Doctoral Thesis Title: Automatic shoreline mapping using multispectral airborne LiDAR data for near-shore

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Abstract: Although the aerial photogrammetric shoreline mapping procedure could provide the most accurate shoreline among other semi-automatic or autonomous approaches, it is a time-consuming process and the placement of shoreline is subject to human interpretation. Airborne LiDAR can further compensate the drawbacks of this image capturing approach as a result of the direct geo-referenced 3D point cloud. The recent introduction of multispectral airborne LiDAR can potentially enhance the capability of water mapping, minimize the involvement of manual intervention and reduce the use of supplementary information or ancillary data. This study will demonstrate the use of multispectral airborne LiDAR data for automatic shoreline delineation under different coastal environments. The proposed method to process LIDAR data for automated shoreline delineation utilizes scan line intensity-elevation ratio (SLIER) to split preliminarily the land and water region. Subsequently, various LiDAR-derived feature sets, particularly based on the multispectral LiDAR intensity, will be constructed in order to serve as an input for the SOM[2] classification model in order to conduct point cloud based classification experiments. Some optional post-classification enhancements can be implemented to further adjust the misclassified data points. In the post-processing phase, a sequence of proposed operations including the Modified Convex Hull algorithm to trace the boundary of the shoreline will be applied to extract vector shorelines from the binary image. Besides, the classification result can be used to obtain bathymetric data for the water area by the water agencies on demand. This study investigates the capability of multispectral LiDAR data for water surface mapping with a high degree of automation and accuracy. Thus can provide valuable datasets for a number of applications in geomorphology, hydrology and hydraulics, such as monitoring of coastal processes, change modeling and mapping.

Available Means: In terms of data, multispectral LiDAR datasets would be used, such as the Tobermory (Ontario, Canada) dataset covering a natural coastal area. Another data source includes terrestrial orthophotos obtained from aerial photogrammetry or satellite imagery to evaluate the quality of the results. The MATLAB / Python programming language would be means of developing and integrating the software required to implement the proposed workflow.

References:

Höfle, B., Vetter, M., Pfeifer, N., Mandlburger, G., & Stötter, J. (2009). Water surface mapping from airborne laser scanning using signal intensity and elevation data. *Earth Surface Processes And Landforms*, *34*(12), 1635-1649. doi: 10.1002/esp.1853

[2] Self-Organizing Maps

Ortiz, A., Górriz, J., Ramírez, J., Salas-González, D., & Llamas-Elvira, J. (2013). Two fully-unsupervised methods for MR brain image segmentation using SOM-based strategies. *Applied Soft Computing*, *13*(5), 2668-2682. doi: 10.1016/j.asoc.2012.11.020

Shaker, A., Yan, W., & LaRocque, P. (2019). Automatic land-water classification using multispectral airborne LiDAR data for near-shore and river environments. *ISPRS Journal of Photogrammetry and Remote Sensing*, *152*, 94-108. doi: 10.1016/j.isprsjprs.2019.04.005

Wichmann, V., Bremer, M., Lindenberger, J., Rutzinger, M., Georges, C., & Petrini-Monteferri, F. (2015). Evaluating the potential of multispectral airborne lidar for topographic mapping and land cover classification. *ISPRS Annals of Photogrammetry, Remote Sensing and Spatial Information Sciences*, *II-3/W5*, 113-119. doi: 10.5194/isprsannals-ii-3-w5-113-2015

Zou, X., Zhao, G., Li, J., Yang, Y., & Fang, Y. (2016). 3D land cover classification based on multispectral lidar point clouds. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, *XLI-B1*, 741-747. doi: 10.5194/isprsarchives-xli-b1-741-2016