



目标表面对FMCW激光雷达拍频信号的影响分析

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Impact analysis of targets' surface to beat-frequency signal in FMCW laser radar

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摘要

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摘要 被测目标表面的粗糙度会影响调频连续波(FMCW, Frequency Modulated Continuous-Wave)相干激光雷达的拍频信号特性,进而影响雷达的测速测距精度.为衡量该影响以改善雷达的性能,通过对照射目标面的空间离散化,建立和分析了拍频信号的场强模型,并针对不同粗糙度的反射表面,进行了Monte Carlo模拟仿真及系统实验验证.仿真和实验结果表明:镜面目标反射面的倾斜将导致拍频信号交流分量强度的急剧衰减;而对于高斯型粗糙面目标,强度与粗糙面高度及波长的比值成负指数关系.实验结果与理论分析和模拟仿真结果一致,且系统的测距误差小于1 mm,静态速度稳定性优于0.1 mm/s.

关键词: 相干激光雷达 调频连续波 信号分析 表面粗糙度

Abstract: The characteristics of beat-frequency signal and the accuracy of range and velocity measurement in frequency modulated continuous-wave (FMCW) coherent laser radar were influenced by the surface roughness of measured target. In order to estimate the impact and improve the system-s performance, the scattering surface was spatially discretized into many patches, and the electric field intensity model was built and analyzed. Monte Carlo simulations and system experiments were carried out for the cases with different roughness surfaces. The results indicate that the alternating component of beat-frequency signal will decrease dramatically with the tilt of mirror plane, and when the surface is Gaussian roughness plane, it has a negative exponential relationship with the ratio of the surface-roughness height to the square of light wavelength. The experimental results are consistent with the theoretical analysis and numerical simulation results, and the system-s range-measurement error is less than 1mm, the static velocity stability is better than 0.1mm/s.

Keywords: coherent laser radar frequency modulated continuous-wave(FMCW) signal analysis surface roughness

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