

Systematic Method for Designing Constellations for Intensity-Modulated Optical Systems

Abstract

We consider the design of compact multisubcarrier constellations for intensity-modulated direct-detected optical systems. The constellations are designed to minimize the average electrical, average optical, and peak optical power for a given minimum distance between constellation points. We formulate the constellation design as a nonconvex optimization problem with second-order cone constraints, (nonconvex) quadratic constraints, and a convex objective function. We show that this problem can be relaxed to a (convex) second-order cone programming (SOCP) problem. We introduce a simple iterative method in which the SOCP relaxation is improved in each iteration. Several numerical simulation examples are provided to illustrate the effectiveness of our method. For the single-subcarrier case, the new constellations are compared with the best known formats in terms of power and spectral efficiency. Our new constellations outperform the corresponding face-centered cubic lattice and quadrature-amplitude-modulation-based constellations, with average electrical and optical power gains in the vicinity of 0.5 dB, for low symbol error rates. The corresponding peak optical power gains are also in the vicinity of 0.5 dB. By studying the mutual information inherent to the new constellations, we show that the potentials are still valid for coded systems. For the two-subcarrier case, we still outperform two-subcarrier schemes based on conventional constellations and optimized single-subcarrier constellations with the same dimensions.

Keywords: Compact multisubcarrier constellations Nonconvex optimization Convex objective function