URBAN THEMATIC MAPPING BY INTEGRATING LIDAR POINT CLOUD WITH COLOUR IMAGERY

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This paper presents an effective approach to integrating airborne lidar data and colour imagery acquired simultaneously for urban mapping. Texture and height information extracted from lidar point cloud is integrated with spectral channels of aerial imagery into an image segmentation process. Then, the segmented polygons are integrated with the extracted geometric features (height information between first- and last-return, eigenvalue-based local variation and filtered height data) and spectral features (line segments) into a supervised classifier. The results for two different urban areas in Toronto, Canada, demonstrated that a satisfactory overall accuracy of 84.96% and Kappa of 0.76 were achieved in Scene I, while a building detection rate of 92.11%, comission error of 2.10% and omission error of 9.25% were obtained in Scene II.

Cet article présente une approche efficace à l'intégration des données lidar aéroporté et de l'imagerie en couleur acquises simultanément pour la cartographie des zones urbaines. L'information sur la texture et la hauteur extraite à partir d'un nuage de points lidar est intégrée aux canaux spectraux de l'imagerie aérienne lors d'un processus de segmentation de l'image. Ensuite, les polygones segmentés sont intégrés aux éléments géométriques extraits (information sur la hauteur entre le premier et le dernier retour de signal, la variation locale basée sur la valeur propre et les données filtrées sur la hauteur) et les éléments spectraux (segments linéaires) dans un classificateur supervisé. Les résultats pour deux zones urbaines différentes de la ville de Toronto au Canada démontrent une précision globale satisfaisante de 84,96 % et un coefficient Kappa de 0,76 dans la scène I, ainsi qu'un taux de détection des bâtiments de 92,11 %, un taux d'erreurs de commission de 2,10 % et un taux d'erreurs d'omission de 9,25 % dans la scène II.

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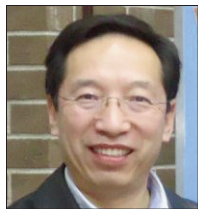

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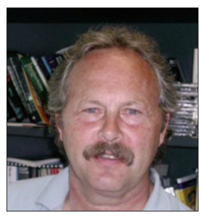

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1. Introduction

Today, most airborne laser scanning or light detection and ranging (lidar) systems can collect point cloud data by a laser scanner and image data by a digital camera, simultaneously. Higher thematic mapping accuracy of complex urban areas becomes achievable when both types of data are used. Airborne lidar can directly collect a digital surface model (DSM) of an urban area. Unlike a digital terrain model (DTM), the DSM is a geometric description of both terrain surface and objects located on and above this surface like buildings and trees. Lidar-derived dense DSMs have been shown to be useful in building detection, which is a classification task that separates buildings from other objects such as natural and man-made surfaces (lawn, roads) and vegetation (trees). Since a common standard property of most buildings is that they are off-terrain points, standard filtering algorithms first can be used to identify off-terrain lidar points. Existing methods for urban scene classification using lidar point clouds data alone include hierarchical Bayesian nets [*Brunn and Weidner* 1998], morphological filtering using sloped kernels [*Vosselman* 2000], and using specified features (e.g., height data, Laplace filtered height data, and maximum slope) [*Mass* 1999]. Fusing lidar point cloud with the digital imagery is promising to improve urban scene classification accuracy [*Haala* et al. 1998; *Haala and Walter* 1999; *Zeng et al*. 2002; *Rottensteiner et al*. 2003; *Collins et al.* 2004; *Charaniya et al*. 2004; *Hu and Tao* 2005; *Walter* 2005; *Rottensteiner et al*. 2005; *Brattberg and Tolt* 2008; *Huang et al*. 2008; *Chehata et al.* 2009; *Awrangjeb et al*. 2010; *Germaine and Hung* 2010]. Besides multispectral imagery, colour infrared (CIR) imagery has also been used to perform a pixel-based land-use classification [*Haala and Brenner* 1999; *Bartels and Wei* 2006].

Traditional pixel-based classification approaches only use spectral information which is inadequate for classifying high-resolution multispectral images in urban environments, because each pixel is individually classified as a certain group, which results in more noise, and classified urban land-cover coars-