Recursive Filters and Positioning Algorithms of Hybrid Inertial Navigation Systems

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This thesis addressed the application of recursive filters to Positioning Algorithm of Hybrid Inertial Navigation System. Especially to the so-called Externally Aided Iner-tial Navigation Systems using the Extended Kalman Filter. The positioning algorithm and these performances are studied in the case of Land-Vehicle and Under Water Ve-hicle by comparing with the traditional filtering techniques. In both cases several ex-perimental tests are carried out using the Inertial Navigation System and external aided equipments.

First, a brief review of the Strapdown Inertial Navigation Systems and the principle of the composed Sensors are presented, also Strapdown Navigation and its alignment in both stationary and moving condition are provided. And the standard Hybrid Navi-gation concept using the GPS (Global Positioning System), Radio and Doppler radar is introduced for the easily understanding of this thesis.

Second, two external aided Inertial Navigation Algorithms are introduced, one is the Land Vehicle Hybrid Navigation System and another is the Unmanned Underwater Vehicle Hybrid Navigation System. In both cases the necessity of aided navigation systems, the selection of estimated errors and these dynamic equations are explained describing noise characteristics. These values and the validity of Extended Kalman Filter are also expressed. In these descriptions, several experimental test runs are conducted to estimate the feasibility of these algorithms. In the Land Vehicle Naviga-tion, the method of avoiding the initialization of covariances when the aided signal is switched from DGPS (Differential Global Positioning System) information to VMS (Vehicle Motion Sensor) information, is advantageous. Also the approximate expres-sion of aided signal is advantageous in Unmanned Underwater Vehicle Navigation.

Finally, in Land Vehicle Navigation, the necessity of high accuracy positioning using low cost Inertial Sensors like MEMS (Micro Electrical Mechanical System) is discussed. Further the necessity of the transfer alignment technique for improving the position accuracy is described in Underwater Vehicle Navigation.