Counting, Prospecting, and Analyzing Craters using Unmanned Aerial Vehicles

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ABSTRACT

This paper presents some of the factors that should be considered when examining the potential roles and benefits of using unmanned aerial vehicles (UAVs) for scientific measurements and explorations of the lunar surface or for other types of interplanetary exploration. This paper explores considerations for crater counting, crater prospecting, and crater analysis from UAV platforms.

(Keywords: unmanned aerial vehicles, UAV, lunar exploration, interplanetary exploration, atmospheric measurements).

INTRODUCTION

Unmanned aerial vehicles (UAVs) hold tremendous promise for the collection of atmospheric measurements, soil sampling, exploring lava tubes, and the search for extant life on Mars, the Moon, and other extraterrestrial bodies. It is important to consider and describe some specifications before deployment for design of UAVs that can effectively be used to better characterize craters [1].

COUNTING CRATERS

The craft must possess either a relatively long rotor battery life or some alternative form of fuel. For example, NASA's Extreme Access Flyers are using jets of oxygen gas and water vapor as propellants to aerially maneuver and are estimated to last ~20 minutes [2]. This is the time restriction for acquisition of photo and video data of the topography of the extraterrestrial body of interest.

Another application is the use of solar-powered UAVs for over grounds exploration, which effectively can overcome the time limitations, provided proper seasonal or geometric orientation. This will allow for more rigorous methods of crater counting such as the use of automated programs or real-time neural networks to calculate crater count from photo/video data.

PROSPECTING CRATERS

Solar power is an interesting energy source to keep in mind as it offers a more elegant solution to the limited power supply problem with a hybrid of batteries, photovoltaic cells, and regenerative fuel cells optionally. Unfortunately, solar power is a double-edged sword and becomes a limitation in more prevalent low-light craters [3].

Two important considerations for prospecting craters are a high climb rate and loiter speed. Some crater walls can have tilts greater than 30 degrees, which prevent a standard rover from being able to traverse. Higher ranges of operating altitudes are more desirable as they improve chances of survival and coverage.

It is important to ensure the loiter speed is also relatively high so there is higher payload coverage – that is, area for sensors to scan [2].

Another aspect of prospecting is navigation devoid of global positioning systems (GPS). UAV flight data is typically geo-referenced in Earth by GPS satellite data, however this is a challenge for tracking heading information in extraterrestrial bodies. A combination of real-time 3D mapping, solar positioning, and radio or optical beacons produced by other UAVs may serve to landmark and function to ease the task wayfinding. In this manner, UAVs can serve as a pseudo-GPS for future missions.

ANALYZING CRATERS

Data-link bandwidth capabilities can affect interfacing with mission planning, control, and monitoring. As such, it will require optimization with satellites and hubs. There should also be a system functionality for controlling the flight route plan, payload plan, and a direct connection to the ground control station.

The bandwidth is also a function of the payload, meaning the more sensor and motor technology incorporated, the poorer the output quality. This is why the relative cost-benefit ratio of each sensor added should be carefully considered to assess compliance with the mission goals.

Another advantage of the UAV is that it can collect a stream of temperature, atmospheric, and electromagnetic radiation data. This permits scientists to better couple this information with 3D topography data and describe crater phenomena. For example, the crater Korolev is an ice-filled crater that is suggested to have a protective ice sheet that guards a vast water-rich area on Mars. [4] UAV data could tremendously help in analyzing the temperature dynamics that optimize the preservation of these resources.

CONCLUSION

The search for extant life on Mars is intimately linked with building better systems surrounding geographic surveillance and habitat scanning. Developing on-site mechanisms for detection of nano-motion can improve the efficiency with which we search for microorganisms.

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