(2)

1-10-② 張瑾文

Hand detections based on invariant skin-color models constructed using linear and nonlinear color spaces

Cheung-Wen Chang[†,‡], Yung-Nien Sun[†]

[†]Department of Computer Science & Information Engineering, in National Cheng Kung University,

[‡] Department of Information Management, in Chia-Nan University of Pharmacy and Science, Tainan, Taiwan, ROC (correspondence: Y.N. Sun; e- mail: ynsun@mail.ncku.edu.tw)

Abstract

Hand detections based on two proposed pixel-based skin-color models are proposed. Different from the conventional methods, the proposed models are built on the invariant surface obtained by supervised learning on nonlinear color space which effectively preserves vital properties of skin colors in low illumination. By using a high-dimensional feature space, which incorporating probability of fitting the invariant surface with a nonlinear mapping value of chrominance in linear space, first skin-color model is proposed as a thresholding method according to feature values of pixels. Subsequently, a second skin-color model is constructed based on a parametric region which maps the learning data on an invariant surface. This mode achieves more favorable skin-color segmentation results than the conventional methods in experiments.

1. Introduction

An accurate pixel-based skin-color model is crucial for achieving successful faces or hands detection in real applications [1-3]. It mainly relies on a good selection of color spaces which provides sufficient information to separate skin-like colors from non-skin ones.

For the last decade, several studies on skin detection have been developed using skin-color segmentations. Using a linear color space, the Cr value in YCbCr model is used to discriminate skin colors with a biased red chrominance (Cr=R-Y) which represents a more reddish extent of pixel color. Most of skin colors have been investigated as being inside a certain range of Cr [4]. In nonlinear color space, the H channel in HSV or HIS space has been examined to be effective in representing skin colors under varying lighting. In addition, a modified nonlinear color space of LUX has also been explored to segment faces excluding the lip pixels effectively [2]. It appears more accurate in detecting skin colors by refusing similar colors, such as that of lip.

This paper intends to build two skin-color models for hand detections. By using the proposed nonlinear color space which records three invariant color features, an invariant surface is learned for most representative of skin-colors. Subsequently, on this surface, the first model is built by integrating with Cr information, and the second one is constructed directly according to a certain region on invariant surface. The experimental results of the proposed model are compared with the results of three conventional color spaces and show more favorable performance.

2. Methods and Materials

2.1 Color Spaces on skin-color detection

In general, the chrominance Cr provides useful information for skin-color detection and segmentation [4]. But the drawback of using Cr is its incapability in highlighting reddish (or skin-like) colors for low-illumination condition because both the R and Y values are too small at the same time. On the other hand, the biased H channel in nonlinear color space (HSV) is expressed in equation (1) where the biased data H_{bias} is added to emphasize the skin colors with more apparent values. This value is 0.5π here.

$$H = \cos^{-1}\left(\frac{\frac{1}{2}((R-G)+(R-B))}{\sqrt{(R-G)^2+(R-B)(G-B)}}\right)+H_{bias} \qquad (1)$$

In another modified nonlinear color space LUX [2], the U channel is used to retrieve skin colors and exclude the reddish color with high saturation values. Using the exponential luminance L, the U encourages the middle-range saturation reddish color but depresses the color approaching to the pure red. The drawbacks for HSV and LUX are similar; they appear noisy and unstable for low illuminated pixels.

2.2 Proposed nonlinear color space