Melanoma Skin Cancer Detection:A Review

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***Abstract*— Skin is a vital component of the human body and covers the entire human system. Skin cancer is one of the complex and severe types of cancer. Nowadays young adults are mostly affected by skin cancer. In spite of the unforeseen progression medical science, curing skin cancer is a complex process. Malignant melanoma is one type of skin cancer, which cannot be cured and leads to death unless detected earlier. One of the major challenges is detection of melanoma at an early stage. Various techniques have emerged for detecting melanoma and this paper reviews the most extensively used algorithms.**

Keywords: *Skin Cancer, Melanoma, Non-melanoma, Ultraviolet rays, Moles.*

I. INTRODUCTION

Cancer is a cluster (faction) of more than 100 diseases (Lung cancer, Breast cancer, Blood cancer etc.) were unwanted cells are grown in the human body [13]. It is a deadly disease, which starts from the unrepaired cells in DNA. Cancer is also known as cell disease. World Health Organization states that death due to cancer will increase to 13.1 million in 2030[12]. Skin Cancer is one of the common types of cancer. It occurs when abnormal cells are grown in the skin. Skin cancer mainly occurs when the skin is exposed to ultraviolet rays, tanning beds. Melanoma is a severe type of skin cancer, which affects the skin pigment cells called melanocytes. Melanoma can be easily identified by abnormal moles.

Skin cancer affects all colors of people, especially people with fair skin. Skin cancer can also occur due to exposure to sunlight during childhood. Melanoma can spread to other parts of the body. World Health Organization estimates that more than 65,000 people a year worldwide die due to melanoma [9]. By not exposing the skin to too much of sunlight, more than 2 million people could be saved from skin cancer every year. Curing melanoma is very difficult, but death can be reduced using certain treatments like Chemotherapy, Immunotherapy, Radiation and Surgery. Melanoma is fatal and 75% of all skin cancer results in death. Skin cancer is common in the United States and Australia. According to the American Cancer Society, skin cancer in the United States during 1st July 2014 is estimated as follows:

- About 76,100 new melanomas will be diagnosed (about 43,890 in men and 32,210 in women).
- About 9,710 people are expected to die of melanoma (about 6,470 men and 3,240 women). [7]

The main objective of this paper is to provide a brief description of melanoma skin cancer and how it can be detected early. Section 2 analyses skin cancer and its types. Section 3 presents a survey of melanoma skin cancer detection. The conclusion is presented in Section 4.

II. SKIN CANCER AND ITS TYPES

Skin is one of the vital and largest organs in the human body. The colored skin pigments produce cells called melanocytes. Melanocyte is located in the epidermis, which is the outer layer of the skin. Skin cancer starts with the outer layer of epidermis due to the exposure of the skin to ultraviolet rays. Thus, it has been classified into two types. The Following Figure: 1 shows the classification of skin cancer:

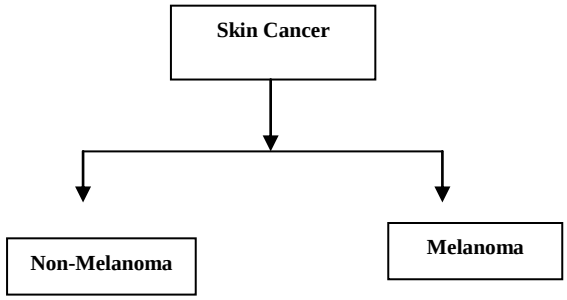

Figure 1: Classification of Skin Cancer

Melanoma is more severe than Non-melanoma, but it is rare in case. Non-melanoma and Melanoma are curable, if detected early. While Non-melanoma does not spread to other parts of the human body, Melanoma spreads to other parts of the body [8]. Non-Melanoma is higher in males when compared to females.

2.1 Non-Melanoma

Non-Melanoma is one of the important threats of skin cancer [4]. Non-Melanoma has been categorized into two sub-types, namely, Basal Cell Carcinoma (BCC) and Squamous Cell Carcinoma (SCC) .The Following Figure:2 shows the categorization of Non-Melanoma:-

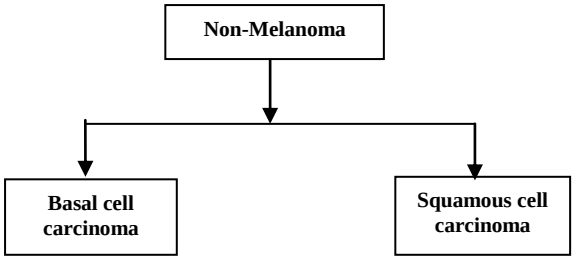

Figure: 2 Categorization of Non-Melanoma

2.1.1 Basal Cell Carcinoma

Basal Cell Carcinoma is one of the familiar types of Non-melanoma skin cancer.BCC starts with the bottom layer of epidermis, and arises from the hair follicle.BCC is slow growing, and it does not spread to other parts of the body. More than 90% of skin cancer results in BCC.BCC occurs due to the sporadic exposure of skin to ultraviolet rays.BCC usually resembles lump and patches, where lump appears on face, ears, head and neck with patches on chest and back.

In rare cases, it can also appear on the other parts of the body. It often looks red, pink and skin colored and it can also be brown and black.BCC will be 10-15cm (i.e., 4-6 inches). People above 40 years have higher chances of developing BCC. Though it leads to itching and bleeding, it is painless.BCC is more dangerous unless detected early.BCC can be removed through surgery.

2.1.2 Squamous Cell Carcinoma

Squamous Cell Carcinoma is another type of non-melanoma skin cancer that arises from the upper layer of epidermis.SCC mostly occurs due to the long term exposure to sunlight and also due to chemical exposure.SCC is almost curable if detected early, or else it will spread to other parts of the body.SCC occurs especially on nose, ears and lips. They appear like red patchy and open sores. About 70,000 people were diagnosed with SCC every year in the United States.

2.1.3 Melanoma

Melanoma is the least common type of skin cancer. Melanoma can also be called as malignant melanoma or cutaneous melanoma. It is very aggressive and affects the skin pigment cells called melanocytes.

Melanoma occurs due to the absorption of ultraviolet rays by the skin and it is fast growing. It becomes very severe, unless detected early. Melanoma can be identified when there is change in moles [9]. The moles grow in irregular sizes and shapes greater than 6mm diameter. Melanoma will be black or brown in color. Small amount of melanoma will be pink, red or fleshy in color. Irregular streaks are vital clues of melanoma. Melanoma is harder to treat when it reaches an advanced stage and spreads to other parts of the body.

Melanoma can be easily identified with abnormal moles Symptoms of melanoma are

- A-asymmetrical,
- B-border,
- C-Color Variation,
- D-Diameter, and
- E-Evolving.

A Graphic Picture of the melanoma symptoms is presented in Figure: 3.

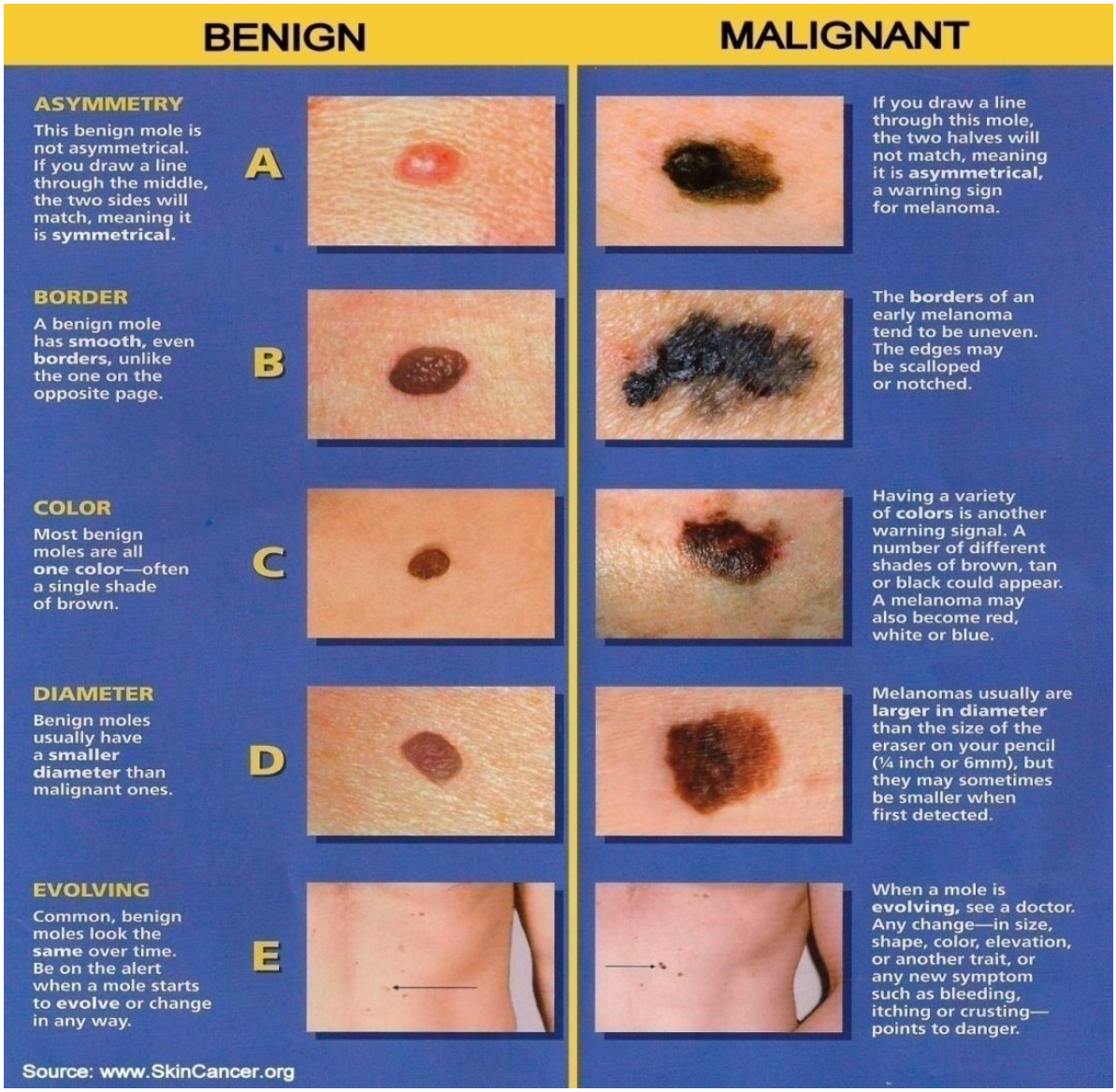

Figure: 3 Melanoma Symptoms

Some other symptoms of melanoma are appearance of a new mole during adulthood or paining, itching or bleeding around the moles. People affected by more than 100 melanoma moles are at higher risk of malignant melanoma. More than 1, 60,000 people are diagnosed with melanoma worldwide every year. Streaks that are irregular are another type of clue to identify melanoma. Mostly, melanoma appears on the backside for men and in legs for women. Melanoma has been classified into four types. Figure: 4 show the types of melanoma [9]

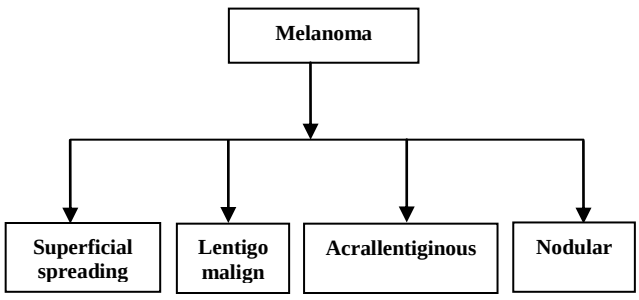

Figure: 4 Types of Melanoma

Superficial spreading melanoma

It is one of the common types of melanoma and 70% of melanoma is of this type. It occurs on the basal layer of epidermis. This type of melanoma appears only during the middle age, but nowadays it has increased in young adults.

Lentigo maligna

It is the same as superficial spreading melanoma and starts from the deeper layer of skin dermis. It appears on the face, head or neck and especially on the nose and cheeks (i.e., mainly in areas exposed to the sun).

Acrallentiginous melanoma:

It is one of the most serious types of skin cancer that arises on skin pigments. It is common in dark skinned people than fair skinned ones.

Nodular melanoma

It is one of the most aggressive types of melanoma. Nodular melanoma is common in elderly people.EFG (E – Elevated, F – Firm to touch, G – Growing progressively over more than a month) is a way to identify nodular melanoma easily.

III. REVIEW OF MELANOMA

The review of various methods for detecting melanoma is shown in the following page in Table : 1.

Table: 1 A review of different techniques and algorithms used in detecting melanoma skin cancer.

Paper Title	Year	Author	Pre-Processing	Segmentation	Edge-Detection	Feature Extraction	Classification	Result
Detection of pigment network in dermoscopy images using supervised machine learning and structural analysis	May 2013	Jose Luis Garcia Arroyo, Begona Garcia Zapirian			Sobel	Color, Spectral, Statistical Extraction	C4.5 algorithm for generation of a decision tree classifier	Sensitivity of 86% and Specificity of 81.6%
Detection and Analysis of Irregular Streaks in Dermoscopic Images of Skin Lesions	May 2013	Maryam Sadeghi, Tim K.Lee, David McLean, Harvey Lui and M.Stella Atkins		Random Walker Segmentation	Laplacian of Gaussian	Lesion and color extraction	Simple Logistic Classifier Using Powerful Boosting Algorithm	Accuracy of 91.8%
Non-Invasive diagnosis of melanoma with tensor decomposition based feature extraction from clinical color image	Aug 2013	Ante Jukic, Ivica Kopriva, Andrzej Cichocki				Spatial-spectral profile of the lesion, texture, spectural diversity extraction	SVM classifier with Gaussian kernel	Sensitivity by 82.1% and Specificity by 86.9%
Pattern Classification of Dermoscopy Images: Perceptually Uniform Model	Aug 2012	Qasiar Abbs, M.ECelebi, Carmen Serrano, IreneFond-on Garcia, Guangzhi Ma	ROI Extraction			Texture Extraction by Steerable Pyramids Transform (SPT)	Pattern Classification by Multi label Ada Boost.Mc	Sensitivity by 89.28% Specificity by 93.75%
Using adaptive thresholding and skewness correction to detect gray areas in melanoma In situ images	July 2012	Gianluca Sforza, Giovanna Castellano, SaiKrishna Arika, Robert WLeAnd-er, R.Joe Stanley, Senior Member, IEEE, William V.Stoecker, and Jason R. Hagerty		Optimization of basic adaptive thresholding using skewness correction				Shows best in Accuracy results with an average of 0.296

Paper Title	Year	Author	Pre-Processing	Segmentation	Edge-Detection	Feature Extraction	Classification	Result
Automatic Segmenation of Dermoscopy Images Using self-Generating Neural Networks Seeded by Genetic Algorithm	Aug 2012	Fengying-Xie, Alan C.Bovik		Region-Based Segmentation	Laplacian of Gaussian	Color and texture extraction	Adaptive clustering based on genetic algorithm and self generating neural netwroks	Accuracy of 85.5%
Toward a combined tool to assist dermatologist in melanoma detection from dermoscopic images of pigmented skin lesions	June 2011	German Capdehou-rat, Andres Corez, Anabella Bazzano, Rodrigo Alonso, pablo Muse	Hair Removal Filtering	Ostu's method		Lesion's shape, color, texture extracted	AdaBoost with C4.5 decision trees	Automatic detected yields 77%of Specificity for 90% sensitivity While manual detection 85% of specificity for 90% sensitivity
Melanomas non-invasive diagnosis application based on the ABCD rule and pattern recognition image processing algorithms	June 2011	A. GolaIsasi, B. Garcia Zapirain, A. Mendez Zorrilla			Canny Edge detection	Pattern, shape extraction	Globular pattern recognition, Reticulated pattern recognition, Homogen-eous blue pigmentation recognition, ABCD rule	Average of above 85%
Automated prescreening of pigmented skin lesions using standard cameras	Feb 2011	Pablo G.Cavalc-anti, Jacob Scharcanski	Shading affects are attenuated	Ostu's thresholding		Asymmetry, border, irregularity, color, variation and differential structures	KNN and KNN-DT classifier	Accuracy of 96.71%
Concentric decile segmentation of white and hypo pigmented areas in dermoscopic images of skin lesions allows discrimination of malignancy melanoma	Sep 2010	AnkurDal-Al, Randy H.Moss, R.Joe Stanley, William V.Stoecher, Kapil Gupta David A.Calcara, JinXu Bijaya Shrestha, Rhett Drugge		Euclidean Distance Transform	Adaptive detection	Absolute and relative color blotch extraction	Back-Propagation Neural Networks	Accuracy of 95%
Border detection in dermoscopy images using hybrid thresholding on	Aug 2010	Rahil Garnavi, Mohammad Aldeen, M.Emre Celebi,	Morphological closing operation, median filtering	Color space transformation noise removal, intensity adjustment, Ostu's	Local clustering based thresholding, Gaussian filter		Clustering based histogram thresholding, optimized parameter	Accuracy of 98.01%

optimized color channels		Geroge Varigos, Sue Finch		thresholding, connected component analysis			(W30B60)	

Paper Title	Year	Author	Pre-Processing	Segmentation	Edge-Detection	Feature Extraction	Classification	Result
Detection of granularity in dermoscopy images of malignant melanoma using color and texture features	Sep 2010	WilliamV. Stoeckera,, Mark Wronkie wiecza, Raeed Chowdhurya, R.Joe Stanleyb, Jin Xua, Austin Bangertb, Bijaya Shresthab, DavidA. Calcaraa, HaroldS. Rabinovi-tzc, Margaret Olivieroc, Fatimah Ahmedd, LindallA. Perrye,Rhett Druggef				Color and Texture Extraction	Back propagation neural network, Receiver operating characteristic (ROC) curve analysis best separation	Accuracy of 96.4%
Color and contrast enhancement for improved skin lesion segmentation	Aug 2010	Gerald Schaefera, MaherI. Rajabb, M. Emre Celebic, Hitoshi Iyatomid	Enhances color information and image contrast, applying color normalisation technique, namely automative color equalization	Itreative segmentation scheme, co-operative neural network				Errors reduced to 0.24, 0.07,0.05 for RGB
Modified watershed technique and post-processing for segmentation of skin lesions in dermoscopy images	Sep 2010	Hanzheng Wanga, RandyH. Mossa, XiaoheChenb, R.Joe Stanleya, WilliamV. Stoeckerc, M. Emre Celebid, JosephM. Malterse, JamesM. Grichnikf, AshfaqA. Marghoobg, HaroldS. Rabinovitzh, ScottW. Menziesi, ThomasM. Szalapskij	Morphologi-cal closing operator for hair removal, Black Borders are cropped using black rim, Vignetting minimized using Circular regions.	Watershed segmentation	Edge Object Threshold Method.	Mean R and G values at the watershed rim, pear R,G,B values of the object histogram, Blue plane LRE, pixel histogram standard deviation in Band L planes	Neural network classifier	Error rate achieved of 11.09%
An Integrated and iterative decision support system for automated melanoma recognition of dermoscopic	Oct 2009	M.M.Rahman, P.Bhattach-arya		Iterative thresholding segmentation	Double Threshold-ding, Elastic curve fitting technique	Color and texture feature	SVM's, Gaussian ML,K-NN classifier	Accuracy of 83.75%

images								
Overview Of Advanced Computer Vision Systems for Skin Lesions Characterization	Sep 2009	Ilias Maglogiannis and Charlampos N.Doukas		Contour Approach	Snakes and Active Contour	Color and texture feature	Bayes Network, SVM's, CART (Classification and regression trees)	Accuracy of 76.08%

4. CONCLUSION

Research in melanoma detection has been developing very seriously with the aim of detecting melanoma at a very early stage. From the study, the lesion texture, shape and color are used to detect melanoma. Reviews of melanoma for the past 5 years are presented in the above Table: 1 with various types of edge detection, segmentation, feature extraction and classification.

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