ATTITUDE AND ANGULAR RATES OF PLANETARY PROBES DURING ATMOSPHERIC DESCENT : IMPLICATIONS FOR IMAGING

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ABSTRACT

There is scientific interest in imaging during descent to a planetary surface, notably in recent studies of Titan and Venus missions considered at APL. However, imager design requires an estimation of the angular rates of the vehicle such that exposure times and/or pixel scale can be set to avoid motion blur while desirably attaining high resolution and signal-to-noise. Ideally the actual vehicle configuration to be flown would be drop-tested extensively in representative flight conditions, but schedule and budget constraints rarely allow this. As a proxy, I review (1) attitude dynamics data from planetary missions to obtain a zeroth-order expectation on the tilts and angular rates to be expected on atmospheric probes during descent. In the absence of more specific data, these should at least serve as a starting point for design.

While recent Mars missions have been equipped with capable inertial measurements, attitude measurements for missions to other planetary bodies are rather limited but some angular motion estimates can be derived from accelerometer, Doppler or other data. It is found that robust camera designs should tolerate motions of the order of 20-40deg/s, encountered by Mars Pathfinder, Pioneer Venus , Venera and the high speed part of the Huygens descent on Titan. Under good conditions, parachute-stabilized probes can experience rates of 1-5 deg/s, seen by the Mars Exploration Rovers and Viking, Galileo at Jupiter, and the slow speed parts of the Huygens descent. In the lowest 20km of the descent on Titan, the Huygens probe was within 2 deg of vertical over 95% of the time. Some factors influencing these motions, and imaging mitigation approaches, are discussed.

(1) Lorenz, R. D., Planetary and Space Science, in press, 2010