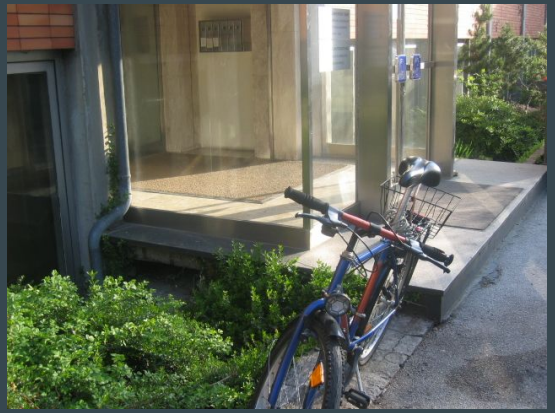
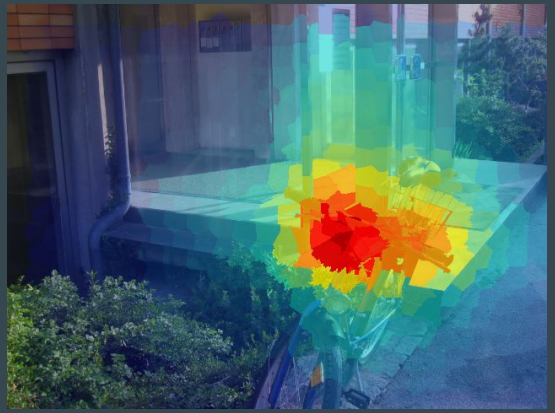
Saliency Filters

- **Team:** willWorkForPizza
- **Team Members:**
  - Pulkit Gera: 20171035 (CSD)
  - Vaibhav Garg: 20171005 (CSE)
  - Saraansh Tandon: 20171007 (CSD)
- **Mentor TA:** Aditya Aggarwal
- **Repo URL:** https://github.com/VAIBHAV-2303/DIP_Project

Problem Statement





Saliency estimation is the process of finding regions of interest in the image.

- Given an image we would like to extract regions from it that can deemed important objectively.
- Moreover we would like to do this without any additional human/historical input and solely based on the properties of each individual image.

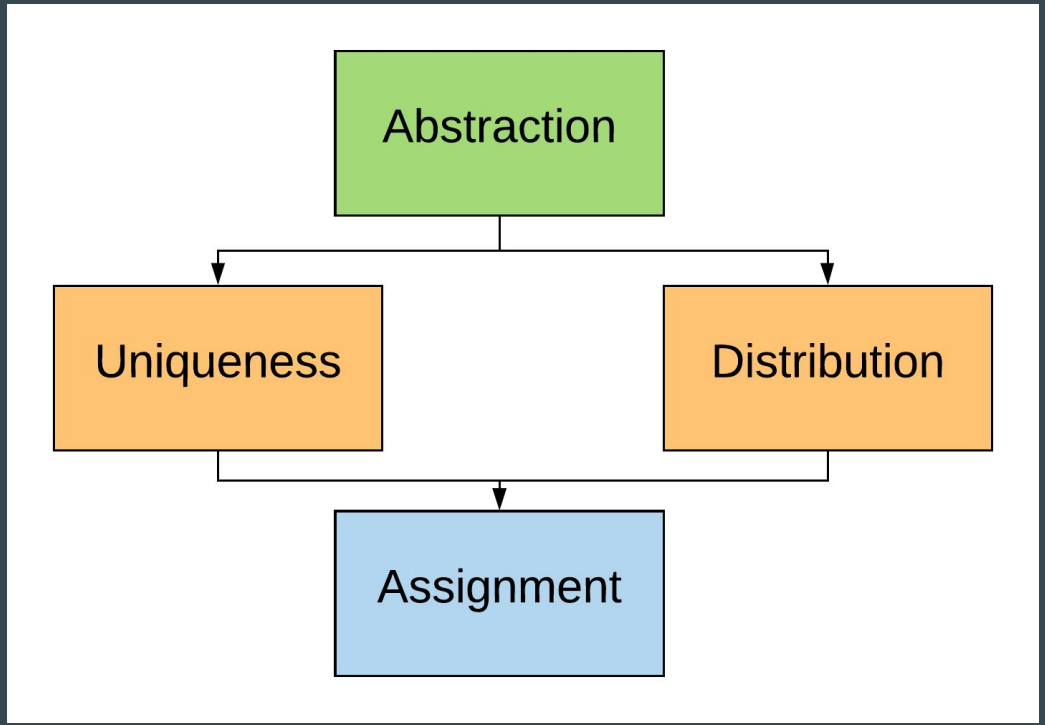
We would like to avoid this !!!

Solution

Results from perceptual research indicate that the most influential factor in low level visual saliency is contrast.

However the definition of contrast in previous works is based on various different types of image features like colour variations of individual pixels, edges, multi scale descriptor,etc. However significance of each individual feature often remains unclear.

Our Approach

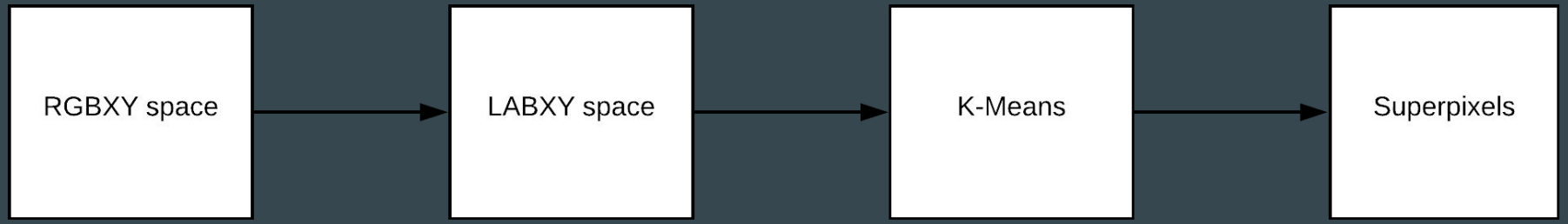


Abstraction

We aim to decompose the image into basic relevant structures. Each element should locally abstract the image by clustering pixels with similar properties into homogenous regions. Strong contours and edges in the images must be preserved as boundaries.

Abstraction Phase

The SLIC approach

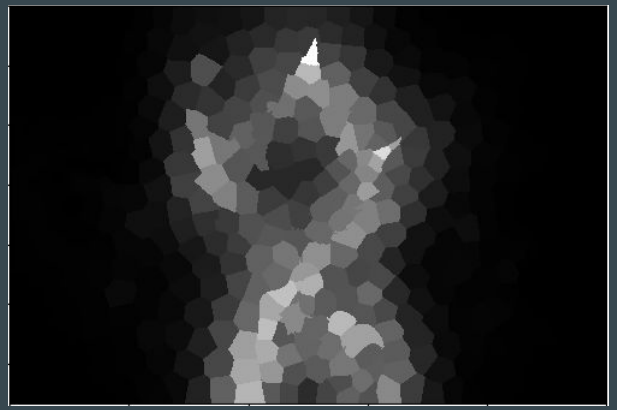


All further processing done on the superpixels.

CIELAB color space gives more compact clusters compared to RGBXY space.

Measuring Element Uniqueness

- This step basically measures the “rarity” of each cluster in the image.
- We use this as a contrast measure based on the hypothesis that the more rare an element is in the image in terms of color, the more salient it is.
- Moreover since we do this operation on superpixels rather than pixels, we eliminate the problem of dealing with small noisy regions.



Measuring Element Uniqueness- Technicalities

Uniqueness is defined as rarity of a segment i given its position pi and colour in lab space ci with respect to all other elements. Question is how do we sample weights or ‘w’.

$$U_i = \sum_{j=1}^{N} \|\mathbf{c}_i - \mathbf{c}_j\|^2 \cdot \underbrace{w(\mathbf{p}_i, \mathbf{p}_j)}_{w_{ij}^{(p)}} .$$

Measuring Element Uniqueness

Measuring Element Uniqueness - Technicalities

We use Gaussian modelling to assign weight scores.

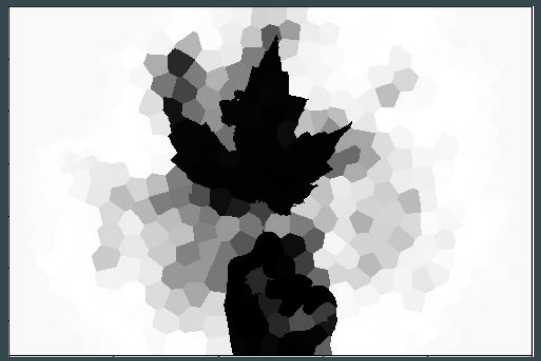
Here Z represents a normalization factor which makes the sum of all weights 1.

$$\frac{1}{Z_i} \exp\left(-\frac{1}{2\sigma_p^2} \left\| \mathbf{p}_i - \mathbf{p}_j \right\|^2\right)$$

Measuring Element Distribution

Ideally colors belonging to background will be distributed all over the image whereas foreground objects are more compact.

We exploit this feature as unique elements are more salient when they are grouped as compared to evenly distributed.



Element Distribution - Technicalities

- For the second measure we find out the spatial distribution of each color in the image.

- We do this by computing a weighted variance of the colored clusters weighed by the similarity in the color.

- This variance is computed against a global mean position of each color.

Element Distribution - Technicalities

Distribution measure

$$D_i = \sum_{j=1}^{N} \|\mathbf{p}_j - \mu_i\|^2 \underbrace{w(\mathbf{c}_i, \mathbf{c}_j)}_{w_{ij}^{(c)}},$$

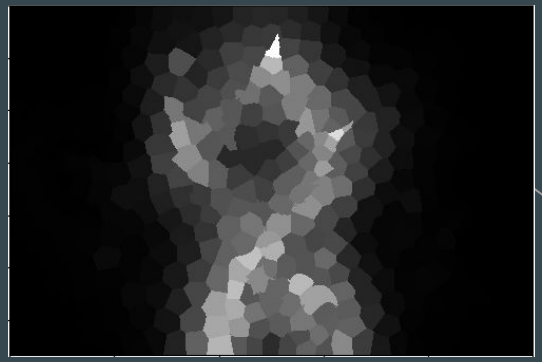
Mean position of the color

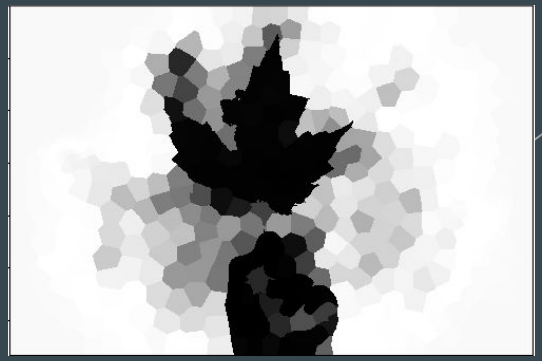
$$\mu_i = \sum_{j=1}^{N} w_{ij}^{(c)} \mathbf{p}_j$$

Similarity Measure

$$w_{ij}^{(c)} = \frac{1}{Z_i} \exp\left(-\frac{1}{2\sigma_c^2} \|\mathbf{c}_i - \mathbf{c}_j\|^2\right),$$

Pixel Level Assignment





$$S_i = U_i \cdot \exp(-k \cdot D_i),$$

Combining the scores

$$\tilde{S}_i = \sum_{j=1}^{N} w_{ij} S_j.$$

$$w_{ij} = \frac{1}{Z_i} exp(-\frac{1}{2}(\alpha||c_i - c_j||^2 + \beta||p_i - p_j||^2))$$

Assigning scores to the individual pixels

Applications

Used to find what is ‘important’ the image, what exactly grabs the human’s attention.

Applications

Computational speed-up

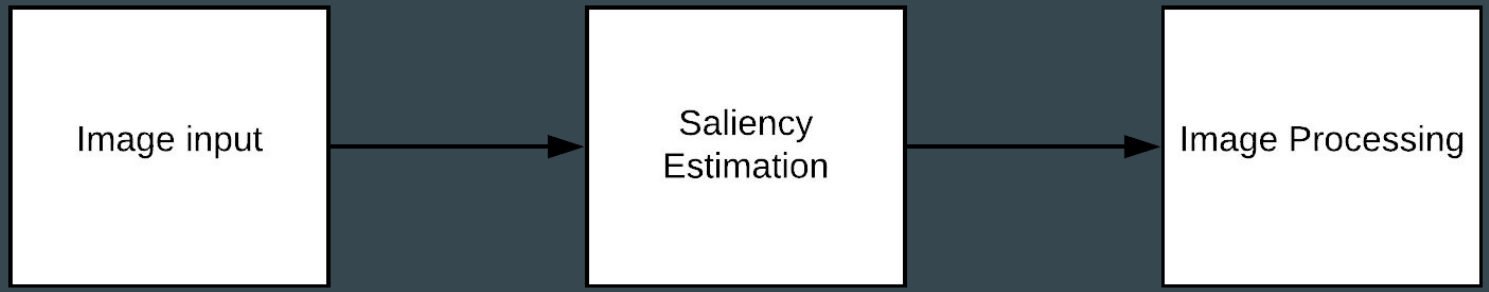
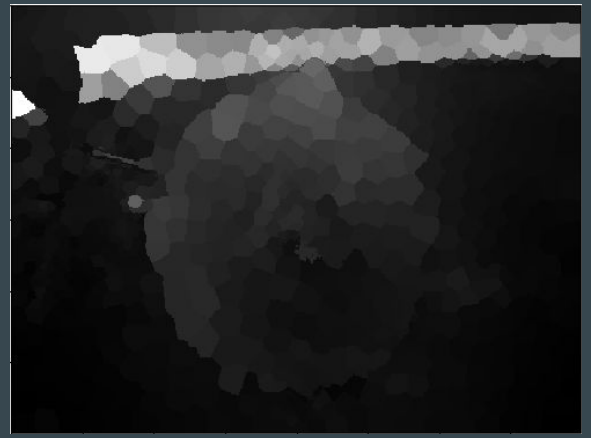


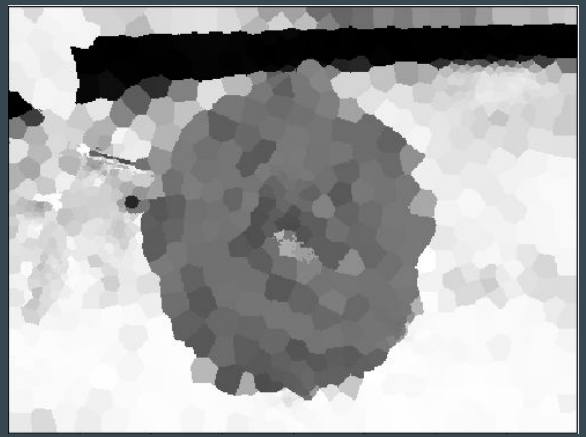
Image Segmentation, Object Detection, Resizing, etc.

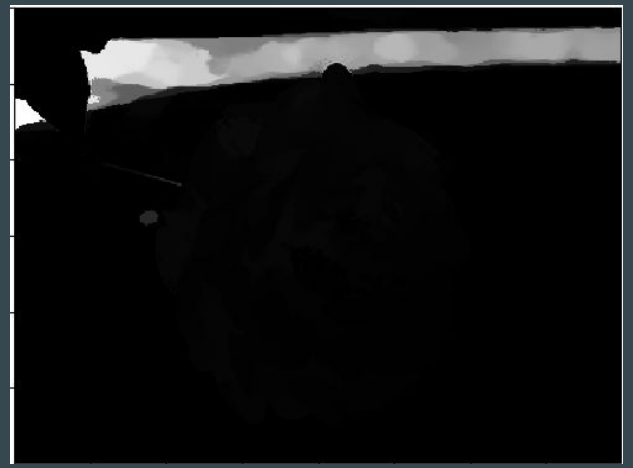
Limitations

In case of Lighting Variations or when foreground and background are similar, saliency assignment may not work that well and thresholding would give incorrect outputs.

As per paper, there are various post processing steps which can be done to counter which are beyond the scope.

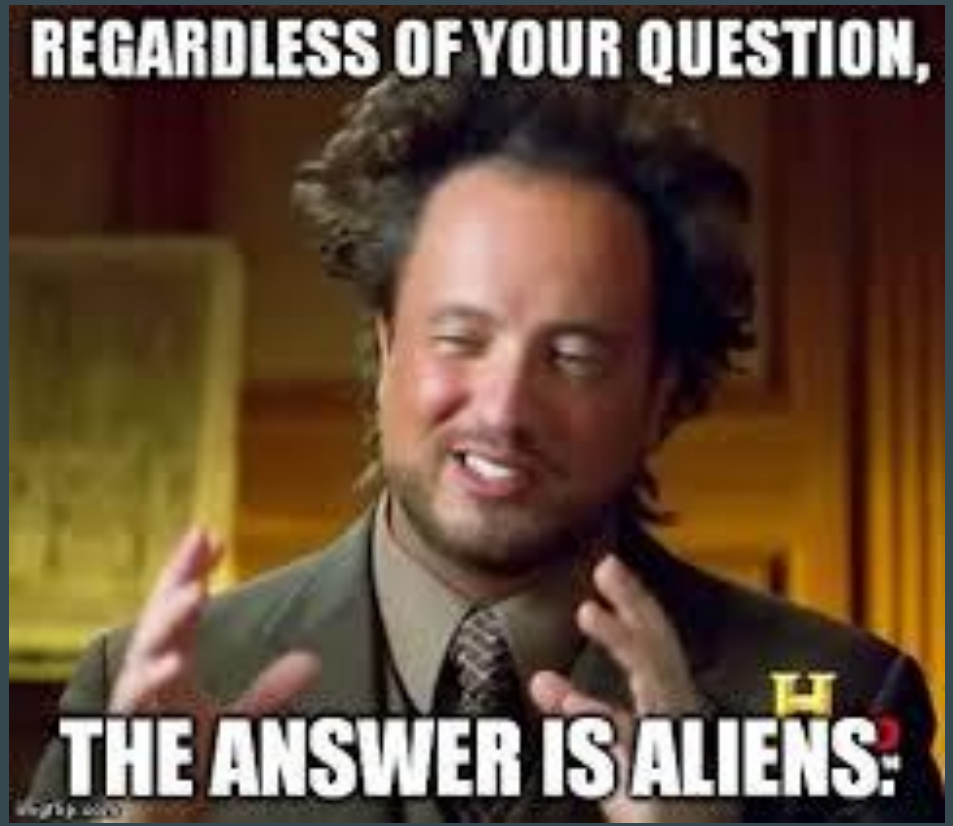






Division of Work

- **Vaibhav Garg:**
  - Implemented the first part of the project, i.e. the **abstraction pipeline**, where the image was clustered into superpixels.
  - Implemented the final **assignment phase,** where the two scores are merged and saliency is assigned to each pixel.
- **Pulkit Gera:**
  - Implemented the first contrast measure, i.e. the **uniqueness pipeline,** where the the clusters are scored based on their rarity.
- **Saraansh Tandon:**
  - Implemented the second measure, i.e. the **distribution pipeline,** where the clusters are scored based on their spatial compactness/distribution.
- **Presentation and Documentations:**
  - Done by all 3


REGARDLESS OF YOUR QUESTION,
THE ANSWER IS ALIENS.