Clustering-Based Color Image Segmentation Using Local Maxima

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ABSTRACT
Color image segmentation has contributed significantly to image analysis and retrieval of relevant images. Color image segmentation helps the end user subdivide user input images into unique homogenous regions of similar pixels, based on pixel property. The success of image analysis is largely owing to the reliability of segmentation. The automatic segmentation of a color image into accurate regions without over-segmentation is a tedious task. Our paper focuses on segmenting color images automatically into multiple regions accurately, based on the local maxima of the GLCM texture property, with pixels spatially clustered into identical regions. A novel Clustering-based Image Segmentation using Local Maxima (CBIS-LM) method is presented. Our proposed approach generates reliable, accurate and non-overlapping multiple regions for the given user input image. The segmented regions can be automatically annotated with distinct labels which, in turn, help retrieve relevant images based on image semantics.

KEYWORDS
Color Image Segmentation, Fast K-Means, Fuzzy C-Means, Gray Level Co-Occurrence Matrix, Local Maxima, Median Centroid, Natural Images, Region Clustering

INTRODUCTION
Images are vital to conveying information. The value of machine learning lies in understanding images and predicting information from them. For better understanding, images are segmented into multiple regions and objects in each region identified. Image segmentation is ideal for dividing an image into uniform and non-overlapping regions, so done to extract meaningful information from the segmented images.

For a given input image I, the region R is the subset of the regions with respect to criteria such as gray levels or textures. A segmented image f is partitioned into several homogeneous regions Ri, i = 1, … m such that P(Ri) is a logical predicate defined over all points in Ri. It must be true for all pixels inside the region and false for pixels in other regions. Suppose the regions Ri and Rj are neighbours, the union forms a connected component.

Image segmentation finds wide applications in research areas such as pattern recognition and high-level image analysis. Color image segmentation is invaluable in the field of video surveillance, face recognition, object detection, fingerprint recognition, multimedia applications, and image retrieval based on image contents and medical imaging.

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Color image segmentation, a central component of image analysis, is reckoned the first step and major issue in object recognition and image understanding. It is a difficult image processing task and the quality of the final image analysis results depends on segmentation.

Color image segmentation is the partitioning of a digital image into semantically meaningful parts. Problems in color image segmentation have been comprehensively studied in the literature, with a wide variety of approaches being used. In the literature reviewed, different approaches are reported that suit different types of images, but the quality of the output of a particular algorithm is quantitatively difficult to measure. There is no general-purpose segmentation methodology for a purely analytical difficulty.

Color image segmentation is based on the properties of intensity values, discontinuity and similarity. The property of discontinuity partitions the image, based on sharp changes in intensity, and the property of similarity divides images based on similarity criteria. The most common color image segmentation methods are edge-based, region-based, threshold, feature-based clustering and model-based clustering. In the threshold-based segmentation technique, a histogram is generated and the peaks and valleys in it used to identify image regions. Edge-based segmentation discovers multiple object edges from images. In the feature space clustering approach, the intensity value is found for each pixel and image pixels are grouped into clusters. Region-based segmentation splits the image into multiple regions after the process of region growing, region splitting and region merging.

The clustering process partitions input datasets into homogeneous groups of the same objects in one cluster, and varying objects in different clusters. Clustering algorithms aim to group data objects into clusters and can be classified into prototype-based, model-based, density-based and graph-based. A prototype-based clustering method divides data objects into ‘k’ clusters initially, and the prototype clusters are refined thereafter in an iterative process. A model-based algorithm represents data objects in a statistical model of distribution, while a density-based algorithm seeks to find dense regions where similar data objects are concentrated.

Hard and soft are, generally speaking, two types of clustering. Hard clustering is a simple clustering technique that divides an image into a set of clusters such that each pixel belongs to exactly one cluster. Soft clustering is an ideal type of clustering used in image segmentation in which divisions are not strict. Soft clustering works so each pixel is partitioned into clusters, based on partial membership.

Key issues to be tackled when dealing with colour image segmentation, based on the clustering approach, are user input for a number of clusters and the generation of stable and identical clusters. Our paper focuses on identifying the number of regions ‘R’ automatically from the input RGB image, based on the local maxima of the gray level co-occurrence matrix invariant of offset and symmetric properties. The RGB image is accurately segmented into R regions, based on median centroid clustering.

The paper follows a sequential structure. The related work carried out in the field of color image segmentation is discussed in section 2. The process modules of the proposed system are explained in section 3. The implemented algorithm, with its performance measures, is discussed in section 4. The paper is finally concluded in section 5 with a note on future research directions.

RELATED WORK

Many approaches to color image segmentation have been proposed over the years. Region-based segmentation is the most widely used method for segmenting color images into distinct regions. The chief sections of region-based segmentation are initial seed selection, region growing and region merging, based on s single pixel or group of pixels. A technique of region-based segmentation is the clustering approach. A major issue with clustering-based segmentation is that the user has to specify the number of clusters / seeds, K- regions clusters based on which region merging can be
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