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Multi-Level Manifolds for Remote Sensing Imagery Classification

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Abstract

A systematic approach for supervised classification of remote sensing images is introduced in this letter. The proposed method deals with the Multi-Level Manifolds, which primarily deals by preserving the local information inside a class along with the class label information. The sharing features are also considered while training the data to represent the parent manifold. The out of sample problem is solved by using Pulse Coded Neural Network which potentially reduces the computational cost. The proposed method solves the major problems of supervised learning systems such as out of sample and preserving local structure. The proposed system is tested in the standard data sets and the results are appreciable.

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Keywords: Multi-level manifolds; Out of sample; Pulse code neural network; Sharing features; Supervised classification.

1. Introduction

Classification is a process of searching meaningful features to describe its pictorial information. The method is to define the features which human use to interpret the image. Such fundamental features are spectral, textural, and contextual features[1]. Spectral features provides the variations in various bands of the electromagnetic spectrum, textural features provides the content of spatial distribution in a band. Contextual features provide the inferred information from the closure property of image[1].

Relating each object/pixel to one or more elements of defined labels in the study area is the objective of classification in remotely sensed data. Hence the radiometric information is commuted to thematic information[2]. The Fig. 1 depicts the classification process as a mapping function.

Quality of the remote sensing data doesn't guarantee the accurate feature extraction but it offers the objectives of the user in an extensive way. The technique used for classification in remote sensing data is a significant factor because of the extensive availability of data with different characteristics. As the spatial resolution increases, the pixel based or sub pixel based approaches are not feasible due to several pixels representing a single object. The object based image analysis comes into existence which produces sound results[3]. The Synthetic Aperture Radar (SAR) is an active imagery system having the potential of imaging in "All weather all time" conditions. The number of SAR based satellites has increased in the past decade because of its vigorous impacts in the applications such as Ice Monitoring, Surface Deformation and Detection, Oil spills, Glacier Monitoring, Urban planning and in Military Applications. SAR

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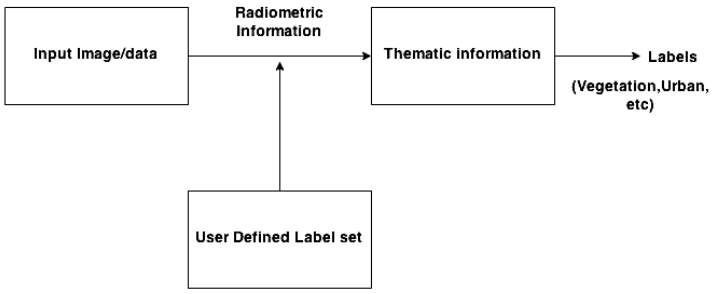

Fig. 1. Mapping of image/data to user defined label set.

imagery has number of merits such as Multi-band, Multi-polarization, Variable size perspective and strong penetration ability so on.

Classification on SAR data has concentrated on point-based classification techniques. These techniques depend on the spectral characteristics of pixels. Some problems exist with these methods when applied to high resolution SAR images, e.g. discrete points which exist at the edges lead to ambiguous results[4]. These methods provides only the lower level information about images, since consideration of single pixel characteristic in isolation neglects the rich and complex information of land covers.

The original SAR image is highly influenced by the granular noise which is known as Speckle, formed by the back scattering coefficient which is coherent in nature[5]. The speckle possesses strong hindrances over the preprocessing task such as Segmentation and classification etc. A prior despeckling process on SAR images will boost up the classification results to a good extent.

Different methodologies produces different result on classification, hence the methodology is dependent on the application. To obtain reliable results the analyst should understand the behaviour of the method[6]. The classification methodologies are broadly categorized as Supervised and Unsupervised. In supervised classification the users have to collect the samples to train classifier to determine the decision boundaries in feature space[7]. Usually 80 % of the training data have been used to achieve desirable results. This massive use of training data leads to complexity in computation and in remote sensing, heterogeneity level of information is high which often ends up with misleading results. In unsupervised classification the methodology learn the characteristics of each class directly from the input data. Characteristics like mean, maximum likelihood etc. will be taken into account for classification. This method is less accurate when compared to supervised methods and often lead to mixed pixel problems.[8]. The ills of supervised learning is discussed in the introduction section, which has motivated to introduce the new concept called multilevel manifold.

In this paper a manifold based classification using nonlinear features extraction is discussed while retaining the intrinsic geometrical features providing better results. The paper is organized as follows: Brief discussion of manifold learning is provided in Section 2, the proposed methodology is introduced in Section 3 and the experimental evaluations are made in Section 4 and Section 5 provides the final discussion about the proposed system.

2. Manifold Learning

Classifiers such as linear discriminant analysis (LDA), Support Vector Machines (SVM) and Partial Least Squares (PLS) rely on the discriminative mode where the features which lie on the Euclidian spaces are taken into account to provide progressive results[9]. Nevertheless these are not enforced to the feature which lies on the Riemann Manifold. Such data often lies in non-Euclidian spaces. Some of the popular features which lie on Riemann manifold are Shapes, Histograms, Co-Variance features, etc. in the field of remote sensing. To obtain progressive results in the classification, the investigator should make use of the underlying manifold structure[10].