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Melanoma Skin Cancer Detection with Deep learning and Artificial Intelligence: A Systematic Review

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Abstract: Cancer remains a foremost cause of death worldwide. Skin is the largest organ in the human body. Skin cancer is one of the most widespread and rigorous types of cancer. Earlier detection is vital for civilizing survival rates especially for melanoma, one of the deadliest types of skin cancer. In the modern scenario, the main aim is for the development of computer aided diagnosis in dermoscopic images. This paper reviews and presents the algorithms used in automatic detection in dermoscopic images using artificial intelligence. The critical need for an automated system is to reduce the effort and time in diagnosis process. Artificial Intelligence in medical diagnosis helps identify the disease from images or data more quickly and accurately.

KeyWords: Cancer, Skin, Melanoma, Dermoscopic, Diagnosis, Artificial Intelligence.

I.INTRODUCTION

Skin cancer is the most common type of cancer diagnosed worldwide. Skin cancer is cancer that starts with a development of outgrowth cells on the skin. Skin Cancer occurs due to the over exposure of sunlight. The skin cancer has been classified into two type's melanoma and non-melanoma is shown in Fig 1. Non-melanoma skin cancer is usually treatable by removing the cancer cells through surgery. All non-melanoma skin cancers are moreover basal cell carcinoma or squamous cell carcinoma. Whereas malignant melanoma is a deadly disease, which can be treatable only when identified in earlier stage[1]. Melanoma is widely recognized as one of the fatal form of cancer, this type of skin cancer can metasize to other organs if not detected early. Majority of cases being fatal, the fatality rate could be considerably reduced with early treatment.

Skin lesions are more common and increase with time. Malignant skin lesions can be constantly identified in the early stages by examination. The formal method for diagnosing melanoma is the biopsy method. This method can be a very painful one and a time-consuming process. Recent advancements in CAD computer-aided diagnostic have shown a guarantee in improving melanoma detection by combining image processing techniques and deep learning methodologies.

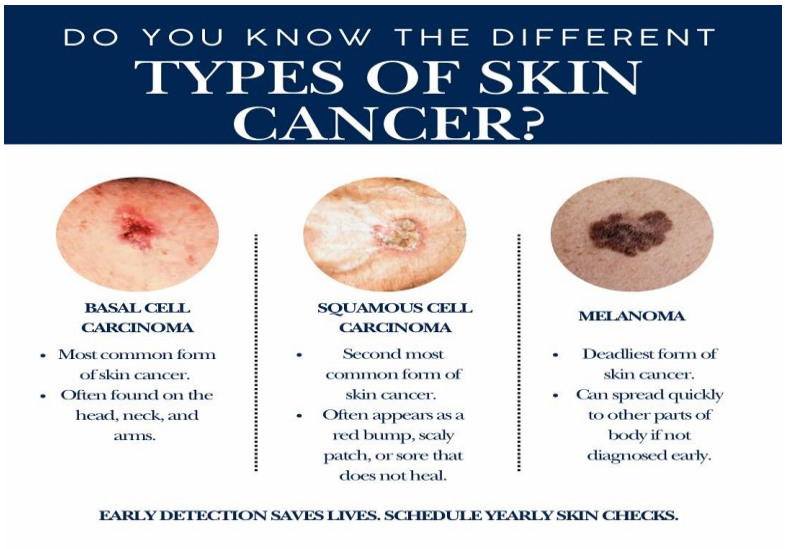

Fig 1. Types of Skin Cancer

1.1 Basal Cell Carcinoma

Basal cell carcinoma arises in the basal cells which begin in the epidermis, the outer layer of cell It produces new skin cells as old ones die off.BCC occurs to those people who are too much exposed to ultra violet rays. The lesion arises in the sun –exposed areas of the body. The lesion looks like open pores, red patches, pink growth and shiny bumps. It affects the people who are older than 50 years. BCC grows very slowly and are curable that causing only minimal damage when treated early. The U.S, 5.4 million BCC cases are diagnosed every year.

1.2 Squamous Cell Carcinoma

Squamous cell carcinoma of the skin is a type of cancer that grows in the cells called squamous cells. The squamous cells build up the middle and outer layers of the skin. This type of cancer is not life-threatening [2]. If it's not treated, it spread to other parts of the body. The growth of thecancer can cause severe complications. It appears anywhere on the skin, where the skin is over exposed by too much ultraviolet (UV) radiation like sunlight or from tanning beds or lamps.

1.3 Malignant Melanoma

Melanoma is a type of skin cancer that starts in the melanocytes. Melanocytes are cells that build the pigment that gives skin its color. The pigment is called melanin. Melanoma, which means "black tumor," is the most dangerous type of skin cancer. It grows fast and has the ability to spread to any organ. Melanoma usually starts on skin that's often exposed to the sunlight. This includes the skin on the arms, back, face and legs. Melanoma can also form in the eyes. Rarely, it can occur inside the body, such as in the nose or throat. The melanoma can be identified by using the five warning signs of the ABCDE rule as shown in Fig1.1

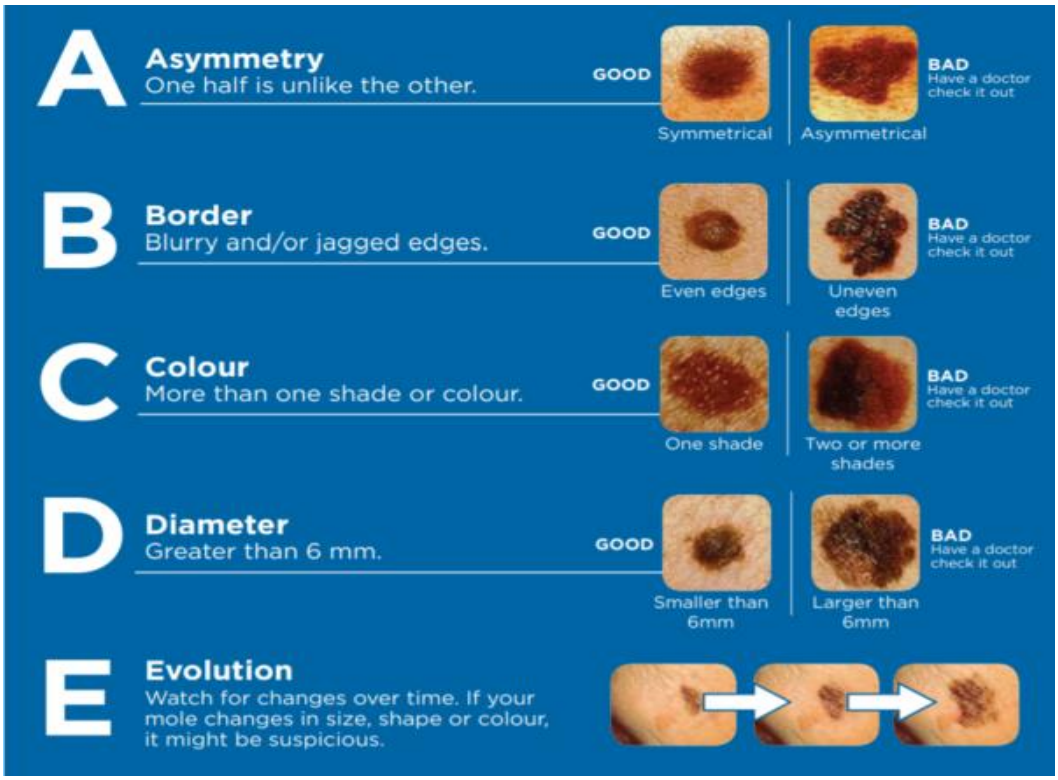

Fig 1.1 ABCDE rule for Melanoma Identification.

The risk of melanoma seems to be rising in people under 40, especially women. Early detection and accurate diagnosis are essential for improving the prediction and survival rates of patients with melanoma.In 2025, skin cancer will be a main global health concern, with over 1.5 million new cases estimated. In 2025, global skin cancer statistics point toward the fact that melanoma, a type of skin cancer, is likely to account for 104,960 new cases and 8,430 deaths. While melanoma represents a smaller percentage of all cancer cases (5.1%), it is responsible for 1.4% of all cancer deaths. The overall death rate from melanoma has declined in recent years, but it still remains an important public health concern.

1.4 Malignant melanoma in Artificial Intelligence

This review explores the use of artificial intelligence (AI) techniques combined with non-invasive imaging methods to improve melanoma detection. This review evaluates the current state of AI-based techniques using tools including dermoscopic images. The several AI algorithms perform better than dermatologists in detecting melanoma, particularly in the analysis of dermoscopy images [10]. It also highlights the potential of AI to enhance diagnostic accuracy, leading to improved patient outcomes, and to ensure the reliability and effectiveness of AI-based techniques. Artificial Intelligence, algorithms demonstrate how to classify skin lesions, segmenting images, extracting features and predicting risks. It aids in risk satisfaction, prognostic prediction and treatment response analysis. Even though all factors support AI, there are

Some challenges that remain to be overcome are data quality, transparency, and integration into clinical practice. Even though the traditional approach includes physical examination, histology, imaging, nodal assessments, this may result in missed or misdiagnosis in identifying melanoma.

Recent innovations include (AI)-based techniques for skin lesion image analysis showing potential use of AI in the early detection of melanoma with image processing techniques are shown in Fig.2

Early detection is crucial for improving patient outcomes, and recent advancements in artificial intelligence (AI) have shown promise in enhancing the accuracy and efficiency of melanoma diagnosis.

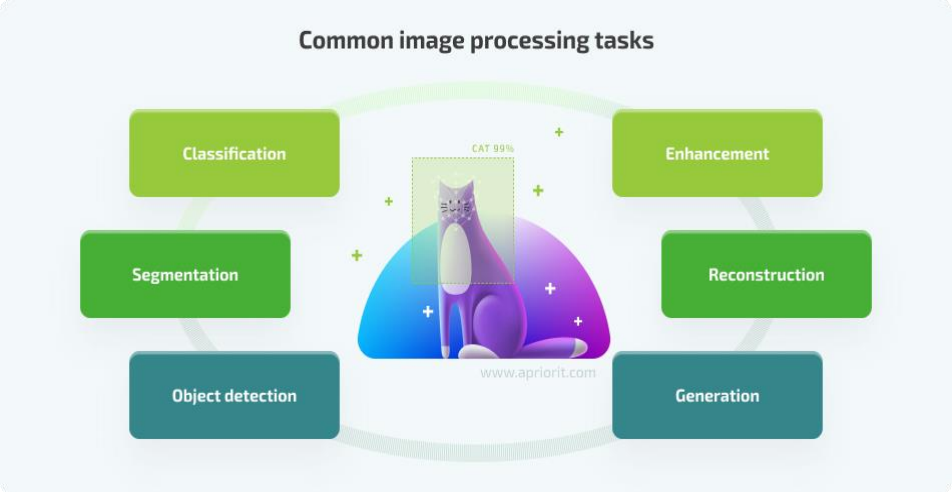

Fig 2. Common image processing tasks

II. Review of Literature

Packiamary et al. (14) proposed a deep learning model of a hybrid and modern feature extraction method that combines conventional image processing algorithms. The preprocessing techniques are done by scaling, normalization uses linear transformations and noise removal is done by Gausian filter which helps to enhance the image quality. Therefore, RGB to LAB is used to improve the performance in feature extraction. They extract the border of skin lesions, including the global and local features ,which are processed using CNN(conventional neural network) architecture ,where raw image data will give an outcome to complex melanoma patterns. This methodology combines data preprocessing, hybrid feature extraction , and CNN architecture for enhanced melanoma detection.

PengZhang et al(15) implemented the hybrid deep learning framework, integrating U-net Segmentation and Efficient Net Classification. The preprocessing steps focus on the datasets by resizing and normalizing the pixel values. Resampling and data augmentation are the two techniques applied, were resampling helps to alleviate the bias, which improves the models sensitivity for detecting melanoma. Data augmentation increases the dataset and also enhances the models robustness for real world conditions. The U-net model architecture is designed to segment the cancerous skin lesions from the skin images. It uses a contracting path(encoder) for feature extraction and an expansive path (decoder) for precise localization. The proposed model does not all the segmented region to pass directly to classification; instead, it uses a data processing bridge that integrates the predicted segmented masks with the original image, creating a blended visualization with the infected regions.

Chandran Kaushik Viknesh et al(16) proposed an algorithm with an SVM classifier and a convolutional Neural Network which classifies the skin disease into benign, malignant and normal. The preprocessing converts the RGB image into a gray scale ,which undergoes five filtering processes for noise reduction ,targets hair and heals skin damage. The image segmentation uses the combination of watershed and maximum entropy thresholding which makes the difference between the foreground and background. The morphological operations improve the image quality by smoothing edges, removing small pixels, light artifacts and filling empty holes for dermoscopic images. The complex non linear features are extracted from convolutional layers.The Pooling layer is again divided into maximum and average pooling to reduce the parameters and speed up the CNN training process. The wholly connected layer collects the features from the reviewed previous convolution process, and the output is processed. Tensor flow function initializes multiple CNN models for the training process. The SVM classifier directly sends the extracted feature into the classifier, which effectively optimizes the boundaries to divide the data into different groups. The methodology of deep learning with CNN architecture provides an accurate result when compared to the SVM classifier.

Nourelhoda M.Mahoud at el(17) implemented the system to detect skin cancer ,skin lesions as benign or malignant. The First step starts with preprocessing which uses serious of filters like median, Gaussion and Lee to enhance the image. The Segmentation process uses the Adaptive Snake algorithm(AS), to identify irregular shaped lesions that have prior knowledge about the shape, color, texture, and appearance of skin lesions. Region Growing (RG) is used to find the size of the lesion until it satisfies the criteria of intensity and color. The feature extraction uses GLCM(Gray Level Co-occurrence which examines and characterizes the texture of the image. It follows the ABCDE rule of dermatology for extracting the features from the segmented lesion.ANN and SVM algorithms are used for classifying the extracted features. The ANN is excellent in learning the complex patterns and relationship from the extracted data, which accurately classifies the skin lesions. The SVM is effective as it can handle high-dimensional data, robustness ,and efficiency ,which provides accurate classification.SVM performs well for small training datasets, where large amount of datasets are challenging.

Tarek Khater at el(5) implemented the typical direction to classify the skin cancer as Melanoma and Non-melanoma using Machine Learning models(ML).The CNN is used to train the ML models. The Explainable Artifical Intelligence uses a collection of techniques that can be easily understood by humans. The steps begins with pre-processing of images, later the features are extracted using chi-square analysis which identifies asymmetry and pigment networks. The Classification algorithms like XG Boost , Decision Tree, Random Forest, and KNN are used. The XG boost and the Decision Tree are achieving the highest accuracy.

S. P. Angelin Claret at el(6) uses a sophisticated system for accurate skin cancer detection that fuses Discrete Wavelet Transform (DWT) and Convolutional Neural Networks (CNN) methodologies. The process involves five main stages, beginning with rigorous preprocessing of images, using median filtering for resizing, standardization, and noise reduction followed by feature extraction using DWT to isolate key characteristics like the Low-Low (LL) frequency subband. The core of the system is the CNN, which automatically learns to identify relevant patterns and features directly from the data, bypassing the need for manual feature crafting, a significant advantage in computer vision tasks like image classification. By combining DWT-extracted features with a deep learning-based CNN, the proposed method efficiently categorizes seven different types of skin lesions from datasets such as ISIC 2018, aiming for improved accuracy in cancer recognition.

Seena Joseph at el(7) method uses the collaboration of color histogram clustering with Ostu thresholding , to demonstrate that preprocessing is abolished in the saliency segmentation of skin lesions. The color histogram determines the initial clustering ,which represents the homogenous regions in the input image. A saliency map is used for color contrast and spatial features to effectively detect the regions of skin lesions in dermoscopic images. Finally, in segmentation, the Ostu's thresholding followed by morphological analysis are applied to destroy or destablize the undesired artifacts, which are present the saliency detection stage. The Ostu's algorithm is robust, effective , and independent of preprocessing. It accurately segments the skin lesion without the restraint of preprocessing.

Manishi Shakaya at el(18) proposed the techniques for identifying skin cancer with deep learning models. Pre-Processing is done on the initial image, were CLACHE algorithm, is used, which includes scaling, denoising and brightness enhancement to improve the quality of the image. The active contour algorithm , commonly known as snakes, is used in segmentation, which selects the image by curves, and accurately cuts the lesion from the skin. The three different deep learning-based approaches for classifying dermoscopic images. This paper combines the feature extraction with a classification algorithm to yield a better performance compared to other feature extraction alone. Here, ResNet-18, VGG19, and MobileNetv2 feature extraction is combined with SVM, Decision Tree(DT), Naive Bayes , and KNN Classifier. The best accuracy is achieved by combining ResNet-18 and MobileNet pretrained networks by concatenation using an SVM classifier.

C.Kavitha at el(11) implemented the methodology with deep learning algorithms which classifies into nine various types of skin cancer. The Pre-Processing includes data cleaning like hair ,noise removal, contrast enhancement,and resizing of the image to improve the quality of an image. Segementation process takes place by delineating the borders the lesion with the ROI. The features are extracted from the segmented lesion with ABCDE rule. The extracted metrics are Asymmetry, Diameter, Compactness, Borders, and Color Channel

Values. Deep learning architecture uses CNN and ResNet50 for classifying the extracted features. Res Net 50 has improved accuracy and efficiency.

M.A Ahmed Thaajwer at el(12) implemented computer aided diagnosis for early detection of melanoma. The image processing techniques and Support Vector Machine (SVM) algorithms are introduced for early and efficient diagnosis. The first step includes the Preprocessing where unwanted parts are removed from the background. Noise and hair removal process, which removes the unwanted hair, a major challenge in preprocessing. Followed by the next step of Converting the RGB to Grayscale, where grayscale images are easier and faster to process than colored images. Smoothing is done by applying Gausiaan filter to the grayscale images. The next step is extracting the affected region of interest(ROI) from the lesion using the segmentation techniques. Adaptive image threshold using Otsu's thresholding method and closing the hole using morphological operation. The preprocessing output of Gaussian filter is used as input for segmentation. The feature's are extracted to specify the benign and malignant melanoma. The GLCM methodology is used to extract features like contrast,Correlation,Entropy and Inverse difference moments. The Shape distinguishes the border irregularity index abnormality index, Circularity and diameter to calculate a lesion in a binary image. The color features are extracted using mean and standard deviation. The final step of classification uses an SVM classifier which differentiates the image as benign-melanoma or malignant-melanoma. While comparing the formal biopsy method, the machine learning methodology is very cost-effective and time-saving.

Sirnidhi.R.Bharadwaj at el(13) proposed research on automated skin cancer detection to accurately classify them as benign or melanoma ,using CNN and feature extraction. The aim is to provide an efficient and accurate skin cancer classification for early detection and diagnosis without frequent visits to doctors. The overall methodology is divided into two phases. The First phase involves dataset collection and pre-processing model training and testing. The deep CNN architecture is used in the training phase and later the model is tested on a separate dataset to evaluate its performance of classifying skin lesions accurately. After, including the CNN model with several layers, the model accurately achieved by the desired results and its ability to correctly predict the classes, benign or malignant for the test images. The second phase is a user-friendly GUI implementation, which allows the users to upload an image in JPEG form, from any imaging device. The uploaded images is pre-processed and then trained into a CNN model for classification. Later, the GUI displays the prediction, indicating whether the lesion is benign or malignant.The entire system is built with a combination of deep CNN architecture, transfer learning from pre-trained models, which enhances the accuracy of skin cancer classification. It offers a robust and efficient solution for the early detection and diagnosis of skin cancer without any expert consultation.

Paul Nasra at el(19) proposed as research the EfficientNetV2-L Model for dermatological images to differentiate them as benign lesions and malignant melanoma This Efficient NetV2 model has more accuracy compared to other deep learning and traditional models. This model concurrently uses compound scaling to scale depth, width and resolution . It generates the probability of every class using a soft-max activation function to generate the input into benign or malignant. The Fine tuned efficient NetV2-L consists of seven blocks. The first block has a Convolutional layer(CONV1) where low-level traits, including edges, textures are extracted and uses several filters in simple forms to the input image. The Second and third block employs a fused MBConv(Mobile Inverted Bottle Neck Convolution 4*4 different arrangements enabling the network to learn more advanced features. Fourth and Fifth block has Fused MBConv 4*4 and 4*6 to carry on the feature extraction. Blocks Six and Seven enable the detailed extraction and high level features. Later, the Global Average Pooling 2D layer reduces the spatial dimensions, the Drop out layer randomly sets the activation to zero to prevent over fitting. The two classes, malignant and benign the last dense layer, and finally, the validation accuracy results in 96.10% on validation data.

Govinda Rajulu,Lanke at el(22) implemented the early-stage detection of skin cancer by analyzing the factors of texture, size, segmentation, lesion image, associated with melanoma including color, diameter, spatial characteristics, and more. Depending on the feature parameters, the images are classified into melanoma or representing benign skin lesions. The proposed frame processes the input image and all the image processing techniques are processed. In preprocessing to reduce the computational complexity size bilinear interpolation

is used. Hair removal plays a major challenge, where the vascular method is used. Next comes the segmented method, the K- Means clustering segmentation is used for sorting specific events into predefined group based on predefined criteria. Features are extracted after separating the lesion from the skin using ABCDE rule. Depending on the TDS Score, the skin cancer lesions are classified into benign and malignant.

Vijayalakshmi at el(20) proposed a methodology to identify the prediction of skin cancer and also to classify whether it is benign or malignant. This model is designed with three phases. The phase 1 includes the collection of dataset from the ISIC dataset. t (International Skin Imaging Collaboration), it also process the preprocessing phase where hair removal,glare removal and shading removal are done. It is done to identify the color,texture,shape in efficient manner.The next comes the phase 2,where segmentation and feature extraction are followed.The segmentation is examined with three methods . a. Otsu segmentation method b. Modified Otsu segmentation method c. water shed segmentation method. The color, shape, size and texture are the features extracted. The most important part of the phase, involves designing of the model and training. Back Propagation Algorithm (Neural Networks), SVM (Support Vector Machine), and CNN (Convolutional Neural Networks) are trained on the dataset that was collected in the phase1, the model after training was tested for the accurate output.SVM and Deep Neural networks will be used for classifying the data that are trained with features. The Back propagation algorithm is used to calculate the error, Minimum the error, to update the parameters and to make the model ready for prediction. The SVM classifier is used to classify whether the skin cancer is benign or malignant,as it is very accurate even in small datasets. CNN is used to learn the relationship between the inputs and class labels of two components to compromise. The hidden layers features are extracted and fully connected layers are used for classification task.

Ghadah Alwakid at el (21) proposed deep learning algorithm to make the automated diagnosis of detecting melanoma. The step pre-processing is used to improve the quality of images to eliminate the various kinds of noises. The ESRGAN is used in preprocessing to improve the overall accuracy of the image followed by data augmentation to overcome the difficulty of unbalanced class and later images are being resized and then normalization is performed at last. The segmentation is performed with ROI(Region of Interest) to separate the affected lesion. The Ground Truth mask is applied to all the images while segmenting. The Classification is performed with CNN and modified version of Resnet- 50. Both the classifiers performs the same accuracy level in detecting melanoma.

Conclusion

The AI plays a vital role in detecting skin cancer using their image and their features. This review presents various algorithms and techniques used for detecting skin cancer earlier. Deep learning algorithms gained an important role with outstanding classifying metrics for detection. The features used for extracting information from images has a clear view for the future work as it helps in enhancing the diagnosis accuracy. The skin cancer identification is escalating its field to accurately detect the diagnosis using advanced AI features to develop an approach of patient progress.

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