

# Procedural Generation of Pencil Drawings

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## Introduction

Our work deals with the problem of turning an image into a pencil drawing. Similar methods, which are concerned with converting an image into a painting, animated cartoon or technical illustration are part of the Non-photorealistic rendering area. NPR has wide application in the movie industry, game development, architectural illustrations or scientific visualizations.

The aim of the thesis was to implement a procedural method which transfers a natural image into a pencil drawing-like style.

Since neural networks are frequently questioned, as to whether or not they are better than procedural methods for artistic style reproduction, this work presents also a detailed comparison of both of these approaches.

## Algorithm description

From all of the well-known methods for image transfer into a pencil drawing we used algorithm proposed by Lu et al. [2012]. Their algorithm consists of two main steps: pencil stroke generation and pencil tone drawing. Their effect complement each other.

Specifically, stroke drawing aims at expressing general structures of the scene, while the tone drawing focuses more on shapes, shadow and shading than on the use of lines. These two steps are processed separately.



$$p_1(v) = \begin{cases} \frac{1}{\sigma_b} e^{-\frac{1-v}{\sigma_b}} & \text{if } v \leq 1. \\ 0 & \text{otherwise.} \end{cases}$$

$$S = \sum_{i=1}^8 (L_i * C_i)$$

$$p_2(v) = \begin{cases} \frac{1}{\mu_b - \mu_a} & \text{if } \mu_a \leq v \leq \mu_b. \\ 0 & \text{otherwise.} \end{cases}$$

$$\beta^* = \arg \min_{\beta} \|\beta \ln P - \ln J\|_2^2 + \lambda \|\nabla \beta\|_2^2$$

$$p_3(v) = \frac{1}{\sqrt{2\pi}\sigma_d} e^{-\frac{(v-\mu_d)^2}{2\sigma_d^2}}$$

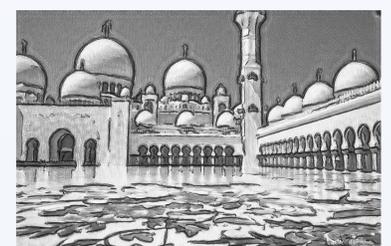
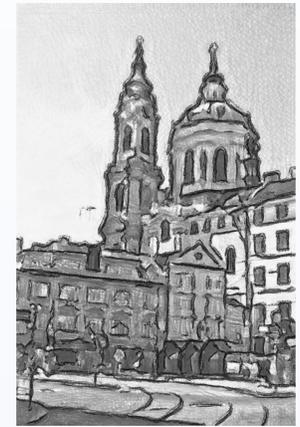
$$p(v) = \frac{1}{Z} \sum_{i=1}^3 w_i p_i(v)$$

## References

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- Yijun Li, Chen Fang, Aaron Hertzmann, Eli Shechtman, and Ming-Hsuan Yang. Im2Pencil: Controllable Pencil Illustration from Photographs. page arXiv:1903.08682, Mar 2019
- Leon A. Gatys, Alexander S. Ecker, and Matthias Bethge. A Neural Algorithm of Artistic Style. arXiv e-prints, art. arXiv:1508.06576, Aug 2015

## Results

Below can be seen the results of our implementation (left side) and the Im2Pencil project (right side) which is based on Convolutional Neural Networks:



## Conclusion

As we observe the results there can be seen some differences between these two projects. Im2Pencil produces in some cases noises and it does not seem to us that CNNs offer some huge advance against our implementation and procedural methods in general.

On the other hand, there can be seen that textures of Im2Pencil fit at surfaces much more accurately than in our project. Still it is really questionable, if CNNs are better to use for image to pencil drawing transfer. Only thing we can say that the transfer with CNNs is still quite a new approach and at our opinion CNNs still do not have such a pleasurable results in image to pencil drawing transfer.

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