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短文与研究通讯

基于波束域的子空间正交性测试宽带DOA估计方法研究

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摘要：

投影子空间正交性测试(Test of Orthogonality of Projected Subspace:TOPS)算法通过测试宽带信号各频率点上噪声子空间和信号子空间之间的正交性对目标方位进行到达角估计(DOA:direction-of-arrival)。此算法对参考频点上的信号子空间的估计依赖性较大，因此存在较多伪峰，低信噪比条件下性能差等缺点。针对该问题，提出一种基于波束域的宽带DOA估计方法。该方法通过将阵列接收信号转换到波束域，在波束域中利用信号带宽内各频率分量的波束域方向向量与噪声子空间之间的正交关系构造判决向量，根据判决向量搜索空间谱的极大值对应的角度进行DOA估计。该方法不需要进行角度预估，避免了TOPS算法中常出现的伪峰，降低了信噪比分辨门限，减少了计算量，具有较好的估计效果。将该方法分别运用到均匀圆阵和线阵上，通过仿真对比和海试实验数据的处理，证明了本文所提方法的有效性。

关键词： 阵列信号处理 宽带信号 到达角估计 波束域方法 投影子空间正交性测试算法

Research on the wideband DOA estimation with test of orthogonality of subspace based on beamspace

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Abstract:

The direction-of-arrival (DOA) can be estimated by measuring the orthogonal relation between the signal and the noise subspaces of multiple frequency components of the wideband signal with Test of Orthogonality of Projected Subspace (TOPS) algorithm. This algorithm largely depends on estimation of signal subspace of the reference frequency; therefore, it has some shortcomings such as more fake peaks, poor performance under low SNR and so on. To avoid these problems, a new direction of arrival (DOA) estimation method for wideband sources based on beamspace is proposed in this paper. In the proposed method, the array receiving data is firstly transformed to beamspace by beamspace transformation, and then the decision vector can be constructed by the orthogonal relation between the noise subspaces and steering vector of multiple frequency components of the wideband sources in beamspace, finally, the DOA can be estimated by searching the maxima of the pseudo spatial spectrum according to decision vector. The new method does not require initial focusing angles and avoid the fake peaks that often appear in TOPS algorithm. At the same time, the new method reduces not only the SNR resolution threshold but also the computational burden so that it has better performance than TOPS algorithm. Applying the method on a uniform linear array and circular array respectively, simulation results and sea-experiment demonstrate the effectiveness of the proposed method by comparing it with some wideband DOA estimation methods.

Keywords: array signal processing wideband sources direction-of-arrival estimation beamspace method;test of orthogonality of projected subspace algorithm

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