Department of Computer Science, Rutgers University

CS534 – Introduction to Computer Vision

Assignment 2

Computational Photography

Texture Synthesis and Image Inpainting

Due Sunday April 15th – 11:55pm

1. Introduction

This assignment involves Texture Synthesis and Image Inpainting . The goal is to implement and evaluate the idea of Texture Synthesis by Non-Parametric Sampling proposed by Efros and Leung, ICCV99, and region filling by Criminisi et al "Region Filling and Object Removal by Exemplar-Based Image Inpainting", TIP 2004. We will also test a recent deep learning approach (the Lama Project) for the same problem.

1.1. Paper and Code

Efros and Leung paper can be found at:

http://graphics.cs.cmu.edu/people/efros/research/EfrosLeung.html

A pseudo-code for their work is provided in:

http://graphics.cs.cmu.edu/people/efros/research/NPS/alg.html

The algorithm is also described in Forsyth and Ponce textbook in Chapter 6, and in Szeliski's textbook in Section 10.5.

Criminisi's paper can be found in http://research.microsoft.com/apps/pubs/default.aspx?id=70029

Lama Project can be found here https://saic-mdal.github.io/lama-project/

2. Main Task

2.1. Preliminaries

You will be given five images that you are going to use for synthesis.

Download the test images from Sakai resources

2.2. Implementation and Experiments

2.2.1. Texture Synthesis

Write a Python code, implementing Efros and Leung's approach, to synthesize a 200x200 pixel image for each of the five example images T1,T2,…, T5.gif. Show synthesized images for T1,T2,…, T5.gif by changing the WindowSize parameter to 5, 9,11 pixels around the center.

2.2.2. Image Inpainting

Use your code (with modification if necessary) to fill in the gaps (black regions) in the images test_im1.bmp, test_im2.bmp. Try different parameter settings 5, 9, 11, and others if necessary, to see which one give you the best results. Comment about it in your report.

2.2.3. Object Removal

A better image inpainting approach was proposed in Criminisi, Perez and Toyama, "Region Filling and Object Removal by Exemplar-Based Image Inpainting", Download and read that paper. Write your own implementation of the algorithm in Python.

The goal of this experiment is to compare Efros and Leung approach, which you implemented in 2.2.1, and this newer algorithm, for the task of object removal. The task is removing three objects/regions from the image test_im3 (the man on the left, the sign and pole on the bottom right, and the oversaturated area on the ground). Use and compare both approaches for this task. This is a color image, so first you need to convert it to a grayscale image. Run both codes on the image, with one of the regions marked to be filled at a time, and compare the results.

2.2.4. Object Removal using Lama Project

In a recent paper (Lama Project), researchers proposed a method for image inpainting using deep neural network architecture using "Fourier Convolution". The paper and implementation can be found here

https://saic-mdal.github.io/lama-project/

Read the paper, and run their code to test it on the examples test_im3.jpg to remove the areas mentioned above (the man on the left, the sign and pole on the bottom right, and the oversaturated area on the ground). You will need to create masks to mark these areas. This can be done using the provided colab tool. You don't need to convert the image to grayscale for this test, also you can test removing all three areas together.

How do you find the results of this approach compared to the results of the previous approach (in 2.2.3) ?

Write an essay (no more than 500 words) describing how Fourier Convolution works and why you think it is advantageous in removing large objects

2.2.5. About Efficiency

It is very important to write an efficient code. To achieve that, avoid using for/while loops and try to use array and matrix operations instead, which are much faster. Also try to write your code using built-in functions, whenever possible.

2.2.6. Submitting the Code

You will submit all your code on canvas. There should be at least two files; one for texture synthesis and one for image inpainting/region filing. No need to submit codes for the Lama project test

2.3. Report

Write a report with all necessary images properly labeled. Submit only a softcopy of your report to Sakai.

2.3.1. Images

Show synthesized images for T1,T2,…, T5.gif by changing the WindowSize parameter to 5, 9,11 pixels around the center.

In total you will have 21 synthesized images (7 images x 3 parameter settings). If you find a different better parameter set for inpainting part, submit result of that as well and comment about it in the report.

Show the output of the two object removal/region filling approaches on the three regions in image test_im3

3. Grading

Texture Synthesis - This part will be up to **30%** of your grade

Image Inpainting - This part will be up to **30%** of your grade

Region Filling - This part will be up to **25%** of your grade

Region Filling – Lama Peoject - This part will be up to **15%** of your grade

Grade Penalties

- **10%** for late submission up to two days.

- Up to **10%** if the code is not running for some reason and/or giving significantly different results than the ones reported. Do not forget to submit all the files you have written and any external files that you have used. Create a '**how to run**' section in your report if your code needs a special procedure to run.

- Up to **50%** if group work and/or code sharing is noticed. See Academic Integrity section for details. Any code downloaded from the internet has to be acknowledged in the report.

3.1. Academic Integrity

This is an **individual assignment** and it has to be completed by each person independently and **not with groups**. Sharing code or/and specific ideas is not allowed. The code, results and report that you have submitted will be compared with other people's submissions and your grade will be severely affected if a clear resemblance exists. Instead of consulting to your classmates, please contact the TA or the Professor to clear out any confusing points about the assignment. You are expected to write your own code unless otherwise instructed, in such case you need to specify from where it was downloaded.

Please note that posting your code for the assignment in the future online is a violation of Rutgers policy since it might facilitate cheating in the future.