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An Analysis of Skin Cancer Detection Using Imagery Techniques (2010-2015)

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Abstract--In recent years, there has been a fairly rapid increase in the number of melanoma skin cancer patients which is the deadliest form of skin cancer, must be diagnosed early for effective treatment. Image-based computer aided diagnosis systems have significant potential for screening and early detection of malignant melanoma. We have reviewed 16 research papers from year 2011-2015which uses image processing for detection and diagnosis of skin cancer.

Keywords: melanoma, segmentation, classification, image pre-processing, skin cancer, MAFIA algorithm, ABCD rule, Optical coherence tomography, fuzzy system, neural network, data mining, Epiluminescence microscopy (ELM).

I. INTRODUCTION

Skin cancer is a major public health problem in the light skinned population. Skin cancer is divided into non melanoma skin cancer (NMSC) and melanoma skin cancer (MSC).Non melanoma skin cancer (MMSC) is the Types of skin cancer most prevalent cancer among light-skinned population. It is divided into basal cell carcinoma (BCC) (75%), squamous cell carcinoma (SCC) (24%), and other rare types (1%) such as sebaceous carcinoma. The critical factor in assessment of patient prognosis in skin cancer is early diagnosis. Recent work has shown that skin cancer recognition from images is possible via supervised techniques such as artificial neural networks and fuzzy systems combined with feature extraction techniques. Other supervised classification techniques, such as k-nearest neighbors (k□NN) also group pixels based on their similarities in each feature image can be used to classify the normal/abnormal images. Therefore image processing become our choice for an early detection of the skin cancer, as it is non-expensive technique.

II. CRITICAL ANALYSIS

A.A.L.C. Amarathunga et al(2015)[1]: This research paper presents a development of a skin diseases diagnosis system which allows user to identify diseases of the human skin and to provide advises or medical treatments in a very short time period. To detect diseases of the skin and offer a treatment recommendation.It uses technologies such as image processing and data mining for the diagnosis of the disease of the skin. The expert system used in the paper exhibits disease identification accuracy of 85% for Eczema, 95% for Impetigo and 85% for Melanoma. This system used rule based and forward chaining inference engine approach to identify the disease of the skin. Given system enables user to identify children skin diseases via online and provide useful medical suggestions. Used five different data mining classification algorithms (AdaBoost, BayesNet, J48, MLP and NaiveBayes) to predict and diagnose the skin disease. This only works for three skin diseases (Eczema, Impetigo and Melanoma).Further work can be done on this.

Messadi M et al(2014)[2]:The aim of this paper is to propose an interpretable classification method for skin tumors in dermoscopic images based on shape descriptors. Researchers presents a fuzzy rule based classifier to discriminate a melanoma. An adaptive Neuro Fuzzy inference System (ANFIS) is applied in order to discover the fuzzy rules leading to the correct classification. The method used in this paper is called ABCD. It requires calculating 4 factors: Asymmetry (A), Border (B), Color (C) and Diversity (D). This framework has been tested on a dermoscopic database of 320 images. The sensitivity of the ABCD rule is reported to be between 59% and 88%.Used dull razor technique for preprocessing. Asymmetry (A) is one of the more important parameters used indifferentiating malignant tumors from benign lesions. Border irregularity have four special features to quantify irregular edges: compactness, radial variance and extraction of small changes in the contour. Color criterion uses four parameters which are Correlation, Homogeneity, Energy and Contrast.Next is Diameter. Reseachers were able to demonstrate the feasibility of this approach by creating prototypes capable of recognizing an indicator.

Sarika Choudhari et al. (2014)[3]**:** This paper tells about the Early Detection of skin cancer as Early detection has the ability to reduce mortality and morbidity. Researchers have done segmentation of images using Maximum Entropy Threshold, feature extraction using GLCM and c1assification using Artificial Neural Network (ANN). To obviate these problems, image processing techniques, a neural network system (NN) are used in this paper as promising modalities for detection skin cancer. Paper's methodology consist several steps: Dermoscopy , Dull Razor Filtering, Converting to gray scale, Contrast Enhancement, Noise Filtering. Maximum Entropy Thresholding. Feature Extraction technique used is gray Level Cooccurrence Matrix. Mean or provides a measure of distribution. A Computer aided skin cancer detection system can achieve a new discovery of detecting benign or malignant skin lesions and separating them.

Nadia Smaoui et al(2013)[4]: This Paper's work is based on a combination of a segmentation method and an analytical method, and aims to improve these two methods in order to develop an interface that can assist dermatologists in the diagnostic phase. In this paper, the segmentation process used is region growing. This segmentation technique begins with a pixel as the seed point. Calculate the average of the region. To remove isolated pixels, a further step of morphological closing is produced. Measure the asymmetry in terms of form, measure the asymmetry in terms of color.The maximum irregular border score is 8, and the minimum one is 0. Melanomas are characterized by the presence of six different colors, namely, white, red, light brown, dark brown, blue-gray and black. For Diameter Total Dermatoscopic value (TDV) is calculated by :***1.3 _ A + 0.1 _ B + 0.5 _ C + 0.5 _ D***; if TDS < 4.75: Benign skin lesion;if 4.75 <= TDS<= 5.45: Suspicious; if TDS > 5.45: Melanoma.Based on the experiment, the accuracy of the system is 92% with 4 false diagnosis of the 40 samples.

Teresa Mendonca et al(2013)[5]: The researchers presents a database. A dermoscopic image database, called PH2, is presented. The PH2 database includes the manual segmentation, the clinical diagnosis, and the identification of several dermoscopic structures, performed by expert dermatologists, in a set of 200 dermoscopic images.Uses techniques like pattern analysis, the ABCD rule,the 7-point checklist, and the Menzies method. Computer-aided diagnosis (CAD) have been proposed to assist the clinical evaluation of dermoscopic lesions. Three stages: image segmentation, feature extraction/selection, and lesion classification. The PH2 database:*Manual segmentation of the skin lesion, Clinical diagnosis, Dermoscopic criteria.* This paper presents a database which includes medical annotation of all the images namely medical segmentation of the lesion, clinical diagnosis and dermoscopic criteria (asymmetry, colors and the presence of typical and atypical differential structures).

Kawsar Ahmed et al(2013)[6]:In this paper researchers have used several techniques Data Pre-processing, Disease Diagnosis, Classification, MAximal Frequent Itemset Algorithm (MAFIA) algorithm, K-means clustering and significant frequent pattern. Treatment for skin cancer depends on the type and stage of the disease, the size and place of the tumor. MAFIA algorithm is very easy and effective to find out frequent patterns. The pre-processed data is clustered using the K-means clustering algorithm. MAFIA algorithm is chosen for its efficiency and simplicity than others for large data set.The weightage significant patterns are mined by using the Equation :**S**w(i)=Σ(Wi*Fi); significant Frequent Pattern is selected by using the following Equation:**S**FP=Sw (n) ≥φ for all values.

MAFIA algorithm is used to reduces time and memory compare to others.This paper proposed an effective Skin cancer prediction system based on data mining and provided an efficient approach for the extraction of significant pattern from data. The proposed method is implemented using Lotus Notes. The proposed method can efficiently and successfully predict the Skin cancer

Angel Alfonso Cruz-Roa et al(2013)[7]:Researchers presents and evaluates a deep learning architecture for automated basal cell carcinoma cancer detection that integrates (1) image representation learning, (2) image classification and (3) result interpretability.To discriminate between cancerous and normal tissues patterns, this paper presents a unified method for histopathology image representation learning,visual analysis interpretation, and automatic classification of skin histopathology images as either having basal cell carcinoma or not. The novel approach is Deep Learning(DL) architecture. DL architectures are an evolution of multilayer neural networks (NN). The different stages corresponding to different layers of the NN are: Unsupervised feature learning via autoencoders, Image representation via convolution and pooling, Automatic detection of BCC via softmax classifier, Visual interpretable prediction via weighted feature maps. The paper also presented a natural extension of a DL architecture to do digital staining of the input images. The inclusion of an interpretability layer for a better understanding of the prediction produced by the automated image classifier.

Mahmoud Elgamal (2013)[8]: This paper presents two hybrid techniques for the classification of the skin images to predict it if exists. The proposed hybrid techniques based on the following techniques, discrete wavelet transforms DWT, the principle components analysis PCA, FP-ANN, and k-NN. It consists of the following phases: feature extraction, feature reduction, and classification phase. Due to the computational simplicity and convenience of scalar (single channel) processing, the resulting RGB (red-green-blue) color image is often converted to a scalar image using one of the following methods:

- Retaining only the blue channel (lesions are often more prominent in this channel).
- Applying the luminance transformation, i.e Luminance = 0:299_Red+0:587_Green+0:114_Blue:
- Applying the Karhunen-Love (KL) transformation and retaining the channel with the highest variance.

The results of the deployed techniques were promising as, we got 100% for sensitivity, 95% for specificity , and 97.5% for accuracy.

Alejandro Garcia-Uribe, Jun Zou et.al.(April 5, 2012)[9**]:** This paper shows an oblique incidence diffuse reflectance spectroscopic (OIDRS) system . System was tested under clinical conditions by obtaining spectra from pigmented and non pigmented skin lesions, including melanomas, differently staged dysplastic nevi, and common nevi by standard. second analysis, we showed that this spectroscopy system can also differentiate non pigmented basal cell or squamous cell carcinomas from noncancerous skin abnormalities, the statistically significant skin types included in this study.Wereduced these variations by measuring and subtracting the optical priorities from the surrounding healthy skin for each lesion. A one-way ANOVA test was carried out to compare ma(l)L for common nevi, dysplastic nevi, and melanoma. The P value was significant ($P < 0.01$) in the spectral region between 488 and 576 nm. OIDRS distinguished malignant melanoma with 90% sensitivity. This system has also successfully classified BCCs and SCCs with 92% sensitivity and specificity.

Mariam A.Sheha,Mai S.Mabrouk, Amr Sharawy(2012)[10**]:** This paper presents an automated method for melanoma diagnosis applied on a set of dermoscopy images. Features extracted are based on gray level Co-occurrence matrix (GLCM) and Using Multilayer perceptron classifier (MLP) to classify between Melanocytic Nevi and Malignant melanoma. classification process was implemented using MLP classifier. The proposed methodology of discrimination between malignant and nevi tumors.The method uses the steps of Pre-processing, feature extraction, feature selection, classification and then evaluation. The first technique: Automatic MLP proposed 93.4% and 76% for training and testing accuracy respectively. The second technique: Traditional MLP, proposed 100% and 92% for training and testing accuracy respectively. The results indicated that the Traditional MLP yielded the better performance when compared to the first one.

Alexandros Karargyris, Orestis Karargyris, Alexandros Pantelopoulos(2012) [11]: This paper describes a mobile hardware/software system (DERMA/care) to help with screening of skin cancer (melanomas). A preliminary screening of the skin lesion by means of inexpensive mobile digital photography and algorithms based on the clinical ABCDE principles that are suggestive of malignancy. In the vector of features researchers used derived from both categories: texture and geometry: 4 +24 + 3 = 32 total features. In collaboration with the dermatology department of hospital we retrieved six cases of suspicious cases. We also used six normal cases. However acquiring cases requires effort and time since the medical personnel needs to be trained and consent of the patient needs to be given.This algorithm was able to successfully identify 5/6 of the normal cases as normal ones and 6/6 of the suspicious cases as abnormal ones.In the following figures visual results are offered. Screenshot of the application installed on an iPhone. Researchers are currently in the process of improving the classification part by increasing our training dataset. Additionally, they are planning to add encryption and security measures on top of the application to be fully HIPAA compliant [9]. They are also creating an online anonymized database where cases are publicly available for medical research or engineering development.

Charalampos Doukas, Paris Stagkopoulos, Chris T. Kiranoudis, and Ilias Maglogiannis(2012)[12]: This paper presents a smart phone based system for storing digital images of skin areas depicting regions of interest (lesions) and performing self-assessment of these skin lesions within these areas. The system runs on an Android mobile device achieving an accuracy of 66.7% in melanoma detection. evaluated a number of different classification algorithms provided by the WEKA tool. Accuracy (%) in correctly classifying instances, Root Mean Square Error (RMS), True Positive Rates (TPR), False Positive Rates (FPR) and Area under ROC Curve (AUC) have been also utilized as evaluation metrics. The first experiment involves the evaluation of the algorithms in characterizing melanoma versus dysplastic and non-dysplastic (i.e. benign) skin lesions. dysplastic and non-dysplastic with an average accuracy of 77.06%.the discrimination between melanoma and benign regions with 85-90% accuracy. The main advantages of the proposed system are the utilization of a Cloud infrastructure for on-line storage, continuously improving the classification model and providing accurate characterization results in various mobile platforms. In addition it is the first system to collect contextual information from the user that can be later used for a better assessment from an expert and the progress assessment as well.

E. Barati, M. Saraee, A. Mohammadi, N. Adibi and M. R. Ahamadzadeh(2011)[13]: This paper is intended to introduce data mining and its various techniques and a survey of the available literature on medical data mining. In this paper, summarized the different uses of classification in dermatology. In the use of clustering techniques, Ubeyli and Dogdu [60] proposed the method based on *k*-mean clustering which had 94.22% classification accuracy. they obtained the SVM diagnosis model which had 98.61% classification accuracy. Medical data mining can help to prepare some methods for diagnosis, prognosis, decision making, etc. we have summarized some uses of data mining techniques in medical domain.

Suhail M. Odeh(2010)[14]: This paper presents a diagnosis system, based on an adaptive neuro-fuzzy inference system (ANFIS) algorithm, for applications in biomedical fields. This paper deals specifically with skin cancer diagnosis. Our system can be divided into two main parts: feature selection, using the Greedy feature flip algorithm (G-flip), and classification method using ANFIS algorithm. The ANFIS algorithm could be trained with the back propagation gradient descent method in combination with the least squares method. The RMSE was also calculated on training data set for every iteration. The optimal number of iterations obtained was 9 epochs by the time RMSE reached its minimum value. We then convert the error from RMSE to percentage error. This paper validates the optimization technique of the different features to a high level of classification accuracy, where these features were extracted by image processing and then selected by using G-flip algorithm.

Radu Dobrescu ,Matel Dobrescu ,Stefan Mocanu Dan Papescu (2010)[15**]:** This paper describes a method and an algorithm for automatic detection of malignancy of skin lesions which is based on both local fractal features (local fractal dimension) and texture features which derives from the medium co-occurrence matrices (contrast, energy, entropy, homogeneity). The system performs image processing operations (noise rejection, segmentation to binary images with variable threshold and contour extraction), statistical and fractal features extraction and image comparison and classification. The texture features (energy, entropy, contrast, homogeneity, and correlation) derive from the average grey level cooccurrence matrix and fractal features derive from fractal dimension (box counting dimension, local dimension, and local connected dimension). Future plans include improvement of threshold level selection, development of a new or improved procedure for calculating R, G,B mean fractal dimensions. Researchers also aim to improve the processing speed and efficiency by implementing all the algorithms and procedures on a parallel processing platform.

Gabriella Fabbrocini, Giovanni Betta, Giuseppe Di Leo et.al.(2010)[16]: This paper describes an experimental automated diagnosis setup of melanocytic skin lesions through an image processing methodology focused on finding the

presence of different epiluminescence parameters. In this paper the image processingset up allows the automatic detection of some specific dermoscopic criteria. A good concordance between ELM 7 point checklist parameters detected and the new method of image processing was achieved by kappa analysis. 210 digital dermoscopy images, obtained from the CDROM Interactive Atlas of Dermoscopy [19], were observed by epiluminescence microscopy by two different dermatologists (M.S., G.F.) to evaluate the grade of accuracy in the management of 7 point check list algorithm

III. CONCLUSION AND FUTURE SCOPE

Our study analyses the research done during 2010 to 2015 in detection and classification of skin cancer using different imagery techniques. This paper presents a quick review that will help the future researchers to understand the techniques and methods that has been implemented till now. We present a summary of the 16 different papers reviewed by us as well as the techniques and methods used by those researches as follows:

Table1: Imagery techniques used during 2010-2015 for detection of skin cancer

Authors' Name	**Techniques Used**	**Critical Remarks**
A.A.L.C. Amarathunga et al(2015)[1]	Expert system, image processing, data mining, eczema, impetigo, melanoma, multilayer perceptron.	More than 85% accurate.Works only for three skin diseases: Eczema, Impetigo and Melanoma
Messadi M et al(2014)[2]	ANFIS;An adaptive Neuro Fuzzy inference System (ANFIS) to discover fuzzy rules for classification of skin cancer	The results of this paper are significant and quite promising for the future
Sarika Choudhari et al(2014)[3]	Artificial Neural Network, a computer aided diagnosis system for skin cancer detection	Images are classified as cancerous or noncancerous. Methodology used in the paper is 86.66% accurate
Nadia Smaoui et al(2013)[4]	Segmentation using region growing,ABCD rule	3 diagnosis used in this research; melanoma, suspicious, & benign. System is 92% accurate.
Teresa Mendonca et al(2013)[5]	A dermoscopic database is represented.	It is a open source database for dermoscopic images.
Kawsar Ahmed et al(2013)[6]	Data Mining: Extraction of significant pattern	can efficiently and successfully predict the Skin cancer
Angel Alfonso Cruz-Roa et al(2013)[7]	visual analysis interpretation, and automatic classification of skin histopathology	Presented a natural extension of a DL architecture to do digital staining of the input images
Mahmoud Elgamal(2013)[8]	Automatic Skin Cancer images Classification	The proposed techniques performance evaluated in terms of confusion matrix, sensitivity, specificity, and accuracy.
Jun Zou et.al(2012)[9]	Oblique Incidence Diffuse Reflectance Spectrometry	it is feasible to use OIDRS as a potential tool for in vivo discrimination of malignant cutaneous melanoma from other types of pigmented skin lesions
Mariam A.Sheha(2012)[10]	Texture Analysis	tells that combination between cooccurrence matrix and ANN is a promising technique for discrimination between malignant melanoma and melanocytic nevi dermoscopy images.
Alexandros Karargyris et.al(2012)[11]	An Advanced image-Processing Mobile Application	this application we tried to emphasize and showcase the tremendous potentials new mobile technology offers.
Charalampos Doukas et.al(2012)[12]	Mobile Technologies and cloud platforms	the Cloud infrastructure for on-line storage, continuously improving the classification model and providing accurate characterization results in various mobile platforms
E. Barati, M. Saraee etal(2011)[13]	Data Mining Approaches	Finding association rules between different features of skin cancer images., Discovering most significant risk factors for skin cancer
Suhail M. Odeh(2010)[14]	Adaptive Neuro-Fuzzy Inference System (AnFis) Algorithm	this classification method showed that by using ANFIS, produces better result than with otheralgorithms for diagnosis systems, in the field of biomedical studies.
Radu Dobrescuet.al(2010)[15]	Medical images classification	The experimental results for the test images database worked with excellent results, the

		errors in retrieving were very few or not at all.
Gabriella Fabbrociniet.al(2010)[16]	Epiluminescence Image Processing	describes an experimental automated diagnosis setup of melanocytic skin lesions through an image processing methodology

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