Optical Investigation of Skin Morphology and Anatomy

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Motivation

This project investigates skin anatomy and physiology by three optical, non-invasive techniques: Fringe projection topography mainly for the investigation of tissue topography, Parallel laser Doppler blood flow imaging for the investigation of tissue micro circulation, and Optical Coherence Tomography (OCT) assessing the anatomy and tissue morphology. The different methods are compared and contrasted with respect to their ability to analyze the microstructure of healthy human skin.

Fringe projection topography

Projection of illumination beams of appropriate periodic intensity distribution. A single image, of the projected patterns, distorted by the shape of the surfaces, encodes the object heights.

Fourier Domain data processing

Comparison of in vivo measurements on the skin with print data and optical coherence topography of the same area. The in vivo OCT images were obtained by two different methods. The left image shows the OCT images obtained by mechanical scanning. The right image, with 18,000 spectra per second, was obtained by OCT in Fourier Domain.

Optical Coherence Tomography

OCT is a non-invasive imaging technique used to visualize subsurface structure in biological tissues. Employing light at 1300nm one penetrates strongly scattering tissue such as skin down to 2mm. In Fourier Domain OCT (FD-OCT) a 1D depth scan is deduced directly by Fourier transform of a spectral interference signal. The lateral dimensions are obtained by mechanical scanning. With a current speed of 18,000 spectra per second one tomogram of 1000 lines takes only 55ms.

Laser Doppler blood flow imaging

Tissue is illuminated by laser light. Some of the photons are scattered by moving blood cells and undergo a frequency shift due to Doppler effect. The analysis of the spectrum of the intensity fluctuation yields the information about concentration and speed of the moving blood cells.

Summary

✓ A clinical study was performed on 19 volunteers including fringe projection and Laser Doppler perfusion imaging. The FP allowed to measure the effect of cosmetics.
✓ The LDI data gave no significant difference for treated and untreated skin.
✓ OCT yields depth resolved skin structure. The epidermal thickness was investigated for serving as indicator of skin health and skin status. A first study shows a tendency for the region of interest at the eye corner that only less than 20% of the volunteers' OCT images have sufficient contrast to extract the epidermal junction independent of gender but depending on age.

Reference