perfect encrypted communication systems. Indeed, the particular time evolution nature of chaotic signals constitutes the fundamentals of their application to secure the optical communications. The information coded on the carrier wave can be extracted with knowledge of the system dynamic evolution law.

The work presents the implementation of experimental chaos generation systems by means of electro-optic feedback of the semiconductor laser. The output photocurrent of the optical receiver is amplified and reinjected as a feedback to the semiconductor laser source. The injected feedback photocurrent produces a chaotic behavior in the laser output.

The change of the chaotic series and its jump from chaotic to periodic form depends on the initial operation condition of the laser diode and on the amplification of the injected feedback photocurrent. The chaotic signal has been used as a carrier for data transmission, the phase masking technique was used during the work. The data (message) signal was injected with the chaotic signal.

Finally, two of the chaotic laser systems have been established to find the synchronization between two chaotic attractors. This step was done in order to extract the encoded message via the chaotic laser system.

المستخلص

تعد ديناميكيا الشواش او الفوضى الحاصلة في الليزرات مركزا لدراسات متعددة تهدف الى تحقيق أمان تام للاتصالات الضوئية . فى الحقيقة، تُشكّلُ طبيعةَ تطورِ الإشاراتِ الفوضويةِ أساس لتطبيقِات ضمان أمان الإتصالاتِ بواسطة التشفير. يمكن استخلاص المعلومات المشفرة على الموجه الحاملة بمعرفةِ قانونِ تطورِ النظامَ الديناميكيَ.

في هذا البحث جرى تطبيقَ أنظمةِ توليدِ الفوضى تجريبياِ بواسطة التعليقاتِ الكهروِ البصريةِ في ليزرِ شبه الموصل.

يضخم التيار الكهروضوئي للمستقبل البصريٍ ويحقنُ ثانيةً كتغذية عكسية للمصدر الليزرِي شبه الموصل.ينتج التيارالكهروضوئي المغذى عكسيا سلوك فوضوي في خرج الليزرَ.

تغييرسلوك الفوضى او الشواش وقفزتِه مِنْ فوضويٍ إلى شكلِ دوريٍ يَعتمدُ على حالة التشغيل الابتدائية لليزر و على مقدار التكبير في تيار الحقن الكهروضوئي.

تم خلال العمل استعمال اشارة الشواش او الفوضى كأشارة حاملة لنقل المعلومات باسلوب قناع الطور ثم تحميل البيانات (رسالة) على الإشارةِ الفوضويةِ.

اخيرا , تم بناء نظامين فوضوييين لاجراء عملية التزامن بينهما كأساس لنظام اتصالات متكامل. تم عمل هذه الخطوة لاستخلاص البيانات المرسلة خلال نظام شواش (الفوضى) الليزري.

تم اختبار النظام بمعلمات مختلفة وأثبت نجاحه كنظام عالي الامان للاتصالات الضوئية.

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List of abbreviations

TDS	Theory of Dynamical Systems
DF	Maximum Frequency Deviation.
EM	Electromagnetic
GaAs	Gallium Arsenide
GaAlAs	Gallium Aluminum Arsenide
InP-InGaAsP	Indium Phosphate Gallium Aluminum Arsenide Phosphate
LED	Light Emitting Diode
APD	Avalanche Photodiode
OCS	Optical Chaos Synchronization
CS	Chaos Synchronization
EDFRL	Erbium-Doped Fiber Ring Laser
SL	Synchronization Link
SSU	Synchronization Supply Unit
PRC	Primary Reference Clock
MB	Maxwell- Bloch
DFB	Distributed Feedback
CW	Continuous Wave
MCL	Multi-Channel Lasers
NEP	Noise Equivalent Power
CMRR	Common Mode Rejection Ratio
PVG	Precision Voltage Generator
HC	Homoclinic Chaos

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