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Image Segmentation Using Graph Partition Methods

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Abstract— Image segmentation is a method of partitioning an image into meaningful parts, which can be put into a detailed study. This method is largely useful for the practical applications such as machine vision, bacterial study, face detection, video surveillance, fingerprint detection, etc. Graph partitioning is a method developed from Graph Theory which has multiple applications in various fields. This process considers an image as a graph with V vertices and E edges. It can be partitioned into k-components with specific properties. This enables the detailed study of an image for various purposes. The variation in the pixels, texture, etc, from one component to another component can be easily identified. This paper involves in proposing an effective Graph partitioning method overcoming all the existing disadvantages.

Keywords - Segmentation, Graph, Vertices, Edges, Connected graph, Disconnected graph, Planar graph.

I. INTRODUCTION

Image segmentation has gone through a very long process of development. Even though the process is slow, the achievement is very steady and progressive. The field of Mathematics has played a great role in segmenting the images which has many of its great methods applied into it directly as well as indirectly. The history of image segmentation traces some forty eight years back. The first step was made by Robert in the year 1965, who is linked to the term Robert's operator. The detector developed by Robert was used to decompose an image and was greatly helpful in detecting the edges. The developmental process was well witnessed by the works of Brice and Fenema in the year 1970, Pavlidis in 1972 and Rosenfeld and Kak in 1976.

Image, in general is an important tool for humans, which gives a detailed explanation of recorded events [4] [5]. It is clearly evident that many long researches have been made to study and to do various operations in an image. A new branch called Image engineering has emerged and making a good progression in recent days. Image engineering comprises of three important components. They are Image processing, Image analysis and Image understanding. Image processing is done at the lower layer of an image, Image analysis is done at middle layer and Image understanding at high layer of an image. Image segmentation is the basic approach in image

analysis component. Image segmentation, as the name says, is the process of dividing images into segments under a logical concept which should be able to form the original image when grouped together. This process affects the other processes of image analysis namely object representation and description, feature measurement and also higher level tasks such as object classification and scene interpretation. The algorithms for Image segmentation developed on the basis of thresholding, edge detection and region clustering. Figure.1 can give the clear pictorial representation of study of an image.

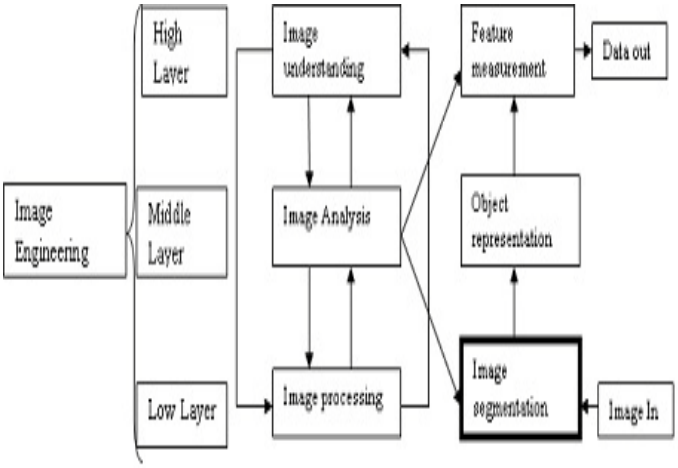

Fig.1: Pictorial representation of Study of an Image.

II. RELATED WORKS

Graph Theory has played many vital roles in Image Segmentation process. Many methods have been developed in the past decade and the segmentation process has achieved its maximum development through these methods.

Image Segmentation using Minimal Graph cuts method [1] is one of the famous methods which had its best application. In this method, an image is made into a graph in which each pixel is considered as a node and edges are introduced between those nodes/pixels which are similar with certain measures. The distance between the connected nodes is determined and it is the weight of the edge connecting those nodes. The min-cut method of Graph Theory is then applied to the resulted graph (image). This is considered as the segmentation of the image and this segmentation is now taken as a partition. According to the definition of the image-pixel resemblance the similar pixels of the image are grouped together.

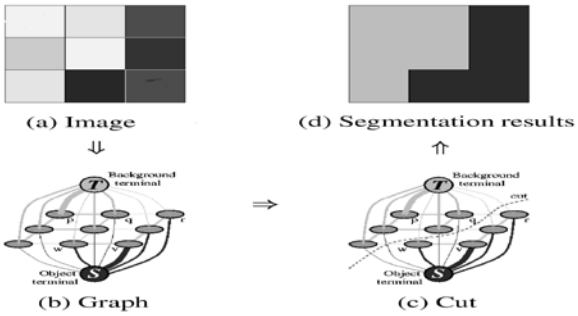

Fig.2: Image representing Minimal graph cut method.

In the case of Image Segmentation using Euler graphs [2] the image is considered as a graph G with V vertices and E edges. The graph is then converted into a grid graph which is then made into an Euler graph. Here, each pixel is taken as a vertex and an edge is introduced between neighbourhood vertices based on the 8-connectivity of neighbourhood vertices. If the image is of dimension N×N then there will be N^2 vertices in the graph formed from the image. Thus the graph now formed is called as the Grid graph. This graph is then converted into an Euler graph by making all odd degree vertices into even degree vertices. This can be achieved by introducing an edge wherever needed. The main advantage of making it an Euler graph is that cycles can be formed which makes the segmentation process simpler. In the Euler graph, all the edges are made white and the edges which are visited while forming a cycle are made grey. The edge in black colour indicates the boundary of a region. This way the segmentation process is achieved through Euler graph method.

Using Graph Partitioning Active Contours for image segmentation [3], advanced methods of segmentation can be achieved. In this method, an image is converted into a graph using simple method and min-cut algorithm is used. Several curves are being drawn using the edges which are segmented. This process is defined as Curve evolution. A new concept namely geometric active contour method is developed where the major advantage is that geometric properties of curves can be applied for segmentation. This method is cost

efficient and an advanced approach for image segmentation.

The Bi-partite graph partitioning [6] is the most effective method which made its mark in a clear image segmentation process. It defines a term called super pixel, which is nothing but when the image regions are segmented into smaller regions it gives rise to super pixels of an image. In this method, an image is converted into a graph using normal procedure and a bi-partite graph is constructed collectively using pixels and super pixels. An unbalanced partitioned graph is obtained which is still under observation to obtain a smooth graph. Since it is a bi-partite graph, spectral clustering plays an important role in segmenting the graph. The main advantages of this method is that, it efficiently uses the concept of super pixels and it lessens the normalization prior of other N cut methods which separates the uniform regions abruptly.

III. PROPOSED SCHEME

Some of the technical terms are to be defined before getting into the method [9] [10] [11]. They are pixel, RGB component of an image, connected graph, disconnected graph and planar graph.

PIXEL:

A minute area of illumination, one of many from which an image is formed. The number of pixels in an image, determine the resolution of the image. The value of the pixel is nothing but the value of RGB component of an image. It is the measurement of the composition of Red, Green and Blue colors in the component.

RGB component:

RGB is an additive color model where Red, Green and Blue light are mixed in many ways to produce a broad array of colors.

CONNECTED and DISCONNECTED GRAPH:

A graph G is said to be connected if there exists atleast one path between every pair of vertices in G. Otherwise, it is called disconnected graph.

PLANAR GRAPH:

A Graph G is said to be planar if there exists some geometric representation of G which can be drawn on a plane such that no two of its edges intersect.

The methodology can be described in steps in the following way.

STEP1: Consider the given image as a Graph G with V vertices and E edges. It can be denoted as G(V, E).

STEP2: Take each pixel of the image as a vertex. So, the number of as pixels in the image says the number of vertices in the graph.

STEP3: Instead of naming the vertices in a usual way as $\{v_1,v_2,.....,v_n\}$ we name them by determining the values of the pixels such as 170, 125, etc,...,.

STEP4: If two vertices have same values consider two possibilities.

Possibility1: If the two vertices are in the same region join them to make a single vertex.

Posibility2: If the vertices lie at a long distance leave them as such without disturbing.

STEP5: Introduce edges between the neighbouring vertices. Make sure that the vertices do not intersect with each other.

STEP6: Now we get a planar graph which is also a connected graph.

STEP7: It is to be noted that RGB value approaching 0 determines the dark region of an image whereas RGB value approaching 255 determines the light region of an image.

STEP8: The vertices with values 0 near to 0 will remain in the same domain. Similarly, the vertices with values 255 or near to it remain closer together in another domain.

STEP9: Since it is a planar graph there will be e-n+2 regions in the graph (by a theorem).

STEP10: Now e-n+2 regions can be split into number of smaller regions such as dark and light regions. There will be numerous such dark and light regions.

STEP11: The splitting can be done by done by deleting the edges connecting the dark region and light region. This will result in numerous disconnected graphs.

STEP12: The dark regions should be coloured with black color and given a boundary with coloured line.

STEP13: The light regions should be overshadowed with a grey color differentiating it from the dark region.

STEP14: Finally each dark region can be joined together by exactly connecting one of the vertices from a dark region to another vertex of neighbouring dark regions.

STEP15: This results in a segmented image with differentiated dark and light regions.

This method helps us to determine the black and white color composition in an image. This can be widely used in photographical department where light and coloring plays an important role.

IV. BENEFIT ANALYSIS

Various Image segmentation methods have existed over the years. All these methods over the years have been implemented using region based or edge based segmentation. All these methods have their own advantages and disadvantages. The major disadvantage in common was the verifying the regions based on colors(light and dark) and separating them accordingly. The basic element of an image is a pixel. When the segmentation, known as division of an image into region is done using the fundamental element of image called pixel, higher results can be achieved. Differentiating an image based on color gives a clear segmentation result.

V. FUTURE SCOPE

Since there is a lack of application of image segmentation process in various fields like Forensics, Astronomy, etc, we will work in the process of implementing our method in such fields. Right now, we are in the stage of developing a code using any of the higher level language (Java, C++) with this method as logic.

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