Comparative impression analysis between real and virtual human skins

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INTRODUCTION

It is a common problem for many people to keep their skins fine, and there have been huge number of cosmetics products. We have developed of image recognition and geometric modeling technique for impression analysis of human skins [1]. The technique firstly extracts parameters of micro-geometry of human skins from real photographs, as shown in Figure 1. It then constructs similar micro-geometry of human skins by a polygon-based shape modeling technique with the parameters including radii of pores and directional distribution of furrows, extracted from the real photographs, as shown in Figure 2. This poster introduces the impression analysis results of the skin images generated by our skin simulation technique.

USER EXPERIMENT AND IMPRESSION ANALYSIS

We conducted a user experiment of real and virtual human skins for comparative impression analysis. We asked 26 female students to participate this experiment. The procedure of the experiment was the following:

1. Take close-up photographs of cheeks of participants by using a special microscope camera.
2. Ask the participants to answer the impression of their own skins as five grade evaluations with predefined sensitivity words after looking at the photographs.
3. Acquire the parameters from the photographs.
4. Generate virtual skins by applying our micro-geometry skin simulation technique with the parameters.
5. Ask the participants again to answer the impression of the virtual skins.

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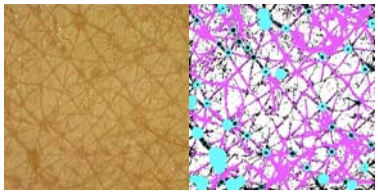

Figure 1. Image recognition for parameter acquisition. (Left) Real photograph of a well-cared skin. (Right) Image recognition result. Sky-blue portions denote pores, while pink portions denote furrows.

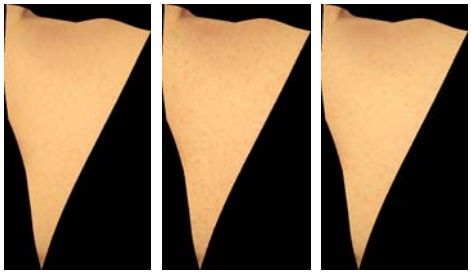

Figure 2. Virtual skin. (Left) Well-cared skin. (Center) Pore-expanded skin. (Right) Dry skin.

We used the following 18 words, *hydratedness, fluffy, smoothness, silky smoothness, clarity, fine-texture, freshness, rustleness, moisturized, favorability, softness, resilience, stickiness, vibrancy, brightness, dullness,* and *polish*, as "sensitivity words".

Meanwhile, we divided the close-up photographs of the 26 participants to the following five groups,
Group 1: *Especially well-cared*,
Group 2: *Relatively well-cared*,
Group 3: *Relatively rough*,
Group 4: *Especially rough*, and
Group 5: *Pore-expanded*,
from the viewpoints of experts in cosmetics.

We calculated the average scores of the participants for each group, for each sensitivity word. Average scores are shown in the below polyline charts, where the X-axis denotes the sensitivity words in the above mentioned order, and the Y-axis denotes the average scores.

Result with real skin images

Figure 3 shows the average scores for the real photographs. We found expected results as follows:

- Average scores of Group 1 were higher than others with several words such as "hydratedness", "fine-texture", and "freshness".
- Average scores of Group 5 were actually lower than others with several words such as "clarity", "freshness", and "favorability".

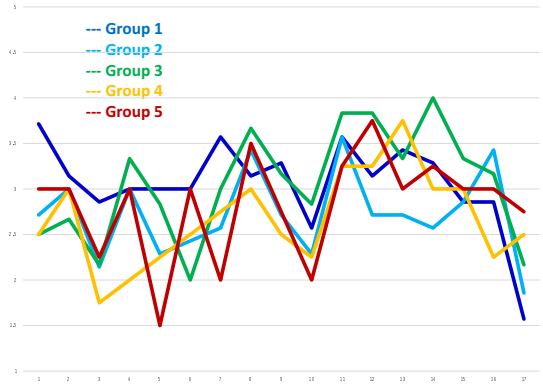

Figure 3. Average five grade scores for real skins.

We also found the following unexpected results:

- Average scores of Group 3 were higher than those of Groups 1 and 2 with many words, even though the condition of the skins in Group 3 was not better than those of Groups 1 and 2.
- Average scores of Group 4 were relatively high with several positive words such as "stickiness", and relatively low with a negative word "dullness", even though Group 4 was not good.
- Differences of average scores among the five groups were unexpectedly small with several words such as "rustleness", "moisturized", "favorability", "softness" and "brightness".

Results with virtual skin images

Figure 4 shows the average scores for the virtual photographs. We found the following results:

- Average scores of Group 1 were actually higher than others with several words such as "smoothness" and "rustleness".
- Average scores of Groups 2 and 3 were relatively moderate, consistent to the real conditions of skins.
- Average scores of Group 4 were totally lower with many words, except only a few words such as "moisturized" and "vibrancy".
- Average scores of Group 5 were lower with several particular words such as "clarity", "moisturized" and "polish", and higher with a negative word "dullness".

These results were surprisingly successful, because they denote better explanatory adequacy with virtual skin images rather than real skin images. Especially, it was expected that Groups 4 and 5 had worse impressions while using virtual skin images. On the other hand, the results contain inconsistency with Group 1 that the highly scored words were different between real and virtual skin images. These results suggest that our implementation adequately represent skins in bad conditions, while we need to improve for skins in good conditions.

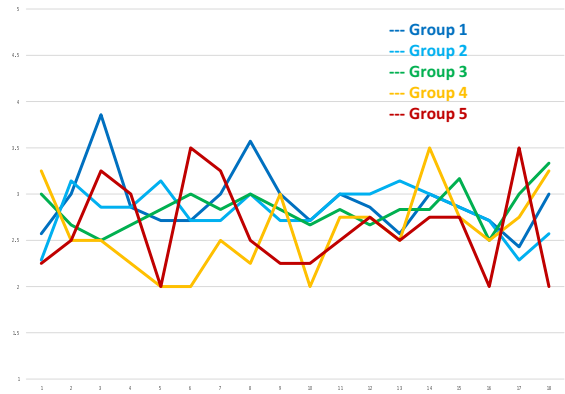

Figure 4. Average five grade scores for virtual skins.

Correlations between real and virtual skin images

Finally, we calculated the correlations of the scores between real and virtual skin images for each of the sensitivity words. We divided the sensitivity words as shown in Table 1 according to the correlations.

Table 1. Division of sensitivity words according to correlation between real and virtual skin images.

Strong positive correlation (>0.4)	moisturized (0.57), silky smoothness(0.56), vibrancy(0.50), rustleness(0.49), freshness(0.46), smoothness(0.45)
Moderate positive correlation	brightness(0.35), clarity(0.27), favorability(0.27), resilience(0.23)
Weak correlation (<0.2)	softness(0.17), hydratedness(0.16), polish(0.09), stickiness(0.09), dullness(0.07), fluffy(-0.03), fine-texture(-0.05)

We found that several words which associate micro-geometry, such as "silky" and "smoothness", actually got higher correlations between scores of real and virtual skin images. This result denotes our micro-geometry simulation for virtual skin image generation is effective for the impression analysis. On the other hand, we found lower correlations with several words which associate reflection or color information, such as "clarity", "polish", and "dullness", or face geometry, such as "softness" and "fluffy". This result denotes we need to improve reflection and color models for realistic rendering. Also, we need to have similar experiences with virtual images generated by mapping the micro-geometry to whole the face geometry.

REFERENCES

1. F. Banba, et al., Micro-Geometric Skin Simulation for Face Impression Analysis, *The Journal of Society for Art and Science*, 13(1), 11-20, 2014.