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Chaotic Transmission System in Free Space

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Abstract: In this paper we numerically analyze a new scheme of secure chaotic transmission compatible with free-space optics technology for line-of-sight communication links. Chaotic behaviour and synchronization are based on current injection of a common chaotic signal into a pair of twin lasers, one at the transmitter, the other at the receiver.

1. Introduction

Optical chaotic cryptography [1] is being investigated for secure transmission in fiber networks. This method makes use of a matched pair of synchronized semiconductor lasers routed to chaos, one to hide, the other to recover a message. Transmission links based on free-space optics represent an interesting alternative to standard fiber optics links for small/medium private networks, for reconfigurable connections and for satellite to satellite communications. With such open space transmission, security is a key issue. Unfortunately, the standard chaos cryptographic schemes are difficult to implement in this case due to the strong attenuation of the unguided beam, which cannot be conveniently optically amplified. For this reason we propose a new scheme [2] where optical injection is replaced by electrical injection so that electrical amplification can be used. Similar three-laser schemes proposed so far employed optical injection [3].

2. The chaotic transmission system in free space

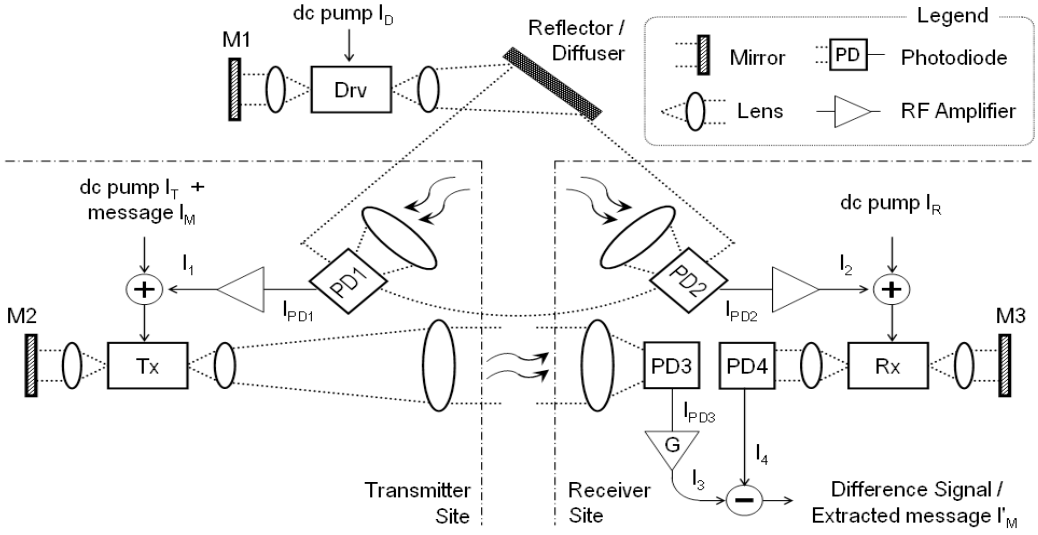

Fig.1 Scheme of the chaotic transmitter/receiver system in free space.

The proposed scheme is based on a chaotic laser (DRV), and two matched lasers, one at the transmitte (Tx) and another at the receiver (Rx) side. The DRV emission is collected by suitable optics, photodetected and electrically amplified before being injected into the TX and RX laser pumps. Under proper conditions, the matched lasers produce the same chaos, different, however, from that of the DRV. A message applied to the pump of the TX can be thus extracted at the RX by chaos subtraction, much as in the standard scheme.

The performances of such method have been investigated numerically, both with a baseband signal and with a carrier, demonstrating effective message masking and message recovery with operation in the line of sight. Laser and potodetection noise have been taken into account. The effect of parameter mismatch has been also considered for security assessment. Further investigations are required to evaluate the effect of the larger attenuation and of multipath dispersion in case of operation in the diffused regime.

3. References

[1] S. Donati and C. Mirasso, eds."Feature section onn optical chaos and applications to cryptography," JQE 38-9, 1137-1196 (2002).
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[3] T. Yamamoto et al., "Common–Chaotic-Signal Induced Synchronization in Semiconductor Lasers", Opt. Expr. 15-7, 3974-3980 (2007).