Caractérisations de la diffusion de la peau

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Résumé

La peau humaine est un organe suffisamment complexe pour caractériser un individu, de par sa structure spatiale, la couleur de celle-ci, ou sa qualité, quantifiable par l’état des pores de la peau. Ce papier présente une technique d’analyse de la réaction de la peau quand on l’éclaire avec de la lumière de différentes longueurs d’ondes. consistant à utiliser un faisceau lumineux et capter la diffusion de celle-ci sur la peau. On propose un système permettant d’évaluer la diffusion de la peau, captée par une photodiode montée sur un bras motorisé, dont le signal utile est converti en tension et envoyé dans un système de traitement de données. Nous avons extrait des caractéristiques de la peau pour 7 sujets, et l’on présente un système de traitement permettant la reconnaissance à NC% des sujets sur l’échantillon de test, via les données de diffusion, mais également de spectrophotométrie couplées aux données du capteur.

Introduction :

* Prendre la these de spectral imaging and analysing human skin / kusse BERSHA, intro, et la faire en 3-5 lignes
* Regarder l’évolution historique du sujet

Notre motivation à été de caractériser la peau, en utilisant la spectrophotométrie, et l’absorption nous montre la pigmentation de la peau et les pathologies liées à l’épithélium, de manière non-invasive.

La problématique est de caractériser les anomalies. On peut se servir de cette technologie dans les domaines de la médecine, cosmétologie, et de la biométrie.

On a mené cette approche pour caractériser le facteur diffusion de la peau pour en tirer des informations sur la peau.

Le but à été d’identifier des régions sous-cutanées coresspondant à une vascularisation anormale des tissus conjonctifs

In this paper, a system, consisting a sensor mounted on a rotating axe around a stepper motor in order to calculate a polar diffusion diagram of skin sample which is based on its reflectance rate, is presented. Moreover, a spectrophotometer is used to gather the data of the tissue as a spectrum in visible wavelengths. Once, signal-to-noise ratio computation is performed, its data feed a processing system to characterize each sample and then, a cross-validated recognition task, achieving NC% accuracy and legitimizing the biometric application of this method, is executed.

Les deux premiers paragraphes annoncent le contexte, le troisième la problématique/motivation, le quatrième on pose le problème.

Introduction

Skin is the largest organ of the body and the most discriminative part of the recognition task of different human beings. Its inner characteristics of humidity determines the quality of the skin pores [1], and the skin chromophores constitutes the main element of interaction with light [2]–[4]. The melanin rate is used to make a barrier to avoid harmful exposure of electromagnetic radiations in the environment [5], and the oxy-hemoglobin which can be found in veins can inform suffocation or breath irregularities of the human being [6]. Moreover, the blood flow can be analyzed in order to determine the heartbeat of the body, among other uses [7]. The skin has very specific properties studied in different fields as in cosmetics (how to make more efficient products that penetrate the skin/protect it [8]), computer graphics (in order to emulate realistic tissues [9]), and medicine to evaluate irregularities of the skin, and human health [10].

Optical Analysis of human skin is a non-invasive way to observe skin physiology, morphology and composition. For instance, white light can be used to obtain a spectrum which is useful to analyze the skin and also all the quantitative variations related to skin components. Reflective properties are used to identify and recognize humans by presenting a part of their skins, as in biometrics, and to detect spatially distributed irregularities such as veins or abnormally vascularized regions, melanomas or malign tumors. In fact, different skin tissues have distinct or unique reflectance pattern which helps to differentiate different skin conditions [2], [11], [12]. Hence, the idea behind the diffuse reflectance is that light reflected from a target tissue provides information on the quantity of melanin pigment and its chemical structure, oxygenated and deoxygenated hemoglobin, carotene, and also the chemicals [13], [14]. This information, based on biochemical composition and the structure of the tissue, does not only indicate the presence and location of the pathology, but also indicates where the pathology has originated, also contributes to find the most appropriate treatment to cure the pathology by observing the characteristics of the tissue if it is needed [11], [12].

Those characteristics and the recent developments in analytical techniques of the skin, made us think about what kind of system should be envisaged to identify individuals in terms of biometrics. Thus, analyzing diffusion diagram of the skin, and the spectrum of skin diffusion by using certain wavelength is proposed.

In the first section different physical aspects of the interaction of light with skin are introduced. Then the measurement system is described and characterized. In the second section, samples, measurement protocol and results are presented. In the last section before conclusion, the obtained results are analyzed and discussed in terms of efficiency for biometric applications.

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Références a ajouter

Introduction

Optical Analysis of human skin is a non-invasive way to observe skin physiology, morphology and composition, relevant in medicine, cosmetics and biometrics. In optical analysis, continuous light is used to obtain a spectrum which is useful to analyze the skin and also all the quantitative variations related to skin components.

Continous light, referred to a light intensity measurement, has been used to investigate the human tissue in a non invasiveve way, since 19th century (Bright, 1831; Curling, 1856; Cutler, 1929). In 1862 german scientist Hoppe-Seyler, described the spectrum of oxyhemoglobin (O2Hb) (Perutz, 1995) and in 1864 Stokes from United Kingdom contributed by observing deoxyhemoglobin(HHb), eventually, the importance of haemoglobin for the oxygen transport is discovered (Perutz, 1995). In 1876 von Vierordt who is also from Germany, measured the spectral changes of light by penetrating the tissue while the blood circulation was occluded (Severinghaus, 2007; von Vierordt, 1876) and Hüfner observed absolute and relative amounts of O2Hb and HHb in vitro (Hüfner, 1894).

After decades of no relevant research in spectroscopic observation of tissue, in 1930s the researchs were retaken in this field. Matthew and Gross demonstrated the spectroscopic determination of O2Hb and HHb in human tissue by using two wavelengths such as; red and near infra-red.

The most important step was the discovery of the Beer-Lambert law, related to the attenuation of the light to the properties of the material through which the light is traveling, with the contribution of French mathematician Bourguer in 1729. However, although the Beer-Lambert law work only in non-scattering media condition, it could not be applied to biological tissue. Therefore, modified Beer-Lambert law (MBLL) was proposed by Delpy (Delpy et al., 1988), in order to take into account the light scattering. Most of the important steps are also the analytical solutions of the diffusion equation to describe the light transport through the tissue in a quantitative way ( Arridge et al., 1992; Patterson et al., 1989).

* Motivation : Pourvoir détecter des zones fortement vascularisés, cancer dans les tissus épithéliaux ; Pouvoir identifier des personnes via la présentation de leur peau
* La peau diffuse d’une certaine manière
* Photodiode -> Intégration sur le spectre total (émission\*diffusion\*reception)
* Diagramme angulaire de diffusions -> information sur l’hydratation de la peau par système optique
* Spectrophotométrie -> Spectre dans le visible, de réfléxion de la peau
* Capteur CCD -> Agencement spatial de la peau -> Veines, biométrie, données de forte caractéristique

Evaluation de la diffusion de la peau

* Photodiode, équation mathématique, corrélation des taux de mélanine, oxyhémoglobine, eau
* Système optique, etc
* Quelle bonne longueur d’onde d’émission/absorption à regarder

Description du modèle

* Montage, etc
* CAN 16 bits pour la précision
* Caméra afin de faire du « binning » sur les valeurs de la photodiode ?

Protocole d’expérimentation, Analyse et tests

* On a présenté, pour chaque sujet, une portion de peau au système correspondant au revers de la main. Nous avons effectué les mesures en faisant un balayage de la photodiode sous différents angles. Nous avons varié légèrement la portion de peau. Ensuite on a présente cette même portion de peau au spectrophotomètre
* On a obtenu des mesures de tension de la photodiode sur un certain intervalle de temps avec le faisceau éteint puis allumé, et également des spectres d’absorption
* On fait les mesures de bruit, variance, et on transforme en vecteurs caractéristiques
* On implémente un k-ppv à 1 et on obtient un taux de reconnaissance en cross-validation

Discussion

* On aurait pu utiliser le monochromateur, étant donné que nous avons eu une démarche expérimentale pour trouver une bonne valeur de longueur d’onde pour l’absorption, et un bon angle de diffusion, le système aurait utilisé ces deux informations.
* On a expérimenté sur d’autres photodiodes mais on aurait pu expérimenter sur des photodiodes avec de meilleurs caractéristiques, faire des amplifications/filtrages spécifiques…
* Améliorer le code, on aurait pu aussi faire du multimodal avec des images, pour avoir un agencement spatial, faire de la biométrie : images de la segmentation de veines

Conclusion

Nous avons présenté un système, les entreprises font de la recherche/développement sur ce domaine comme le VeinViewer (amélioration de la vision des veines sur la surface de la peau) ou le Sony Beauty Explorer (LED dans le visible et le NIR, puis CMOS) pour voir la couleur, pigmentation, humidité, condition des pores…

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