Fusion of hyperspectral and LiDAR data using sparse stacked autoencoder for land cover classification with 3D-2D convolutional neural network

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Abstract. Fusion of complementary information from multisensor data is of great importance for identifying the land covers. However, integration of multisource information is a challenging task. A framework is developed to integrate hyperspectral and LiDAR data for land cover classification. In the proposed method, sparse stacked autoencoders are used to represent the spectral and spatial information in a compact form. The spatial information is extracted both from hyperspectral and LiDAR data using morphological operators. The encoded spectral and spatial features are combined with elevation information to form a joint feature vector. The joint features are fed to a convolutional neural network (CNN) classifier to classify the land covers. The CNN classifier is a hybrid three- and two-dimensional (3D)–(2D) model having three 3D convolutional layers and one 2D convolutional layer. The experiments are carried out on two datasets Houston and Samford to evaluate the performance of the proposed method. The results have demonstrated the effectiveness of the method with global $\kappa = 0.9285$ and global naive accuracy (OA) of 93.44% for Houston data. For Samford data, it achieves $\kappa = 0.9811$ and OA = 98.93%. © *2022 Society of Photo-Optical Instrumentation Engineers (SPIE)* [DOI: 10.1117/1.JRS.16.034523]

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1 Introduction

Advances in sensor technology have led to the availability of multisource information on multiple aspects of the objects. With the progress in technology, the spectral and spatial resolution of remotely sensed data are improving.[1] Hyperspectral images[2,3] provide fine spectral information useful to discriminate the land cover classes. However, in a complex region consisting of many similar materials, only the spectral information is not sufficient to accurately interpret the ground objects. Additional spatial information can enhance the accuracy of the results. But unlike spectral information, spatial information is not inherently available with hyperspectral images. Although, it can be modeled using neighborhood relations. Remotely sensed hyperspectral images have been successfully used for land cover and land-use classification.[4–8] Still it is difficult to accurately distinguish similar classes in complex areas such as urban and forest. Light detection and ranging (LiDAR) sensor provides useful complementary elevation information of the surveyed region. Fusion of hyperspectral and LiDAR data of the same region can provide reliable classification results. Classification based on the fusion of hyperspectral and LiDAR data is now an active research area.

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