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Title:THz-TDS Signal Classification via Sparse Representation
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Abstract:It is demonstrated by the THz-TDS (terahertz time domain spectroscopy) signal analysis based on geometric algebra that: THz signals can be represented as real vectors under the framework of the geometric algebra, vectors corresponding to the same substance belong to the intrinsic 2-dimensional feature subspace of that substance, and especially when the samples studied are of the same thickness value or when the Fresnel loss can be neglected, vectors of the same substance are linearly dependent to each other. Vectors of THz signals can be represented as a linear combination of the signal vectors correspondingly from the same class. Based on that, from the view of the signal sparse representation, THz signal vectors can be represented in an overcomplete dictionary whose base elements are the "known" signal vectors themselves. Such that, the signal classification can be modeled as the problem of finding the optimal sparse solution to linear equations. A signal classification method via the sparse representation is presented. In the method, an overcomplete dictionary is constructed using the "known" THz signal vectors. And for one test signal, the optimal sparse coefficients of the linear equations are obtained efficiently via the l₁-mininmization. Finally, the class of the test sample is determined based on the coefficients. Each step of the method is discussed in detail: an optimal construction method of the overcomplete dictionary is developed based on the geometrical distribution and the algebraic structure properties of signal vectors, the model of the signal classification is modified to account for possibly noise, and the test sample is classified using the criterion of either the maximized coefficient or the minimized residual. Feasibility and effectiveness of the method is confirmed by experiments presented.
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equations - THz signal vectors - l₁-minimization - optimal construction method - geometrical distribution - algebraic structure properties - residual minimization - coefficient maximization
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