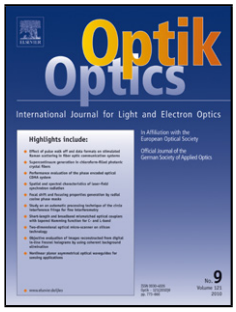

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Relative Navigation for Autonomous Aerial Refueling Rendezvous Phase

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Abstract: A relative navigation system for autonomous aerial refueling (AAR) rendezvous phase is proposed in this paper. The system uses the inertial navigation system (INS), the Global Positioning System (GPS) and the infrared search and track system (IRST). It has both advantages of cooperative aircraft relative navigation and passive target location. A hybrid multistage fusion structure and corresponding algorithm are designed to estimate the high precision relative position, velocity and attitude information between the tanker and the UAV in real time. For the INS/GPS subsystem, a two-stage filtering algorithm based on extended Kalman filter is developed without any use of base-station, which helps to improve the accuracy of the filter model. Considering the requirement of reliability and robustness for aerial refueling, an independent IRST relative state tracker filter is set up in the system. It weakens the dependence of relative navigation system on data link, and makes the system highly reliable and fault-tolerant. The numerical simulation results indicate that the proposed algorithm can provide good performance in terms of accuracy and reliability.

Keywords: Relative Navigation; Optical Measurement; INS/GPS/IRST; Aerial Refueling

1. Introduction

With the extensive application of UAVs, the Autonomous Aerial Refueling has gained wide attention in recent years [1]. It means that UAV can add fuel without landing, which greatly increases the flight time and improves the efficiency [2]. Unlike the traditional aerial refueling of manned aircraft, UAV has no direct operation of pilots. Therefore, in the whole process of AAR, the UAV needs to execute automatically according to multi-sensor information [3].

As the key technique, the relative navigation has always been the focus of research [4]. However, the previous studies mainly focus on the contact phase of AAR by adopting visual sensors or Visual/INS combination [5]. The relative navigation algorithms also concentrate on the close range condition [6]. As the initial stage of aerial refueling, rendezvous phase is less studied. To design the relative navigation system of AAR rendezvous phase, we need to solve the following problems: how to select appropriate sensors, how to design the algorithm to provide real-time and high precision relative navigation information, and how to design the architecture of system to satisfy the reliability and fault tolerance