Summary

Facial Age estimation using a hybrid of SVM and Fuzzy logic

The purpose of this research is to estimate the facial age of a human being. This research was carried out to develop a software tool that can predict the age of the human. To provide the inputs for the software, a huge data set of images was taken, and from each photo features like wrinkles and skin color were extracted. This extracted information was further given as input to the hybrid of Support Vector Machines (SVMs) and Fuzzy Logic (FL). The output of SVMs is an age group and FL uses this age group to estimate the point age of the person.

Human age can be estimated by the facial characteristics of a human. As a human grows older, his/her facial structure expands, due to repeated muscle movements. This expansion of skin causes changes in facial characteristics like change in skin color, formation of freckles and wrinkles. The age of a person was predicted using these facial changes. Freckles and wrinkles are nothing but visible edges in an image. Hence, using image processing edges were detected in 7 regions of a human face. The regions were forehead area, eyes corner, area under both eyes and cheeks. Sobel mask was used to detect edges and Gabor filter was used to enhance these edges. Skin color is also an important feature. As a person grows older, the melanin cell at the bottom layer of the skin gets damaged by the exposure of ultra-violet rays from the sun. This effects in the change in skin color of the certain facial regions. Change in skin color of both the cheeks was used as input to the SVMs. The image was converted from RGB to HSV. Then, the standard deviation is calculated for the images to obtain the change in skin color. So, 9 inputs were provided to the SVM to predict the age of the person. The classes of the SVMs were five age groups, namely A, B, C, D and E. Group A consisted of people with age less than 20 years. Group B consisted of people from age 21 to 30. Group C consisted of people from age 31 to 40. Group D consisted of people from age 41 to 50. Group E consisted of people with age greater than 50 years.

The output of the SVM was age group, which had a range of numbers. For more precise output, the point age or single value must be predicted. Hence, fuzzy logic is introduced in this system to take fuzzy input and give crisp output. Two inputs are provided to the inferencing system. The two inputs are wrinkles and skin color. The extracted 7 wrinkle values and 2 skin color values are normalized to form two inputs;

$$\text{Wrinkle} = \frac{\sum(feature\ 1{-}7)}{\max(feature\ 1{-}7)} \times 10 \qquad \text{Skin Color} = \frac{\sum(feature\ 8{-}9)}{\max(feature\ 8{-}9)} \times 10$$

Triangular membership functions were used for each input. The fuzzy sets formed were;

Wrinkle = {Low, Medium, High} and Skin color = {Low, Medium, High}

The output age group predicted by the SVMs is used as output range in FL and we get a crisp value from the predicted range. The output of FL also uses triangular membership function. Its fuzzy set is given by:

Age = {Low, Medium, High}

The inferencing technique used here is Mamdani fuzzy inferencing technique. Nine rule bases were formed using the two fuzzy sets. The Rule Base table is shown below:

Wrinkle \ Skin color	Low	Medium	High
Low	Low	Low	Middle
Middle	Low	Middle	High
High	Middle	High	High

After defuzzification using centroid method, we get a crisp or point age of the person, from the age group predicted by SVM.

Hence, the proposed method to use hybrid of SVM and FL together to estimate the age of a person was conducted successfully and it can help in various applications like facial recognition. The other ways implemented for Age Estimation are Signal and Image processing, Pattern recognition using hierarchical based on local and global facial features, Dissimilarity based classification, Hybrid SVR for facial features. The proposed method out performed other methods.