ABSTRACT

Chokchai Puatanachokchai. Ph.D., Purdue University, May, 2007. Mathematical Models and Photogrammetric Exploitation of Image Sensing. Major Professor: Edward M. Mikhail.

Mathematical models of image sensing are generally categorized into physical/ geometrical sensor models and replacement sensor models. While the former is determined from image sensing geometry, the latter is based on knowledge of the physical/geometric sensor models and on using such models for its implementation. The main thrust of this research is in replacement sensor models which have three important characteristics: (1) Highly accurate ground-to-image functions; (2) Rigorous error propagation that is essentially of the same accuracy as the physical model; and, (3) Adjustability, or the ability to upgrade the replacement sensor model parameters when additional control information becomes available after the replacement sensor model has replaced the physical model. In this research, such replacement sensor models are considered as True Replacement Models or TRMs. TRMs provide a significant advantage of universality, particularly for image exploitation functions.

There have been several writings about replacement sensor models, and except for the so calles RSM, almost all of them pay very little or no attention to errors and their propagation. This is because, it is suspected, the few physical sensor parameters are usually replaced by many more parameters, thus presenting a potential error estimation difficulty. The third characteristic, adjustability, is perhaps the most demanding. It provides an equivalent flexibility to that of triangulation using the physical model. Primary contributions of this thesis include not only "the eigen-approach", a novel means of replacing the original sensor parameter covariance matrices at the time of estimating the TRM, but also the implementation of the hybrid approach that combines the eigen-approach with the added parameters approach used in the RSM. Using either the eigen-approach or the hybrid approach, rigorous error propagation can be performed during image exploitation. Further, adjustability can be performed when additional control information becomes available after the TRM has been implemented.

The TRM is shown to apply to imagery from sensors having different geometries, including an aerial frame camera, a spaceborne linear array sensor, an airborne pushbroom sensor, and an airborne whiskbroom sensor. TRM results show essentially negligible differences as compared to those from rigorous physical sensor models, both for geopositioning from single and overlapping images. Simulated as well as real image data are used to address all three characteristics of the TRM.