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HARANG: STUDENT RESEARCHED AND DEVELOPED SOUNDING ROCKET CAPABLE OF DEPLOYING 3U CUBESAT AT 10,000 FT ALTITUDE

Abstract

Harang, an ancient Korean word for high skies, is the name of the sounding rocket developed by student rocket team "Hanaro", aiming to participate in Spaceport America Cup 2023. Its mission is to reach the altitude of 10,000 ft and deploy a 3U Cubesat payload. Due to the complexity and the scale of the project, system engineering processes was applied along the entire project phases. System requirements were thoroughly specified and regular design review meetings were held. This minimized timeline risks and ensured consensus within team members. Several technical innovations were implemented to the Harang rocket such as in-house composite materials. Load-bearing components that are specific to the rocket design and demand custom manufacturing, namely nose cone and the coupler, are produced in-house using vacuum-assisted resin infusion process, which is cost-effective in that it yields superior mechanical properties. The mass margin was set rather leniently during the design phase to accommodate the

uncertainty with venturing new manufacturing methods. Since the number of available rocket motors was limited, two design alternatives based on the final design mass were established. Avionics aims to give the appropriate deployment signal to the recovery system in various situations and to collect accurate flight data. The functional flow block diagram was designed to signal the recovery system even at the worst scenarios. In addition, Kalman filtering is used to increase the accuracy of the data. In case of rocket recovery failure, data telemetry is used to obtain data, making it possible for the aerodynamics team to analyze the cause of the failure. To ensure both public safety and the recovery of the rocket for analysis and future development, designing a robust recovery system was the utmost priority of the recovery system team. Verified pyrogenic charges and in-house manufactured "Tender Descender" enabled controlled deployment of cubesat payload and parachutes. FDM method was used to make complex parts of the system. To test the system at various airspeed and attitude, the system was tested at the back of a running truck at various angles. Since the COTS rocket motor cannot be shipped to Korea, a rocket motor equivalent had to be developed, which was challenging. Custom propellant and data acquisition systems were utilized to design the rocket motor for the test flight. By the development of the Harang rocket, invaluable knowledge and experience were acquired, inspiring the new generation of Korean aerospace engineers.