RSHS18-129
Remote Sensing and Hydrology Symposium (ICRS-IAHS)

Multi-spectral LiDAR bathymetry of an urban river environment

Maxim Okhrimenko, Craig Coburn, and Chris Hopkinson

Department of Geography, University of Lethbridge, Lethbridge, Canada (maxim.okhrimenko@uleth.ca)

River environments are dynamic and accurate bathymetric data are vital sources of information needed for flood mapping and management of the riparian zone. The need for accurate mapping is especially acute when rivers and human settlements intersect in flood-prone areas. Rapid changes in channel morphology is common and information related to these spatial and temporal changes are vital for our understanding of these environments. Mapping shallow water bathymetry (SWB) in river environments presents a difficult set of challenges for remote sensing. Past studies have used multi-spectral LiDAR (ms-LiDAR) or passive optical data to develop models of bathymetry. Innovations in ms-LiDAR systems combined with passive optical data for this application will improve the quality of data used for these applications. While many applications exist for both active and passive technologies, they are centred around environments where the surface of the water is reasonably flat. At the same time, most river environments possess a significant stream gradient. Current off-the-shelf (OTS) software solutions for bathymetric LiDAR were designed around lake shore or coastal environments and can be problematic in river applications, where there may be overhangs or complex bed morphology. This paper presents i) a method for deriving a digital water surface model (WSM) from the LiDAR; ii) a novel post-processed bathymetric correction that does not require trajectory files; iii) a method of return separation for bottom and volumetric echoes utilizing passive imagery. The result is a bathymetric model of the Bow and Elbow rivers within city boundaries.
Titan ms-LiDAR data (Teledyne Optech, Toronto, Ontario) were collected over two river reaches near the downtown area of Calgary, Alberta, Canada (Bow River and Elbow River). The Titan system operates at three wavelengths: 1550 nm, 1064 nm, and 532 nm. Flight lines were flown with 50% overlap at an altitude 500 m above ground, providing 200% coverage with a pulse density of 18 points per square meter per channel or 56 points per square metre. SPOT 5 satellite imagery was obtained to complement the ms LiDAR data. Ms-LiDAR incidence angle was ignored in this simplified approach, as it was deemed to have a negligible impact on depth correction for shallow river beds. Two types of WSM were developed: the first based on LiDAR intensity and the second based on virtual transects derived from LiDAR points within a priori defined water boundaries. The resulting bathymetric correction proved superior to that using OTS software. Water surface variations of up to 80 cm were observed across two channels of the river around a small island, illustrating that the commonly adopted assumption of a flat water surface is not always appropriate in dynamic river environments. Fusion of ms-LiDAR and passive imagery enhanced automatic extraction of channel morphology.