MULTIPLE SENSORS FOR ABSOLUTE MEASUREMENT OF AEROBRAKING SPACECRAFT STATE ESTIMATION. B. Pigneur[1] and K. B. Ariyur[2], [1]Graduate Student, School of Mechanical Engineering, Purdue University, [2]Assistant Professor, School of Mechanical Engineering, Purdue University.

Abstract: Several missions such as Magellan, Mars Global Surveyor and Mars Odyssey efficiently used aerobraking technique. Typically, accurate peak dynamic pressure, heating rates and peak temperatures are common parameters for corridor control strategies [1]. Knowledge of the atmospheric environment and navigation accuracy are keys in the success of the aerobraking drag pass. Regardless of the control strategy implemented during the atmospheric pass, spacecraft state estimation affects the cost and risks of the aerobraking maneuvers.

Commonly, radiometric tracking data (both prior and post atmospheric pass) has been used to determine the spacecraft state [2], [3]. This technique was successful in numerous missions however there are some drawbacks.

1. The main issue is the time and cost linked to the navigation and orbit reconstruction post atmospheric pass. As an example, Mars Odyssey aerobraking operations required 6 full-time-equivalent navigators during the 3 months span of the aerobraking operation.
2. Lack of radiometric data during atmospheric pass associated with dynamical perturbations results in high uncertainty in state estimation.
3. Therefore non-real time state estimation leads to increased errors in corridor control and more propellant used.

Another more recent approach has been developed based on IMU measurement for state estimation. This method is called IMAN [4]. This approach has comparable navigation accuracy than traditional radiometric tracking but the main advantage is that it addresses issues due to post drag pass reconstruction. Unfortunately, inertial measurements highly depend on the initial sate of the spacecraft and propagate error through successive measurements.

At the Autonomous Systems Laboratory, we are currently developing a novel method for full state estimation based on multiple sensors. The use of multiple CMOS imagers allows real-time absolute measurement for full state estimation. This technique limits the propagation of uncertainty due to atmospheric pass. It also increases autonomy and by consequence the operational cost drops. More accurate real-time state estimation decreases corridor control errors and reduces maneuvers and thus reduces propellant.

This full state estimation technique will be presented in depth in another publication. The goal of this paper is to focus on the application of this method to aerobraking maneuver. Comparison with previous methods (radiometric tracking, inertial measurement) will be drawn in this paper. Future work would be the development of new corridor control techniques based on real-time full state estimation.

References:

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