Senior Design Project

"Bumpster"

Software Specification Report

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1. Introduction

There are several types of mapping targeting to different aspects of material. Bump mapping is one of these techniques used in computer graphics which enables realistically rendering bumps and wrinkles on the surface of a model. It is possible to obtain the appearance of textured surface by simply using RGB or grayscale values to define dark parts as deepened and bright parts as heightened areas [1]. The shading effect and tiny details on the surface creates an illusion of depth which is useful for graphic designers and game artists to get realistic surfaces of their models.

The existing systems based on texturing software such as CrazyBump and nDo2 are good at exporting different kinds of maps from photographs or scanned images [2]. Getting good results is possible, but the accuracy is not high. The map types that will be generated in this software will include bump, metalness, roughness, gloss or ambient maps. The results can be customized with photoshop features of these texturing software programs but it also takes time to get realistic textured surface of a model. In addition, existing texture software programs are not available in mobile platforms so reaching wide range of customers and accessing benefits of these programs are impossible. Therefore, there is a need for creating bump maps in different platforms with higher accuracy which also reduces the necessity of additional customization.

1.1 Description

Our software will generate bump and physically based rendering maps using a specifically trained neural network. It will be able to identify the topological properties of the surface, as well as the material properties using a single photograph. Our product will be the used in the server to make the required operations, and communicate with the front-end applications on various platforms. We believe our software will provide rather large benefits for the industry, as the previous solution to this kind of topographical analysis required expensive methods which require personnel with expertise, expensive equipment, and time [3].

Since there are no other tools that extract physically based rendering (bump, metalness, roughness, gloss or ambient) maps with one or more photos using a neural network, this application will be beneficial in terms of accuracy and usability. After the extraction of the user selected mapping, the user will be able to obtain the resulting map and fit it onto the original photo to see the material properties or bump to create a realistic image. Then, the artists can tweak the chrominance, roughness and other properties of the final product and save it for later usage.

1.2 Constraints

The implementation, economic, language, ethical, privacy, security, confidentiality, maintenance and time constraints are listed below.

1.2.1 Implementation Constraints

- The application will be available for iOS, Android, Windows, MacOSx and Linux platforms.
- The programming languages used in the application will be Python, C++ and Swift.
- For version control, GitHub will be used.

1.2.2 Economic Constraints

The data which will be used to train the neural network will be acquired from trusted sources, as well as from software-rendered scenes which will automatically generate the corresponding bump map of the image during creation. We are planning to use Google's TensorFlow library, which is an open-source software library for Machine Intelligence [4].

1.2.3 Language Constraints

The language of this application will be English, since it is a universally accepted and used language.

1.2.4 Ethical Constraints

The users' photographs and scanned images will not be shared with any third-parties.

1.2.5 Privacy and Security Constraints

- The photos that users upload are seen only the users themselves.
- The client part’s communication with the server will be secure in order to preserve the privacy and the security of the users’ data.

1.2.6 Confidentiality Constraints

- The maps generated in the application and the settings of every user will be kept confidential.
- The source codes of the application will be kept confidential.

1.2.7 Maintenance Constraints

The neural network contained within the software will be updated and extended to recognize more types of materials and surfaces.

1.2.8 Time Constraints

The application will be completed and tested by May 2018.

1.3 Professional and Ethical Issues

The main aim of the project is to generate physically based rendering maps by using a single photograph or a scanned image. This photograph or image will be provided by the user. Since the user may desire not to share his/her photographs and images, the application ensures that they will not be shared with any third-parties.

2. Requirements

The functional and non-functional requirements are listed below in two separate sections.

2.1 Functional Requirements

- The software will generate the physically based rendering maps from one user specified photo.
- The map types will include gloss, metalness and other physical properties from one user specified photo with the aid of deep learning.
- The application will be able to identify which parts are metal and which parts are other materials from one photo via deep learning.
- The data to train the neural network will be generated from computer rendered scenes in which the bump, metalness, roughness, gloss or ambient maps are extracted (this process is expensive and hard, since these maps are extracted by hand by graphical designers or in special rooms and with special setups).
- The chrominance values of certain surfaces will be determined by the network, which is an advantage over Bitmap2Material, which is not able to determine the chrominance values alone.
- There will be a mobile app that will be compatible with both iPhone and Android smartphones that will allow the user to send photo(s) of the textures in which they want map extraction to be performed on.
- The software will contain a neural network of map / surface image pairs which will be calibrated.
- The input photo(s) will be sent to the server that performs the extraction, and then the server will send the product back to the user's phone to be viewed.
- The user can view the end product in their phone or PC and they can overlap the initial texture of the photo and the map generated to see the realistic image.
- User can view the end product in many different angles in the mobile and desktop application.
- The user (especially the graphic artists) will be able to tweak different properties of the generated map such as amount of metallicity.
- User will be able to easily map the input photo onto the bump/metalness/roughness/gloss or ambient maps using the GUI in the desktop and the mobile applications.
- User will be able to save the extracted map.

2.2 Non-functional Requirements

2.2.1 Compatibility

Software will support the up to date versions of the mobile-desktop front end applications created for it. The application will be compatible with iOS, Android, Windows and MacOSx operating systems.

2.2.2 Performance

Software needs to answer the peer request as fast as possible to ensure best possible response and move on to process future requests in time.

2.2.3 Adaptability

The software will be adaptable to a certain degree and will support the addition of different technologies using the software.

2.2.4 Reliability

Software should minimize the chance of failures like unterminating requests and crashes by handling all of the special cases.

2.2.5 Scalability

The software should be prepared for an increase in requests (users) and possible change at hardware scale which will provide processing power on a larger scale. The server-client architecture will be able to supply the increasing demand.

2.2.6 Flexibility

Because of the fact that users (especially graphical designers) always increase the realisticness of their works as their clients desire, their needs from these kinds of applications always increase to keep up with their needs and to make their lives easier.

2.2.7 Maintainability

The operating systems such as iOS, Android, Windows, MacOSx and Linux always improve via their updates. Our application will be able to keep up with the operating systems by the aid of its developers adding updates.

2.2.8 User Friendly Interface

User friendly interface is one of the most important non-functional requirements of our software, because it builds a bridge between the computer graphics and image processing tools and the graphic designers. An easy and understandable GUI for the desktop and mobile apps are our aim. This GUI will ensure the easy tweaking of the preferences of the map generated and even view it from different angles.

3. Existing Systems

Currently available systems are described in following subsections

3.1 CrazyBump

CrazyBump is a tool that generates normal map from an image. Users can change the intensity of the normal map, sharpen it and remove noise. It's useful for creating textures from a single image [5].

However, this application only uses Shape Recognition. Our application will use Deep Learning to create more precise bump maps. Also this application's user interface is not user friendly, looks outdated and requires user to change tens of sliders to obtain desired map. Our application asks the user their preferences before generating the map, so that the user wouldn't be required to tweak with settings and sliders to obtain the desired map.

CrazyBump is offered at $299 for professional use, $99 for personal use and $49 for students [6].

3.2 Substance B2M

Substance B2M (Bitmap2Material) is a tool that generates physically based rendering outputs from a single image based on its base color, metallic properties and roughness [7].

This tools is more comprehensive compared to CrazyBump, and it has a more user friendly interface. However Substance B2M also requires users to tweak with lots of settings. Additionally, our application promises more precise and accurate solution since it will use Deep Learning. Also our application will ask user's preferences beforehand to generate the desired map more accurately, rather than generating a medium quality map and then requiring the user to tweak the settings.

Substance B2M is offered at different prices based on the revenue of the customer [8].

4. References

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