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A PRACTICAL LOW-COST BALLOON-LAUNCHED PLATFORM FOR MICROGRAVITY EXPERIMENTS: CONCEPT, DESIGN AND DEVELOPMENT

Abstract

Current microgravity experimentation techniques can be expensive and difficult to perform. However commonly available latex high altitude balloons, frequently used for meteorological measurements, can provide a much simpler and more cost effective approach to achieving microgravity conditions. This project aims to develop a reusable, easy to use and low cost alternative for undertaking microgravity experiments, using a capsule carried aloft by a helium weather balloon. From an altitude of over 25km the capsule is separated from the balloon and free-falls towards the Earth, providing the microgravity conditions required for the experiment payload. By using on-board sensors to measure the capsule's acceleration, a cold-gas propulsion system is controlled to actively cancel the aerodynamic drag acting on the capsule. Current simulations suggest that microgravity conditions of up to $\pm 10^{-4} g$ can be achieved for up to 16 seconds. A two-stage parachute recovery system is then deployed to safely recover the capsule and experimental data. This design concept combines the fundamental simplicity of high altitude latex balloon-drop microgravity techniques with advanced electronics and propulsion systems sourced from common off-the-shelf consumer products, in order to refine experiment conditions. Test results have demonstrated a proof-of-concept of the propulsion system by static testing and the wind tunnel testing of the recovery system parachutes has validated theoretical calculations. The project team will soon undertake flight testing of the capsule prototype. By minimising costs with readily available components, this experiment platform has applications not only for scientific research into the impact of microgravity on other behaviours, but this system can also support and motivate science learning in education and outreach programs while appealing to the inspirational value of space. By using this platform, schools and universities have the potential to involve students in the construction and launch of the system, as well as inexpensively fly student experiments which can investigate microgravity conditions.