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论文与技术报告

基于非均匀FFT的压缩感知雷达信号快速重构方法

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摘要：

雷达处理是压缩感知理论重要的应用方向之一，基于压缩感知的雷达处理可以降低对回波信号的采样速率要求，并且在部分应用中也可改善处理性能。然而，压缩感知重构算法的计算复杂性限制了压缩感知理论在实际雷达信号处理中的应用，尤其是大尺度雷达数据的处理。本文提出了一种基于压缩感知的雷达信号快速重构方法，利用均匀和非均匀快速傅里叶变换运算实现了常规压缩感知重构算法中的矩阵-向量乘法运算，有效降低了重构算法的计算复杂度，加快了压缩感知雷达信号的重构速度。同时，由于引入了快速傅里叶变换运算，该方法消除了大多数常规重构算法对感知矩阵的存储需求。仿真实验验证了该方法的可行性和高效性。

关键词： 压缩感知；非均匀快速傅里叶变换；迭代阈值法；脉冲压缩

Nonuniform FFT Based Fast Reconstruction Algorithm for Compressive Sensing Radar Signal

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Abstract:

Radar process is one of the most important applications of compressive sensing (CS) theory. Compressive sensing theory can reduce the sampling rate of echo signals and improve the processing performance in some radar applications. However, the huge computational complexity in signal reconstruction puts strict constraint on some practical radar applications, especially on large scale problems. This paper proposes a novel fast reconstruction algorithm for compressive sensing radar signal. The proposed algorithm realizes the direct implementation of the costly matrix-vector multiplications in conventional reconstruction algorithms with fast Fourier transform (FFT) and nonuniform fast Fourier transform, i.e., NUFFT, which greatly reduces the computational complexity of the reconstruction algorithm and therefore significantly speeds up the recovery of compressive sensing radar signal. In addition, the algorithm eliminates the huge storage requirement of sensing matrix in most common compressive sensing recovery algorithms, since the matrix-vector multiplication is realized with fast Fourier transform algorithm here. Numerical simulation results validate the feasibility and efficiency of the proposed algorithm.

Keywords: Compressive sensing Nonuniform fast Fourier transform Iterative shrinkage/thresholding algorithm Pulse compression

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