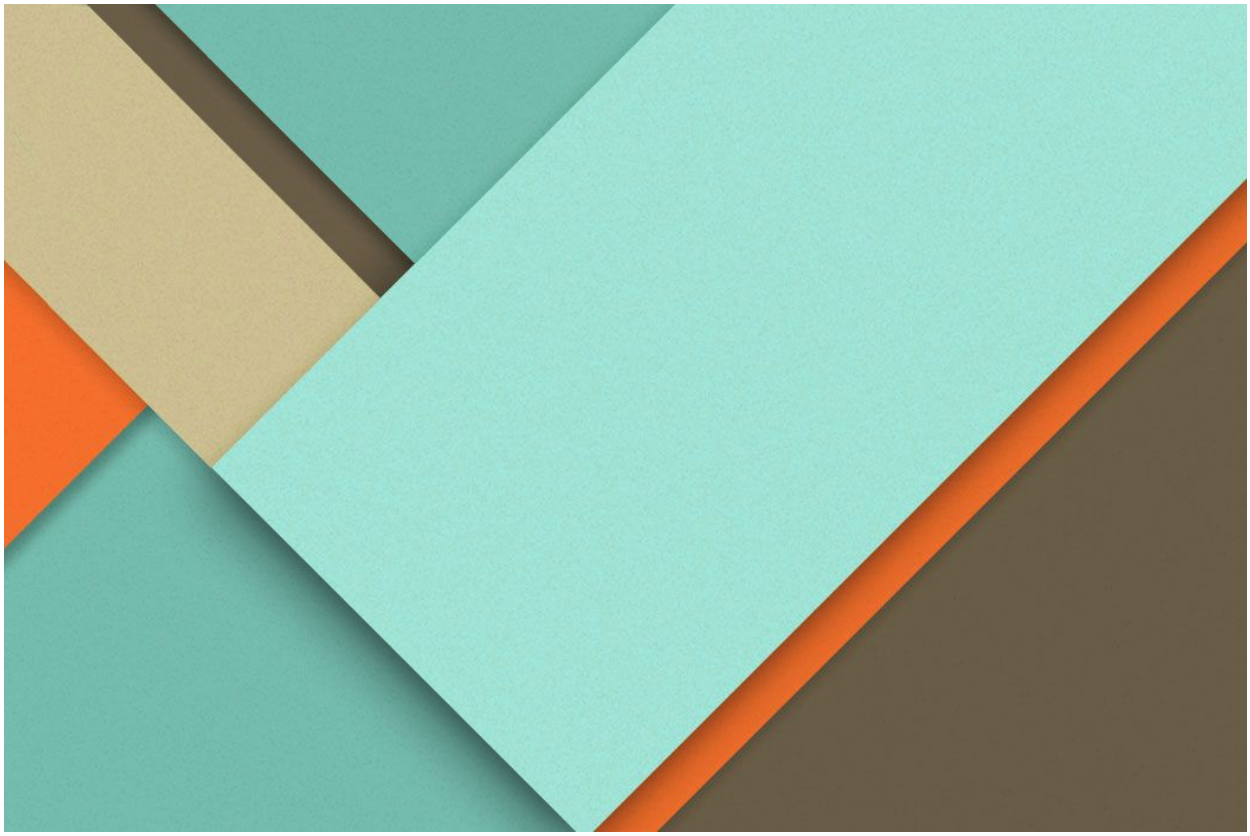

Seam Carving

And Content Aware Re-Sizing

By:-

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Introduction:

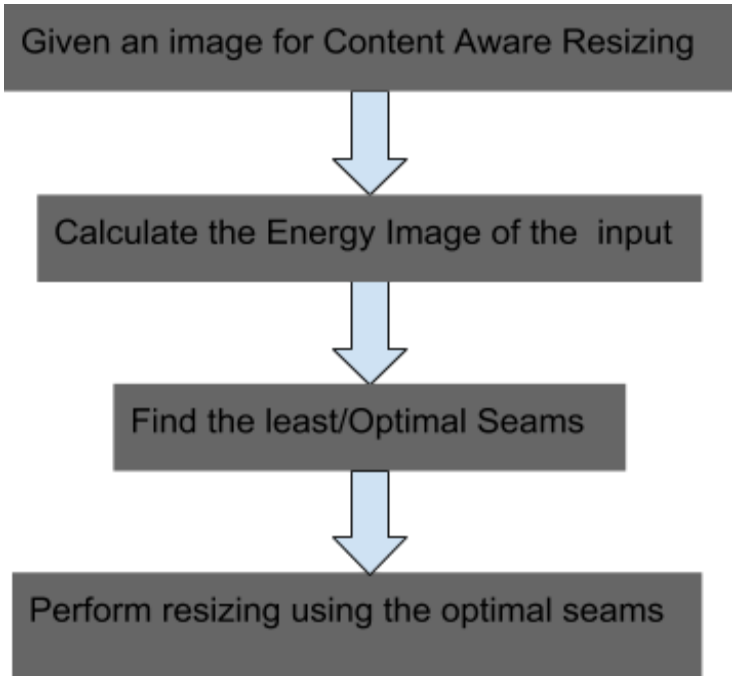
Problem Statement

The project is an implementation of an image resizing approach "**Seam Carving**". Seam carving allows a change in size of the image by modifying the least noticeable pixels in an image. A typical application for seam carving is to reduce the size of an image along one dimension. This can be done by finding one pixel wide paths from the top to the bottom of the image and removing those paths. If the pixels in those paths are similar to surrounding pixels, then their removal or addition may be unnoticed . Other seam carving applications include increasing the size of an image, changing the size of an image in two dimensions and even object removal.

Motivation

Digital images are often viewed in many different display devices with a variety of resolutions. Variation of resolution makes viewing images difficult because they usually are resized to accommodate limited space. Simple attempts at resizing include scaling and cropping. Scaling reduces perceivable detail and cropping can't be done automatically and there might be loss in data(Information) because cropping alters the image's composition and is not always desirable.

Overview



What is Seam Carving

Seam Carving is a newly developed technique targeting image compression and resizing based on detection of seams from the energy function of the image. The method aims at finding seams(threads) of minimum energy and manipulating the image using them.

What is a seam ?

Seams can be either vertical or horizontal. A vertical seam is a path of 8 connected pixels from top to bottom in an image with one pixel in each row. A horizontal seam is similar with the exception of the connection being from

left to right. The importance/energyfunction values a pixel by measuring its contrast with its neighbor pixels.

Why Seam Carving

Effective resizing of images should not only use geometric constraints, but consider the image content as well. Conventional image resizing consists of cropping or evenly down sampling that lead to loss of important features or distortion. This method enables us to remove pixel from uninteresting parts of the image while preserving important content.

- On the contrary scaling introduces geometric distortion.
- And cropping resulted in loss of important features of the image.

Approaches

Generating an Energy Map :

- **(Gradient Magnitude)**- There are various methods to extract the unnoticeable pixel from an image. First and most basic method is to assign energy to each pixel by using a gradient operator.(Sobel, Prewiit, Robert or Laplacian) to compute the gradient in both x and Y direction. The energy function is defined as follows:

  $$e1(I) = \left| \frac{\partial}{\partial x} I \right| + \left| \frac{\partial}{\partial y} I \right|$$

- **Determining the Cumulative Energy Map:**

  We now use Dynamic Programming to find the cumulative energy of a path taken from the top (in case of a vertical seam carving) and left(in

case of horizontal seam carving) till the pixel(I,j). We can define the cumulative energy function as:

M(I,j) = e(I,j) + min(M(i-1, j-1), M(i-1, j), M(i-1, j+1))

- **Detecting the optimal seam:**

  In order to detect the optimal seam we consider the cumulative energy map such that the Pixel with the lowest value of M(I,j) in the last row (in case of vertical seam carving) or last column (in case of horizontal seam carving) is picked and is backtraced to obtain the optimal seam.

Backtracing in x direction:

$s^x = \{s^x_i\}^n_{i=1} = \{(x(i),i)\}^n_{i=1}$, s.t. $\forall i, |x(i)-x(i-1)| \leq 1$, Similarly for y direction.

- **Manipulating the Optimal Seam:**

  We can now use the optimal seam to perform the desired task. For reducing the image size we can remove the optimal seams, to increase the image size we can insert the copy of optimal seams in the image at the appropriate positions.

Work Performed

1) Content Aware Image Resizing

Our goal is to resize the image by preserving the contents in the image . For preserving the content we define a energy function to the image . In our case we took Energy function as gradient of the image.So objects with high gradients are preserved .

2) Aspect ratio Change

Our main goal is to make a photo / Image be able to display on any screen irrespective of their Aspect Ratio . For this we must resize the image and there might be chances of loss of information by resizing using some methods.Therefore we use Seam Carving (Content Aware Image Resizing Algo) .

3:2

5:4

3) Object Removal & Content Amplification

Here we select an object that you want to remove from the image . After selecting the object in the energy image give it very less value to ensure that first seams from that object are removed even their previous energy pixels are high. We will discuss about Content Amplification detailed below.

Algorithm:

Image size reduction:

Generate the energy map using gradient method.

Find the cumulative energy map of the image

For each iteration:

- Detect the optimal seam(in the desired direction-horizontal, vertical)
- Remove the Seam from the image thereby reducing the size of the image.

Image size Expansion:

Generate the energy map using gradient method.

Find the cumulative energy map of the image

Find the least k seams and then duplicate them by either copying or averaging with the neighbouring pixels.

Image size reduction with a protective region provided:

Generate the energy map using gradient method.

Find the cumulative energy map of the image Provide the maximum energy values to the M(I,j) if (I,j) is a selected pixel by the user

For each iteration:

- Detect the optimal seam(in the desired direction-horizontal, vertical)
- Remove the Seam from the image thereby reducing the size of the image.

Object Removal:

It can be seen as the above case but not protecting we want to destroy.

Generate the energy map using gradient method.

Find the cumulative energy map of the image Provide the minimum(-ve value) energy values to the M(I,j) if (I,j) is a selected pixel by the user

For each Iteration:

- Detect the optimal seam(in the desired direction-horizontal, vertical)
- Remove the Seam from the image thereby reducing the size of the image.

Content Amplification:

If we want to see an image in a zoomed way but zooming can make the scope of vision to only near pixels i.e there two objects left and right in an image then zooming can not be done . Then we can content Amplification which is basically scaling and Seam Carving.

Results along with their discussion

Each method have both success and failures it mainly depends on the type of data we provide.For example we will see a case where seam carving doesn't work for geometric structures.

Success Cases

1)Aspect ratio change

3:2

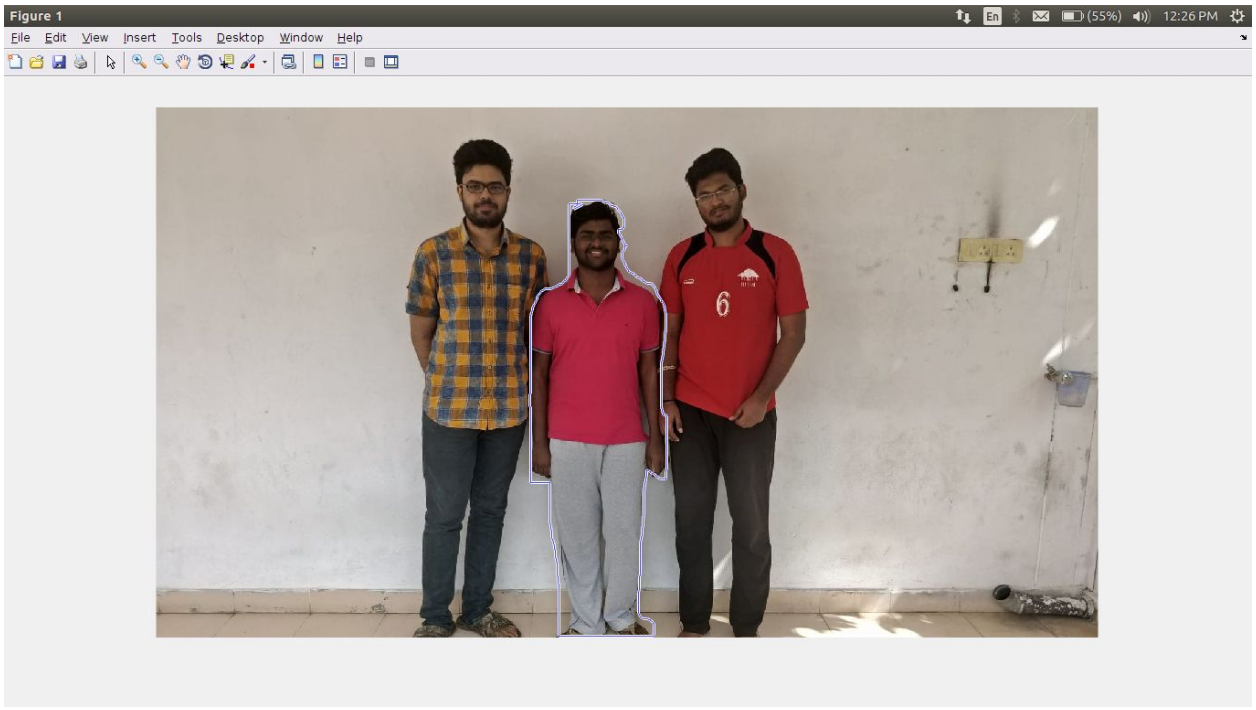
5:4

3:2

16:9

2) Object Removal

We select an object to remove from the image and then we create a mask so that the pixels in the mask will be given less energy value so that it would be selected in the seam.



3)Content Amplification

Failure Cases

1) Failure while seam removal

Here if we observe the output the cone structure is distorted.This is mainly due to the seam doesn't look at the cone as an important feature so removal could lead to loss of cone slantness.

2) Failure while seam removal containing different types of objects(Diff patterns on object)

When resizing a photo consisting of objects with varying textures like the below image of me with two of my friends.There abhilash(leftmost person) wore a grid type of shirt whereas sandeep(middle person) wore a plain T-Shirt and the rightmost person wore a shirt which is not completely plain . So the chances of seam going through our shirts will be

Leftmost(Patterns) < RightMost(Not completely plain) < Middle (completely plain)

Here we can see that the middle person got more slim compared to the leftmost and rightmost person and the rightmost person also got slim compared to leftmost person . Due to the Grid pattern in leftmost person he didn't got slim :p .

Failure when needed to elongate more(Seam Insertion)

If we want to increase the below dolphin image to about 1.5 times the length then the results would be same as just elongating the image with other algos. This is mainly due to selection of seams having dolphin in it . We can observe in the second image that dolphin is elongated which is easily perceived.

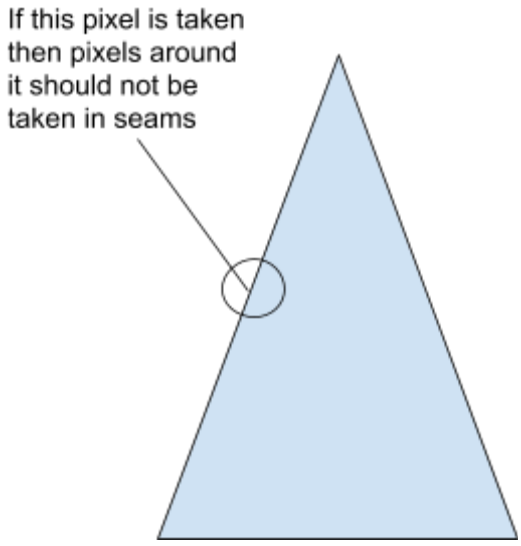
Discussion on the above failure case (Idea): The failure case of elongating to more extent is seen above . We can rectify this problem by having a threshold in the elongation length. Lets say the initial length is L and we want to increase the length to say 1.5 times then half of the images will be selected in the seams and so that dolphin gets included . Instead of that if we do increase it to 1.25 L first time and 1.5 L second time then dolphin maynot get included in the seams.Therefore instead of inserting the seams in one go maintain a threshold value . Do it multiple number of times until we reach the desired size.

Elongating dolphin Image in two steps

we can observe that dolphin is not distorted.

Future Directions:

1) In the above failure cases , one of the failure case is distortion of cone structure . We may modify the algo in such a way that whenever we select a pixel in a line(the slant '/' in cone structure) then we must make sure that pixels in a certain radius are not taken into the seam.Like



GitHub Link : https://github.com/SandeepKallepalli/SeamCarving

TASK ASSESSMENT

As discussed in the project proposal we have divided our work between us.There might be a slight difference in the work division which was promised in the proposal. It was the team effort which allowed us to complete the project in the given time period.Whenever we are stuck in our respective work then it was solved effectively with the help of the other team member .

Sandeep Kallepalli kept efforts on to achieve Aspect Ratio Change,Object Removal , Image size reduction with a protective region provided , Content Amplification(It was done by both the members)

Siva Abhilash Varma kept efforts on to achieve Seam Selection,enlarging Image, Content Amplification(It was done by both the members), Different types of seam insertion.