Detection of Skin Cancer Using ABCD Features

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Abstract

In recent years, great effort has been put for the development of diagnosis of skin cancer. This paper aims develops a system to segment and classify skin lesions based on ABCD rule. Here algorithm runs in four different stages, 1.Preprocessing includes the image resizing and contrast and brightness adjustment 2.segmentation using   watershed 3. Feature Extraction by the ABCD rule. 4. Classification by the TDS Score. The achieved result shows the acceptable performance with respect to the other state of art methods.

Keywords: Dermoscopy, ABCD rule, melonama, TDS.

INTRODUCTION

Skin cancer is a malignant tumour which grows in skin cells. It is one of the most common of all cancer which affects human beings and accounts for more than 50% of all types of cancers around the world. Skin cancer is skin's unwanted growth with differing causes and varying degrees of malignancies. It can spread very fast to all organs/parts of human body through lymphatic system or blood. The incidences of melanoma - the deadliest form of skin cancer has been on rise at an alarming rate of 3% per year [1]. Detection of malignant melanoma in its early stages considerably reduces morbidity and mortality. Skin cancer can be cured at very high rates with simple and economical treatments [2, 3, 4, 5], if detected at its earlier stages presently there is a greater need of automatic diagnosis of skin cancer for masses at an early stage. The basic aim of this "automatic cancer detection system" implementation paper is, to have a simple, efficient and automatic skin cancer, detection and diagnosis system with the use of commonly available software for non-experts/clinicians/doctors.

LITERATURE SURVEY

Skin cancer is the most common form of cancer, globally accounting for at least 40% of cases. It is especially common among people with light skin. The most common type of non-melanoma skin cancer, which occurs in at least 2-3 million people per year. Of non-melanoma skin cancers, about 80% are basal cell cancers and 20% squamous cell cancers. Basal cell and squamous cell cancers rarely result in death. In 2003, it was estimated that 105,000 people would receive a diagnosis of melanoma and a further 33,000 would die from the disease worldwide. In the United States, there was cause of less than 0.1% of all cancer deaths.[6]

Skin cancer detection using Digital Image Processing by et al. Sanjay Jaiswar, MehranKadri, Vaishali Gatty suggested a computer aided method used for the detection of melanoma skin cancer using image processing tools. The input to the system is the skin lesion image and then by applying novel image processing techniques, it analysis it to conclude about the presence of skin cancer. The lesion image analysis tools checks for the various melanoma parameters like asymmetry, border, colour, diameter (ABCD) by texture, size and shape analysis for image segmentation and feature stages. The extracted feature parameters are used to classify the image as normal skin and melanoma cancer lesion. [7]

Detection of Skin Cancer Using Image Processing Techniques by et. al. Chandrahasa M, Varun Vadigeriand Dixit Salecha suggested a method to detect ski cancer in early stages using smart phone application by analyzing properties of the cancer, Asymmetry, Border, Colour, Diameter and   Expansion (ABCDE). These properties are analyzed using different image processing techniques like Grey scale conversion, segmentation, contour tracing and histogram analysis. [8]

Automatic Lesion Detection System (ALDS) for Skin Cancer Classification Using SVM and Neural Classifiers by et.al. Muhammad Ali Faros, Muhammad Aatif Mobeen Azhar, Rana Hammad Raza suggested an important application in the medical field is Automatic Lesion Detection System (ALDS) for skin cancer classification. . This method is focused towards the development of improved ALDS framework based on probabilistic approach that initially utilizes active contours and watershed merged mask for segmenting out the mole and later SVM and Neural Classifier are applied for the classification of the segmented mole. After lesion segmentation, the selected features are classified to ascertain that whether the case under consideration is melanoma or non-melanoma. [9]

The Melanoma Skin Cancer Detection and Feature Extraction through Image Processing Techniques by et al. Dr. S.Gopinathan, S. Nancy Arokia Rani suggested a method for an approach to detect the melanoma skin cancer and feature extraction through various image processing techniques .The input for the system is the skin lesion which is uncertain to be melanoma cancer. The image is pre-processed to ejection of hair and noise etc. and contributed a quality image. The Otsu thresholding and boundary tracing algorithm is used for image segmentation. The STOLZ algorithm is used for feature classification stage, the extracted features that are proceeded in order to assort the image as mole, benign, suspicious, highly suspicious skin lesions. [10] Among the following

methods, the first and the fourth method is combined to implement this project as it gives proper accuracy in detecting Melanoma skin cancer. This paper combines segmentation and feature extraction technique by using Otsu and STOLZ algorithm to give much better TDS calculation results and we have proposed the method that may detect the skin cancer at first stage and so can save many lives.

PROPOSED TECHNIQUE

Most Automated Skin Lesion Diagnosis methods adopt the standard computer-aided diagnosis (CAD) pipeline which is illustrated in Fig: 1 and it consists of five general stages. After the image is acquired, it contains many artifacts such as hair and oil bubbles which could bias downstream processes are identified. Next, the lesion is segmented from the surrounding healthy skin.
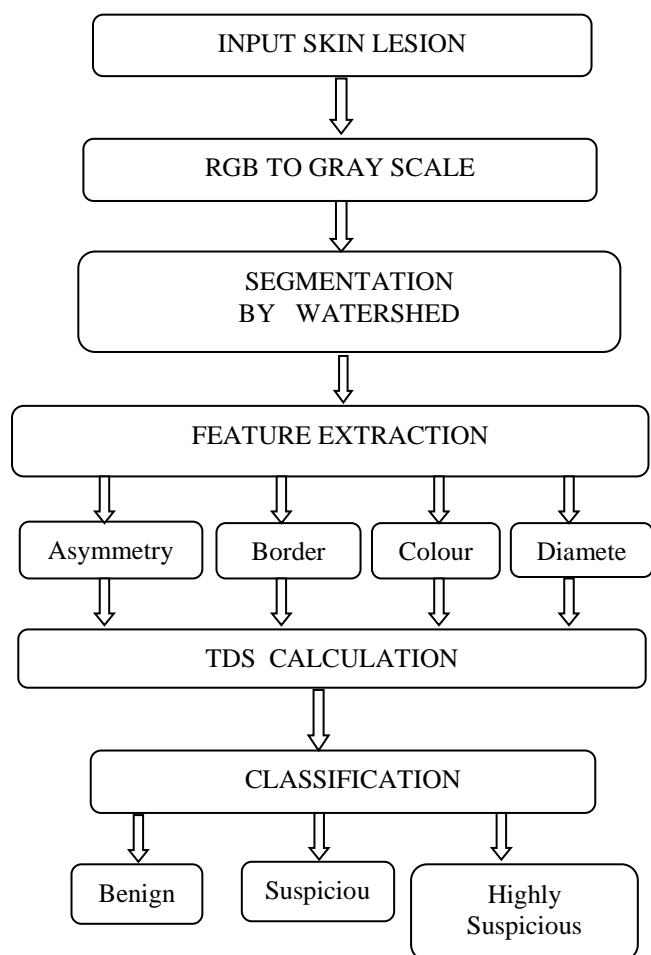

Figure 1: Block Diagram of Proposed Technique

After segmentation, discriminative features are extracted from the lesion. Features which are usually extracted are border, color, entropy, compactness, radial variance of the mask, coarseness. Finally; by extracting these features the detection is done which finally shows the risk probability of the lesion which is present in the image

A. Image Pre-processing Techniques

The acquisition of the digital image of affected skin is the first and primary step in image processing. We are using images taken from commercially available digital camera or from Epiluminscence microscopy (ELM or Dermoscopy). Once image is acquired, then it goes for pre-processing. In first part of pre-processing digital images of skin cancer, collected in Bitmap or JPEG format from different sources are converted to indexed images. It converts the ordinary image to first RBG then grayscale and at the end binary. It makes an image suitable for a particular application. The second part of pre-processing involves enhancement of image (edge highlighting, sharpening, deblurring, brightening, change in contrast, masking, hair removal, cropping or resizing and/or noise removal). For border detection of skin lesion we are using Canny Edge Detection technique.

B. Segmentation Techniques

Image segmentation involves image partitioning into multiple segments or regions of interest. It helps in to grouping similar characteristics regions. It is a process of extracting and representing information from the image to group pixels together with region of similarity. In this process a label is assigned to each pixel, such that pixels with same labels share common visual characteristics. Image segmentation is used to locate skin lesions and their boundaries. This paper includes Watershed segmentation, because of its popularity due to generation of less complex computational results. Steps involved in the watershed algorithm are. 1. Read the colour image and convert it into gray scale. 2. Using the gradient magnitude as a segmentation function. 3. Mark the fore ground objects.4.Compute the back grounds Markers.5.Tracing the exterior boundaries of the objects. 6. Performing the canny edge detection of the objects.

C. Feature Extraction

In order to educate the masses to recognize melanoma in its early stages in 1985, group from New York University [3] devised the ABCD acronym (Asymmetry, Border irregularity, Colour variegation, Diameter > 6mm). It is one of the easiest guides to the most common signs of melanoma. Further, Stolz, W. [7] established this diagnosis scheme for dermatoscopic images known as the ABCD rule of dermatoscopy. The characteristics needed to diagnose a melanoma as malignant are

(1) Asymmetry:

To assess asymmetry, the melanocytic lesion is bisected by two 90° axes that were positioned to produce the lowest possible asymmetry score. If both axes dermocopically show asymmetric contours with regard to shape, colours and/or dermoscopic structures, the asymmetry score is 2. If there is asymmetry on one axis only, the score is 1. If asymmetry is absent with regard to both axes the score is 0.

$$\text{Asymmetry Index (AI)} = \frac{\Delta A}{A} \quad \text{......................... (1)}$$

Where ΔA pixel difference. A=Total pixel count of lesion.

(2) Border irregularity:

The lesion is divided into eighths, and the pigment pattern is assessed. Within each one-eighth segment, a sharp, abrupt cut-off of pigment pattern at the periphery receives a score 1. In contrast, a gradual, indistinct cut-off within the segment receives a score of 0. Thus, the maximum border score is 8 and the minimum score is 0.

In order to calculate border irregularity, there are different measures such as: compactness index, fractal index, edge abruptness, pigment transition. Compact index, fractal dimension, and edge abruptness has been calculated.

(i)Compact Index:

Density index (compact index/CI) is the measurement of the most popular form of barrier which estimates unanimous 2D objects. However, this measure is very sensitive to noise along the boundary. This can be determined by using the following equation:

$$\text{CI} = \frac{(Pl)^2}{(4\pi A)} \quad \text{.. (2)}$$

Where, Pl = Perimeter of the Lesion. A = Area of the Lesion.

(ii)Fractal Dimension:

Fractal has characteristics self-similarity, and properties to the scale/size. Each section has a fractal which is different scale with the whole fractal. These characteristics causes suitable for fractal compression techniques. Another characteristic is fractal dimension. Dimension size generally an integer, such as the line has 1 dimension, the field has 2 dimensions, and cube has 3 dimensions and so on. However, fractal dimension is a strange as it may worth fraction. This fractal dimension can be used as a characteristic of an image.

Fractal dimension can be calculated by the method of calculation of the box (box-counting). To find the fractal dimension of an image, the Haussdorf dimension calculation method is simpler and effective one. Consider the line with 2-dimension cube of side e and let N (e) is the smallest of e-sided cubes that can cover this line. The dimension of this line is then:

$$\text{FD} = \lim_{e \to 0} \frac{(N(e))}{(\frac{1}{e})} \quad \text{............................... (3)}$$

Using equation (3), fractal dimension of an image can easily be calculated.

Edge Abruptness:

Lesion with irregular boundaries (abruptness edge) has a large difference in radial distance (e.g. distance between the centre d2 and the barrier P). Barrier irregularity is estimated by analyzing the distribution of radial distance difference

$$\text{VI} = \frac{\frac{1}{pl}(\sum_p d2(p - m_d)^2)}{m_d^2} \quad \text{.................. (4)}$$

Where m_d is the mean difference. Converting the RGB into HSV, taking the mean and variance of value components.

L= mean of value components

LG= variance of value components

(3) Colour:

Six different colours are counted in determining the colour score: white, red, light brown, dark brown, blue-gray, and black. White should be counted only if the area is lighter than the adjacent skin. The maximum colour score is 6 and the minimum score is 1.

Converting the RGB into HSV, from the HSV values getting the values for black, white, red, blue, light-brown & dark brown.

If black is zero then b=0 else b=1, If white is zero then w=0 else w=1, If red is zero then r=0 else r=1, If blue is zero then bL=0 else bL=1, If light-brown is zero then li=0 else li=1, If dark-brown is zero then d=0 else d=1. Hence according to the colour either 0 or 1 will be assigned to the b or w or bL or li or d or r accordingly.

(4) Diameter :

Cancerous lesions are greater than 6mm wide. Differential structures with at least five patterns are relevant for specific types of lesions. Any growth of a mole should be of concern. Its value ranges 0 to 5.

Calculating the diameter of the skin cancer lesion, if the diameter is greater than threshold, then treat the diameter score (dia) as 5, else diameter score (dia) as from 0 to 4.

Table 1: Features of skin lesion with score and factor

S.no:	Criteria	Score	Factor
1	Asymmetry	0-2	1.3
2	Border	0-8	0.1
3	Colour	1-6	0.5
4	Diameter	1-5	0.5

TDS CALUCLATION

TDS (Total Dermatoscopy score) Index is an important tool used in the diagnosis of melanoma.

Calculation of the TDS index is based on Asymmetry, Border irregularity, Color and Diameter of the skin lesion. Each of the criteria is then multiplied by a given weight factor to yield a Total Dermatoscopy Score.

Formula for TDS:

$$A\ score=AI ....(5)$$

$$B\ score= (CI+VI+FD+L+LG)............................. (6)$$

$$C\ score=(b+w+r+bL+d+Li).................................(7)$$

$$D\ score=dia...(8)$$

The range of the scores and weighting factor is depicted in the tabular form Table1.

TDS= [(A score x 1.3) + (B score x 0.1) + (C score x 0.5) + (D score x 0.5)]

.... (9)

If the TDS Index is less than 4.75, it is benign (non-cancerous) skin lesion. If TDS Index is greater than 4.75 and less than 5.45, it is suspicious case of skin lesion. If TDS Index is greater than 5.45, it is malignant melanoma (cancerous) skin lesion.

RESULTS

Fig.2 shows the graphical user interface (gui) window Skin cancer detection which consists of original RGB image, gray scale image. Colour histogram of the image, asymmetric parts of the image. Displaying the TDS score of the Benign1 image.
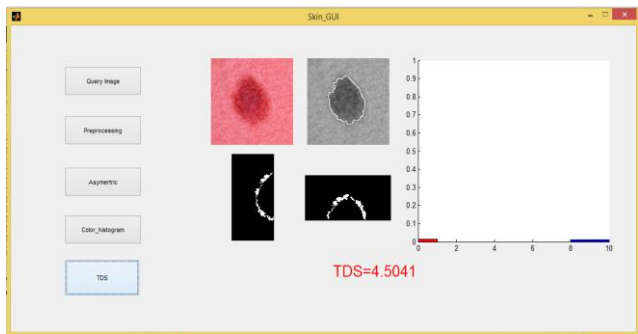

Figure 2: skin lesion detection showing TDS score for Benign1

Fig.3 shows the graphical user interface (gui) window Skin cancer detection which consists of original RGB image, gray scale image. Colour histogram of the image, asymmetric parts of the image. Displaying the TDS score of the Benign2 image.
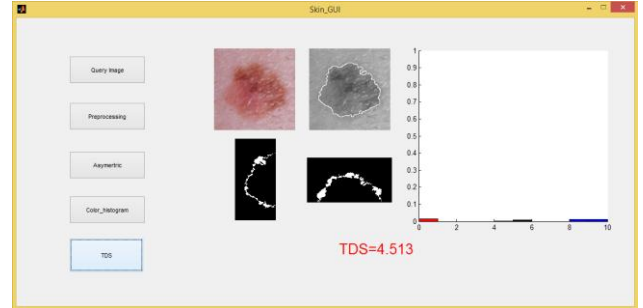

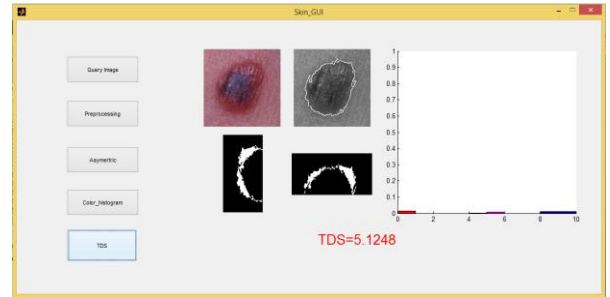**Figure 3:** skin lesion detection showing TDS score for Benign2.

Figure 4: skin lesion detection showing TDS score for Malignant1

Fig.4 shows the graphical user interface (gui) window Skin cancer detection which consists of original RGB image, gray scale asymmetric parts of the image. Displaying the TDS score of the Malignant1 image.

Figure 5: skin lesion detection showing TDS score for Malignant2

Fig.5 shows the graphical user interface (gui) window Skin cancer detection which consists of original RGB image, gray scale asymmetric parts of the image. Displaying the TDS score of the Malignant2 image.
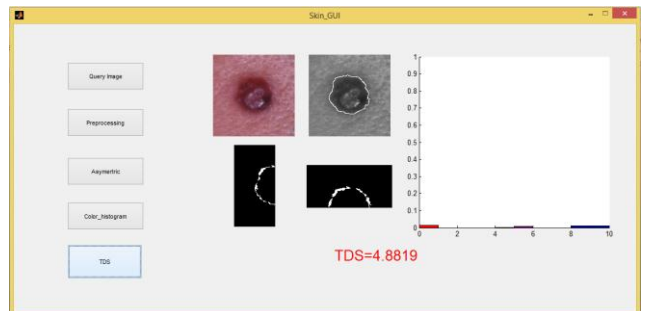
This result shows that how efficiently the skin cancer detection is carried out and how benign and malignant classification is done using TDS Score.

Table 2. Illustrates the how individual features (Asymmetry, Border, Colour, Diameter) are obtainted. By multiplying with the weighted factor to the ABCD features one can obtain the value of TDS score. From the TDS Score, Classification of skin cancer lesion either benign or malignant is determined

Table 2: TDS Score evaluation of four skin lesions

Type of lesion	AI	CI	VI	FD	L	LG	b	w	r	bL	LI	d	dia	A	B	C	D	TDS
Benign1	0.1164	2.0511	0.0129	1.1393	0.3140	0.0109	0	0	1	0	1	1	5	0.1513	0.3528	1.5	2.5	4.5041
Benign2	0.0927	2.3293	0.0165	1.2351	0.3377	0.0072	0	0	1	0	1	1	5	0.1205	0.3926	1.5	2.5	4.513
Malignant1	0.1609	2.5830	0.0144	1.2403	0.2992	0.0203	0	0	1	1	1	1	5	0.2091	0.4157	2	2.5	5.1248
Malignant2	0.0719	1.4256	0.0030	1.1505	0.2928	0.0130	0	0	1	1	1	1	5	0.0934	0.2885	2	2.5	4.8819

CONCLUSION

This paper concludes the detection of skin cancer is carried through the process of pre-processing, segmentation, feature detection & Classification. The result shows how clearly the TDS value is used in classification of skin lesion is either benign or malignant. This algorithm clearly gives good idea of how TDS score is obtained with all the intermediate parameters and when compared with the state of art methods is highly efficient.

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