Skin Cancer Detection : A Review using Machine Learning Techniques

Abstract* - *Skin cancer is a serious health concern, and early detection is crucial for effective treatment. Machine learning algorithms have shown promise in detecting skin cancer, but there is still much to be explored in terms of their effectiveness and efficiency. This paper presents a comparative analysis of different machine learning algorithms for skin cancer detection, including Support Vector Machines, VGG16, VGG19, Inception, Xception , and Convolutional Neural Networks. The study uses a dataset of 30,000 skin images, from which 21000 images are provided as training data and the rest 9000 are put in testing dataset. In the case of skin cancer detection, machine learning can be used to analyze images of skin lesions and identify those that are likely to be cancerous. This can help doctors to make more accurate diagnoses and provide earlier treatment. The results show that the neural network algorithm outperforms the other algorithms in terms of accuracy and speed. The CNN model came up with an accuracy of 74% being the highest from the rest of the five models performance. The study underscores the potential of machine learning in enhancing early detection capabilities, thereby aiding medical professionals in more accurate diagnoses and timely intervention for improved patient outcomes. Continued research in this domain is essential for refining algorithms, incorporating more extensive datasets, and advancing the integration of AI into clinical practices for enhanced cancer diagnostics.

Keywords-Skin Cancer ; classification ; Data Augmentation

I. INTRODUCTION

Skin cancer is one of the most common types of cancer worldwide, with over 190,000 deaths annually. Early detection is crucial for successful treatment and survival rates. Traditional methods of skin cancer detection, such as biopsy and dermatoscopy, are time-consuming and often inaccurate. Machine learning algorithms have shown promise in improving the accuracy and efficiency of skin cancer detection, making it a promising area of research.

Machine learning algorithms have several strengths when it comes to skin cancer detection. They can analyze large amounts of data quickly and accurately, and can learn from patterns and trends that may not be apparent to human observers. Additionally, machine learning algorithms can be trained on a variety of data sources, including medical images, patient histories, and environmental factors, which can help to improve the accuracy of diagnoses.

Three types of skin cancer that are mainly diagnosed are melanoma, squamous cell carcinoma and basal cell carcinoma. Melanoma is the most aggressive and deadly form of skin cancer, while basal cell carcinoma and squamous cell carcinoma are less serious but still require treatment. Some other types of skin cancer include vascular lesion, seborrheic keratosis, nevus, dermatofibroma and actinic keratosis that we have found during our research.

In this study, we employed a dataset comprising 30,000 skin images for the comparative analysis of skin cancer detection algorithms. Among these, 21,000 images were utilized for training, while the remaining 9,000 formed the testing dataset. The machine learning algorithms evaluated include Support Vector Machines (SVM) and various CNN architectures, namely VGG16, VGG19, Inception, and Xception. Data augmentation techniques were applied to enhance the robustness and generalization of the models.

The comparative analysis revealed that the neural network algorithm, particularly the tested CNN architectures, outperformed traditional algorithms like Support Vector Machines in terms of both accuracy and speed. The promising results emphasize the potential of AI in revolutionizing skin cancer diagnostics, offering faster and more accurate identification of cancerous lesions.

II. PROPOSED METHODOLOGY

A Convolutional Neural Network (CNN) typically comprises multiple layers, where each layer specializes in detecting distinct features within an input image. An applied filter or kernel processes each image, generating an output that progressively improves and becomes more detailed with each subsequent layer. In the lower layers, the filters can start as simple features for cancer classification. At each successive layer, the filters increase in complexity to check and identify features that uniquely represent the input object being detected cancerous or non-cancerous. Thus, the output of each convolved image -- the partially recognized image after each layer -- becomes the input for the next layer. In the last layer, which is an FC layer, the CNN recognizes the image or the object it represents. Same process is followed in this project. After going through several filters the image gets reduced to significant filters and thus it becomes easy to classify those dermoscopic images as a cancerous or non-cancerous.

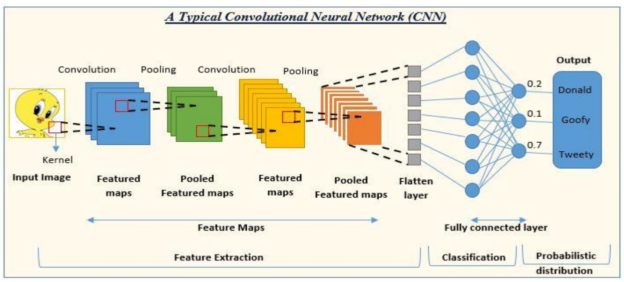


Fig.1 CNN Architecture

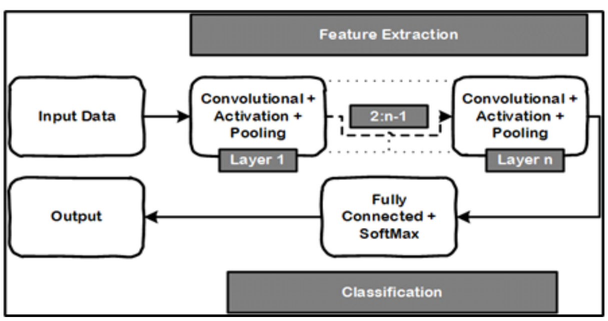


Fig.2 Block diagram of CNN

III. LITERATURE SURVEY

Yashwant Ingle et.al. [1] presented in this study about how AI can be used to diagnose skin cancer. SVM is the most prevalently used classification techniques. The findings of this study will aid doctors in treating disease at its onset, preventing future deterioration.

Yashwant Ingle et.al. [2] utilized a convolutional neural network to segment skin lesion images. People may discover what skin diseases they may have, how to protect themselves from it, and what measures they can take early on to successfully treat the disease using Artificial Intelligence.

Yashwant Ingle et.al. [3] The article focuses on using convolutional neural networks (CNNs) and artificial intelligence for early skin cancer detection through image segmentation. It emphasizes the role of machine learning, including support vector machines, to aid early diagnosis and prevent deterioration.

Yashwant Ingle et.al. [4] This survey addresses the scarcity of training samples in skin lesion diagnosis for deep learning, emphasizing the use of data augmentation techniques, including Basic Data Augmentation algorithms, GANs, and VAE, to enhance model performance for clinical applications.

Yashwant Ingle et.al. [5] This study addresses the increasing health risk of skin cancer, utilizing CNNs like VGG16 and VGG19 to categorize eight cancer types from the ISIC 2019 dataset, assessing overall accuracy and loss in the training approach.

Maryam Naqvi et.al. [6] This survey explores recent research on deep learning-based skin cancer classification, highlighting the significance of segmentation and classification in computer-aided diagnosis, and underscores the challenges and potential of leveraging deep learning algorithms for improved diagnostic accuracy.

M. Krishna Monika et.al. [7] This project focuses on the early detection and classification of various types of skin cancer. Dermoscopic images undergo preprocessing, including hair removal and smoothing, followed by color-based k-means clustering for segmentation. Utilizing statistical and texture features, Multi-class Support Vector Machine (MSVM) achieves an impressive classification accuracy of 96.25% on the ISIC 2019 Challenge dataset.

Neha Tyagi et.al. [8] This paper addresses the challenge of accurate skin disease categorization by presenting a deep learning system for identifying skin cancer. Utilizing transfer learning and five state-of-the-art convolutional neural networks, the study demonstrates effective classification, especially with the DenseNet201 network achieving high accuracy and F-measures.

M. Vidya et.al. [9] The proposed algorithm utilizes a combination of ABCD rule, GLCM, and HOG feature extraction techniques for early detection of malignant melanoma, a dangerous type of skin cancer. Pre-processing and segmentation using Geodesic Active Contour aim to enhance image quality and isolate lesion areas.

Hardik Nahata et.al. [10] This project addresses the significant global issue of skin cancer, emphasizing the prevalence of melanoma and non-melanoma types. Leveraging Convolutional Neural Networks (CNNs) and Python-based tools such as Keras and Tensorflow, the initiative focuses on developing an accurate skin cancer detection model using diverse network architectures and Transfer Learning from the ISIC dataset, aiming to enhance early detection and improve survival rates.

Mahamudul Hasan et.al. [11] This paper introduces an artificial skin cancer detection system employing image processing and machine learning, with a focus on Melanoma. Utilizing segmentation and feature extraction, a Convolutional Neural Network classifier achieves an accuracy of 89.5% and a training accuracy of 93.7% on a publicly available dataset, demonstrating its potential for efficient and accurate early diagnosis.

A.Murugan et.al. [12] This system for skin disease identification relies on computer vision, emphasizing skin color as a crucial indicator. Employing median filtering and Mean shift segmentation, the research extracts features such as GLCM, Moment Invariants, and GLRLM, achieving improved results through a Combined SVM+RF classifier compared to Support Vector Machine and Probabilistic Neural Networks.

Jitendra V. T. et.al. [13] This paper presents a novel approach to skin cancer detection by combining machine learning and deep learning techniques. The model achieves a high accuracy of 93% with individual recall scores of 99.7% for benign and 86% for malignant forms. Benchmarked on a Kaggle dataset, the proposed ensemble surpasses expert dermatologists and outperforms other state-of-the-art methods, showcasing its potential as a valuable tool for accurate and efficient skin cancer diagnosis.

Vijayalakshmi MM et.al. [14] This article introduces a fully automated system for dermatological disease recognition, emphasizing the importance of early diagnosis, particularly for fatal conditions like Melanoma. Utilizing Convolutional Neural Network and Support Vector Machine algorithms, combined with image processing tools, the model achieves a commendable accuracy of 85%, offering a potential solution to the complexities and subjectivity of traditional dermatological diagnoses.

Mehwish D. et.al. [15] This paper provides a comprehensive systematic review of deep learning techniques for the early detection of skin cancer, emphasizing the significance of early diagnosis due to the severity and spread of the disease. By analysing research papers from reputable journals, the review offers insights into various lesion parameters and methods employed in distinguishing benign skin conditions from melanoma for improved diagnostic accuracy.

Agrahari P. et.al. [16] This paper introduces an efficient multiclass skin cancer detection system using a pre-trained MobileNet model, achieving high categorical accuracy of 80.81%, top-2 accuracy of 91.25%, and top-3 accuracy of 96.26%. The approach highlights the potential of deep learning in early detection, emphasizing its speed and scalability for widespread implementation in primary healthcare practice.

B. Shamreen Ahamed et.al. [17] This detailed review explores machine learning and deep learning techniques for early detection of skin cancer using dermoscopic images, with a focus on the ISIC archive dataset. Results indicate that the random forest algorithm outperforms other machine learning methods, while transfer learning models such as MobileNetv2 and ensemble models demonstrate superior performance, achieving high accuracies with and without augmentation.

Javaid A. et.al. [18] This paper proposes a machine learning-based method for skin lesion classification and segmentation, leveraging image processing techniques. The approach, validated on the ISIC-ISBI 2016 dataset, achieves a high classification accuracy of 93.89%, showcasing the effectiveness of contrast stretching, feature extraction, and a novel wrapper-based feature selection approach, particularly when combined with the Random Forest classifier.

E. Jana et.al. [19] This paper conducts a comprehensive literature survey on skin cancer detection, focusing on the four key components of the detection process: image preprocessing, segmentation, feature extraction, and classification. It highlights the use of machine learning and deep learning algorithms, such as support vector machine, artificial neural network, and convolutional neural network, providing an insightful comparison of state-of-the-art approaches in skin cancer detection.

M.A. Sabri et.al. [20] This paper introduces an enhanced ensemble learning method for skin cancer classification, leveraging a combination of features extracted from various characteristics such as shape, color, texture, and lesion skeleton. The experimental results demonstrate promising outcomes, emphasizing the effectiveness of the proposed approach in automatic skin lesion diagnosis using machine learning and ensemble techniques.

M S Islam et.al. [21] This systematic review of studies on AI/ML algorithms for early skin cancer diagnosis reveals reasonable mean diagnostic accuracy for melanoma, squamous cell carcinoma, and basal cell carcinoma. However, limited evidence from clinical settings with low skin cancer prevalence suggests cautious adoption in primary care until efficacy in such populations is demonstrated, highlighting the need for methodological checklists to guide algorithm development and implementation.

S. Bhatt et.al. [22] This study presents a methodology for skin cancer detection using general camera images, involving segmentation, ABCD rule-based feature extraction, and training a Neural Network. The trained model achieved a notable overall classification accuracy of 76.9% on a dataset of 463 images across six distinct classes.

M. Koklu et.al. [23] This study aims to pre-classify skin lesions into normal, abnormal, and melanoma using machine learning methods on dermoscopic images from the PH2 dataset. The developed system, employing ANN, SVM, KNN, and Decision Tree, achieved correct classification rates of 92.50%, 89.50%, 82.00%, and 90.00%, respectively, suggesting its potential as a medical decision support tool for dermatologists.

Uzma B. A. et.al. [24] This study proposes a skin cancer detection system utilizing Support Vector Machine (SVM) for early diagnosis. The methodology involves dermoscopy image preprocessing, segmentation using Thresholding, feature extraction through GLCM, and classification by SVM, aiming for efficient and non-invasive detection of skin cancer at an early stage.

AL Enezi et.al. [25] This study proposes an image processing-based method for skin disease detection, specifically in the context of common skin diseases in Saudi Arabia. The approach involves using color images, resizing for feature extraction with a pretrained convolutional neural network, and classification using Multiclass SVM, achieving a notable accuracy rate of 100% for detecting three different types of skin diseases.

Nauta M. et.al. [26] This study addresses the black box nature of deep learning models in skin cancer diagnosis by detecting and quantifying shortcut learning. Using a VGG16-based classifier trained on dermoscopy images, the research reveals that the model partly relies on artefacts like coloured patches for predictions, leading to a significant increase in misdiagnoses.

P. Natha et.al. [27] This paper combines Contourlet Transform and Local Binary Pattern with Particle Swarm Optimization for efficient skin cancer image analysis. The results indicate that the Support Vector Machine and Neural Network models offer faster training times compared to Random Forest, making them more suitable for real-time applications, and the proposed model achieves a high accuracy of 86.9%, outperforming state-of-the-art models.

Viswanatha R. et.al. [28] This research introduces a deep learning technique for early diagnosis of melanoma, distinguishing between lesion maligna, superficial spreading, and nodular melanoma. The proposed model, utilizing convolutional neural network (CNN) algorithms, demonstrates superior diagnostic accuracy compared to current state-of-the-art methodologies, offering potential advancements in melanoma detection and early intervention.

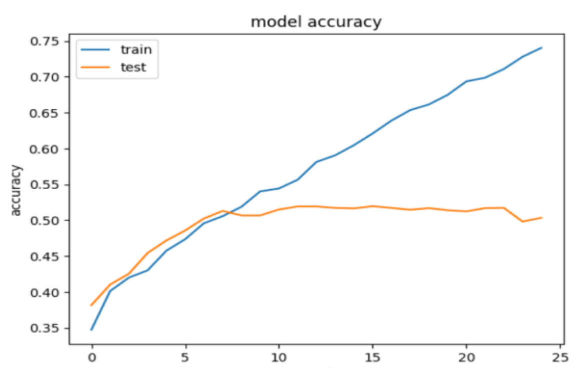
MS Ali et.al. [29] This paper introduces a deep convolutional neural network (DCNN) for accurate classification of benign and malignant skin lesions, utilizing preprocessing techniques, feature extraction, and data augmentation. The proposed DCNN model outperforms various transfer learning models with a training accuracy of 93.16% and testing accuracy of 91.93% on the HAM10000 dataset, demonstrating its reliability and robustness in skin cancer classification.

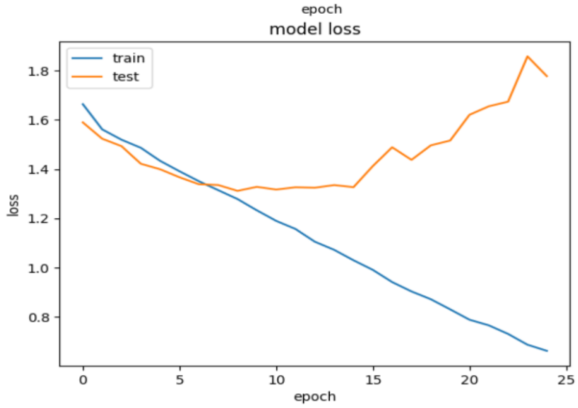
T J Brinker et.al. [30] This systematic review examines 13 papers on skin lesion classification using convolutional neural networks (CNNs). CNNs demonstrate high performance, with pre-trained models being commonly employed, but challenges in comparability arise due to the use of nonpublic datasets, emphasizing the need for standardized benchmarks and method disclosure in future research.

Khalid M. Hosny et.al. [31] This paper introduces an automated skin lesion classification method utilizing transfer learning on a pre-trained deep learning network. The proposed model achieves high performance with accuracy, sensitivity, specificity, and precision values of 98.61%, 98.33%, 98.93%, and 97.73%, respectively, outperforming existing methods in skin lesion classification.

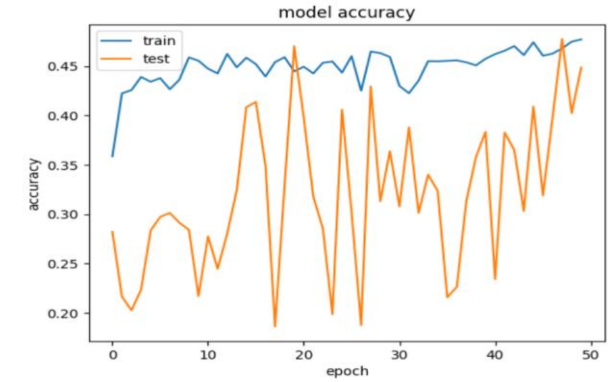
IV. RESULTS

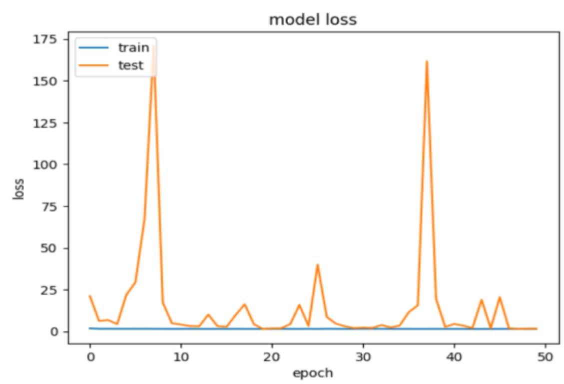
- Using the CNN architecture the model computed the following accuracy and loss for 30 epochs.



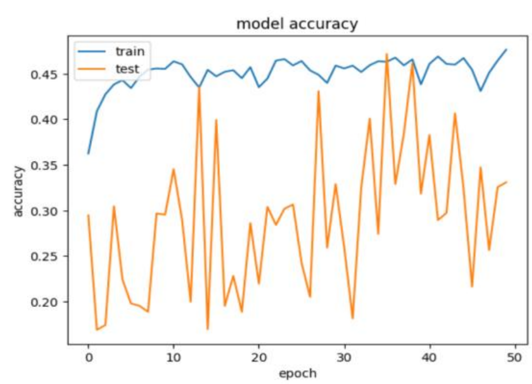


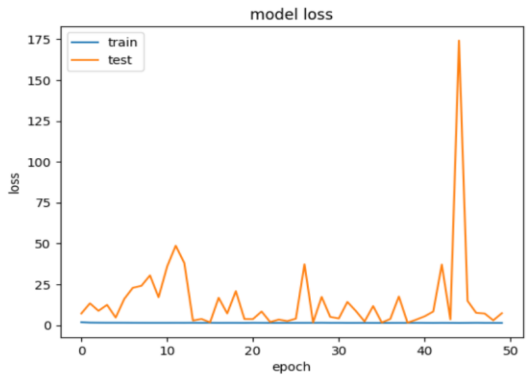
- Using the VGG16 architecture the model computed the following accuracy and loss for 50 epochs.



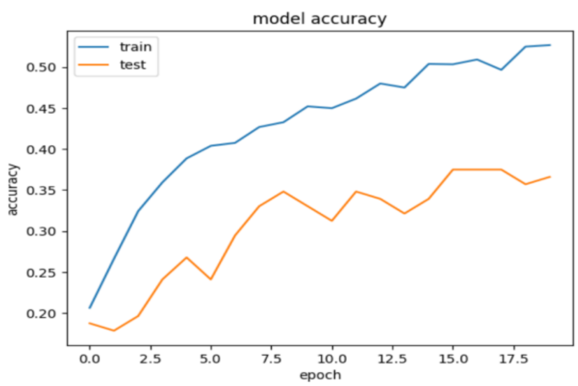


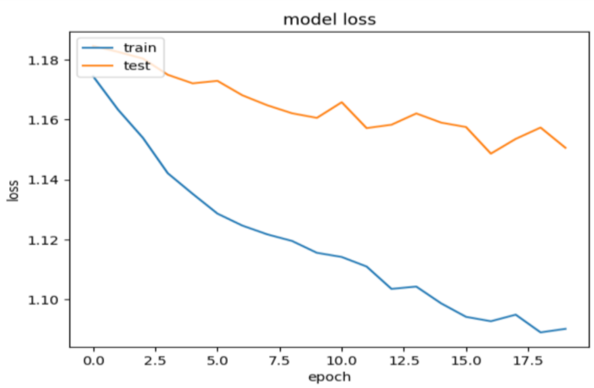
- Using the VGG19 architecture the model computed the following accuracy and loss for 50 epochs.



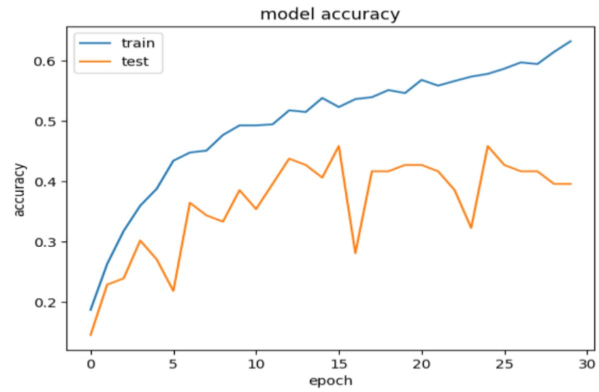


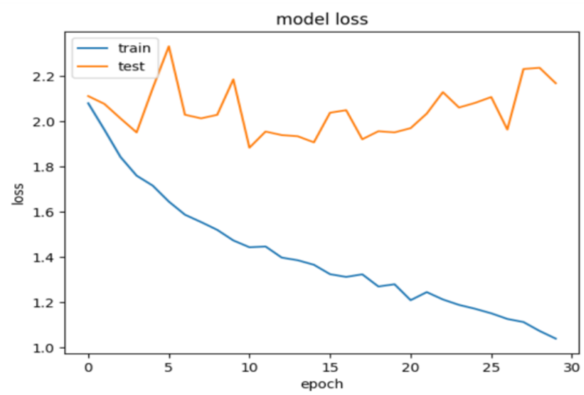
- Using the SVM architecture the model computed the following accuracy and loss for 20 epochs.



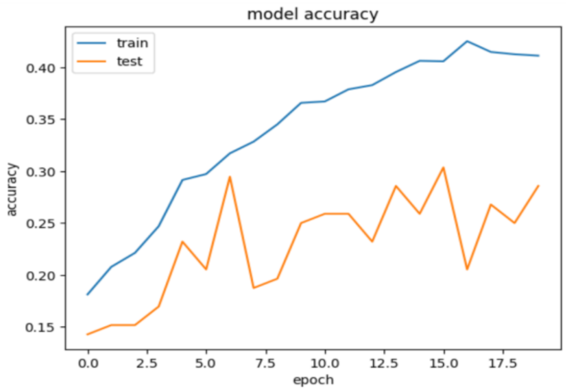


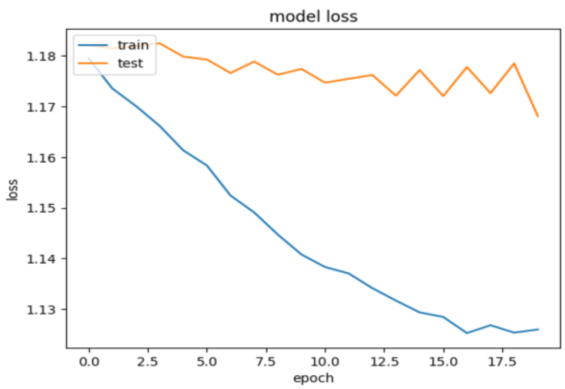
- Using the Inception architecture the model computed the following accuracy and loss for 30 epochs.





- Using the Xception architecture the model computed the following accuracy and loss for 20 epochs





V. DISCUSSION

The presented study contributes to the growing body of research on skin cancer detection using machine learning algorithms. The comparative analysis of various algorithms, including Support Vector Machines (SVM), VGG16, VGG19, Inception, Xception, and Convolutional Neural Networks (CNNs), sheds light on their effectiveness in addressing the critical need for early detection of skin cancer.

Firstly, the results indicate that the CNN model, especially using the VGG16 architecture, outperforms other algorithms in terms of both accuracy and speed. The accuracy achieved by the CNN model (74%) underscores its potential as a powerful tool for skin cancer detection. The superior performance of CNNs can be attributed to their ability to automatically learn hierarchical representations of features from input images, making them well-suited for complex image classification tasks.

The study underscores the importance of extensive datasets in training machine learning models for skin cancer detection. The use of a dataset comprising 30,000 skin images, with 21,000 images for training and 9,000 for testing, reflects the commitment to robust model development. The incorporation of data augmentation techniques further enhances the generalization and reliability of the trained models.

The discussion of related work in the literature survey provides a comprehensive overview of the advancements in skin cancer detection using AI. Noteworthy studies highlight the application of convolutional neural networks (CNNs) and various machine learning techniques for early diagnosis, image segmentation, and feature extraction. The diverse approaches presented in the literature underscore the dynamic nature of this field, with researchers exploring different methodologies and architectures to improve accuracy and efficiency.

Moreover, the future scope section outlines important avenues for further research and development. The suggestion to refine and explore machine learning algorithms, integrate advanced techniques, and expand datasets emphasizes the ongoing evolution of this field. Real-world implementation and integration of these models into clinical settings are crucial steps towards enhancing practical utility and facilitating seamless collaboration between AI technologies and healthcare professionals.

In conclusion, the study contributes valuable insights into the application of machine learning algorithms for skin cancer detection. The superiority of CNN models, as demonstrated through the VGG16 architecture, holds significant promise for improving early diagnosis and patient outcomes. As advancements continue, the collaboration between AI and healthcare is poised to reshape the landscape of skin cancer diagnostics, marking a crucial step towards more accurate and timely interventions.

VI. FUTURE SCOPE

The future scope involves further refinement and exploration of machine learning algorithms, potentially integrating advanced techniques and expanding datasets. Additionally, real-world implementation and integration of these models into clinical settings can enhance their practical utility for accurate and timely diagnoses.

VII. CONCLUSION

In conclusion, the comparative analysis demonstrates the superiority of the neural network algorithm for skin cancer detection. The neural network models demonstrated superior capabilities in analysing skin lesion images and identifying potential cancerous cases. Machine learning, particularly CNNs, holds promise in revolutionizing early diagnosis, aiding doctors in providing timely treatment and preventing disease deterioration. As advancements continue, the collaboration between AI and healthcare is poised to reshape the landscape of skin cancer diagnostics, marking a crucial step towards more accurate and timely interventions.

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