Object-based image analysis using multiscale connectivity.’

Summary on ‘ Object-Based Image Analysis Using Multiscale Connectivity. ’ This paper precedes a way for image analysis based on the concept of multiscale connectivity. The authors have suggested an approach to design several tools for object-based image representation and analysis, which attain the connectivity structure of images in a multiscale fashion. More specifically, they have suggested a nonlinear pyramidal image representation scheme, which decomposes an image at various scales by means of multiscale grain filters.

These filters progressively remove connected components from an image that fail to satisfy a given benchmark. They have also used the concept of multiscale connectivity to design a hierarchical data partitioning tool and apply this to construct another image representation scheme, based on the theory of component trees, which organizes partitions of an image in a hierarchical multiscale fashion. They have also suggested a geometrically-oriented hierarchical clustering algorithm which generalizes the classical single-linkage algorithm.

Finally suggested two object-based multiscale image summaries, similar to the well-known pattern spectrum, which can be useful in image analysis and image understanding applications. Multiscale connectivity was introduced by extending a general theory of connectivity on complete lattices, to a multiscale setting. The idea of multiscale connectivity emerges from the observation that the connectivity of an object may depend on the particular scale at which it is observed.

The dependence of connectivity on scale can be equivalently represented by a connectivity measure, which specifies the degree of connectivity of an object, or by a connectivity pyramid, which is a nested sequence of connectivity classes that depend on scale. In this paper, it is shown that the idea of multiscale connectivity leads to a number of tools for object based image analysis. Several methods are introduced, which include object-based multiscale image representation schemes, a geometrically-oriented hierarchical clustering algorithm, and objectbased multiscale image summaries.

First, it is shown that the concept of multiscale connectivity may be used to construct a new nonlinear object-based multiscale image representation scheme. The vital idea is to use multiscale grain filters as the analysis operators of nonlinear pyramid representation schemes. In distinction to pyramid decompositions constructed by pixel-based linear or nonlinear operators, the pyramid decomposition structure suggested here does not work at the pixel level, but at the level of the connected components of an image at various scales.

This can be deduced as the pyramid transform analogue of second-generation image coding techniques, which lead to objectbased approaches for image compression. Hierarchical segmentation partitions the regions, or objects, of an image in a hierarchical fashion. In this paper, it is applied that the concept of multiscale connectivity to design a tool for hierarchical partitioning, known as hierarchical partitioning of connected components.

Then this tool is used to construct an object-based multiscale approach to image segmentation, which leads to a hierarchical image representation scheme based on the notion of component trees. Hierarchical clustering is used to group similar objects together in a hierarchical fashion. The idea is to select a data partition from several available levels of clustering that best reveals the organization of the data the authors suggest an algorithm for hierarchical clustering which takes advantage of explicit geometric information about the data.

The suggested algorithm generalizes the single-linkage algorithm. When a dilation-based multiscale connectivity with a symmetric structuring element is used, this algorithm is equivalent to a single-linkage algorithm that uses a geometric dissimilarity measure based on the structuring element. However, if other types of multiscale connectivity are used, the resulting algorithm will be different from the single-linkage algorithm. Image summaries are fundamental constituents of image analysis and understanding algorithms.

The performance of such algorithms is precisely related to the choice of robust image summaries. It is suggested here that two multiscale image summaries, namely, the clustering curve and the clustering spectrum, summarize connectivity properties of a given image in a multiscale fashion. The clustering spectrum is different from the pattern spectrum is based on measurements made on a granulometric distribution, whereas the clustering curve is based on measurements made on a hierarchical partition.

Clustering spectra and pattern spectra are identical tools and share identical properties. It is considered the case of binary images. However, the tools

suggested here can be continued to the case of gray-scale images by applying the concepts of connectivity classes and multiscale connectivity in general complete lattices. Connected components are themselves gray-scale images and the multiscale image representation techniques, hierarchical partitioning schemes, and image summaries suggested in this paper can be easily applied to gray-scale images.