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

Name	Roll Number
Kushal Rathod	AU2340189
Shayan Pariyal	AU2340107
Deep Suthar	AU2340232
Ura Modi	AU2340031

I. INTRODUCTION

Following last week's exploration of DWT and its potential for frequency-domain seam carving, this week we focused on constructing an effective importance map from wavelet sub-bands and focused on how we can create awareness to protect meaningful objects during resizing. Traditional gradient-based seam carving can distort people/important structures when energy distribution does not correlate with semantic relevance.

To address this limitation, we began developing a frequency-based energy map that merges wavelet-based structural details with semantic object detection, specifically face preservation, to ensure that seams are removed mainly from low-importance background regions.

II. WORK COMPLETED THIS WEEK

A. Importance Map Construction from DWT Sub-Bands

We created an initial formula to combine LH, HL, and HH wavelet coefficient magnitudes into a single 2D importance representation:

$$Importance(x, y) = |LH(x, y)| + |HL(x, y)| + \alpha \cdot |HH(x, y)|$$

Initial tests indicate that LH and HL bands strongly capture major edges, while HH contributes valuable fine texture information.

B. Multi-Level Wavelet Decomposition

A 2-level DWT decomposition was implemented to analyze structural cues at different resolutions. Lower-frequency levels capture broader shape structure, while higher-frequency levels represent finer details. Multi-resolution fusion helped create a more stable importance map.

C. Face Detection and Semantic Masking

To prevent distortion of human faces during resizing, OpenCV Haar Cascade was integrated for face detection. A semantic mask was generated and assigned high importance weight to ensure seam protection. The fused final energy map was defined as:

$$FinalEnergy = w_1 \cdot Gradient + w_2 \cdot ImportanceMap$$

D. Initial Seam Path Visualization

We visualized seam paths on sample images using gradient-only energy and the proposed hybrid approach. The traditional approach risked cutting through facial boundaries, while the hybrid model redirected seams to background regions, preserving key content.

III. FUTURE SCOPE

Although the current approach shows promising results, future extensions may include:

- Object-aware saliency beyond face detection (text, shapes, logos, etc.)
- Deep learning-based energy maps for richer semantic recognition
- Real-time performance optimization and GPU-based processing