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HIGHLY ACCURATE GUIDANCE ALGORISM FOR LANDING ON A PLANET WITH GRAVITY

Abstract

Recently national governments are discussing about lunar exploration. U.S government declare that United States will go back to the moon and many other countries are planning lunar landing missions; SLIM (Japan), Chandrayaan-2(India), Chang'e-4(China), and so on. And a number of private companies are also interested in lunar landing missions. One of the reasons of the recent movement is water. Long-term research about the moon discovered the indication of water witch is necessary for human activities. And from water, we can also produce hydrogen and oxygen which can be used as propellant of spacecraft. The existence of water opens the door to possibility of moon base and human habitation on the moon. But in order to realize the moon base, we need to resolve many more technical challenges. For example, we want to land just besides the base but we don't want to crash on the base. Precise landing is one of these challenges. Typical landing sequence for planet without atmosphere is composed of 4 phases. 1st phase is de-orbit burn usually from low planet orbit (e.g. LLO), 2nd phase is coasting phase, 3rd phase is powered descent phase to cancel horizontal and control vertical velocity, and the last one is vertical descent phase intended to correct horizontal position error. Commonly, optical navigation is used in this last phase. Although this method can decrease landing point dispersion as less as navigation error theoretically, it usually needs a lot of time and more fuel. So we tried to minimize the position error at the end of the 3rd phase. In this paper, MHI proposes a new type of highly accurate guidance algorism applied for powered descent phase (phase 3). We conducted simulations with errors in initial states and vehicle characteristics, and from these results we produce one polynomial function to calculate the guidance command. This new guidance algorism can reduce landing site error less than 100m. In addition, guidance calculation is merely polynomial process without any iteration or numerical integration. Therefore, calculation load is much less than that of modern guidance algorism such as real-time integration method.