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Code Aided Extended Kalman Filtering for Mitigation of Transmission Impairments in Coherent Optical Communication Systems

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Coherent optical communication systems offer a great possibility to transmit high data throughput over several thousands of kilometers. However, fiber linear and nonlinear impairments degrade the transmission performance and therefore restrict the transmission reach and capacity. Although, the linear impairments including chromatic dispersion (CD) and polarization mode dispersion (PMD) can be compensated by the well-developed linear equalization techniques, fiber nonlinear effects still pose a challenging constraint on the transmission capacity. Moreover, phase and frequency offset between the transmitter and the local oscillator (LO) laser as well as the laser phase noise further deteriorate the system performance. In the recent era, Kalman filters have gained high attention for their capability to jointly mitigate several impairments, simultaneously. We have proposed a carrier phase and amplitude noise estimation (CPANE) algorithm using an extended Kalman filter (EKF). The EKF-CPANE algorithm has been investigated in detail for the mitigation of fiber nonlinearity, linear and nonlinear phase noise, frequency offsets, as well as polarization effects.

On the other hand, forward error correction (FEC) has been considered as a promising solution that ensures reliable transmission and therefore, has become an essential technology for coherent optical communication networks. By adding redundancy to the information bits while encoding, after transmission and reception, the FEC decoder will detect and correct the bit errors, if the errors are in the correction range. In this work, we propose an approach to incorporate FEC with the EKF-CPANE algorithm for error detection and correction exploiting the knowledge from both FEC as well as EKF-CPANE algorithm, to enhance the transmission performance. This approach is termed as code aided (CA) EKF-CPANE algorithm. We show that by employing simple error correcting codes and utilizing the parity check and error correction at the instant of decision making of EKF-CPANE algorithm, significant improvement can be obtained in the transmission performance.