

# The Common Adjustment of GPS and Photogrammetric Measurements

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## SUMMARY

GPS controlled aerial photogrammetry is, in its current guise, a mature technology that has found near universal acceptance in the mapping community. The current integration strategy is to first process the GPS data using a stand-alone processor, and then to use the resulting positions as parameter observations in a photogrammetric bundle adjustment. This implementation has obvious benefits in its simplicity; however, a more fundamental fusion of the GPS and photogrammetric data streams is possible. In this paper, investigations are made into a single combined adjustment that natively uses both photogrammetric image measurements and raw GPS code and carrier-phase observations. The anticipated advantages of this new integration technique include improved reliability and the ability to make use of GPS data when less than four satellites are available. The technique also streamlines processing as only a single software package need be used. Background and details are provided on existing integration techniques, on the revised collinearity equations that facilitate the inclusion of GPS observations and on the undifferenced and double-differenced code and carrier phase range observations used in the combined adjustment. Design details of the hierarchical adjustment software created to perform the combined adjustment are provided, with specific attention given to the GPS adjustment component. Through tests, the combined adjustment is compared against the conventional integration strategy in a variety of configurations of input data. The tests are not conclusive, but appear to indicate that the new technique is no more accurate than the old technique.