IAF SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
Future Space Transportation Systems Verification and In-Flight Experimentation (6)

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LOW COST ROCKET GUIDANCE AND AERODYNAMIC CONTROL DEVELOPMENT PLATFORM

Abstract

Sounding rockets are often launched from ranges with limited area, which requires a great amount of control over landing point dispersion. Factors such as wind gusts and non-axial thrust influence the rocket's trajectory and have to be taken into account when preparing for launch. Often, the risk of the rocket landing beyond the designated landing zone is too high for a launch to be deemed safe. This can put strain on the launch operations personnel as launch dates are delayed, and the cost of a single flight test can rise significantly.

To limit the influence of those factors on flight tests, guidance systems are often employed for attitude control. Development of active control systems is expensive both in terms of time and money. Complex aerodynamic interactions between the elements of the rocket and the control system make analytical methods inadequate, due to the lack of knowledge of the way of modeling those interactions or high complexity of the derived equations, resulting in a greater need for performing experiments and hardware tests.

The paper will present the FOK rocket design and it's main characteristics, as well as the results of it's test campaign, including development of control algorithms using various regulators.

The FOK rocket was designed as a low-cost aerodynamic guidance and control demonstrator and development platform. Thanks to its low range and quick turnaround time, several test flights can be performed in a single day leading to more effective use of range time. The cost-effectiveness is further increased by the rocket's full reusability thanks to a parachute recovery system. The avionics consist of an in-house developed single-board computer, which uses the VectorNav VN-200 AHRS as the main source of data for the control algorithms. Commands are sent via UART interface to the control module, comprised of four canards, driven by servomotors. The rocket is powered by a solid rocket motor which uses a composite propellant, allowing the craft to reach a maximum velocity of 220 m/s.

Aerodynamic characteristics were obtained through wind tunnel tests and allowed to create a mathematical model, which was used in the control algorithms development. Several algorithms were tested numerically, in the wind tunnel and in flight. Several types of regulators, including PID and LQR have been tested and the results will be presented. Further developments are planned, including an LQG algorithm and non-linear PID regulator.