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A NOVEL NAVIGATION SOLUTION OF REUSABLE LAUNCH VEHICLE BASED ON MULTI-SOURCE GEOSPATIAL 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 RLV. The advanced RLV GNC technology will lead to reduced cycle times during vehicle design and to reduced costs associated with demonstrating payloads and modified vehicles. Moreover, the GNC technology will also offer 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 operation, 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 subject to outages due to blockage or atmospheric ionization during reentry phase. INS-only navigation during GPS signal blockage period is not adequate for RLV navigation task. Therefore, this study suggests the use of a new navigation solution of RLV to the navigation position problem. 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 geospatial 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. A new information fusion technique integrated with Unscented Kalman Filtering (UKF) based on federated filter is investigated and applied to the above multisensor navigation system. Except for INS/GPS, the integrated navigation system of RLV includes geomagnetic navigation system (GNS) and polarized-light navigation system (PNS). The simulation platform is set up for verifying the INS/GPS/GNS/PNS integrated navigation scheme and the federated UKF algorithm. The simulation 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.