PhD Proposal 2017

School: Ecole Centrale de Lyon	
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Collaboration with other partner during this PhD: **In France:**	**In China:**

Title: Human skin characterization and analysis
Scientific field: Computer Vision, Pattern Analysis, Medicine
Key words: Human Skin Modeling, Multimodal Modeling, Skin Characterization, Skin analysis, Human Skin Aging

Details for the subject:

Background, Context:

The human skin has a complex multilayered structure that evolves with age. Numerical modeling and analysis of the skin has numerous applications in medicine but also in aesthetics, in computer graphics, etc.

The general structure of human skin is a stratified tissue into four layers which are, from surface to depth, the stratum corneum (thickness of about 0.02mm) the living epidermis (thickness of about of 0.06 mm), the dermis (thickness of about 1 mm), and the reticular dermis (thickness 1.1mm). The stratum corneum (SC) is the most superficial part of the epidermis. It consists of a stack of keratinized cells (corneocytes) which, in scanning electron microscope, appears as a pavement penta or hexagonal cells 26 to 45 microns in diameter. In transmission electron microscopy, the SC appears to be composed of 10-30 layers of flat cells of 0.3 to 0.7 microns thick. The surface of the skin tissue presents a particular morphology, which varies by region of human's body and its characteristics by region. It is formed by the association of tension lines shaped grooves, follicular orifices or sweat pores and the saillie of each corneocyte. Almost everywhere the main tension lines, first order lines, from 70 to 200 microns in depth, are oriented in at least two main directions and delimit the trays of various shapes according to the anatomical sites. The follicular orifices are located at the intersection of these lines while the sweat pores are preferentially on trays or in more superficial lines, said second-rate, deep 30 to 70 microns. The network of skin lines is already present at birth and its depth increases with age until puberty. On the human face, the aging also reveals wrinkles (depth 0.2 to 1 mm) and deep wrinkles (depth> 1 mm). Elsewhere, the deeper lines grows, the shallower disappear, and the surface skin is distended. The main function of the groove's network is mechanical. They allow, by flattening (partially), an extension of the epidermis and dermis. Thus, their anatomical arrangement for each region reflects the direction of mechanical stress to which the skin is subjected. In addition to the mechanical properties, the inhomogeneous character of the human skin provides complex optical properties. Thus, the characterization of the mechanisms of light propagation and absorption that determine the visual attributes of the human skin requires to carefully accounting for its biophysical and structural characteristics. The analysis of these characteristics brings the knowledge on how they affect skin appearance, which may vary considerably not only among different individuals, but also through the natural aging process and among different cutaneous regions belonging to the same individual. The appearance of human skin depends on spectral and spatial light distributions controlled by exogeneous and endogeneous factors. Exogeneous factors are associated with environmental conditions (e.g., illumination and temperature) and the presence of external materials (e.g., hair, oil, sweat, and cosmetics), whereas endogeneous factors are associated with skin constituents (e.g., pigments, cells, and fibers). The variations of these factors among the human population result in different spectral signatures and scattering profiles. Several photobiological processes that affect the appearance and health of human skin are triggered by light interaction with human skin.

Research subject, work plan:

In this thesis, we propose to investigate a multimodal parameterization strategy of the skin tissue in 2D and 3D, from shape and texture. To characterize by imaging the layers of skin tissue, this work will capitalize on the various advanced in three-dimensional imaging, such as confocal and interferometric microscopy, and hyperspectral imaging of skin tissue. If the first probes the biomechanical properties, the second address the biophysical and structural characteristics.

Indeed, three-dimensional microscopy has experienced in recent years a great change, both in terms of the rapid acquisition of images and information processing. The development of high-resolution devices has expanded scales X, Y, Z analysis of the morphology of biological surfaces, and gives the biologist and the clinician observation tools tissue at different scales. Moreover, hyperspectral imaging has recovered the characteristics of the skin through the analysis of the interaction of light with the skin.

Enhancing our expertise on 3D modeling, analysis, and human skin characterization and analysis, the study and characterization of chronological process of the human skin would be conducted based on multimodal analysis, classification and recognition. This approach is valuable in many applications such as computer vision, cosmetics, medicine, photo-aging, etc.

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