


COMP4422

Painterly rendering methods for visual arts

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Project Structure

- Introduction to painterly rendering methods
 - Brush-stroke based painterly rendering
 - Flow-based line drawing
 - Style transfer (Neural style transfer)
- Experiment:
 - combining different painterly rendering methods together
 - Stroke based painterly rendering → Line drawing
 - Line drawing → Stroke based painterly rendering (Brush drawing)
 - Line drawing → Style transfer
 - Brush drawing → Style transfer
 - Edge-enhanced Style Transfer (Overlay line drawing on source image → Style transfer)
- Result
- Limitation and Future work

Brush-stroke base painterly rendering

- Mimic painting with brush strokes

Typical brush-stroke based painterly algorithm:

1. Create and divide a canvas into brush grids
2. Draw the grids with different sizes of brush(from large to small)
3. Each layer(brush size):
 - Compare the canvas color with reference image on each grid
 - If (Color difference > Threshold)
 - Create brush stroke with image color
 - Paint the canvas with the generated strokes

Example

- Painterly Rendering with Curved Brush Strokes of Multiple Sizes(Hertzmann,1998)



Source image



Output image

Flow-based Line-drawing

- Purpose: to generate a sketch for both simplicity and expressiveness

Typical line drawing algorithm:

1. Calculate edge tangent flow from gradient
2. Adjust the flow direction to reduce noise
3. Filter strong edges / generate strokes
4. Add texture (optional)

Example

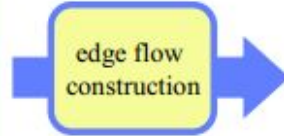
- Coherent Line Drawing (Kang et al., 2007)



Process Overview



(a) Input image



(b) Edge Tangent Flow



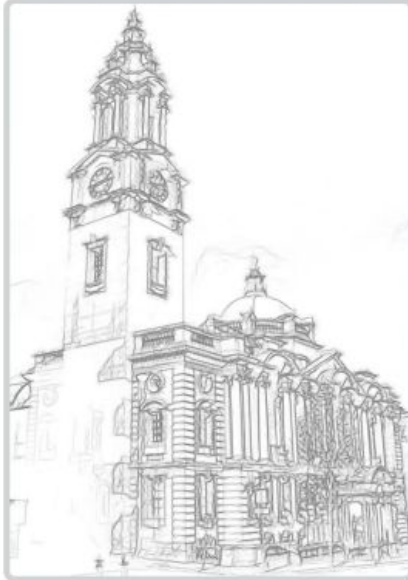
(c) Line drawing

Example

- Combining Sketch and Tone for Pencil Drawing Production (Lu et al., 2012)



(a) input image



(b) line drawing with strokes

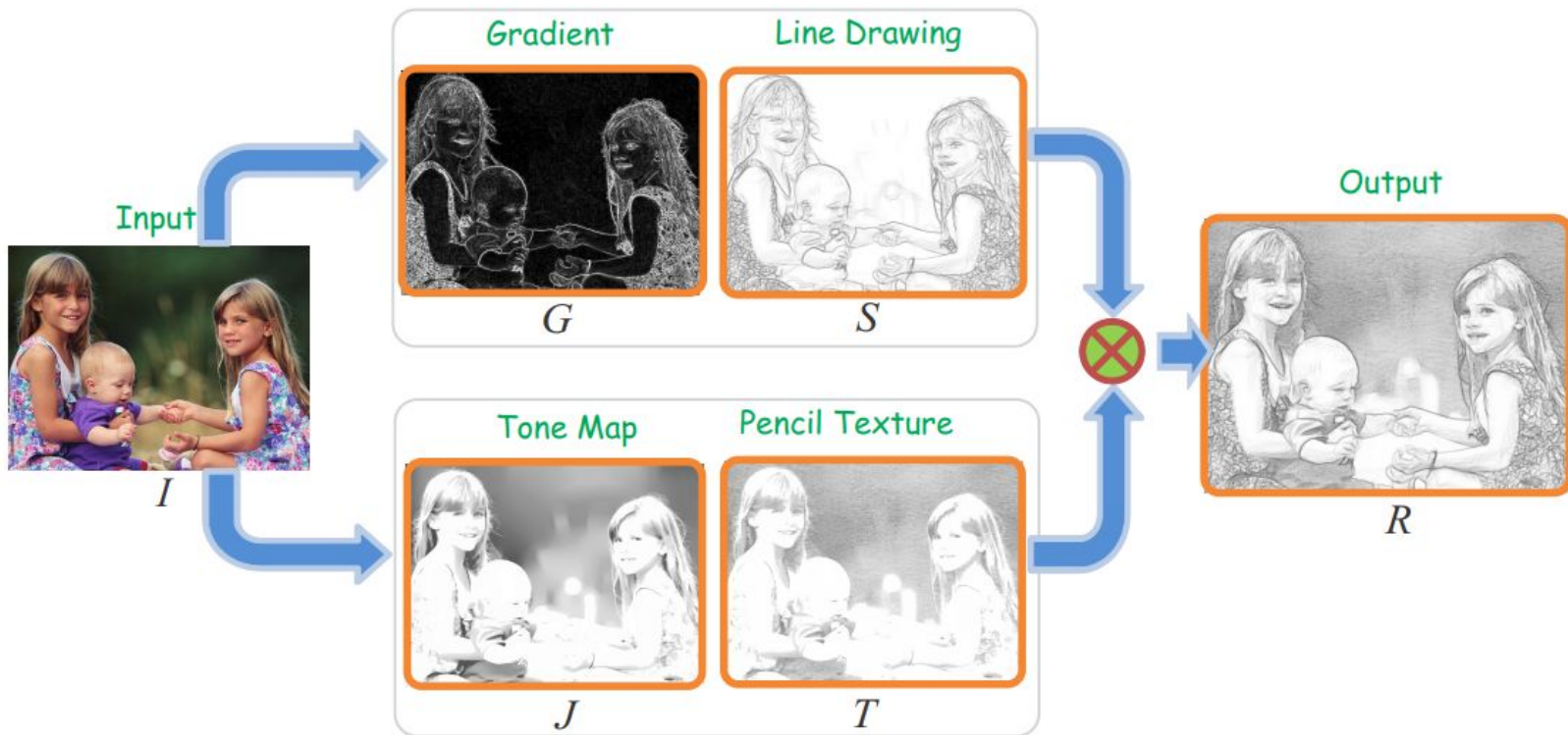


(c) tonal texture



(d) output

Process Overview



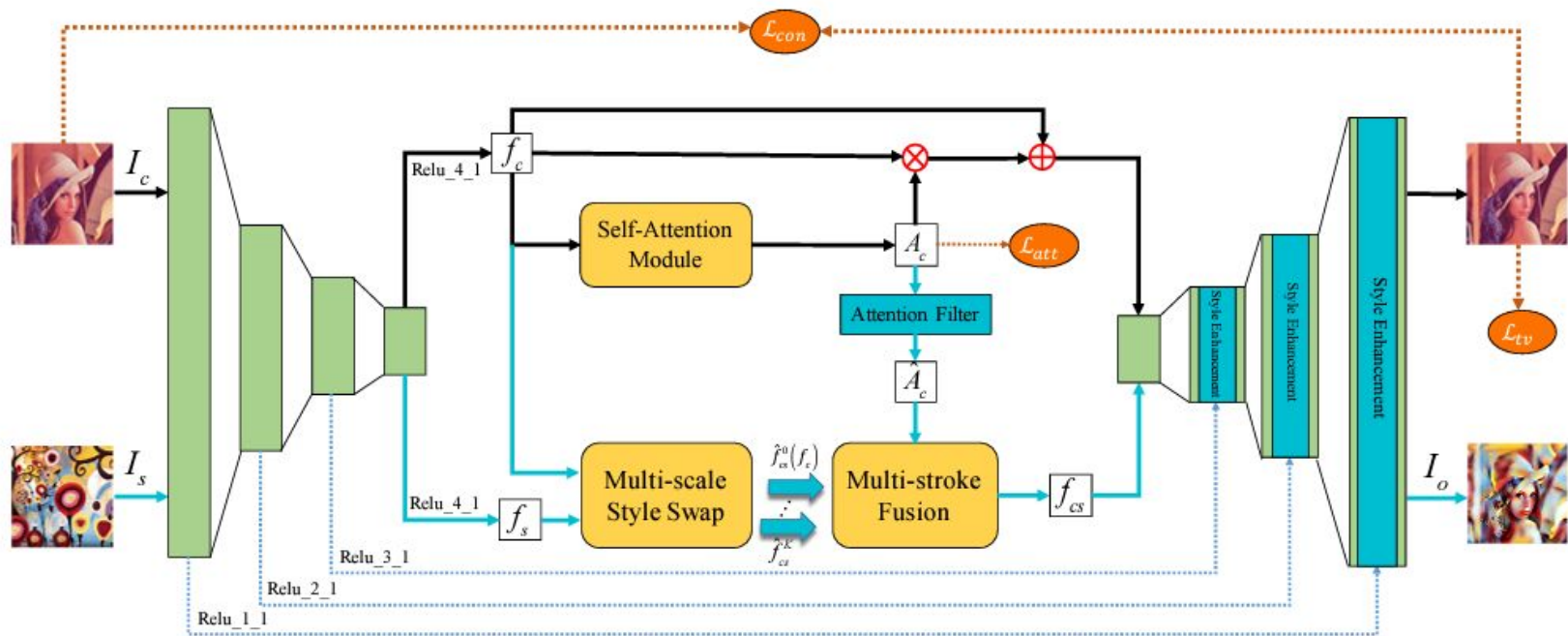
Style transfer (Neural style transfer)

- **Neural style transfer (NST)** refers to software algorithms that manipulate digital images, or videos, in order to adopt the appearance or visual style of another image.
- NST is an example of image stylization, a problem studied for over two decades within the field of non-photorealistic rendering.
- Publicly available software like Prisma and DeepArt successfully implemented NST.



DEEPAART.io

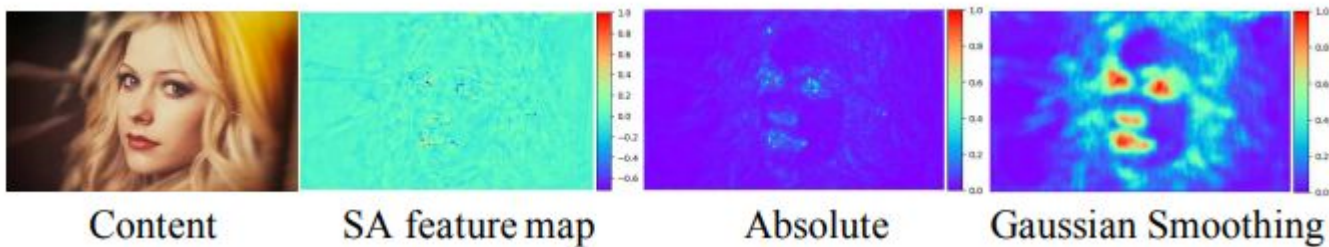
Case study: AAMS



Yao, Y., Ren, J., Xie, X., Liu, W., Liu, Y.-J., & Wang, J. (2019). Attention-aware Multi-stroke Style Transfer.

Self-attention module

- Learn the important properties of the input content picture
- Generate a self-attention feature map for content within the input content picture by indicating spatial region in the image
- Attention filter conducts Absolute and Gaussian smoothing transformation upon the self-attention feature map before fusion



Multi-scale style swap

- Synthesize features on the both input images with different size of strokes (Scaling coefficient K/input by user), which will be obtained and used in the next module
- Style-swap procedure between the content feature and style features simultaneously (swapping size of stroke as the algorithm tries to mimic the feature)



Figure 6. Stylized result via different stroke sizes.

Multi-stroke fusion

- Handle controllable blending
- Input content features and K-swapped stroke features
- The smoothing factor γ is used to control the smoothing degree for fusion
- Combining filtered self-attention feature map and all filtered features



Example

Style Image



Content Image



Experiment

Source Image

Line drawing

Brush-stroke based
painterly rendering

Brush painting

Source Image

Brush-stroke based
painterly rendering

Line drawing

Source Image

Brush painting

Neural style transfer

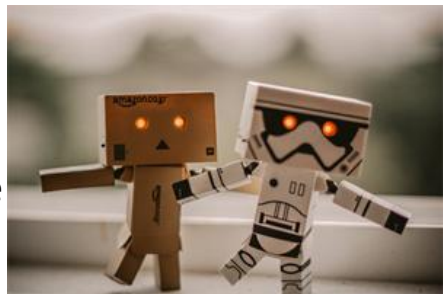
Source Image + Line drawing

Neural style transfer

Edge-enhanced
Neural style transfer

Result

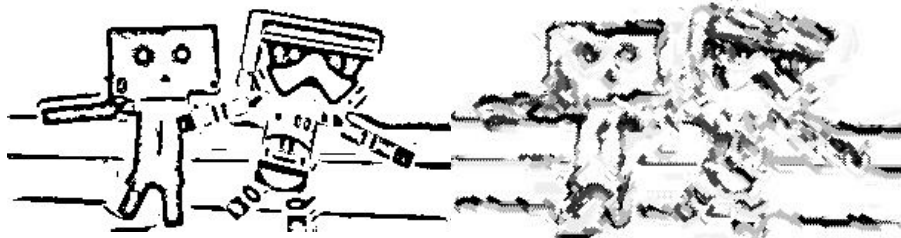
Content image



Brush-strokes



Line drawing



Line \rightarrow Brush
(Brush drawing)

Brush \rightarrow Line



Result

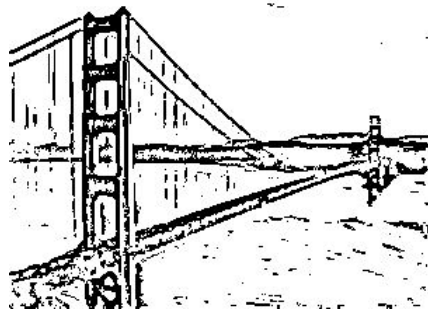
Content image



Brush-strokes



Line drawing



Line \rightarrow Brush
(Brush drawing)



Brush \rightarrow Line



Result

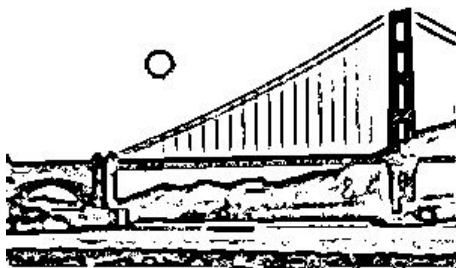
Content image



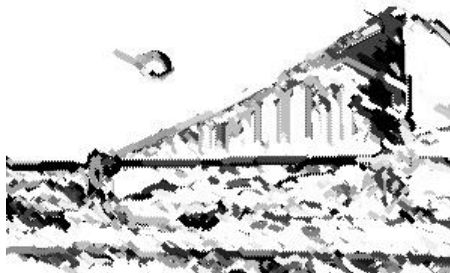
Brush-strokes



Line drawing



Line \rightarrow Brush
(Brush drawing)



Brush \rightarrow Line

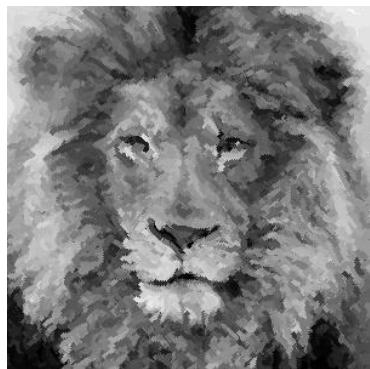


Result

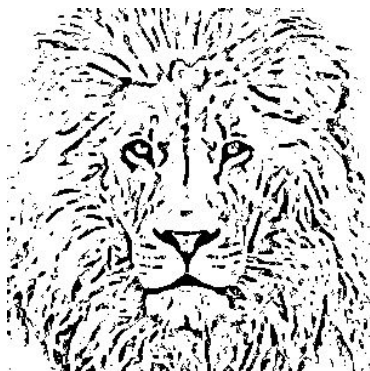
Content image



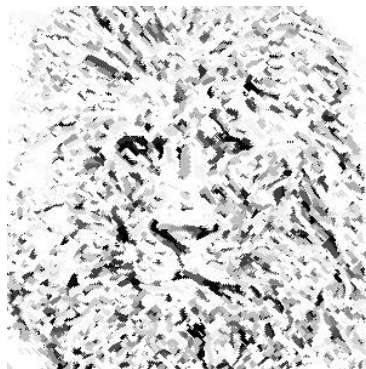
Brush-strokes



Line drawing



Line \rightarrow Brush
(Brush drawing)



Brush \rightarrow Line

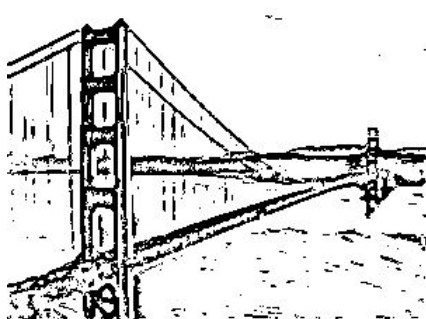


Result

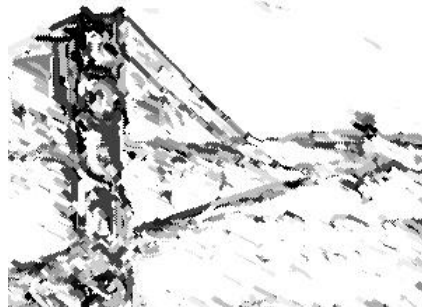
Input of AAMS
Original source image



Line drawing result



Brush drawing result



Edge-enhanced result



Output



Style image



Result

Input of AAMS

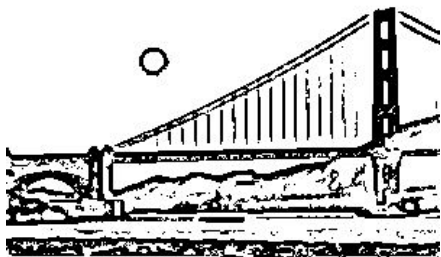
Original source image



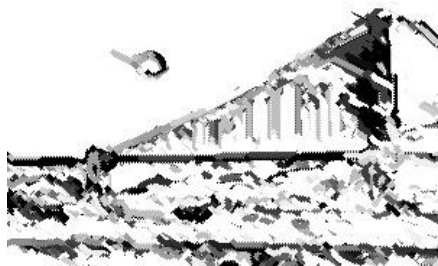
Output



Line drawing result



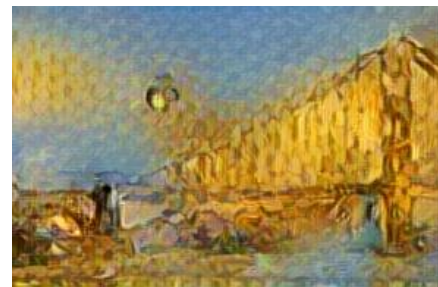
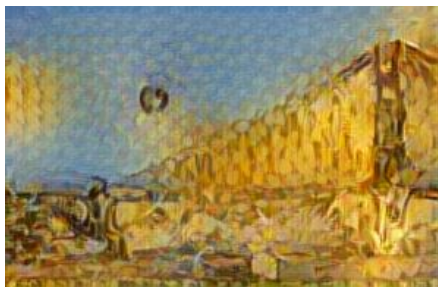
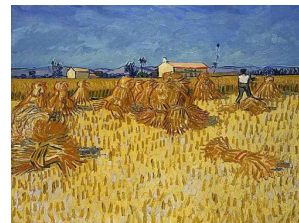
Brush drawing result



Edge-enhanced result



Style image



Result

Input of AAMS

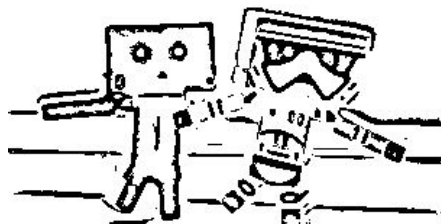
Original source image



Output



Line drawing result



Brush drawing result



Edge-enhanced result



Style image



Result

Input of AAMS

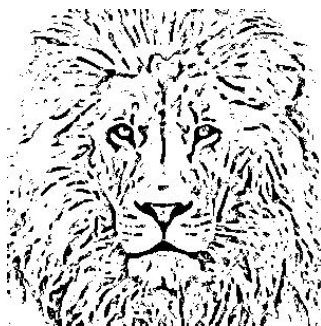
Original source image



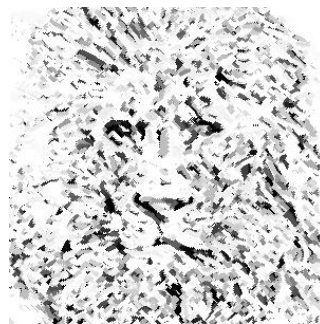
Output



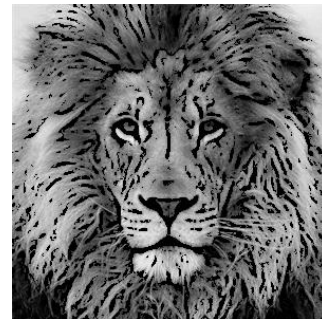
Line drawing result



Brush drawing result



Edge-enhanced result



Style image



Strength

Brush drawing

- Simulate the aesthetic effect of marker drawing
- Creates brush effects of marker
- Highlighting the edges

Edge-enhanced NST

- Improving the clarity of edges
- Emphasize the object while maintaining shadow information

Limitation

Brush drawing

- Losing fine details of the source image

Brush drawing + NST

- Losing color information of the original source picture
- Inability to present shadow
- Difficult to recognize the original scene
- Artifact

Brush stroke based Line drawing

- Distortion of line
- Losing details → Too abstract
- Difficult to recognize the image object

Edge-enhanced NST

- Poor performance in Pencil style transfer

Conclusion

- We proposed 4 novel painterly rendering methods that are inspired by the combination of different types of methods
- Brush drawing can be used to generate visually attractive paintings in the marker drawing style
- Brush-stroked based line drawing can be used to generate abstract paintings as the content is distorted and blurred out



Conclusion

- Brush drawing NST loses the content and colour intensity of the original image
- Edge-enhanced Style Transfer can improve clarity and emphasize on the main object in the original image



Future work

Brush drawing

- Use smoother and clearer line drawing algorithms
- Use different brush radius in different areas
- Increase the variety of brush effect: e.g. ink effect

Edge-enhanced NST

- Use colored line drawing
- Saliency map (focus on properties like color, orientation and intensity)
- Real-time video processing

Q & A