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Design of integrated navigation system based on FOG/SINS and star tracker

Nassim Bessaad, Bao Qilian, Du Yuding, Liu Ling and **Mahmood ul Hassan**
Shanghai Jiaotong University, China

This paper focuses on the design of an integrated navigation system based on fiber optic gyroscope-strapdown inertial navigation system (FOG/SINS) fused with an accurate star tracker in order to obtain precise estimation of attitude. A model of the inertial measurement unit (IMU) based on FOG and MEMS accelerometer is established. The sensors errors are analyzed rigorously, special interest is given to the random noises. The modeling of the noise existing in sensors has a great effect on design of the fusion filter. In order to achieve better estimation of the random process parameters, a novel wavelet denoising function and Allan variance is utilized. Experimental results based on real data from FOG-IMU shows a satisfactory improvement in denoising performance. The design of fusion filter for FOG/SINS and star tracker is discussed. The dynamic model of FOG/INS/Star tracker integrated system is set. An adaptive iterative modified Sage-Husa filter requires only an initial approximation, and then the covariance is validated harnessing available measurements. Finally, the results of the stochastic modeling of real data from FOG/SINS using Allan variance on data denoised by an adaptive dual threshold wavelet denoising function are integrated to the fusion filter. A simulation system based on real FOG-IMU and a star tracker simulator is devised for testing and experiments. Experimental results show satisfactory performance of the presented integrated navigation system. The accuracy of the attitude, velocity, and position has been improved in comparison to standalone FOG/SINS system and higher updating rate compared to the star tracker sensor.