Information

- Author :
  Masaru Naruoka, Takeshi Tsuchiya
- Address :
  Hongo 7-3-1, Engineering No.7,
  Bunkyo-ku, Tokyo, Japan
  Postal-code : 113-8656
- Affliation :
  The University of Tokyo, Suzuki - Tushiya Lab. (both of two)

- Title :
  A powerful autopilot system for small UAVs with accurate INS/GPS integrated navigation

- Corresponding Author : Masaru Naruoka
  Postal Mail : (same as the above address)
  E-Mail : tt077062@mail.ecc.u-tokyo.ac.jp
  Phone / Fax : +81-3-5841-6568 / +81-3-5841-8804

Abstract

In this presentation, we will propose a new autopilot system for small unmanned aerial vehicles (UAVs). The proposed system has accurate navigation function and strong calculation capacity for advanced guidance and control algorithm. We build a prototype system and validate its functionality of our autopilot system by a real flight test of a small UAV. Furthermore, a comparison experiment with ultra-precise navigation device, GAIA, shows that our system is accurate enough for controlling small UAVs.

The motivation of our study is based on the today's demand for applying small UAVs to many fields, for example, disaster monitoring, security purpose, and a test bed for advanced experiments. Although these applications require autonomous operation that has been implemented by autopilot system for manned aircraft, no existing autopilot system for small UAVs achieve it. We think that the reason is lack of both accuracy of navigation and calculation power. Therefore we propose a new autopilot system with two novel functions, accurate navigation and large processing capacity.

In order to implement the former function, we adopt a strap-down INS/GPS (Inertial Navigation System / Global Positioning System) integrated navigation system. A Strap-down INS/GPS system for typical aircrafts is very accurate and reliable because they use dedicated components. Although we have to replace these components to lighter and smaller ones for applying the system to small UAVs with degrade of accuracy, we can keep its accuracy enough for controlling small UAVs using MEMS inertial sensors and a civil-use GPS receiver as components. This fact is based on our previous research, which shows performance by post processing using the "loose-coupling" Kalman filtering (KF) and utilizing quaternions. In this study, we also consider real-time performance with the delayed measurement of the KF.

The latter function, strong calculation capacity, is supported with a Digital Signal Processor (DSP). A DSP is mostly used in the field of sound and video processing that requires instantaneous performance represented by the number of MIPS (mega instruction per seconds) or FLOPS (floating operation per seconds). Therefore it is suitable for controlling small UAVs through modern complicated algorithms such as inversion dynamics and H-infinity that carry large time delay with a slow processing unit.

In order to examine the functionality of our system, firstly we build a prototype system. The system mainly consists of 6 DOF (degree of freedom) MEMS inertial sensors, an L1-wave GPS receiver, and DSP processing board. Our developed prototype system is installed into a small UAV, and it works well in a real flight test. Moreover, the experiment for comparing the prototype with GAIA, a high-precision INS/GPS instrument developed by Japan Aerospace Exploration Agency (JAXA), is performed in flight of an experimental aircraft MuPAL-alpha of JAXA. The result shows that the prototype also has navigation accuracy enough for guidance and control of small UAVs.