

9 Computational complexity of the new hierarchical tensor decomposition

In correspondence with [6], the computational complexity of new algorithm for decomposition of the tensor $[T_{2^n \times 2^n \times 2^n}]$, is $O(2^{4n})$. The comparison with the H-Tucker tensor decomposition $O(3 \times 2^{3n} + 3 \times 2^{4n})$ shows, that for the new decomposition it is approximately 3 times lower. But, the needed memory should be about 1/3 larger, than that for the H-Tucker tensor decomposition.

10 Conclusions

The basic advantages of the new approach for calculation of the hierarchical tensor decomposition, used to represent 3D images of various kind, are as follows:

- The offered HSVD algorithm, unlike the H-Tucker tensor decomposition, has lower computational complexity and does not need iterative calculations;
- In accordance with Eqs. (3) and (9), in each hierarchical level is executed repeatedly same decomposition of elementary tensors of size $2 \times 2 \times 2$, which permits their parallel calculation;
- The comparison with the famous tensor decompositions shows, that the HSVD algorithm opens new and better abilities to enhance the efficiency of the systems for real-time processing of 3D images, and also in the 3D computer vision systems and 3D objects recognition.

References:

- [1] H. Lu, K. Plataniotis, A. Venetsanopoulos, MPCA: Multilinear Principal Component Analysis of Tensor Objects, *IEEE Transactions on Neural Networks*, Vol. 19, No 1, January 2008, pp. 18-39.
- [2] G. Bergqvist, E. Larsson, The Higher-Order Singular Value Decomposition: Theory and an Application, *IEEE Signal Processing Magazine*, Vol. 27, Iss. 3, 2010, pp. 151-154.
- [3] A. Cichocki, D. Mandic, A. Phan, C. Caiafa, G. Zhou, Q. Zhao, L. De Lathauwer, Tensor Decompositions for Signal Processing Applications, *IEEE Signal Processing Magazine*, Vol. 32, Iss. 2, 2015, pp. 145-163.
- [4] L. De Lathauwer, B. De Moor, and J. Vandewalle, A Multilinear Singular Value Decomposition, *SIAM Journal of Matrix Analysis and Applications*, Vol. 24, 2000, pp. 1253–1278.
- [5] R. Kountchev, R. Kountcheva, Radix- (2×2) Hierarchical SVD for multi-dimensional images, *Proc. of the IEEE Intern. Conf. on Telecommunications in Modern Satellite, Cable and Broadcasting Services (TELSIKS'15)*, Nis, Serbia, Oct. 2015, pp. 45-55.
- [6] R. Kountchev, R. Kountcheva, Hierarchical Decomposition of 2D/3D Images, based on SVD 2×2 , *International J. of Multimedia and Image Processing (IJMIP)*, Vol. 5, Iss. 3/4, September/December 2015, pp. 286-296.