Abstract

Rendering convincing human figures is one of the unsolved goals of computer graphics. Previous work has concentrated on modeling the physics of human skin. We have taken a different approach. We are exploring techniques used by artists, specifically artists who paint air-brushed portraits. Our goal is to give the impression of skin, without extraneous physical details such as pores, veins, and blemishes. In this paper, we provide rendering algorithms which are easy to incorporate into existing shaders, making rendering skin for medical illustration, computer animations, and other applications fast and simple. We accomplish this by using algorithms for real time drawing and shading of silhouette curves. We also build upon current non-photorealistic lighting methods using complementary colors to convey 3D shape information. Users select areas from a scanned art work and manipulate these areas to create shading models. The flexibility of this method of generating a shading model allows users to portray individuals with different skin tones or to capture the look and feel of a work of art.


1 Introduction

Currently the process of shading and lighting human or human-like characters in animated features is experiencing a renaissance. New computer-based techniques are being integrated into systems that before were only concerned with duplicating existing lighting techniques. In addition, systems are being built which can create virtual photorealistic characters from previously acquired data [24, 18]. However, little work has gone into designing algorithms which can automatically render images in the style of portrait illustrations. This paper presents algorithms for rendering human skin based on the style of modern portrait illustrations such as Alberto Vargas, Hajime Sorayama, and Olivia DeBerardinis [9, 22, 1].

Photorealistic skin rendering has proven to be a difficult problem partly because as humans, we are particularly attuned to the range of features which qualify as human [16]. Any rendering which fails to accurately capture these details will fail to achieve viewer acceptance. However, where art is concerned, an audience is often quite willing to accept some loss of detail in exchange for greater clarity of presentation. This willing suspension of disbelief on the part of the viewer allowed us to create a paradigm for viewing human models which can communicate far better than traditional rendering algorithms allow. In Section 2 we review previous computer graphics work and conclude that little has been done to apply non-photorealistic techniques to human models. In Section 3 we analyze the conventions used by artists to portray human skin. Then in Section 4 we discuss the issues involved creating an interactive interface for rendering human characters. We conclude by discussing the results and future work in Section 5.

2 Related Work

Traditional approaches to rendering human skin have focused on simulating the underlying physical structures. As an example, Hanrahan et al. [14] model the skin with two basic epidermal layers, each containing distributions of scattering and absorbing elements. These elements are comprised of simulated pigment and tissue particles, which cause both wavelength independent and wavelength dependent attenuation resulting in variation of opacity and coloration respectively. Our paper takes a different approach, focusing on reproducing the shading algorithm used by an artist in their work. Reverse engineering BRDF’s was applied to the domain of photorealism by Yu et al. [26]. In this paper, we attempt to solve a similar inverse problem to reproduce artistic shading by sampling art work.

Our skin shading algorithms belong to a family of computer graphics techniques collectively referred to as non-photorealistic rendering (NPR). An underlying assumption in NPR is that artistic techniques developed by human artists have intrinsic merit based on the evolutionary nature of art. For this reason techniques are usually borrowed from artists rather than reinvented from first principles.

There has been some prior work applying NPR methods to the depiction of the human form. Haebler used image processing to produce some stunning images of a woman figure skating in Siggraph 90 [13]. More recently, Cassidy Curtis captured the dynamic quality of human figures using depth buffers to pull out “loose and sketchy” edge lines. Markosian et al. and Gooch et al. made use of silhouettes to provide cues of depth and shape. In addition Gooch used complementary colors to provide additional depth cues [20, 10, 11].

Finally, modeling is a critical aspect of depicting the human form. In the absence of a good model, any attempt at rendering skin will fail to satisfy. There has been some research in the area of modeling human figures [23, 5]. In our work, we have not considered modeling issues, relying instead on a Digibot scan of Michelangelo’s David and a female model by Louise Bell.

3 Artistic Principles in Portraiture

In his book, The Technique of Portrait Painting [19], classical portrait painter Harrington Mann emphasizes that form and color are...