

# A Study on the Guidance and Control System for Lunar Landing

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## ABSTRACT

This paper describes an autonomous guidance and control system which enables safe and precise landings on the moon. Autonomous lunar precision-landing system will safely and repeatedly land on the surface of the moon with the capability to detect and avoid surface hazards. Integrating lunar model with attitude control incorporated with hazard avoidance algorithm and a sensor suite would help to assess the safety and reliability of the landing profile.

## I. INTRODUCTION

Traditional lunar landing approaches based on inertial measurement system do not provide autonomous precision landing. Vision system could be used to augment traditional lunar landing approach system by providing position or bearing measurements relative to known surface landmarks. This system use advanced sensors for imaging the landing area and detecting surface hazards.

## II. GUIDANCE SCHEME

The Powered Descent Phase is depicted in Fig 1. Powered Descent consists of 4 sub-phases:<sup>1</sup>

### A. Braking Phase Guidance

The objective of the braking burn is to steer the vehicle toward a soft landing at the landing site as efficiently as possible.

### B. Pitch-up Phase

This is a rate limited maneuver that adjusts the vehicle attitude from the angle at the end of the Braking Phase to the orientation required for the start of Approach Phase.

### C. Approach Phase

During Approach, the vehicle maintains a relatively constant attitude with a relatively low throttle setting.

### D. Final Descent Phase

The objective of the final phase is to descend slowly to the landing site in a near vertical

orientation, staying above the landing aim point and nulling out any remaining horizontal velocity.

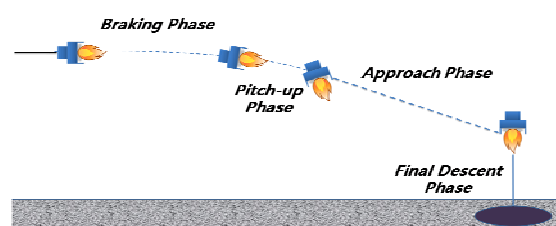


Fig. 1 Powered Descent Phase

## III. Hazard Detection and Avoidance

For safety landing, spacecraft uses onboard sensors to detect hazards in the landing zone, selects an alternate landing site, and then maneuvers to the new site. Potential candidates for the sensor suite are LiDAR(Light Detection And Ranging), visible camera, and Doppler radar.<sup>2</sup> We can obtain the information of the terrain by using these sensors and The information can be used for hazard avoidance algorithm.

## IV. CONCLUTION

In this paper, we introduce the powered descent phase. And we select sensor for hazard detection and avoidance. In the future, we simulate lunar landing module using the mathematical model of the module and the sensors. In this simulation, trajectory guidance and attitude command are formulated for the descent phase.

## REFERENCES

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