The potential of non-semantic features for UAV's remote sensing data fusion

Eduard Angelats [1*], M. Eulàlia Parés[1]
& Ismael Colomina[2]

[1] *CTTC, Geomatics Division, Av. Carl Friedrich Gauss 7, Castelldefels, Spain,*
eduard.angelats@cttc.cat

[2] *Geonumerics S.L., Av. Carl Friedrich Gauss 11, Castelldefels, Spain;*

Recent advances in UAV platforms together with the miniaturization of cameras and laser scanner sensors make feasible to fly simultaneously, in terms of size and cost, multi-sensor payloads, expanding UAV-based possible applications and targeting new communities. These payloads can consist, for example, of several cameras sensing different spectral bands and/or lightweight, low cost laser scanners. The use of fused data from these sensors can boost the use of UAVs for environmental mapping purposes such as landslide volumetric estimation, biomass estimation or forestry management, to mention a few. In this context, co-registration becomes a key step in order to exploit the complementary characteristics of several cameras and/or laser scanners, and thus generating additional information layers.

The main outputs of these combined systems use to be a set of oriented camera images and 3D point clouds. These point clouds can be derived from a pair of overlapping images or using the laser raw data together with the platform estimated trajectory. Some applications might also require coloured point clouds, which are usually derived from a registration process between camera and laser scanner or, if several cameras are used, from a registration process between all the cameras images.

Nowadays, the standard procedure for camera to camera and camera to laser co-registration requires from several steps. The first one is the system calibration, where the lever arm and the boresight between all sensors and the positioning system must be determined. This calibration is usually done by means of a least square adjustment of data acquired specifically for calibration purposes. Note that these values may not be constant and may vary significantly in each mission; these may be even unknown. Thus this calibration step must be done for every mission. Next step is the system orientation. Sensor orientation can be done with direct or indirect approaches and it is usually computed separately for each sensor. Then, it is possible to compute separate point clouds for each sensor. Finally, the derived point clouds are co-registered. This last step is also based in a least squares adjustment and is a complex process with a high computational burden.

The aim of the research presented in this paper is to reduce the aforementioned co-registration steps to a system's boresights calibration problem. In contrast to the standard approach, we propose to solve the orientation and calibration of laser and camera data in a single, combined adjustment. Solving the orientation and calibration allows us to implicitly deal with the co-registration problem. The proposed method is based on the identification of common tie features between images and point clouds and their use in a combined adjustment. In this research we propose to use non-semantic features. By non-semantic features we understand those that provide useful data to solve a certain task but provide no relevant information to describe or understand the scene. Examples of common tie features, used in our approach are basic geometric primitives such as straight line segments, points, planes and ellipses. The parameters to estimate in our new problem will be those describing the features, the orientation and system calibration parameters and the self-calibration parameters. These parameters will be estimated from image coordinates, and raw laser scanner measurements belonging to non-semantic objects extracted from images or point clouds.

The co-registration strategy have been tested using real data from a UAV mapping system including a low cost laser scanner and two COTS cameras. The preliminary results suggest the feasibility and the potential of the approach. The tests show that with the proposed approach co-registration is feasible, cheaper in terms of computational burden and, last but not least, colored point cloud with high density can be obtained even with low-textured scenes.