

Sketch Colorization

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ABSTRACT: Sketch Colorization is a field that has magnificent demand in the market. As compared to the photo colorization, Sketch colorization is more challenging and it may not have proper texture. This project consists of a semi-automatic learning based framework to colorize a sketch containing proper color, gradients as well as texture. This framework consists of two stages out of which first is the Drafting stage which guesses color required region and obtain a color draft by splashing various rich variety of colors over the sketch. In the second stage, it tries to fix and refine the result by detecting artifacts and unnatural colors. This model removes water-color blurring and deformity of color. Sketch colorization is performed by using gradient approach.

KEYWORDS: Sketch colorization, Gradient approach, Sigma factor, Entropy, Machine Learning, Image Processing, Rendering, Drafting.

I. INTRODUCTION

During the art creation coloring is considered a time-consuming process. To create a proper colored sketch, it requires proper color composition and shading. A semi-automatic colorization is beneficial to those who are professionals in this field as well as the novice. The goal of this project is to add a gray image such that colorized image is perceptually meaningful and usually appealing.

Pattern recognition is the process of recognizing patterns by using machine learning algorithm. Pattern recognition can be defined as the classification of data based on knowledge already gained or on statistical information extracted from patterns and/or their representation. One of the important aspects of the pattern recognition is its application potential. Face identification is one of the crucial issues, especially for law enforcement. Police department utilizes this technology to search for suspects on the run and missing people. Unfortunately, the photos of the suspects are not always available. The sketches of the suspects drawn by artists based on the information of eyewitnesses are used as substitutes of photos to recognize and identify suspects. However, the direct comparison of sketches and photos is difficult to do because of the significant difference between those images. Image colorization assigns a color to each pixel of a target gray scale image. This framework consists of two stages out of which first is the Drafting stage which guesses color required region and obtain a color draft by splashing various rich variety of colors over the sketch. In the second stage, it tries to fix and refine the result by detecting artifacts and unnatural colors. This model removes water-color blurring and deformity of color. Here, we are implementing a semi-automatic method that allows users to precisely control over colorization on real-world sketches. No extensive input is required from the users. To achieve this, we borrow the idea of drafting from the artist painting practices. Professional artists like to make drafts before the detail painting on sketches. For this we are using entropy and sigma factor concept. By finding the sigma values of any incomplete region, the region will be completed by drawing an imaginary line based on the obtained sigma values. Entropy will be used for coloring purpose. Entropy basically means a sudden change. By comparing the original and suggested colored image by the user, a new final image will be displayed to the user by coloring the whole image.

Sketch Coloring is the most important but time-consuming process. The system faces major challenges like color inconsistency and saturation. This tool will be helpful for those who are facing this problem. Achieving the task is not trivial as it requires both the sense of aesthetics and the experience in drawing. Even professionals may spend a significant amount of time and effort in producing the right color composition, fine texture and shading details. An automatic or semi-automatic colorization system can greatly benefit the community. With the system, novice artists can learn how to color

and texture, while experienced artists can try out different color compositions and save much time on the tedious colorization.

Coloring is one of the most important but time-consuming steps during art-creation. Creating an impressive and expressive painting requires a nice color composition and also proper usage of texture and shading. Achieving the task is not trivial, as it requires both the sense of aesthetics and the experience in drawing. Even professionals may spend a significant amount of time and effort in producing the right color composition and fine texture and shading details.

II. LITERATURE SURVEY

In paper “**Two-stage Sketch Colorization**” [1] author proposes a semi-automatic learning-based framework to colorize sketches with proper color. It also colorize with texture and gradient. There are two stages in this interface. In the first is known as drafting stage. The main function of drafting stage is to splash variety of colors over the sketch for obtaining the color draft image. Second stage is known as refinement stage that removes those colors which are not natural and refines the final output.



Fig. 1: Two-Stages of Colorization[1]

In paper titled “**Unsupervised Pixel-Level Domain Adaptation with Generative Adversarial Networks**” [2] author presents a state-of-the-art method for performing unsupervised domain adaptation in which PixelDA model outperforms previous work on a set of unsupervised domain adaptation scenarios, and in the case of the challenging “Synthetic Cropped Linemod to Cropped Linemod” scenario, model more than halves the error for pose estimation compared to the previous best result.

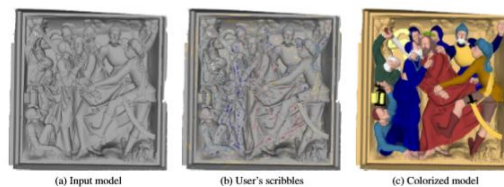


Fig. 2: Transformation of Color[2]

In paper titled “**Fully automatic image colorization based on Convolutional Neural Network**” [3] author introduces a novel, fully automatic colorization algorithm based on VGG-16 and a two-stage CNN. VGG-16 provided multiple discriminative, semantic information which was used to train a two-stage CNN architecture without pooling layers. The two-stage architecture proved us a richer representation by adding information from a preceding layer.

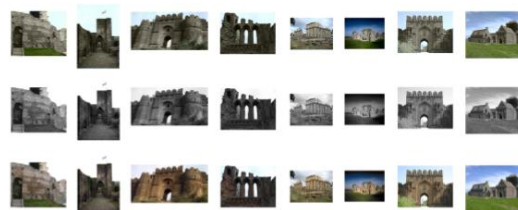


Fig. 3: Colorized results: In the first row the output of the proposed algorithm can be seen. The second row presents the grayscale input images. In the third row the ground-truth colorful images can be seen[3]

In paper “Automatic Manga Colorization with Color Style by Generative Adversarial Nets” [4] proposes a new method for coloring a gray scale image which can be done by transformation of color from a example image. This method is independent of decisions given by pixel. For this a new plan was developed. For obtaining pixels having high level there must be an attempt to account.

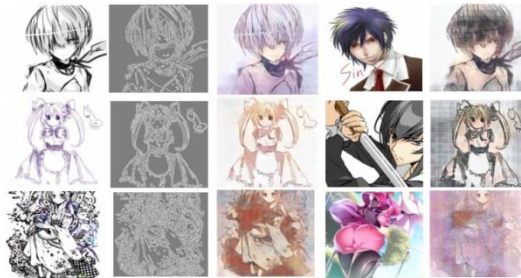


Fig. 4: Images repainted by color style[4]

In paper titled “Two-stage Color Ink Painting Style Transfer via Convolution Neural Network” [5] author proposes a two-stage method to transfer flower photo to color ink painting. Color ink painting is a fusion of freehand brushwork and realism. Traditional image processing methods lead to a complex generative mapping, limiting their applications. Common one-stage neural style transfer methods, mostly based on CNN, may not be suitable for the task. Because lines tend to be lost by CNN, which fails to construct line sense in stylized images.



Fig. 5: Color ink Paintings[5]

In paper titled “Two-Stage Image Colorization Based on Salient Contours” [6] author proposed a novel method for image colorization that minimizes the need of user-guidance and instead requires only sparse color hints in inner areas of distinct image regions. By incorporating contour’s information and dividing the image in two differently treated categories of areas, we produce an intermediate enhanced color indication image.

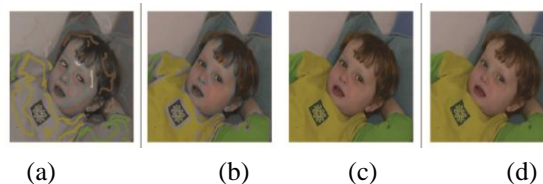


Fig. 6: Color stages (a)User marked image (b)1st stage colorization (c)2nd stage colorization (d)Colorized Result[6]

Sketch colorization is important but often skipped when drawing illustrations due to its time consuming and monotonous nature of the procedure. However, adding colors to illustrations almost always enhances the drawing, and it is a shame to having to skip such an important step. In paper [7], Yuki Inoue proposed a neural network based method that automates the illustration coloring process. More specifically, we implement models inspired by recent successes in photo colorization problem, which takes in black and white images as the input, and apply them to sketch colorization problem. We find that

photo colorization problem and sketch colorization problem share many characteristics, such as classification models outperforming regression models, and allow models to execute the task at a very high level.



Fig. 7: Example Dataset Image[7]

The main aim of paper [8] is to give an overall idea about how a gray scale image can be converted into a colorful image with the colorization problem and how it can further be used to color a video. To achieve artifact-free quality this generally requires manual reconciliation and therefore considered as a very strenuous problem. A cautious selection of colorful allusion images is generally required for the process. Far from the preceding methods, this paper aims at a high grade fully unmanned colorization method and also attempts to apply this concept to images obtained from video sequences. The recent achievements in deep learning approaches is the inspiration behind this paper, that focuses on reformulation of the problem of colorization so as we can employ the deep learning approaches promptly and that this technique can be applied on to the videos. Our proposed method is a fully automated process.

III. PROPOSED SYSTEM

Drawing is a two step process: Firstly, we draw the outline of the objects and then add colors. Of these two drawing steps, many can agree that making the sketch requires more creativity and carries more importance. However, the colorization step is not something to be scoffed off either. Colorization immensely enriches the quality of the sketches, and makes them more memorable. Unfortunately, colorization step is often skipped due to its time-consuming and monotonous nature. Input image is sketch from dataset. Segmentation is performed to differentiate different parts of image. According to pattern image is sorted out as per result from segmentation. Splash color and after refinement result seen.

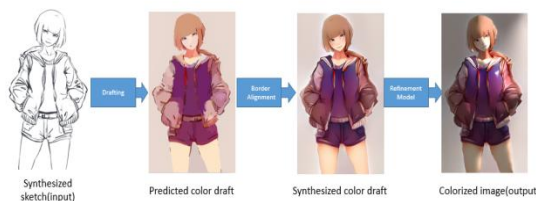


Fig. 8: Architecture of Proposed System

Sketch or line art colorization is a research field with significant market demand. Different from photo colorization which strongly relies on texture information, sketch colorization is more challenging as sketches may not have texture. Even worse, color, texture, and gradient have to be generated from the abstract sketch lines. In this paper, we propose a semi-automatic learning-based framework to colorize sketches with proper color, texture as well as gradient. Our framework consists of two stages. In the first drafting stage, our model guesses color regions and splashes a rich variety of colors over the sketch to obtain a color draft. In the second refinement stage, it detects the unnatural colors and artifacts, and try to fix and refine the result. Comparing to existing approaches, this two-stage design effectively divides the complex colorization task into two simpler and goal-clearer subtasks. This eases the learning and raises the quality of colorization. Our model resolves the artifacts such as water-color blurring, color distortion, and dull textures.

IV. RESULT

This interface colorizes an input sketch image in two different methods. First one is automatic and second is manual sketch colorization. In automatic sketch colorization, system colorizes the image automatically by considering its own color combinations. It also suggests more than one color combinations for a single sketch image. In manual, it colorizes the image according to the colors suggested by the user. In these two different ways, the user gets final output.

Manual Colorization:

Actual Expected Value = 10

Image 1	Stud 1	Stud 2	Stud 3	Stud 4
Trial 1	9.1	9.4	9.9	9.9
Trial 2	9.8	9.6	9.7	9.7
Trial 3	9.5	9.1	9.2	9.6
Trial 4	10	8.9	9.4	10
Average	9.6	9.25	9.55	9.8
% Error	4%	7.5%	4.5%	2%
% Accuracy	96%	92.5%	95.5%	98%
Avg – Low Value	0.5	0.35	0.35	0.2
Avg – High Value	0.4	0.35	0.35	0.2

Average Accuracy: 95.5%

Precision Value: 0.2

Manual Colorization:

Actual Expected Value = 10

Image 1	Stud 1	Stud 2	Stud 3	Stud 4
Trial 1	6.8	6.6	7.7	6.4
Trial 2	7.2	7.4	7.1	6.9
Trial 3	6.7	6.9	7.3	7.4
Trial 4	7.8	7.5	6.8	7.9
Average	7.12	7.1	7.22	6.95
% Error	28.8%	29%	27.8%	30.5%
% Accuracy	71.2%	71%	72.2%	69.5%
Avg – Low Value	0.4	0.5	0.4	0.5
Avg – High Value	0.6	0.4	0.4	0.4

Average Accuracy: 70.97%

Precision Value: 0.4

V. CONCLUSION

Here, we introduce a two-stage learning-based framework for sketch colorization. The two-stage effectively breaks down the complex colorization into two relatively simpler two-stages, drafting and refinement. This both reduces the learning difficulty and raises the quality of the final colorization results. Our colorization system and results achieve the state-of-the-art user experience and visual quality. The proposed refinement model can work independently as a color refinement tool to fix/refine the colorization results of other colorization models. We believe this drafting & refinement approach can inspire further study.

REFERENCES

- [1] Lvmin Zhang, Chengze Li, Tien-Tsin Wong, Yi JiChunping Liu, “Two-Stage sketch colorization” ACM Transactions on Graphics (SIGGRAPH Asia 2018 issue), Vol. 37, No. 6, November 2018, pp. 261:1-261:14.
- [2] KonstantinosBousmalis, Nathan Silberman, David Dohan, DumitruErhan, and Dilip Krishna, “Unsupervised Pixel-Level Domain Adaptation with Generative Adversarial Networks”, CVPR (2017).
- [3] DomonkosVarga, TamasSziranyi, “Fully automatic image colorization based on Convolutional Neural Network” 2016.
- [4] Kataoka, Y., Matsubara, T., &Uehara, K, “Automatic manga colorization with color style by generative adversarial nets”, 2017.
- [5] ChengyuZheng, Yuan Zhang, “Two-stage Color Ink Painting Style Transfer via Convolution Neural Network”, 2018 15th International Symposium on Pervasive Systems, Algorithms and Networks.
- [6] N. Anagnostopoulos, C. Iakovidou, A. Amanatiadis, Y. Boutalis and S. A. Chatzichristofis, “Two-Staged Image Colorization Based on Salient Contours”, 2014 IEEE International Conference on Imaging Systems and Techniques (IST) Proceedings.
- [7] CS231N Final Project Line Drawing Colorization Yuki Inoue.