

# Visual Navigation - SARE Mission

Roberto Alonso, Jose Kuba, Daniel Caruso\*

## 1. Introduction

The SARE Earth Observing and Technological Mission is part of the Argentinean Space Agency (CONAE - Comisión Nacional de Actividades Espaciales) Small and Technological Payloads Program. The Argentinean National Space Program requires from the SARE program mission to test in a real environment of several units, assemblies and components to reduce the risk of using these equipments in more expensive Space Missions. The objective is to make use those components with an acceptable maturity in design or development, but without any heritage at space. From the application point of view, this mission offers new products in the Earth Observation data market which are listed in the present paper.

One of the technological payload on board of the SARE satellite is the sensor *Ground Tracker*. It computes the satellite attitude and orbit in real time (goal) and/or by ground processing. For the first operating mode a dedicated computer and mass memory are necessary to be part of the mentioned sensor. For the second operational mode the hardware and software are much simpler.

Some advantages of this sensor are addressed below,

1. By using the images taken by the optical payload (2D CCD camera) for the calculation of attitude and orbit, the typical alignment error between the reference frame of the sensor and the payload camera is zero. The costly calibration task are unnecessary.

---

\*Comisión Nacional de Actividades Espaciales (CoNAE) Paseo Colón 751, (1063) Buenos Aires, Argentina. e-mail: {beto|kuba}@conae.gov.ar

2. Possibility of using inexpensive of the shelf panchromatic camera as the active sensor, for example to have better accuracy by selecting smaller pixel size.
3. This sensor can be used as backup of GPS receiver and Star Tracker.

For the real time mode, a reference map or keypoints of the area of interest are stored in the computer memory to compare with the instantaneous image to calculate the orientation and positioning. For the SARE mission only the area of Argentina is the area under interest for the optical sensor, so the stored map is reduced to one country.

Because most of the missions have others standard sensors for attitude and for orbit determination, the area, on which the search is performed, is dramatically reduced to a few degrees more than the necessary. Almost all missions have at least for coarse attitude determination: a set of magnetometers and at least six coarse sun sensor, and for positioning they have GPS, and/or internal orbit propagator. SARE mission is not the exception to this rule: it has the sensor already mentioned, but the ultimate goal of this project is to obtain the orientation and orbit solution in real time, without external aid (similar to *Lost in Space* in Star Trackers).

The main body of the paper is dedicated to present the algorithm to the end mentioned above. The final implementation is not described in detail, but is also presented.

1. The algorithm starts extracting clouds, crops and sea or big rivers, which can created a false solution from the area under consideration. The spatial and spectral analysis as well the number of counts per pixel are used for cleaning the image from these corrupted factors.
2. The second step is the keypoints determination to represent with them the complete image. In other words, the image is replaced by a set of points which are invariant to scale factor, translation, rotation, line of sight, etc. Several techniques are used: wavelets, double Fourier transform, etc. In the computer memory, the reference pattern is a set of keypoints obtained from LANDSAT images on the same area of interest.
3. The matching between the keypoints of the real time image and the stored synthesized LANDSAT image allows the calculation of the attitude and orbit. The methods for that registration are the graph matching and the same algorithm used in Star Trackers (inner product between the selected points.

It is expected to prove the algorithm on an UAV in late 2007. Computer simulation will be presented in the Symposium.