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A MARGINALIZED PARTICLE FILTER IN INITIAL ALIGNMENT FOR SINS

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Abstract. *Since the states of the system are not totally observable, particle filter cannot collect adequate measurement information as demanded while marginalized particle filter is applied to stationary self-alignment with large misalignment angles. To solve this problem, a filtering model of initial alignment with large misalignment angles is constructed. A marginalized particle filtering method assisted by the gyro measurement information is proposed. The simulation results show that the proposed approach can greatly lighten the heavy computational load with high dimensions and large initial errors, quicken the alignment speed of the azimuth misalignment angle, and get higher initial alignment precision than the conventional method with ordinary particle filter.*
Keywords: Particle filter, Initial alignment, Inertial navigation system, Strapdown inertial navigation system

1. **Introduction.** The initial alignment mainly functions to obtain the positional and attitude relationship between the body coordinate system and the navigation coordinate system [1-5]. The most important indices in assessing the performance of the initial alignment are the precision and speed of the azimuth misalignment angle convergence. In the case of small misalignment angles, J. C. Fang uses horizontal misalignment angles to improve the convergence speed of the azimuth misalignment angle [4], while X. L. Wang takes into consideration both the horizontal velocity error and acceleration error to increase the two-position alignment speed and precision [5]. In order to improve initial alignment speed, the initial alignment is often carried out in case of large misalignment angles. Therefore, the initial alignment system equation is non-linear which has to be dealt with by non-linear filter.

PF (Particle Filter) can effectively solve the problem of nonlinear filtering [6-8]. In [9-11], initial alignment on moving base is realized via particle filter; however, its limitation is obvious: the number of particles will increase at a rapid rate along with the increase of the system dimensions. MPF (Marginalized Particle Filter) assisted by Rao-blackwellization technique can lower the dimensions of non-linear filter, especially when the dimensions of non-linear subsystem are relatively low compared with the dimensions of the whole system [12,13]. In consequence, marginalized particle filter can reduce the computational load and improve the real-time performance of particle filter in initial alignment.

In the SINS (Strapdown Inertial Navigation System) stationary self-alignment, there are two horizontal velocities taken as observation variables, not including the state information of the non-linear subsystem. When Marginalized particle filter is used in initial alignment, the non-linear subsystem lacks necessary measurements. Since the system states cannot be totally observed, both the convergence speed and the azimuth misalignment angle