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面向高光谱图像分类的半监督丛流形学习

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Semi-supervised bundle manifold learning for hyperspectral image classification

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摘要

考虑高光谱遥感数据集多类别非线性的特点,本文假设高光谱遥感数据集具有丛流形结构属性,提出了一种半监督丛流形学习(SSBML)算法来有效提取高光谱遥感图像的鉴别特征。该算法利用标记样本和无标记样本构建两个近邻关系图来保持数据集中丛流形的"整体"结构(各个子流形之间的相互关系)和每个子流形的内蕴结构特征,实现半监督的丛流形学习。在肯尼迪航天中心(KSC)和帕维亚大学(PaviaU)高光谱数据集上的实验结果表明:该算法可以发现高光谱遥感数据集中丛流形结构的精细特征,有效提升高光谱遥感图像的分类精度。实验显示:该算法的总体分类精度比单一流形假设的局部保形投影(LPP)和邻域保持嵌入(NPE)算法提升了约2.9%~15.7%,比半监督最大边界准则(SSMMC)和半监督流形保持嵌入 (SSSMPE)等半监督算法提升了约2.6%~12.4%。

关键词 : 高光谱遥感图像, 鉴别特征, 丛流形结构, 半监督丛流形学习

Abstract :

On the basis of multi-class and nonlinear characteristics of hyperspectral remote sensing image database, this paper assumes that hyperspectral remote sensing database have a bundle manifold structure property and proposes a Semi-supervised Bundle Manifold Learning (SSBML) algorithm to effectively extract the discriminant characteristics of hyperspectral remote sensing image. The algorithm uses labeled samples and unlabeled samples to construct two neighborhood graphs to maintain a "whole" structure (the relationship between the various sub-manifolds) of bundle manifold in the data set and the intrinsic structure characteristics in each sub-manifold. By which, it achieves semi-supervised bundle manifold learning. The experimental results on Kennedy Space Center(KSC) and PaviaU hyperspectral database show that the algorithm efficiently discovers the subtle characteristics of the bundle manifold structure in hyperspectral remote sensing database, and enhances the classification accuracy of hyperspectral remote sensing images. For the overall classification accuracy, this algorithm is improved by 2.9%—15.7% as compared with those of Locality Preserving Projection(LPP) and Neighborhood Preserving Embedding(NPE) algorithm based on single-manifold assumptions, and increased by 2.6%—12.4% as compared with those of the Semi-Supervised Maximum Margin Criterion (SSMMC)and the Semi-Supervised Sub-Manifold Preserving Embedding(SSSMPE) based on semi-supervised algorithms.

Key words : hyperspectral remote sensing image discriminant characteristics bundle manifold structure Semi-supervised Bundle Manifold Learning(SSBML)

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