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姿态匹配法测量船体变形角中时间延迟的补偿

杨功流[1,2], 郭蔚林[1,2], 袁二凯[3]

1. 北京航空航天大学 仪器科学与光电工程学院, 北京 100191;
2. 惯性技术国防重点实验室, 北京 100191;
3. 中国人民解放军93716部队, 天津 301700

Compensation of time delay in ship deformation measured by attitude matching

YANG Gong-liu[1,2], GUO Wei-lin[1,2], YUAN Er-kai[3]

1. School of Instrumentation Science and Opto-electronics Engineering, Beihang University, Beijing 100191, China;
2. Science and Technology on Inertial Laboratory, Beijing 100191, China;
3. Unit 93716 of the Chinese People's Liberation Army, Tianjin 301700, China

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摘要

提出了一种时间延迟的估计方法来解决用姿态匹配法测量船体变形角时惯性测量单元(IMU)数据之间存在的时间延迟对测量精度的影响。首先,对光学测量得到的船体变形数据进行处理,确定船体变形过程的数学模型。 然后,通过高精度的主惯导和子惯导输出的局部姿态信息进行惯性量匹配,并构建卡尔曼滤波器估计船体变形角。 最后,在卡尔曼滤波器中加入时间延迟估计参数,对时间延迟进行估计和补偿。设计了一套惯导数据同步录取装置,验证了算法的有效性。实验结果表明:同步录取装置与时间延迟算法补偿所测得的船体变形角与光学测量得到的数据相近,均能达到纵挠角误差13",横扭角误差12",艏挠角误差5"的精度水平。得到的结果显示卡尔曼滤波能有效估计出时间延迟,从而有效补偿时间延迟的影响,提高变形角测量精度。

关键词 : 船体变形, 变形角度, 姿态匹配, 建模, 卡尔曼滤波, 时间延迟

Abstract :

To solve the influences of time delay between Inertial Measurement Unit(IMU) data on measuring accuracy in the attitude matching measurement of ship deformation, a time delay estimation method was established. Firstly, the ship deformation data measured by optical devices were proposed to confirm a mathematic model of ship deformation process. Then the local attitude information from high-accuracy master-Inertial Navigation Sytem(INS) and slaver-INS was used to match the inertia and Kalman filter equations were used to estimate the ship deformation. Moreover, the time delay parameters were added into the Kalman filter to estimate and compensate the time delay. Finally, an IMU data synchronous read device was designed to verify the effectiveness of proposed algorithm. Experimental results show that compensation results by IMU data synchronous read device and the algorithmic are similar to optical measurement data, and the pitch errors, rolling errors and the heading errors are 13", 12" and 5", respectively. These results demonstrate that the Kalman filter estimates the time delay effectively, compensates the time delay and improves the measurement accuracy of ship deformation.

Key words : ship deformation deformation angle attitude matching modeling Kalman filter time delay

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作者简介: 郭蔚林(1991-),男,江西赣州人,硕士研究生,2013年于天津大学获得学士学位,主要研究方向为惯性导航技术。E-mail:guoweilinlin@163.com

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