Melanoma Skin Cancer Detection: A Review

D. Saranya  Research Scholar  
Department of Computer Science  
Avinashilingam Institute of Home Science and Higher Education for Women  
Coimbatore, India  

V. Radha  Professor  
Department of Computer Science  
Avinashilingam Institute of Home Science and Higher Education for Women  
Coimbatore, India  

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).

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:

![Classification of Skin Cancer](image)

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:

![Non-Melanoma Diagram]

**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 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.
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: 3 Melanoma Symptoms**

<table>
<thead>
<tr>
<th>BENIGN</th>
<th>MALIGNANT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ASYMMETRY</strong>&lt;br&gt;This benign mole is not asymmetrical. If you draw a line through the middle, the two sides will match, meaning it is symmetrical.</td>
<td><strong>If you draw a line through this mole, the two halves will not match, meaning it is asymmetrical, a warning sign for melanoma.</strong></td>
</tr>
<tr>
<td><strong>BORDER</strong>&lt;br&gt;A benign mole has smooth, even borders, unlike the one on the opposite page.</td>
<td><strong>The borders of an early melanoma tend to be uneven. The edges may be scalloped or notched.</strong></td>
</tr>
<tr>
<td><strong>COLOR</strong>&lt;br&gt;Most benign moles are all one color—often a single shade of brown.</td>
<td><strong>Having a variety of colors is another warning sign. A number of different shades of brown, tan or black could appear. A melanoma may also become red, white or blue.</strong></td>
</tr>
<tr>
<td><strong>DIAMETER</strong>&lt;br&gt;Benign moles usually have a smaller diameter than malignant ones.</td>
<td><strong>Melanomas usually are larger in diameter than the size of the eraser on your pencil (½ inch or 6mm), but they may sometimes be smaller when first detected.</strong></td>
</tr>
<tr>
<td><strong>EVOLVING</strong>&lt;br&gt;Common, benign moles look the same over time. Be on the alert when a mole starts to evolve or change in any way.</td>
<td><strong>When a mole is evolving, see a doctor. Any change—in size, shape, color, elevation, or another trait, or any new symptom such as bleeding, itching or crustings—points to danger.</strong></td>
</tr>
</tbody>
</table>

Source: www.SkinCancer.org

---

**Figure: 4 Types of Melanoma**

```
+----------------+           +----------------+
| Superficial    | Melanoma         | Nodular         |
| spreading      |                 |                 |
| Lentigo        |                 |                 |
| malign         |                 |                 |
| Acralentiginous |                 |                 |
```


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.

<table>
<thead>
<tr>
<th>Paper Title</th>
<th>Year</th>
<th>Author</th>
<th>Pre-Processing</th>
<th>Segmentation</th>
<th>Edge-Detection</th>
<th>Feature Extraction</th>
<th>Classification</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detection of pigment network in dermoscopy images using supervised machine learning and structural analysis</td>
<td>May 2013</td>
<td>Jose Luis Garcia Arroyo, Begona Garcia Zapirian</td>
<td>Sobel</td>
<td>Color, Spectral, Statistical Extraction</td>
<td>C4.5 algorithm for generation of a decision tree classifier</td>
<td>Sensitivity of 86% and Specificity of 81.6%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Detection and Analysis of Irregular Streaks in Dermoscopic Images of Skin Lesions</td>
<td>May 2013</td>
<td>Maryam Sadeghi, Tim K.Lee, David McLean, Harvey Lui and M.Stella Atkins</td>
<td>Random Walker Segmentation</td>
<td>Laplacian of Gaussian Segmentation</td>
<td>Lesion and color extraction</td>
<td>Simple Logistic Classifier Using Powerful Boosting Algorithm</td>
<td>Accuracy of 91.8%</td>
<td></td>
</tr>
<tr>
<td>Non-Invasive diagnosis of melanoma with tensor decomposition based feature extraction from clinical color image</td>
<td>Aug 2013</td>
<td>Ante Jukic, Ivica Kopriva, Andrzej Cichocki</td>
<td>Spatial-spectral profile of the lesion, texture, spectral diversity extraction</td>
<td>SVM classifier with Gaussian kernel</td>
<td>Pattern Classification by Multi label Ada Boost.Mc</td>
<td>Sensitivity by 82.1% and Specificity by 86.9%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pattern Classification of Dermoscopy Images: Perceptually Uniform Model</td>
<td>Aug 2012</td>
<td>Qasiar Abbs, M.E.Celebi, Carmen Serrano, IreneFond-on Garcia, Guangzhi Ma</td>
<td>ROI Extraction</td>
<td>Texture Extraction by Steerable Pyramids Transform (SPT)</td>
<td>Pattern Classification by Multi label Ada Boost.Mc</td>
<td>Sensitivity by 89.28% Specificity by 93.75%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Using adaptive thresholding and skewness correction to detect gray areas in melanoma In situ images</td>
<td>July 2012</td>
<td>Gianluca Storza, Giovanna Castellano, SaiKrishna Arika, Robert WLeAnd-er, R.Joe Stanley, Senior Member, IEEE, William V.Stoecker, and Jason R. Hagerty</td>
<td>Optimization of basic adaptive thresholding using skewness correction</td>
<td></td>
<td></td>
<td>Shows best in Accuracy results with an average of 0.296</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paper Title</td>
<td>Year</td>
<td>Author</td>
<td>Pre-Processing</td>
<td>Segmentation</td>
<td>Edge-Detection</td>
<td>Feature Extraction</td>
<td>Classification</td>
<td>Result</td>
</tr>
<tr>
<td>---------------------------------------------------------------------------</td>
<td>-------</td>
<td>----------------------------------------------------------------------</td>
<td>----------------------------------------</td>
<td>---------------------------</td>
<td>-------------------------</td>
<td>--------------------------</td>
<td>-------------------------------------------------------------------------------</td>
<td>---------------------------------------</td>
</tr>
<tr>
<td>Automatic Segmentation of Dermoscopy Images Using self-Generating Neural Networks Seeded by Genetic Algorithm</td>
<td>Aug 2012</td>
<td>Fengying-Xie, Alan C.Bovik</td>
<td>Region-Based Segmentation</td>
<td>Laplacian of Gaussian</td>
<td>Color and texture extraction</td>
<td>Adaptive clustering based on genetic algorithm and self generating neural networks</td>
<td>Accuracy of 85.5%</td>
<td></td>
</tr>
<tr>
<td>Toward a combined tool to assist dermatologist in melanoma detection from dermoscopic images of pigmented skin lesions</td>
<td>June 2011</td>
<td>German Capdehourat, Andres Corez, Anabella Bazzano, Rodrigo Alonso, Pablo Muse</td>
<td>Hair Removal Filtering</td>
<td>Ostu’s method</td>
<td>Lesion’s shape, color, texture extracted</td>
<td>AdaBoost with C4.5 decision trees</td>
<td>Automatic detected yields 77%of Specificity for 90% sensitivity While manual detection 85% of specificity for 90% sensitivity</td>
<td></td>
</tr>
<tr>
<td>Melanomas non-invasive diagnosis application based on the ABCD rule and pattern recognition image processing algorithms</td>
<td>June 2011</td>
<td>A. Golalsasi, B. Garcia Zapirain, A. Mendez Zorrilla</td>
<td>Canny Edge detection</td>
<td>Pattern, shape extraction</td>
<td>Globular pattern recognition, Reticulated pattern recognition, Homogenous blue pigmentation recognition, ABCD rule</td>
<td>KNN and KNN-DT classifier</td>
<td>Average of above 85%</td>
<td></td>
</tr>
<tr>
<td>Automated prescreening of pigmented skin lesions using standard cameras</td>
<td>Feb 2011</td>
<td>Pablo G.Cavalcanti, Jacob Scharcanski</td>
<td>Shading affects are attenuated</td>
<td>Ostu’s thresholding</td>
<td>Asymmetry, border, irregularity, color, variation and differential structures</td>
<td>Back-Propagation Neural Networks</td>
<td>Accuracy of 96.71%</td>
<td></td>
</tr>
<tr>
<td>Concentric decile segmentation of white and hypo pigmented areas in dermoscopic images of skin lesions allows discrimination of malignancy melanoma</td>
<td>Sep 2010</td>
<td>AnkurDal-AI, Randy H.Moss, R.Joe Stanley, William V.Stoecher, Kapil Gupta David A.Calcara, JinXu Bijaya Shrestha, Rhett Druggge</td>
<td>Euclidean Distance Transform</td>
<td>Adaptive detection</td>
<td>Absolute and relative color blotch extraction</td>
<td>Back-Propagation Neural Networks</td>
<td>Accuracy of 95%</td>
<td></td>
</tr>
<tr>
<td>Border detection in dermoscopy images using hybrid thresholding on</td>
<td>Aug 2010</td>
<td>Rahil Garnavi, Mohammad Aldeen, M.Emre Celebi</td>
<td>Morphological closing operation, median filtering</td>
<td>Color space transformation noise removal, intensity adjustment, Ostu’s</td>
<td>Local clustering based thresholding, Gaussian filter</td>
<td>Clustering based histogram thresholding, optimized parameter</td>
<td>Accuracy of 98.01%</td>
<td></td>
</tr>
<tr>
<td>Paper Title</td>
<td>Year</td>
<td>Author</td>
<td>Pre-Processing</td>
<td>Segmentation</td>
<td>Edge-Detection</td>
<td>Feature Extraction</td>
<td>Classification</td>
<td>Result</td>
</tr>
<tr>
<td>----------------------------------------------------------------------------</td>
<td>------</td>
<td>----------------------------------------------------------------------</td>
<td>----------------</td>
<td>--------------</td>
<td>----------------</td>
<td>------------------</td>
<td>---------------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>Detection of granularity in dermoscopy images of malignant melanoma using color and texture features</td>
<td>Sep 2010</td>
<td>William V. Stoecker, Mark Wronkie wiecza, Raeed Chowdhurya, R. Joe Stanley, Austin Bangert, Bijaya Shresthab, David A. Calcaraa, Harold S. Rabinovitz, Margaret Oliviero, Fatimah Ahmedd, Linda A. Perry, Rhett Drugge</td>
<td>Color and Texture Extraction</td>
<td>Back propagation neural network, Receiver operating characteristic (ROC) curve analysis best separation</td>
<td>Accuracy of 96.4%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Color and contrast enhancement for improved skin lesion segmentation</td>
<td>Aug 2010</td>
<td>Gerald Schaefera, Maherl Rajabb, M. Emre Celebic, Hitoshi Iyatomid</td>
<td>Enhances color information and image contrast, applying color normalisation technique, namely automatic color equalization</td>
<td>Iterative segmentation scheme, co-operative neural network</td>
<td>Errors reduced to 0.24, 0.07, 0.05 for RGB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modified watershed technique and post-processing for segmentation of skin lesions in dermoscopy images</td>
<td>Sep 2010</td>
<td>Hanzheng Wang, Randy H. Mossa, Xiaohu Chenb, R. Joe Stanley, William V. Stoeckerc, M. Emre Celebid, Joseph M. Malterse, James M. Grichniki, Ashfaq A. Manghoobg, Harold S. Rabinovitzh, Scott W. Menziesi, Thomas M. Szalapskij</td>
<td>Morphological closing operator for hair removal, Black Borders are cropped using black rim, Vignetting minimized using Circular regions.</td>
<td>Watershed segmentation</td>
<td>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</td>
<td>Neural network classifier</td>
<td>Error rate achieved of 11.09%</td>
<td></td>
</tr>
<tr>
<td>An Integrated and iterative decision support system for automated melanoma recognition of dermoscopic</td>
<td>Oct 2009</td>
<td>M.M. Rahman, P.Bhattach-arya</td>
<td>Iterative thresholding segmentation</td>
<td>Double Thresholding, Elastic curve fitting technique</td>
<td>Color and texture feature</td>
<td>SVM’s, Gaussian ML, K-NN classifier</td>
<td>Accuracy of 83.75%</td>
<td></td>
</tr>
</tbody>
</table>
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.

References
[5] State of Science Fact Sheet - Skin Cancer - American Cancer Society
www.cancer.org/acs/groups/content/@nho/documents/.../skinca
cancerpdf.pdf
[13] https://www.google.co.in/?gws_rd=cr#q=common+types+of+cancer+%2Bpdf(introduction)