Project

COL-783

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The goal of this project is to perform Image retargeting and video retargeting. You will be required to implement a paper named "Improved Seam Carving for Video Retargeting"[1] for image retargeting and video retargeting, further you need to suggest and implement extensions over it.

1 Image Retargeting

In the first part, you will implement Image retargeting algorithm as proposed in [1].

A digital image of size m × n can be represented by a 2D discrete grid of pixels with m rows and n columns, where each pixel has a value that encodes its color or intensity information. The image retargeting problem can be stated as follows. Given an image I of size m×n and a new size $m' \times n'$, the goal is to produce a new image I' of size $m' \times n'$ that will be a good representative of the image I. There are three main objective for Image retargeting [2]:

- The important content of I should be preserved in I'.
- The important structure of I should be preserved in I'.
- I' should be free of visual artifacts.

Two traditional and straightforward methods for image retargeting are uniform scaling and fixed-window cropping. These methods are not content-aware and only consider geometric constraints in image retargeting. The technique proposed in [1] is content-aware and based on seam carving. A seam in a image is one pixel wide vertical (or horizontal) curve over the image which traces one pixel from every row (or column). Seam carving is based on extraction of seam(s) from the image which has the lowest information (or minimum energy cost) associated with it so that even if we remove those seams from the image, the resultant image is unaffected in terms of overall structure and content. [1] proposed a forward energy criterion to extract seam from image via dynamic programming.

For this part, you will be provided with an image dataset, in which you have to perform image retargeting method proposed in [1] based on graph-cuts and forward energy. Your objective is to reduce the width of the image by a factor of 0.75 i.e. for an image of size m x n you will need to retarget to $\lfloor 0.75m \rceil$ [1] x n. Below are the examples of original images of size m x n and their retargeted version of size $\lfloor 0.75m \rceil$ x n:

2 Video Retargeting

In the second part, you will implement video retargeting. Retargeting videos is a more complex problem than image retargeting due to the additional temporal dimension. You should implement the following methods for video retargeting and compare the results:

1. Use the image retargeting method from Part 1 on each frame individually.

[1] rounding to nearest integer

(a) Original image

(b) Retargeted image

(c) Original image

(d) Retargeted image

(e) RGB image

(f) Retargeted image

Figure 1: Original RGB images and their corresponding Retargeted images with it's width reduced to 0.75 of the original

2. Compute a static seam that minimizes the energy function across all image frames in the video. This will result in all frames of the video being resized similarly.

3. Implement the graph-cuts based video retargeting method proposed in [1]. Instead of removing 1D seams from 2D images, this method removes 2D seam manifolds from 3D space-time volumes.

For this part, you will be provided with a video dataset, and your objective is to convert the original height and width in each frame by a factor of 0.75 and 0.5 respectively (i.e. for each video frame of size m x n you will need to retarget to $\lfloor 0.75m \rceil$ x $\lfloor 0.5n \rceil$).

3 Extensions:

There are few drawbacks associated with the technique of [1]. Your task for this part is to extend/improve the following challenges of the concerned paper:

- Suggest a technique on top of [1] method and implement its model for improving image retargeting results in highly textured environments. (Hint: You can refer [3], [4] or similar works).
- Suggest a technique on top of [1] method and implement its model for improving in video retargeting results in presence of object motion wrt camera. (Hint: You can refer [5] or works similar to it).

Rules

1. Please use Python for implementation using only standard python libraries (e.g., numpy, opencv, matplotlib etc.). Please do not use any third party libraries/implementations for algorithms.
2. You can do the Project in groups of two, or individually.
3. You are required to write all the three tasks (i.e. Image retargeting, video retargeting and their extensions) in different folders using '.py' format files.
4. Your code should have appropriate documentation for readability.
5. You can take inspiration from open-source code(s) available on the internet, **do not forget to cite the source** in your report as well as code, (but you can't copy the whole thing) the relative similarity between the code and referenced code should be less (if referred). You have to write code on your own.
6. You are advised to make your own functions and classes for different tasks.
7. For each part of the project, we have provided the dataset on which you should run your method. Include your resulting images/videos in the report as well your submission folder.
8. Additional Reading: Refer resources section
9. You are not allowed to discuss or borrow code from other groups.
10. You will be graded based on what you have submitted as well as your ability to explain your code.

Submission Instructions

1. Submit your source code, along with a readme.
2. Submit output files for all input images provided. The output file for a given image should be stored in the same directory as the input image.
3. Please prepare a report to accompany your implementation. The report should contain the methodology, design choices, results and analysis.Outputs (along with corresponding input images) should also be clearly shown in your report.

4. Zip the code and report in a single file, rename the zip as <Member1-entry-number> _ <Member2-entry-number>.zip and submit on moodle.
5. Only one submission per team.

Evaluation Rubric

Your evaluation will be based on:

- Image retargeting Paper Implementation - 2 points
- Video retargeting Paper Implementation - 4 points
- Extension for improving image retargeting results in highly texture environments - 1.5 points
- Extension for improving video retargeting results in presence of object motion wrt camera - 1.5 points
- Report + demo - 1 point

  There are no quantitative metric on which you will be evaluated. Evaluation will be based on qualitative Analysis only.

Resources

Resources which could be used for references:

- Real-world dynamic programming: seam carving – tutorial
- Improved seam carving with forward energy – tutorial
- CVFX Lecture 8: Image Retargeting and Recompositing (Video Tutorial)
- A Comprehensive Review on Content-Aware Image Retargeting: From Classical to State-of-the-art Methods
- Algorithms for video retargeting
- Implementation and evaluation of content-aware video retargeting techniques
- Improved seam carving for video retargeting (Video ppt)

References

[1] M. Rubinstein, A. Shamir, and S. Avidan, "Improved seam carving for video retargeting," *ACM transactions on graphics (TOG)*, vol. 27, no. 3, pp. 1–9, 2008.

[2] D. Vaquero, M. Turk, K. Pulli, M. Tico, and N. Gelfand, "A survey of image retargeting techniques," in *Applications of Digital Image Processing XXXIII*, vol. 7798, 2010, pp. 328–342.

[3] W. Dong, F. Wu, Y. Kong, X. Mei, T.-Y. Lee, and X. Zhang, "Image retargeting by texture-aware synthesis," *IEEE Transactions on Visualization and Computer Graphics*, vol. 22, no. 2, pp. 1088–1101, 2015.

[4] M. Rubinstein, A. Shamir, and S. Avidan, "Multi-operator media retargeting," *ACM Transactions on graphics (TOG)*, vol. 28, no. 3, pp. 1–11, 2009.

[5] Y.-S. Wang, H. Fu, O. Sorkine, T.-Y. Lee, and H.-P. Seidel, "Motion-aware temporal coherence for video resizing," in *ACM SIGGRAPH Asia 2009 papers*, 2009, pp. 1–10.