Cinematic Wound Synthesis Optimized for Real-time Gameplay

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Abstract

Cinematic rendering techniques have been sporadic in movie industries rather than in game industries because rendering time seems to be critical. In recent, some scenes in gameplay have been almost like cinematic because of a great computational power of GPU. However, there are several drawbacks in synthesizing of wounds on human body. In this paper, we present a task that provides a real-time rendering of wound synthesis on 3d face that employs WARD's BRDF. To solve this, anisotropic diffusion has to be taken into consideration rather than isotropic surface. An efficient and easy interface is designed to let users simulate super-realistic wound synthesis of a face as well. To validate, we have shown wound synthesis samples between traditional methods and the proposed one as well.

Keywords: *Cinematic gameplay, wound synthesis, super-realistic scenes*

1. Introduction

In recent, we come to a realization that hardware is improving rapidly which can make us expect a proliferation on game graphics in desktop computers as well as smart devices using cloud computing. In particular, a great computational power of GPU can be extended to utilize an advanced computer graphics renderings into real-time games [1]. Unreal Engine 4 (Epic Games) of which the first game probably is said to be released in 2013, proves that high speed computation power of GPU enables us to achieve high-end visuals, super-realistic scene rendering techniques including high-quality shadows, mass hair simulation and dynamic lighting features [2].

Most wound synthesis techniques have primarily depended upon manual works done by 3d graphic artists. Previously, some researchers presented wound synthesis for the purpose of medical training or virtual treatment [3, 4]. However, these approaches did not seem to provide fully automatic tasks. Veredas, *et al.*, [5] presented a hybrid identification approach to classify tissues of wound images using color and texture features by designing neural networks and Bayesian classifiers. Methods of wound synthesis from a source image, which is not as simple as it first appears, have been investigated. Wounds in physiological tend to be complex enough, even if one considers only the structures underneath the wound that can be visualized. For instance, skin depth varies slightly, depending on the location. In addition, skin appearance depends on the quantity of hemoglobin, melanin, and so forth [6]. Hence, a region needs to be deformed as well as rendered as representing particular features, such as color, depth, and components. However, doing this alone cannot always assure the quality of wound synthesis, because wounds vary significantly in size, depth, and color, and there are various classes of wounds [7, 8, 9]. This implies that we need to represent wound synthesis as involving more details than included in the image itself. A task for making cinematic wound synthesis has not been reported yet. Wound synthesis can be found in movies and games. Cinematic wound synthesis is required to draw gamers' interests.

The ultimate aim of the method is to realize a cinematic wound synthesis (CiWS) on a 3d face. As a power of GPU is exceedingly increasing, some traditional computer graphics techniques can be applied into a real-time game. The paper is organized as follow. The introduction delivers overview of the background and approach. The methodology is described in the next section, which is composed of three main steps including a wound system, light models and a real-time simulator. We have employed Ward's BRDF [10, 11] model to create cinematic wound synthesis samples. To evaluate the method, we have shown experimental comparisons as well. The overall approach and system configuration are shown in Figure 1 and Figure 2.

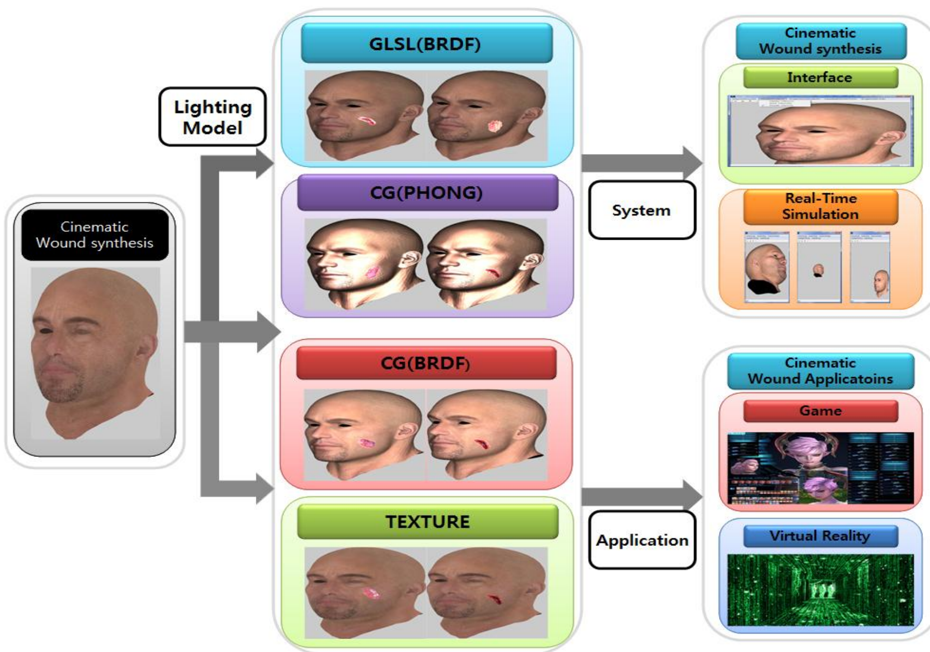

Figure 1. Conceptual Approach of CiWS

2. The Methodology

2.1 Wound system

The wound system is designed to provide an easy and convenient interface that makes it possible to simulate wound synthesis. At first, we have built a plug-in to load a 3d face model. Once a user selects a wound type among bruising, abrasion, burn and cut wound textures and he picks the spot on the face where he wants to attach the wound, then the wound texture is automatically embedded into the surface of the face model. At this stage, a user also choose a size of level such as small, medium and large which implies how to set a set of mesh index to make proper wound synthesis. Our ultimate goal is to show a possibility to realize a realistic wound synthesis for real-time. A flexible camera model that can manipulate camera angles as well as zoom-in and out is built to validate whether variations of wound synthesis are conveyed caused by some implemented light models described in the next section. The details of configuration are shown in Figure 2.

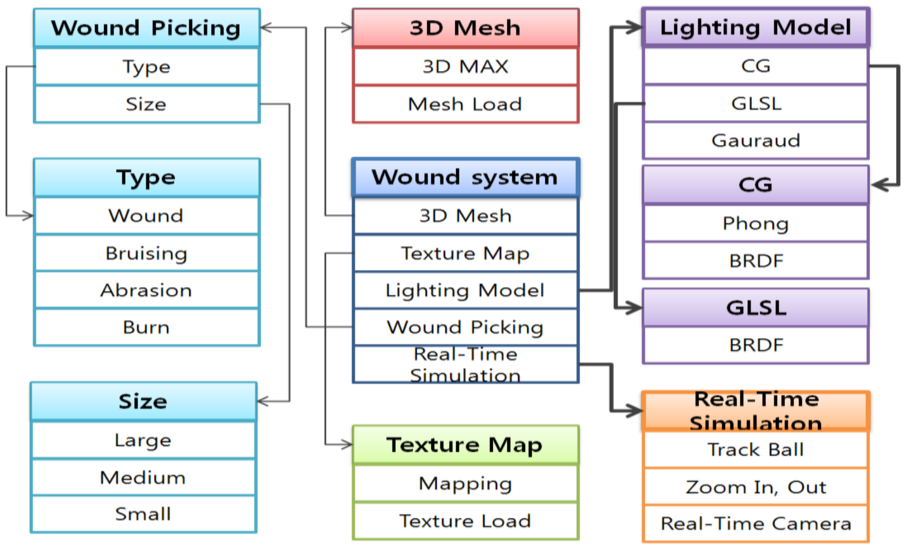

Figure 2. The System Configuration

2.2 BRDF Light Model

The conventional reflectance model takes into consideration three components including ambient, diffuse, and specular lights. The ambient light can be described as a certain level of to a quantity of the light that is not from a light source directly but from an indirect light reflected by environmental objects. The diffuse light can be scattered in all directions. The diffuse reflection is maximized when the surface normal is aligned to the light source. The specular light is the highlights that are come from the reflection of shiny surfaces like a mirror.

We have to design a physically-based light model that may overcome the simplistic light model. We have employed BRDF (BIDIRECTIONAL REFLECTANCE DISTRIBUTION FUNCTIONS), presented by Greg Ward [11]. A BRDF model computes the relative quantity of light reflected in the outgoing direction. A BRDF is a function that takes two pairs of angle parameters as well as the wavelength and polarization of the incoming light. The two angles called elevation and azimuth are taken into consideration for computation of BRDF that follows anisotropic reflection properties [12]. BRDF is computed by equation (1) as below :

$$P_{bd}(\theta_i, \phi_i, \theta_r, \phi_r) = \frac{P_d}{\pi} + P_s \cdot \frac{1}{\sqrt{\cos\theta_i \cdot \cos\theta_r}} \cdot \frac{1}{4\pi\alpha_x\alpha_y} \cdot exp\left[\frac{\left[\frac{H \circ T}{\alpha_x}\right]^2 + \left[\frac{H \circ B}{\alpha_y}\right]^2}{1 + H \circ N}\right], \quad (1)$$

where related parameters are described, P_{bd}: Ward`s BRDF, (θ_i, ϕ_i): the incident light vector, (θ_r, ϕ_r): the reflected light vector, P_d: diffuse parameter, P_s: specular parameter, α_x: the standard deviation of the surface slope in the x direction, α_y: the standard deviation of the surface slope in the y direction, H: the unit angular bisector of V (camera vector) and L (light source vector) called the halfway vector, T: the unit vector in the plane of the surface that is perpendicular to N, B: a unit vector in the plane of the surface that is perpendicular to both N and T.

The final BRDF is merged into following equation (2) that takes into account overall illumination models by addition of all light sources.

$$L(\theta_r, \phi_r) = I \frac{P_d}{\pi} L_s P_s \sum_{i=1}^{N} L_i \omega_i \cos\theta_i \, P_{bd}(\theta_i, \phi_i, \theta_r, \phi_r), \quad (2)$$

where related parameters are explained, I: the indirect radiance, L_s: the radiance from the indirect semi-specular contribution, L_i: the radiance from light source i, ω_i: the solid angle of light source i.

3. Experimental Results and Discussion

The system has been realized using OpenGL that is well-known for a flexible and portable API broadly used in various platforms. We have chosen MFC that is useful for making a interface. The system is developed on Intel® Core(TM) i5-3470 CPU @ 3.20GHz, with Nvidia Geforce graphic card GTX 580 GPU, Windows 7 Home Premium K. The system interface of CiWS is shown in Figure 3.

In the experiments, we have compared wound samples using a OpenGL lighting model with ones which are made using Phong, OpenGL shader (GLSL), and CG shader (BRDF).

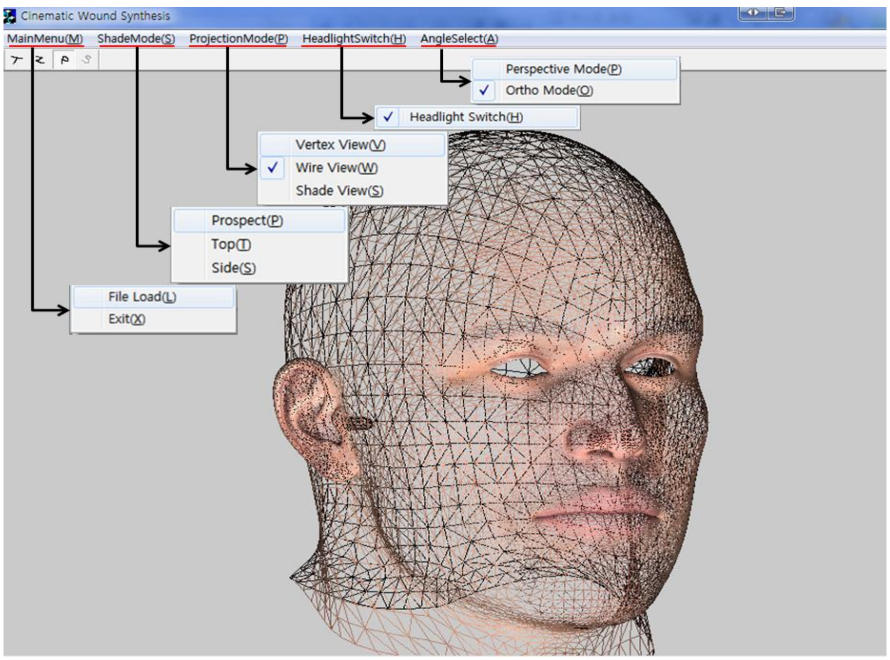

Figure 3. System Interface (CiWS)

Based on a wound synthesis, we have investigated each wound synthesis with respect to appearance of wound synthesis on light models. In order to closely observe the wound synthesis, a light position can be flexible and zoom in and out need to be employed. In this approach, we make the camera position be automatically movable using a mouse control that enables us to take a look at more details. To keep unbiased experimental conditions, we have used a set of same illumination parameters to every model as well.

(a) Texture (b) CG (PHONG)

(c) CG (BRDF) (d) GLSL (BRDF)

Figure 4. Wound Synthesis Samples on Various Illumination Models

At first, we do not add a particular light model to the wound system except OpenGL default light model. It is not easy to figure out that the wound synthesis samples are affected by the camera position which makes various viewpoints of wounds. The samples shown in Figure 4 (a) remain in constant shading even in different camera angles.

Secondly, we have a set of same illumination parameters to Phong light model. We have observed that the wound synthesis samples shown in Figure 4(b) on the Phong light model are exceedingly different from the OpenGL light model in terms of conveying delicate appearance on the wounds when angle movements occur. The more light comes in, the brighter wounds we can observe. Similarly, the light comes less, the wounds become darker as well. Phong takes into consideration that the light positions critically affect the final appearance. However the wounds look exceedingly greasy.

Thirdly, we have also created wound synthesis samples simulated by BRDF light model using CG. The wounds seem to be more delicate than others (OpenGL, Phong, and GLSL) with respect to displaying subtle difference on the wounds in which a quantity of light is smoothly switched when the camera position is moved. In addition, the surface where its normal is aligned to the camera position is found to be brighter than one in Phong. Hence BRDF using CG is most preferable among four experiments. The samples are shown in Figure 4 (c).

Lastly, BRDF using GLSL is also implemented to create wound synthesis samples shown in Figure 4 (d). Basically we have used exactly same lighting parameters as BRDF in CG. However the results do not look similar to BRDF in CG. In particular, a wound area is quite brighter than other methods. Hence we have to take this into account when making wound synthesis using GLSL. The wound textures have to be adjusted by reducing intensity in advance. In addition, we add a real-time camera that can show a potential to utilize CiWS into a real-time gameplay. We observed that CG (BRDF) synthesis samples display satisfactory results without seamless of the scene that reflecting illumination conditions as well. The set of outcome is shown in Figure 5.

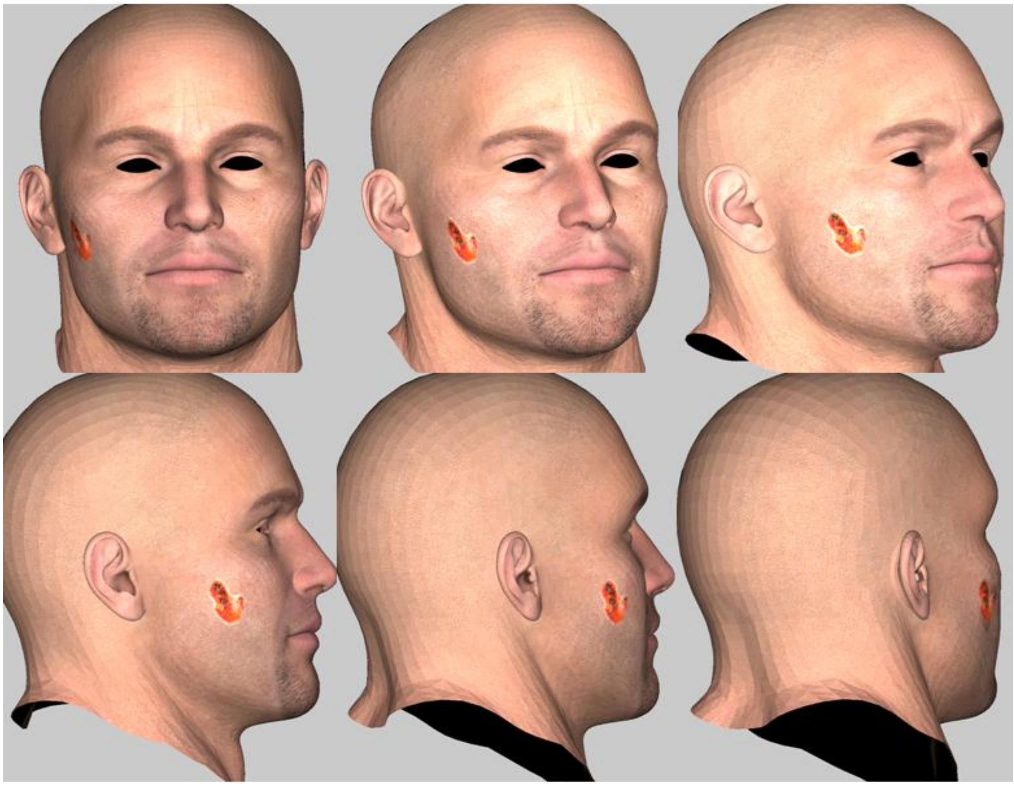

Figure 5. CG (BRDF) Synthesis Samples with Various Angles using a Real-time Camera

4. Conclusion

It is troublesome to make a realistic wound synthesis applicable to movies or games. So far, we have not found a fully automated wound synthesis system that provides realistic appearance of wounds. Mostly wound synthesis tends to be made by a graphic designer who spends lots of time for manual works. In this paper, we have proposed a fully automated cinematic wound synthesis (CiWS) that considers four light models to analyze each appearance. OpenGL light model, Phong, GLSL (BRDF) and CG (BRDF) have be implemented and evaluated by changing a camera position that reflects an amount of the light source. Phong has been found to be critically affected by the light which results in the fact that wounds look exceedingly greasy. GLSL shows that a wound area is quite brighter than other methods. Particularly, wound texture seems too bright to accept it. We conclude that CG is most preferable among four experiments. For the future work, we need to consider sub-surface scattering techniques on wound synthesis that can be run on real-time.

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