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陀螺稳定平台扰动的自抗扰及其滤波控制

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Active disturbance rejection and filter control of gyro-stabilized platform

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摘要 分析了影响陀螺稳定平台隔离控制精度的主要因素, 包括被控系统模型中的未建模部分、状态的随机扰动以及输出信号的测量噪声等。研究了综合解决各方面影响因素的控制方案以进一步提高陀螺稳定平台隔离精度。针对上述影响因素,设计一个两步控制策略。第一步,利用自抗扰对系统中未建模部分进行观测及其前向补偿,将自抗扰控制中的反馈控制设计为PID控制, 以实现抗平台扰动的调节控制;第二步,利用Kalman滤波器对系统中的状态扰动及测量噪声进行滤波消除。详细描述了提出的控制策略并对其性能进行了系统仿真实验及参数优化。结果表明,该方案在幅值为3°、频率为1/6 Hz的载体扰动下能达到4.61%的隔离度,与非线性摩擦力建模辨识及其前向补偿策略控制实际陀螺稳定平台达到的隔离度的最好值9.39%相比,文中提出的控制隔离性能提高了50.9%,具有更高的实用价值。

关键词 : 陀螺稳定平台, 隔离控制, 自抗扰, Kalman滤波器, PID控制

Abstract : The main factors effect on isolation control accuracy of a gyro-stabilized platform were analyzed, including the un-modeled unit in a controlled system, the random disturbance of state and the measurement noise of an output signal. The control schemes to overcome these effect factors and improve the isolation accuracy of a gyro-stabilized platform system were explored. In order to improve the control accuracy, an integrated solution for eliminating all effect factors was researched and a two-step control strategy was proposed. The first step is to employ the Active Disturbance Rejection Control (ADRC) to observe and compensate the un-modeled unit and to design the feedback control in ADRC as PID controller to control the compensated system. The second step is to use a Kalman filter to eliminate the random disturbance and measurement noise. The control scheme was described in details and its performance was simulated. The results indicate that the isolation degree reaches 4.61% by using this control strategy when the disturbance of the platform is 3° and 1/6 Hz, which means the isolation performance has improved by 50.9% as comparing with the performance 9.39% from the control strategy which consists of the parameter identification of nonlinear friction and its forward compensation. The control strategy evidently has a higher practical application value.

Key words : gyro-stabilized platform isolation control Active Disturbance Rejection Control(ADRC) Kalman filter PID control

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