Proposta de dissertação

Chaos based optical communications

Proposta de dissertação de mestrado no âmbito dos projectos "Wireless-optical-wireless interfaces for picocellular access networks" e "Optoelectronic Oscillator Circuits for Communication Systems"

Since the discover, in 1961 by Edward Lorenz, what is now known as the butterfly effect, chaos became an essential research topic in biological, chemical, physical, and social sciences. With particular interest is the use of chaotic signals for information transmission. The use of the noise-like appearance of chaotic carriers gives a very efficient way to mask messages, and is considered a promising method to improve security in communications. Communication systems using chaotic optical carriers allow implementing steganography techniques at the physical level, which improves substantially the security of the software current encryption techniques. In such systems the receiver circuit, an identical version of the transmitter circuit, is synchronized with the chaotic emission to allow message decoding.

Following recent reports on chaotic dynamics in a new type of optoelectronic circuit, we propose an alternative laser diode system configuration capable of chaos generation based on the integration of a double-barrier quantum well (DBQW) resonant tunnelling diode (RTD) with a communications semiconductor laser diode (LD), the RTD-LD circuit/system. Such system takes advantage of the combination of RTD and LD intrinsic nonlinear dynamics, leading to substantial reduction of transmitter and receiver circuits' complexity and less restrictive operation conditions. The DBQW-RTD is a nonlinear nanoelectronic device capable to operate at room temperature as a high frequency voltage controlled oscillator (VCO), that shows wideband negative differential resistance allowing ultra-broadband electrical gain (currently up to 831 GHz), that when properly perturbed shows extremely complex non-linear dynamics. Preliminary results indicate this complex system can be an alternative to proposed optoelectronic chaotic generator systems. The investigation will comprehend the physics that leads to the system nonlinear dynamics and synchronization between two identical circuits, one acting as transmitter and the other as receiver.

Since the RTD-LD system is completely compatible with current optical communication systems, and because the combination of RTD nonlinear characteristics with LD dynamics reduces significantly operation conditions constraints of the laser diode necessary to produce high-dimensional chaos, it leads to straightforward chaos based optical communication systems implementation. The investigation will also allow a deeper insight into the theory of a new category of optoelectronic complex systems.

Participating Institutions

- Centro de Electrónica Optoelectrónica e Telecomunicações (CEOT/UAlg)
- Instituto de Engenharia de Sistemas e Computadores do Porto (INESC Porto/FE/UP)
- Department of Electronics and Electrical Engineering, University of Glasgow, UK
- Instituto de Microelectrónica de Sevilla, IMSE-CNM, Universidad de Sevilla, Spain

O projecto de dissertação poderá apoiado com uma bolsa de investigação.

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