# Blind decomposition of multispectral(RGB) image using sparse component analysis (SCA): clustering and $L^p$ regularization for $(0 < p \leq 1)$

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**Abstract.** Application of sparse component analysis to the blind decomposition of low-dimensional multi-spectral (RGB) images will be presented. We give static linear mixture model formulation:

$$\mathbf{X} = \mathbf{AS},$$

where $\mathbf{X} \in \mathbb{R}_+^{M \times T}$ represents observed multispectral image consisting of $M$ spectral bands (in RGB case $M = 3$) and $T = P \times Q$ pixels, $\mathbf{A} \in \mathbb{R}_+^{M \times N}$ represents mixing matrix and $\mathbf{S} \in \mathbb{R}_+^{N \times T}$ represents matrix of $N$ materials that are present in the image scene.

In the first stage of sparse component analysis, partial $k$ - dimensional subspace clustering algorithms will be applied to the estimation of the mixing matrix $\mathbf{A}$. We will especially consider cases when sparsity coefficients are $k = 1$ and $k = 2$. Second stage of this approach includes estimation of materials (matrix $\mathbf{S}$). Original problem of materials estimation is NP-hard combinatorial optimization problem. It assumes sparsity constraint on pixel footprints. First, we will consider linear programming formulation and give some theoretical and intuitive justifications. $L_1$ and $L_{1/2}$ regularization of the original problem will be also considered. $L_1$ regularized least square problem can be solved by means of interior point method. We will propose half thresholding algorithm for solving of $L_{1/2}$ regularization. Numerical experiments on all aforementioned algorithms will be also presented.

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