Real-time image-based control of skin melanin texture

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Introduction

In the reproduction of human images in posters, TV commercials, movies and other media, the skin melanin texture of the photograph is often controlled manually by an experienced operator in a time consuming process. As such, a tool able to assist in controlling the texture would be useful in the fields of computer graphics and imaging to accelerate the reproduction processes.

In this paper, we present a novel process to control the skin melanin texture over a continuous range. The process is implemented on graphics hardware and can achieve real-time processing for a live-video stream. A component map of melanin texture is utilized, which was extracted from a skin color image by our previous method [Tsumura et al. 2003]. A feature vector is calculated from the extracted melanin texture and shifted in a feature space to control the melanin texture over a continuous range. The feature space is constructed based on the texture database to extract physiologically plausible changes in the melanin texture.

Continuous control of melanin texture

Figure 1 shows an overview of the process to control the skin melanin texture. The input texture is decomposed into layers by the Laplacian pyramid method. The feature vector f is extracted to represent the histograms of the layers by using the parameters σ, γ of the Gaussian and exponential distributions. Principal component analysis is applied to the feature vectors of 123 samples of the melanin texture from our own database to extract the physiologically plausible space of changes. The obtained principal component vector p is shifted in the principal space to control the melanin texture. The shifted vector is inversely transformed into histograms of the layers. The pixel values at each layer of the input texture are transformed by a lookup table created for matching the original histograms and the transformed histograms synthesized by the shifted feature vector. The transformed layers compose the synthesized texture. Figure 2 shows that the texture is animated continuously based on the proposed skin texture control.

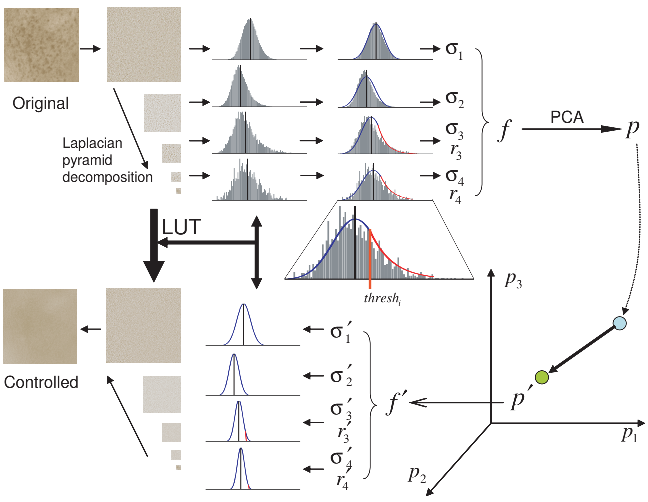


Figure 1: Control process of skin melanin texture

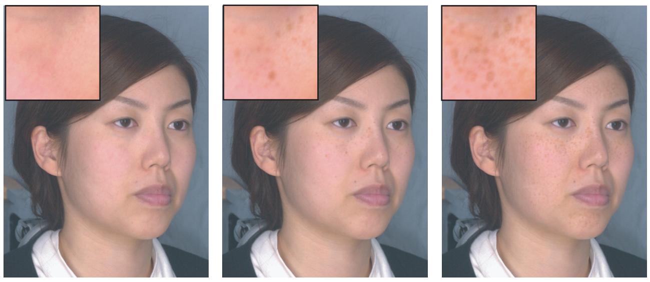
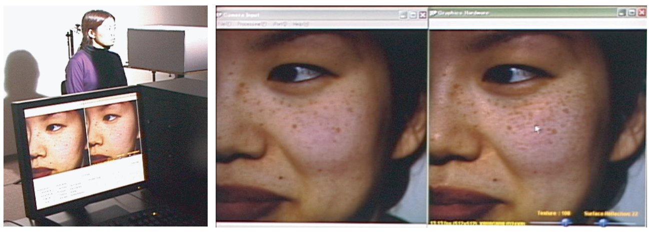


Figure 2: Continuous melanin texture controls based on the data-driven physiological model from the skin texture database.

Real-time processing

For real-time processing, a beam splitter is placed between two cameras at 45 degrees. The two video signals obtained through the different orientations of the polarizer are digitized into the personal computer. In the computer's CPU, the two images are processed into specular, shading, melanin and hemoglobin components. This operation is achieved at 25 frames per second by using a lookup table for the diffuse reflection image. All components are transferred into the graphics processing unit (GPU) for control of the texture by user interface tools such as the mouse and keyboard. The graphics hardware synthesizes the controlled components of the image to display on the monitor. The graphics processing unit can perform at 28 frames per second in these processes, but only 17 frames per second performance for video stream processing is possible due to the bottleneck at the connection between the CPU and GPU. Figure 3 shows examples of the real-time processing of a human face.



(a) Overview of the system (b) Change in texture:(Left)original image, (Right)synthesized image.

Figure 3: Real-time processing using our developed system.

References

Tsumura, N., Ojima, N., Sato, K., Shiraishi, M., Shimizu, H., Nabeshima, H., Akazaki, S., Hori, K., and Miyake, Y. 2003. Image-based skin color and texture analysis/synthesis by extracting hemoglobin and melanin information in the skin. In *Proceedings of SIGGRAPH 2003*, ACM, 770–779.