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UE18CS202

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UE18CS202 – Data Structures

REPORT
ON
"Image Segmentation using MSTs"

SECTION :

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ABSTRACT

This project addresses the problem of segmenting an image into regions. We define a predicate for measuring the evidence for a boundary between two regions using a graph-based representation of the image. We then develop an efficient segmentation algorithm based on this predicate, and show that although this algorithm makes greedy decisions it produces segmentations that satisfy global properties. We apply the algorithm to image segmentation using two different kinds of local neighborhoods in constructing the graph, and illustrate the results with both real and synthetic images. The algorithm runs in time nearly linear in the number of graph edges and is also fast in practice. An important characteristic of the method is its ability to preserve detail in low-variability image regions while ignoring detail in high-variability regions.

This technique makes use of graphs, specifically the Minimum Spanning Trees. We make use of a greedy algorithm very similar to the Kruskal's MST algorithm to classify the images into separate regions, which are different components sticking to graph terminologies.

This method of image segmentation is more efficient time and space wise. It is faster than most of the other existing image segmentation methods. The state of the art techniques of today use extensive Machine Learning image processing techniques. However, our method is simpler but also efficient. Since this is purely a graphs-based approach, it doesn't require any time training the models like the ML models.

The use cases of Image segmentation in general are:
1. Stereo and motion estimation
2. Improving image recognition, including better OCR
3. Improving image matching by parts
4. Autonomous Driving, which uses extensive image segmentation for environmental objects detection

DESCRIPTION OF DATA STRUCTURE, LOGIC AND FUNCTIONALITY

Write a detailed procedure adopted like logic, functionality implemented in your project in detail. (Minimum 1 page)
Data Structure : Minimum Spanning Tree - Kruskal's Algorithm.

Structures used:

1. Image_all : To store an rgb image with 3 channels.
2. Image : To store an image with single channel along with size , width and height of an image.
3. Subset : To implement union by rank algorithm.
4. Edge : To store each edge of the graph.

Logic of the Graph Based Image Segmentation implemented:

- In order to read and write images in the C language, we used an open library called the "STB". The image properties are accessed and stored in different structures with the help of special functions in the STB header file.
- Once the image is read , we extract each channel of the image and store it in r,g,b respectively.
- Then we apply "smooth" function on all the three channels.
- In the smooth function , we first create a gaussian filter.Then we normalize the gaussian mask.
- Then we convolve the image twice with normalized gaussian mask.Convolution is basically matrix multiplication.
- To create an undirected graph , we find the dissimilarity of each pixel with the neighbouring pixels and the dissimilarity is the weight of the edge in the graph.
- Now we sort the edges in non-decreasing order of the weights.
- Threshold is calculated based on 'c' value.
- Start with a segmentation S 0 , where each vertex vi is in its own component.
- Construct S q given S q−1 as follows. Let vi and vj denote the vertices connected by the q-th edge in the ordering, i.e., oq = (vi , vj). If vi and vj are in disjoint components of S q−1 and w(oq) is small compared to the internal difference of both those components, then merge the two components otherwise do nothing.Now we find the components connected by the edge. [1]
- Then we post-process small components based on minimum size entered by the user.
- We then choose random colors for each component and then write the image in JPG format.

Reference Paper:Pedro F. Felzenszwalb,Daniel P. Huttenlocher- Efficient Graph-Based Image Segmentation http://people.cs.uchicago.edu/~pff/papers/seg-ijcv.pdf

CONCLUSION

What have you learnt from this project and how you can improve the concept can be discussed in this part of the report. (Minimum 6 lines)

We learnt and understood graph-based Minimum Spanning Trees. We compared multiple greedy-technique based algorithms such as Kruskal's and Prim's MST algorithms. We learnt the Union Find Algorithm which is used to detect cycles in a graph, which we further integrated with Kruskal's algorithm.

We also learnt the concepts of Image segmentation, required to thoroughly understand and interpret varying results for different sorts of images. By consecutive trial and error methods, we approximated the strengths and weaknesses of our algorithm.

We also had to learn the concepts of a module named "STB" which is one of the very few Image-handling and processing libraries supported for C language. Through this module, we understood the methods and concepts related to Image representation in the form of matrices, the existence of multiple channels in any image and other related concepts.

However, our algorithm can be improved to provide better results for a wider range of images. Our present algorithm doesn't provide satisfactory results with images with minute details and tougher boundaries. However these results can be improved by fine-tuning the parameter values. The time and space constraints can be improved with more efficient sorting and traversal techniques.

THANK YOU