# Development and Application of Image-Based Skin Diagnosis Technology using Deep Learning in Skin Research and Cosmetic Evaluation

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## Introduction:

The skin diagnosis is actively used in the cosmetics industry and related research fields in addition to medical purposes [1][2], and the market demand for the method of performing more easily and accurately skin diagnosis is increasing with the development of Online-market and personalized service. [3] Meanwhile, existing skin diagnosis methods using measuring devices require expensive equipment and can measure limited items by equipment. Conversely, image analysis-based skin diagnosis method is relatively inexpensive and can measure various items at once, however it has the disadvantage that it is difficult to use professionally due to low accuracy, or it is difficult to obtain quantitative data. In this study, we developed an image-based quantified skin diagnosis system that can quickly and accurately perform various skin diagnoses using artificial intelligence (AI) technology, and studied whether this technology can be used for skin aging research and cosmetic efficacy evaluation.

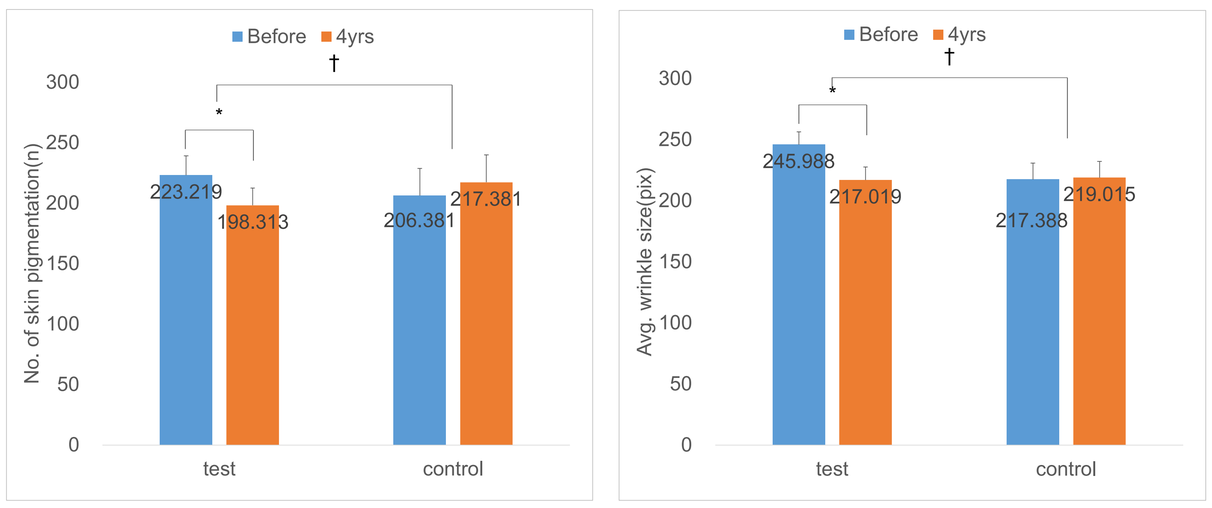
## Materials & Methods:

For the development of skin diagnosis system, 12,000 facial skin photograph patches were collected from Korean volunteers aged 19 to 79 years, the clinical experts labeled melanin, trouble, wrinkles and pores areas in each skin image. The A.I. skin diagnostic system was developed based on the encoder-decoder structure model which is initialized with ImageNet Pre-trained Weight and developed to calculate the area and intensity of each of the four items in the facial skin. To verify the diagnostic accuracy and performance of the system, 2000 facial photograph patches were evaluated as skin diagnosis system and three clinical experts. In addition, long-term skin anti-aging cosmetics studies and whitening cosmetics evaluation images were tested to check the applicability of the system's skin change study and cosmetic efficacy evaluation study.

## Results & Discussion:

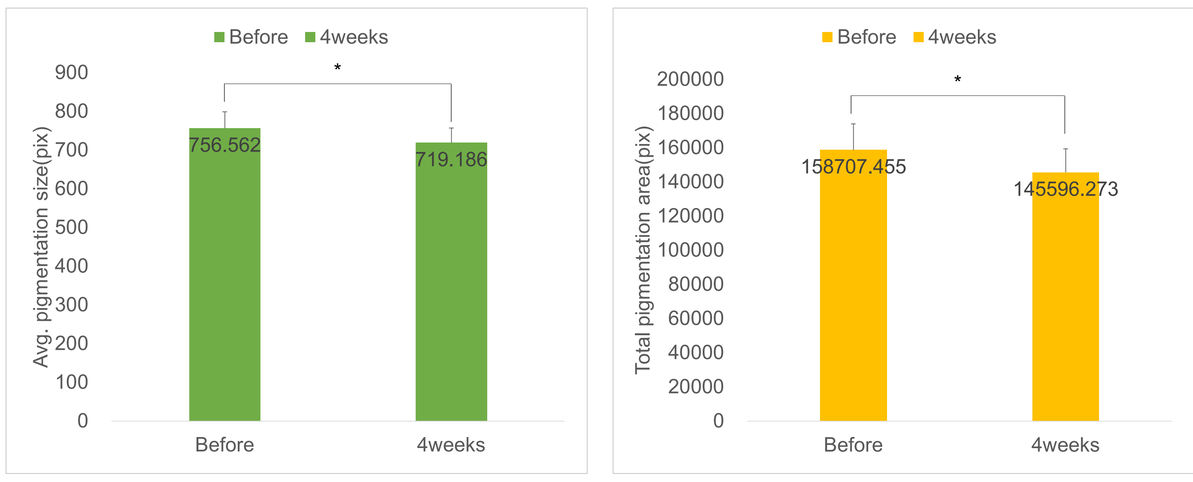
As a result of confirming the skin diagnosis performance of the A.I. image-based system in facial photos of various skin conditions, it showed an accuracy of 85% or more in all items, and showed a significant correlation with the evaluation of clinical experts on a set of over 2000 validation images. In addition, to confirm the possibility for skin research and cosmetic efficacy evaluation of the AI skin diagnosis system, facial imaging was performed on participants in the clinical efficacy evaluation of anti-aging products and whitening products. First, in the 4year long-term efficacy evaluation study of anti-aging products containing retinol, the group using the test product significantly reduced both the number of skin pigmentation and the average wrinkle size, and significantly decreased compared to the group using the control product. Figure 1. Next, as a result of analyzing the clinical efficacy evaluation image for 4 weeks of whitening serum containing TCTE, the average size of pigmentation and total area of pigmentation of the facial skin of the test subjects were significantly reduced. Figure 2. The developed optical image-based AI skin diagnosis system showed results close to the level of clinical expert judgment, and it was possible to quantitatively and visually diagnose four items of facial skin unlike existing cosmetic efficacy evaluation systems.[2] In addition, long-term skin aging change studies and clinical evaluation of anti-aging or whitening cosmetics containing retinol or TCTE have been successfully conducted [3][4], so it can be used as a system to evaluate long-term skin research and efficacy of cosmetics.

**Figure 1. Analysis result of AI skin diagnosis system in the study of long-term use of anti-aging products**




* by independent t-test at within groups, † by RM-ANCOVA between groups. ($p$<0.05)

**Figure 2. AI skin diagnosis system analysis result of whitening product clinical efficacy study.**




* by independent t-test at within groups. ($p$<0.05)

## Conclusions:

Skin diagnosis research using deep learning based on images is being tried in various fields, and it has advantages in terms of low cost, accuracy, and large data processing speed compared to existing professional measuring equipment or visual evaluation by experts. Unlike the existing image analysis, this AI skin diagnosis system was able to diagnose changes in various skin items judged by clinical experts, which could be effectively applied to skin change research or cosmetic efficacy evaluation. Additionally, this technology can quantify and visualize changes in actual skin condition, rather than simply grading based on expert judgment, to ensure the accuracy of diagnosis and to directly prove the efficacy of various skin changes or cosmetics to customers. The optical image-based automatic skin diagnosis system using AI makes it easy to track and collect long-term skin change data on a large scale, so it is expected as a technology for developing new services such as personalized skin diagnosis and customized cosmetics.

## References:

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