

Melanoma Skin Cancer Analysis Using ABCD Feature Extraction

Apurva S. Solanke¹, Prapti D. Deshmukh²

^{1,2}Department of Computer Science, MGM University, Dr. G. Y. Pathrikar College of C.S.
I.T., Aurangabad, Maharashtra, India. asolankeresearch@gmail.com

The sixth fastest growing kind of cancer worldwide is skin cancer. In basic terms, skin is formed out of cells, and those cells are composed of tissues. Consequently, cancer originates when cells in the relating tissues or other nearby tissues grow in number excessively or uncontrollably. Melanoma, basal cell carcinoma, and squamous cell carcinoma are among the various forms of skin cancer. Melanoma is the deadliest of these forms of skin cancer, and it spreads quickly if it is not identified and treated quickly. The biopsy procedure is the standard way to diagnose and detect melanoma. This approach can take a long time and be very painful. This work provides a computer-aided detection approach for melanoma early detection. The image of the afflicted skin is captured and sent through several types of pre-processing methods to provide a smoothed and improved image. Following that, the image is subjected to thresholding and morphological techniques for segmentation. In order to diagnose melanoma skin cancer, this study presents the asymmetry, border irregularity, color variation, and diameter (ABCD) feature extraction of dermatoscopic images. The ABCD feature is the key information derived from the image dermatoscopic lesion's morphology analysis. The Total Dermatoscopic Value (TDV) is computed using the ABCD feature in order to diagnose melanoma skin cancer. The asymmetry characteristic includes the lesion's lengthening index and asymmetry information. Features of border irregularity include information about the lesion's pigmentation transition, fractal size, edge abruptness, and compactness index. The colour homogeneity feature includes correlation and color homogeneity data between photometry and geometry of the lesion. The lesion's diameter is known as the diameter extraction. Melanoma and benign skin lesions are the two diagnoses used in this study. Thirty samples of dermatoscopic images of melanoma skin cancer are used in the investigation.

1. Introduction

Human skin is one of the body's primary organs. The body's internal organs and bones are covered by the skin. The skin is responsible for protecting the body from ultraviolet light. Melanin, which is present in skin cells, helps protect the skin from UV rays [1]. Fair-skinned people are more susceptible to UV radiation than dark-skinned people because dark-skinned people have more pigment in their skin. For this reason, most people with fair skin are recognized as melanoma sufferers. Melanoma cancer is the deadliest skin disease in humans out of all of them. One of the deadliest forms of skin cancer, melanoma accounts for 75% of all melanoma-related deaths. Early detection is the only way to cure it; if it has spread, treatment will be more challenging [2]. Melanocytes, which occur in human bodies, are the primary cause of melanoma. The traditional method for diagnosing skin cancer is a biopsy. In this method, a doctor removes a piece of a human cell, which is then sent to a lab for analysis. It is one of the most painful and time-consuming process. Therefore, it is essential to identify

the condition as soon as possible in order to begin treatment as soon as possible and cure it quickly [3]. Thus, automated detection of melanoma skin cancer has been developed. Pre-processing, segmentation, feature extraction, and classification are the four key steps in the melanoma detection. This study covers ABCD feature extraction method of object segmentation result that suspected melanoma lesion to get information whether the injury is non-melanoma or melanoma [4].

ABCD feature is the important information based on morphology analysis of image dermatoscopic lesion. ABCD feature is Asymmetry, Border Irregularity, Color Variation and Diameter features [5]. The melanoma lesions usually have morphology characteristics such as asymmetrical characteristic, irregular edge of the lesion, different colour composition, and a large diameter. Asymmetry feature consists information of asymmetry and lengthening Index of the lesion. Border Irregularity feature consists information of Compactness Index, Fractal Dimension, Edge Abruptness, and Pigmentation Transition from the lesion [5]. Colour homogeneity feature consists of Colour Information Homogeneity and the correlation between Photometry and Geometry of the lesion. Diameter extraction is diameter of the lesion [6].

The rest of the paper is organized as follows; section 2 described related work. Section 3 describes the flow of work as well as result of different steps and also describes ABCD feature extraction. Section 4 described about the experimental result and evaluation performance and section 5 describes conclusion of this study and last section 6 mentions references of this study.

2. Related Work

[1] The author of this study introduced MSVM classification, which achieved 96.25% accuracy by using two efficient feature extraction techniques, ABCD and MSVM. The author suggested a system that uses eight different kinds of skin cancer to classify them with great accuracy. A study used the ABCD rule for feature extraction along with a Multi-class SVM (MSVM) for classifying eight types of skin cancers. This method achieved a high accuracy of 96.25%, showing that combining medical rules with machine learning gives better and more reliable results in early skin cancer detection.

[2] In order to categorize skin lesions as either benign or melanoma, the author of this paper has proposed hybrid feature extraction by combining the ABCD rule, GLCM, and HOG. The segmentation result with 0.9 JA and 0.82 DI was obtained using the GAC method that was proposed. Features including color, symmetry, texture, and shape were retrieved using ABCD, GLCM, and HOG. Images from the ISIC dataset were classified using SVM, KNN, and Naïve Bayes. SVM earned the greatest accuracy of 97.8% and AUC of 0.94%, while KNN received 86.2% sensitivity and 85% specificity. Following augmentation, the technique showed improved outcomes and might be expanded to neural networks for more precision.

[3] The difference between the maximum and minimum ferret diameters from the lesion's best-fit ellipse is a novel feature of the ABCD rule that is employed in this paper. The author obtained 86.5% accuracy from just one feature, but 98% accuracy was obtained by using all features on 200 photos. This author also classified benign or melanoma lesions using a backpropagation neural network (BNN).

[4] The Bat algorithm and Otsu's thresholding were utilized in this study's soft computing approach to segment cutaneous melanoma, which was followed by Watershed extraction. The ABCD rule is used to categorize lesions as benign or malignant after the segmentation has been verified against ground truth. The method's effectiveness on certain photographs is demonstrated by the results.

3. Methodologies

In this paper, we proposed some image processing-based techniques for melanoma skin cancer detection from the dermoscopic images, these techniques will help for classification and diagnosis of melanoma skin cancer.

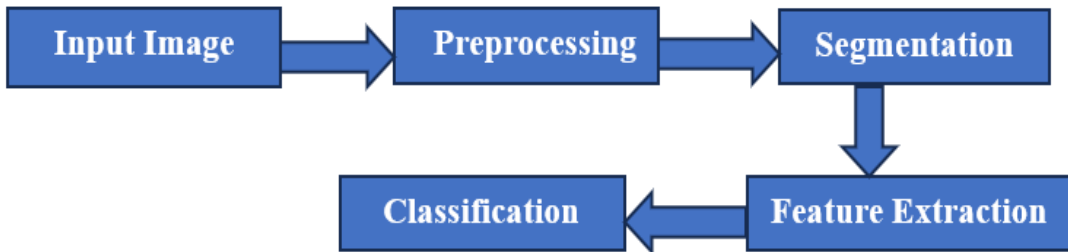


Figure. 1 The proposed system block diagram

3.1 Input Image

The images are collected from ISIC as well as PH2 dataset. Different datasets are available online but we used two of these datasets.

3.2 Preprocessing

This step includes converting the RGB acquired skin cancer images to gray image, after this we have applied Morphological closing operation for removal of hair noise from lesion area and after that we used histogram equalisation to enhance lesion area[8].

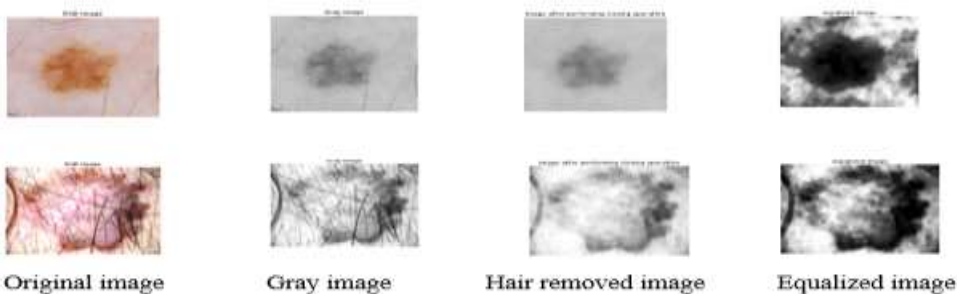
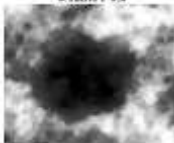
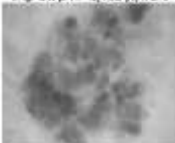
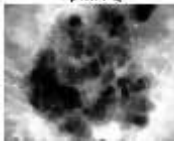
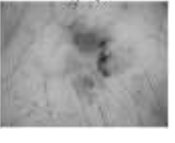
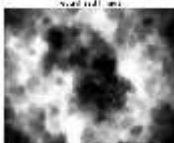
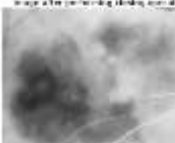
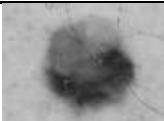
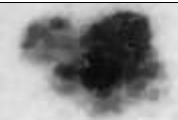
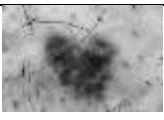
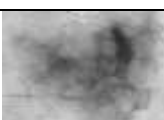
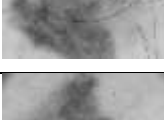
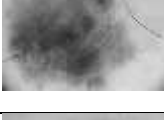
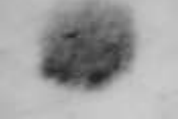
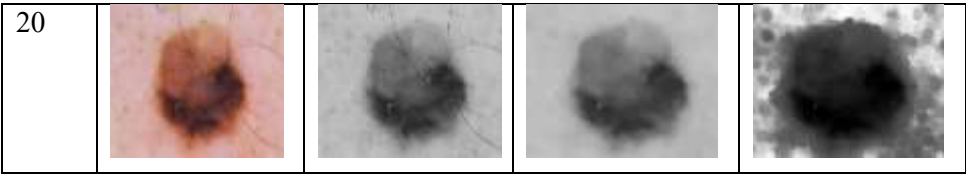


Figure. 2 Pre-processed images

Table 1. Preprocessing of different melanoma dermoscopic images

Sr. No.	Original image	Gray image	Morphological closing	Equalized image
1				
2				
3				
4				
5				
6				
7				
8				
9				

10				
11				
12				
13				
14				
15				
16				
17				
18				
19				



3.3 Segmentation

After Preprocessing second stage is separation of melanoma lesion area from background i.e. is segmentation of lesion area. In this step we have used Otsu thresholding and edge-based segmentation to extract only lesion area and from that lesion we have extracted the edges of lesion area. Before use of Otsu thresholding, we need to calculate threshold value for segmentation purpose[9]. With Otsu we get binary image of lesion area and we use that image as mask on original image so that we get the exact image of melanoma lesion area[10].

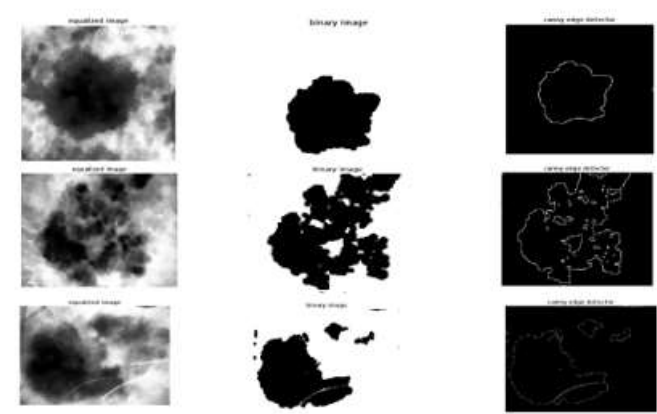
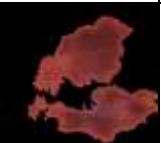
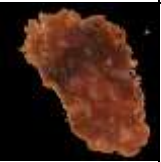
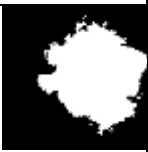


Figure 3. Segmented lesion area using OTSU thresholding

Table 2. Segmented melanoma images with threshold value, sensitivity, specificity and accuracy of segmented images using Otsu thresholding

Sr. No.	Original Image	Binary image	Segmented image	Threshold value	Sensitivity	Specificity	Accuracy
1				125	77.39	97.16	95.71
2				127	78.74	94.43	94.92

3				135	68.43	95.18	95.09
4				107	69.36	96.29	95.51
5				129	70.27	96.11	95.48
6				134	65.86	93.52	94.37
7				116	66.48	96.02	93.81
8				150	70.47	93.34	94.22
9				116	69.21	94.29	93.38
10				109	78.29	96.60	95.34
11				119	68.35	97.25	96.94

12				138	72.53	94.74	95.1
13				151	61.84	95.49	94.32
14				126	69.37	96.92	94.89
15				154	67.93	95.66	94.47
16				118	69.18	92.02	93.61
17				140	76.17	90.14	93.12
18				126	65.11	91.79	94.18
19				129	88.19	93.10	96.14
20				134	88.15	96.15	95.64

3.4 Feature Extraction

Feature extraction is considered as the most crucial part in the entire process of classification. After extracting the region of interest in the segmentation stage, the predefined features will be extracted from the segmented lesion area for classification [11]. There are different feature extraction techniques but, in this stage, we extract the feature to detect melanoma lesion area because it covers most of the criteria to classify and detect melanoma lesion [12]. For that purpose, we extract the feature with ABCD rule where features check with asymmetry, border, colour and diameter. ABCD method is the standard method for any dermatological applications [13,14]. There are some particular symptoms which need to consider in skin cancer case, they are Asymmetry, Border irregularity, Colour and Diameter which are known as ABCD parameters [15]. The method of finding these parameters is termed as the ABCD method. Asymmetry is calculated by considering the area of the lesion, where the total area of the segmented image is divided into two halves [16]. Thus, the asymmetry index is calculated by figuring how much one-half of the region matches with the other half and is indicated with a score of 0, 1, 2. Border irregularity is the abruptness and unevenness of the image [17]. It is important to depict the colour of the images which are irregular in shades. For colour values, each colour channel is separated and average intensity and standard deviation are calculated. The diameter of all the images is extracted. For example, malignant melanoma diameter is greater than 6 mm [18].

Table 3. ABCD Rule to assess Melanoma

Property	Details
Asymmetry (A)	Asymmetric, meaning one half of the lesion does not match the other half.
Border (B)	Irregular, poorly defined or scalloped borders
Colour (C)	Varied colours within a lesion such as shades of brown, black or red
Diameter (D)	The lesions larger than 0.24 inches in diameter

3.4.1 Asymmetry

Asymmetry measures by dividing lesion area in two halves and comparing two halves. Calculate asymmetry indices for both divisions.

Asymmetry index is computed with the following equation $A1 = \frac{A1+A2}{2Ar}$

Where, A1= Area of non-overlapped region along minor axis of the lesion,

A2= Area of non-overlapped region along major axis of the lesion,

Ar= Area of lesion implementation

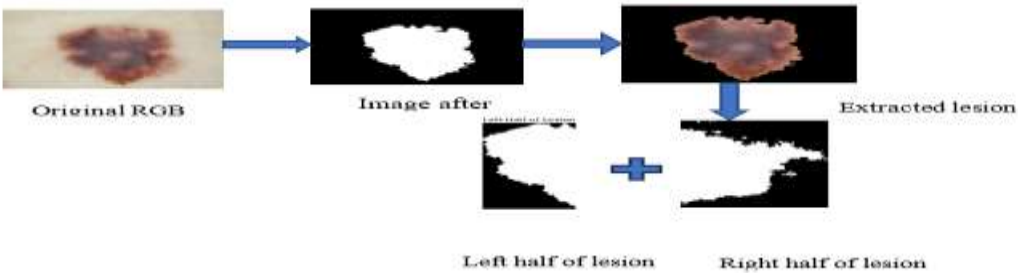


Figure 4. Asymmetry feature

3.4.2 Border

Border irregularity checks by calculating the perimeter and comparing it to a circular shape.

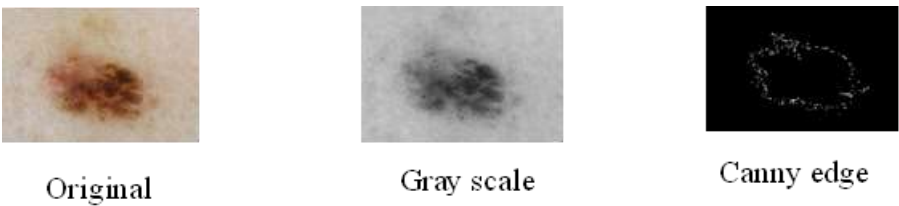


Figure 5. Border detected with canny edge

Circularity (border regularity): 0.41735

The lesion has an irregular (uneven) border

- Border Irregularity is a key feature of the ABCD rule used in melanoma detection.
- Irregular borders are characteristic of malignant melanomas and are usually uneven, jagged, or notched.

3.4.3 Colour

To determine the colour score, it is necessary to consider the following colour: White, red, light and dark brown, blue-grey and black. In this feature we need to calculate the number of unique colours and the standard deviation of colours intensities within the lesion area[19]. Colour refers to the heterogeneity of pigmentation in a lesion, with melanomas often displaying multiple uneven colours (brown, black, red, blue, white).



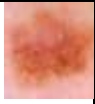
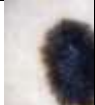
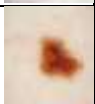
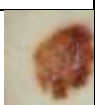
Figure 6. Colour Feature

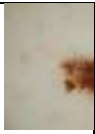
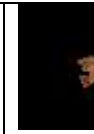
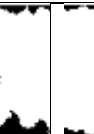
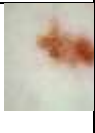
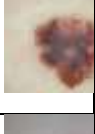
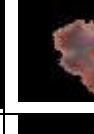
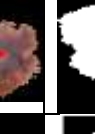
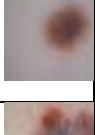
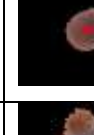
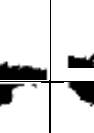
Brown: 9.78%, Red: 90.79%, Black: 0.00%, Blue: 0.00%.

3.4.4 Diameter

If the diameter of the region of the skin lesion is greater than 6mm, it alarms of malignancy. The diameter score is evaluated based on its size. The diameter of a skin lesion is evaluated as a maximum distance between two pixels of the lesions. To evaluate the diameter, we need to know the resolution of the image [19].

Table 4. ABCD Feature Extraction with different images

Sr . No.	Original image	Binary Image	Segment ed image	Left half	Righ t half	Asym metri cal value	Bor der Irre gula rity (BI)	Domin ant Color	Diamet er (mm)
1						0.265 2	1.45	Brown	7.2
2						0.2111	1.62	Dark Brown	8.5
3						0.280 3	1.33	Black	6.9
4						0.194 9	1.5	Brown	7.6
5						0.371 5	1.28	Dark Brown	5.9
6						0.276 3	1.71	Black	9.1
7						0.122 6	1.42	Brown	6.3
8						0.215 9	1.39	Reddis h- Brown	7

9						0.211 0	1.54	Dark Brown	8.4
10						0.319 9	1.6	Black	6.7
11						0.168 1	1.47	Brown	7.9
12						0.192 1	1.58	Grayish -Brown	9
13						0.108 9	1.3	Brown	6.2
14						0.117 9	1.65	Black	8.1
15						0.207 9	1.4	Brown	6.5

4. Result and discussions

- The Total Dermatology Score in the context of the ABCD rule for melanoma assessment is a composite score calculated from four main features i.e. Asymmetry, Border, Color and Diameter.
- Each of the features is scored individually, often on a scale of 0-2 or 0-3.
- The individual scores are then combined using a weighted formula to calculate the total score. A common formula used in dermatology is:

$TDS=(A*1.3)+(B*0.1)+(C*0.5)+(D*0.5)$

Table 5. Range of TDS Value

TDS Value	Interpretation
0-4	Mole

4-4.75	Benign
>4.75	Malignant Melanoma

Table 6 . Feature extraction with ABCD rule for different melanoma images

Image	Asymmetry	Border	Colour	Diameter	TDS Value
1	1	2	3	6.5	5.1
2	0	1	2	5.3	3.4
3	2	3	3	7.8	6.7
4	1	2	2	6	4.9
5	0	1	1	5	2.8
6	1	2	3	6.7	5.3
7	2	3	3	8.5	7.5
8	1	2	2	6.2	5
9	0	1	1	4.8	2.6
10	1	2	3	7	5.4
11	2	3	3	9	7.8
12	1	2	2	6.1	4.8
13	0	1	1	5.2	3.3
14	1	2	3	6.9	5.5
15	2	3	3	8.2	7.4
16	1	2	2	5.9	4.7
17	0	1	1	4.9	2.7
18	1	2	3	7.3	5.6
19	2	3	3	8.7	7.6
20	1	2	2	6.4	5.2

Table 7. Accuracy of ABCD, GLCM and LBP feature extraction techniques

Image No.	ABCD Accuracy (%)	GLCM Accuracy (%)	LBP Accuracy (%)
1	90	88	85
2	92	87	84
3	93	85	83
4	89	86	80
5	91	84	82

6	90	85	81
7	92	86	83
8	93	85	84
9	91	87	82
10	90	86	83
11	91	85	84
12	93	86	82
13	94	88	85
14	92	87	84
15	90	84	80
16	91	86	83
17	89	85	81
18	93	87	85
19	90	84	82
20	92	86	83

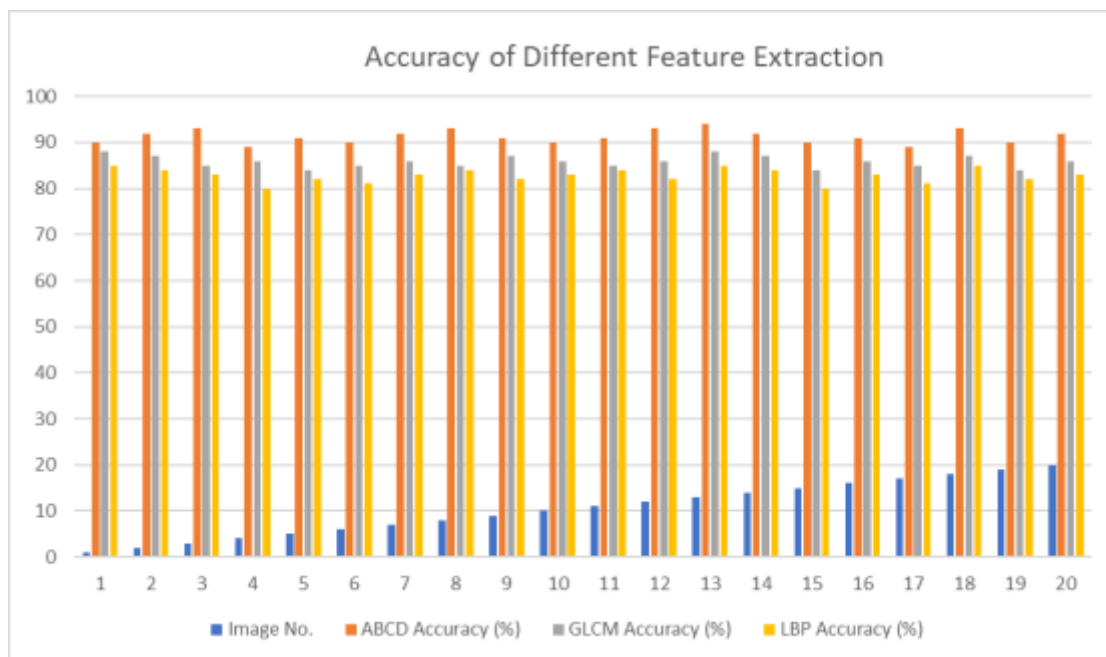


Figure 7. Graphical representation of different feature extraction techniques

Melanoma classification was tested using ABCD, GLCM, and LBP feature extraction methods with an SVM classifier on 20 images. Overall, ABCD performed best, but combining all three methods could improve classification accuracy in future work.

5. Conclusion

Early diagnosis of melanoma skin cancer accelerates the time of dermatologists and improves diagnosis performance. The intention of this work is to provide the accurate segmentation and feature extraction for early diagnosis of melanoma skin cancer that to classify the given image is melanoma or not. For this purpose, we have done step wise work that is preprocessing for noise removal with morphological closing, median filtering and histogram equalization, then segmentation with OTSU thresholding, then feature extraction with ABCD rule. It is more efficient and comfortable method than biopsy method for both patients and doctors because it is timeless and painless method.

6. References

1. M. Krishna Monika, N. Arun Vignesh, Ch. Usha Kumari, M.N.V.S.S. Kumar, E. Laxmi Lydia, Skin cancer detection and classification using machine learning, *Materials Today: Proceedings*, Volume 33, Part 7, 2020, Pages 4266-4270, ISSN 2214-7853, <https://doi.org/10.1016/j.matpr.2020.07.366>.
2. M, V., & Karki, M. V. (2020). Skin Cancer Detection using Machine Learning Techniques. In IEEE, IEEE [Journal-article].
3. Majumder, S., Ullah, M. A., & Department of Electrical and Electronic Engineering, Chittagong University of Engineering and Technology, Chittagong-4349, Bangladesh. (2018). Feature Extraction from Dermoscopy Images for an Effective Diagnosis of Melanoma Skin Cancer. 10th International Conference on Electrical and Computer Engineering, 185.
4. Rajinikanth, V., Sri Madhava Raja, N., Arunmozhi, S., Department of Electronics and Instrumentation Engineering, Department of Electronics and Communication Engineering, St.Joseph's College of Engineering, & Manakula Vinayagar Institute of Technology. (2019). ABCD Rule Implementation for the Skin Melanoma Assesment – a study. In Proceeding of International Conference on Systems Computation Automation and Networking 2019 [Conference-proceeding]. @IEEE 978-1-7281-1524-5.
5. Tom, A., & Daba, J. (2023). Revisited OTSU Algorithm for skin cancer segmentation. *WSEAS TRANSACTIONS ON INFORMATION SCIENCE AND APPLICATIONS*, 20, 50–58. <https://doi.org/10.37394/23209.2023.20.7>.
6. Guang Yang. (2020). Automating the ABCD Rule for Melanoma Detection: A Survey. *WSEAS TRANSACTIONS ON INFORMATION SCIENCE AND APPLICATIONS*.
7. Senan, E. M., & Jadhav, M. E. (2021). Analysis of dermoscopy images by using ABCD rule for early detection of skin cancer. *Global Transitions Proceedings*, 2(1), 1–7. <https://doi.org/10.1016/j.gltp.2021.01.001>
8. Thanh, D. N. H., Prasath, V. B. S., Hieu, L. M., & Hien, N. N. (2019). Melanoma Skin Cancer Detection Method Based on Adaptive Principal Curvature, Colour Normalisation and Feature Extraction with the ABCD Rule. *Journal of Digital Imaging*, 33(3), 574–585. <https://doi.org/10.1007/s10278-019-00316-x>
9. Thaaajwer, M. A., & Ishanka, U. P. (2020). Melanoma Skin Cancer Detection Using Image Processing and Machine Learning Techniques. *IEEE Explore*, 363–368. <https://doi.org/10.1109/icac51239.2020.9357309>
10. Jaisakthi, S. M., Mirunalini, P., & Aravindan, C. (2018). Automated skin lesion segmentation of dermoscopic images using GrabCut and k-means algorithms. *IET Computer Vision*, 12(8), 1088–1095. <https://doi.org/10.1049/iet-cvi.2018.5289>
11. Mukherjee, N., Dolzake, N., Ubhare, H., Sahu, S., Sharma, S., & Shirdhankar, S. (2023). Melanoma Espial employing deep learning applied to Mobilenet. *International Journal for Research in Applied Science and Engineering Technology*, 11(8), 2105–2111. <https://doi.org/10.22214/ijraset.2023.51353>
12. [Hsieh, T. M., Liu, Y., Liao, C., Xiao, F., Chiang, I., & Wong, J. (2011). Automatic segmentation of meningioma from non-contrasted brain MRI integrating fuzzy clustering and region growing. *BMC Medical Informatics and Decision Making*, 11(1). <https://doi.org/10.1186/1472-6947-11-54>

13. Bechelli, S., & Delhommelle, J. (2022). Machine Learning and Deep Learning Algorithms for Skin Cancer Classification from Dermoscopic Images. *Bioengineering*, 9(3), 97.
<https://doi.org/10.3390/bioengineering9030097>
14. Poornima, J. J., Anitha, J., Henry, A. P., & Hemanth, D. J. (2023). Melanoma classification using machine learning techniques. In *Frontiers in artificial intelligence and applications*.<https://doi.org/10.3233/faia220712>
15. Tchema, R. B., Polycarpou, A. C., Nestoros, M., & The Author(s). (2025). Skin cancer classification using machine learning. In *Multimedia Tools and Applications* (Vols. 84–84, pp. 3239–3256) [Journal-article].
<https://doi.org/10.1007/s11042-025-20595-7>.
16. Alquran, H., Abu Qasmieh, I., Alqudah, A. M., Alhammouri, S., Alawneh, E., Abughazaleh, A., Hasayen, F., & Department of Biomedical Systems and Informatics Engineering, Yarmouk University. (2017). The Melanoma Skin Cancer Detection and Classification using Support Vector Machine. In *2017 IEEE Jordan Conference on Applied Electrical Engineering and Computing Technologies (AEECT)*.
17. Dubal, P., Bhatt, S., Joglekar, C., Patil, S., Department of Information Technology, & K. J. Somaiya College of Engineering. (n.d.). Skin cancer detection and classification. In *Department of Information Technology* [Journal-article].
18. Viknesh, C. K., Kumar, P. N., Seetharaman, R., & Anitha, D. (2023). Detection and classification of melanoma skin cancer using image processing technique. *Diagnostics*, 13, 3313.
<https://doi.org/10.3390/diagnostics13213313>
19. Gupta, A., Thakur, S., Amity School of Engineering and Technology, Rana, A., & Amity University Uttar Pradesh. (2020). Study of Melanoma Detection and Classification Techniques. *IEEE*.