Airborne GNSS Signals Segmentation for Water Body Detection

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Abstract

The aim of this work is to develop an automatic segmentation model that divides airborne GNSS signals into stationary segments based on the reflectivity measurements associated with different areas of reflection. We adapt a linear transitional model to characterize the changes in the GNSS reflectivity measurements along a flight trajectory. The changes are detected online by a Kalman-CUSUM approach. We propose a Maximum Likelihood Localization Estimate (MLLE) for accurate geo-positioning of the edges of the scanned reflecting surfaces. This approach is close to the optimal estimation because we maximize the size of the working windows in which the detected change points are localized. In the presence of noise, the CUSUM algorithm over segments the GNSS reflectivity measurements. In this regard, we propose an interval merging algorithm that uses the statistical properties of the segments in order to decrease the number of false alarm detections. We show using synthetic data that the proposed MLLE approach can localize changes more accurately than reference approaches. This work is applied to airborne GNSS-R observation of in-land water body surfaces. We show using the airborne GNSS measurements obtained from a gyrocopter experiment that the proposed radar technique detects different surfaces along the flight trajectory, and in particular in-land water bodies, with high temporal and spatial resolution, allowing the detection of very small water body surfaces such as streams of 3 meters width. We also show that we can localize the edges of the detected water body surfaces with a meter precision.