UAVs and the Built Environment

My Endpoint column in the February 2011 issue touched upon general characteristics of Unmanned Aerial Vehicles (UAV). Here, I focus on low-weight, low-altitude and the built environment. Low-weight UAVs are easily transportable and can be purchased at affordable prices. Thanks to their user-friendliness and fidelity, today's low-weight UAVs offer a seemingly cost-efficient method of collecting 3D data for a single building, or a handful of adjacent premises, in urban areas. In practice, however, the effective use of low-weight UAVs is far from simple.

According to the European Unmanned Vehicle Systems Association (EURO UVS), a UAV plus load should not exceed 30kg to receive the tag 'low weight'. A UAV is classed as 'Micro' when its take-off weight is less than 5kg while its flying height should be less than 250m and its flight duration less than one hour. UAVs weighing between 5 and 30kg are classed as 'Mini'; they may remain in the air for up to two hours and may operate at altitudes up to 300 metres. A Micro is subject to minimum legal constraints and this – in conjunction with its price – makes it valuable to many small-scale projects in urban areas. Since the payload is at most one third of the UAV's tare weight, the UAV itself should not weight more than 3.5kg. At a maximum of 1.5kg, the payload is limited to a low-cost GNSS and a consumer digital camera – no scope for mounting on a stabilised platform and no integrated differential GNSS/inertial navigation system (INS) for direct georeferencing. In the near future, the miniaturisation of accelero-meters and gyroscopes – based on micro-electromechanical system (MEMS) technology – may mature to a level that enables low-cost integrated GNSS/INS. However, for now one has to be satisfied with a low-cost GNSS, which means that positioning of the camera's projection centre restricts accuracy. So for any surveys requiring conventional photogrammetric accuracy levels, ground control points are needed resulting in higher costs.

An object weighing just 5kg is sensitive to crosswinds and turbulence. Thermal effects can easily cause pitch, roll and yaw, resulting in nadir views becoming oblique views and – in combination with the small footprints of consumer cameras – planned overlaps showing up as gaps. The only way to avoid gaps is to capture extreme overlaps, such as 90% along track and 60% across track. The quality of images recorded with consumer cameras is limited, while turbulence and vibration in the air may introduce blur and destabilise the interior orientation. Pre-calibration in a laboratory is not enough, since the values of the interior orientation may degrade over time. Therefore, self-calibration should be carried out using known geometry in object space. Meanwhile, intermediate fluctuations may be tackled by algorithms modelling drift.

With their toy-like appeal, Mini UAVs appear to offer a low-cost option for capturing photogrammetric images of the build environment. However, the high level of skill and degree of inventiveness required to use them effectively should not be under-estimated.

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