Francesco Nex
ITC Faculty - Earth Observation Science (EOS) Department, University of Twente
The Netherlands

"REAL-TIME PHOTOGRAMMETRY WITH UAVS AND ROBOTS: WHERE DO WE STAND?"

Processing time is an important parameter in all the photogrammetric applications. The general trend of using everyday larger datasets has further increased the request of fast and efficient algorithms able to process thousands of images in acceptable times. If fast computing is a plus, real time processing is not always a priority in most of the Geomatic applications and, in the common sense, it is often associated with applications traditionally far from our domain. Only the use of UAV platforms for real time monitoring and mapping have more recently triggered the implementation of real-time solutions also in our community. In this regard, what we would like to see in the future are UAVs able to autonomously fly over an unknown area, plan autonomously their flight path and generate accurate 3D models interpreting and classifying the scene in real time. But, how do we stand now?

Looking at the Robotics community the autonomous navigation is still a burning topic for most of the research groups. Visual SLAM and Visual Odometry techniques aim at localizing the mobile platform in the space in real time. The position of the (terrestrial or aerial) vehicle is determined using medium/low resolution images extracted from high rate videos. From these videos, only few key-frames are selected to determine the platform position while the other frames are oriented in a second stage. The priority is to be fast and provide a sufficiently good orientation to localize the vehicle in a roughly reconstructed environment. Compared to the Photogrammetric standards (see Clive Fraser's article), the orientation is often simplified running local Bundle Adjustments (or not running it at all) and safeguarding low deformations only at a local level: of course, the main aim is the fast positioning of the platform instead of the accurate reconstruction of the 3D space. It should be noticed that in many Geomatic applications, such as object detections, these approximations can be often sufficient too.

The delivered point clouds are then sparse and only few solutions (like some recent deep learning approaches) are trying to provide dense reconstruction in real time. Again, their aim is to provide fast collision avoidance depth maps and these results are not suitable for 3D models as we intend them.

In this context, terrestrial robots have the advantage to work with a reduced number of degrees of freedom and less limits in terms of weight or power supply compared to aerial robots like UAVs. The development of lighter and more efficient micro-PCs exploiting CPUs and GPUs have only partially compensated these drawbacks allowing their use on relative small and light UAVs. Available on board processor are probably fast enough for real time photogrammetry but they require huge energy consumptions, putting researchers in front of two options: the use of bigger platforms with more batteries or the flight time reduction. Most of the experiments undertaken so far last very few minutes limiting their practical usability on larger scales and in every day projects. The developed platforms are then rather expensive and the (sometimes common) possibility to damage the platform during flights limits the impact of these tools in many applications. The streaming of the data on external (and more powerful) PCs/clusters solves the energy and flight time issues (reducing the platform costs too) but completely relies on the communication quality: the unavoidable delays between platform and ground station prevents the prompt reaction of the platform and can generate fatal failures if this information is needed to plan the flight.

It’s clear that road to travel for real time photogrammetry is still quite long, but it will happen much faster than we expect: the technological and algorithmic improvements seen in the last five years have been impressive and the near future won’t be less existing. On board processor will be more efficient while communication will be faster and more reliable. UAVs are not a niche technology for researchers and hobbyists, not anymore at least. The UAV market is booming, not only in the hobby segment, and this will boost the development of new hardware and software solutions. In this regard, don’t be surprised if some real time functionalities will be embedded in many consumer grade platforms in the incoming years!