Impact Protection System Based on Adaptable Airbag with Semi-passive Valve

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ABSTRACT

The integration of a parachute with an adaptive pneumatic absorber represents a significant advancement in payload protection systems for aerial platforms, air-drop capsules and drones. This hybrid approach leverages the advantages of both systems to achieve optimal performance in various landing scenarios [1]. Furthermore, the seamless integration of the parachute and absorber components streamlines the deployment process, minimizing complexity and reducing the risk of operational failures.

The proposed payload protection system utilizes adaptable pneumatic absorber [2], which alters its energy dissipation capabilities in real-time by using semi-passive discharge valve to accommodate fluctuating impact forces during landings. The proposed design not only ensures the protection of sensitive payloads against heavy overloading but also can enhance the overall stability and control of the aerial platform during the grounding process. The contribution presents subsequent stages of the design and development of the proposed payload protection system. The crucial step is elaboration of the mathematical model capable of predicting the dynamic of the air-drop capsule during descent and touchdown. The proposed algorithm enables optimal tuning of system parameters to maximize efficiency and effectiveness of impact mitigation. Through comprehensive numerical analyses and simulations, we demonstrate the unique performance of the adaptive protection system for various landing conditions. By effectively mitigating reaction forces and minimizing decelerations experienced during touchdown, this innovative solution provides increased safety and reliability for aerial platforms, drones, and air-drop capsules in commercial, professional, and military applications.

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