**Motivation**
- Restrict the processing to a small rectangular window
- Reduced complexity
- Efficient ROI compression
  - involving a rectangular bounding box

**Problem Definition**
- Use seam carving to
  - tightly fit ROI into a rectangular window
  - containing an unknown object of interest
  - minimizing the background contained
  - without any user input and
  - with no knowledge about ROI size

**Possible Approaches**
- Detect salient objects and fit a boundary
  - non-uniform saliency map
  - bounding box may contain a substantial part of the background
- Seam carving [Avidan et al.] performs
  - content-aware image resizing
  - image retargeting
- Object carving using existing seam carving requires the final image size

**Algorithm Overview**
- A seam is an 8-connected path from image left to image right (horizontal seam) or from top to bottom (vertical seam)
- Find seams that avoid objects of interest
- Remove vertical seams
- Remove horizontal seams
- Obtain a rectangular box around the object

**Optimal Horizontal Seam**
- Minimize cost function $C(Q)=\sum_{i=1}^{N}E(I(Q_i))$
- Energy ($E$) of pixels [Avidan et al.]
  - L1-norm of gradient
  - e-HoG
- Seams avoid textured regions
  - removes low-gradient object regions

**Proposed Energy Function**
- To retain the salient pixels in the image
  - incorporate saliency of pixels
  - discard image texture information
  - If saliency output $S$ and
  - Texture removed image $J$

**Texture Removal**
\[ \text{min} \sum (J^i - I)^2 + \lambda \left( \frac{D(i)}{L(i)+\delta} + \frac{D(i)}{L(i)+\delta} \right) \]
- Weighted sum of absolute x-gradients in a window around pixel- $i$. $D_i$
- Absolute weighted sum of x-gradients in a window around pixel- $i$: $L_i$ [Xu et al. 2012]
- Texture removed image $J = \sum_{i\in\Theta} \alpha_i J^i$
- Histogram mass as weights $\alpha_i$

**Saliency Computation**
- Superpixel segmentation of image [Achanta 2012]
- Color histogram of each superpixel as feature
- K-means clustering

**Different Energy Functions**
- The saliency output, the textured removed image and the proposed (PR) energy as the cost function separately

**Results - Visual Comparison**
- Plot cost for removing every seam
- Detect maximum curvature of the cost curve to find the optimal number of seams to be removed

**Results - Inclusion and Exclusion Error**
- We detect only the salient ROI.
- The optimal number of seams to be removed is computed from the image without any user input.
- Vertical and horizontal seam removal may be performed in any order.