ASSESSMENT OF AIRBORNE LIDAR DATA FOR INSTREAM FLOW TYPE CLASSIFICATION

Yu-Li LIN and Chi-Kuei WANG

National Cheng Kung University

1. INTRODUCTION

The instream biotype classification is based on the associated flow type, water depth, substrate material, and bottom topograph. The information regarding the locations and extend of various biotype is important for river management, such as freshwater eco-system preservation and restoration. Remote sensing images, with image resolution ranging from 0.25 to 3 m, has been used for instream biotype classification [1-4]. For the upstream river, which is main subject considered in this article, collection of high quality airborne image may be difficult, if not impossible, due to hazardous narrow valley environment to the airborne vehicle and angular and temporal constraints to eliminate sun glint from the water surface. In addition, the shadow of the handing trees from the river side creates more confusion for instream biotype classification.

More recently, airborne lidar system has been applied for data collection of estuary topography [5]. In this article, we propose using airborne for intream biotype classification. The advantage of airborne lidar data is capable of working in all light conditions and avoiding sun glint [6]. Semi-variogram is one of the means to represent the texture features of remote sensing image [5, 7]. Following the same procedure, the semi-variogram can be applied to lidar point clouds, which 3D values can be used for calculation.

2. MATERIAL AND METHOD

The study area

The study area is located near the confluence of Nan-Shih River and Pei-Shih River, northern Taiwan (Figure 1). The above ground features include gravel, low vegetation, forest, bridge and buildings.

LiDAR data

The LiDAR dataset of the study area was flown on 13 May 2008 at the altitude of 400 m. The dataset was delivered as an ASCII file containing xyz coordinates. The mean density in the resulting dataset is about 100 points per square meters to ensure the calculation of variogram computation.

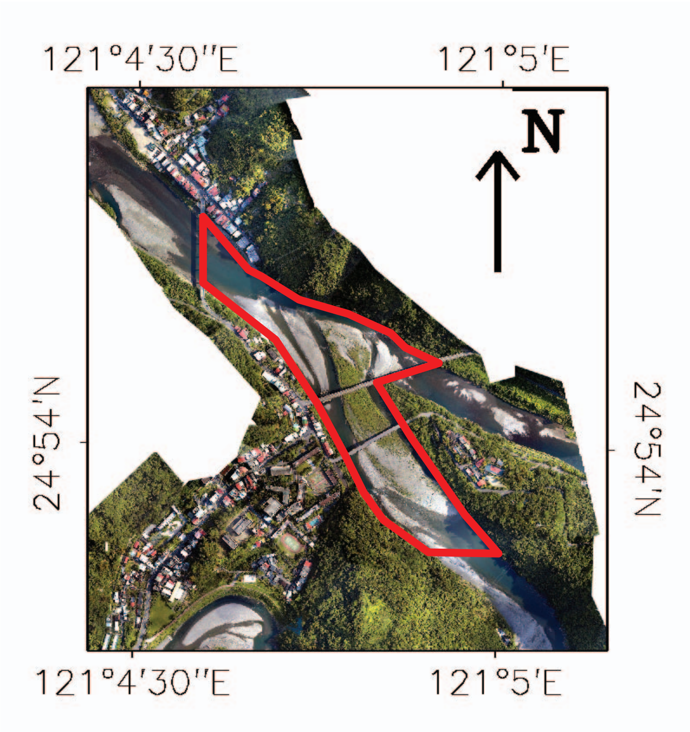

Figure 1. The study area

Semi-variogram

A semi-variogram $\gamma(h)$ is a function of the spatial dependence of semi-variance, it groups semi-variance values at different lag distances. Semi-variogram shows the water surface height dependence at different distance, which represents the texture of flow types.

Figure 2 shows the representative semi-variograms of gravel and four different flow types, including broken standing wave (BSW), unbroken standing wave (USW), and no perceptible flow (NP). Nugget values ($\gamma(0)$) of BSW and USW, denoted as red and green lines in Figure 2, respectively, are larger than those of gravel and NP. In the study area, the difference between BSW and USW are quite consistent, which suggests that nugget value is useful for classification. In addition, the slope is also a useful parameter as an added criterion for classification. For example, the nugget difference of gravel and NP is not consistent in this study area, while their slopes are distinctively different.

Principle component analysis

Principal component analysis (PCA) performs orthogonal linear transformation onto the data and transfer the data to a new coordinate system, such that and greatest variance of the data is projected on the first coordinate, called the first principal component (PC1). The second greatest variance of the data lies on the second coordinate, called the second principal component (PC2), and so on. The lag distance of the semi-variograms for flow types is setup at 10cm. For the window size of 6m x 6m, the maximum lag distance is 3 m, and there are 30 samples in each semi-variogram. The 30 samples are treated as 30 bands of an image in order to apply principal

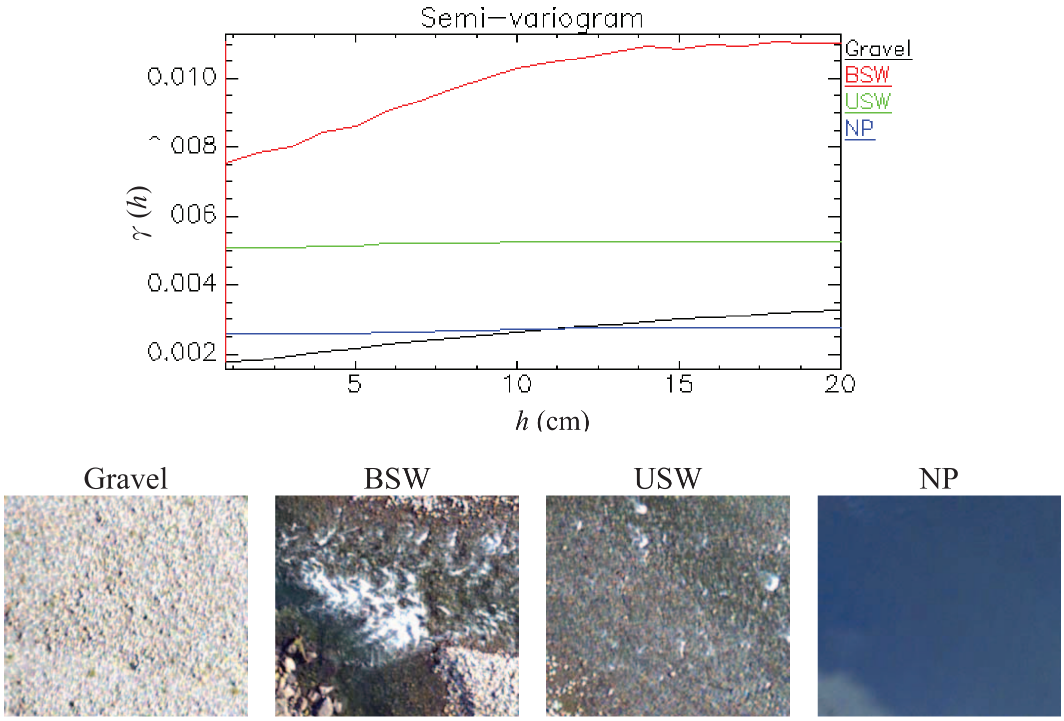

Figure 2. Representative semi-variogram of gravel and flow types in the study area.

component analysis on these data and transformed it to 30 principle components.

Two sequential PCA iterations are performed on the semi-variogram image. The first iteration is to extracted water by building a mask using PC1. After the water is extracted, the second PCA iteration is used for flow type classification.

3. RESULTS

The PC1 of the semi-variogram image using 6 m x 6 m window size with stepping distance of 6 m is shown in Figure 3a and 3b using gray and color scale, respectively. In the color image (Figure 3b), BSW appears red (denoted as i), USW appears green (denoted as ii), NP appears blue (denoted as iii).

4. CONCLUSIONS

The use of lidar data combining semi-variogram analysis and PCA for flow type classification is demonstrated. It is found that PCA is efficient for revealing the texture properties of different flow types. Our results are promising for ecology survey of flow type in large area with short turnaround time.

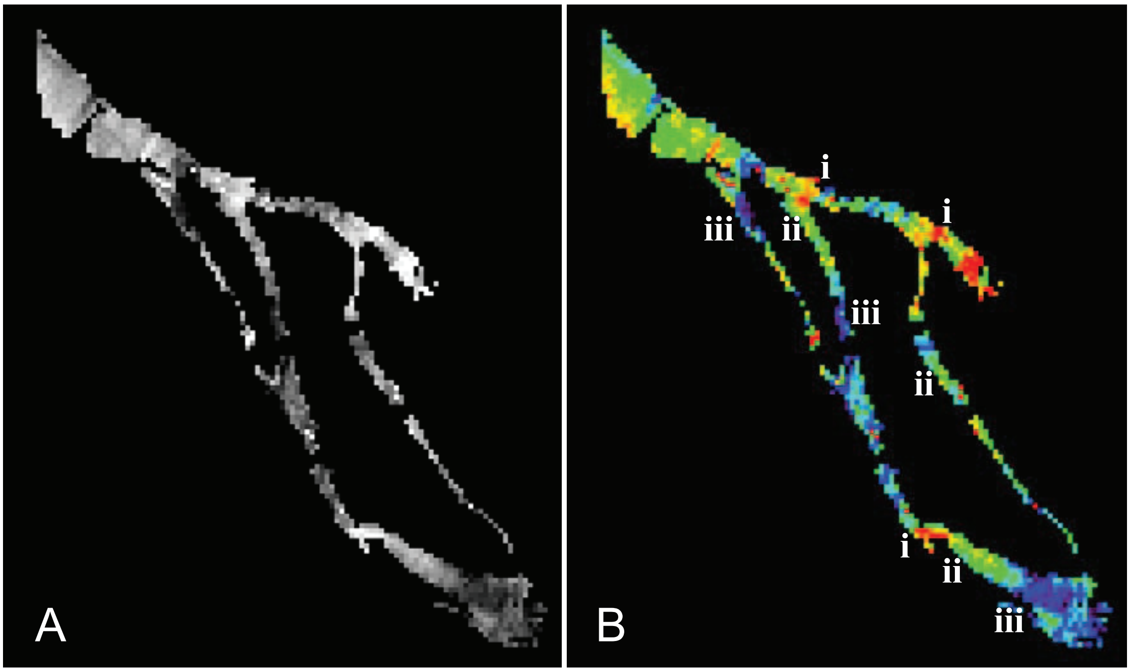

Figure 3. (A) Principle component 1; (B) Color map of principle component 1. i, ii, and iii denotes BSW, USW, and NP, respectively.

5. REFERENCES

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