Instructions for Running the LIDAR Error Propagation Calculator

The LIDAR error propagation calculator enables the user to determine the accuracy of the ground coordinates for a certain point derived from a LIDAR system, given the values of the fifteen LIDAR input parameters and their accuracies. The user must input the following LIDAR input parameters, along with their accuracies:

- X, Y, Z ground coordinates of the GPS antenna phase center, obtained from the GPS/INS integration process (3 parameters)
- ω, ϕ, κ orientation angles of the INS unit with respect to the mapping frame, obtained from the GPS/INS integration process (3 parameters)
- α, β rotational offsets between the laser unit frame and the laser beam frame, obtained via laser measurement (2 parameters)
- laser range measurement to the object point under consideration (1 parameter)
- ΔX, ΔY, ΔZ boresighting spatial offsets (between the GPS antenna phase center and the laser beam firing point) relative to the laser unit coordinate system, obtained via calibration (3 parameters)
- $\Delta\omega$, $\Delta\phi$, $\Delta\kappa$ boresighting rotational offsets (between the INS frame and the laser unit frame), obtained via calibration (3 parameters)

The accuracies of these input parameters may be determined by the equipment and/or calibration procedures used to derive the parameter values. The calculator determines the resulting accuracy of the ground coordinates of the point via error propagation; specifically, the dispersion matrix of the final ground coordinates is computed. Conversely, if the user requires a specific accuracy in the final ground coordinates from a LIDAR system, the calculator may be used to determine the accuracies that would be required in the input components, through an iterative trial and error process. For more technical details, interested readers can refer to Habib et al, 2006.

The calculator is based on a C++ program and can be run via the provided executable (*.*exe*) file. Figure 1 below shows the calculator user interface. To operate the calculator, one must simply enter the values for the fifteen input parameters along with their standard deviations (i.e. sigma values) in the boxes provided, and then click the “Calculate” button. The results are generated in the box at the bottom of the screen. In Figure 1, typical values for the fifteen LIDAR input parameters have been entered, along with typical sigma values. The output box displays the dispersion matrix of the final ground coordinates of the point under consideration, followed by the actual accuracies (sigma values) of the computed coordinates. The dispersion matrix provides information regarding the overall accuracy of the final ground coordinates of the point. The square roots of the diagonal elements of the matrix are the standard deviations of the X, Y, and Z coordinates (the output sigma values), and the off-diagonal elements are the covariances of these coordinates. In Figure 1, the contents of the output box have been scrolled downward so that the output sigma values are shown.

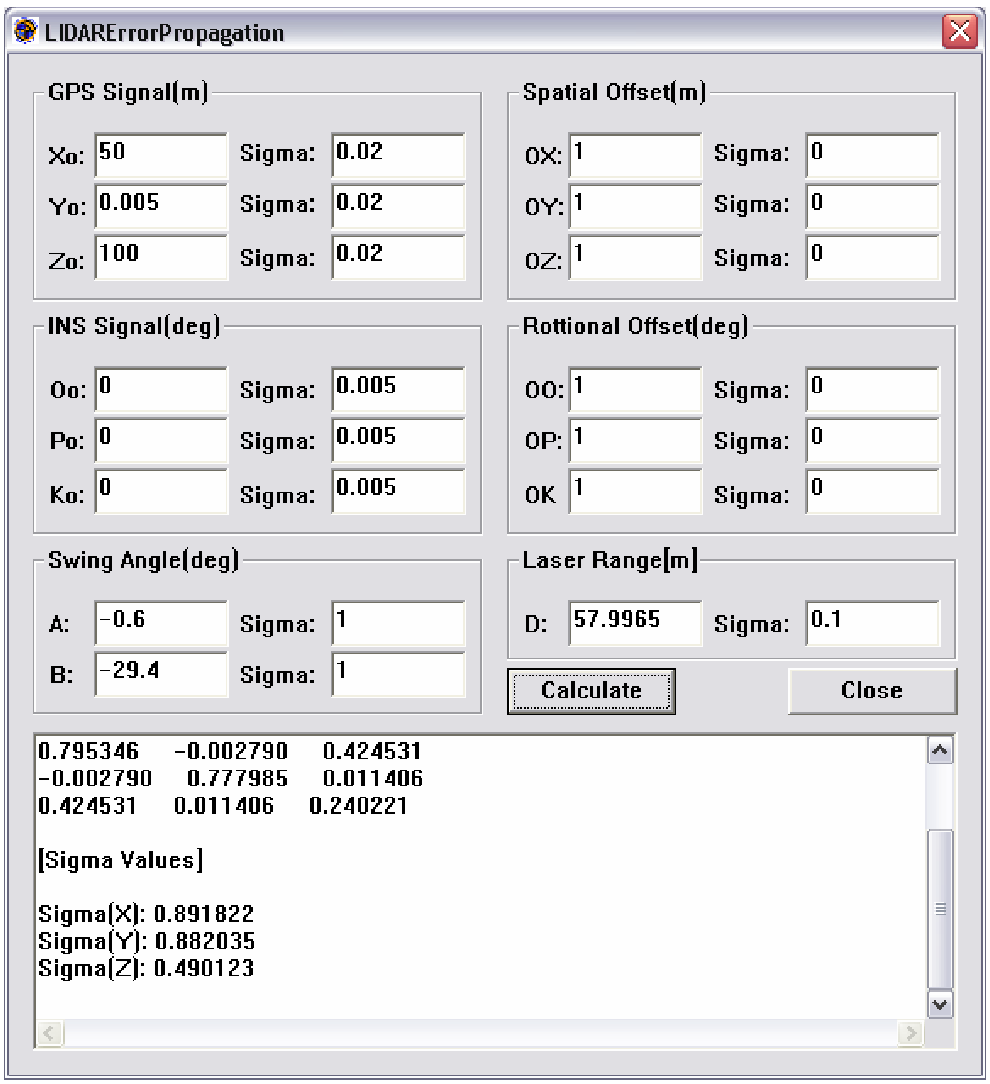

Figure 1: LIDAR error propagation calculator user interface

References:

1. Habib, A., Lay, J., Wang, C., 2006. Accuracy, Quality Assurance, and Quality Control of LIDAR Systems: Technical Background. Technical report submitted to the Integrated Land Management Bureau (ILMB), Base Mapping and Geomatics Services, July 2006 (71 pages).