Sensor-Dependent Skin Color Detection and Skin Tone Prioritized 3A Control

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Skin color detection plays an important role in people tracking, in filtering out adult content images, or in facilitating human-computer interaction. It is very useful for skin detection as a cue for detecting people in real-world photographs. After skin color area is detected, methods can be applied to enhance the skin color so that preferred color is reproduced. It can also be useful to improve the camera exposure or focus control when skin color is detected such that the skin tone is optimally captured. The main challenge is to make skin tone detection robust to the large variations in appearance that can occur. Skin appearance changes in color and shape and is often affected by occlusion, such as clothing, hair, eye glasses etc. Moreover, changes in intensity, color and location of light sources affect skin appearance. Other objects within the scene may cast shadows or reflect additional light and so forth. Imaging noise can appear as speckles of skin-like color. Many other objects in the world are easily confused with skin: wood, copper, sand and clothes. Many skin color detection approaches are based on the assumption that the skin colors cluster in chroma plane no matter what the luma is, however, it has been verified that this is not true. In addition, the training images are often obtained through web searching, which are taken under all kinds of illumination conditions with unknown types of sensors in which the signals may be processed differently. The derived skin color classifier from these images can hardly guarantee detection accuracy. In essence, the skin color cluster is illuminant-dependent, luma-dependent and sensor-dependent. The proposed skin tone detection in this study tries to solve these three difficulties: The characteristics of a sensor under multiple types of illuminants are calibrated based on a predefined imaging procedure, and the skin tone region in the target color space is modeled through the correlation between a training set of skin color reflectance spectra and the reflectance spectra of standard test target which are used to calibrate the sensor.

Skin color is mainly determined by the epidermis transmittance which depends on the dopa-melanin concentration and it has been well known that the skin color reflectance spectra can be represented with limited number of basis functions, so does the printed test targets, such as Macbeth ColorChecker (MCC). The skin reflectance spectra can be represented as the linear combinations of MCC reflectance spectra. If the sensor response is linear or linearized, the RGB of skin spectra can be linear represented as the linear combinations of RGB of MCC. As the color conversion matrices and gamma function of the sensor is optimized based on MCC and the imaging noise is measured simultaneously, the possible skin colors can be predicted from the whole process. The skin color classifier is built in YCbCr color space, where Y is partitioned into multiple levels in each of which the skin color region is modeled as an ellipse in the CbCr plane. In addition, to discount the illuminant influence, the classifier is calculated for daylight, tungsten and fluorescent light individually. Through these steps, the skin tone can be detected accurately. Moreover, the skin tone region is applied into camera exposure and focus control to prioritize skin tone. A demo is created to illustrate that the skin tone is kept in optimal exposure no matter how the surroundings change.

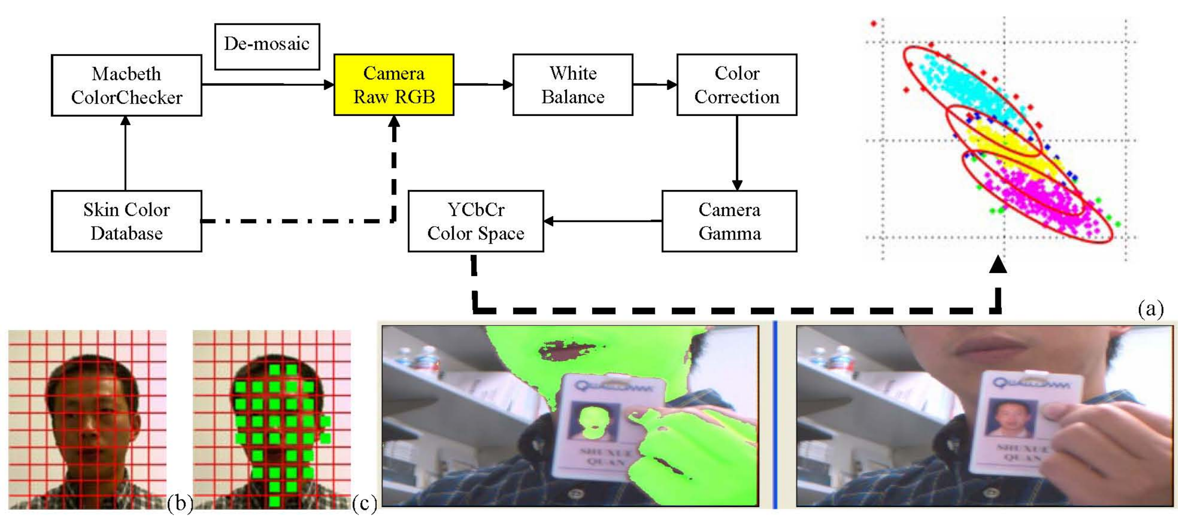

Figure 1. *(a) The flowchart of sensor-dependent skin color detection, where the skin color cluster is illuminant-dependent, lumadependent and sensor-dependent; (b) image is partitioned into multiple blocks; (c) after skin color is detected, mark the blocks where skin color is dominant; (d) skin color detection demo where the skin color area in the image is prioritized for automatic exposure control such that the skin color is optimally captured.*