

论文与报告

基于软件接收机技术的低载噪比信号自适应鲁棒锁相环研究

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摘要

在低载噪比条件下能够对GPS信号进行连续、精确地跟踪是GPS技术的重要研究方向. 论文以软件接收机平台为基础, 开发了适用于低载噪比信号跟踪的自适应鲁棒锁相环. 综合考虑了低载噪比信号对传统环路的影响, 建立了并行相关跟踪环路. 论文首先研究了处理独立噪声的线性最优估计滤波器, 进一步研究了基于三段式函数自适应调节因子的自适应鲁棒滤波器. 当接收到的信号比较理想时, 该新型滤波器的性能与标准Kalman滤波器基本相同. 当接收到的信号较弱或受到干扰时, 该新型滤波器能够根据接收到信号中的总相位抖动噪声智能地调节环路参数. 通过动态的平衡动态方程和量测方程对最优估值的权值贡献, 能够有效的抵制观测量野值和动态模型的建模误差对滤波器的影响. 论文通过一组实测数据对相关算法进行了验证. 试验结果证明在载噪比为24dB-Hz的弱信号条件下, 锁相环的相位跟踪误差标准差能够达到0.01周, 明显的改善了锁相环对弱信号的跟踪性能.

关键词

[信号处理](#) [软件无线电](#) [锁相环](#) [全球定位系统](#)

分类号

Adaptively Robust Phase Lock Loop for Low C/N Carrier Tracking in a GPS Software Receiver

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Abstract

An important issue in GPS applications is how to track GPS (global positioning system) signal precisely and continuously under low carrier-to-noise ratio (C/N). In this paper, an adaptively robust filter based low C/N carrier phase lock loop (PLL) is developed under a GPS software receiver platform. Considering the effect of low C/N carrier signal on the traditional tracking loop, a parallel correlation tracking loop is established. A linear optimal estimator is designed to deal with the dependent noises in kinematics model and measurements. Furthermore, an adaptively robust filter is designed based on a three segment function adjust factor. When received signals are under favorable conditions, the performance of the new filter is very similar to a standard Kalman filter. For a practical weak carrier tracking, this new enhanced PLL intelligently tunes the loop parameters according to the total phase jitter analysis. It successfully resists the outliers and dynamic model errors by

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adaptively balancing the influence of updated dynamic model state and the measurements. The robustness and efficiency of the new filter is demonstrated by some real data testing experiments. The results verify that the standard deviation of the phase errors with this adaptively robust phase tracking loop can reach 0.01 cycles with satellite C/N ratios around 24 dB-Hz, which improves the performance significantly.

Key words [Signal processing](#) [software radio](#) [phase tracking loop](#) [global positioning system \(GPS\)](#)

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