SPACE SYSTEMS SYMPOSIUM (D1)
Space Systems Architectures (4)

Author: Mr. Sergi Luque Ribas
Institut Supérieur de l'Aéronautique et de l'Espace, France, luque.sergi@gmail.com

Mr. Daniel HERNANDEZ
Devil-Hop, France, danieljean.hernandez@orange.fr
Mr. Emmanuel Zenou
Insitut Supérieur de l'Aéronautique et de l'Espace, France, emmanuel.zenou@isae.fr

VISION BASED LOCALIZATION SYSTEM FOR A MARS PROBE

Abstract

Mars is the planet that has the most interest for the scientific community. Because of this, a lot of missions have reached the planet and landed on the surface. One of the principal challenges is to place the rovers exactly in the desired landmark. The actual systems are open-loop. It means that they start from a known position in approach, determined by the Deep Space Network, and from that point they estimate its positions using dead-reckoning (inertial measurements) and measurements of the atmosphere. This type of navigation has allowed a precision on landings up to a 10km diameter ellipsoid for the last mission, the Mars Scientific Laboratory (Curiosity rover).

The objective of this project is to **design a closed-loop navigation system by the use of vision-based systems**, in order to provide a better navigation data to the control systems and increase the landing precision of the probes. To achieve this, the system uses feature detection algorithms, such as SIFT (Scale-Invariant Feature Transform). The system is divided into two parts: absolute localization and motion estimation.

The **absolute localization** function gives as output the position (longitude, latitude and altitude) of the probe during the descent. It is obtained with a camera that takes images of the surface; these images are compared with a database of images of the surface of Mars, previously taken by the Mars Reconnaissance Orbiter. Once the feature detection algorithm has found a suitable match with the database, the location is obtained.

The **motion estimation** function is independent of the success of the absolute localization function. It only needs a first estimation of the position –which can come from either the absolute localization function or another less precise system, such as an Inertial Measurement Unit– and two images taken by the camera onboard. By measuring the movement of the image and having the previous position and altitude estimation, a new estimation of the absolute position, the altitude over the surface of Mars, the heading, the rotation and the ground and vertical speeds of the probe is obtained.

Finally, the data is displayed in a web simulator with a simple interface. It allows seeing the results and performances of the system. The "Google Earth API" is used to show the trajectory of the probe in 3D, while the simulation parameters are pre-defined through the browser and then processed in server side.