Skin Cancer Diagnosis by Using Fuzzy Logic and GLCM

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Abstract. Image processing is one of the most strong and popular computer science technologies increasingly used today especially with medical sciences. It’s commonly used to diagnose and detect many kinds of cancer diseases early such as skin cancer, and others. In this paper two techniques have been used to detect Skin Cancer. These two techniques are Fuzzy logic and GLCM (Gray Level Co-occurrence Matrix) where they can distinguish among cancerous skin and non-cancerous. The distinguish operation is based on extracted featured values from GLCM. The features GLCM include are Contrast, Correlation, Energy, Entropy, and Homogeneity. However, our contribution is a new algorithm for diagnosis two phase, the first is the normal situation and second is the skin cancer. After the design and implementation of the algorithm the result was good as we can see in the implementation section.

1 Introduction
Skin disease as the most widely recognized growth in human starts in the skin. A few tumors likewise can begin in different organs and spread on the skin, yet these malignancies are not considered as skin ones. The diverse sorts of skin diseases generally can be ordered as malignant melanoma and non-melanoma skin growth (NMSC), the last including Basal Cell Carcinoma and Squamous Cell Carcinoma as the major subtypes. Malignant melanoma, as one of the sorts of skin malignancy, has achieved the most noteworthy rate of among a wide range of growth. It is subsidiary from epidermal melanocytes and can emerge in any tissue which contains these cells; however, it is Showing up on the lower appendages in females and on the back inn males (1)As it happens on the skin surface; along these lines, it is distinguishable by visual assessment. The clinical appearance is changed by the sort and site of the tumor. Much exertion has been made over the most recent two decades to enhance the clinical analysis of melanoma. These incorporate option imaging innovations, for example, dermoscopy and a few analytic calculations. Dermoscopy is a non-invasive diagnostic technique for the early diagnosis of melanoma and the assessment of other pigmented and non-pigmented sores on the skin that are not also observed with the unaided eye (2). Polarized dermatoscopy doesn't be in contact with the skin. They can be immediately looked over numerous lesions. As a rule, the polarized view is as best as the fluid immersion technique and may be ideal for assessing vessels. However, it might be useful to wipe a scaly lesion with oil to improve the view. The surface scale may also be evacuated by rehashed tape stripping. It can likewise automate the investigation, and in this way diminishes the measure of dull and repetitive undertakings to be finished by doctors. “The rest of this paper is organized as follows: Section 2” “describes related work on skin cancer image” classification. Section 4” explains the components of the proposed system to assist in the skin cancer’detection and prevention. Section 5 the fuzzy logic. Section6 reports the experimental results.
2 Related Workss
Damilola [3] proposed automatic diagnosis of skin cancer using well-defined segmentation and classification technique. Arivazhagan [4] developed texture analysis based method for recognizing human skin diseases. In this method they classified skin diseases by extracting Independent components. Sparavigna and Marazzato [5] proposed a texture based method in which differences in color and coarseness of skin are quantitatively evaluated by using statistical approach to the pattern recognition. [6] utilizes morphologic operators in segmenting a d wavelet analysis to extract the feature which culminated in to better melanoma diagnosis system. Alcon, J. F. “[7] “has used pigmented skin lesion’s images, acquired using consumer digital camera for automatic melanoma diagnosis with an accuracy of 86%, sensitivity of 94% and specificity of 68%. Odeh, S. M.” [8] “presented a diagnosis system based on Neuro-Fuzzy inference system based algorithm for three different types of skin lesions. Ogorzalek, M. J. “[9] proposed computer aided enhanced diagnostic tools for non-standard image decomposition. Blackledge, J.M.” [10] “uses recognition and classification of digital images with texture based characterization of digital images. He also describes fuzzy logic and membership function theory based decision engine. Patwardhan, S. V.” [11] “uses wavelet transformation based skin lesion images classification system which utilizes a semantic representation of spatial frequency information contains in the skin lesion images.”

3 SKIN AN OVERVIEW
Skin is one of the most incredible which is created by God in the human body. The main function for it is to protect the body from infection. Also, it has the ability to protect our body from ultraviolet (UV) radiation. Its consider as a storehouse of water and fat. there are several layers for the skin, one of them is the epidermis and dermis are the main layers.”

“Epidermis: The epidermis is the outermost layer of the body skin.it has a primary function to protect the human body and provide an effective barrier from the outside world. The thickness of the epidermis varies in different types of skin.”

“Dermis: The dermis is the middle layer of skin. It is a place stand between the hypodermis layer and epidermis layer. The dermis is composed of many parts like connective tissue, cells, ground substance, can contain blood vessels, sweat glands, fat and hair folicles it ranges from 1-4mm in thickness. It is usually much thicker than epidermis folicles.”

“Sweat glands: Sweat glands function’s to regulate temperature and remove waste by secreting water, sodium salts and nitrogenous waste (such as urea) onto the skin surface.”

“Fat: Fat is a macronutrient for the body. It is also called as triglycerides. Fats are solids at room temperature.”

“Hair Follicle: The hair follicle is a part of a skin organ from which hair grows. Usually, there are hair follicles all over the skin, without the lips, palms of the hands, and soles of the feet.”

“ Connective Tissue: Connective tissue is one of the four types of biological tissue. It supports connect or separate different types of tissues and organs in the body. [12] “Hypodermis: The hypodermis is the most inner layer of the skin. It invigilates the dermis and is attached to the latter of dermis. It is essentially composed of a type of cells specialized in accumulating and storing fats, known as adipocytes. The hypodermis acts as an energy reserve.

Skin cancer and its type: Skin cancer is abnormal growth of skin cells. There are several types of skin cancer and most Common are melanoma and non-melanoma. Non-melanoma are basal cell skin cancer and squamous cell skin cancer.”

“ Melanoma: Melanoma usually can occur on the skin. It starts in melanocytes. Melanoma can grow in a short time. It can spread to many parts of the body.”

“ Basal cell skin cancer: skin cancer is basal cell carcinoma. it is very slow growing and does not spread to other parts of the body. Because of proper treatment basal cell cancer are completely cured. Basal cell cancer: It is skin cancer and basal cell carcinoma.”
"Squamous cell skin cancer: 'Most common Squamous cell skin cancer begins in squamous cell. It also can be protected by simple treatment. It also does not spread to other parts of the body.

4 PROPOSED METHOD
In project we suggest algorithm for diagnosis the normal and cancer for skin, our algorithm consist of (6-step) and the result of these step gave good result and we done this algorithm in two stage (training stage and testing stage.

4.1 Algorithm:
Algorithm consists from 6-step starting from image acquisition and ending by decision of the skin cancer or normal as shown in figure (1):

Figure 1: The Algorithm flowchart.

4.2 Image Selection step (acquisition):
In images acquisition, the image collected from internet website (free database), these images has JPG format and we selected image from database to do some enhancement as shown in figure 2.

![Image Selection](image_url)
4.3 Pre-processing steps:
We need to make all the pictures have the same feature and “has the same environments to get the real results for all the samples by resize all images and convert them to gray level. In this step the color image is converts into grey image” to applying tools of image processing, since the color image has the ability to carry much more information than a gray image. So it would be more difficult to process with our need for non-colored images shown in figure 3.

4.4 Segmentation step:
In this step we need to separate the object (Tumor) from other parts of image (background). by using (8-connection neighbors) technique to create a mask, this mask contain black and white (0,1) values, this values will multiply by original image to obtain segment image contain tumor only as show in figure 4.

4.5 Extract the features by using GLCM step:
Haralicket “all first introduced the use of co-occurrence probabilities using GLCM for extracting Gray various texture features. GLCM is also called as Gray Level Dependency Matrix. It is defined as “A two dimensional histogram of gray levels for a pair of pixels, which are separated by a fixed spatial relationship.” GLCM of an image is computed using a displacement vector defined by its radius \( \delta \) and orientation \( \theta \)[9].” Consider a 4×4 image represented by figure (2-2-a) with four gray-tone values 0 through 3. A generalized GLCM for that image is shown in figure (2-2-b) where \( #(i,j) \) stands for number
of times gray tones \( i \) and \( j \) have been neighbors satisfying the condition stated by displacement vector \( d[9] \).

“Haralick extracted thirteen texture features from GLCM for an image. These features are as follows:”

4.5.1 Contrast: “Is a measure of intensity or gray level variations between the reference pixel and its neighbor. In the visual perception of the real world, contrast is determined by the difference in the color and brightness of the object and other objects within the same field of view.”

\[
f_1 = \sum_{n=0}^{N-1} \sum_{i=0}^{N-1} \sum_{j=0}^{N-1} P_d(i,j)  
\]  

4.5.2 Correlation feature: “Shows the linear dependency of gray level values in the co-occurrence matrix. It’s present how a reference pixel is related to its neighbor, 0 is uncorrelated, and 1 is perfectly correlated.”

\[
f_2 = \sum_{i=0}^{N-1} \sum_{j=0}^{N-1} P_d(i,j) \frac{(i - \mu_x)(j - \mu_y)}{\sigma_x \sigma_y}  
\]

“Where \( \mu_x, \mu_y \) and \( \sigma_x, \sigma_y \) are the means and standard deviations of \( P_x, P_y \).”

4.5.3 Energy: “It measures the uniformity of an image. When pixels are very similar, the ASM value will be large.”

\[
f_3 = \sum_{i=0}^{N-1} \sum_{j=0}^{N-1} P_d(i,j)  
\]

4.5.4 Homogeneity: “Those measures the local homogeneity of an image. IDM feature obtains the measures of the closeness of the distribution of the GLCM elements to the GLCM diagonal.”

\[
f_4 = \sum_{i=0}^{N-1} \sum_{j=0}^{N-1} \frac{1}{1 + (i - j)^2} P_d(i,j)  
\]
“General form of GLCM”

| Gray “Tone” | “0” | “1” | “2” | “3” |
|-------------|-----|-----|-----|-----|
| “0”         | “#(0,0)” | “#(0,1)” | “#(0,2)” | “#(0,3)” |
| “1”         | “#(1,0)” | “#(1,1)” | “#(1,2)” | “#(1,3)” |
| “2”         | “#(2,0)” | “#(2,1)” | “#(2,2)” | “#(2,3)” |
| “3”         | “#(3,0)” | “#(3,1)” | “#(3,2)” | “#(3,3)” |

“Figure (5) the test image for GLCM”

| GLCM for δ=1 and θ=90 |
|-----------------------|
| “4” “2” “1” “0” |
| 0 4 2 0 |
| “2” “4” “0” “1” |
| 2 2 2 2 |
| “1” “0” “6” “1” |
| 0 0 2 0 |
| “0” “0” “1” “2” |

“GLCM for δ=1 and θ=0”

| GLCM for δ=1 and θ=0 |
|-----------------------|
| “4” “1” “0” “0” |
| “2” “1” “3” “0” |
| “1” “2” “1” “0” |
| “3” “1” “0” “2” |
| “0” “0” “2” “0” |

“GLCM for δ=1 and θ=135°”

“GLCM for δ=1 and θ=45°”

“Extract the features by using GLCM (Grey Level Co-occurrence Matrix) to extract the features that obtained from 9 vector that is contain” (sum, standard, variance, median, maximum, minimum, skewness, mean, entropy) in (0°, 45°, 90°, 135°) degrees respectively as shown in figure (6).
Figure 6: Extract the feature

4.6 Diagnostics by using fuzzy logic step

In diagnosis step we need to decide the kind of the disease (Normal, skin cancer) depending on features extraction, give the final decision about the disease if normal or skin cancer depends on last details as shown in figure 7.

Figure 7: Fuzzy logic (Diagnoses)

5 Fuzzy Logic

The fuzzy logic in our project has 9 inputs represent the features as shown in figure 8.
Figure 8: Fuzzy logic
And the range value of input used for training as shown in figure 9.

Figure 9: range of input

6 The result
We used two groups of images, one of them is for training stage and the second group of images is for testing stage. We found that the results from analysis step by using GLCM which produce many features but not all of them works in classification step, only nine of them work for classification such as (sum, standard, variance, median, maximums, minimums, skewness, mean, entropy) and the ranges of these features are collected as shown in (table 1) and the output range in shown in (table 2). The ranges of input is typically changed and can be input for classification as shown in figure 10. The ranges of output can be shown in figure 11.

| Feature   | Sum   | Std   | Var   | Median | Max   | Min   | Skeness | Mean   | Entropy |
|-----------|-------|-------|-------|--------|-------|-------|---------|--------|---------|
| Normal    | [11]  | [1.55] | [2.65] | [3.33] | [11.01]| [0.37] | [-1.044] | [2.75]  | [0.811] |
|           | [11.20]| [1.62] | [2.65] | [3.42] | [–]   | [0.44] | [–]     | [2.79]  | [0.9]   |

Table 1 shows the range of inputs
Table 2 shows the range of outputs

| cancer | Normal | Cancer |
|--------|--------|--------|
| range  | [1-5]  | [6-10] |

Figure 10: range of input
7 Conclusion
In project we used GLCM for image analysis and the for features extraction and we found that (9) features as (SUM, mean, STD, variance, median, maximum, skewness, entropy and minimum) working for classification features and can be easily classify or diagnosis (normal and abnormal) from the image.
We tried may analysis methods to obtain features to be used in classification or diagnosis but this method did not given good features such as DWT (Discrete Wavelet Transform) and DCT (Discrete Cosine Transform) because the image in causes (normal and cancer) are so closed and similar in color and background skin texture and tumor shape…. etc.
But we found that shape for tumor only if we cut the background will be asymmetric and after using GLCM we got the features can be separate the normal from abnormal. The second thing is segmentation part play create role for get the features. In segmentation part “we create mask, this mask have two values (0,1) black and white only by using threshold to cut the” tumor area from the background.
In diagnosis we used fuzzy logic diagnosis because we used input as range not only one value and also the output.

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