Matrix decomposition algorithms for two types of quaternions and their applications

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With the increasing application of quaternions in fields such as quantum mechanics, rigid body rotation, aerospace engineering, signal and color image processing, and artificial intelligence, 3D signal and color image models represented by quaternion matrices have emerged. This model treats 3D information as a whole, and the processing preserves the intrinsic connections among different channels, providing a new algebraic framework for solving problems with multidimensional data.

This report will discuss my research, which formed the basis of my PhD thesis, including the development, theoretical justification, and numerical implementation of efficient computational algorithms for solving certain matrix decomposition problems. The low-rank decomposition of pure imaginary quaternion matrices, the full rank decomposition of quaternion matrices, the generalized eigen-decomposition and the singular value decomposition of split quaternion matrices, etc. are considered. In addition, some new computational algorithms are presented that combine the algorithms described above with current signal and color image processing problems.