J. Indian Inst. Sci., May–June 2005, **85**, 157–159

Book Review

Guidance and control 2004, Advances in the Astronautical Sciences, Vol. 118, edited by Jim D Chapel and Robert D Culp, published for the American Astronautical Society by Univelt, Inc., P.O. Box 28130, San Diego, California 92198, 2004, pp. 668, $150.

This volume covers the proceedings of the 27th Annual AAS (American Astronautical Society) Rocky Mountain Guidance and Control Conference, held during February 4–8, 2004, at Breckenridge, Colorado, USA. It is edited by J. D. Chapel and R. D. Culp, and contains papers both from academia as well as industry from around the globe (US, Canada, France, Japan, etc.), mainly concerning the guidance and control problems encountered in space application problems. The papers are organized in six sections, namely, Section I: Advances in guidance and control, Section II: Unmanned arial vehicle (UAV) guidance and control, Section III: Enabling technologies for precision pointing spacecraft, Section IV: Guidance and control storyboard displays, Section V: Back to the moon and Section VI: Recent experiences in guidance and control.

In Section I, the papers address a range of problems: formation flying of multiple spacecraft, common attitude control designs for diverse spacecraft (to reduce cost and development time), star trackers for better navigation (without ground/satellite support), etc. The papers included in Section II (UAV Guidance and control) essentially represent a special invited session at the conference. As pointed out in the Preface, such a special session is held at the annual conference every year, which is not directly related to the traditional spacecraft guidance and control topics (which is the main focus of this conference). This section also presents a variety of interesting papers ranging from autonomous aerial refuelling, automatic air collision avoidance, etc. In addition, keeping its space science emphasis, the section includes a few papers on UAVs being designed for the environmental conditions in Mars as well.

In Section III (Enabling technologies for precision pointing spacecraft), the papers address the emerging spacecraft missions that demand high precision. The topics addressed include a combined nonlinear observer-controller design for gyro calibration, control design and stability analysis of two-spacecraft electromagnetic formation flying array, adaptive tuning of spacecraft structural dynamics, orbit design of magnetospheric multiscale mission (a NASA mission intended to make fundamental understanding of Earth's magnetosphere), spacecraft payload vibration isolation, etc. In Section IV (Guidance and control storyboard displays), the papers discuss the problems of designing magnetic attitude control systems (in a generic framework), attitude control design for orbit raising, behaviour analysis of reaction wheels near zero speeds, an integrated health management system for space vehicles (for quicker and cheaper maintenance) and the technical details about an attitude measurement sensor.

Incidentally, the Conference coincided with the 35th anniversary of the first Apollo lunar landing. With the renewed interest in lunar exploration around the globe (including India),

probably it is appropriate to look back about the control and guidance challenges for executing successful lunar landings (especially since much of the challenges have not diminished in the 35 years). Having this in mind, a special session was justifiably arranged at the Conference, which was named as "Back to the Moon". The papers presented in that section have been included in Section V of the proceedings. Many of these papers are written by pioneers of yesteryears who actively took part in the Apollo program. Almost all of the historic papers in this section are interesting to read. In particular, it was interesting to know from the paper AAS 04-061 that *the Saturn launch vehicle program of NASA Marshall Space Flight Centre is the "only" major rocket development program all over the world ever to be completed without any major failure in flight!* Incidentally, the program had numerous (to be exact, 33) flights in 1960s and 1970s and all were successful. Apart from the historical papers, Section V of the proceedings includes a few papers addressing the problems of the renewed interest in lunar exploration as well. Especially the paper on Lunar Prospector (which is the first lunar mission after 25 years following the end of Apollo program) is nice to read. Another paper in this section discusses the SMART-1 mission (a recent European Space Agency initiative).

The last section in the proceedings, namely Section VI (Recent experiences in guidance and control), includes six informative papers on wide topics. The topics discussed in these papers include precision pointing of NASA's Spitzer space telescope (which is the last spacecraft in NASA's great observatory series), PROTEUS platform (mainly a French initiative), TERRA spacecraft deep-space calibration maneuver, Gyro-less attitude control for SORCE spacecraft, low-budget spinning sounding rocket experiment, etc.

In general, the papers included in the proceedings are good to read and give diverse exposure of the guidance and control problems encountered in space missions. However, in my personal opinion, there are a couple of limitations as well. The conference organizing committee claims (see Foreword and Preface, pp. vii–xi) that the papers are quite advanced and discuss cutting-edge technologies in space science. Probably that is true for the experimental papers (I am not an expert in hardware and hence cannot comment precisely on that aspect). However, many of the theoretical papers are not of cutting-edge quality! The control synthesis techniques used in many of the papers are simply PID, LQR, Kalman filtering, etc. which are well-established for over 4–5 decades! Many of the papers claiming to use 'modern control' rather use linear MIMO (multi-input multi-output) techniques that are fairly well-established as well (LMI technique, for example). In fact, a majority of the papers are simply descriptive in nature and do not outline the underlying mathematics in detail (probably because lack of space or might be because of lack of interest). Anybody looking for good mathematical papers on truly advanced nonlinear control design techniques (for example, dynamic inversion, model-predictive control, nonlinear optimal and/or robust control design, etc.) will be disappointed. However, the following papers may partially satisfy such a reader: AAS 04-006, AAS 04-012, AAS 04-021, AAS 04-022, AAS 04-033, AAS 04-065. Probably the only paper that presents a nonlinear design technique (based on Lyapunov theory) is AAS 04-021. *Given this fact, probably this volume will be of more interest to the scientists and engineers in the industry, and not in academia*! Second, it was a bit surprising to me to notice that many of the papers presented at the conference are not available in the printable format and hence not included in the proceedings. Third, I noticed

that some of the papers discussed some topics that are probably too much digressed from the control and guidance topics, and hence, do not deserve a place at the Conference (definitely not in a book on control and guidance). A couple of such examples include the papers AAS 04-038 (on behaviour of reaction wheels near zero speed) and AAS 04-038 (on vehicle health management). These issues, I believe, expose the organizing committee's 'soft approach' to authors, which degrades the conference quality in the long run. Such papers should not have been included in the conference. I hope that the organizing committee will address these important issues and the subsequent volumes in the series will be of improved quality.

Assistant Professor Radhakant Padhi
Department of Aerospace Engineering
Indian Institute of Science
Bangalore 560 012, India
Email: padhi@aero.iisc.ernet.in