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AN INNOVATIVE NAVIGATION SCHEME FOR REUSABLE LAUNCH VEHICLE USING MULTI-SOURCE INFORMATION FUSION

Abstract

Future reusable launch vehicle (RLV) will often be required to fly a wide spectrum of missions and survive numerous types of failures. RLV presents the opportunity to reduce the cost of launches and to provide capabilities that are not available at present. Guidance, Navigation and Control (GNC) technology is critical for meeting safety, reliability and operational cost requirements for the next generation of reusable launch vehicle. The advanced RLV GNC technologies will lead to reduced cycle times during vehicle design and to reduced costs associated with demonstrating payloads and modified vehicles. The GNC technologies will also lead to more robustness to unforeseen circumstances in flight, thereby enhancing safety and reducing risk. Due to reusage, RLV will go through many flight phases, such as ascent, in orbital flying, proximity operations, reentry and landing many times. There are very high requirements for autonomy, accuracy, reliability, fault tolerant, light weight and small volume of the RLV GNC system. These characteristics have put forward many challenges to the normal GNC system of a flight vehicle. An integrated INS/GPS navigation system may be able to meet the navigation requirements of all flight phases. HoweverGPS may be subject to outages due to blockage or atmospheric ionization during reentry phase. ThereforeINS-only navigation system during GPS signal blockage period is not adequate for RLV navigation accuracy. In this paper, the goal and characteristics of RLV GNC are outlined, and the current technology efforts are reviewed, and the additional work needed for accomplishing this goal is proposed. A new multi-source information RLV navigation scheme is presented and some simulation works are carried out. The information fusion architecture of the fault tolerant multisensor navigation system of RLV is designed. The integrated navigation system of RLV includes inertial navigation system , celestial navigation system and odometer . The principle is as follows: at start, the attitude errors can decrease greatly by the observation of star sensor, then the biases of three accelerometers can be estimated by using the odometer; therefore the position errors can converge to small values. A new information fusion technique integrated with Unscented Kalman Filtering based on federated filter is investigated and applied to reduce the navigation errors and to correct the bias of INS. The experiment results show the feasibility of the navigation scheme and validate benefits of the proposed algorithm. Finally, the problems still existing are pointed out, and some suggestions are made for further improvements.