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Graph Partitioning for Image Segmentation using Isoperimetric Approach

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Abstract: Image segmentation play a crucial role in effective understanding of digital images. Past few decades saw hundred of research contribution in this field. Image segmentation is an important technology for image processing which aims at partitioning the image into different homogeneous regions or clusters. Graph cut is fast method performing a binary segmentation. Graph cuts proved to be a useful multidimensional optimization tool which can enforce piecewise smoothness while preserving relevant sharp discontinuities. This paper is mainly intended as an application of isoperimetric algorithm of graph theory for image segmentation and analysis of different parameters used in the algorithm like generating weights, regulates the execution, Connectivity Parameter, cutoff, number of recursions.

The First which present a segmentation algorithm within a frame work which is independent of the feature used and enhance the correctness and stability with respect to parameter of different images. In this paper image segmentation using graph cut method which finds parameter psnr, RI, gce, voi.

Keywords: Graph cut method, isoperimetric approach, psnr, RI, gce, voi.

I INTRODUCTION

Graph cut is new algorithms for image processing may be crafted from the large corpus of well-explored algorithms which have been developed by graph theorists. For example, spectral graph partitioning was developed to aid in design automation of computers and has provided the foundation for the development of the N cuts algorithm. Similarly, graph theoretic methods for solving lumped Ohmic electrical circuits based on Kirchhoff's voltage and current law. Adaptive sampling and space-variant vision require a "connectivity graph" approach to allow image processing on sensor architectures with space-variant visual sampling. Space variant architectures have been intensively investigated for application to computer vision for several decades, partly because they offer extraordinary data compression.

The isoperimetric algorithm is easy to parallelize, does not require coordinate information and handles non-planar graphs, weighted graphs and families of graphs which are known to cause problems for other methods. This algorithm provides fast segmentation without affecting the stability. Local Global interactions are well expressed by graph theoretical algorithms. New algorithm for image processing may be crafted from large set of well-explored algorithm which can be developed by graph theories. Adaptive sampling and space variant requires a "connectivity graph" which can be well established using graph theories.

New architectures for image processing may be defined that generalize the traditional Cartesian design. Just in the special case, the temporal domain can (and does, in animals) exploit an adaptive, variable sampling strategy. In a computational context, this suggests the use of graph theoretic data structures, rather than pixels and clocks. Some applications based on graphs have no counterpart in quasi-continuous, pixel based application. For example, the small world property of graphs, which allows the Introduction of sparse global connectivity at little computational cost, has been applied to image processing with good results. In general, the flexible nature of data structures on graphs provides a natural language for space-time adaptive sensors.

Graph processing algorithms have become increasingly popular in the context of computer vision. Typically, pixels are associated with the nodes of a graph and edges are derived from a 4- or 8-connected lattice topology. Some authors have also chosen to associate higher level features with nodes. For purposes of importing images to space-variant architectures, we adopt the conventional view that each node corresponds to a pixel. Graph theoretic algorithms often translate naturally to the proposed space-variant architecture. Unfortunately, algorithms that employ convolution (or correlation) implicitly assume a shift-invariant topology. Although shift-invariance may be the natural topology for a lattice, a locally connected space-variant sensor array (e.g., obtained by connecting to K-nearest-neighbours) will typically result in a shift-variant topology. Therefore, a re-construction of computer vision algorithms for space-variant architectures requires the use of additional theory to generalize these algorithms [2].

II LITERATURE REVIEW

M.Trocan, B.Pesquet-Popescu et.al in paper [14]"Graph-cut rate distortion algorithm for contour let-based image compression" The geometric features of images, such as edges, are difficult to represent. When a redundant transform is used for their extraction,

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the compression challenge is even more difficult. In this paper we present a new rate-distortion optimization algorithm based on graph theory that can encode efficiently the coefficients of a critically sampled, non-orthogonal or even redundant transform, like the contour let decomposition. The basic idea is to construct a specialized graph such that its minimum cut minimizes the energy functional. We propose to apply this technique for rate-distortion Lagrangian optimization in sub band image coding. The method yields good compression results compared to the state-of-art JPEG2000 codec, as well as a general improvement in visual quality.

Mo Chen et.al. In paper "isoperimetric cut on a directed graph". In this paper, we propose a novel probabilistic view of the spectral clustering algorithm. In a framework, the spectral clustering algorithm can be viewed as assigning class label to samples to minimize the Byes classification error rate by using a kernel density estimator (KDE).From this perspective, we propose to construct directed graphs using variable bandwidth KDEs. Such a variable band width KDE based directed graph has the advantages that it encodes the local density information of the data in the graph edges weights. In order to cluster the vertices of the directed graph, we develop a directed graph portioning algorithm which optimizes a random walk isoperimetric ratio. The portioning result can be obtained efficiently by solving a system of linear equations .We have applied our algorithm to several benchmark data sets and obtained promising result [12].

Wenbing Tao et.al [10] "Image thresholding using graph cut" A novel thresholding algorithm is presented in this paper to improve image segmentation performance at a low computational cost. The proposed algorithm uses a normalized graph cut measure as thresholding principle to distinguish an object from the background. The weight matrices used in evaluating the graph cuts are based on the gray levels of the image, rather than the commonly used image pixels. For most images, the number of gray levels is much smaller than the number of pixels. Therefore, the proposed algorithm requires much smaller storage space and lower computational complexity than other image segmentation algorithms based on graph cuts. This fact makes the proposed algorithm attractive in various real-time vision applications such as automatic target recognition. Several examples are presented, assessing the superior performance of the proposed thresholding algorithm compared with the existing ones. Numerical results also show that the normalized-cut measure is a better thresholding principle compared with other graph-cut measures, such as average-cut and average-association ones.

Mohmad Ben Salah et.al[7] in a paper "Multinational image segmentation by parametric kernel graph cut "The purpose of this study is to investigate multiregional graph cut image partitioning via kernel mapping of the image data. The image data is transformed implicitly by a kernel function so that the piecewise constant model of the graph cut formulation becomes applicable. The objective function contains an original data term to evaluate the deviation of the transformed data, within each segmentation region, from the piecewise constant model, and a smoothness, boundary preserving regularization term. The method affords an effective alternative to complex modeling of the original image data while taking advantage of the computational benefits of graph cuts. Using a common kernel function, energy minimization typically consists of iterating image partitioning by graph cut iterations and evaluations of region parameters via fixed point computation. A quantitative and comparative performance assessment is carried out over a large number of experiments using synthetic grey level data as well as natural images from the Berkeley database. The effectiveness of the method is also demonstrated through a set of experiments with real images of a variety of types such as medical, synthetic aperture radar, and motion maps

III METHODOLOGY

Local Global interactions are well expressed by graph theoretical algorithms. New algorithm for image processing may be crafted from large set of well-explored algorithm which can be developed by graph theories. Adaptive sampling and space variant requires a "connectivity graph" which can be well established using graph theories.

A. Isoperimetric Algorithm:

The isoperimetric algorithm is easy to parallelize, does not require coordinate information and handles non-planar graphs, weighted graphs and families of graphs which are known to cause problems for other methods. This algorithm provides fast segmentation without affecting the stability.

Algorithm Detail

1. Find weight for all edge using and build the matrix.
2. Choose the node of largest as the ground node vg, determine Lo and do by eliminating the row and column corresponding to vg.
3. Threshold the potential x at the value that gives portions Corresponding to lowest isoperimetric ratio.
4. Continuous recursion on each segment unit the isoperimetric ratio of sub partition is than stop parameter.

B .Graph Cut Method:

In graph theoretic definition, the degree of dissimilarity between two components can be computed in the form of a graph cut. A cut is related to a set of edges by which the graph G will be partitioned into two disjoint sets A and B. As a consequence, the segmentation of an image can be interpreted in form of graph cuts, and the cut value is usually defined as: Cut (A,B) = ∑u€A,v€B w(u,v), where u and v refer to the vertices in the two different components.

The first which presents a segmentation algorithm within a frame work which is independent of the feature used & enhance the Correctness and Stability with respect to parameters of different images.

The graph partitioning problem is to choose subsets of the vertex set such that the sets share a minimal number of spanning edges while satisfying a specified cardinality constraint. Graph

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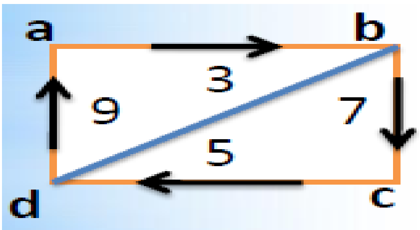
partitioning appears in such diverse fields as parallel processing, solving sparse linear systems, and VLSI circuit design and image segmentation.



Node: Vertices of a Graph i.e.: a,b,c &d
Edges: Path between two Nodes (direction)
Path: Sequence of Nodes connected byEdges
Cycle/Loop: A Closed path: (a-b-d-a),(a-b-c-d-a) etc
Length of a Path: Number of Edges along the shortest path
Diameter: Length of the Longest Path

C. Comparison Parameters with Standard

The performance of the algorithm is evaluated on Berkeley Segmentation Database. Two significant criteria namely PSNR and RI (Rand Index) are used to evaluate the performance of our algorithm. The main standard of reference is the Berkeley Data base. For our result evolution we have taken a standard image set from Berkeley data base with their own segmented images and compare their results with our Algorithm output. The two sets of parameters which we have mainly focused to evaluate the result with standard data base are PSNR and RI.

PSNR (Peak Signal to Noise Ratio)

Peak Signal-to-Noise Ratio, often abbreviated PSNR, is an engineering term for the ratio between the maximum possible power of a signal and the power of corrupting noise that affects the fidelity of its representation. Because many signals have a very wide dynamic range, PSNR is usually expressed in terms of the logarithmic decibel scale.
PSNR is most commonly used to measure the quality of reconstruction of lossy compression codec's (e.g., for image compression). The signal in this case is the original data, and the noise is the error introduced by compression. When comparing compression codec's, PSNR is an approximation to human perception of reconstruction quality. Although a higher PSNR generally indicates that the reconstruction is of higher quality, in some cases it may not. One has to be extremely careful with the range of validity of this metric; it is only conclusively valid when it is used to compare results from the same codec (or codec type) and same content. Typical values for the PSNR in lossy image and video compression are between 10 and 20 dB.
In the absence of noise, the two images I and K are identical, and thus the MSE is zero. In this case the PSNR is undefined.

RI (Rand Index)

Image segmentation can be viewed as a special case of the general problem of clustering, as image segments are clusters of image pixels. Long ago, Rand proposed an index of similarity between two clustering's. Recently it has been proposed that the Rand index be applied to image segmentations. RI is the measure of similarity between the two data images i.e. Accuracy, this index has a value in between 0 to 1.

GCE (Global consistency error)

It is a Region-based Segmentation Consistency, which measures to quantify the consistency between image segmentations of differing granularities. It is used to compare the results of algorithms to a database of manually segmented images. Let S and S' be two segmentations as before. For a given point xi (pixel),
consider the classes (segments) that contain xi in S and S0.These sets are denoted in the form of pixels by C (S, xi)and C (S0, xi) respectively. It measures the extent to which one segmentation can be viewed as a refinement of the other. Segmentations that are related in this manner are considered to be consistent, since they could represent the same natural image.

VOI (Variation of information)

It measures the sum of information loss and information gain between the two clustering, and thus it roughly measures the extent to which one clustering can explain the other. The VOI metric is nonnegative, with lower values indicating greater similarity. It is based on relationship between a point and its cluster. It uses mutual information metric and entropy to approximate the distance between two clustering across the lattice of possible clustering. More precisely, it measures the amount of information that is lost or gained in changing from one clustering to another (and, thus, can be viewed as representing the amount of randomness in one segmentation which cannot be explained by the other). The variation of information is a measure of the distance between two clustering (partitions of elements).

IV EXPERIMENT RESULT ANALYSIS

Example of Berkeley segmentation produced by the isoperimetric algorithm using the same parameter

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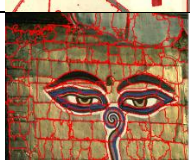
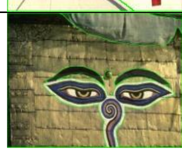
(stop=1e_4,valscale=200,volflag=1,geomscale=20,num=60,sz=8) Our MATLAB implementation required approximately 0.0500 sec to segment each image. Best parameter to analysis the image.

COMPUTATIONAL TIME

Parameter	Previous work	Proposed work
Time(sec)	0.5863	0.0500

Compare our output with Berkeley database to find parameter

Output image	Berkeley image	Parameter calculation
		PSNR-18.0779 RI-0.9888 GCE-0.9716 VI-11.7766
		PSNR-18.8235 RI-0.9822 VI-10.1393 GCE-0.9309
		PSNR-18.0309 GCE-0.9807 VI-12.5573 RI-0.9895
		PSNR-18.0072 RI-0.9859 GCE-0.9517 VI-11.5559
		RI-0.9769 GCE-0.9688 VI-11.800 PSNR-15.7203

V CONCLUSION

Recently there has been increasing interest in using graph based method as a powerful segmentation image. Image segmentation achieve a segmented output to extract the interesting object, it gives correctness and stability of image. Developing algorithm to process a distribution of data on graphs is an exciting area. Many biological sensory units are non-uniformly distributed space with spatial distribution often differentiating radically between species. Medical image analysis makes the development of a graph theory library for the ITK library a necessary and useful addition for accurate and effective processing and analysis of images. This graph cut method is used in medical field for image segmentation which gives the high accuracy. Application of this method used in data processing, clustering, segmentation of natural images, medical field.

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