Quantitative Evaluation of Human Skin Surface Characteristics Based on Image Processing

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Thesis Abstract

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Thesis Summary

Skin changes depending on disease, aging or season and conventional skin measurement are not sufficient. Therefore, it is necessary to simultaneously evaluate a plurality of characteristics, while the conventional single-purpose device does not perform high effectively. Therefore, establishment of an objective evaluation method of skin condition using multi-measured skin scope and the image analysis technique aimed at this research is an extremely important task.

To assess skin condition objectively and comprehensively, several properties are involved in evaluation system, including skin hydration, skin sebum, skin micro-relief, skin color, and skin microbiological flora. Chapter 1 introduces the fundamental knowledge of skin structure and skin surface properties. What's more, an overview of existing measurement of these characteristics is provided. With rapid development of image processing technology, typical and classic image processing algorithms are given a presentation, as the basis for subsequent algorithms in Chapter 2 to 6.

Skin micro-relief relates to quite a few parameters, and it is hard to evaluate all of them at the same time. In chapter 2, we propose a quantitative evaluation algorithm of skin micro-relief and extract four aspects, including skin surface properties, skin pores, skin furrows, and the skin closed polygons. The age-dependent changes of them are explored, that most parameters increased as age went on with significant differences. In addition, skin coarseness is proved to be strongly related to the skin pore area.

Skin color is one of the most obvious features of the skin. According to the CIE-L*a*b* color model, we perform a skin color measurement in Chapter 3, utilizing the individual typology angle (ITA) and hue angle, indexes that are calculated from digital images with specific algorithms. The changes of skin color parameters by age, anatomical sites, and geographic locations are figured out.

Chapter 4 develops a novel approach to segment skin porphyrins induced by P. acnes from ultraviolet images, which has the potential to predict skin conditions as an assisted tool. We also investigate the age-dependent changes, that all parameters of porphyrins arrive at the peak at 30 years old.

Abundant hydration in the skin is quite important for skin barrier function. A prior study for quantitative evaluation algorithm of skin surface hydration by visible optical image processing is proposed in Chapter 5. Skin hydration content is successfully extracted which has a heavy correlation with the results measured by commercial instruments.

Chapter 6 establishes a comprehensive skin condition measurement system from 5 sides by combining the parameters extracted from Chapter 2 to 5. The measurement system is displayed as a radar chart with 5 levels. The integrated quantitative evaluation of skin surface characteristics has become reality so far. Finally, Chapter 7 summarizes the conclusions and imagines the future perspectives of this work.