Rendering of human skin during physical exercise

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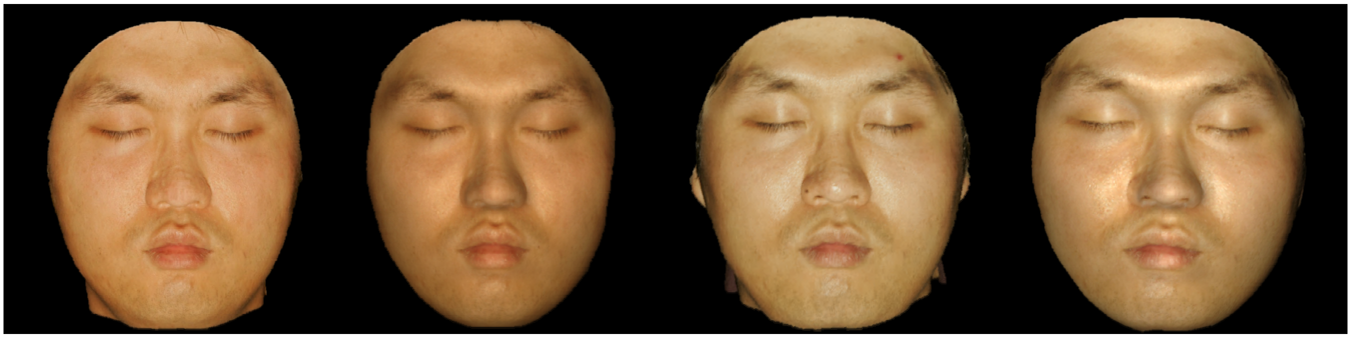

(a) (b) (c) (d)

Figure 1: *(a) Real image before exercise (b) Rendering result before exercise (c) Real image after exercise (d) Rendering result after exercise*

Keywords: Human skin, exercise, appearance rendering

1 Introduction

Many researchers have shown interest in the realistic rendering of a human face since it is crucial to the success of many applications in computer graphics, games and animation. However, it is difficult to represent the realistic appearance of a facial skin since it has complex physical properties and its appearance tends to vary as the situation changes. For example, the glossiness of a facial skin increases after exercise and the color of it becomes red after drink. In this paper, we introduce a method to simulate the appearance change of a human skin during physical exercise. Our key idea is that the appearance of a skin under exercise can be divided into a surface reflectance component and a subsurface scattering component so that they are approximated by a BRDF model and a BSSRDF model, respectively. The Torrance-Sparrow BRDF model describes the glossiness and the roughness that are affected by sweat and oil on the skin surface. The Multipole model [Donner and Jensen 2005] with absorption σ_a and scattering σ'_s parameters represents subsurface scattering effects that occur between cells and pigments under the surface. In this paper, the parameters of each reflectance model are acquired by measurement.

2 Our approach

For the skin rendering, we need the geometry, the face albedo, and the face reflectance data of the face. The face albedo is used to represent the spatial details of the facial skin. The geometry of the face is acquired by using a commercial scanning device. The face albedo is computed by using a single image that is captured by illuminating from the front by a projector. This method uses an assumption of Lambertian reflectance of a skin. We acquire the specular surface reflectance component and the diffuse subsurface scattering component by an image based measurement setup. This setup consists of a camera, a projector, and a material holder. In measuring the surface reflectance and the subsurface scattering, the project emits a uniform area light and multiple beams into the face from the front, respectively. The multiple beams are uniformly distributed with the distance of 20mm to avoid the interference with neighboring beams. Before and after the exercise of running 5 minutes at the running machine, we take six-pictures with a series of different exposure times, ranging from 1/30 second to 2 seconds for each measurement. These images are used to construct high dynamic range images of a facial skin. The total measurement time of our experiment is about 20 seconds. In our experiments, we find that the exercise changes the appearance of the facial skin such as specular reflectance, roughness, and translucency (see Figure 2). Compared to the normal face before exercise, the specular reflectance is increased from 0.1817 to 0.2434 and the roughness is slightly increased from 0.2244 to 0.2284. The average translucency $\sigma_{tr} = \sqrt{3\sigma_\mathrm{a}(\sigma_\mathrm{a}+\sigma'_\mathrm{s})}$ for each of three colors (red, green and blue) is reduced 31.4%, 16.6%, 35.8%, respectively. Figure 1 show the rendering results of our experiment.

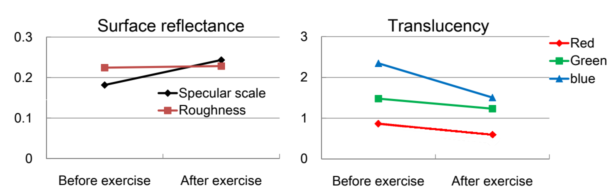

Figure 2: *The variation of skin appearance after exercise.*

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References

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