VALIDATION FACILITIES FOR RV AND AEROCAPTURE GNC

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The proposed paper presents the validation facilities for a vision based GNC suitable for both automated RV in either circular or elliptical orbit, either an interplanetary aerocapture GNC system.

The simulation infrastructure consists on a Real-Time Test Bench (RTTB) subdivided in two different implementations: a Processor in-the-loop (PIL) configuration and Hardware in-the-loop (HIL) configuration based on an image processing (IP) laboratory mock-up.

This RTTB is largely based on a Image Processing (IP) laboratory, used to achieve HIL objectives. Proper evaluation of IP performance in realistic conditions is of paramount importance because IP is a slave subsystem to GNC that provides information on the chaser/target relative positions, i.e. provides optical navigation observables used in the closed-loop chain. The specific objectives of the IP laboratory are:

- Test IP methods with real images taken on a spherical canister (different from a more classical distributed beacon light pattern), which may lead to a variety of scenarios;
- Test specific sequences especially during the transition between IP modes or states;
- Work with real camera parameters (opto-electronic noise, MTF, …) instead of simulating all camera performances based on parameters which are not available most of the times.

The RTTB (PIL+HIL) objectives can be enumerated as:

- Evaluation of the GNC algorithms real-time performance in a target environment, chosen to be a LEON3 processor, which includes basic (RTEMS) operating system and application programming interface (API) functionalities for realistic integration;
- The GNC real-time and algorithmic performance evaluation;
- Assessment of FES architecture suitability (by means of real-time performance evaluation) when integrated in a real-time V&V environment, chosen to be a dSPACE real-time simulation environment.

The additional HIL objectives are:

- Evaluate the integration and performance of the entire GNC and IP chain, i.e. from image acquisition down to navigation/control outputs;
- Test the algorithmic and real-time performance of IP routines under realistic imaging conditions (e.g. light and shape conditions, CCD properties, etc.).

The limitations of the RTTB are also discussed in the proposed paper, while the emphasis is put on the interfaces between the HW elements (COTS camera, dSpace computer, control PCs and RT processor) and the problems associated to these interfaces.