Weekly Report – Content-Aware Image Resizing using DWT + Seam Carving

Members

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I. INTRODUCTION

This week we jumped into understanding what are the possible stategies to do content aware image resizing in frequency domain rather than spatial domain. While the core resizing method is Seam Carving, the main focus in this week was to explore the potential of integrating **Discrete Wavelet Transform (DWT)** into the resizing pipeline.

Traditional seam carving relies on spatial-domain energy functions such as gradient magnitude. In this week, our effort was focused toward studying whether **multi-resolution frequency-domain representation** using DWT can provide richer structural detail and lead to improved semantic preservation during resizing.

The DWT framework enables representation of an image at multiple scales, separating coarse structure from high–frequency detail. This decomposition opens the possibility of defining **importance maps** through analyzing wavelet sub-bands rather than gradients alone.

II. WORK COMPLETED THIS WEEK

The following major activities were completed during the week.

A. Understanding the Discrete Wavelet Transform (DWT)

We learned the mathematical foundation of 2D DWT and how it decomposes images into:

- LL (approximation)
- LH (horizontal detail)
- HL (vertical detail)
- HH (diagonal detail)

We reviewed its connection to multi-resolution analysis and contrast-selective property. This domain separation makes it suitable for constructing feature-driven importance maps.

B. Wavelet Family Selection

We studied common wavelet families. Haar wavelet was selected initially because:

- mathematically simple
- computationally lightweight
- easy to invert

We plan to later test smooth wavelets like Daubechies (db4).

C. Tool Familiarization

We explored the PyWavelets (pywt) library:

- DWT decomposition / reconstruction
- extraction of LL, LH, HL, HH bands
- visualization of band responses

This enabled basic understanding of how key structural information is retained in wavelet coefficients.

D. Initial Observations

From preliminary experiments on sample images:

1) The LL band retains global structure (coarse shapes).
2) LH, HL bands capture larger directional edges.
3) HH is noisy but carries fine texture.

This suggests that frequency-domain coefficient magnitude may serve as a valid alternative importance indicator for seam removal decisions.

III. Summary

This week allowed us to position DWT as a tool that extends conventional seam-carving approaches. Unlike spatial-gradient energy maps, DWT embeds richer contextual information about detail directions, intensities, and texture organization.

We believe that an importance map built over DWT coefficients, instead of raw gradients, may yield:

- Better retention of meaningful structures
- Greater robustness to noise
- Possibility of hierarchical energy estimation

IV. Plan for Next Week

- Construct an **importance map** using LH, HL, HH coefficients
- Perform multi-level DWT (up to 2–3 levels)
- Fuse sub-band magnitudes into a single 2D importance function
- Compare seam-energy definition:
  - Spatial gradient only
  - DWT-driven scores
- Evaluate effects during seam deletion

The objective is to understand whether seam carving in transform domain yields visually superior results or maintains content better than conventional gradient-based maps.