PS3-27

Unseen Style Transfer Network

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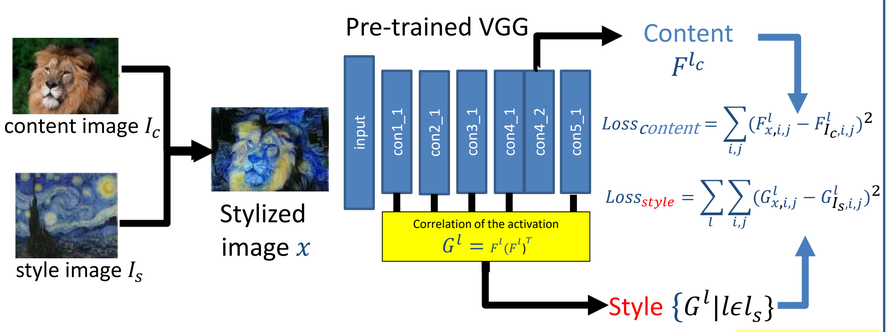
Project HP with online demos:
http:/foodcam.mobi/deepstylecam/

DeepStyleCam
bit.ly/deepstylecam

1. Introduction

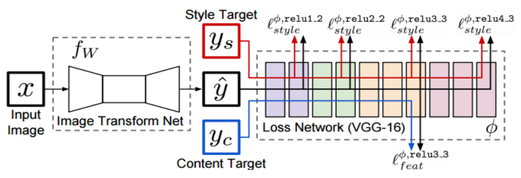
• **Neural artistic style transfer** by Gatys et al. (2015) [A]



– *Optimization-based method* ⇨ **time consuming** (1 min-)

• **Feed-forward fast style transfer network** by Johnson et al. (2016) [B]

– *train a feed-forward Conv-Deconv network with perceptual loss*
– *train only one fixed style*



⇨ **need to train an individual model for each style image**
e.g. ten styles ⇨ ten models

Multiple style feed-forward network is desirable !

[idea 1] Conditional fast style transfer network

⇨ **However, only trained styles can be transferred.**

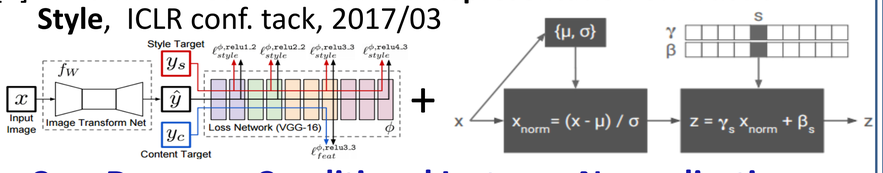
Unseen style transfer feed-forward network is better !

[idea 2] Unseen style transfer network
(Extension of a conditional fast style transfer net.)

2. Concurrent Works *(mini survey)*

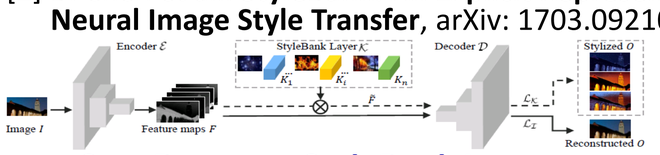
(A) Multiple Styles

[1] V. Dumoulin et al.: **A Learned Representation of Artistic Style**, ICLR conf. tack, 2017/03



ConvDeconv + Conditional Instance Normalization
(Train style-specific scale and shift parameters of all the IN layers)

[2] D. Chen et al.: **StyleBank: An Explicit Representation for Neural Image Style Transfer**, arXiv: 1703.09210, 2017/03.

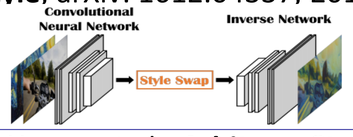


(Train style-specific conv. layers, and switch them)

ConvDeconv + StyleBank Layer

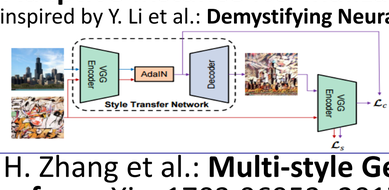
(B) Arbitrary Styles

[3] T. Q. Chen et al.: **Fast Patch-based Style Transfer of Arbitrary Style**, arXiv: 1612.04337, 2016/12.



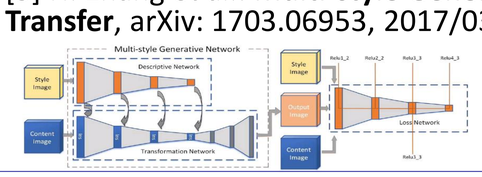
VGG16 (Enc.)
+ Style Swap
+ Inverse VGG16 (Dec.)
(modifying f-maps)

[4] X. Huang et al.: **Arbitrary Style Transfer in Real-time with Adaptive Instance Normalization**, ICLR WS, 2017/03.
(inspired by Y. Li et al.: **Demystifying Neural Style Transfer**, arXiv: 1701.01036, 2017.)



VGG16 (Enc.)
+ Adaptive IN
+ Inverse VGG16 (Dec.)

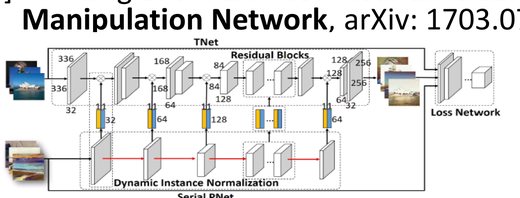
[5] H. Zhang et al.: **Multi-style Generative Network for Real-time Transfer**, arXiv: 1703.06953, 2017/03.



similar to ours

ConvDeconv
+ Style feature net (VGG16)
+ Integration (inspirarion) **Layer**

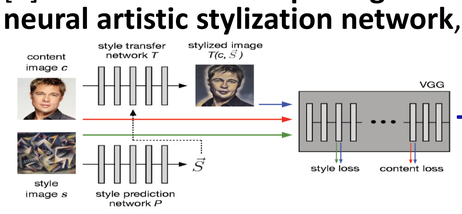
[6] H. Wang et al.: **ZM-Net: Real-time Zero-shot Image Manipulation Network**, arXiv: 1703.07255, 2017/03.



natural extension of [1]

ConvDeconv
+ Parameter net
+ Dynamic IN

[7] G. Ghiasi et al.: **Exploring the structure of a real-time, arbitrary neural artistic stylization network**, arXiv: 1705.06830, 2017/05.

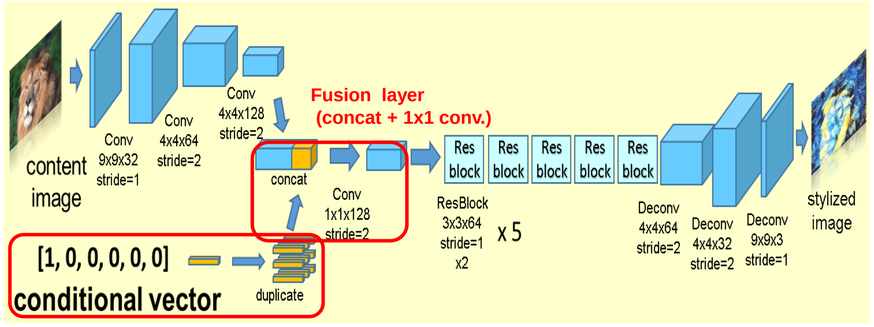


ConvDeconv
+ Style predict net
+ Dynamic IN

Same idea as [6] by authors of [1] (Google Brain team)

3. Conditional Fast Style Transfer

▪ ***Add a style condition input to ConvDeconv net.***
– Add a fusion layer and a style input
– Style input: one-hot conditional vector
e.g. style1 [1,0,0,0,…], style2: [0,1,0,0,…], style3: [0,0,1,0,…]….
– Base network: Johnson's ConvDeconv net [B]
Each layer has BN and ReLU except last one.

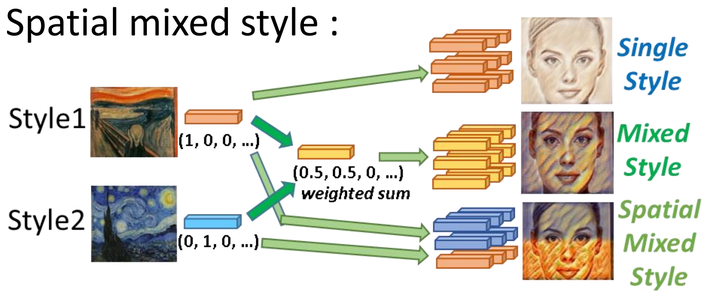


Conditional Fast Style Transfer Network

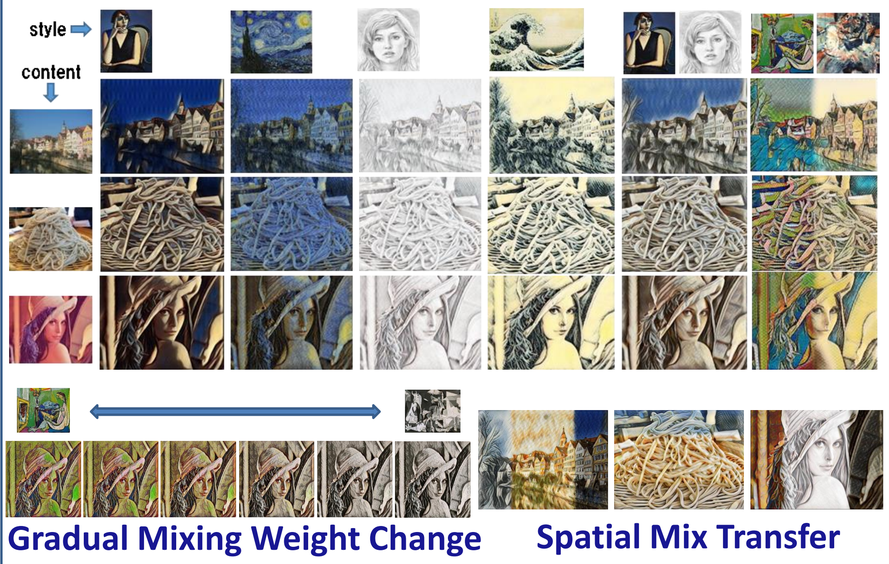
DeepStyleCam

▪ ***Training***
– Perceptual loss with VGG16
(the same way as Johnson's work [B])
content: conv3_3
style: conv1_2, c2_2, c3_3, c4_3
– Each mini batch : one content image
+ all the style images
(= multi-style version of Instance Normalization)

▪ ***Generating stylized images in three ways***
Input: content image + style condition vector
– Single style: one-hot vector [1,0,0,0,..] , [0,1,0,0,..]
– Mixed style: multiple-style-weighting
[1,1,1,…], [0.2, 0.1, 0.8,..]
– Spatial mixed style :

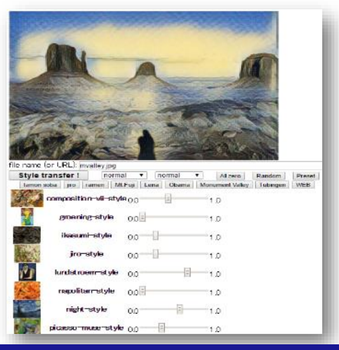


▪ **Results of cond. style transfer *with trained styles***



Gradual Mixing Weight Change **Spatial Mix Transfer**

Online Demo



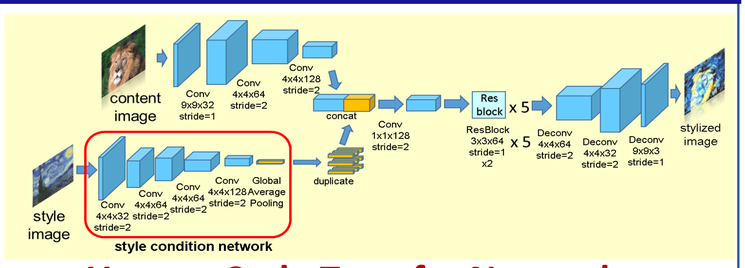
Conditional style transfer
http://bit.ly/mixstyle

Unseen style transfer
http://bit.ly/unseenstyle

4. Unseen Style Transfer

▪ ***Add a style condition network to the conditional FST network.***
– Confirmed that a real-value cond. is OK.
⇨ *Style condition vector can be generated by a CNN (not by hand)*
– Propose **a style condition network** which generates a style condition vector from a given style image directly.

Conditional Style Transfer + Style Network
⇨ **"Unseen style transfer network"**



Unseen Style Transfer Network
= Conditional Fast Style Transfer Network + Style Condition Network

▪ ***Training***
- End-to-end training with perceptual loss
- Each mini batch : one content image
+ randomly selected style images
from 50,000 style images (WikiArt)

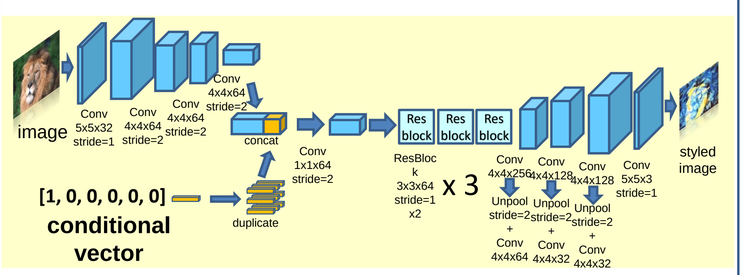
• ***Generating stylized images in three ways***
– the same way as a Conditional Fast Style Transfer Network

▪ **Results of unseen style transfer *with NOT-trained styles***

Qualitative comparison (single/multi/unseen)

5. Mobile Implementation

▪ Shrink the network for mobile devices.
- Add one down-conv. and one up-conv.
- Reduce the num of ResBlock from 5 to 3
⇨ **180ms (250x250), 250ms (350x350)**



Conditional Style Transfer Network for Mobile

DeepStyleCam

For iPhone 7/7+/SE
iPadPro

References

[A] L. A. Gatys et al.: Image style transfer using convolutional neural networks, CVPR, 2016.
(A Neural algorithm of artistic style, arXiv: 1508.06576, 2015)

[B] J. Johnson et al.: Perceptual Losses for Real-Time Style Transfer and Super-Resolution, ECCV, 2016.