ABSTRACT

Mulyana, Ade K. Ph.D., Purdue University, May, 2005. Error Propagation for Geopositioning from Airborne Spotlight SAR using The Stereo Method . Major Professor: James S. Bethel.

The stereo SAR technique computes 3D coordinates of ground objects by making use of two quantities that can be derived from a SAR image: range and doppler angle. Due to the flexibility in the image collection requirements, this is an attractive alternative to interferometric SAR. Applying stereo SAR to stripmap SAR images, however, is known to produce coordinates with only modest accuracy. On the other hand, another mode of SAR, the spotlight mode, produces SAR images with a superior resolution (at the expense of the coverage). Together with the more advanced navigation systems available today, this makes applying the stereo technique to airborne spotlight SAR images an interesting object of study.

An error model for stereo spotlight SAR in the form of the precision for the observations is developed. The precision of the navigation data is derived directly from the performance description of available navigation systems. The error in the range and doppler angle is derived from the analysis of the image formation process applied to real spotlight SAR data, including the autofocus process. This ties the image formation process to the geopositioning aspect of SAR.

An error analysis for stereo SAR is performed based on a covariance analysis study. The impact of navigation data quality, different flight trajectories, and different distances to the scene, on the precision of the computed ground coordinates are evaluated. The analysis is done using simulated spotlight SAR images of discrete point objects.

Ground coordinates with CE90 on the order of 1-2 m and LE90 of 1 m are possible to achieve from a medium distance of about 6 km. From a longer distance of about

50 km, CE90 of about 6 m is obtained from a reasonable flight configuration. The results also reveal the necesscity to determine the direction of the velocity vector precisely. Each component of the velocity vector must be determined to better than by 10 cm/sec. These results show that high quality SAR image produced by the spotlight mode combined with high accuracy navigation data available from the current system indeed produces high precision ground coordinates.