Multimedia Computing

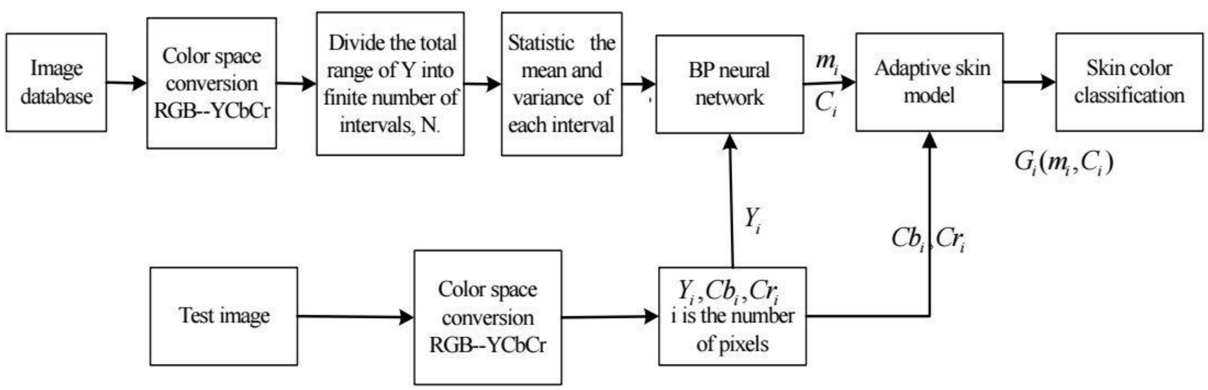
and Machine Learning Project

Comparative Study of Adaptive skin color detection algorithm based on YUV, YCbCr and YIQ model.

Charu Tak

Abstract

Several applications for example face detection for human-computer interaction and skin detection etc. are intensively used in the field of computer vision. Color based segmentation has proven to be one of the most successful ways of tackling the problem of segregating skin and detecting faces in image and video format. The characteristics of the skin color are mainly defined by the color spaces and the models used for their analysis. Various color spaces are being used commonly nowadays like RGB, YCbCr, CIE-XYZ, YUV, YIQ, HSV, Lab etc.



The objective of this project is to take into account this model in combination with the inspiration from several other research papers to test this model using the YUV, YCbCr and YIQ and compare the results and check their effectiveness. The model has been made according to different Y values as the chrominance components are not completely separate of the luminance part, as shown in the above-mentioned paper, therefore the adaptive model which adjusts to different Y will be formed.

Theory

Theoretically, the chrominance and luminance values get separated using YCbCr/ YUV/ YIQ model, but from the research paper [1] we found a direct correlation between the Covariances values for Cb and Cr and Y. Therefore, a simplistic model using only the chromaticity values fail to provide sufficient results in classifying the skin color pixels. The Approach uses the various values of Y to develop a luminance dependent model for classification of the pixel. Furthermore, the different color spaces provide different relationships and can result in various error rate.

Procedure

1. Data collected.

   Size = 555 images with masks

   Collected from

   ‘ https://archive.ics.uci.edu/ml/machine-learning-databases/00229/
2. Convert the RGB image into YUV, YCbCr and YIQ color spaces.
3. Collect the pixels which are marked as sin the masks of the corresponding images.
4. Arrange the values in increasing values of Y and divide the range into finite number of partition ‘N’.
5. Calculate the mean value of Y for each of the partition and covariance and mean for the corresponding Chrominance (U,V / Cb,Cr / IQ) for each of the partition.
6. Train the Neural Network using the N mean values for Y as the input and the covariance and mean of the Chrominance component as the output.
7. Develop a gaussian model using the statistical data found in the above step to determine the probability of a particular pixel to be skin. This model has been taken directly from the research paper.

   -> $P(Cb,Cr) = \exp(-0.5(x - m)^T C^{-1} (x - m))$

   Where, m = [mean(Cb) ; mean(Cr)];

   X = [Cb ; Cr]; // Cb Cr for the pixel to be used for prediction.

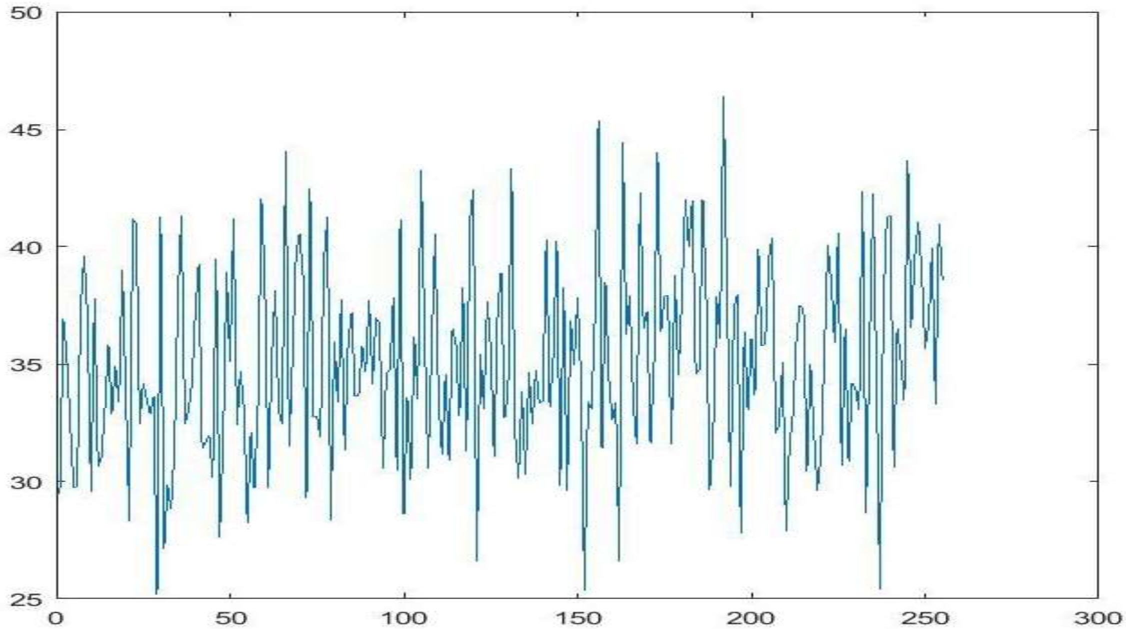
   $C = [\sigma_{CrCr} , \sigma_{CrCb} ;$

   $\sigma_{CbCr} , \sigma_{CbCb}]$

8. A threshold ‘T’ is set as to determine at what probability the pixel can be qualified as a skin pixel.
9. For every test image, each pixel is classified into skin or not skin and the mask is generated.

Experimental Data

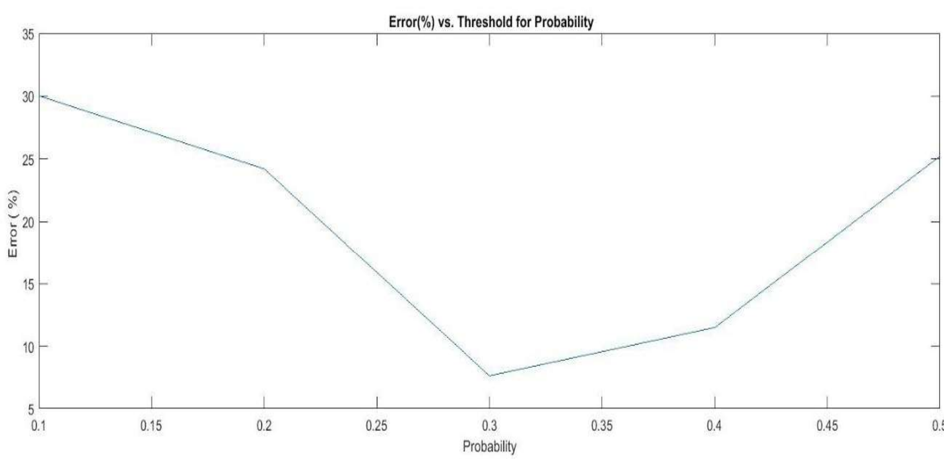
➢ Analysis using different values of N



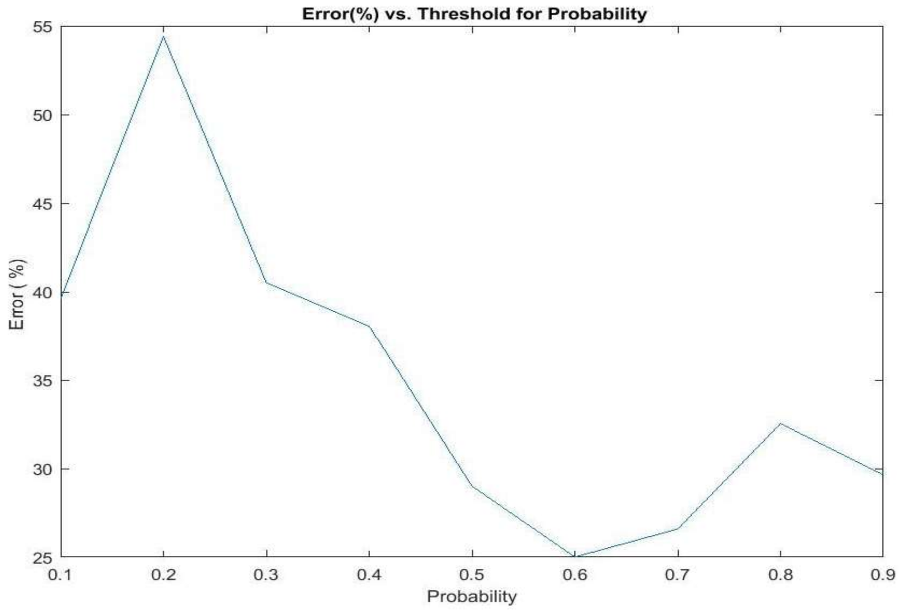
Error Vs. N

The value of N would be around 200 - 255.
Further analysis resulted in finalising N = 255.

➢ Analysis using different values of probability

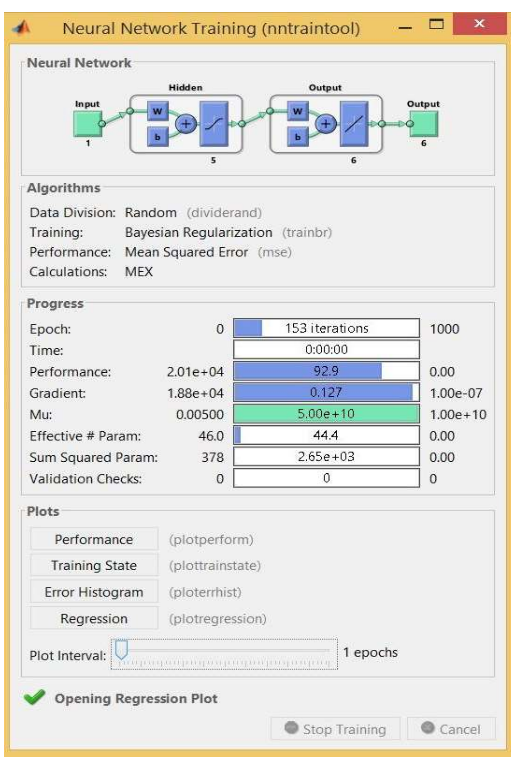


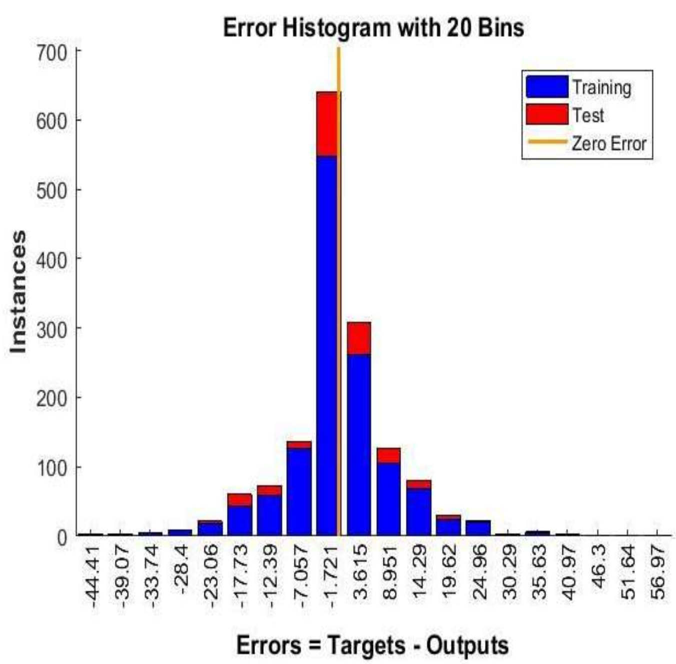
The value for probability chosen is 0.3 for YUV, YCbCr.



The value for probability chosen is 0.6 for YUV, YCbCr.

Neural Network: Training the dataset for YUV for N = 255, p = 0.25 and number of hidden layer neutron 10.
N = 255 ; P = 0.25; Hidden layer neutron = 10 ; Training = Bayesian Regularization





Results :-

The value of N selected = 255.
The value of Probability selected -
0.3 for YCbCr and YUV.
0.6 for YIQ

Test Case 1.

Original Image

Mask using YUV
Error = 9.92%

Mask using YCbCr
Error = 11.57%

Mask using YIQ
Error = 19.13%

Test Case 2.

Original Image

Mask using YUV
Error = 2.38%

Mask using YCbCr
Error = 3.25%

Mask using YIQ
Error = 13.07%

Conclusions

The YUV and YCbCr model work very well for classifying the skin and give satisfactory results, while the YIQ model has much lesser accuracy. The adaptive skin model works much better than the non luminance based model. Higher number of partition give better results. The above model can be further used to detect faces and skin for further applications.

References

1. *Research on a Skin Color Detection Algorithm Based on Self-adaptive Skin Color Model, Guoliang Yang,Huan Li, Li Zhang, Yue Cao*
2. *Face Detection in Color Images using Skin Color Model Algorithm based on Skin Color Information, Chandrappa D N*
3. *A Hybrid Skin Color Model for Face Detection,Vandana S. Bhat, Dr. J.D. Pujari, Bhavana*
4. *Adaptive Learning of an Accurate Skin-Color Model, Qiang Zhu Kwang-Ting Cheng Ching-Tung Wu Yi-Leh Wu*
5. *RGB-H-CbCr Skin Colour Model for Human Face Detection, Nusirwan Anwar bin Abdul Rahman, Kit Chong Wei and John See*
6. *Comparative Study of Statistical Skin Detection Algorithms for Sub-Continental Human Images,M. R. Tabassum, A. U. Gias, M. M. Kamal, H. M. Muctadir, M. Ibrahim*
7. *Face Detection Using Skin Tone Segmentation, Sayantan Thakur, Sayantanu Paul, Ankur Mondal*
8. *Robust and adaptable method for face detection based on color probabilistic estimation technique, Reza Azad, Fatemeh Davami*
9. *M Jones, J. Rehg, "Statistical color models with application to skin detection," International Journal of Computer Vision, Jan, 2002, pp. 81–96.*