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Skin cancer detection using dermoscope images

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ABSTRACT

Skin cancer is an abnormal growth of skin cells which develops on the body when exposed to the sunlight. Most of the skin cancers are curable when detected at early stage. Early diagnosis can help to treat the patients effectively. Formal method for diagnosing skin cancer is biopsy. In this paper, skin cancer detection system is developed using LabVIEW. The proposed method uses vision development module in LabVIEW to process dermoscope images. Preprocessing steps such as median filtering and contrast stretching is performed for noise removal and image enhancement. Threshold based segmentation is adopted to segment the affected area. Features such as Asymmetry, Border, Color and Diameter (ABCD) are extracted. The presence of cancer is detected using ABCD rule.

1. Introduction

The three main types of skin cancers are Basal Cell Carcinoma, Squamous Cell Carcinoma and Melanoma. Basal Cell Carcinoma and Squamous Cell Carcinoma are grouped together as non-melanoma skin cancers. These carcinomas are unlikely to spread to other parts of body if treated early. Malignant melanoma is the appearance of sores on the skin that cause bleeding. It is the deadliest form of all skin cancers, which arises from cancerous growth in pigmented skin lesion. Melanomas are aggressive and spreads to the other parts of the body [1]. It can spread out to all parts of the body through lymphatic system or blood stream. A biopsy is the conventional method for skin cancer detection, involving the removal of skin and testing it for malignancy. Laboratory sampling often causes the spread of lesions. So it tends to be dangerous as it may damage the healthy cells. Computer Aided Diagnosis (CAD) can improve the speed of skin cancer diagnosis, which works according to the disease symptoms. But, there are some unique symptoms of skin cancer, such as: Asymmetry, Border irregularity, Color variation and Diameter (ABCD). These are popularly known as ABCD parameters [2].

Asymmetry is one half of the tumor that does not match the other half. Border irregularity is the unevenness of skin. Color intensity change in the lesion region is not regular (variation in intensity). Segmentation is used to separate the cancerous region from the healthy skin and features are extracted in cancerous region using Gray-Level Co-Occurrence Matrix (GLCM). Based on the features, the images are classified as cancerous skin or normal skin. This methodology has got an accuracy of 88% [3].

A system to identify carcinoma at the early stage using GLCM and SVM is proposed. [4]. GLCM is used to extract required features such as mean, standard deviation, variance, entropy, RMS and smoothness. The accuracy is more when compared to biopsy. The rate of detection can be increased by using more data and other algorithms like K-Nearest Neighbor (KNN).

SVM and GLCM are used for the detection of skin cancer [5]. This methodology uses SVM algorithm for classification. GLCM is used for feature extraction. GLCM features are given as input to SVM classifier which takes training data, testing data and classifies whether the given input image is cancerous or non-cancerous. The accuracy of the proposed system is 95%.

Automatic skin cancer classification using three layer Back Propagation Neural Network (BPN) classifier and Auto Associate Neural Network (AAN) are discussed [6]. The input image undergoes two phases such as training and testing. The accuracy of 3 layer BPN classifier is 89.9% and AAN is 80.8%.

A completely automated system for dermatological disease recognition through lesion images, a machine intervention in contrast to conventional medical personnel - based detection was explained [7]. The model is designed in three phases compromising of data collection and augmentation, designing model and finally prediction. Multiple AI algorithms like Support Vector Machine (SVM) and deep learning techniques are used for classification. The accuracy of the system is 85%.

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A classification model for twelve lesions that includes Malignant Melanoma and Basal Cell Carcinoma is proposed [8]. In this work, ResNet-152 architecture is trained over 3797 images, and augmented by a factor of 29 times, using positional, scale, and lighting transformations. The network was tested with 956 images and achieved an area under the curve (AUC) of 0.96 for Melanoma and 0.91 for Basal Cell Carcinoma.

A mathematical model called High-Level Intuitive Feature (HLIF) has been designed for the detection of skin cancer [9]. The input image undergoes three stages namely illumination correction preprocessing, segmentation of the lesion, feature extraction. Four features are extracted from the skin image such as Asymmetry, Border, Color, and Diameter for the detection of skin cancer.

Melanoma skin cancer by is detected using various image processing techniques such as gamma correction and contrast enhancement is discussed [10]. Four features are extracted such as Asymmetry, Border irregularity, Color, Diameter to classify the input image as cancerous or non-cancerous.

The performance of the SVM classifier Machine aided skin cancer detection using deep learning technique and SVM classifier is presented [11]. The input image is pre-processed under various stages such as hair removal, segmentation, division and feature extraction such as color and texture for identification of cancer.

A CAD system is designed for identification of skin cancer. Gaussian filter is used for removing artifacts [12]. Pattern analysis method is used for feature extraction. In the proposed system, the comparison between classifiers such as SVM, ANN, Statistical Decision tree, Extreme Learning Machine is done in order to find the accuracy of the classifiers. ANN is found to be superior to other classifiers.

Gaussian filter is used for removing noise from the skin lesion of the acquired images followed by the use of improved K-mean clustering to segment the lesion [13]. A distinctive hybrid super feature vector is formed by the extraction of textural and color features from the lesion. Support Vector Machine (SVM) is used for the classification of skin cancer into melanoma and nevus.

A hybrid system based on Particle Swarm Optimization and Support Vector Machine (PSO-SVM) is proposed [14]. The features used are the co-occurrence matrix and the energy of the wavelet coefficients resulting from the wavelet packet decomposition. The PSO-SVM system selects the best feature set and the best values for the SVM parameters that optimize. The paper is organized as follows.In section 2 is about the proposed system, section 3 deals with implementation and results. Finally conclusions are drawn in section IV.

2. Proposed method

The proposed system is designed using simple algorithms in order to reduce the time consumption in detecting skin cancer through other methods like biopsy. The proposed method is illustrated in Fig. 1.

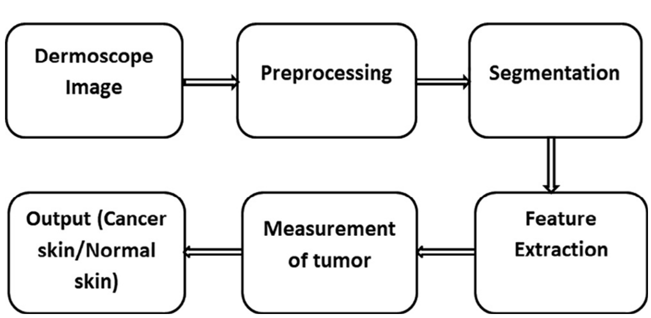

Fig. 1. Flow chart to detect skin cancer.

2.1. Input image

Melanoma images are taken from the DermIS and DermQuest database {15. These datasets are used for research purpose. The database contains a total of 206 images in which 119 are melanoma images and 87 are non-melanoma images. The dermoscope image of skin is given as the input image.

2.2. Pre-Processing

The dermoscope images may contain unwanted particles such as hair, gel and air bubbles. So, the dermoscope images are pre-processed using image processing techniques such as Gray scale conversion, Noise removal and Contrast enhancement. The input image (dermoscope image) is converted into gray scale image. The gray scale image is represented by luminance using 8 bits value. The conversion of a color image into a gray scale image is executed by converting the RGB values (24 bit) into gray scale value (8 bit). After gray scale conversion, the image is reversed and comparison is done between the reversed image and gray scale image in order to find the symmetry of the cancer.

Noise removal is a pre-processing step done to remove unwanted noises. Median Filter is a non-linear filter which is used for hair removal and feature enhancement in the cancerous image. Contrast enhancement is a process that makes the features of the image to stand out more clearly. Contrast manipulations involve changing the range of values in an image in order to increase contrast for better quality.

2.3. Segmentation

Image Segmentation is the process of partitioning a digital image into multiple segments (sets of pixels, also known as image objects). Thresholding method of segmentation is done to simplify or change the representation of an image to make it easier to analyze.

Thresholding is one of the important method in image segmentation. Thresholding is used to create binary images from gray scale images. Usually a pixel value of 0 represents white and the value 255 represents black with the numbers from 1 to 254 representing different gray levels. The proposed system uses thresholding in order to separate cancerous area from healthy region of the skin by converting gray scale image into binary image. It separates the image into different regions based on some threshold value. It can also provide clear edges of cancerous area.

2.4. Morphological Operation

It is related to shape or morphology of features in an image. Processing of the image is carried out according to its shape. In this work, two fundamental operations are used.

- Dilation: Pixels are added to the boundaries of objects in an image
- Erosion**:** Pixels are removed from object boundaries.

2.5. Particle analysis

After the Morphological operation, particle analysis process is carried out in order to find the area of the cancerous part.

2.6. Edge Detection

Edge detection in image processing technique is used for finding the boundaries of objects within images. In this project, edge detection is used to identify the border of the cancerous area.

2.7. Feature Extraction

Four features are extracted as work per ABCD rule such as Asymmetry, Border, Color, and Diameter.

- Asymmetry: Most of the cancers are asymmetrical *i.e.* one half of the mole doesn't match the other half.
- Border irregularity: Cancerous moles have uneven edges where normal moles have smooth edges.
- Color: Normal moles are mostly brown shaded where cancerous moles are tan or black. When the cancer grows, the color may change into red or white.
- Diameter: It is used to compute the cancerous area. It is calculated using the number of pixels.

3. Implementation & results

The proposed system is developed using IMAQ (Image Acquisition) Vision and Motion Toolkits and NI Vision Assistant toolkits of

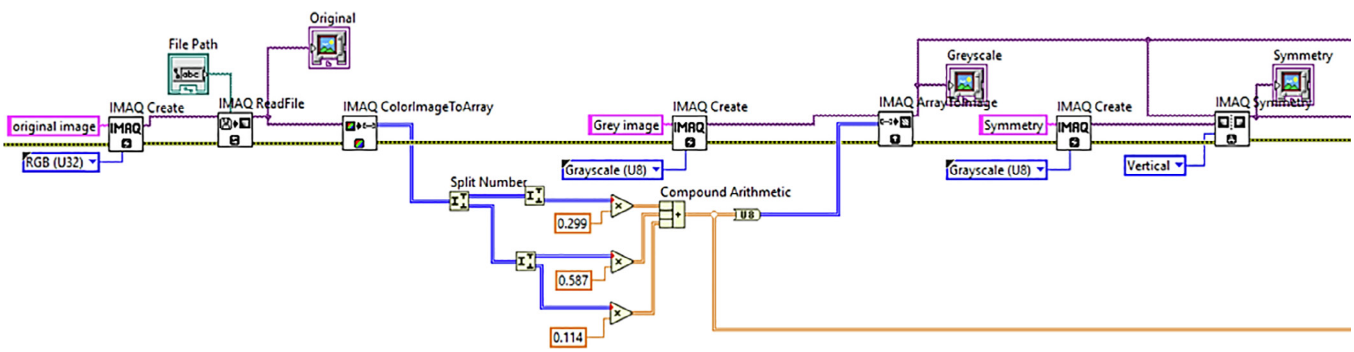

Fig. 2. VI to Read the Image and Gray Scale Conversion.

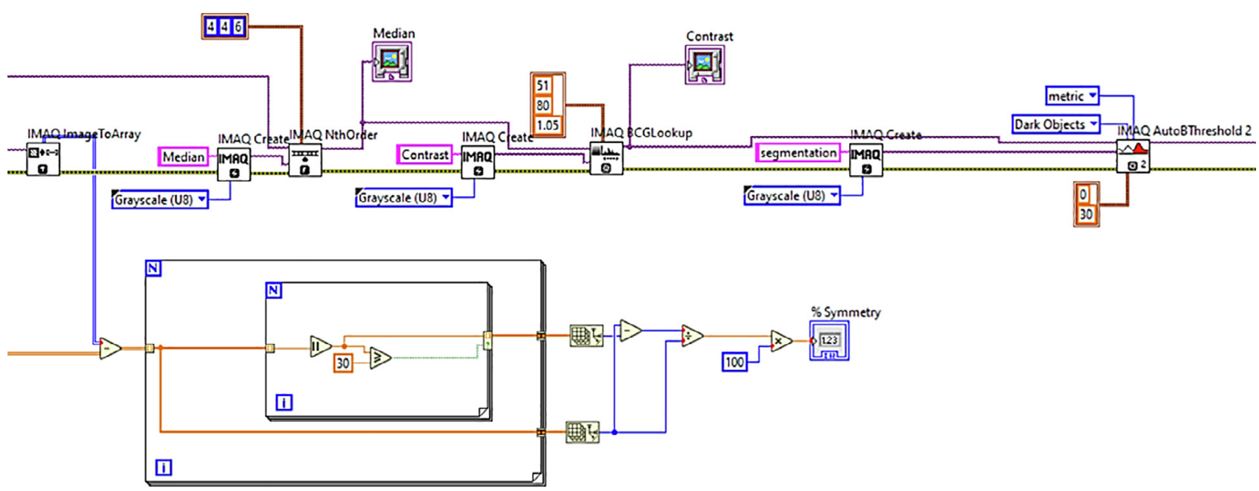

Fig. 3. VI for Filtering and Thresholding.

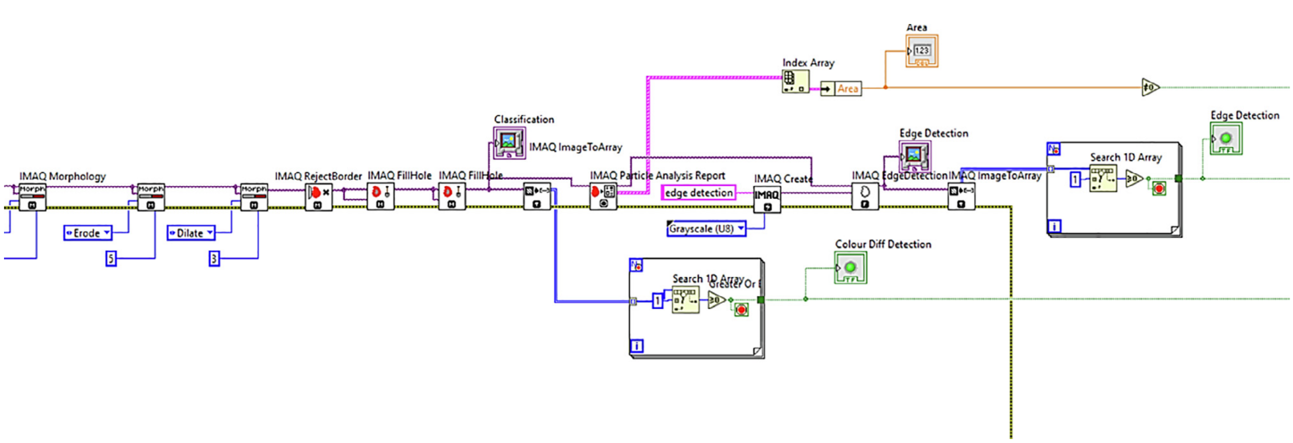

Fig. 4. VI for Morphological Operation and Particle Analysis.

Table 1
Results of skin cancer detection.

	Asymmetry(%)	Border	ColorDifference	Diameter(area)	Result
Image 1	67%	Yes	Yes	11,278	Cancerous skin
Image 2	98%	Yes	Yes	3092	Cancerous skin
Image 3	93%	Yes	Yes	5470	Cancerous skin
Image 4	79%	Yes	Yes	7417	Cancerous skin
Image 5	77%	Yes	Yes	15,979	Cancerous skin
Image 6	2%	No	No	NA	Normal skin
Image 7	1%	No	No	NA	Normal skin
Image 8	26%	Yes	Yes	11,771	Cancerous skin
Image 9	71%	Yes	Yes	163	Cancerous skin
Image 10	18%	Yes	Yes	23,028	Cancerous skin
Image 11	20%	Yes	Yes	15,627	Cancerous skin
Image 12	17%	Yes	Yes	44,465	Cancerous skin
Image 13	28%	Yes	Yes	24,115	Cancerous skin
Image 14	22%	Yes	Yes	17,510	Cancerous skin
Image 15	30%	Yes	Yes	10,240	Cancerous skin

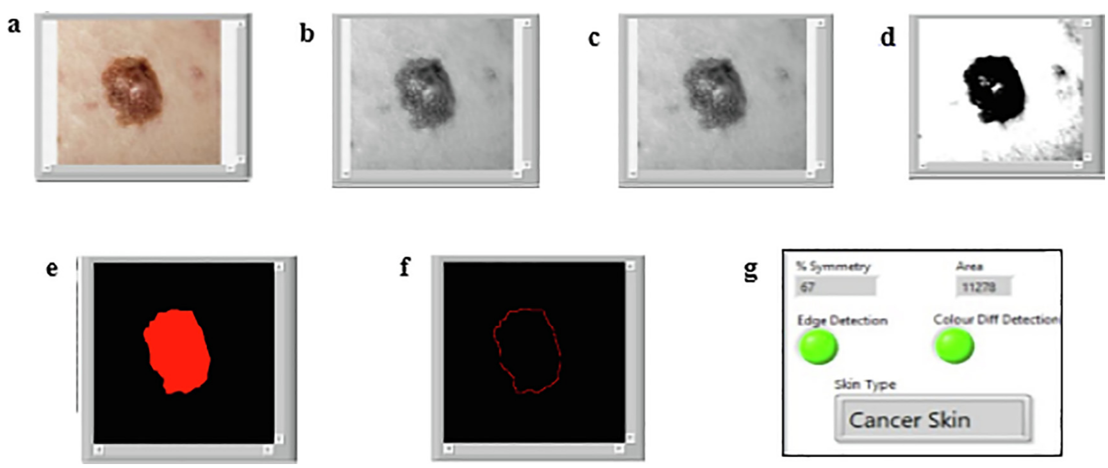

Fig. 5. Output of image 1 (a) Original Image: (b) Gray Scale Image; (c) Filtered Image (d) Contrast Stretched Image; (e) Tumor Area; (f) Edge Detected Image; (g) Output.

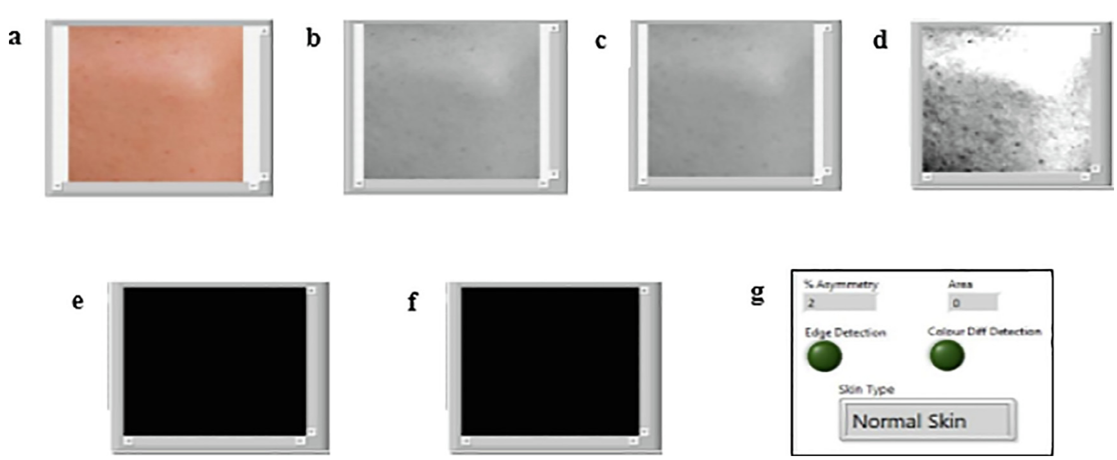

Fig. 6. Ouput of Image 6 (a) Original Image: (b) Gray Scale Image; (c) Filtered Image (d) Contrast Stretched Image; (e) Tumor Area; (f) Edge Detected Image; (g) Output.

LabVIEW to detect the cancer. Fig. 2 shows the process of reading the image and gray scale conversion. Fig. 3 explains the process of filtering and thresholding. Fig. 4 illustrates the process of morphological operation and particle analysis. The color difference between the normal skin and cancerous skin is reported. Four features such as Asymmetry (%), Border, Color, and Diameter of cancerous region are extracted.

To test the effectiveness of the proposed method, experiments are carried out using fifteen different dermoscope images and the results are tabulated in Table 1. This proposed algorithm is tested with 15 Images (13 Abnormal & 2 Normal Images). The output images obtained at different stages are shown in Fig. 5 and Fig. 6. The results obtained for the fifteen images are tabulated in Table 1. From the table it is observed that the proposed method is able to detect affected region and able to identify whether the skin is normal or cancerous.

4. Conclusion & Future work

This paper presents a skin cancer detection system based on ABCD rule using LabVIEW. It can be concluded from the results that the proposed system effectively discriminates normal (non-melanoma) and cancerous area (melanoma) with 100% accuracy. Hence this tool will help dermatologists in diagnosis of skin cancer. Future work will focus on evolution of skin cancer of the same patient at different period of times.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Further Reading

[1] Melanoma images are from the DermIS (http:/www.dermis.net) and DermQuest (http://www.dermquest.com) database.