An Introduction to the Special Issue on Orbital Dynamics and Spacecraft Attitude Control

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This Special Issue on Orbital Dynamics and Spacecraft Attitude Control brings high-quality papers providing theoretical and/or practical matters in these areas and also in Aeronautical Engineering.

The activities of today's society require speed and accuracy in the communications between the people, governments, research institutions and commercial and industrial corporations. Such activities also require accuracy in weather forecasting to avoid natural disasters, sustainable exploitation of natural resources, transports, defense and public safety, and scientific researches. In this context, satellites in Earth's orbit, probes travelling in deep space as well as unmanned aerial vehicles (UVAs) have fundamental importance for the development of these activities.

Orbital Dynamics studies the motion of natural bodies and spacecrafts in space. Gravity is the primary force acting between these bodies, but other forces such as drag, solar radiation pressure, thrust, aerodynamic and electromagnetic must also be considered during some time. Often, forces of gravity from multiple bodies must also be taken into account. All these disturbances acting on the spacecrafts cause deviations in their orbits. In order to solve the problems caused by such disturbances, it is needed the development of several techniques to control the orientation, or attitude, and the orbital motion of the spacecrafts.

Considering this scenario, the Special Issue on Orbital Dynamics and Spacecraft Attitude Control presents research works on the dynamics of natural bodies and spacecrafts, highlighting the close connection between this research line with works related to the attitude control of spacecrafts under the action of various disturbances in their orbital motion, and also the devices of their control systems, as sensors; star trackers systems; actuators as step motors and magnetic dual-spin, among others. On the other hand, techniques to control the attitude and the stability of unmanned aerial vehicles are also presented.

The included papers give viewpoints on the advanced control systems of spacecrafts and unmanned aerial vehicles developed by scientists of research institutes and Universities from Brazil, Russian Federation and Vietnam.

We start this Special Issue with the article entitled "The Brazilian Autonomous Star Tracker – AST" whose main subject is to describe the approach used to estimate the attitude on board the spacecrafts. AST is an autonomous star tracker in currently development at the Brazilian National Institute for Space Research (INPE), Department of Aerospace Engineering from Federal University of ABC and Wisersoft Informatics Company, and it will integrate the attitude control systems of the future Brazilian satellites within the goals of the space program in progress.

The second paper "Exact Solution in Attitude Dynamics of a Magnetic Dual-Spin Spacecraft and a Generalization of the Lagrange Top" brings an investigation on results for the attitude motion of a magnetic dual-spin spacecraft (DSSC) in geomagnetic field. The paper's results can be directly reduced to the Euler coaxial top's general exact explicit solutions, and a "dynamical equivalence" between the magnetic and gyroscopic DSSC attitude stabilization factors is illustrated. The work was developed at the Space Engineering Department of Samara State Aerospace University in Russian Federation.

A new approach based on the specialization of the Model-Driven Architecture (MDA) with the Real-time Unified Modeling Language (RT UML) and hybrid automata to effectively analyze design and implement controllers for quadrotor UVAs is presented in the third paper. Considering this approach, it was possible to complete the development of a trajectory-tracking controller of a mini quadrotor UAV that was successfully taken on trial flights. This work was developed at the Department of Aeronautical and Space Engineering from Hanoi University of Science and Technology.

Finally, in the paper "Reduction of Residual Generated by Vibration Actuator Type Motor Step in a Flexible Beam Euler-Bernoulli" a study on two passive control strategies to minimize the vibration of the flexible beam first vibration mode is presented. This work was also developed as cooperation between Brazilian National Institute for Space Research (INPE) and Department of Aerospace Engineering from Federal University of ABC, both in Brazil.

Before we leave you to enjoy this Special Issue, we would like to thank all the authors, who invested a lot of work and effort providing their really valuable contributions as the results of their research work. These papers make a significant contribution to the problems related with Orbital Dynamics and Spacecraft Attitude Control, and also control of UVAs. Special thanks go to reviewers who dedicated their precious time in providing numerous comments and suggestions, criticism and constant and enthusiastic support. In closing, we hope that the contributions included should provide not only knowledge, but inspiration to researchers of these fascinating areas.