

On minor prime factorization for rank-deficient multivariate polynomial matrices

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Multivariate polynomial matrices are fundamental objects in symbolic computation and commutative algebra, and their associated factorization problems have long constituted important research topics in fields such as multidimensional systems and signal processing. Building on Youla and Gnavi's analysis of the structural theory for multidimensional systems in the 1970s, factorizations of multivariate polynomial matrices have become a key research direction for mathematicians and engineers. Minor prime factorization of multivariate polynomial matrices is a critical subproblem in this area, where factorization algorithms for bivariate polynomial matrices play an important role in mu-basis computation for rational parametric surfaces. We focus on minor prime factorization of rank-deficient multivariate polynomial matrices. We first establish an algebraic relationship between a rank-deficient polynomial matrix and its arbitrary row-full-rank submatrix. Subsequently, a necessary and sufficient condition for the existence of minor prime factorization in the rank-deficient case is rigorously derived. Finally, an algorithm is presented, accompanied by experimental results demonstrating its computational efficiency. This is a joint work with Dong Lu.