Image Processing

Content-Aware Image Resizing

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Abstract

For our course module in image processing we are to review a paper based on the topic image resizing. The purpose of this project is to implement a content aware image resizing method. The paper to review was seam carving content aware image resizing by ”Shai Avidan and Ariel Samit”. Their technique had many problems especially with the issues of objects being not well resized, having it content mostly to be lost. We found ways based on this theory and made a proposal on which we could implement this paper and solve the limitations it had. Our approached is based on region of interest by preserving the content in which we want to keep during the resize. This report will give you much details on our approach.

Chapter 1

Introduction

1.1 Background Of study

We can all bare to the fact that technology today as driven the world towards many advances, creating adaptive processing tools has become of more and more interest. One of the applications that has brought much attention to it recently is the use of intelligent image resizing techniques in order to fit the images into the variety of display tools which we attain such as smart-devices, monitors, different page layouts. Conventional image resizing techniques consist of cropping or evenly down-sampling the image without taking into account the content of the image. These methods can lead to loss of important image features or distortion. A better method is by having pixels remove from uninteresting parts of the image while preserving the important content.

Seam Carving is a method in which was implemented to achieve the statement mentioned. It uses a kind of metric to determine the importance of each pixel of the image. Different metrics include gradient magnitude, entropy or visual saliency. By using this importance map, the algorithm finds the optimum seam, which is defined as the path of pixels with the lowest cumulative energy, and removes it from the image. This way, because the interesting features in the image usually have more energy, the method automatically preserves the important contents and removes pixels from the uninteresting parts. Other interesting things that can be done using this method. For example, the seam carving method can be run reversely to insert interpolated seams along the optimum seams to enlarge the image. Below is a diagram to as gotten as a result of using seam carving method:

1.2 Problem Statement

The seam carving method does not work on all images. If the image is too condensed in the sense that, it contains less important areas then the image at the end loses most of its valuable content.

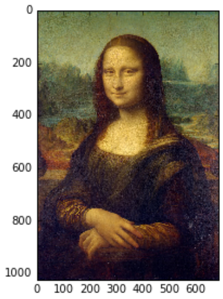


Figure 1.1: Original Image

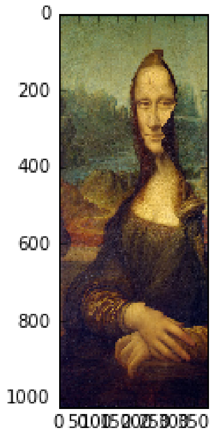


Figure 1.2: seam carving using python Function

1.3 Aim

Our aim is to develop a method to resize any image given and retain its valuable content.

1.4 Objectives

To solve this problem we undertook these steps in achieving the aim.

- Research on the literature review and other methods for image resizing
- Ways to preserved the content while resizing
- Creation of a good GUI using Matlab
- Implement the methods and show result

Chapter 2

Methodology

The main idea of the project is to preserve the significant content of the image by removing content with less information. So for that we have to generate function in order get energy of the image using edge detection. Edge detector operators (gradient operator, Prewitt, Sobel Laplacian) can be used for that task and each method gives different advantages and different artifacts. Then we defined a path of pixels which have the minimum energy to get the optimal seam and finally remove seam horizontally or vertically from the image. optimal seam.
This process is repeated until the desired resized image is attained. In this section,each step of the process is described in details.

2.1 Grayscale conversion of the original image

First the image is converted to grayscale to facilitate the detection of the edges.

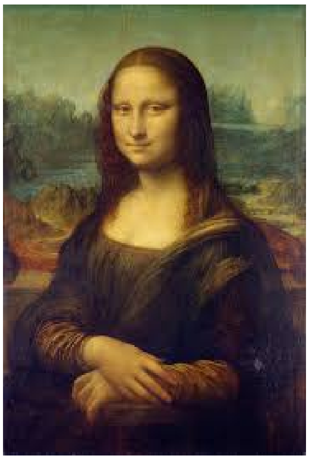


Figure 2.1: Original image

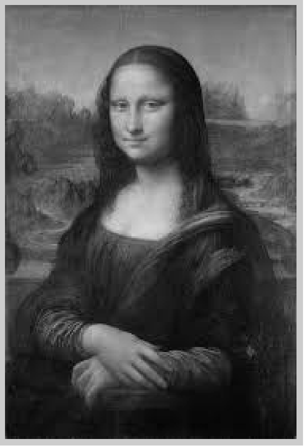


Figure 2.2: Image as grey of monalisa

2.2 Generating energy map

The analyze of the energy map of the image will help us to see which part of the image is high energy pixel and which is low energy. To extract the unimportant pixels from an image, we assign energy to each pixel by using a gradient operator. The energy function will be the sum of the gradients in both x and y directions. The energy function is defined for each pixel as follows :
E = $|\delta I/\delta x| + |\delta I/\delta y|$

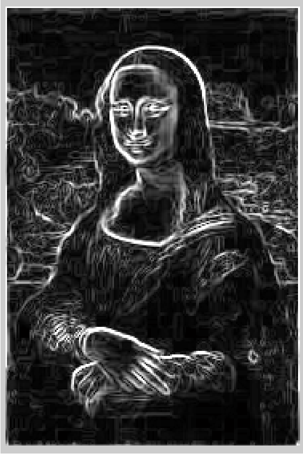


Figure 2.3: Edge detector

2.3 Optimal Seam detection

One way to resize image is to remove equal numbers of pixels with lowest energy from every row/column. Seam is an 8- connected path of pixels in the image from top to bot-tom/left to right, containing one, and only one, pixel in each row/column of the image.

As described in the paper "Seam Carving for Content Aware Image Resizing", the optimal seam can be found using dynamic programming. The first step is to traverse the image from the second row to the last row and compute the cumulative minimum energy M for all possible connected seams for each pixel (i, j): M(i, j)= E(i, j) +min(M(i -1, j -1),M(i -1, j),M(i -1, j +1))

The above calculations were all described for vertical seams. To find the horizontal seam, we just need to transpose image and repeat same steps

2.4 Image resizing

Shrinking images

The next step is to resize the image and make it to fit in a smaller display. This can be done by removing the optimal seams in horizontal and vertical directions from the image. One way is to first remove all the horizontal optimal seams and then remove all the vertical ones. Another way is to remove the seams in an optimal order.

Let n' x m' are desirable size of the image (n' < n, m' < m). We introduce a transport matrix T which defines for every n' x m' the cost of the optimal sequence of horizontal and vertical seam removal operations. It is more suitable to introduce r = n - n' and c = m - m' which defines number of horizontal and vertical removal operations. In addition to T we introduce a map of the size r x c which specifies for every T(i, j) whether we came to this point using horizontal (0) or vertical (1) seam removal operation.

By repeating this process and recalculating the new energy map in each iteration, the image can be converted to the desired size.

Enlarge images

In order to enlarge the image, we can add pixels to regions of image that do not have a lot of variation. Again, we can use the optimal seams to identify these regions, but instead of deleting the k optimal seams, copy average between neighbors.

2.5 Object Preservation

The importance of image preservation is based on the fact that there is features in an image that need to be preserved. For example the importance of face or body of a person in an image where the proportion have a key role, but can be modified by the seam carving algorithm which will remove some seams who will deform the human body present in that image.
That is why the selection of the area to be protected is important which will enable the user to get a good resulted resized image without modification of the content selected.
We will be using the function provided in Matlab called "roipoly" which correspond to the region of interest. By using this function we will be specifying a polygonal region of interest inside the image.

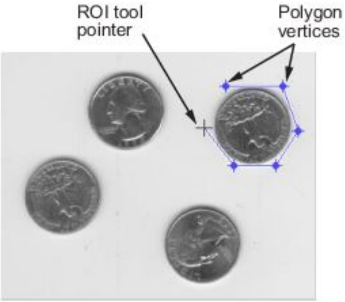
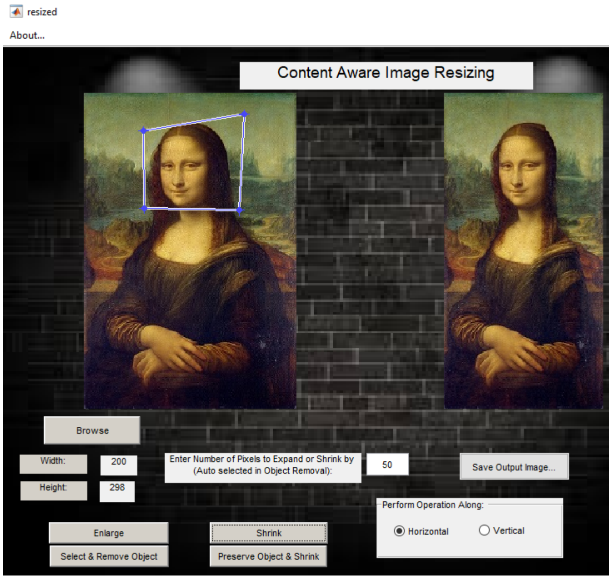


Figure 2.4: Region Of Interest



Width: 200
Height: 298
Enter Number of Pixels to Expand or Shrink by (Auto selected in Object Removal): 50
Perform Operation Along: ● Horizontal ○ Vertical

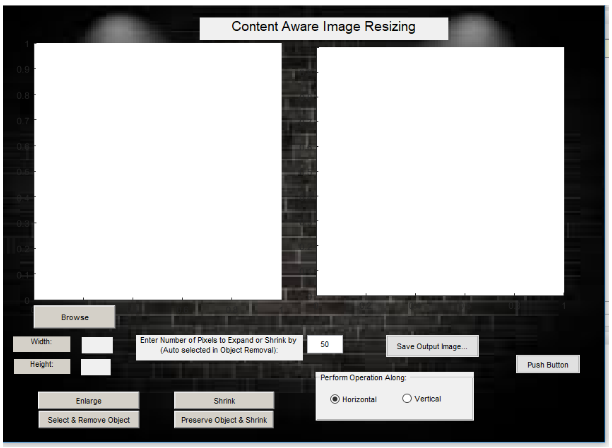
Figure 2.5: Performing Region Of Interest

Chapter 3

Gaphical User Interface

We implemented a GUI created on on MATLAB environment to enable us to be able to perform the methods given and compare results. Our GUI was made with these features:

- Loading an image
- Enlarging the image
- Shrinking of the image
- Saving the image
- Preserving object



Enter Number of Pixels to Expand or Shrink by (Auto selected in Object Removal): 50

Perform Operation Along: ● Horizontal ○ Vertical

Figure 3.1: Graphical User Interface

Chapter 4

Results

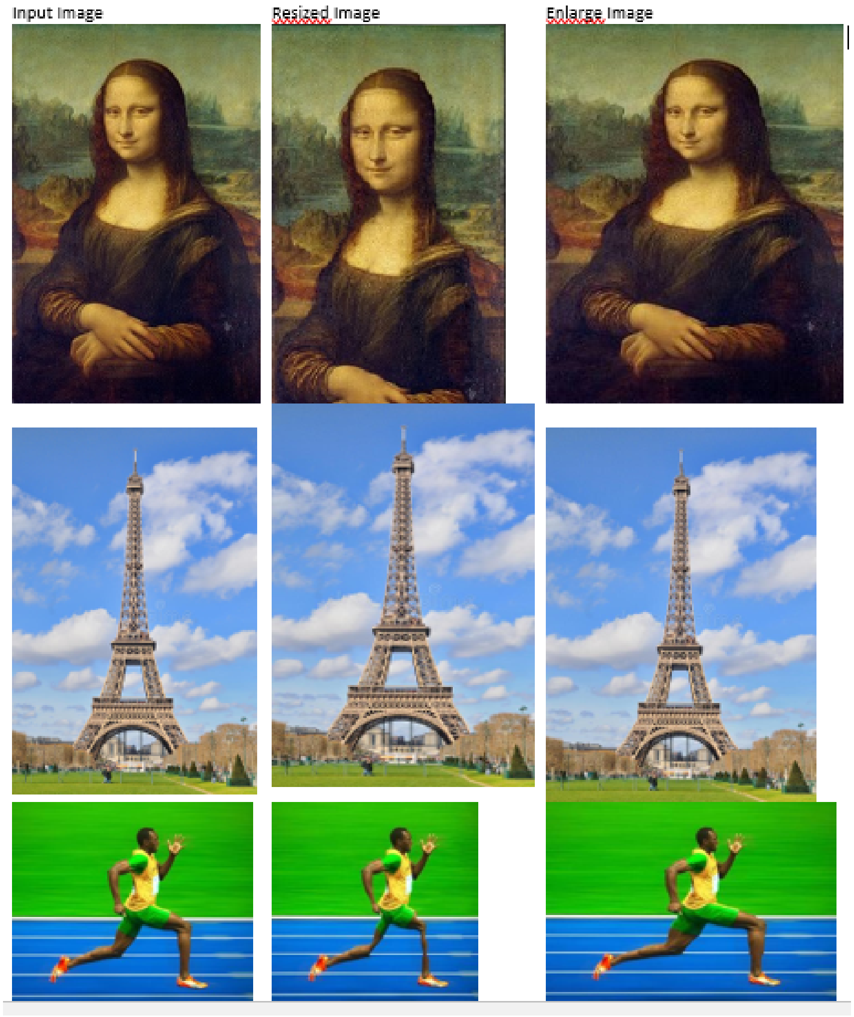


Figure 4.1: Result test on different pictures

Obeservation We can see from the above figure that comparing each row to from right to the left being the original to the transformed images which being the resized image with the object preservation to the the last image being the image enlargement. We tested three images. Each tested image had different resolutions. The low resolution images showed better results than the high ones. We can see "Usain Bolt" in one of the images had been enlarge making him to be a fat man running.

Chapter 5

Conclusion and Perspectives

We implemented seam carving method based on the algorithm described in the paper we reviewed and proposed a method in which we could be able to give better results having its limitations of content aware regarding it not be able to implemented on objects in images with low energy. We based this method on Region Of Interest(ROI) where the image in which we wanted to attain or keep after resizing are selected using a mask.

This approach could also be implemented on video. where the necessary video in when we would like to resize can be done and also added the feature of the object preservation. we will further on make morer research on this part and try to implement the necessary procedures necessary.

Chapter 6

References

- **Object preservation** https://stacks.stanford.edu/file/druid:my512gb2187/Zargham_Nassirpour_Content_aware_image_resizing.pdf
- **ROIPOLY Matlab function** https://fr.mathworks.com/help/images/ref/roipoly.html?requestedDomain=true
- **Matlab GUI** https://www.google.fr/search?ei=W8JWWoLbMYbiUZX2jcgI&q=grahical+user+interface+matlab&oq=grahical+user+interface+matlab&gs_l=psy-ab.3...17839.25593.0.25941.30.30.0.0.0.0.221.2854.0j21j1.22.0....0...1c.1.64.psy-ab..8.22.2841...0j35i39k1j0i67k1j0i20i263k1j0i10k1j0.0.E__puzbY-po
- **Content Aware Image Resizing** https://stacks.stanford.edu/file/druid:my512gb2187/Zargham_Nassirpour_Content_aware_image_resizing.pdf
- **Seam carving algorithm** http://kirilllykov.github.io/blog/2013/06/06/seam-carving-algorithm/
- **Content Aware Image Resizing** https://web.stanford.edu/class/cs231a/prev_projects_2016/projectreport.pdf
- **Matlab background GUI** http://we15hang.blogspot.fr/2012/02/matlab-gui-inserting-background-image.html
- **Content Aware Image Manipulation by M.Rizwan, Waleed A. Malik and Fayyaz Minhas**