CS 395T - Final Project Proposal
Comparing Optimization Techniques for Interactive Image Segmentation

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I. Motivation

The goal of our project is to compare the performance of different optimization techniques in the task of interactive image segmentation. Rather than relying on large amounts of labeled masking/segmentation data and leveraging deep methods to learn image segmentation, we plan to use small amounts of manual labeling for a single image instance to define 'segmentation handles' that will then be used to optimize segmentation across the entire image.

While much of the current work in interactive segmentation focuses on binary (foreground/background) segmentation [1], [2], we plan to define an objective function that incorporates multiple-component segmentation. Once we have defined an adequate objective function, we will use optimization techniques such as alternating minimization and trust region to minimize our objective and compare their performances (both in time and accuracy) for our given task. As an end result, we hope to present an exhaustive analysis on the performance of multiple optimization techniques for the task of interactive image segmentation that may provide insight into when it may be most-appropriate to use a particular technique for visual tasks.

II. Technical Merit

Our project includes multiple different technical components which require both theoretical and practical components. Firstly, we must formally define our problem and perform background research to see what work has been done in both deep and non-deep methods of interactive image segmentation. Because our goal is to perform image segmentation without the presence of large amounts of labeled data, we must define an objective function that considers a multitude of factors, namely: interactive 'segmentation handles' to guide the segmentation process, smoothness across a segmentation component, adherence to object boundaries, etc…

Once our objective function has been formally stated, we must implement different optimization techniques to solve our task. This requires a non-trivial amount of effort, as we must fully understand which methods are most appropriate for our problem and determine proven solutions for each method we wish to study. Lastly, we must perform an in-depth investigation on the outcomes of our experiments and provide a high-level analysis on numerical optimization for interactive image segmentation.

III. Broader Impact

Interactive image segmentation is a widely studied image processing task. However, most existing work focuses on binary foreground-background segmentation. The work that covers multiple-foreground cosegmentation techniques tends to have lots of failure cases or

have slow implementations in practice. Since we will be applying multiple optimization techniques to this problem, we hope to gain a better understanding of why different techniques perform better than others at this problem. In particular, we hope to develop clear insights into why binary foreground-background image segmentation works so much better than multiple-foreground segmentation. Ideally, our project will serve as a guideline for how future work should select optimization techniques to apply to image segmentation problems.

IV. Project Plan

Date	**Tasks**
October 21st	● Complete existing work survey ● Formulate objective function
October 28th	● Select 3-4 optimization techniques given our objective function ● Collect labeled data ● Develop program for collecting user input
November 4th	● Implement optimization technique 1 ● Writeup
November 11th	● Implement optimization technique 2 ● Writeup
November 18th	● Implement optimization technique 3 ● Writeup
November 25th	● Implement optimization technique 4 ● Writeup
December 2nd	● Write paper ● (Stretch goal) Extend to video segmentation or depth scan segmentation

V. References

[1] Jifeng Ning, Lei Zhang , David Zhang and Chengke Wu, "Interactive Image Segmentation by Maximal Similarity Based Region Merging", Pattern Recognition, 43(2), pp. 445-456, 2010.

[2] Yu, Hongkai, et al. "Loosecut: interactive image segmentation with loosely bounded boxes." arXiv preprint arXiv:1507.03060 (2015).