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DESIGNING OF LANDING SYSTEM FOR MARS USING ELECTROMAGNETIC FORCE

Abstract

Space Exploration is a dream frontier of mankind, in this journey of colonization of space; Mars has a distinct importance due to its close proximity and an ideal planetary destination for human settlement and exploration programs. The demand for missions with such extensive scope requires a higher payload capacity which needs the development of more efficient landing systems. Recent developments in the field of Low-Density Supersonic Decelerators (LDSD) have produced significant results but the payload weight still remains a major barrier to the effectiveness of these models, Sky crane model on the Curiosity rover has a weight constraint of 1 ton. Increase in payload weight means more retro-thrusters which uses up a lot of fuel, added up in form of fuel weight to carry. This paper aims to design a landing system that minimizes the need for retro propulsion by decelerating in the transitional flow regime using Lorentz force to counteract gravity. As detected by Mars Global Surveyor MAG/ER (1996), the southern hemisphere of Mars has an array of magnetic loops and umbrellas referred to as mini-magnetospheres. The crustal magnetic field of Mars is over 30 times more powerful than on Earth, with a minimum of 4nT at 200 KM, they extend well beyond 250 KM of altitude. Martian atmospheric conditions are considered to be in the Goldilocks zone - with enough atmospheric density to cause heat damages to the re-entry vehicles but not enough to slow it down effectively. This has resulted in failures of about 45 percent of Mars Landing Missions with the recent case of Schiaparelli EDM Lander. Taking the example of Phoenix lander, re-entry begins at around 175 KM and the vehicle continues to fall at close to 16 Mach with limited deceleration for the next hundred kilometers known as the transitional phase of the atmosphere. Visible deceleration begins at around 60 KM altitude when the vehicle enters the Martian atmosphere where heat shields become effective enough to decelerate the vehicle. In this paper, an analysis is conducted using the direct simulation Monte Carlo method for charged spacecraft flying through these mini-magnetospheres and the Lorentz force thus induced as a way to decelerate the vehicle. The intensity of the force will depend solely upon the velocity and charge of the vehicle and since the terminal velocity of the vehicle is very high, the magnitude of the force will be increased.