Weekly Report: Content-Aware Image Resizing (Seam Carving)

Members

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***Abstract*—This report documents our progress on reproducing results from the base paper on seam carving for content-aware image resizing. We describe the theoretical foundations, dataset selection, and our ongoing implementation efforts.**

I. Introduction

Our main focus this week was to reproduce the results from the base paper [1]. For that, we all worked on understanding and implementing the paper, so that we are aware of how the results were obtained.

II. Understanding the Base Paper

Seam Carving is a content-aware image resizing technique. Unlike traditional scaling or cropping methods, seam carving removes or inserts "seams" of low-importance pixels, preserving essential content.

A. Energy Function

As a measure to quantify the importance of a pixel is needed, which is quantified via an energy function:

$$e(I) = \left|\frac{\partial I}{\partial x}\right| + \left|\frac{\partial I}{\partial y}\right|$$

Pixels with high gradients (edges, textures, objects) have high energy, while smooth regions have low energy.

B. Seams and Seam Removal

A seam is a connected path of pixels in the image. The optimal seam has the minimum cumulative energy:

$$M(i,j) = e(i,j) + \min\left(M(i-1,j-1), M(i-1,j), M(i-1,j+1)\right)$$

This is calculated in the base paper using Dynamic Programming. Seams are iteratively removed to reduce image dimensions without distorting important regions.

C. Seam Insertion and Aspect Ratio Retargeting

For image enlargement low-energy seams are duplicated. For changing both width and height, a dynamic programming computes the optimal sequence of seam operations to minimize distortion.

III. Dataset Finalization

We selected the RetargetMe dataset [2], publicly available at https://people.csail.mit.edu/mrub/retargetme/. It includes portraits, natural scenes, urban environments, and object-centric images, providing a standardized benchmark for image retargeting.

IV. Current Progress

We did a literature survey on various seam carving techniques, including gradient-based, improved dynamic programming, and deep learning approaches. We are currently implementing the base algorithm and verifying outputs against the reported results.

V. Outcomes

1) Successful reproduction of base paper results.
2) Clear understanding of algorithm strengths and weaknesses.
3) Performance metrics including execution time and visual quality scores.
4) Optimized implementation ready for experimentation.
5) Documentation of workflow and analysis.
6) Research direction for refinement and extension of seam carving.

VI. Action Plan (Next Week)

1) Implement the base seam carving algorithm using enhanced Dynamic Programming.
2) Test different energy functions: Sobel, Prewitt, Laplacian.
3) Optimize algorithm performance for efficiency.
4) Document findings and observations.
5) Explore potential improvements: object-aware protection, forward energy, deep learning-based seam detection.

References

[1] S. Avidan and A. Shamir, "Seam carving for content-aware image resizing," *ACM Trans. Graph.*, vol. 26, p. 10–es, July 2007.

[2] M. Rubinstein, D. Gutierrez, O. Sorkine, and A. Shamir, "A comparative study of image retargeting," *ACM Trans. Graph.*, vol. 29, Dec. 2010.

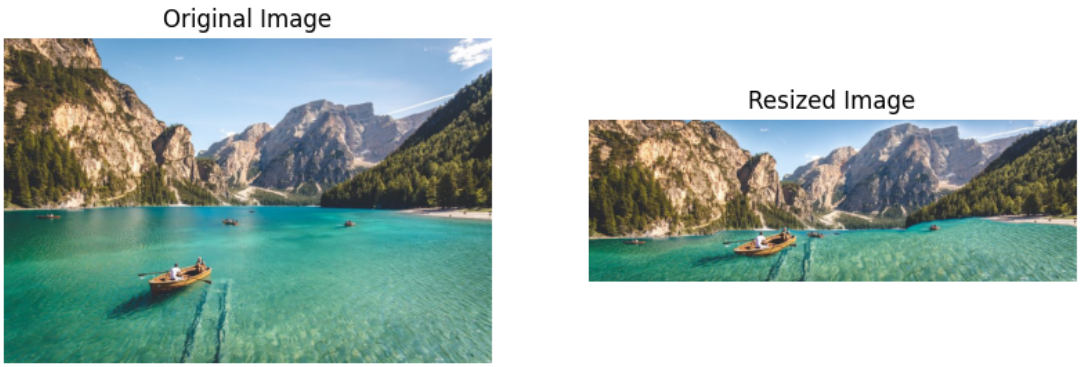

Fig. 1. Our team working on seam carving experiments.