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论文与技术报告

复合高斯杂波加热噪声中基于Rao检验的分布式目标检测

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摘要：

随着雷达分辨率的不断提高，每个距离单元中分布的杂波能量逐渐减少，当杂噪比低于10dB时，热噪声对检测性能的影响是不可以忽略的。针对低杂噪比的情况，在复合高斯杂波加热噪声的背景中研究了分布式目标的检测问题。首先假设内部热噪声和外部杂波统计独立，在给定杂波纹理分量τ的前提下，将白高斯热噪声加上由球不变随机向量表示的复合高斯杂波之后的总干扰近似等效处理成一个新的复合高斯杂波，只是将其参数做了适当调整。然后将分布式目标建模为在距离维和Doppler频率维同时扩展的子空间模型，基于Rao检验构造了N-Rao检测器。通过对N-Rao检测器虚警概率的计算表明，在不存在目标的假设下，虚警概率只由脉冲重复数N、分布式目标占据的实际距离单元数H、每个距离单元内目标散射点总数目Nt来决定，即N-RAO检测器具有恒虚警率特性。最后通过Monte Carlo仿真实验表明，杂波形状参数v的减少与CNR的增加都会使N-RAO检测器的检测性能有所提高，且在低杂噪比的情况下，N-RAO检测器有很好的检测性能。

关键词： 高分辨率雷达；复合高斯杂波；Rao检验；分布式目标；热噪声

Rao test of distributed targets in compound-Gaussian clutter plus thermal noise

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Abstract:

Increasing the resolution of the radar reduces the amount of energy per cell backscattered by the distributed clutter. When the clutter-to-noise ratio (CNR) is lower than 10dB, the effect on the detection performance which is put by the thermal noise is not neglectful. On the condition of the low CNR, distributed targets detection embedded in compound-Gaussian clutter plus thermal noise is studied. Firstly, we assume that the thermal noise is statistically independent of compound-Gaussian clutter which is modeled as a spherically invariant random vector (SIRV). Given a specific value of τ which is usually named texture, the total interference which is composed by the superposition of compound-Gaussian clutter and white Gaussian thermal noise is approximatively equivalent to a new compound-Gaussian clutter, whose parameters are suitably adjusted for the actually condition. And then, based on the Rao test, the new N-Rao detection is derived to implement the distributed target. The distributed target, which is modeled as a subspace random signal, may be distributed both in range and also in Doppler frequency axes. By calculating the probability of false alarm, it is shown that the probability of false alarm is only a function of the number of pulses N, the number of target range resolution cells H, the number of scatterers in each range cell Nt. So the N-RAO detection is a constant false alarm rate (CFAR) detection. In the end, performances of the proposed detector are assessed through Monte Carlo simulations. The experimental results show that a decrease of the shape parameter v makes the N-Rao detection performance improved. This case that makes the performance improved can be made by increasing the CNR. And in low CNR, the N-Rao detection has better detection performance.

Keywords: High-range resolution radar compound-Gaussian clutter Rao test distributed target thermal noise

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