A Review on various Techniques for Human Skin Detection

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Abstract— In image processing application such as face detection, face tracking, gesture analysis, human computer interaction etc. human skin detection in images or videos plays an integral role. This process is typically used as a preprocessing step to find regions that potentially have human faces and limbs in images. Several computer vision approaches have been developed for skin detection.
Key words: PSO Algorithm, Human Skin Detection

I. INTRODUCTION

During the last several decades Automatic skin detection has become a most challenging topic. The correct classification rate and response time are an important requirement for automatic skin detection. There are two major problems such as what color space to choose and how exactly skin color distribution should be modeled. There are few techniques are describe in this paper.

To improve face and skin detection performance Color space transformation is mostly used by researchers. In this paper, authors proposed a new three-dimensional hybrid color space termed *SKN* by employing the genetic algorithm heuristic and principal component analysis to find the optimal representation of human skin color in over seventeen existing color spaces [1]. Genetic algorithm heuristic is used to find the optimal color component combination setup in terms of skin detection accuracy while the Principal Component Analysis projects the optimal genetic algorithm solution to a less complex dimension. Pixel wise skin detection was used to evaluate the performance of the proposed color space. The proposed color space was compared to some existing color spaces and shows superior results in terms of pixel-wise skin detection accuracy.

Using color information the robustness of skin detection depends on real world conditions like background, noise, change of intensity and lightening effects. To improve this situation they used texture as a descriptor to extract skin pixels in images [2]. This study proposes color based skin detection algorithm with a texture based skin location algorithm called Modified Weber's Law Descriptions (MWLD) to evaluate region features, which is based on the fact that the Human Visual System (HVS). In MWLD, the differential excitation and gradient orientation of the current pixel are considered to extract the texture features; Just Noticeable Distortion (JND) is also used for differential excitation. Further the Cr component of YCbCr color space is included to obtain the color features.

R. Vijayanandh and G. Balakrishnan proposed an application of human skin region detection using Hybrid Particle Swarm Optimization (HPSO) algorithm. In this technique there are two steps. The first step is the input RGB color image, which is converted into CIEL*a*b color space [3]. Then this is clustered by the Hill climbing segmentation with K-Means clustering algorithm, which will be useful to find the number of clusters and the local optimal solutions. Secondly, these local solutions are further improved by PSO algorithm using YCbCr explicit skin color conditions in order to find the global solution. This solution helps to detect the robust skin region. At last the performance measured as Peak Signal-to-Noise Ratio (PSNR) is performed on the ground-truth skin dataset.

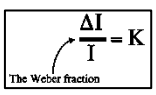
II. METHODOLOGY

A. Genetic Algorithm Heuristic Search and Principal Component Analysis Technique

In this technique authors proposed a new hybrid color space, which is achieved by applying GA heuristic and PCA technique to seventeen existing color spaces including HSI, HSV, LAB, LUV, nRGB, RGB, TSL, XYZ, YCbCr, YCgCr, YES, YIQ, YPbPr, YUV i1i2i3, RIQ and YQCr. Genetic Algorithm heuristic searches for the optimal color component combination setups in terms of skin detection accuracy while PCA projects the GA optimal solution into a lower dimensional space [1]. The given color space has been termed *SKN* (taken from word "Skin") where "*S*" resembles the 1st Principal Component, "*K*" denotes the 2nd Principal Component and "*N*" indicates the 3rdPrincipal Component of the GA optimal solution. to measure and compare the performance of the proposed color space in terms of skin detection four classifiers have been used such as Naïve Bays, Random Forest, SVM and Multilayer Perception. This method showed that the proposed hybrid color space improved skin detection accuracy is as compared with existing color spaces. The given color space can be used in wide range of skin detection applications ranging from face detection, tracking body parts and hand gesture analysis, to retrieval and blocking objectionable content.

B. Fusion of Color and Modified Weber's Law Descriptor Technique

Weber's Law- Weber's Law states that the ratio of the increment threshold to the background intensity is a constant. So in a noisy environment you must shout to be heard while a whisper works in a quiet room. And when you measure increment thresholds on various intensity backgrounds, the thresholds increase in proportion to the background.



The fraction $\frac{\Delta I}{I}$ is known as the Weber fraction (aka Fechner fraction). If rearrange the equation to ΔI=IK, it shows that Weber's Law predicts a linear relationship between the increment threshold and the background intensity [4]. This hypothetical data showing Weber's Law and The slope of the line is the Weber fraction.

In this paper, skin regions are identifying by the fusion of color and texture. This algorithm is implemented in two phases firstly color feature extraction secondly texture feature extraction. The equation to find the skin feature of the image at (x, y) using the color feature and the texture feature is given by Equation (1):

$$P(x, y) = TLx, y + b * Ttx, y \quad (1)$$

Where:

b = gain constant

TL x, y = color feature

Tt x, y= the texture variations which is calculated by using MWLD and JND

Basically the performance of the detection technique is estimated by Receiver Operating Analysis (ROC) and Area under Curve (AUC). For visualizing, organizing and selecting the methods based on their performance ROC graph technique is used. And to depict the characteristic of ROC False Positive and False Negative, True Positive, True Negative, are the parameters used. The development of detection methods and comparative study of the proposed technique are fully based on the two parameters such as True Positive Rate (TPR) and False Positive Rate (FPR). This further helps to draw the ROC curve. TPR and FPR are given by:

TPR = Total no. of pixels detected correctly as Skin Pixels/Total No. of Skin Pixels = TP/P

FPR = Total no. of pixels detected correctly as Non Skin Pixels/Total No. of Non Skin Pixels = FP/N.

To analyze the performance of the proposed method area under ROC is used. If two models have high TPR and similar FPR is considered as good one. For high FPR the reverse process is taken. The ROC curve for the proposed and the existing methods are possible to analyze and compare this with the existing methods. AUC for the proposed technique is highly compared with the existing ones. For medium to high TPR, this technique performs well. Likewise, for low TPR, all technique is performed similarly. After JND, no illumination compensation is required. In this method, both color and texture features of the images are combined, which further results to obtain the skin tones. More skin tones are detected by the use of textures, and by comparing the existing techniques.

C. Hybrid Particle Swarm Optimization

Authors R. Vijayanandh and G. Balakrishnan proposed a technique, which deals with 3D Histogram, local and global optimum solution and dynamic cluster formation. Using Hillclimbing segmentation with K-Means clustering algorithm of CIEL*a*b color image the local optimum solutions are determined. Further it refined using the PSO algorithm, to find the global solution by YCbCr color space explicit skin color conditions. Particle Swarm Optimization was originally introduced by Kennedy and Eberhart [14], inspired by social behavior of fish schooling or bird flocking.

In PSO, a swarm of individuals which also called particles fly through the search space. To the optimization problem each particle represents a candidate solution. The optimization techniques are Simulated Annealing, Genetic Algorithms, Ant Colony Optimization algorithms and Particle Swarm Optimization. In that, PSO has been applied to various different applications of segmentation [1],[7], pattern classification and image analysis. The position of a particle is assessed by the best position visited by it and the position of the best particle in its neighborhood. Further when the neighborhood of a particle is the entirely swarm, the best position in the neighborhood is referred to as the global best particle and results as a *gbest* PSO. The algorithm is generally referred to as an *lbest* PSO When smaller neighborhood is used. Using a fitness function that varies depending on the optimization problem [8] the performance of each particle is measured. It is a population based stochastic optimization technique in which individuals called particles change their positions and velocity with time. Also PSO is easy to implement for its simple particle updating operation. The proposed PSO algorithm based skin region segmented image.

III. CONCLUSIONS

In this paper, we have proposed different methods for human skin detection. At first proposed system Genetic algorithm is used which is fully based Heuristic Search and Principal Component Analysis Technique. They optimize color component combination setups in terms of skin detection accuracy. In second method Fusion of Color and Modified Weber's Law Descriptor Technique, both color and texture feature of the images are combined to obtain the skin tones and having satisfactory performance. In third, a new skin region detection algorithm based on PSO was proposed. Dynamic formation of clusters by Hill climbing segmentation with K-Means clustering algorithm and the chrominance based global solution of the skin cluster found by PSO algorithm makes the process more robust to detect the skin region.

ACKNOWLEDGMENT

The authors would like to thank the referees for their valuable comments which helped improve the quality of the paper greatly.

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