IMAGE ORIENTATION OF CLOSE RANGE BLOCKS WITHOUT GCP

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ABSTRACT:

A solution to the orientation of close range blocks not requiring approximate values for the bundle adjustment parameters (OE and tie points) was presented in Sept 2002 at the Comm. V Symposium in Corfu. It integrates in a management module, that control the sequence of computations, space resection, space intersection and bundle block adjustment. Approximate values for the exterior orientation of every image are provided by a space resection algorithm which needs at least 4 GCP per image; a close formula computes the approximate ground coordinates of tie points intersecting a pair of image rays. To provide the resection module with at least 4 object points for every image, we apply an incremental process where, starting from a minimal set of oriented images, we add new images and compute preliminary ground coordinates of tie point as soon as this is feasible. Examples with simulated and real blocks were presented, discussing the performance of the algorithms.
Since last September, improvements have been made to minimize or eliminate the need of GCPs and related surveying work on site; moreover, the procedure has been checked to strengthen it against identification and measurement errors.
According to the terms of reference of WG 4, we tried to make the procedure integrated in a low cost and easy-to-use working scheme. Rather than resorting to survey of GCP with total stations or other means, we decided to define the object reference system in an arbitrary fashion, possibly providing a scale information by a known length or even accepting the reconstruction up to a scale factor. Basically, rather than starting the procedure from a kernel of images oriented using GCPs, we begin with the relative orientation of a stereo pair, compute the coordinates of the tie points in the model reference frame and use them as the kernel of GCPs. In such a way, apart from giving a distance measurement on the object (e.g. with a tape) no preliminary work is necessary and all information is provided by photogrammetry. Since the relative geometry of the stereo pair may be far from the normal case, a general solution of the relative orientation problem is implemented, which makes use of the fundamental matrix and does not need approximate values for the relative orientation parameters. The method was successfully integrated in a AAT program with the purpose of identifying and discarding mismatches between tie points, so it is inserted in a robust estimation scheme. Once the computed model coordinates of the tie points, possibly scaled 1:1 to the object, are available, the procedure implemented in TRIACR is started and proceeds as usual, based on a bundle block solution. Obviously, if the block to be oriented is large, the lack of GCPs may adversely affect the accuracy of the orientation; particular care must then be put in selecting number and distribution of the camera stations to keep the block strong enough. This also applies to the number and distribution of the tie points, which must ensure that in any new image at least 4 tie points are common to previously oriented images (much like in AT, where at least 3 tie points must be available along the strip). This new way of starting the procedure is more flexible and may be ideally suited to an interactive implementation of the method, which currently it works off-line.
An analysis of the sensitivity of the method to measurement errors is also being performed; preliminary results can be anticipated When introducing large errors (e.g. in the order of several hundred μm, such as in mismatches with repetitive object details) in the image coordinates of the initial kernel of GCPs , if only four points are available the image cannot be oriented: this is obvious, being the minimum for the resection algorithm. If more points are available, the inconsistency is identified (the "clean" kernel of points is separated and the image coordinates are discarded). Because of the way the solution for the resection is computed, though, small gross errors may cause the threshold on the discrepancy between the available GCPs coordinates and those computed by intersection for a check to be exceeded. This is safe when redundancy is low and embarking wrong measurements is dangerous, unnecessary at a later stage, when redundancy is enough because more images have been inserted. Therefore, the steps where checks are applied have been revised to make them more tolerant the more the redundancy of the block. Some self-diagnosis index is now being provided to the user to evaluate block characteristics prior to start the procedure.
The changes and improvements made to TRIACR will be illustrated, as usual, either by simulated and real data.