AUTHORING TOOL DESIGN DOCUMENT OUTLINE

TITLE: Stylit
Developers: Li Zheng, Keyi Yu

PROJECT SUMMARY

Movies, games and advertisements require a bunch of artists and designers to create virtual characters and scenes. Before the development of computer graphics technology, artists can only do these works with hand drawing. Currently, artists can improve the work efficiency with the help of computer-aided design tools, which make movies and games with complex scenes and high-poly models possible. Realistic rendering technologies have been widely used. However, non-realistic rendering technologies like stylizing synthetic don't have many mature applications.

Our authoring tool is to give 3D models hand-crafted artistic appearances. The target audiences are artists, animators and game designers, especially those work on independent games and animations. Pursuing of realistic rendering of movies and games can meet the problem of homogenization. Stylized rendering can help movies and games stand out from others. Traditionally, to create a non-realistic scene, the artists need to make specific textures for the models, which is a great cost for independent developers. Our authoring tool can significantly reduce the workload of artists and developers. They just need to provide an exemplar painting on a "sphere on the table" scene. For the test version of the authoring tool, we will provide some sample styles. Then, for a more complex target scene with a similar lighting environment, the tool computes the light propagation and uses it to guide the synthesis. The target scene will exhibit a similar visual style to the exemplar.

We plan to develop the authoring tool as a Maya Plugin. It is based on the paper *Stylit: illumination-guided example-based stylization of 3d renderings* [Fiˇser et al. 2016]. It combines the Light Path Expressions (LPEs) with image analogies to implement style synthesization. We will develop a Cuda test app to start, then develop C++ plugin. Next step is strictly MEL or Python scripting. Finally, C++ and Maya will be deeply integrated.

1. AUTHORING TOOL DESIGN

1.1. Significance of Problem or Production/Development Need

Physical based rendering technology has produced many realistic games and movies. To distinguish a game or movies from others, the producer pays more attention to the stylization. So a tool that can efficiently synthesize the design of artists and 3D models is required. We plan to develop an authoring tool that can interactively reflect the designed visual effect to the model. the tool will provide an artistic visual effect for the digital products with very lost cost, especially suitable for independent developers.

1.2. Technology

The paper we choose is *Stylit: illumination-guided example-based stylization of 3d renderings* [Fiˇser et al. 2016]. It proposes a stylization technology combining Light Path Expressions (LPEs) and image analogies.

LPE: It uses a three-pass, bidirectional ray tracing algorithm that traces rays from both the lights and the eye. 1) The "size pass" records visibility information on diffuse surfaces; 2) the "light pass" progressively traces rays from lights and bright surfaces to deposit photons on diffuse surfaces to construct the radiosity textures; 3) and the "eye pass" traces rays from the eye, collecting light from diffuse surfaces. One of its uses is to separate the various illumination effects into distinct buffers for the purposes of filtering or in order to use a different rendering algorithm for each.

Image Analogies: A pair of images serves as an exemplar. For each pixel in the target, the algorithm finds the best corresponding location in the unfiltered source and transfers the look from the filtered counterpart.

We choose this paper because it comprehensively reviews the previous stylization technologies and innovatively takes advantage of the light propagation to improve the stylization performance.

1.3. Design Goals

Describe how your authoring tool will address the problem or need

1.3.1 Target Audience.

Artists, animators and game designers can use this tool to interactively design the visual effects of their works. It's especially useful for independent game and movie producers.

1.3.2 User goals and objectives

Users can use this tool to give the 3D models a visual effect corresponding to the exemplar they provide.

1.3.3 Tool features and functionality

The tool provides several visual effect samples that can be used to render user provided models. Also, users can use the exemplar they designed.

1.3.4 Tool input and output

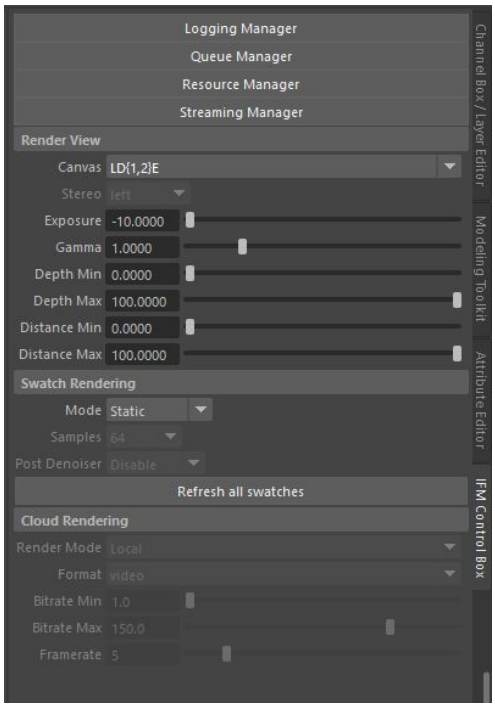
"sphere on the table" exemplars

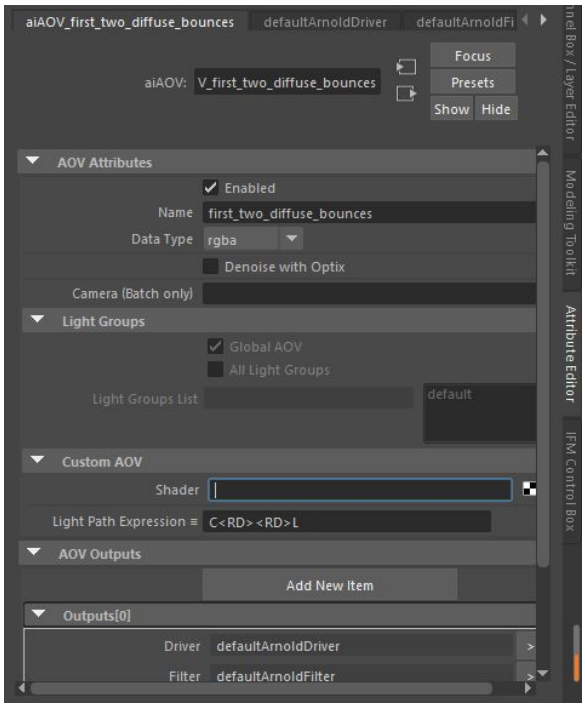
Input: The user should provide the model they want to render. It's better to put the model in our provided lighting environment, which will have the best performance. Alos, the users need to provide a "sphere on the table" exemplar, as shown in the figure above. We also have preset exemplars. For the test version, the users should provide four LEP images for rendered models. Users can achieve them from the Arnold or Iray renderer. The images should have JPG or PNG format.

Output: For the test version, the output will be a stylized image with JPG or PNG format. The images can be downloaded to the folder and displayed in Maya's renderView as well. Ideally, we want to get an real-time and interactive output from a renderer like Arnold or Iray.

1.4. User Interface

1.4.1 GUI Components and Layout



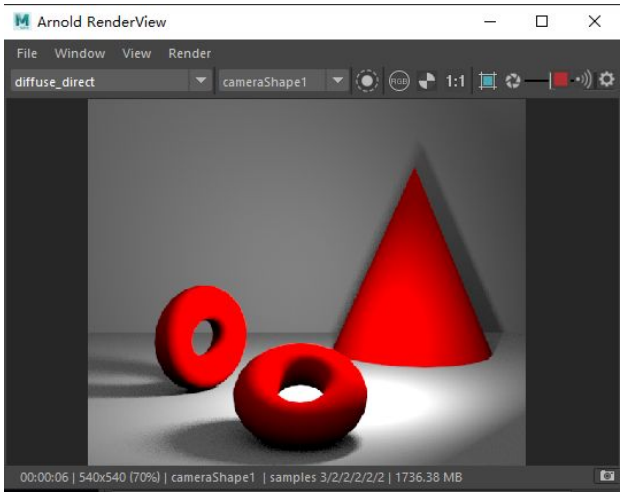


Iray IFM Control Box

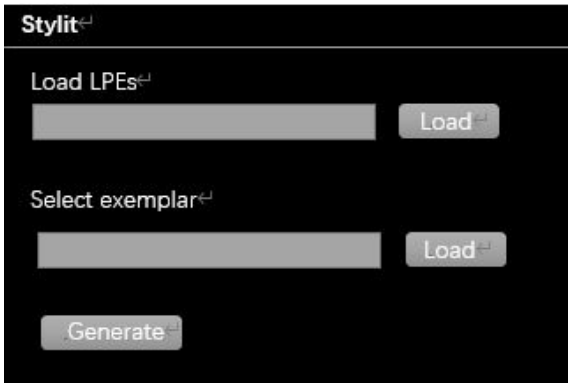
Arnold AOV Attribute Editor

Users can use Iray or Arnold to set the LPEs. Maya installs the Arnold render in default. If you want to use the Iray plugin, it can be downloaded from https://www.irayplugins.com/iray-for-maya/.
The LPEs can be set in Render settings. They are a little different for Arnold and Iray. Please refer to

https://docs.arnoldrenderer.com/display/A5ARP/Light+Path+Expression+AOVs and https://raytracing-docs.nvidia.com/iray/manual/index.html#reference#light-path-expressions.



Then you can save images in JPG or PNG format from the render view of Maya or Arnold.

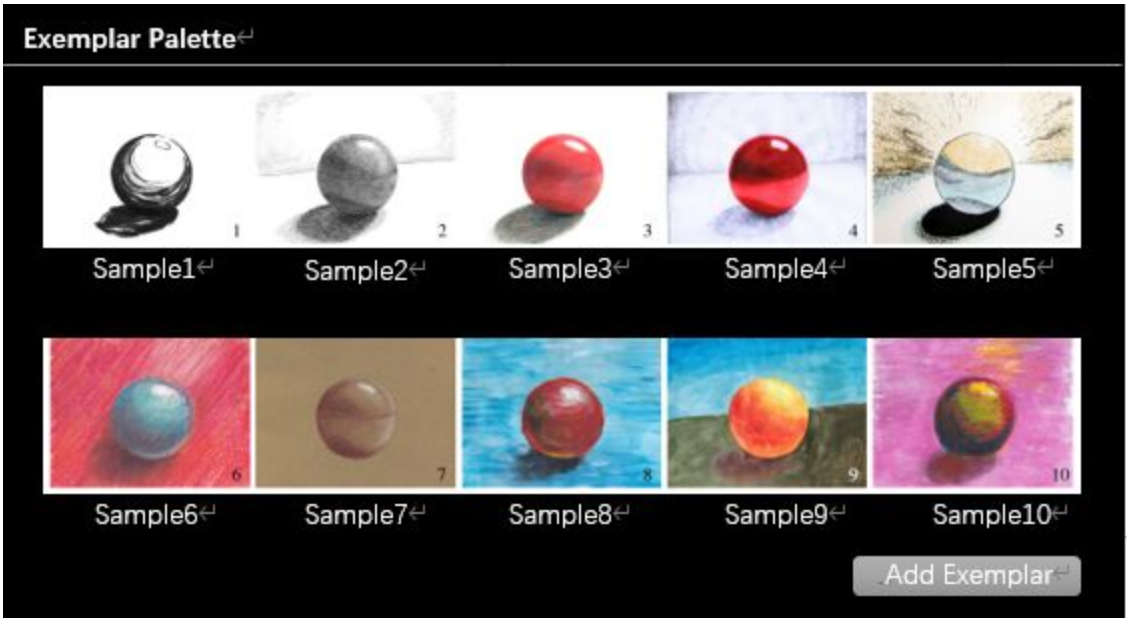


This is the **Stylit** GUI, it is the main window of the authoring tool. Users can open it from Maya's menu.

Load LPEs: For the test version, the user should provide four light path expressions of the rendering target, including direct diffuse, direct specular, first two diffuse bounces and diffuse interreflection. they can be achieved from renderers like Arnold and Iray.

Select exemplar: the user can load an exemplar from the **Exemplar Palette**.

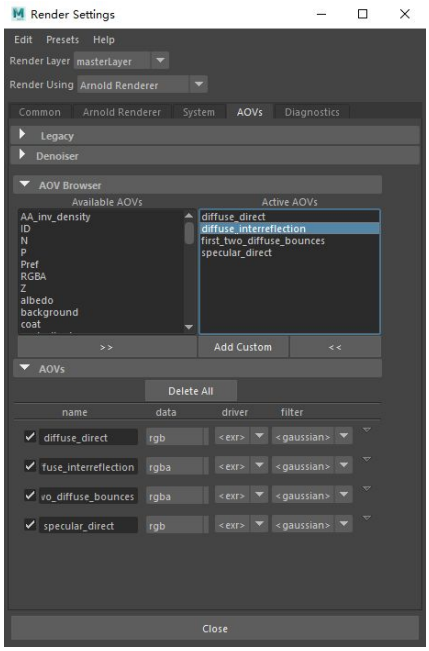
Generate: Generate the stylized result.



This is the **Exemplar Palette** GUI. It can be opened from the **Stylit** GUI. Double click an image, it will be loaded as an exemplar. Uses can also load their custom exemplar by clicking on the **Add Exemplar** button.

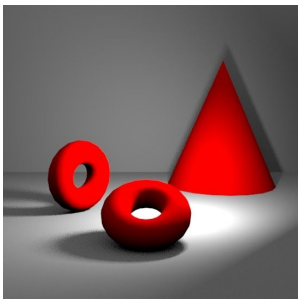
1.4.2 User Tasks

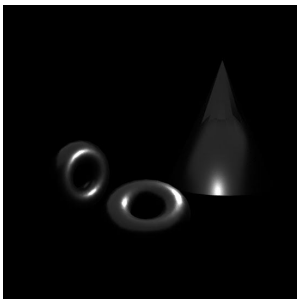
The user needs to draw on the provided “ball on the tabe” scene, where the highlight and shadow areas are outlined. Also, they need some basic knowledge about renderers (Arnold, Iray, etc.) and be able to generate LPE images with them. Take Arnold as an example, the user should follow these steps:

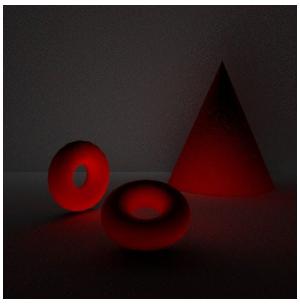


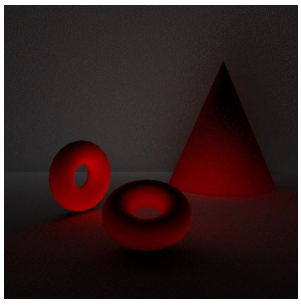
1. Add AOVs in Render Setting. You can select diffuse_direct and specular_direct AOV from available AOVs. Then add another two custom AOVS.

2. Type in the light path expression. For Anold, the first two diffuse bounces expression is *C<RD><RD>L*. The interreflection expression is *C<RD><RD>.*L*. For Iray, they should be *LD{1,2}E* and *L.*DDE*. Direct diffuse is *LDE*. Direct specular is *LSE*.


Direct Diffuse

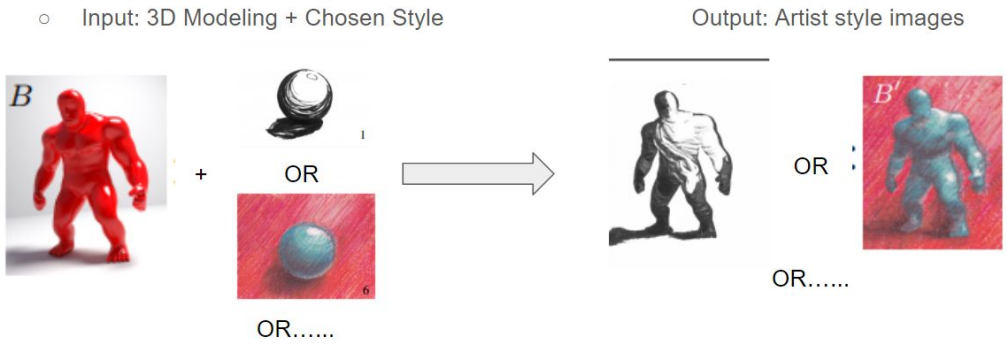

Direct Specular


first two diffuse bounces


interreflection

3. Save four LPE images in JPG or PNG format from the render view.

1.4.3 Work Flow



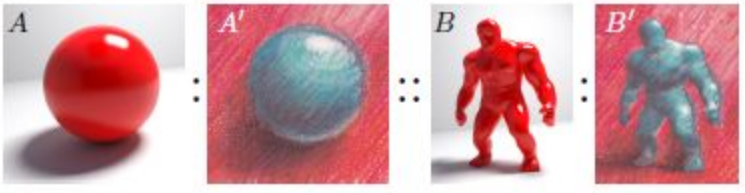
1. Generate four LPEs, including direct diffuse, direct specular, first two diffuse bounces and diffuse interreflection, with a renderder like Arnold or Iray.
2. Select an exemplar from file or the preset samples.
3. Click the Generate button.

   The first step is just for a test version. Ideally, this step will be integrated to our plugin with Iray API. Currently, we haven't dive into the API, so this step is put here just in case.

2. AUTHORING TOOL DEVELOPMENT

2.1. Technical Approach

2.1.1 Algorithm Details



Given three multi-channel images A (exemplar scene rendered with LPE channels), A' (stylized exemplar aligned to the exemplar scene), and B (target scene rendered with LPE channels). The authoring tool is to synthesize a new target image B' such that A : A' :: B : B'.

For each resolution level and each pixel q ∈ B' in scan-line order, a best matching pixel p is found in the source A' such that

$$E(\boldsymbol{A}, \boldsymbol{B}, p, q, \mu) = \| A'(p) - b'(q) \|^2 + \mu \| A(p) - b(q) \|^2 \quad (1)$$

is minimized. Here A = {A, A'}, B = {B, B'}, and is a weight that controls the influence of guidance. For any image I, we use I(p) to denote a feature vector at a pixel p. The vector I(p) is a concatenation of all pixels in a small square patch of width w centered at the pixel p, where each pixel can have multiple feature channels, containing colors of the full rendered image (RGB) and four LPE channels (each stored as a RGB image):

$$\{A, B\} = (\text{FULL}, \text{LDE}, \text{LSE}, \text{L.*DDE}, \text{LD}\{1,2\}\text{E}) \quad (2)$$

FULL represents the full global illumination render. LDE is direct diffuse. LSE is direct specular, L.*DDE is first two diffuse bounces. LD{1,2}E is diffuse interreflection. An optimization scheme is to minimize the following energy:

$$\sum_{q \in \boldsymbol{B}} \min_{p \in \boldsymbol{A}} E(\boldsymbol{A}, \boldsymbol{B}, p, q, \mu) \quad (3)$$

using EM-like iteration executed multiple times from coarse to fine resolution:

input : multi-channel images $\mathbf{A} = \{A, A'\}$ and $\mathbf{B}_k = \{B, B'_k\}$
output: synthesized target image B'_{k+1}

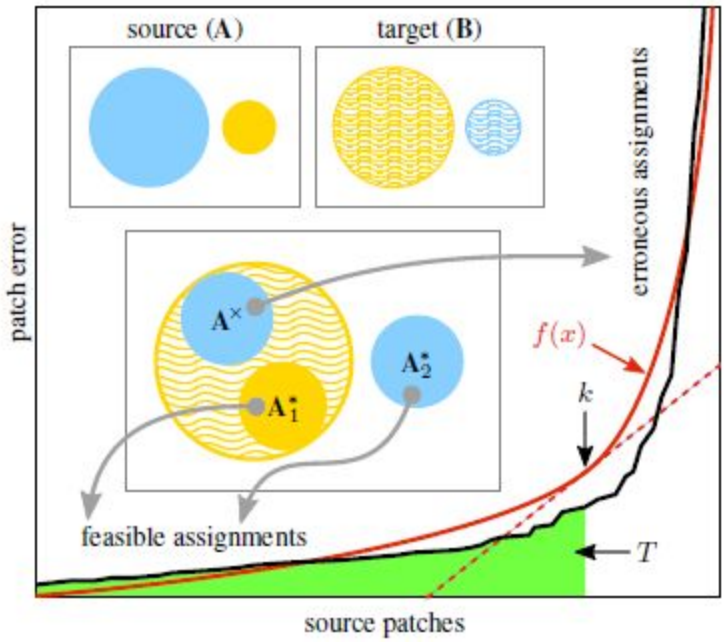
for *each pixel* $q \in \boldsymbol{B}_k$ **do**
  $NNF(q) = \underset{p \in \mathbf{A}}{\operatorname{argmin}} E(\mathbf{A}, \mathbf{B}_k, p, q, \mu)$

for *each pixel* $q \in \boldsymbol{B}_k$ **do**
  $B'_{k+1}(q) = Average(\mathbf{A}, NNF, q)$

Algorithm 1: EM-like iteration used to minimize energy (3).

Here B'_k denotes the current pixel values stored in B_k and B'_{k+1} are the updated values. NNF is the nearest neighbour field that assigns source patch to each target patch and function *Average* computes the average color of colocated pixels in neighbour patches.

The uniform source patch usage can alleviate the wash-out effect. However, this restriction is suitable only when each randomly picked sub-region of the source texture is perceived similarly. Enforcing uniform patch usage in our scenario would create artifacts. Our solution is based on the idea of reversed NNF retrieval [Rosenberger et al. 2009; Jamriˇska et al. 2015], in which a best matching target patch is retrieved for each source patch.



It is observed that, in practice, when we sort all matching error values and plot them with normalized axes, the resulting graph has a distinct, hyperbolic shape. The graph can be fitted to a hyperbolic function $f(x)= (a - bx)^{-1}$. Retrieve the point where $f'(x) = 1$, i.e., $k = \sqrt{1/b} + a/b$ .Patches with indices above k are probably erroneous assignments that need to be avoided. We thus set a feasible error budget T that is an integral of all patch errors with indices below k and modify the original source-to-target assignment in a way that maximizes the number of used source patches |A*| while satisfying an additional feasibility constraint:

$$\sum_{p \in A^*} \min_{q \in B} E(\boldsymbol{A}^*, \boldsymbol{B}, p, q, \mu) < T \tag{4}$$

We can repeat the retrieval and reuse good source patches to cover remaining positions in the target. This iterative scheme stops when all target patches are covered.

2.1.2 Maya or Houdini Interface and Integration

We will implement the algorithms in Maya. A dialog UI component will be created with MEL to access the C++ based plugin. A renderer UI will be used to show the stylized rendering result.

MfnMesh: Polygonal surface function set
MViewportRenderer: A class which represents a hardware viewport
MImage: A class provides methods for reading file images stored on disk.

2.1.3 Software Design and Development

a. The stylized synthetic process will be implemented in C++, including these class:

Image Class: A class responsible for reading from images and writing to images

```
class image {
private:
    int xSize;
    int ySize;
    glm::vec3* pixels;

public:
    image(int x, int y);
    ~image();
    void readFromFile(std::string filename);
    void setPixel(int x, int y, const glm::vec3& pixel);
    void savePNG(const std::string& baseFilename);
    void saveHDR(const std::string& baseFilename);
};
```

FeatureVector Class: The vector I(p) is a concatenation of all pixels in a small square patch of width w centered at the pixel p, where each pixel contains colors of the full rendered image (RGB) and four LPE channels (each stored as a RGB image).

```
class FeatureVector {
public:
    std::unique_ptr<image> RGB;
    std::unique_ptr<image> LDE;
    std::unique_ptr<image> LSE;
    std::unique_ptr<image> LDDE;
    std::unique_ptr<image> LD12E;

    int level;

    FeatureVector(std::unique_ptr<image> rgb,
                  std::unique_ptr<image> lde,
                  std::unique_ptr<image>lse,
                  std::unique_ptr<image> ldde,
                  std::unique_ptr<image> ld12e);
    ~FeatureVector();

};
```

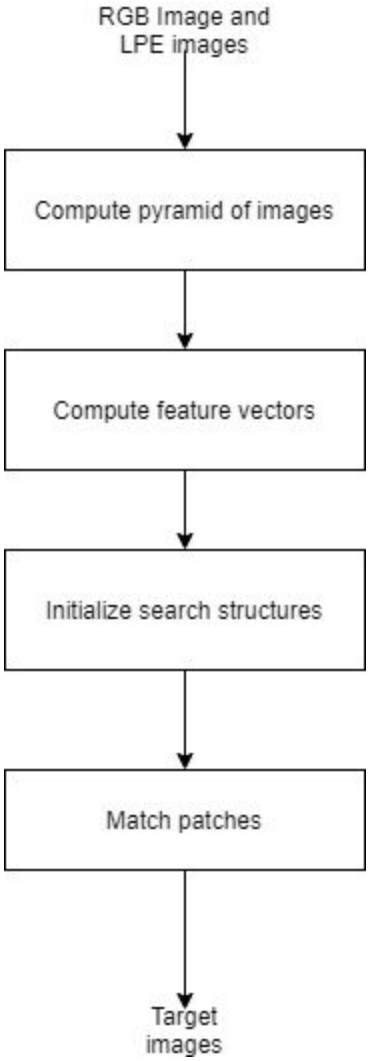
Pyramid Class: A class containing all the FeatureVectors at different levels.

```
class Pyramid {
public:
    int levels;

    std::vector<FeatureVector> featureAtAllLevels;

};
```

b. Detailed breakdown of the associated program structure



c. A standalone test app
Firstly we will generate RGB and LPE images in Maya and save them in a folder. Then we will run our main algorithm including reading from those images and matching. Finally we will save the result images in the same folder and check the accuracy of the result.

d. Thirdparties
Our pipeline needs to load a Iray plugin which helps the users to generate RGB and LPE images.

2.2. Target Platforms

2.2.1 Hardware

CPU: Any modern CPU
Graphics card: A Nvidia card is required

2.2.2 Software

Version of Windows: Windows 10
Maya: 2019 or 2020
IRay

2.3. Software Versions

2.3.1 Alpha Version Features (first prototype)

- Complete set of features to be included in the alpha version.
  - Output an image in exemplar style outside of Maya
- Important development milestones.
  - Week1:
    - Learning how to generate rendering images guided by LPEs with Arnold Plugin
    - Preparing source images and cartoon images
  - Week2:
    - Setting up a basic image filtering program
  - Week3.4:
    - Implementing the main algorithm
- Demo/test app to show off the alpha features.
  - Loading images rendered by Iray to our C++ program and saving the result image in a folder

2.3.2 Beta Version Features

- Complete set of features to be included in the beta version.
  - Output an image in exemplar style in Maya
- Important development milestones.
  - Week1:
    - Implementing part UI and Node
  - Week2:

        - Integrating our plugin with IRay
    - Demo/test app to create to show off the beta features.
        - Loading images to our plugin and compare the output with the results in paper

2.3.3 Description of any demos or tutorials

- How will users know how to use your tool?
    - We will provide a demo and a tutorial on how to use our authoring tool.
- Describe the demos and/or tutorials you plan to develop that will ship with the final version.
    - A demo will be provided to show how to use our authoring tool step by step.
    - A tutorial will be provided to show how to use our authoring tool step by step.

3. WORK PLAN

3.1. Tasks and Subtasks

Task 1 – Arnold LPEs

Duration: 03/02/2021 - 03/07/2021(5 days)

- ***Subtask 1.1. LPE Concept***

  LPE is a way to store light information. We need to learn the basic concept of LPE.

- ***Subtask 1.2. How to select LPEs***

  In the paper, they select several kinds of LPEs for image analogies. We need to dive into the paper and decide what kind of LPE images we need for our authoring tool

- ***Subtask 1.3. LPE in Arnold***

  We will watch tutorials online on how to generate rendering images guided with LPEs in Arnold.

Task 2 – Preparing sources images and exemplars

Duration: 03/02/2021 - 03/07/2021(5 days)

- ***Subtask 2.1. Sources images***

  We will follow this paper and generate images which render the sphere on the desk.

- ***Subtask 2.2. Exemplar***
  In this paper, five trained artists draw the exemplars which need for image analogies. We will look for those exemplars online and find more exemplars.

- ***Subtask 2.3. Light information***
  In week1, we get those rendering images guided by LPEs. We need to get light information from channels in those images.

Task 3 – Setting up project

Duration: 03/08/2021 - 03/14/2021(6 days)

- ***Subtask 3.1. Setup c++ project*** **2 days Keyi Yu**
  We will download the OpenGL library and std_image library online. Then we will create a new project in Visual Studio. Next we will include those libraries in properties and make sure we can include them in our project.

- ***Subtask 3.2. Image class*** **1 day Keyi Yu**
  All the features including RGB and LPE are stored in images, so we use an Images class to store those values.

- ***Subtask 3.3. FeatureVector Class*** **2 day Li Zheng**
  We use a FeatureVector class to store RGB and LPE features which are read from images.

Task 4 – Image Analogies(Main algorithm)

Duration: 03/15/2021 - 03/29/2021(13 days)

- ***Subtask 4.1. Computing pyramids and feature vectors*** **7 days Li Zheng**
  *Firstly, we need to Compute Gaussian pyramids for A', A , and B(three input images). We also need to extract feature vectors from them. In this paper, the authors use FULL, LDE, LSE, L.*DDE, LD{1,2}E in LPEs as feature vectors.*

- ***Subtask 4.2. BestMatch Function*** **7 days Keyi Yu**
  The heart of the image analogies algorithm is the BESTMATCH subroutine. We will implement this function to find the best match pixel in the source images for target images.

- ***Subtask 4.3. Integrate functions and test results*** **6 days Li Zheng&Keyi Yu**

After finding the best match pixels, we can apply the filter to the source image and get the final result. We will simply compare the style of our results to the exemplar with our eyes.

Task 5 – MEL menu and UI

Duration: 03/29/2021 - 04/04/2021(7 days)

- ***Subtask 5.1. Menu and UI*** **4 days Li Zheng**
  We will write MEL codes to generate the menu and UI mentioned in 1.4.1.

- ***Subtask 5.2. Node*** **4 days Keyi Yu**
  We will use c++ to create Node class as we did in previous assignments for input and output images.

- ***Subtask 5.3. Display output images*** **3 days Li Zheng**
  Besides saving output images in folders, our authoring tools will also display images in Maya

Task 6 – Integrate Arnold/Iray with our Plugin

Duration: 04/05/2021 - 04/27/2021(22 days)

- ***Subtask 6.1. Arnold*** **5 days Keyi Yu**
  We hope to integrate the rendering engine with our plugin. We will learn both two SDK- Arnold and Iray. Finally, we will decide on either of them for our authoring tool.

- ***Subtask 6.2. IRay*** **5 days Li Zheng**
  We hope to integrate the rendering engine with our plugin. We will learn both two SDK- Arnold and Iray. Finally, we will decide on either of them for our authoring tool.

- ***Subtask 6.3. Modify our plugin to integrate rendering engine*** **17 days Keyi Yu&Li Zheng**
  Once we are able to call rendering engine apis in our plugin, we could make changes to our code in that users can directly generate artist-style images from 3D models.

Task 7 – Demo/Tutorial

Duration: 04/28/2021 - 05/10/2021(12 days)

- ***Subtask 7.1. Demo*** **7 days Keyi Yu**
  We will make a recording of our plugin showing how to use our plugin step by step.

- ***Subtask 7.2. Tutorial*** **7 days Li Zheng**
  We will write a document in detail to illustrate how to use our plugin step by step. The document will include libraries, dependencies, environment and instructions of using our plugin.

- ***Subtask 7.3. Package our code*** **1 days Keyi Yu&Li Zheng**
  We will clean our code and comments importance procedures and make sure the users can load our plugin easily.

3.2. Milestones

3.2.1 Alpha Version

Task1, Task2
Task3
Task4

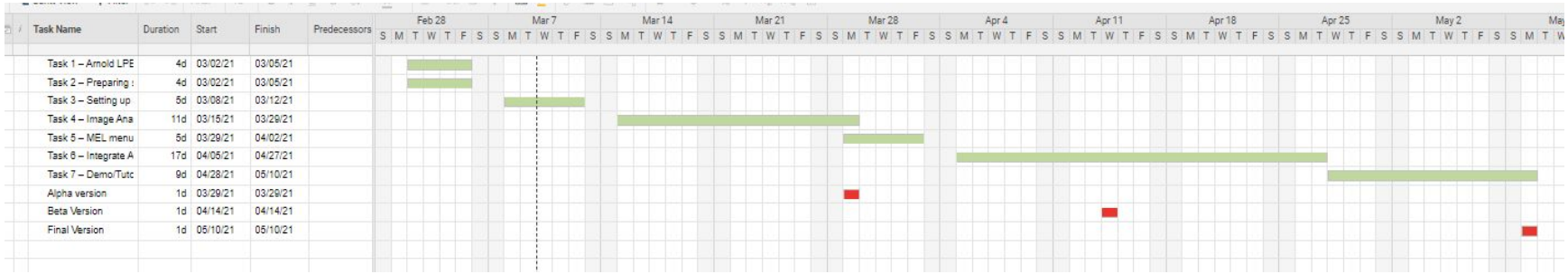
3.2.2 Beta Version

Task5, Task6.1, Task6.2

3.2.3 Final Version

Task7

3.3. Schedule



Task Name	Duration	Start	Finish	Predecessors
Task 1 – Arnold LPE	4d	03/02/21	03/05/21	
Task 2 – Preparing :	4d	03/02/21	03/05/21	
Task 3 – Setting up	5d	03/08/21	03/12/21	
Task 4 – Image Ana	11d	03/15/21	03/29/21	
Task 5 – MEL menu	5d	03/29/21	04/02/21	
Task 6 – Integrate A	17d	04/05/21	04/27/21	
Task 7 – Demo/Tutc	9d	04/28/21	05/10/21	
Alpha version	1d	03/29/21	03/29/21	
Beta Version	1d	04/14/21	04/14/21	
Final Version	1d	05/10/21	05/10/21	

4. RELATED RESEARCH

Introduction

[haeberli1990] is a pioneer to convert a photo or computer generated image into digital painting. Many techniques were developed to achive this goal, including physical simulation, procedural techniques, advanced image filtering and algorithmic composition of exemplar strokes.

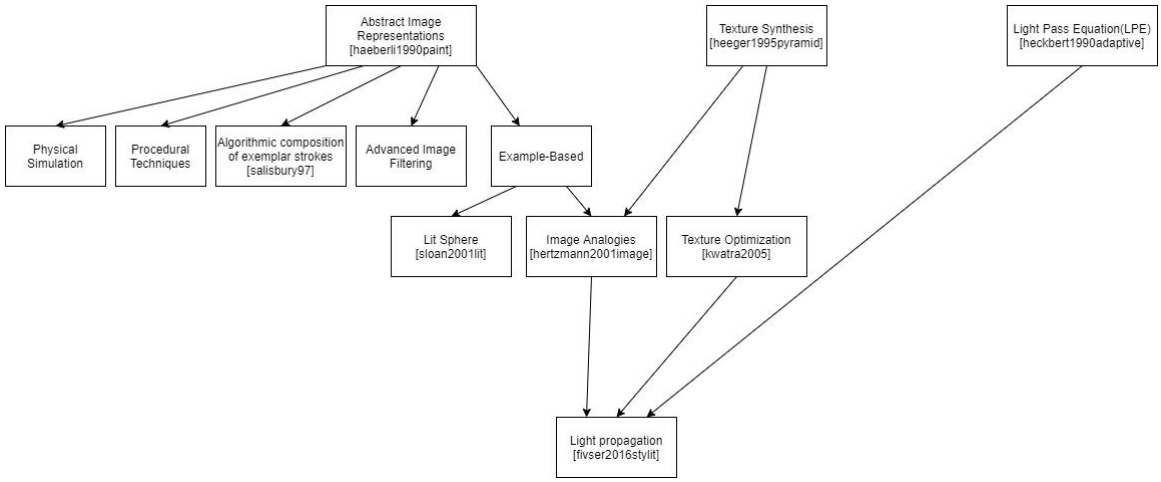
Previous example-based approaches [Sloan2001; Hertzmann2001; B´enard2013; Fi˘ser2014; Barnes2015] have made significant progress, but the synthesized results still have a distinctively synthetic look when compared to real artwork. The first limiting factor is that these techniques rely mainly on color information, but actual artists pay as much attention to lighting effects when painting a scene. Although normals can partially alleviate this limitation [Sloan2001], they are useful only for a simple shading scenario. The second limiting factor is that previous example-based stylization techniques can produce many artifacts [Sloan2001; Hertzmann2001; B´enard2013; Fi˘ser2014; Barnes2015; Kaspar2015; Jamri˘ska2015].

The authoring tool is based on a paper [Fi˘ser2016] that proposes a solution to alleviate these problems. It computes light propagation in a simple scene. Then uses it to guide the synthesis, which depicts various global illumination effects in arbitrary styles. To alleviate the artifacts, it uses source patches uniformly while controlling the overall error budget.

In this literature survey we trace from the paper [haeberli1990], diving into the example-based
Techniques including the lit sphere [Sloan2001] and image pair [Hertzmann2001]. [Hertzmann2001] integrated non-realistic rendering with texture synthesis, which could trace back to the paper [heeger1995pyramid]. Then, the original Hertzmann et al. synthesis algorithm was replaced by a texture optimization technique [Kwatra et al. 2005]. By adding the Light Path Expressions (LPEs) [hertzmann2001image] channels,

[Fi˘ser2016] alleviates the artifacts and improves the fidelity of the synthesized image in global illumination scenarios.

Graph



Content

[haeberli1990paint]:

In this seminal paper, the author used an ordered list of strokes to represent images. Each stroke of the brush is described by a collection of attributes including position of the brush stroke, the RGB and Alpha color of the stroke, the size of the stroke, angle of the stroke in the painting and the shape of the brush stroke. This paper also described how to control those attributes in their program. In addition, it is easy to apply some operations on the paintings, like interpolation and extrapolation beyond two paintings and animation.

There are also some advanced painting techniques. FIrstly, Interesting effects can be created by using arbitrary images to control the brush direction across the canvas. Another interesting technique is to blend the brush strokes onto the canvas.

[salisbury97]:

In this paper, they introduced the notion of “orientable textures” and show how they can be used to readily convert 3D information in an image-based system for pen-and-ink illustration. In their interactive system, a user creates an illustration from a reference image by specifying three components: 1) : a greyscale target image that defines the desired tone at every point in the illustration; 2) a direction field that defines the desired orientation of texture at every point; 3) a stroke example set, or set of strokes, to fill in the tone areas.

[sloan2001lit]:

This paper introduced The Lit Sphere-a generic example-based technique that uses a shaded sphere painted by an artist as the style exemplar. Pixels from this spherical exemplar are then transferred to the target 3D model using environment mapping, i.e, the color for a target pixel is transferred from the location in the source with the same normal.

[hertzmann2001image]:
This paper proposed a concept of image analogies where a pair of images serves as an exemplar. For each pixel in the target, the algorithm finds the best corresponding location in the unfiltered source and transfers the look from the filtered counterpart.

[heeger1995pyramid]:
This paper presents a technique for synthesizing an image that matches the appearance of a given texture sample. This technique works entirely from the example texture, requiring no additional information or adjustment. It starts with a digitized image and analyzes it to compute a number of texture parameter values. Those parameters are then used to synthesize a new texture image that looks like the original image.

[Kwatra2005]:
In contrast to most example-based techniques that do region-growing, this paper proposes a joint optimization approach that progressively refines the entire texture. Also, it is ideally suited to allow for controllable synthesis of textures. It defines a Markov Random Field (MRF)-based similarity metric for measuring the quality of synthesized texture with respect to a given input sample, which allows formulating the synthesis problem as minimization of an energy function.

[Fiˇser2016]
This paper presented an approach to example-based stylization of 3D renderings that takes into account illumination effects. It computes the light propagation and

uses it to guide the synthesis. Artists just need to provide an exemplar painting on a “sphere on the table” scene. Then, a more complex target scene with a similar lighting environment will exhibit similar visual style to the exemplar. The demonstration shows that this technique can handle a great variety of different stylizations.

[heckbert1990adaptive]:
This paper presents a rendering method designed to provide accurate, general simulation of global illumination for realistic image synthesis.
They use a three-pass, bidirectional ray tracing algorithm that traces rays from both the lights and the eye. 1) The “size pass” records visibility information on diffuse surfaces; 2) the “light pass” progressively traces rays from lights and bright surfaces to deposit photons on diffuse surfaces to construct the radiosity textures; 3) and the “eye pass” traces rays from the eye, collecting light from diffuse surfaces.

References

[haeberli1990paint] HAEBERLI, P. 1990. Paint by numbers: Abstract image representations.
SIGGRAPH Computer Graphics 24, 4, 207–214.

[salisbury97] SALISBURY, M. P., WONG, M. T., HUGHES, J. F., AND SALESIN, D. H. 1997. Orientable textures for image-based pen-and-ink illustration. In SIGGRAPH Conference Proceedings, 401–406.

[sloan2001lit] SLOAN, P.-P. J., MARTIN, W., GOOCH, A., AND GOOCH, B. 2001. The Lit Sphere: A model for capturing NPR shading from art. In Proceedings of Graphics Interface, 143–150.

[hertzmann2001image] HERTZMANN, A., JACOBS, C. E., OLIVER, N., CURLESS, B., AND SALESIN, D. H. 2001. Image analogies. In SIGGRAPH Conference Proceedings, 327–340.

[Kwatra2005] KWATRA, V., ESSA, I. A., BOBICK, A. F., AND KWATRA, N. 2005. Texture optimization for example-based synthesis. ACM Transactions on Graphics 24, 3, 795–802.

[heeger1995pyramid] Heeger, David J., and James R. Bergen. "Pyramid-based texture analysis/synthesis." Proceedings of the 22nd annual conference on Computer graphics and interactive techniques. 1995.

[Fiˇser2016] Fišer, J., Jamriška, O., Lukáč, M., Shechtman, E., Asente, P., Lu, J., & Sýkora, D. (2016). Stylit: illumination-guided example-based stylization of 3d renderings. ACM Transactions on Graphics (TOG), 35(4), 1-11.

[hertzmann2001image] HECKBERT, P. S. 1990. Adaptive radiosity textures for bidirectional ray tracing. SIGGRAPH Computer Graphics 24, 4, 145–154.

[B´enard2013] B´ENARD, P., COLE, F., KASS, M., MORDATCH, I., HEGARTY, J., SENN, M. S., FLEISCHER, K., PESARE, D., AND BREEDEN, K. 2013. Stylizing animation by example. ACM Transactions on Graphics 32, 4, 119.

[Fiˇser2014] FIˇS ER, J., LUK´AˇC, M., JAMRIˇS KA, O., ˇCAD´IK, M., GINGOLD, Y., ASENTE, P., AND S´Y KORA, D. 2014. Color Me Noisy: Example-based rendering of hand-colored animations with temporal noise control. Computer Graphics Forum 33, 4, 1–10.

[Barnes2015] BARNES, C., ZHANG, F.-L., LOU, L., WU, X., AND HU, S.-M. 2015. PatchTable: Efficient patch queries for large datasets and applications. ACM Transactions on Graphics 34, 4, 97.

[Kaspar2015] KASPAR, A., NEUBERT, B., LISCHINSKI, D., PAULY, M., AND KOPF, J. 2015. Self tuning texture optimization. Computer Graphics Forum 34, 2, 349–360.

[Jamriˇska2015] JAMRIˇS KA, O., FIˇS ER, J., ASENTE, P., LU, J., SHECHTMAN, E., AND S´Y KORA, D. 2015. LazyFluids: Appearance transfer for fluid animations. ACM Transactions on Graphics 34, 4, 92.