WPI

CS 539: Machine Learning
Project Proposal

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1 Abstract

Style transfer is the technique for recomposing images in the style of other images. With the development of deep learning in the computer vision field, style transfer has been popular with the applications of CNN (Convolutional Neural Network). In this project, our group will build a real-time image style transfer project using CNN.

2 Problem Statement

The goal of this project is to implement a real-time image style transfer demonstration using deep learning. One deep CNN will be used to learn the style of the input image and then output the content image which learns the style of the style image. Style transfer can be defined as finding a pastiche image p whose content is similar to that of a content image c but whose style is similar to that of a style image s [1].

The neural algorithm of neural style transfer proposes the definitions following [1]:

- Two images are similar in content if their high-level features are extracted by a trained classifier are close in Euclidian distance;
- Two images are similar in style if their low-level features as extracted by a trained classifier share the same statistics or, more concretely, if the difference between the features' Gram matrices has a small Frobenius norm.

In the training of the CNN there will be the content and style reconstruction with the combinations of the output of different convolutional layers [2].

The flowchart of the neural style transfer is illustrated in figure 1:

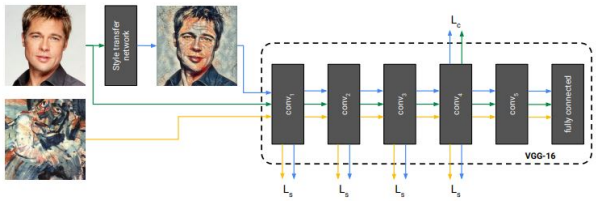

Figure 1: Neural Style Transfer Demonstration [1][2]

3 Motivation

Neural style transfer has been popular for recent years with the application of Deep CNN. The Multi-style transfer with the training with deep neural network has also been applied in the area of computer vision. The motivation of this project is to implement the real-time neural style transfer with the integration of openCV.

OpenCV has provided the state-of-art image processing and computer vision tools for the prerequisite processing functions to process the input style image for the CNN and then output content image. The project will train the COCO image datasets and to implement multi-style style transfer.

4 Hypothesis

The implementations of multi-style transfer in the training Deep CNN is to obtain the convergence of the loss function. In the neural style transfer, the loss function is given on the following with the initialization of p and c from certain type Gaussian Noise as stated in the problem statement part and the algorithm adapts p to minimize the loss function $\mathcal{L}$ [3] in equation 1:

$$\mathcal{L}(s, c, p) = \lambda_s \mathcal{L}_s p + \lambda_c \mathcal{L}_c p \tag{1}$$

$\mathcal{L}_s p$ is the style loss and $\mathcal{L}_c p$ is the content loss and λ_s, λ_c are scaling hyperparameters. The style and content losses are defined as in equation 23 with style layers $\mathcal{S}$ and content layers $\mathcal{C}$ are given.

$$\mathcal{L}_s(p) = \sum_{i \in \mathcal{S}} \frac{1}{U_i} ||G(\phi_i(p)) - G(\phi_i(s))||_F^2 \tag{2}$$

$$\mathcal{L}_s(p) = \sum_{j \in \mathcal{C}} \frac{1}{U_j} ||\phi_j(p) - \phi_j(c)||_F^2 \tag{3}$$

The style transfer network T is a feed-forward convolutional network which takes content image c and outputs the pastiche image p directly. The loss function then can be reduced to equation 4.

$$\mathcal{L}s, c = \lambda_s \mathcal{L}(T(c)) + \lambda_c \mathcal{L}(T(c)) \tag{4}$$

5 Deliverable

This project will rely on the training of the deep style transfer neural network and the graphical user interface to integrate the OpenCV and the pre-trained neural network to perform the function.

A graphical user interface will integrate different function blocks.

6 Summary

The project will implement the neural style transfer with the training of deep CNN. The timetable of the project is on the following:

- Oct. 27th: Submit Project Proposal
- Dec. 5th: Demo Website
- Dec. 6th/13th: Project Presentation

References

[1] V. Dumoulin et al., "A learned representation for artistic style," https://arxiv.org/pdf/1610.07629.pdf, Google Brain, Mountain View, CA, 2017.

[2] L.A. Gatys et al., "Image style transfer using convolutional neural networks," https://www.cv-foundation.org/openaccess/content_cvpr_2016/papers/Gatys_Image_Style_Transfer_CVPR_2016_paper.pdf, Centre for Integrative Neuroscience, University of Tubingen, Germany, 2016.

[3] H. Zhang, "Multi-style generative network for real-time transfer," https://arxiv.org/pdf/1703.06953.pdf, 2017.