Image completion with approximate convex hull tensor decomposition

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Many structural image completion methods are based on a low-rank approximation of the underlying image using matrix or tensor decomposition models. In this study, we assume that the image to be completed is represented by a multi-way array and can be approximated by a conical hull of subtensors in the observation space. If an observed tensor is near-separable along at least one mode, the extreme rays, represented by the selected subtensors, can be found by analyzing the corresponding convex hull. Following this assumption, we propose a geometric algorithm to address a low-rank image completion problem. The extreme rays are extracted with a segmented convex-hull algorithm that is suitable for performing noise-resistant non-negative tensor factorization. The coefficients of a conical combination of such rays are estimated using Douglas-Rachford splitting combined with the rank-two update least-squares algorithm. The proposed algorithm was applied to incomplete RGB images and hyperspectral arrays with a large number of randomly missing entries. Experiments confirm its good performance with respect to other well-known image completion methods, such as NMCSA, TMac, TCTF, SiLRTC, FaLRTC, and HaLRTC. Its computational complexity can be upper-bounded by $O(\xi \prod_{n=1}^{N} I_n J_n)$ for incomplete tensor $M \in R^{I_1 \times \ldots \times I_N}$ given the multi-linear rank $(J_1, \ldots, J_N)$.