Acne Detection and Classification System

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Abstract

Acne is a skin disease which forms when hair follicles are blocked with oil or dead skin. In this paper, a functional image processing technique has been developed for acne detection and classification. An image of skin area affected with acne is being considered as the ROI (region of interest). This is taken into the experiment, which results in automatic markings of the acne and thereby extracting their features and performing the classification of the acne. The presence of acne in different parts of the face or body has different indication of skin diseases and might not be dangerous but depends on severity and leaves scar. Detecting different types of acne lesions is very important in both diagnosis as well as management. To access acne, clinicians and dermatologists use methods such as ordinary flash photography and direct visual assessment, which is time consuming. The classification of various acne types considered in this work include- Acne Cystic, Acne Excoriated and Acne Pustular. Experimental output can be summarized with 91.666% accuracy by using 20 images of each type.

Keywords — *Image Processing, Acne Detection, Acne Classification, Adaptive Threshold, Adaptively Regularized Fuzzy C- Means (ARFCM) clustering:, Haralick features, Naive bayes.*

I. INTRODUCTION

Acne is a skin disease that affects oil glands with inflammation or infection. It affects 3 in every 4 people aged 11 to 30 years. Acnes are usually expressed by red skin area with infection and erupt from a normal skin. It commonly occurs on face, but in fact, it can appear all over the body. It can be in any shape but the most regular shape is circular with various colours such as red, black, or white depending on the cause and stage. It may be caused when bacteria enters into fat glands and infects the skin or it can also be non-inflamed by the clogging of fat gland.

Causes of Acne:

There are various causes for acnes including genetic, hormonal, sebaceous gland activities, bacterial infection, and climate changes, chemical and psychological effects too.

Some of the specific causes are as follows:

- Food with high glycaemic ingredients such as rice, sweets, bread and pasta cause acnes. This is why balanced diet is necessary.
- If both the parents had acne, three out of four children will have acne
- If one parent had acne, then one out of four children will have acne.
- Some acne such as acne vulgaris skip generations.
- Hormonal activities such as menstrual cycle and puberty are one of the causes for acne.
- In hot climates, sebaceous glands produce more oily substance called sebum, which may cause acne.
- Chemical factors like facial wash and exposure to certain chemical compounds, may also cause acne.
- Stress is a psychological factor that makes sebaceous gland hyperactive and may cause acne.

A. Motivation

To provide accurate treatment it can be very challenging to manually analyse the acne conditions and patterns. Recently, many researches have been conducted on computational imaging methods for acne diagnosis supported by image processing. There are thousands of beauty clinics for this increasing conscious in beauty. In acne treatment, dermatologists diagnose quantity and severity of acnes by manual counting and classifying into the following types: comedo, papule, pustule, nodule and cyst etc. Dermatologists mark the spot of acne on the sheet to show acne's location and count them manually. This method has high degree of unreliability, inaccuracy and requires excessive effort from the doctor. Therefore, a computer aided image processing technique for acne detection and classification is being proposed to overcome manual counting and classification.

B. Objectives of the paper

1. To develop and implement an enhanced approach for acne segmentation using adaptive thresholding approach and subjecting the image to contrast adjustment image sharpening technique prior to it
2. To perform segmentation of acne patterns of facial images using Adaptive Regularized Fuzzy C-Means Clustering technique and Morphological opening and generate the mask for the all the training images.

3. To extract 14 Haralick features from all the patterns extracted in the masks that can uniquely describe the type of acne
4. To perform classification of the extracted features using Naive Bayes classifier in level 1 and level 2 and also provide comparative results using linear discriminant analyser.
5. To integrate all the above protocols in a user friendly interface and provide a good user experience.

II. PROPOSED METHODOLOGY

Initially the input images are assumed to be in RGB format which are forwarded for preprocessing. The preprocessing is carried out using contrast adjustment or Histogram equalization technique. Further the image is subjected to Gaussian thresholding to eliminate typical improper illumination artifacts inherent in the image. The image is then segmented through Morphological opening and ARKFCM clustering methods. Fourteen Haralick features are extracted from it and on using grey level difference method (GLDM) statistical texture features are extracted from the grey scale converted images. Once the features are extracted, classification of acnes is done using Naïve Bayesian classifier in multiple levels. In order to compare the performance, classification is done using Linear Discriminant Analyzer (LDA) as well.

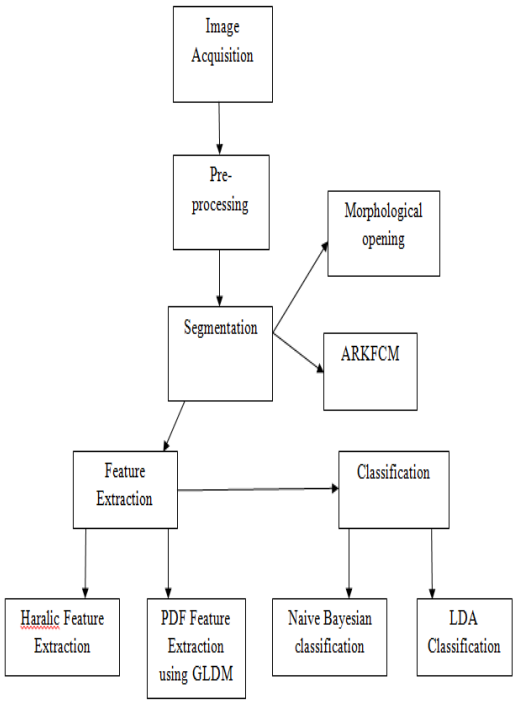


Fig. Flowchart of Acne Detection and classification

A. Image Enhancement

Image intensities are adjusted to enhance contrast using Histogram Equalization technique.

If f is an image represented by m_r and m_c matrix with the pixel intensities ranging from L to L-1 (often 256), then the normalized histogram, p of f for each possible intensity is given by,

$$p_n = \frac{\text{number of pixels with intensity } n}{\text{total number of pixels}} \qquad n = 0, 1, ..., L-1$$

$$g_{i,j} = \text{floor}((L-1)\sum_{n=0}^{f_{i,j}} p_n),$$

Where g is the histogram equalized image.

B. Segmentation

a). Morphological Opening:

The first segmentation is carried out using morphological opening operation with the help of disc structuring element.

$$A \circ B = (A \ominus B) \oplus B,$$

Where – and + indicate erosion and dilation respectively.

This plays a vital role in morphological noise removal. Opening is used to remove small objects from the foreground and to place them in the background and closing removes small holes in the foreground.

This is used to find specific shapes in the image with respect to edges, corners etc.

In the proposed method, structuring element used is of radius 5.

As satisfactory results were not obtained, further segmentation is done using adaptively regularized fuzzy C- means clustering.

b). Adaptively Regularized Fuzzy C- Means (ARFCM) clustering:

A weighted co-efficient is introduced which controls the influence of the neighbourhood pixels to the central pixel automatically.

This method preserves the image details with enhanced robustness as well as decreased computational costs

C. Haralick Features Extraction

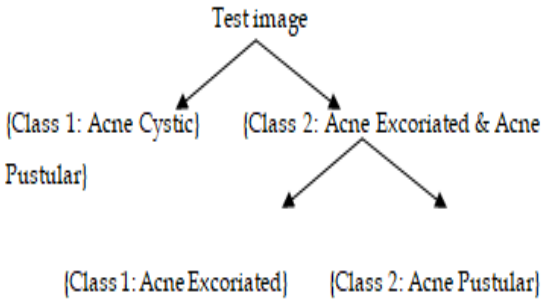
14 Haralick features are extracted and calculated against grey level matrix. These features are calculated in all the directions of adjacency.

The 14 Haralick features extracted from images are:

Angular Second Moment	$\sum_i \sum_j p(i,j)^2$
Contrast	$\sum_{n=0}^{N_g-1} n^2 \{\sum_{i=1}^{N_g} \sum_{j=1}^{N_g} p(i,j)\}, \lvert i-j \rvert = n$
Correlation	$\frac{\sum_i \sum_j (ij) p(i,j) - \mu_x \mu_y}{\sigma_x \sigma_y}$ where μ_x , μ_y , σ_x , and σ_y are the means and std. deviations of p_x and p_y , the partial probability density functions
Sum of Squares: Variance	$\sum_i \sum_j (i-\mu)^2 p(i,j)$
Inverse Difference Moment	$\sum_i \sum_j \frac{1}{1+(i-j)^2} p(i,j)$
Sum Average	$\sum_{i=2}^{2N_g} i p_{x+y}(i)$ where x and y are the coordinates (row and column) of an entry in the co-occurrence matrix, and $p_{x+y}(i)$ is the probability of co-occurrence matrix coordinates summing to $x+y$
Sum Variance	$\sum_{i=2}^{2N_g} (i-f_8)^2 p_{x+y}(i)$
Sum Entropy	$-\sum_{i=2}^{2N_g} p_{x+y}(i) \log\{p_{x+y}(i)\} = f_8$
Entropy	$-\sum_i \sum_j p(i,j) log(p(i,j))$
Difference Variance	$\sum_{i=0}^{N_g-1} i^2 p_{x-y}(i)$
Difference Entropy	$-\sum_{i=0}^{N_g-1} p_{x-y}(i) \log\{p_{x-y}(i)\}$
Info. Measure of Correlation 1	$\frac{HXY - HXY1}{\max\{HX, HY\}}$
Info. Measure of Correlation 2	$(1-\exp[-2(HXY2 - HXY)])^{\frac{1}{2}}$ where $HXY = -\sum_i \sum_j p(i,j) \log(p(i,j))$, HX , HY are the entropies of p_x and p_y , $HXY1 = -\sum_i \sum_j p(i,j) \log\{p_x(i) p_y(j)\} HXY2 = -\sum_i \sum_j p_x(i) p_y(j) \log\{p_x(i) p_y(j)\}$
Max. Correlation Coeff.	Square root of the second largest eigenvalue of $\mathbf{Q}$ where $\mathbf{Q}(i,j) = \sum_k \frac{p(i,k) p(j,k)}{p_x(i) p_y(k)}$

D. Classification

Naive Bayesian classifier is been employed to classify the three class data in a hierarchical manner.



The performance is being compared to Linear Discriminant Analysis.

III.CONCLUSION

To conclude the overall work, this paper begins highlighting the importance of computerized means to detect and classify the acnes. The paper aims at providing a user friendly experience where the acne lesions are detected automatically which avoids the tedious task of manual counting and thereby extracting the features of the acnes and classify them accordingly. This helps in diagnosing and managing the severity of the acnes.

The accuracy obtained using LDA Analyser classification by extracting GLDM features is – 54.8461%

The accuracy obtained using LDA Analyser classification by extracting Haralick features is – 64.7058%

The accuracy obtained using Naïve Bayesian classification method is – 91.66662%

A. Future Scope

This work can further be implemented to classify various other acnes such as Acne Closed Comedo, Acne Infantite, Acne Open Comedo, etc. This can be even built in the form of an app to have easy access on one's mobile.

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